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ASPARAGUS INFORMATION PACKET

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SUBMITTED BY:

Karl Hancock

through

Chemonics International Consulting Division
2000 M Street, Northwest
Suite 200
Washington, D.C. 20036

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2000 M St., N.W. Suite 200 Washington, D.C. 20036 Tel: (202) 466-5340 or 293-1176
Fax: (202) 331-8202 ITT Telex: 440361 CHNC UI

Preface

This literature search was done with the intention of providing pertinent information in regards to establishing an asparagus industry in Central America and Panama. The information contained in this collection or packet hopefully addresses this issue. An asparagus industry consists not only of asparagus production but also of the successful marketing of the product, both fresh and in a processed state. For this reason I sought to find as much published information regarding post harvest handling and packaging of asparagus as possible. As the search progressed it became evident that there is a paucity of published information in regard to post harvest handling, marketing, and also in publications that address the processing of asparagus. General information exists but nothing specific. This packet reflects the current state of published information on asparagus.

I have included considerable information concerning production, which covers establishing the plantation, weed and pest control and cultural practices. Much of this information is current and applicable while some will be outdated or in otherwise of little use. The reason that some of this information may not be applicable is that all these manuals and pamphlets were written for production of asparagus in a temperate climate. In most areas of Central America many of the cultural practices will need to be modified because of the year round growing conditions.

Some of the manuals or pamphlets may contain conflicting information or may address a certain set of circumstances that will not be duplicated in Central America. The potential producer and exporter of asparagus should be cautious in his interpretation of this information as it applies to his particular needs but should also be assured that every effort has been made to include correct and applicable information. This information combined with the sound judgement and experience of the producer/exporter and of the members of the PROEXAG team will produce the best results possible.

Abstracts of Articles and Documents Contained in the Actual Packet

Articles Dealing with Production and General Information
P-Series Articles

Article Number	Title and Description
P1	Physiology of asparagus (Asparagus officinalis) as related to the production of the crop. A.R. Robb, New Zealand Journal of Experimental Agriculture, 1984, Vol. 12: 251-260. A good general overview of the asparagus plant and the relationship between physiology, management practices and growth of the plant. Emphasis on areas such as bud break and carbohydrate movement can help the producer understand the importance of climate and cultivation in determining how to manage his plantation.
P2	Desarrollando una Industria Naciente de Esparragos. Samuel R. Daines, unpublished article, 1987. Describes the potential for an asparagus industry in Central America. Covers the area of Marketing, both potential markets and existing competition, and also describes some of the costs and benefits of this industry.
P3	Establecimiento de la Esparraguera Orientada a la Produccion de Esparrago Verde. Wilson Jimenez, unpublished article written for Fundacion Chile, 1985. This article is a brief but good description of how to establish the asparagus plantation. Covers preparation of the soil, fertilization, pest control, and care and planting of the crowns.
P4	Establishing the Commercial Asparagus Plantation. Frank H. Takatori, Frank D. Souther, William L. Sims, and Brian Benson, University of California, leaflet 21165, July 1980. This pamphlet is a good overview of the entire asparagus planting process, written as a guide to help Californian producers. It covers field selection and land preparation, and describes the

three common methods of planting asparagus: Transplanting Seedlings, Direct Seeding, and Crown planting. The advantages and disadvantages of each method are listed.

P5 Establishing the Commercial Asparagus Plantation, a Spanish Translation. Frank H. Takatori, Frank D. Souther, William L. Sims, and Brian Benson. University of California, leaflet 21165, July 1980.

This is a spanish translation of article P4 that was provided by SRD Research.

P6 Direct-Seeded versus Crown-Planted Asparagus, W.J. Clore and R.E. Early, Washington State University, Bulletin 838, October 1976.

A description of two methods of planting asparagus, direct seeding and crown planting. Covers methodology used and gives results in both marketable yields and spear sizes. Includes data on a 6 year comparison between type of planting and plant density.

P7 Commercial Growing of Asparagus, Farmers Bulletin No. 2232, U.S. Department of Agriculture, 1972.

An older but still useful description of the commercial asparagus plantation. Topics covered include climatic and soil requirements, preparing and fertilizing the soil, crown planting, cultivation and marketing. Some of the information in this pamphlet is outdated, particularly that on varieties, but much is still useful.

P8 Washington Asparagus Production Guide, Cooperative Extension, College of Agriculture, Washington State University, January, 1982.

A good, concise description of how to establish asparagus production in Washington State. Includes information on both crown planted and transplanted seedling methods. Good cultural practices are described as well as recommendations for weed and pest control.

P9 Asparagus Production in California, Frank H. Takatori, Frank D. Souther, James Stillman and Brian Benson. Division of Agricultural Sciences, University of California, February 1977.

This bulletin describes asparagus growing, methods of establishing new plantations, the effects of plant density on yield, and recommended cultural practices for maintaining a productive planting. Also includes information on weed and pest control and the influence of time and duration of harvest on yield and plantation life.

P10 Establishment and Production Costs for Asparagus in South Central Washington, 1983. Cooperative Extension, College of Agriculture, Washington State University, November 1983. Bulletin 1228.

This publication describes the projected 1983 costs and returns for establishing and producing asparagus in Washington state using the seedling transplant method and the seeded-lift-drop method. Certain assumptions were made. There will be considerable differences between the cost in the U.S. and in Central America but this article is a good starting place and does indicate all the different costs that need to be considered when analyzing the costs and returns from asparagus production.

P11 Commercial Asparagus Production, J.A. Schoenemann, L.G. Bundy, et al., University of Wisconsin-Extension, 1987. No. A1622.

A good guide to cultivars, site selection and planting. Also includes information on weed control and indicates what herbicides can be used and their effect on different weeds.

Articles Dealing with Harvest and Market Grades
H-Series Articles

Article Number	Title and Description
H1	Some Thoughts on the Length of Asparagus Cutting Season, Darrel Bienz, Unpublished paper, Washington State University. A short article which describes some of the factors to be considered in determining how long to harvest asparagus. Too short of season means a loss of revenue, too long of a harvest can damage the stand and reduce yields in subsequent years.
H2	Twice-a-Year Harvesting of Asparagus, Campbell Institute for Agricultural Research, Villagran, Guanajuato, Mexico. HortScience, Vol 5, (6), December 1970. Asparagus plantings in the Bajio area of Mexico were managed to provide 2 harvest periods. Cumulative yields for a 5-year period were substantially higher than those from a conventional spring harvest schedule.
H3	Effect of Harvest Duration on Yield and on Depletion of Storage Carbohydrates in Asparagus Roots, D.R. Shelton and M.L. Lacy, J. Amer. Soc. Hort. Sci. 105(3):332-335. 1980. Harvesting a young planting of asparagus for 4 or 6 weeks the second year after transplanting 1-year-old crowns, followed by harvesting for 8 to 10 weeks the third year, reduced yields significantly the fourth year. Describes the effect of harvest on carbohydrate storage and the storage obtained by fern growth.
H4	Synopsis of Agricultural Code Provisions for Packing Asparagus, Issued by E.B. Eby, San Joaquin County, State of California, Agricultural Commissioner. This describes the codes followed by Californian asparagus growers and packers in relation to grades for size , color, and packaging. These are the grades that are followed by most off season producers and are commonly expected by buyers in

the market.

H5 Rules Relating to Standards for Asparagus, State of Washington, Department of Agriculture.

These pages describe the Washington state grades for size, color and packaging which differ from the Californian grades. These grades can also be used by importers as guidelines for their own packing operations.

H6 Fresh Asparagus Quality as Affected by Field Cut and Holding Conditions, J.W. Nelson, S.R. Drake, G.H. Carter, R.E. Early, College of Agriculture Research Center, Washington State University, 1977. Bulletin 846.

This bulletin describes a study which determined the effect of length of cut on the quality of asparagus. Quality was measured by the moisture content, the amount of fiber, and the level of ascorbic acid in the spear. Determined that spear length does not have a great influence on spear quality but that holding conditions and post-harvest handling are very important.

Articles Dealing with Weed and Pest Control
W-Series Articles

Article Number	Title and Description
W1	Insect and Nematode Control Recommendations for Asparagus, et al., Division of Agricultural Sciences, University of California, December 1979. Leaflet 21140. Gives recommendations for chemicals to control insects in asparagus and other similar crops. Tells when to apply and concentration. EPA limitations are also show.
W2	Recomendaciones para el control de insectos y nematodos en los cultivos de Esparragos, et al. A spanish language version of article W1.
W3	Asparagus Integrated Pest Management, Dennis A. Johnson, et al., Cooperative Extension, College of Agriculture, Washington State University. December 1986. Describes a program that was designed to improve pest, disease and weed control in asparagus plantations by coordinating practices and improving timing of chemical applications. Describes various diseases that affect asparagus and their control. Also lists herbicides and the response of different weeds to these herbicides.
W4-W8	Several short brochures dealing with disease, insect, and weed control in asparagus. These brochures are brief descriptions of a particular problem and/or solution. Good information is available from them although some may not be directly applicable to the situation in Central America. W4: Purple Spot and Stemphylium Leaf Spot of Asparagus. W5: Asparagus Rust. W6: Asparagus Aphid. W7: Fertilizer Guide for Irrigated Asparagus for Central Washington.

W8: Weed Control in Asparagus.
Articles Dealing with Prices and Marketing
M-Series Articles

Article Number	Title and Description
M1	Factors Affecting the Supply and Demand for Asparagus in the United States, S.L. Bbuyemusoke, A.H. Harrington, R.C. Mittelhammer, Agricultural Research Center, Washington State University, 1982. Bulletin XB 0918. An article that describes the various components of demand for both fresh and processed asparagus in the U.S. A model was developed that can help determine the effect of changes in any of these components. Differences in demand and prices are found between different regions of the country. This is an interesting, though somewhat technical study, that can help determine the potential market in the U.S.
M2	Marketing California Asparagus, 1986, Federal State Market News Service, United States Department of Agriculture. April, 1987. This is the most recent volume of an annual report that summarizes the available data on marketing California asparagus. Statistical tabulations are included that cover both the fresh and processed portion of the crop. Includes information on shipping both domestic and imports, arrivals by month in 22 U.S. markets, and FOB shipping point and wholesale market prices.
M3	Marketing Washington Asparagus, 1986, Federal State Market News Service, United States Department of Agriculture, April, 1987. The 1986 volume of an annual report compiled by the Federal and State market news services. Describes the marketing season for Washington Asparagus. Includes information on domestic production, imports and prices. Information on U.S. exports of asparagus are also included.
M4	Michigan 1985 Asparagus Season Data, Federal State Market News Service, USDA, 1986. Information on production and deliveries of

asparagus primarily destined for the processing industry.

M6 New Jersey 1986 Asparagus Season Data, Federal State Market News Service, USDA, 1987.

These pages contain information on the New Jersey asparagus production and Market. Includes daily prices and some production data. Some price trend information is also included.

M7 Prices from Principal Wholesale Markets, Federal State Market News Service, USDA, 1986 and 1987.

Wholesale market prices on a weekly basis, prices are usually given for one day of the week or as an average weekly price. Prices are usually broken out by origin of the asparagus and by size and packaging. The following information is included:

Chicago, 1986
Boston, 1986
New York, 1985
Chicago, 1985
Boston, 1985
Los Angeles, 1985
Dallas, 1985
Pittsburgh, 1985
Philadelphia, 1985

M8 Businessman's Guide to the UK Market: Asparagus-Fresh, Chilled, Agricultural Trade Office, U.S Embassy, London England, 1987.

A brief description of prices, consumption, and sources of fresh asparagus in the United Kingdom.

The File Box

The File Box will contain the originals of all information included in the packet so that these will be available for copying and use by the team members. In addition to these articles, the file box will also contain single copies of articles, pamphlets and books of a more general nature that really do not fit into the published packet. A bibliography of these follows.

Articles Found in the File Box
B-Series Articles

Article Number	Title and Description
B1	A computer Simulation to Maximize Asparagus Yield, Emmett P. Lampert, et al. Journal of American Society for Horticultural Science, 105(1):37-42. 1980.
B2	Rescuing Mt. Kinabalu and its People - With Asparagus, Rolex Awards for Enterprise, 1984. An interesting article regarding Thean Soo Tee and his efforts to create an asparagus industry in Malaysia.
B3	Marketing California Asparagus, 1984, Federal-State Market News Service, 1985. Contains production and price information regarding the 1984 Californian asparagus season.
B4	Marketing Californian Asparagus, 1985, Federal-State Market News Service, USDA, 1986. Contains production and price information regarding the 1985 California asparagus season.
B5	Step-by-Step Planting Asparagus, Rosalie Davis, Horticulture, March 1985.
B6	Proceedings of the Sixth International Asparagus Symposium, 1985. Edited by E.C. Lougheed and H. Tiessen, University of Guelph, Guelph, Ontario, Canada. These proceedings contain a considerable amount of information regarding asparagus. Much of it addresses asparagus breeding and other quite technical issues. Many articles contain useful information. A table of contents follows:

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B-Series Articles

Article Number	Title and Description
B7	Asparagus Survey for the Crop Year 1987, California Asparagus Growers Association. Includes information on production and planting of members of the California Asparagus Growers Association.
B8	Refrigeration and Controlled Atmosphere Storage for Horticultural Crops, Cooperative Extension, Northeast Regional Engineering Service, 1984. This booklet contains design information regarding the construction of cold storage rooms, calculations for required refrigeration, and information on controlled atmosphere storage. This is general information that is applicable to all crops. Proper post harvest handling is crucial to the quality of fresh asparagus and many producers will be designing cold storage rooms.
B9	The Board of Directors of Cooperatives, Leon Garoyan and Paul O. Mohn, Cooperative Extension, University of California, 1985. This document contains information to help directors of cooperatives better understand their responsibilities and therefore improve the functioning of a cooperative. Information on the basic purposes of a cooperatives is also included. This book is included as a reference because an Asparagus cooperative will be very important to all producers of asparagus.
B10	Instructions for Establishment Registration and Process Filing for Acidified and Low-Acid Canned Foods, Food and Drug Administration, U.S. Department of Health and Human Services. This contains information regarding the necessary steps to follow for registering the establishment and process for canned asparagus. These steps must be followed if the product will be imported into the U.S. Also included with this information are the proper forms that need to be completed and submitted to the FDA. States have similar requirements that apply to operations operating

within the state.

B11 There are also labelling restrictions that must be followed and these will be included in the file box but are out of print at this moment.

A General Overview for Establishing an Asparagus Enterprise

Planting

While the actual cultural practices will differ from those used in temperate climates, the basic requirements for establishing a good stand are the same.

Site selection is important. Asparagus is adaptable to a wide range of soil types but requires that the soil profile be deep and that it have good drainage. Asparagus plants are deep rooted and do not like "wet feet" or standing water on or in the soil for extended periods of time. The ambient air and soil temperatures are important. The best advice is to avoid areas where the air temperature will be either too hot or too cool during the harvest season. Too high of an ambient air temperature can cause feathering of the asparagus spears and poor quality because of increased fiber. Too high means 90 degrees fahrenheit or above. On the other side, if the air temperatures drop below 65 or 60 degrees fahrenheit, the spear growth will be very slow. Spear growth rate is influenced by both soil and air temperature. Rain or irrigation can lower the soil temperature and reduce the rate of spear growth. Temperatures during the period of fern growth are not as critical. Temperatures can be very high during the fern period and as long as there is sufficient moisture in the soil the asparagus plant will do well. Low temperatures, as mentioned can affect he growth rate, and temperatures below freezing can kill the fern. This is not a problem as it happens every year in temperate climates but the producer should schedule his harvest so that no fern growth occurs between harvest and this period of freezing or so that the ferns are completely mature before this freezing occurs. This is to be certain that the carbohydrate stores have been fully replenished by the ferns before they die or are cut off.

Soil preparation is very important. As the main portion of the asparagus plant is the crown or roots, and since this will be the portion that remains for the life of the plantation, it is important that the bed for the crown be well prepared. First there should be a soil test that indicates the nutrient level and what treatments are recommended. Any soil with nematodes should be treated or avoided. For fields with a weed problem a preplanting treatment is always a good practice. The next step should be a deep subsoil plowing that will turn the soil over, causing the top layer of soil, with its higher organic content, to become incorporated lower in the soil profile and loosening up the deeper soil. This allows the roots to grow more easily and spread more rapidly, giving a better established planting.

It is important to remember that asparagus crowns, seeds, or seedlings, whatever the method of planting is, are planted below the original soil level. There is a tendency to plant asparagus as other vegetable crops are planted, which is in raised beds. The asparagus crown should be 6 to 8 inches below the original surface level

of the field, in some types of soils, particularly dark, light, sandy soils which have a tendency to heat up easily from the suns rays or dry out easily, the crown should be even deeper. Usually a trench or furrow is dug to the correct depth and frequently fertilizer is placed in the bottom of this trench and covered with soil or a mixture of soil and fertilizer is placed in the trench before the crown or seedling is placed in it. After the crown or seedling is placed in the trench, it is covered with a couple of inches of soil and irrigated. As the plant grows up, successive layers of soil are added until the plant is growing above the soil level and the trench or furrow is completely filled.

Cultivation

As the asparagus plant grows, the fern is producing carbohydrates that are stored in the roots. Moisture is essential to the growth of the plant and an irrigation system should be considered if there are extended dry periods. A weed control program is very important and weed control can be by mechanical or by chemical means. There should be regular applications of fertilizer, the frequency and amount depending upon the soil and upon plant growth. Natural fertilizer is acceptable as well as commercial fertilizers.

Temperate climate growers usually wait 2 years from planting the crown before harvesting any spears. Plantings from seedlings are harvest after one year but usually only for 1 to 2 weeks. For the year-round growing conditions found in the region, it is difficult to say how long the producer should wait before harvesting. The minimum period is probably eight months, but this should be eight months of good fern growth and carbohydrate storage. Certainly no harm would be done by waiting 12 months. Taking spears too soon can seriously stress the crown and the plant may never completely recover from this stress and yields will be lower and plant mortality higher. Another question that doesn't have a clear answer is how long to allow ferns to grow between harvests or before cutting them out. Studies have shown that the fern begins to lose its efficiency in photosynthesis after 3 to 5 months. You can observe a change in the appearance of the fern after a few months. Depending upon the schedule of harvest, the growing season, climate, and other factors, the fern could be cut and removed after 5 months, and allowed to grow again for at least three months before harvesting. A twice per year harvest schedule could consist of a 4 to 4 1/2 month period of fern growth, a 6 to 8 week harvest period, another 4 to 4 1/2 period of fern growth and another 6 to 8 week harvest. To harvest only once per year in a year round growing area, the producer could allow the fern to grow for 5 months, cut it, allow 5 more months of growth, cut again and harvest for 2 months. An option to cutting the fern would be to cut the tips of the fern,this would defeat the apical dominance of the ferns and allow others to grow up. This is what growers using the mother fern technique must do to allow spears to grow under the ferns. As unpruned ferns grow old this apical dominance diminished and new spears will begin to appear. This could be one way of determining when the fern has become inefficient in photosynthesis.

There are few pest that actually damage the asparagus plant. Nematodes are one but should be controlled before planting. Other pests can be controlled through chemical means as indicated in the literature. There are diseases that can cause serious problems in asparagus but they are not common. Some of these diseases can be controlled, others cannot. Prevention of these diseases is the best option. Many diseases can be prevented or the risks lowered by proper cultivation techniques such as keeping weeds out of the field, removing the old fern from the field, and keeping the plants free from insects that can carry diseases to the plantation.

Harvest

The harvest period is quite labor intensive and requires training of the laborers. The spears must be cut at a certain length and must be cut without damaging other spears. Often the harvesters will do some presorting of asparagus into grades in the field. A common practice in Chile is to have a group that cuts only Collosal and Jumbo grades, another group cuts the Extra Large and Large, and a third group will cut the remainder and clean up any bent or damaged spears. The actual number of groups and how they are organized depends on the field as well has how the packing shed expects the spears to come in. The frequency of harvest depends upon the growth rate of the spears. Normally the spears should be harvested every day. During very hot periods it is common to harvest twice a day as this reduces the number spears that are unmarketable because of feathering or fiber caused by the heat. The cut spears should be removed from the field as soon as possible and cooled by water spray or bath to remove the field heat. Harvesting in the early morning will help reduce the field heat in the spears. Asparagus is a very perishable crop and the lowering the respiration rate by lowering the temperature down to 33-35 degrees fahrenheit as soon as possible will make a great difference in the quality of the spear as well as the shelf life.

Post-Harvest

Post harvest handling in the asparagus packing shed consists of washing and cooling the asparagus with a cold water spray or bath, trimming the spears to the correct size, sorting into grades, and packing into appropriate containers. Asparagus for the fresh market should also be put through a hydrocooler to lower the temperature to between 32 and 35 degrees fahrenheit. Asparagus should be maintained at this temperature in a cold room until shipped.

The typical layout of a packing shed consists a conveyor belt on which the asparagus spears are placed with the tips all oriented in the same direction, the spears being perpendicular to the motion of the belt. This conveyor belt takes the spears through a spray of water or through a compartment that contains several sprays of water. This water serves the purpose of washing any dirt and mud from the spears and also cools the spears. This conveyor belt also moves the spears past

one or more rapidly turning radial saws which trim the butts of the spears, making the spears uniform in length. For fresh market the length is nine inches, for the processed market there are different lengths, depending upon the preference of the processor. This same conveyor belt carries the spears past graders or sorters who are individuals that are selecting out certain grades to be packed. Each person will select out the grade that he/she is packing and puts the spears vertically in the asparagus container. The most common container for export is the half case waxed fiberboard container. The half case can hold from 12 to 15 pounds of asparagus, depending on whether and how it is bunched. The PROEXAG team and some of the local country organizations have samples of these containers.

The hydrocooler is a necessity for exporting fresh asparagus. It is basically a piece of equipment through which the asparagus passes, usually already packed in boxes, and very cold water flows over the asparagus, lowering its temperature to the temperature of the water. The water temperature can be maintained by ice or by refrigeration. The hydrocooler can be continuous, which means a conveyor belt carries the asparagus through it, or batch, which means that the hydrocooler is loaded, the asparagus is cooled, and then unloaded. The time the asparagus must spend in the hydrocooler is calculated based on the initial temperature of the asparagus, the target temperature, and water flow, coverage, efficiency, etc. After passing through the hydrocooler the asparagus is kept in a cold room until shipped.

Transportation and Marketing

As asparagus is highly perishable, the normal means of transportation to market for distant producers is air. Californian and Mexican producers ship most of their production by truck or rail. Central American producers will want to start with air shipments as they give the best feeling of security, knowing that your product will get to Miami or New York within 24 hours. Problems lie in the fact that air cargo space is limited by the number of flights and by competition from other cargo. A realistic alternative needs to be developed. There is the possibility that Mexico would allow sealed and bonded shipments from border to border. These shipments should be very reasonably priced. Shipment by sea is also possible with techniques of modified atmospheres. Modified atmospheres reduce the respiration rate, just as low temperatures do. Reducing the respiration rate as much as possible increases the life of the product. Some Californian producers are shipping by sea to Japan, which is a two week journey, and the Japanese are very demanding in quality. Chilean producers have experimented with shipments by sea and the results have been good. Central American producers/exporters will need to find an alternative to air shipment. With the price advantage obtained by sea or land shipments the Central American producers could compete effectively even with U.S. producers.

The market for off season asparagus is usually the catering trade, which means restaurants, hotels, large food service organizations that provide airline meals, etc.

Up-scale supermarkets or green grocers will carry asparagus as it is purchased by the more affluent clientele. The off season prices have discouraged the average consumer from purchasing asparagus. Most of the catering trade is served by produce brokers who are essentially middlemen, taking the product from the producer/exporter and selling it for a commission, usually 10%. Large supermarket chains prefer to buy direct from the producer but are quite demanding because they want consistently good quality from a reliable source. The prices that supermarkets offer are usually lower than those that can be obtained from the catering trade but they take much larger quantities. A good goal for any exporter/producer or preferably a marketing cooperative is to develop a relationship with supermarket chains. If producers can organize themselves into a marketing cooperative it would be of great benefit. Supermarkets are more inclined to buy from such cooperatives. Expenses can be shared, shipments are larger and better freight rates can be obtained.

The producers of asparagus should also have other outlets for their production. There will be some asparagus that cannot be exported because it does not make the grade, or climatic conditions can affect some of the production so that it is not good enough for export. Transportation problems can occur that necessitate selling the asparagus locally. There is a need for a processing industry that can accept the excess production or the lower quality production. Both canned and frozen asparagus spears are sold in the U.S. There are other uses of asparagus such as filler in soups, etc.

The development of an asparagus industry is feasible and should bring many benefits to the countries of Central America and Panama.

ARTICLE P1

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Physiology of asparagus (*Asparagus officinalis*) as related to the production of the crop

A. R. ROBB
Levin Horticultural Research Centre
Ministry of Agriculture and Fisheries
Private Bag, Levin, New Zealand

Abstract The growth and physiology of mature asparagus (*Asparagus officinalis* L.) plants is discussed. The relationships between some physiological processes and management practices are considered, with an emphasis on bud break, carbohydrate movement, and the agronomic differences between male and female plants. Areas where physiological research could assist the development of management practices are outlined.

Keywords asparagus; *Asparagus officinalis*; crop management; bud break; carbohydrates; dioecious; flowering; harvesting; nutrition; oligosaccharides; physiology; plant growth substances

INTRODUCTION

The area in New Zealand planted in asparagus (*Asparagus officinalis* L.) increased rapidly from 426 ha in 1978 (Anon 1978) to an estimated 2765 ha in 1983 (R. Wood pers. comm.) following recognition of an unsatisified world market for both fresh and processed asparagus (Hobson 1982). A worldwide decline in asparagus production in the mid 1970s has been a major contributor to this marketing situation (Hobson 1982). Within New Zealand, in the traditional growing area of Hawke's Bay, the yield and longevity of asparagus have decreased from an average of 3.2 t/ha and 20 years respectively in the late 1960s (Brandon 1968) to 2.3 t/ha and 12 years respectively in 1983 (G. Wood pers. comm.). This has been associated with an increase in the incidence of *Fusarium* crown rot, but there is no evidence that disease is the prime cause of asparagus decline. Changes in management practices, such as the use of flat beds, herbicides, and increases in plant density (Conway 1946; June 1951; Moffitt 1959; Brandon 1968; Anon 1973; Riley 1980) have occurred. The effects of such practices on the growth of plants has rarely been studied. Research into the botany and physiology of *A. officinalis* has seldom been related to management of the asparagus crop. This review will consider some of the relationships between management practices and the physiology of mature plants.

BOTANICAL BACKGROUND

The asparagus plant from which edible shoots are harvested is *Asparagus officinalis* L. subspecies *officinalis* and belongs to the family Liliaceae (Tutin et al. 1980). Cultivated asparagus is diploid (n = 10) (Ammal et al. 1966). Triploid or tetraploid asparagus has not been used for commercial production, presumably because of meiotic irregularities in tetraploid plants (Ammal et al. 1966) and consequent low seed set (Wagner & Ellison 1964).

Asparagus is normally a dioecious plant. The sex of asparagus plants is generally accepted as being inherited as a simple Mendelian factor (e.g., Lazarte & Palser 1979; Löptien 1979; Benson 1982) with female plants being homozygous (XX) and male plants heterozygous (XY) (Rick & Hanna 1943), and with a few andromonoecious plants (XY and YY) occurring (Sneep 1953a, b). However, other research indicates that sex inheritance is more complicated (Peirce & Currence 1962; Marks & Barbour 1973; Marks 1976; Marks & Cornish 1979). Marks has proposed a model in which sex expression is controlled by a bipartite supergene, with female plants being double recessives and male plants double heterozygotes. Hermaphrodite and neuter plants are produced when crossing-over occurs in the male parent (Marks & Barbour 1973; Marks 1976). It has yet to be clearly established whether asparagus has a heteromorphic chromosome pair. Some researchers have reported heteromorphic chromosomes in male plants (Reimann-Philipp 1960; Thuesen 1960; Lazarte & Palser 1979), but others have found no evidence of them (Flory 1932; Yarnell 1954; Löptein 1979).

Asparagus is a herbaceous perennial. The underground portion of the plant is known as the crown; the foliage as the fern. The crown consists of many unbranched fleshy storage roots up to 6 mm thick

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attached to the closely spaced basal internodes of an underground stem (Blasberg 1932). Fibrous feeding roots are attached to the storage roots, and buds are present at the growing tip of the underground stem (Blasberg 1932). As the plant ages, some lateral buds on the stem develop to produce several growing points (Blasberg 1932), and the older, non-functional parts of the stem decay (Tiedjens 1924, 1926). The foliage has a fern-like appearance and consists of many shoots, each of which has developed from a separate bud on the underground stem. Each shoot consists of a central stem which subtends many fine, needle-like branches or cladophylls. The leaves on the cladophylls have been reduced in size to form very small scales (Mullendore 1935).

A. officinalis is a native of Europe (Tutin et al. 1980) and is grown commercially in temperate and tropical climates throughout the world. In temperate climates, the fern senesces in autumn and the plant remains dormant during winter. In spring, buds on the underground stem grow to produce new shoots. The edible portion of the plant is the tender, young, unexpanded shoots or spears. The spears are cut either below or above the ground before the shoot tip has expanded to produce the fern. Spears are usually harvested from mid spring to early summer, after which the fern is allowed to develop and flower. The asparagus plant produces small, insect-pollinated flowers throughout summer. Small, bright red berries containing up to 6 seeds develop on female plants (Robbins & Jones 1925).

SHOOT GROWTH

Bud break

The pattern of bud break is controlled by apical dominance within each bud cluster on the underground stem (Tiedjens 1926; Kretschmer & Hartmann 1979) but it can be influenced by environmental factors, the carbohydrate content of the root, the age of plant, and exogenous plant growth regulators.

The temperature at which bud break occurs has not been determined, but an air temperature of 4.4°C has been used to predict the beginning of growth in spring (Le Compte & Blumenfield 1958; Bouwkamp & McCully 1975). An asparagus crop must be harvested regularly, usually daily, to ensure that the maximum number of marketable spears are produced, although individual plants require harvesting less frequently. Mechanical harvesting cannot be used commercially, as a range of spear lengths is present at any one time (Bouwkamp & McCully 1975; Bussell & Minard 1976). It has been suggested that spear emergence peaks about 75 degree days (base temperature 4.4°C) after a non-selective harvest, and that this could be reinforced by harvesting at 75 or 150 degree day intervals (Bouwkamp & McCully 1975). However, the rate of spear production (per degree day) differed in the 2 seasons in which this study was conducted.

From field observations, it is clear that the temperature threshold for bud break varies with age and cultivar. 1- and 2-year-old plants produce spears earlier in spring than older plants, and some varieties are earlier than others. The French varieties, Diane and Cito, for example, emerge 3 weeks before the American variety Rutgers Beacon (W. Bussell pers. comm.). The buds of young plants, especially plants less than 1-year-old remain active at lower temperatures than the buds of older plants. Young plants often produce new ferns during winter when the weather is mild, and in warm climates the fern does not die back in autumn (Lodewijks 1958; Huang 1979).

The low number of spears produced during some summer and autumn harvests has been attributed to low soil moisture levels (Farish 1937; Brasher 1956; Takatori et al. 1970b; Hartmann 1981). In most environments, the soil moisture content during spring is relatively high and is unlikely to limit spear production. Low soil moisture levels may restrict bud break during fern growth also, as the production of new shoots is stimulated by rain in late summer and early autumn (Scott 1954).

As the harvesting season progresses, apical dominance becomes stronger and the rate of spear production decreases (Tiedjens 1924, 1926). This may result from hormonal effects or the carbohydrate content of the storage roots. The time required for a new spear to develop depends on the maturity at which the previous spear on the rhizome was harvested. As a spear grows beyond marketable size, growth of the adjacent bud is suppressed more strongly (Tiedjens 1926).

Several plant growth substances influence bud break. The concentration of abscisic acid in the crown buds and root tips of asparagus is proportional to the degree of dormancy in winter. However, relatively high levels of abscisic acid are also present during periods of active growth in early spring and late summer. It has been suggested that this is caused by an abundance of assimilates which are converted to abscisic acid and maintain apical dominance when transported to the crown buds (Matsubara 1980). There is evidence that apical dominance can be suspended by giberellic acid when it is applied to spear tips or the underground stem (Tiburcio 1961; Kretschmer & Hartmann 1979). When applied as a crown dip before planting, however, giberellic acid does not affect spear emergence (Mahotiere 1976). Ethephon reduces apical dominance, increasing the number and fresh

weight of both roots and shoots (Mahotiere 1976). The growth regulator chlorflurenol also inhibits apical dominance, but the spears produced are deformed (Dean 1978). The viability of mechanical harvesting would be increased if chemicals could be used to control bud break.

Spear growth

Spear growth is strongly dependent on temperature, and increases linearly between 7 and 31°C (Culpepper & Moon 1939a; Blumenfield et al. 1961). Unlike other plants, the rate of vegetative growth is greater during the day than during the night (Blumenfield et al. 1961). A distinct zone of maximum growth is situated just below the spear tip and is more sensitive to changes in temperature than the rest of the spear (Culpepper & Moon 1939a, b). Consequently, spear emergence is influenced by air temperature more than by soil temperature (Bouwkamp & McCully 1975).

The growth rate of asparagus spears can be increased by applying auxin (Dedolph et al. 1963; Kretschmer & Hartmann 1979). Asparagus is very sensitive to supra-optimal levels of auxin, and application of the hormone can retard growth (Dedolph et al. 1963).

Bud size has a major effect on the diameter of the spear. Larger buds usually produce larger spears (Tiedjens 1926; Blasberg 1932). The decrease in spear diameter which occurs as the season progresses may result from a decrease in carbohydrate reserves (Working 1924; Tiedjens 1926) as large buds will produce small spears if several large spears have previously been removed from the crown (Tiedjens 1926).

The depth at which asparagus crowns are planted has a strong influence on bud break and subsequent spear growth. Increasing the depth of the crown delays spear production and reduces the rate of spear production, however the spears produced have a larger diameter (Takatori et al. 1974); Williams & Kendall 1976). Ridging of plants will change the soil temperature and soil moisture profiles and can increase yield (Bouwkamp & McCully 1975; Williams & Kendall 1976).

Bud formation

The main period of bud formation is during the fern growth following harvest. A few buds are formed during the harvesting season (Tiedjens 1924, 1926). The number of buds which form is genetically controlled, and not dependent on the environment or the amount of carbohydrate available (Tiedjens 1924, 1926; Blasberg 1932). However, the size of the bud is dependent on the amount of fern growth and hence the amount of carbohydrate available (Tiedjens 1926).

ROOT GROWTH

As all root and shoot growth originates from the underground stem, it is essential to maintain a favourable environment around this part of the plant. The depth of soil suitable for root development has a strong influence on the economic life of the crop. A study by Reijmerink (1973) showed that 50 cm of suitable soil permitted good production for 5 years, and over 100 cm permitted good production for at least 10 years. Soil with good micro-aggregation allows the best root development although acceptable root development occurs in uncompacted, coarse sandy soil (Reijmerink 1973). The number of feeding roots in the topsoil decreases as the plants age. In response to this, yields decline when the number of roots able to penetrate the subsoil do not compensate for the reduced number of roots in the topsoil (Reijmerink 1973). Possible causes of this decrease in root numbers are nutrient depletion in the topsoil, changes in the structure of the topsoil, or the presence of a root toxin (Reijmerink 1973). Recent research indicates that asparagus roots are allelopathic, as an extract from dead crowns retards the root growth of seedling asparagus (Yang 1982). Poor soil structure may increase the accumulation of a toxic substance by increasing root decay and by reducing leaching. Thus, asparagus prefers a deep soil with a good structure which will remain stable for the expected economic life of the crop.

The response of root growth to temperature differs from the response of shoot growth. Lowering the temperature from 25 to 15°C in laboratory studies increased the growth of feeding roots and decreased the rate of spear growth and the number of new buds formed (Tiedjens 1926). However, the effect of temperature on storage roots is not known.

WATER REQUIREMENTS

The amount of water used by an asparagus crop varies seasonally in proportion to the amount of fern present (Thicoipe et al. 1977). Irrigation increases yield by increasing the number of spears (Takatori et al. 1970a) or by increasing spear size (Hanna & Doneen 1958; Hartmann 1981). This increase in yield is probably caused by an increase in the carbohydrate reserve of the plant as irrigation increases fern growth (Takatori et al. 1970a; Hartmann 1982) and thus photosynthetic capacity.

Table 1 Nutrient [illegible] of harvested [illegible]

Concentration of dry weight: N	P	K	Soil pH	Source
3.4	[illegible]	1.8	7.0–7.2	Hartmann & Wuchner (1979)
[illegible]	[illegible]	3.4	5.3–6.4	Minard (unpublished data)
4.2	[illegible]	3.5	–	Carolus (1961)
5.8	[illegible]	3.2	–	Carolus (1962)

However, irrigation during harvest can decrease yield by decreasing the number of spears produced, probably by decreasing soil temperatures (Takatori et al. 1970a).

NUTRITION

During autumn senescence, most of the nitrogen (N), phosphorus (P), and potassium (K) in the fern is removed from the fern by translocation and leaching (Morse 1916; Carolus 1962). Some trace elements, e.g., magnesium (Mg), manganese (Mn), and calcium (Ca) are also removed from the fern (Carolus 1962). Most of the nutrients required to support harvesting in spring are available from root reserves, although some absorption of N, Ca, and sulphur (S) can occur (Morse 1916). Consequently, the application of fertiliser after harvest has a greater beneficial effect on yield than application before harvest (Hartmann & Wuchner 1979) although the application of N in spring may promote root growth (Morse 1916). A shortage of N decreases fern growth (Morse 1916), thus decreasing photosynthetic capacity and crown size. A smaller crown produces fewer spears, so yield is reduced (Cannell & Takatori 1970).

The actual fertiliser requirements of asparagus have not been clearly defined. Only 2 long term studies on asparagus nutrition have been completed. From a survey of 40 properties on which no correlation between fertiliser application and yield or plant composition was found, it was concluded that the effects of poor soil structure cannot be overcome by applying fertiliser (Carolus 1961). However, nutrient composition of harvested crops is similar, although the highest yielding crop had the lowest nutrient content (Table 1). Asparagus appears to have a low requirement for P — the application of P to soils containing 0.23% P_2O_5 (Morse 1916) or 14 units Olsen P (Bussell & Prasad pers. comm.) had no effect on yield. Recent research indicates that a soil level of 8 units K is adequate, and that some substitution of K by sodium (Na) can occur, but there is no synergistic effect (Bussell & Prasad pers. comm.).

The high tolerance of asparagus to salts has been attributed to an ability to control the absorption of Na, thus preventing an imbalance in the ratio of the nutrients absorbed (Shimose 1973).

CARBOHYDRATE PRODUCTION

The cladophylls of asparagus have a structure similar to cylindrical leaves and are the main site of assimilation (Sawada et al. 1962) although photosynthesis occurs in all green tissue (Sawada et al. 1962; Downton & Törökfalvy 1975). Asparagus has a C_3 photosynthetic pathway with a relatively high level of oxygen-insensitive respiration, especially in the stems (Downton & Törökfalvy 1975). Carbohydrate assimilation is very dependent on the amount of solar energy available, and the optimum temperature for photosynthesis is about 18°C (Sawada et al. 1962). Differences between varieties in yield and in optimum harvesting length may result from differences in their photosynthetic efficiency and/or distribution of assimilates (Benson & Takatori 1980; Benson 1982; Dirks et al. 1982).

Storage carbohydrates in the roots of *A. officinalis* have recently been confirmed as fructo-oligosaccharides (Shelton & Lacey 1980; Shiomi et al. 1976, 1979a; Shiomi 1981) containing a maximum of 21 hexose sugars (Shelton & Lacy 1980). The 11 oligosaccharides so far characterised consist of isokestose, neo-kestose, and some of their derivatives (Shiomi et al. 1976, 1979a, Shiomi 1981a). Three frutosyl transferase enzymes have also been extracted from the roots of asparagus and characterised (Shiomi et al. 1979b; Shiomi & Izawa 1980; Shiomi 1981b, 1982). Other oligosaccharides have been extracted from the seed of asparagus (Jakimow-Barras 1973). Fructo-oligosaccharides occur as storage carbohydrates in several genera of the Liliaceae family (Meier & Reid 1982).

CARBOHYDRATE MOVEMENT

Seasonal changes

Spring harvest

The general pattern of seasonal changes in the concentration of carbohydrates in the roots is well documented (Scott et al. 1939; Taga et al. 1980; Shelton & Lacy 1980). However, most of the information available is expressed as a percentage of total sugars or reducing and non-reducing sugars. Interpretation of results is further restricted by a lack of information on seasonal changes in the root mass.

In spring-harvested asparagus, the carbohydrate concentration decreases as the reserves are used to support spear growth (Scott et al. 1939; Taga et al. 1980; Shelton & Lacy 1980). During harvest, new roots and new buds are also produced (Tiedjens 1926). Thus the carbohydrates mobilised from the roots are partitioned between spear growth and the development of new roots and new buds. Of the dry matter lost from storage roots, ⅓ is lost in the spears, the remaining ⅔ is used in respiration, and in the growth of new roots and buds (Scott et al. 1939).

The carbohydrate concentration in the roots decreases for 2–4 weeks following the end of harvest (Scott et al. 1939; Shelton & Lacy 1980) as no net storage of carbohydrates occurs until the fern has expanded (Scott et al. 1939; Downton & Torokfalvy 1975; Lin and Hung 1978). The carbohydrate concentration is restored to pre-harvest levels within 3 months of harvest, and then generally remains constant or decreases slightly before fern die back occurs in autumn (Scott et al. 1939; Shelton & Lacy 1980). Small fluctuations in root carbohydrate concentration during this summer period have been attributed to the production of new shoots (Scott 1954). This apparent lack of further carbohydrate storage may result from limitation of photosynthesis by environmental conditions or by the age of the fern (Lin & Hung 1978; Huang 1979). Alternatively, the concentration of carbohydrate may remain constant while the carbohydrate produced is being stored in newly formed roots. Carbohydrate concentration in the roots increases slightly during autumn as the fern senesces, and decreases slightly while the plant is dormant during winter (Scott et al. 1939).

Little information is available on seasonal changes in the total quantity of root material. Storage roots develop from a bud in the same season as the bud produces a spear, but the age or conditions under which roots cease to function as a storage site for carbohydrates is unknown. Preliminary results from studies on irrigated plants indicate that roots formed the previous season may provide the major source of carbohydrate for spring growth (Bussell unpublished data). The life span of storage roots is not clear — a maximum of 3 years (Tiedjens 1924), and at least 6 years (Scott et al. 1939) have both been reported.

The length of the harvesting season varies with the age of the plants and the climate in which they are growing. Harvesting of most New Zealand asparagus begins in late September, and growers have determined from experience that they must cease harvesting after 9–10 weeks to allow sufficient vegetative growth to replenish the carbohydrate reserves (Findlay & Ryan 1974). An increase in the length of the harvest may lower the minimum carbohydrate concentration in the crown (Scott et al. 1939; Taga et al. 1980), decrease total root weight (Shelton & Lacy 1980; Taga et al. 1980), and delay post-harvest carbohydrate accumulation (Scott et al. 1939). The time available to restore carbohydrate concentration to the pre-harvest level is reduced, and the quantity of carbohydrate required is increased. The harvesting of a young bed should be restricted to allow the plants to establish and develop large crowns. Thus the balance between length of harvest and recovery time will vary depending on the size of the plant, the length of the growing season, and the presence of factors which limit growth, e.g., disease, drought, and competition. If insufficient recovery time is allowed, plant survival is reduced (Takatori et al. 1970b), spring spear production is delayed (Williams & Garthwaite 1973), and the number, weight, and quality of the spears harvested is reduced (Takatori et al. 1970b; Williams & Garthwaite 1973; Taga et al. 1980).

Other harvest times

The traditional season for harvesting asparagus is spring, although harvesting in autumn or summer is feasible. Autumn harvesting has been investigated in several areas of the world from 46°N (Jasmin & Laliberte 1962) to 25°N (Garza 1970). The spears are not cut in spring, allowing the fern to develop and produce carbohydrates during spring and summer. The fern is cut down in early autumn and the new spears which are produced are harvested. As post-harvest fern production utilises carbohydrates, it is important that the harvest does not end before the plant becomes dormant or new fern growth will cause unnecessary depletion of carbohydrate reserves (Takatori et al. 1970b). The concentration of carbohydrate in the crown of autumn-harvested plants in winter is much lower than that of spring-harvested plants, and this may contribute to the low yield and poor growth of some autumn-harvested plants (Scott et al. 1939; Jasmin & Laliberte 1962). The minimum content of stored

carbohydrate (measured as non-reducing sugars) required for adequate growth is considered to be 2.5–5% of fresh weight (Scott et al. 1939). With careful management, autumn-harvested crops will give yields comparable to spring-harvested crops (Farish 1937; Brasher 1956; Takatori et al. 1970b).

The feasibility of harvesting asparagus during summer has also been investigated. Plants harvested for 8 weeks during summer in Delaware (41°N) were too weak to produce marketable spears in the fourth season, as the 2 months of fern growth following harvest was not sufficient to restore carbohydrate levels (Brasher 1956). However, in the warmer climate of southern California (34°N) plant survival was not affected by summer harvesting although spear quality was reduced (Takatori et al. 1970b).

A shortened cutting period will prevent excessive depletion of carbohydrate reserves by autumn or summer harvesting, and the higher returns for off-season asparagus should compensate for any decrease in yield. An alternative is to split the harvest into 2 very short cutting periods, allowing carbohydrate reserves to increase between the harvests. Yield from split harvests can equal or exceed that of a single spring harvest (Takatori et al. 1970b; Garza 1970).

Tropical production

The Taiwanese have developed a method of growing asparagus which utilises the longer growing season of a tropical climate. The fern does not die off, as winter temperatures remain above 16°C. The harvest is divided into 2 periods: a spring harvest from April to July; and an autumn harvest from August to November (Lin 1979). During harvest, mother ferns (at least 2/plant) are allowed to develop and remain, whereas subsequent spears are harvested, thus maintaining a balance between carbohydrate production and carbohydrate removal. It is recommended that the mother fern be replaced every 3–5 months as the efficiency of carbohydrate production decreases in fern over 3 months old (Lin & Hung 1978; Huang 1979).

FLOWERING AND DIOECIOUS DIFFERENCES

The factors which control the flowering of asparagus have not been clearly identified. Excluding precocious flowers which form on the first shoot of up to 3% of plants (Hung 1975), the first flowers are produced in a lateral position on the 5th–11th shoot of male plants, and the 5th–14th shoot of female plants (Robbins & Jones 1925). In the tropical climate of Taiwan, the plants begin to flower at 5-months-of-age (Hung 1979) but in a temperate climate, 50–90% of the plants may not flower until they are 2 years old (Robbins & Jones 1925; Lodewijks 1958; Wellensiek 1970). The time at which the plants flower is apparently not affected by day length or by vernalisation (Wellensiek 1970). Unspecified cultural practices have been reported as greatly affecting the time of flowering (Hung 1979).

Although asparagus is normally a dioecious plant, flower primordia contain both male and female structures, thus all flowers are potentially hermaphroditic (Lazarte & Palser 1979). Usually, either the stamens or pistil abort, and only a very small proportion of hermaphroditic flowers form on andromonoecious plants (Robbins & Jones 1925; Flory 1932). Asparagus flowers are normally cross-pollinated but hermaphroditic flowers are usually self-pollinated (Rick & Hanna 1943; Peirce & Currence 1962). Homozygous andromonoecious plants, commonly called supermales, can be obtained by self-pollination of hermaphroditic flowers. However, seed set in hermaphrodite plants is reduced by several epistatic modifier genes (Marks & Cornish 1979). Supermale plants are essential in any breeding programme which aims to produce all-male hybrids. The morphology of a supermale is indistinguishable from a normal male, and at present they can be identified only by a test cross (Robbins & Jones 1925; Sneep 1953a; Pierce & Currence 1962). Homozygous supermale plants can be produced from haploids obtained from multiple seedlings (Thévenin 1968; Marks & Barbour 1973) or by tissue culture of anthers (Doré 1979).

Female flowers have been induced to form on both male and supermale plants of asparagus by spraying the spear tip with a mixture of cytokinin and glucose (Lazarte & Garrison 1980). This technique could be used to produce supermale plants for use in a breeding programme, but further research is required as most of the flowers were not viable.

Although there are no obvious differences in the growth or vegetative morphology of male and female plants, male plants in a commercial situation consistently produce a higher marketable yield than female plants and live longer (Tiedjens 1924; Robbins & Jones 1925; Yaeger & Scott 1938; Ellison & Schermerhorn 1958; Ellison et al. 1960; Moon 1976). The male plants produce more spears in a season than the female plants (Tiedjens 1924; Robbins & Jones 1925), although their average spear size is smaller (Tiedjens 1924; Ellison et al. 1960). Male plants tend to produce spears earlier in the spring than female plants (Tiedjens 1924; Robbins & Jones 1925; Ellison & Schermerhorn 1958; Ellison et al. 1960), and the lag between spear removal and the growth of the next bud is less in male plants than in female plants (Tiedjens 1926).

As well as producing a higher yield than female plants, the yield of the male plants begins to decline later than in female plants (Moon 1976). Associated with this is the lower mortality of male plants. A 1 : 1 ratio of males to females exists in seedling asparagus (Robbins & Jones 1925; Yaeger & Scott 1938; Moon 1976) but this can increase to 2.5 : 1 in a 35-year-old planting (Yaeger & Scott 1938). This high mortality of female plants does not result from competition with the more vigorous male plants (Bouwkamp & McCully 1972) although differences in vigour clearly exist. Recent studies have revealed morphological differences in the fern growth of male and female plants which may be related to their productivity (Benson 1982). An earlier study found no differences in the assimilation rate of male and female plants (Sawada et al. 1962).

Biochemical differences also exist between male and female plants. A solution of potassium chlorate induces senescence in cut fern of male plants only (Hagiwara & Kusamitu 1940). Male plants have a higher sugar content in their fern (Moloikovskii & Sokol 1978) and in their roots during winter (Fiala & Jolivet 1979). Fluctuations in the organic acid, amino acid, and carbohydrate content of the roots during a growing season is greater in male than in female plants (Fiala & Jolivet 1979). When the fern is under stress, the male plants have a higher level of invertase before wilting. From this it has been concluded that male plants are more drought-tolerant than female plants (Sivtsev & Sizov 1971).

Whatever the reasons for the superior yield and longevity of the male plants, it should be possible to improve asparagus production by planting only male plants. This can be achieved by planting recently developed, all-male, hybrid cultivars, or by planting only the male plants of a dioecious cultivar. At present, the only practical way to identify male plants is at flowering (Hung 1979), and selecting the male plants before transplanting is practiced only in Taiwan. The use of male plants propagated by tissue culture has been suggested (Davies 1981) and is under investigation (Robb & Seeyle unpublished data.).

An alternative approach to improving yield is to improve the yield of the female plants. The reasons for the lower yield and lower longevity of female plants have not been clearly established (Robbins & Jones 1925; Bouwkamp & McCully 1972; Fiala & Jolivet 1979) but are probably related to berry formation (Robbin & Jones 1925). Thus, it may be possible to improve the yield of female plants by preventing flowering or fruit set, or inducing a fruit drop at an early stage, and consequently increasing root growth and possibly shoot growth.

CONCLUSION

There is need for further physiological research on the factors affecting the growth and activity of storage roots, the level of carbohydrate in storage roots, carbohydrate accumulation, flowering, bud development, and fern growth. Most research on the physiology and the agronomy of asparagus has been conducted separately. Information is available on the effect of climatic and cultural factors on crop yield, but it is often contradictory and the physiological effect of these factors is generally not known. So little is known about the physiology of the crop that a recent computer simulation model of asparagus production required several assumptions, including date of spear emergence, growth rate of photosynthetic tissue, and loss of carbohydrate reserves over winter. The effects of plant age and sex could not be incorporated into the model because of "a lack of consistent information." (Lampert et al. 1980). All these factors are known to have significant effects on crop yield and longevity. An improved understanding of the physiology of the plant would greatly assist the refinement of present management practices and allow the development of new cultural practices to improve crop performance.

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ARTICLE P2

Desarrollando una Industria Naciente de Esparragos

por Samual R. Daines

Estrategia Competitiva: Influencia de las Ventajas de Mano de Obra, Temporadas y CBI hacia los Mercados de masa a $17-$20/caja.

Los esparragos tienen tres características que lo hacen un candidato obvio para una industria principal de exportación Centro Americana. Primero es de mano de obra intensiva en las etapas de cosecha y empacado, y la mecanización no es muy probable que cambie eso en el futuro cercano. Segundo, es un cultivo altamente de temporada en los E.E.U.U. con una ventana de mercado relativamente vacia y relativamente larga. Tercero, es una importación fuertemente castigada con impuestos lo cual le da los países CBI una ventaja substancial sobre los principales competidores (México y Chile). Centro America también tiene una ventaja significativa en lo que respecta costos de transporte sobre Chile en ambos mercados de los Estados Unidos y los mercados lucrativos Europeos de esparragos.

La estrategia básica sería utilizar la tecnología de hidroenfriamiento y empaque-húmedo para permitir un transporte de superficie (ambos camión y barco) para obtener buenos márgenes de ganancia a un precio de mercado de masa de $17 por caja para volúmenes grandes y estables. Los márgenes de ganancia esperados de $4-6/caja sobre volúmenes de blancos de madurez de 500 ytoneladas (80,000 cajas por año) produciría $400,000 por año de ganancias al final del 5o. año. Estos volúmenes deberían obtenerse de más o menos 150 hectareas de producción (a 3-4 tons/ha.) y sería una ganancia anual razonable sobre el capital inicial de 2-3 millones de dolares.

Los mercados blancos principales inicialmente serían el mercado del Corredor Noreste y Londres. La capacidad de estos mercados para una expansión futura a $17-20 por caja durante la temporada desde Agosto hasta Marzo podría ser la base para una industria de $20 millones de dolares anuales con 20 - 30 casas productoras.

El Mercado de Esparrago en los Estados Unidos y Europa

Los Estados Unidos comienza con cantidades pequeñas de producción en Enero en el valle de Coachella en el Sur de California alrededor de El Centro e Indio. Por Febrero los volúmenes son grandes y alcanzan proporciones masivas en el área de Stockton por Abril y Mayo. La producción puede continuar hasta Junio. La producción en el Estado de Washington alrededor de Walla Walla puede comenzar tan temprano como Abril y terminar en Junio. Los Estados Unidos se encuentra sin suministros domésticos desde Julio hasta Enero. Una combinación de productores Italianos, Españoles y Europeos del Norte pone esparragos en el mercado desde Marzo hasta Junio. Estos patrones se resúmen en la Tabla 1.

Tabla 1

Calendario de Producción e Importación de Esparragos

	Ene	Feb	Mar	Abr	May	Jun	Jul	Ago	Sep	Oct	Nov	Dic
California	----------	----------	=	=	=	=	=	=	=	=	=	--------
Washington					----------	----------	=	=	=	=		
New Jersey						=	=	=	=	=	=	
Chile								----------	----------	-------		
México								----------	----------	----------	----------	----------

Producción alta de bajo costo = = = = = =

Producción de alto costo --------

Los Estados Unidos es un mercado de esparragos verdes con alguna demanda gourmet para blanco. El Reino Unido también es un mercado verde, mientras que el Continente Europeo es un mercado para blanco. La producción de esparragos verdes y blancos varía solamente en prácticas de cultivo utilizando las mismas variedades. Los esparragos blancos son producidos al hacer túmulos de tierra alrededor de los brotes para que el crecimiento se lleve a cabo sin luz ni fotosíntesis.

Los precios en los mercados terminales de mayoristas comienzan con más de $50/caja durante la semana de apertura de la estación y se estabiliza alrededor de $20/caja durante los períodos de fuerte cosecha para California y Washington. Durante el pico de los precios de estación Mexicana los precios bajan a una fluctuación alrededor de $18, y durante Septiembre esos precios se mantienen para aún grandes cantidades.

Productores Competitivos Durante la Ventana Europea y de los Estados Unidos

Con costos de producción variantes desde "empujar" los surcos de esparrago, México puede colocar esparragos en los mercados de Estados Unidos durante todos los meses de "ventana". Chile y Argentina pueden colocar esparragos en los mercados de los Estados Unidos y Europa desde Septiembre hasta Diciembre. Sur Africa puede embarcar a los mercados Europeos desde Septiembre hasta Noviembre.

Importaciones de los Estados Unidos provenientes de Mexico

Las importaciones de los E.E.U.U. desde México totalizaron 6,994 toneladas métricas en 1985 concentradas en los meses de Febrero y Marzo que compiten con el Sur de California. La segunda pero más pequeña estación de cosecha Mexicana va desde Agosto hasta Diciembre. Las cantidades importadas pueden verse en la Tabla 2.

Tabla 2

Importaciones de Esparrago de los Estados Unidos en 1985 por mes

(en Toneladas Métricas/Mes)

Importaciones de los Estados Unidos provenientes de Chile

Chile es el exportador segundo más grande hacia los Estados Unidos como está delineado en Tabla 1. Las exportaciones de Chile llegan predominantemente en el período de Noviembre y Diciembre, a pesar de que Chile puede producir tan temprano como Agosto y Septiembre en las áreas del Norte. Antes de 1982 Chile no había exportado cantidades comerciales de esparragos. SRD en sociedad con BHCI fué el exportador más grande de esparragos chilenos en la estación de 1982. El desarrollo rápido de exportaciones de esparragos Chilenos aún con desventajas de transporte substanciales en contra de México y sin beneficios por tarifas califica menos que la factibilidad de potencial de una industria asi para Centro America.

La Posición Competitiva de Centro America

Centro America tiene una ventaja de tarifas, de mano de obra, y de transporte contra todos los productores del Hemisferio Sur en el mercado de los Estados Unidos, y una ventaja de mano de obra y de tarifas contra México. Centro America tiene una ventaja de transporte y de tipo de cambio de mano de obra contra Chile y Argentina en Europa. La desventaja de tarifa contra los embarque aereos desde Sur Africa deberían ser más que compensados por las ventajas de costo por embarques marítimos.

Asuntos de Tecnología de Producción

a. Forzando los Tiempos Inactivos y de Temporadas.

Los esparragos son un cultivo de zona templada que requieren de un período frío para desarrollarse adecuadamente. El obstáculo más grande para la entrada de los productores tropicales en el mercado de esparragos ha sido tradicionalmente la dificultad aparente de producción asociada con producir sin el frio. Este factor es también un asunto principal con referencia para lograr producción cuando se necesita en los períodos más lucrativos en el mercado.

Durante los últimos tres años estos problemas han sido superados y ahora hay tecnología disponible para la producción de esparraos de buena calidad y relativamente altos rendimientos bajo las actuales condiciones presentes en Centro America. Los productores de Guatemala han desarrollado y probado prácticas de producción para un desarrollo rápido y producción aceptable en altitudes que varian desde 500 metros hasta más de 2,000 metros. Tal parece por estas experiencias que la producción en altitudes más bajas es probablemente el mejor debido al rápido crecimiento y flexibilidad de temporada. Estos son desarrollos tecnológicos principales, y van a ser capitalizados pronto. Un esfuerzo coordinado como es un contrato de administración grande puede ser la manera de una entrada rápida hacia estos mercados.

b. Elección de Variedad y Establecimiento de Mostrador

El viejo standard de variedades de esparragos fueron Mary Washington y Martha Washington. En muchas áreas estas siguen siendo sembradas. Ya que una planta de esparrago requiere de 3-4 años bajo condiciones normales para producir cosecha completa, y después dura de 15-30 años, la elección de la variedad es crítica. En los primeros años de los 1980s Frank Takatori y Brian Benson en la U.C. Riverside pusieron en circulación UC 157 y UC 152. Frank estuvo en chile en 1982 asistiendo a SRD con las plantaciones de esparragos utilizando las nuevas variedades ambos con semilla directa y con coronas reproducidas por la Fundación Chile.

Las plantas de esparragos pueden ser producidas en surcos sembrados directamente con semillas, de transplantes de plantillas o de coronas de un año. Coronas

producen lo más pronto desde el transplante, pero toman más tiempo si se le agrega el período de vivero. Las coronas producen dentro de 1 año en las elevaciones más bajas de Guatemala, y podría ser posible obtener una considerable producción comercial antes de los característicos tres años de tiempo de retardo de los E.E.U.U.

c. Opciones de Asistencia Técnica

La Tecnología más penetrante y precisa sobre esparragos esta centrada en la Universidad de California de Riverside en la persona de Frank Takatori, y Brian Benson en Davis. También hay un agente de extensión llamado Bob Mullen en el Valle Central con una experiencia considerable y un "know-how" técnico. Takatori está muy familiarizado con las posibilidades de producción Latinoamericana y sería un asesor muy útil sobre asuntos técnicos.

Asuntos sobre Post-Cosecha, Empaque y Transporte

a. Transporte y Vida en Mostrador

El esparrago es predominantemente embarcado por aire desde puntos distantes de producción como Chile, Nueva Zelandia y Sur Africa. La vida propia del Esparrago es de dos a tres semanas lo cual lo pone al margen de las posibilidades de embarque marítimo. Es vital obtener las tres semanas completas de vida del producto (y aún una semana adicional a travéz de procedimientos rigurosos de manejo y empaque) para poder tomar ventaja de los ahorros de los costos de transporte por superficie. Los costos de transporte por superficie podrían colocar a Centro America en una posición excelente para socavar la producción Chilena y para usar efectivamente su costo de mano de obra y la ventaja del CBI en contra de México.

b. Embarque con Hidroenfriamiento y Empaque Húmedo

Si las puntas de esparragos son hidroenfriadas en el transcurso de una hora de su corte en las facilidades cerca de los campos, esto seráa el factor principal extendiendo su vida en el mostrador y permitiendole el flete marítimo. Midiendo y seleccionando después del hidroenfriamiento va a aumentar la proporción de esparragos quebrados en alguna manera y va a aumentar el porcentaje entresacado porque las puntas de esparrago se hacen quebradizas después del hidroenfriamiento. Estas pérdidas son pequeñas sinembargo, cuando se comparan con las ganancias substanciales que se obtienen de una vida más larga de mostrador. El mejor procedimiento es pasar las cajas del campo a travéz de un ciclo inicial de hidroenfriamiento (aunque esto cause una formación significativa de sedimentos en los tanques), entonces graduar, cortar y empacar en cajas piramidales encera-

das. El último paso antes de embarcar es repasar las piramides a travéz de un hidro ciclo final.

Un contenido fuerte de cera en la caja va a permitir un hidroenfriamiento post-empaque y la presencia de un papel absorvente de empaque húmedo insertado al fondo de la caja en contacto directo con lo cortado pero que va a absorver agua durante mucho del lapso del transporte. La variación en temperatura en tránsito va a causar crecimiento substancial y aumento de fibra utilizando esta humedad asi que se necesita tener un cuidado especial para monitorear y regular la temperatura durante el transporte. Ryans debe ser enviado con un gran porcentaje de cargas por los primeros dos años para establecer un poco de conocimiento y control sobre las variaciones de las temperaturas en tránsito.

ARTICLE 15

ESTABLECIMIENTO DE LA ESPARRAGUERA

ORIENTADA A LA PRODUCCION DE ESPARRAGO VERDE

PREPARACION DE SUELO El suelo que ha sido elegido para establecer la esparraguera deberá ser preparado cuidadosamente. Las labores se inician con la eliminación de los rastrojos del cultivo anterior. La aradura debe ser lo más profunda posible (30 cm.) y seguida de 2 rastrajes, a fin de dejar el suelo bien mullido.

A continuación se procede a marcar el lugar donde se confeccionarán las zanjas, para ello se recomienda el uso de surcadores (melgadores) dispuestos en una barra portaherramientas distanciados a 1,5 m entre ellos.

El uso de un arado subsolador pasado por los surcos dejados en la labor de trazado, ayudará a la hechura de zanjas y dará una mejor condición al establecimiento de las champas.

Las zanjas se preparan mediante un arado aceguiador de vertederas largas (1 a 2 pasadas según el tipo de suelo) y se terminan de arreglar a pala.

Las zanjas deben tener una profundidad de 25 cm. con respecto al nivel original del suelo y un ancho de 20 cm. en la base.

Si se dispone de un cultivador de tracción animal, se puede pasar por el interior de la zanja, para mullir el suelo y dejar plana la parte inferior

FERTILIZACION DE PRE PLANTACION

Una vez abierta la zanja deberá aplicarse al fondo de ella, la siguiente fertilización por hectárea:

- 25 unidades de nitrógeno (2 sacos de 80 kg de salitre sódico)
- 75 unidades de fósforo (2 sacos de 80 kg de superfosfato triple)

Si en otros cultivos se ha visto respuesta a la aplicación de fertilizantes potásicos, o bien si se cuenta con análisis de suelo que indiquen un valor menor a 50 ppm de potasio, se deberá agregar a lo indicado: 80 unidades de potasio (2 sacos de 80 kg de sulfato de potasio).

Los fertilizantes utilizados se deben incorporar en el interior de la zanja, junto al insecticida de suelo, mediante un cultivador de tracción animal o con un rastrillo.

CONTROL DE LARVAS E INSECTOS DEL SUELO

Para proteger las plantas se aplicará en el interior de las zanjas Basudin 10G en dosis de 20 kg de producto comercial por hectárea, el que será incorporado junto con los fertilizantes.

CUIDADO DE LAS CHAMPAS

Cuando reciba las champas, deben ser plantadas lo antes posible. En caso de tener que esperar un tiempo, ubíquelas en un lugar fresco y sombreado cubiertas con aspillera o sacos mojados para evitar que se deshidraten. En estas condiciones no debieran mantenerse las champas por más de 5 días. Si por razones de fuerza mayor se retrasa aún más la plantación, es conveniente colocarlas en barbecho con suelo húmedo.

DESINFECCION DE LAS CHAMPAS

Si las champas no vienen desinfectadas desde el vivero se deben tratar con una solución de 1200 ppm de Benomyl (240 gr de benlate 50% por cada 100 litros de agua) para prevenir ataques de hongos del suelo.

Para esta operación se necesitan 2 recipientes, uno de ellos contendrá sólo agua y se utilizará para retirar la tierra que pueda estar adherida a las champas y el otro tendrá la solución fungicida.

Las champas deben sumergirse primero en agua y luego en la solución de Benlate por un minuto. Posteriormente las champas se mantienen a la sombra para que escurra el excedente de solución y se procede a plantarlas.

PLANTACION

Las champas se ubicarán en el interior de las zanjas separadas a 30 cm para lograr una población aproximada de 20.000 plantas por hectárea.

La disposición de las champas será con su parte superior hacia arriba y con las raíces distribuidas radialmente. Debe cuidarse que las raíces no queden con sus ápices doblados hacia arriba.

Posteriormente se tapan las champas con 10 cm de tierra prefiriendo aquella tierra que provenga de la estrata más superficial.

Será muy importante apisonar la tierra que cubre las champas, para evitar bolsones de aire en contacto con las raíces. Esta labor puede ser reemplazada con un riego cuidadoso por el interior de las zanjas.

TRAZADO DE ACEQUIAS Y DESAGUES

Una vez terminada la plantación se procede a confeccionar las acequias necesarias para regar por las zanjas, y al término de ellas se construirá un desague a mayor profundidad que las zanjas que permita la salida expedita del excedente de agua de riego, evitando apozamientos.

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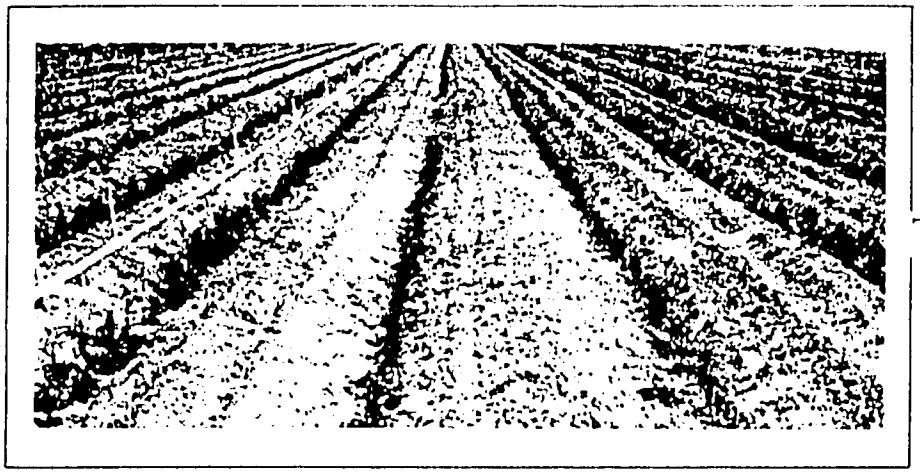
ARTICLE 4



Transplanting

ESTABLISHING THE COMMERCIAL

Direct-Seeding

ASPARAGUS PLANTATION

Crown Planting

Division of Agricultural Sciences
UNIVERSITY OF CALIFORNIA

LEAFLET 21165

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The authors are: Frank H. Takatori, Specialist, Department of Botany and Plant Sciences, Riverside; Frank D. Souther, Staff Research Associate, Department of Botany and Plant Sciences, Riverside; William L. Sims, Extension Vegetable Specialist, Department of Vegetable Crops, Davis; Brian Benson, Staff Research Associate, Department of Vegetable Crops, Davis.

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INTRODUCTION

Asparagus has been one of California's major crops for more than 80 years. Production today is solely of green asparagus—white (blanched) asparagus is no longer grown in California.

The traditional planting method, still the most widely used, is planting of crowns (1-year-old plants) produced in a field nursery. Recently, however, some growers have been using seedling transplants, 10- to 12-week old juvenile plants usually grown in a greenhouse. These plants develop to the spear-producing, crown stage after placement in the field. For several years, direct seeding was advocated and still is used where extremely high plant populations are desired. In this method, the seed is planted in place in the production field.

All three methods can use raised beds or flat planting. In most cases, the plants or seed are planted into furrows that, over many months, are gradually filled in with soil as the plants grow and develop. In this manner, the resulting plant systems are situated deep (6 to 9 inches) in the soil by the time commercial spear production begins. An exception to this practice is in shallow, direct-seeded plantings on raised beds in desert areas.

Certain soils favor asparagus production, and since this perennial crop will tie up the land for 10 to 15 years careful consideration must be given to field selection. However, regardless of planting method all preliminary land preparation is basically the same, consisting usually of land-leveling where necessary, subsoiling, plowing, and disking.

Each planting method has its own particular advantages and disadvantages but it appears that the seedling transplant method may become predominant, especially with the advent of higher-priced and scarce hybrid seed. Transplanting allows quick, uniform development of the commercial plantation and somewhat earlier production.

This leaflet outlines each of the three planting methods.

FIELD SELECTION AND LAND PREPARATION

Asparagus is a perennial and the land it is grown on will be tied up for 10 to 15 years, so careful consideration must be given to selection of the plantation site.

Asparagus is fairly adaptable to a wide range of soil types. It is grown commercially in the peat (muck) soils of the Delta, in some heavier clay soils along the coast and in the Imperial Valley, and in the very sandy soils in the Coachella Valley. Light, sandy soils are best for earlier production in spring.

The soil pH should be between 6.5 and 7.5, or near neutral, for maximum production. Acidic soils below 6.5 suppress plant growth and reduce yield. Compared to other vegetables, asparagus is fairly tolerant to salts.

Asparagus is a deep-rooted crop and soils with a deep profile and good drainage are preferred. The field should have uniform soil conditions—land streaks and varying soil texture will make irrigation and retention of uniform soil moisture difficult. Soils with a shallow profile, hardpan or high water table should be avoided.

Irrigation is required in all California asparagus production areas. Where water is applied by furrow irrigation, the fields must be fairly level to insure good vertical and lateral movement. Where sprinkler irrigation is used, the slope of the land is not as critical. However, a field should be free of low spots where water may stand.

Try to select a field free of perennial weeds such as morning glory, bermudagrass, nutsedge, etc., as these are difficult to control after the field is established, and they tend to spread rapidly.

Once the field is selected, do any necessary land leveling or subsoiling, then plow deeply to be ready for furrow construction or bed shaping at planting time. The incorporation of large amounts of animal or green manures or both in the final seed bed is suggested in much of the older literature, and even today there are advantages to this practice if manures are readily available. However, this is neither necessary nor practical on the large acreages grown in California.

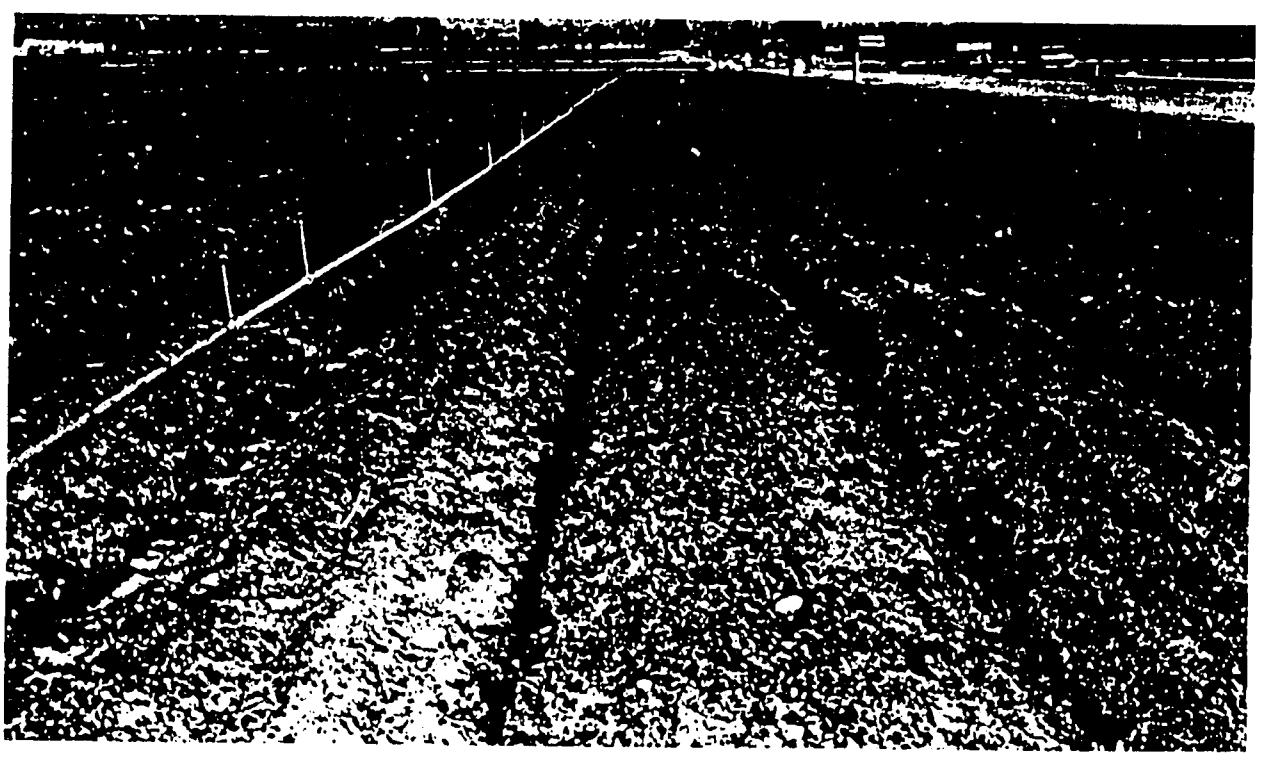
TRANSPLANTING SEEDLINGS

Transplanting seedlings into the field is the most recent method recommended for establishing an asparagus plantation in California. This method is rapidly gaining in popularity and is being widely used by asparagus growers throughout the state.

The seedlings usually are produced in greenhouses and, when about 10 to 12 weeks old, are transplanted into commercial fields. The young seedlings can be mechanically transplanted, thus reducing planting costs. Studies indicate that a survival rate of between 92 and 98 percent can be expected in the field.

Growing seedling transplants

Any grower having greenhouse facilities can produce seedlings, but the common commercial practice is to have them grown by nurseries specializing in transplants. An ad-



A plantation recently established with transplants.

vantage of greenhouse production is that the grower is ready to transplant in late winter or early spring, any time weather conditions permit. This utilizes the longest possible growing period the first season.

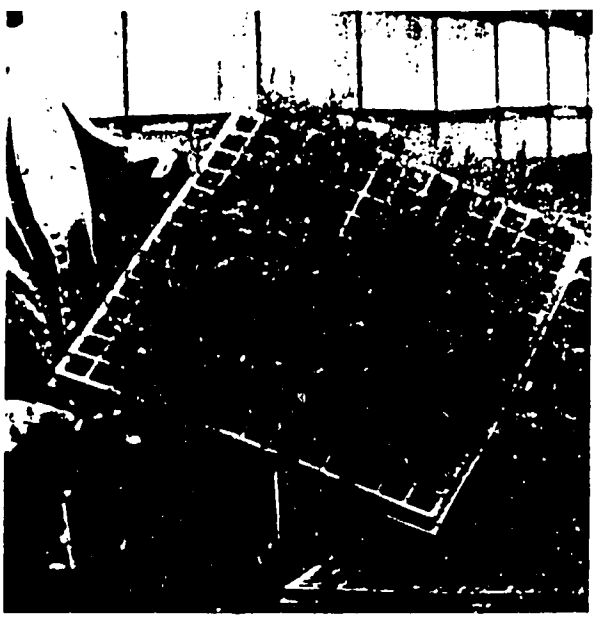
For field plantings in late spring or in the fall, seedling transplants have been grown successfully in lath-houses and outdoors.

Transplants can be grown in peat pots, although for more efficient use of greenhouse space most nurseries use pre-formed trays having a plant density of 1 plant per 1.65 square inches. The soil mix should be porous, (e.g., 1 part peat to 1 part coarse sand) to insure good drainage. Seeds are planted 1/4 to 1/2 inch deep, one seed per space.

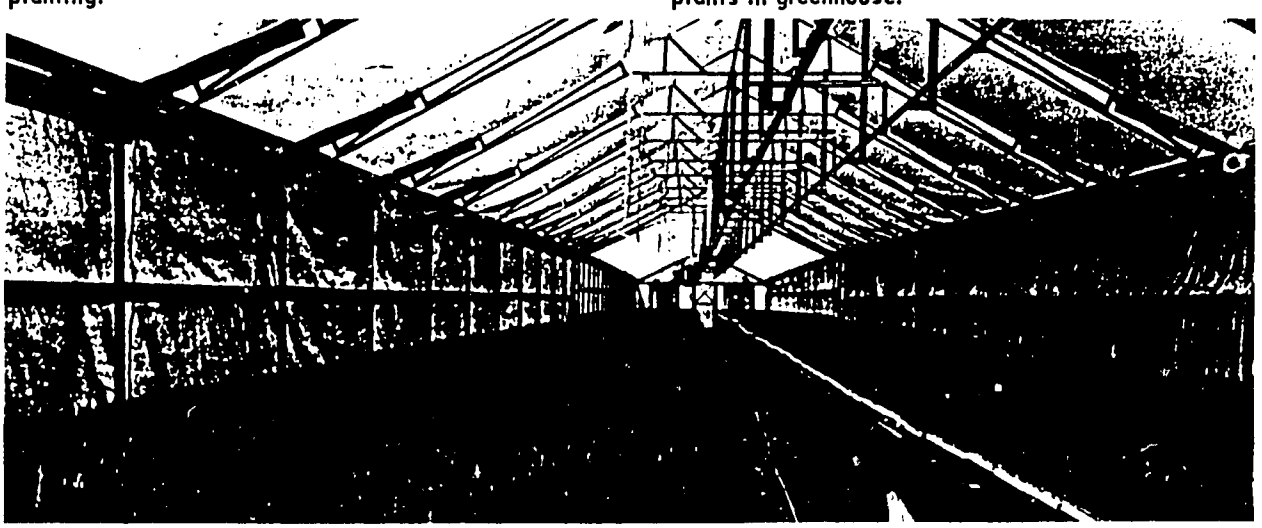
A greenhouse temperature range of 65° F night minimum to 85° F day maximum provides good germination and plant growth.

Irrigation and fertilization needs vary with existing climatic conditions, soil mix, and age of the seedling. The initial nutrient requirements

Proper size of seedling (10 to 12 weeks old) for transplanting.



One type of pre-formed tray used for growing transplants in greenhouse.



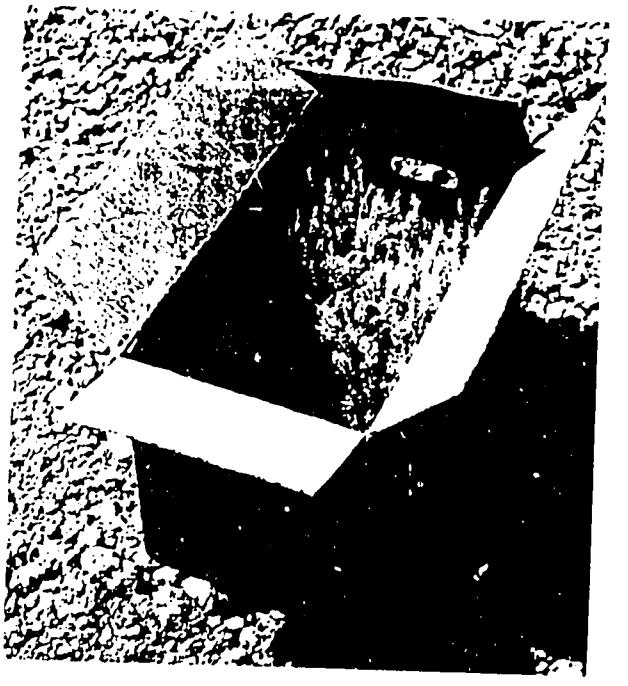
Growing transplants in the greenhouse.

can be met by incorporating a complete fertilizer containing micronutrients into the soil mix. After the seedlings emerge, additional applications of liquid fertilizer should be incorporated into the irrigation water as needed. Because of the porous nature of the mix, the seedlings should be irrigated daily.

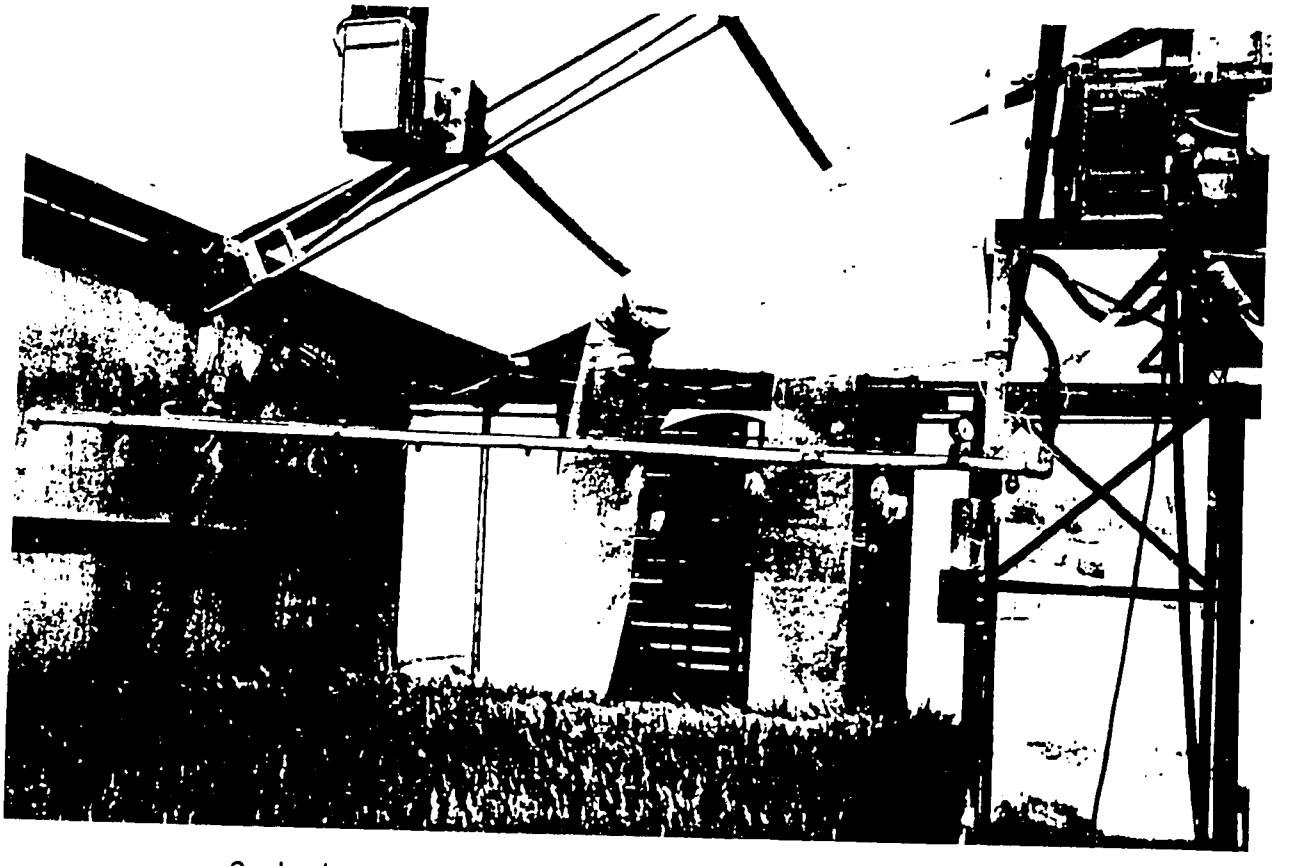
Time of transplanting

The most favorable time for field transplanting in the desert valleys is February through April. In the lower San Joaquin Valley, the best time is March through May. In the Delta, transplanting is best from March through May. Next to the spring months, fall is the next most satisfactory time to transplant, especially in the southern part of the state.

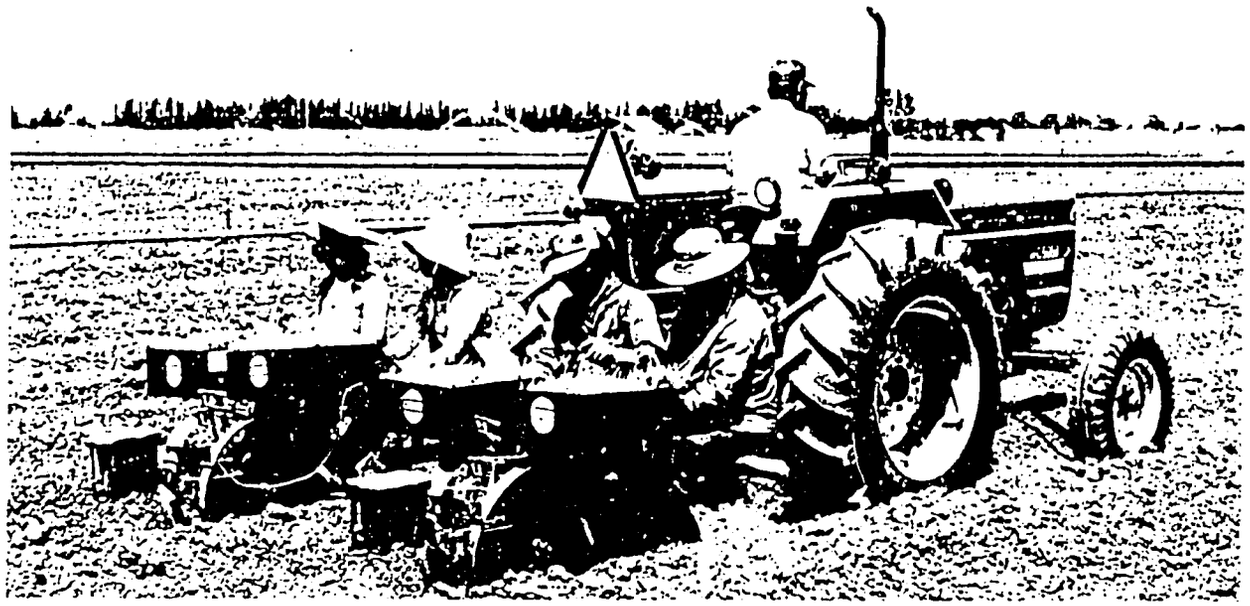
Seedlings are transported to the field either in the trays in which they were grown (the plants are removed from them in the field) or in moisture-resistant boxes into which they have been placed in the greenhouse.



Moisture-resistant box for packing seedlings for transporting to field.



Overhead irrigation and fertilizer application for seedlings in greenhouse.



Transplanting asparagus seedlings.

Seedlings should be transplanted as soon as possible after shipment from the greenhouse, but plants kept moist and cool will remain viable and show little or no physical damage for several days.

Transplanting

Planting furrows are cut into the prepared field 6 to 8 inches deep with a double moldboard plow or lister, or, more preferably, are formed with a bed-shaper. Seedlings are then planted in the furrow bottoms. For best results, the furrow bottoms should have loose soil to allow complete burial of the plants' root systems.

Planting can be done by hand or machine. Many growers have adapted vegetable transplanting equipment capable of handling two and three rows.

Furrows deeper than 8 inches and row spacings wider than described below may be advisable in the Delta area to compensate for subsidence of peat soils.

Spacing

For the production of green asparagus, 5- or 6-foot between-row spacing is common in California. Five-foot spacing is most commonly used in southern California, while the six-foot is preferred by most growers in the Delta.

Spacing of seedlings in-row will vary with the grower.

TABLE 1. NUMBER OF SEEDLINGS OR CROWNS NEEDED TO PLANT 1 ACRE OF ASPARAGUS AT VARIOUS IN-ROW SPACINGS ON 5-FOOT SINGLE-ROW BEDS.

In-row spacing (inches)	4	6	8	10	12	14	16	18
Number of seedlings or crowns per foot	3.0	2.0	1.5	1.2	1.0	0.9	0.8	0.7
Number of seedlings or crowns per acre	26,135	17,424	13,068	10,454	8,712	7,405	6,534	5,808

The most common spacing used is 12 inches between plants. Some growers prefer closer spacings. Others plant at 18 inches. But as bed age increases, all spacings tend to equalize themselves in yield to about that of the 12-inch spacings.

Irrigation

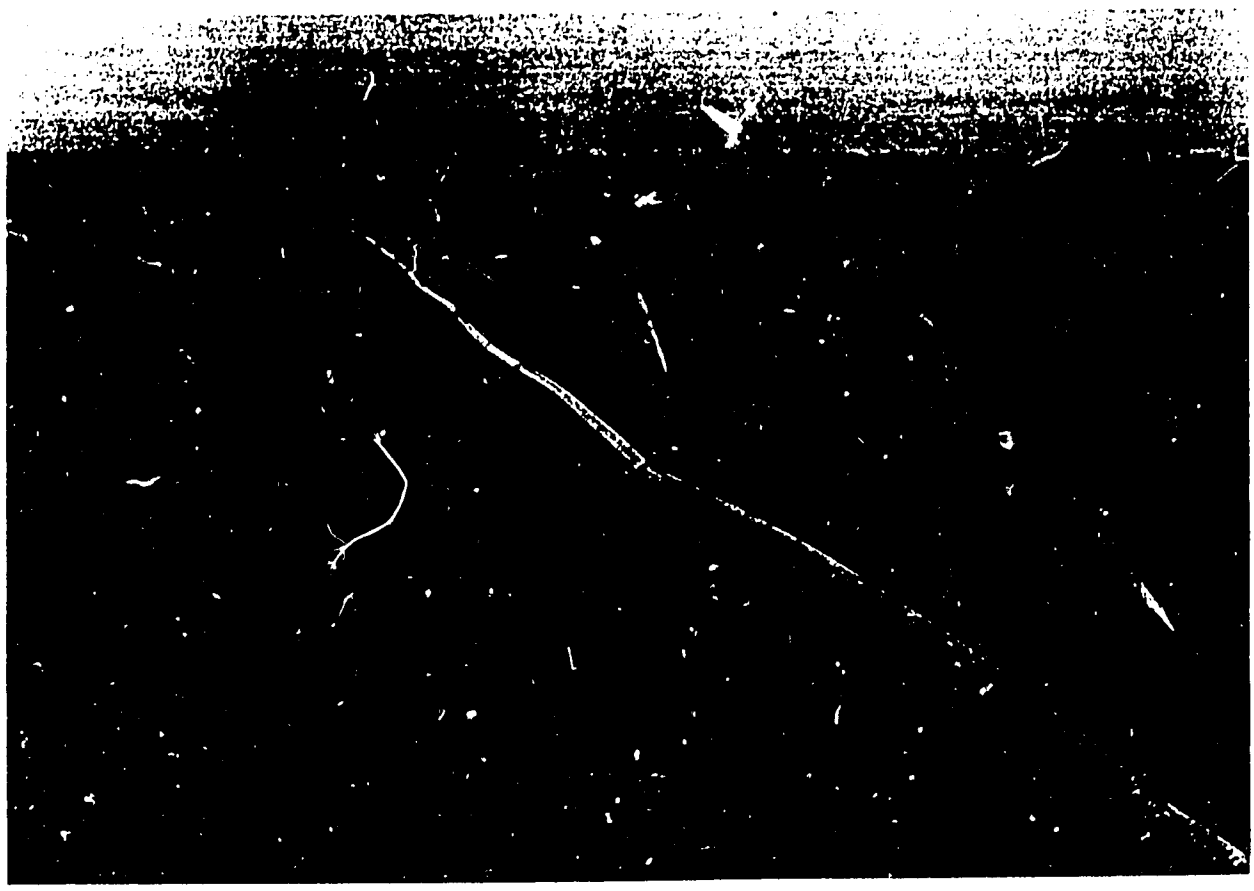
Irrigate immediately after planting to settle soil firmly around the roots and prevent desiccation of the plants. Either furrow or sprinkler irrigation is satisfactory. In furrow irrigation, run the water in a light flow over the base of the plants to avoid washing them out of the ground.

After the initial irrigation, keep the field moist until the new spears emerge from the soil. Subsequent irrigation should be as needed to maintain sufficient moisture to prevent desiccation and sustain normal growth.

Weed control

Weed control is the most difficult problem encountered during the early growth period. Use either shielded spraying with contact herbicides, or mechanical cultivation to control weeds outside the plant row.

Annual weeds around the plants will be controlled as the furrow is gradually filled in with soil during cultivation. Several light cultivations as needed for weed control and soil movement are better than moving a large amount at one time. By the end of the first growing season the field surface should be nearly level, with only a small irrigation furrow still left down the plant row.



Sprinkler irrigation following transplanting.

DIRECT SEEDING

In direct seeding, asparagus seed is precision-planted at the desired spacing directly into the commercial field. This avoids having to grow and maintain a nursery and digging and transplanting seedlings or crowns into the commercial field. Although tried in all of the production areas of California, it is mainly being used in the desert and coastal areas of southern California.

Direct seeding is most advantageous where growers utilize plant densities in excess of 100,000 plants per acre. It also gives the grower more freedom in choosing planting dates, although the slow, 4- to 5-week germination period in cold spring months may cause grower concern about getting a stand. The best germination is in the 77 to 86° F range.

The principal disadvantage of direct seeding is the difficulty of controlling weeds which emerge with the young plants.

Time of planting

In the desert valleys of California (Imperial, Palo Verde, and Coachella), direct seeding usually begins in early February and ends in April. In the cooler coastal production areas, direct seeding has been successful over a period of several months—April through July. In the southern portion of the San Joaquin Valley, seeding has been done from late February into early March. In the Sacramento-San Joaquin Delta, the most favorable time to plant direct-seed asparagus has been from late March to the end of April.

In desert areas growers also have been successful with fall seeding in August and September. Emerging seedlings will over-winter without severe foliage damage in areas having mild winter climates. Filling of the furrows with soil can start after new spears begin to emerge in the spring.

Planting method

Asparagus growers usually plant either on raised beds (some growers in the Imperial and Coachella valleys plant on beds similar to those used for other vegetable crops) or in pre-formed, flat-bottomed furrows.

The first method is exclusively used in desert areas. Beds are made by cutting irrigation furrows, usually on 5-foot centers, in the prepared field. The resulting beds between the furrows are planted with two to five rows of seed. Seed is planted only 3/4 inch to 1 inch deep—this allows penetration of solar heat to promote germination and provide for early crops once the beds are in production. However, plants remain at a shallow depth and the average bed life usually is considerably shorter than when planted in furrow bottoms.

In furrow planting, flat-bottomed furrows on 5-foot centers are cut 6 to 8 inches below the prepared soil surface.

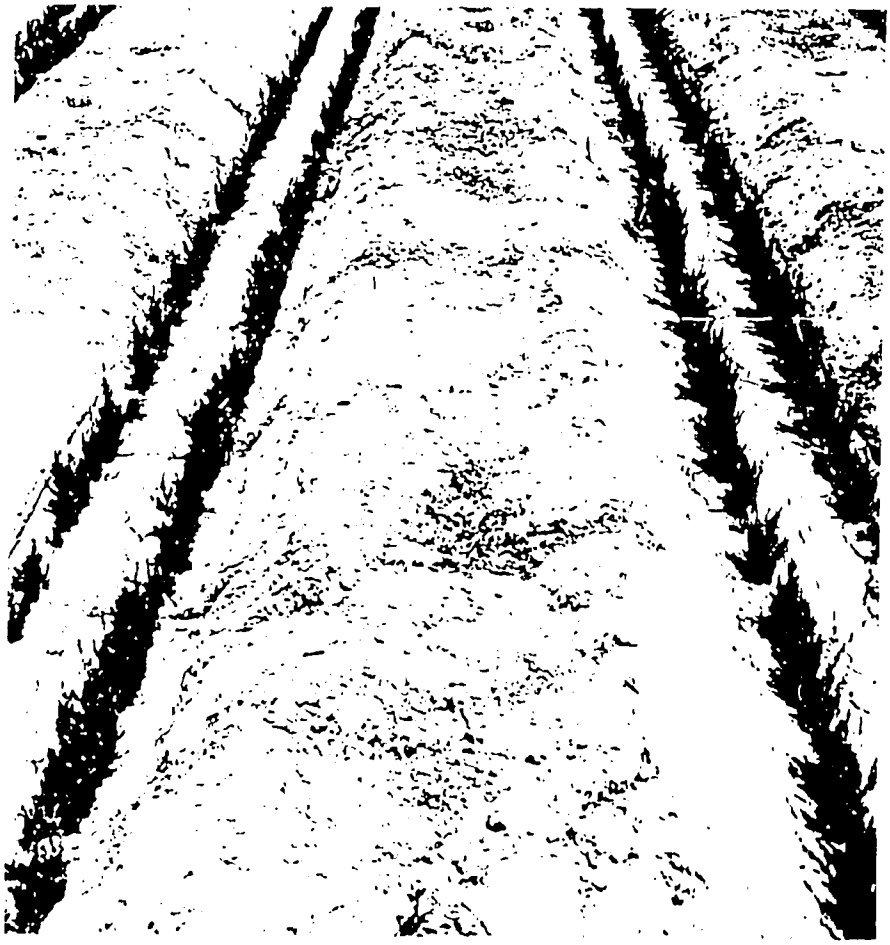
Seeding is done on these recessed flats. As plants grow, soil is pulled from the furrow sides to fill in and form a raised bed. Ultimately, this soil movement creates irrigation furrows on either side of the completed bed and leaves the producing crowns deep in the soil. Such fields are productive for 10 to 15 years.

TABLE 2. DAYS TO EMERGENCE OF ASPARAGUS SEEDLINGS AT VARIOUS SOIL TEMPERATURES.[1]

Soil temperature °F	32	41	50	59	68	77	86	95	104
Days to emergence	x	x	53	24	15	10	11	19	28

[1] Data from J. F. Harrington, Dept. of Veg. Crops, U.C. Davis
x Little or no germination

Direct-seeded four-rows-per-bed in Imperial Valley.



Direct-seeded double-row-per-bed.

Beds in the southern part of the state are usually planted on 60-inch centers, while most growers in the Delta area prefer 72-inch spacing.

Irrigation

If soil moisture at time of planting is not adequate for germination, irrigate to keep the soil moist but not saturated. Both furrow and sprinkler irrigation have been satisfactory for the germination and emergence of asparagus. Of the two methods, we suggest sprinkler irrigation; then, if desired, convert to furrow irrigation after the stand has been established.

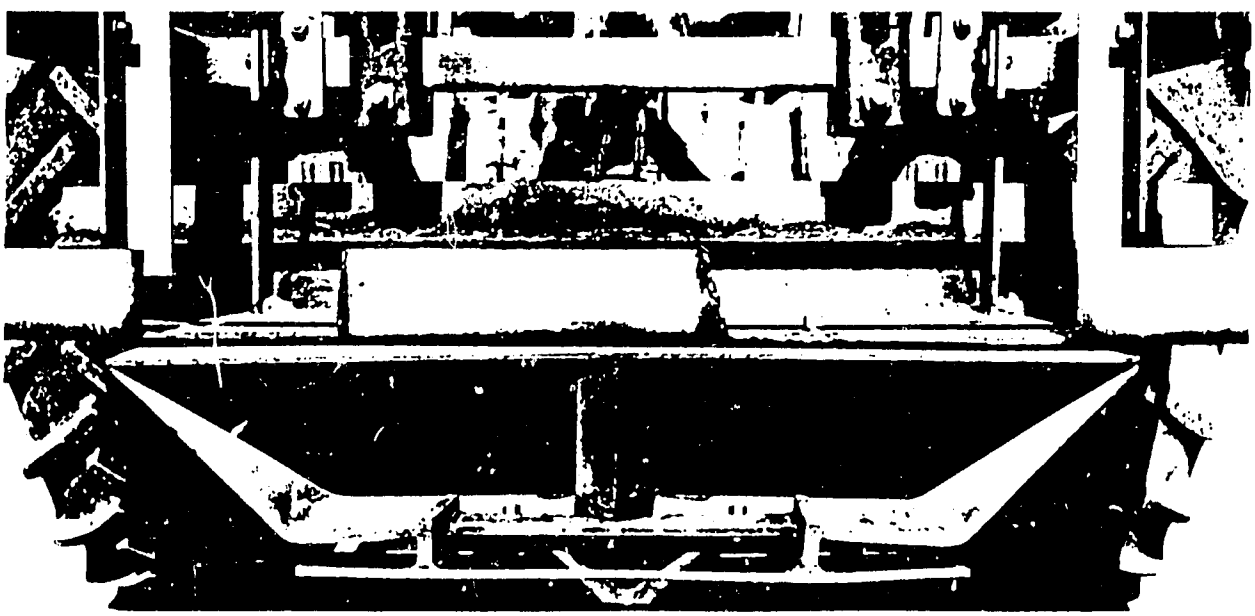
If furrow irrigation is used for germination, run the water carefully over the seed rows in the bottom of the furrow—especially in light, sandy soils—to avoid washing. Washing should not be a problem if a small irrigation furrow was made in the bottom of the basin when the planting bed was formed. Water flow also can be regulated with a gated pipe or other means to prevent washing. Emergence may be retarded or reduced in parts of the field where water tends to stand. In heavier soils, crusting may be a problem.

Weed control

Weed control is a major problem in direct-seeding asparagus because handweeding costs may be prohibitive. Certain chemicals have given satisfactory weed control when applied pre-emergence with good well-calibrated equipment used with precision. New herbicides for both pre-emergence and post-emergence are being tested each year. Consult your Farm Advisor for current information.

Certain cultural practices have also been used to control weeds. Because asparagus seed germinates slowly, you can spray the field with contact herbicides, such as carrot oil, 1 or 2 days before the seedlings emerge. This will destroy existing weed seedlings. Another application of contact herbicide, using a plant shield to protect the asparagus seedlings, may be desirable 1 month after plants have emerged. Once asparagus plants are about 1-1/2 feet high, annual grasses and broadleaf weeds are usually not detrimental to the establishment of a stand.

Annual weeds appearing late in the season will be destroyed when soil is moved from the ridges over asparagus rows as beds are prepared for the following season.



One-row bed shaper.

Perennial weeds should be destroyed before seeding or they will be a continual source of difficulty to the grower.

Special basins are constructed in one operation with double moldboard plows or listers and sled-mounted shapers, making one to three beds at a time. The flat furrow bottoms are about 24 inches wide. Each is seeded with two rows spaced about 8 to 12 inches apart. In making beds, many growers add a special V-shaped piece to the center bottom of each shaper. This forms a 4-inch-wide by 2-inch-deep channel to allow early irrigation without seed-washing.

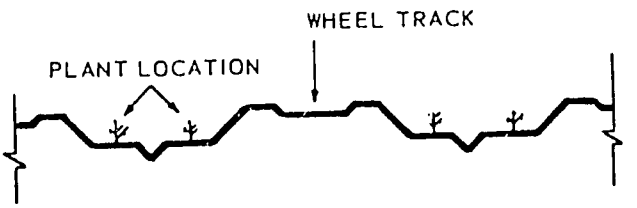


Fig. 1. Cross section of a typical bed used for direct seeding.

Seeding is done at 3/4- to 1-inch depth with precision planters. For best seed placement, planting speed should not exceed 2 miles per hour. Sled-mounted precision planters covering three 60-inch beds can seed 3 acres per hour.

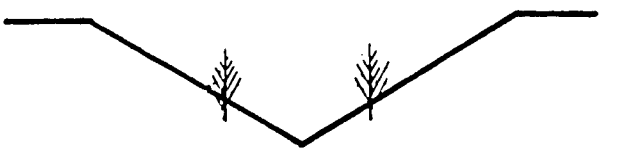
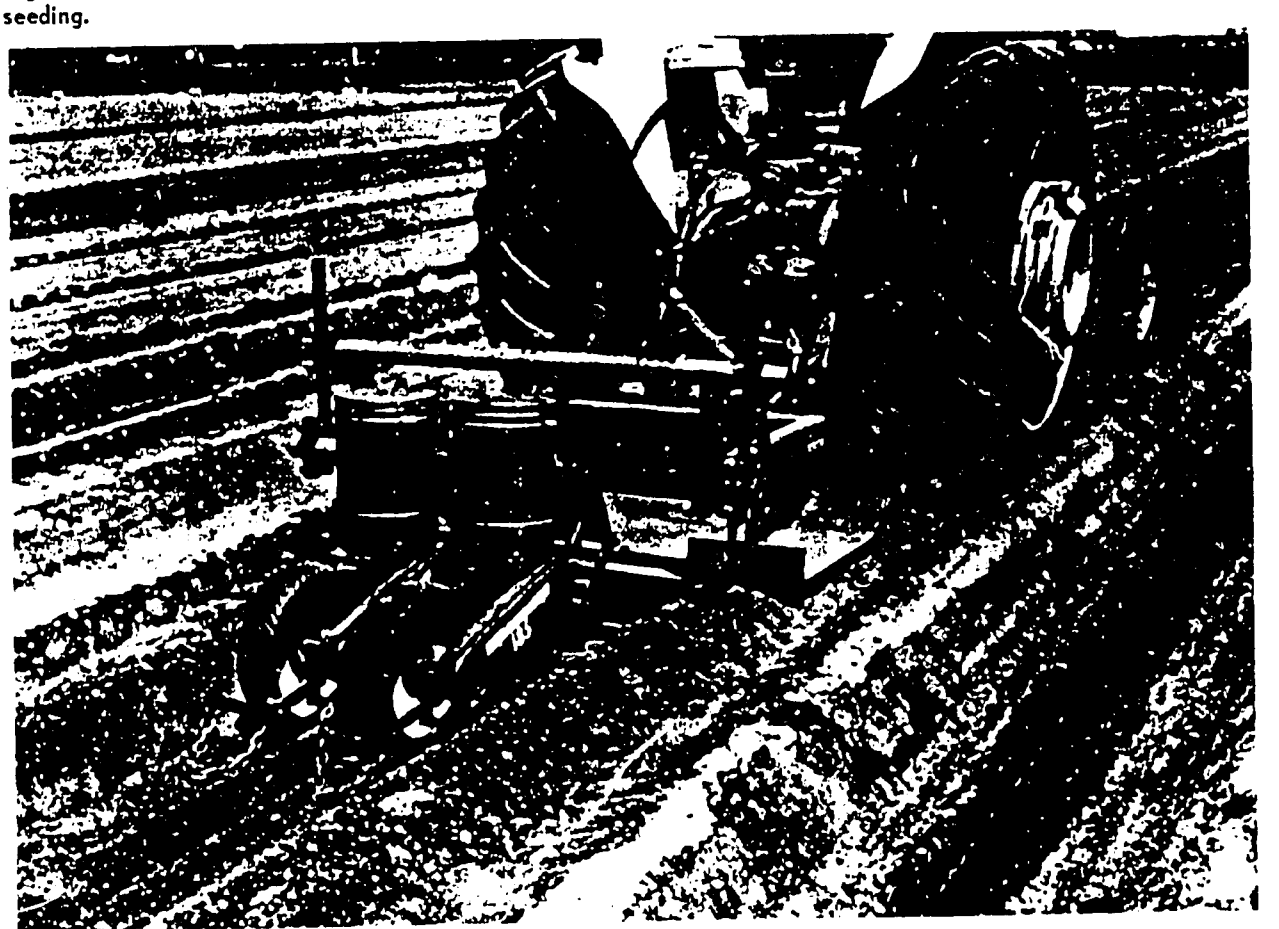


Fig. 2. Angle planter seeding.

Some plantings have been made on the sides of ridges by direct seeding with angle planters.

Delta area. In direct seeding into furrows, growers in the Delta have shown preference for 6-foot row spacing instead of 5 foot. Also, because of subsidence in the organic peat soils, it often is necessary to cut furrows deeper than 6 to 8 inches and to seed deeper than 1 inch.



One-row bed shaper with planters mounted.

Spacing

Most growers who direct-seed do so in preformed furrows, two rows per bed with in-row spacing from 3 to 6 inches. This spacing requires approximately 2 to 3 pounds of seed per acre. However, some growers in the desert area prefer to plant on raised beds utilizing 2 to 5 rows per bed, which gives a population in excess of 100,000 plants per acre.

TABLE 3. AMOUNT OF SEED NEEDED TO DIRECT-SEED ASPARAGUS (5-FOOT BEDS) AT VARIOUS PLANT DENSITIES AND GERMINATION PERCENTAGES.

In-row spacing (inches)	1	2	3	4	5	6
Number plants per ft.	12	6	4	3	2.4	2
Number plants per acre	104,544	52,272	34,848	26,136	20,908	17,424
Germination %	Pounds of seed required per acre*					
100	5.2	2.6	1.8	1.3	1.1	0.9
95	5.5	2.7	1.9	1.4	1.1	0.9
90	5.8	2.9	2.0	1.5	1.2	1.0
85	6.2	3.1	2.1	1.6	1.3	1.0
80	6.6	3.3	2.2	1.7	1.3	1.1
75	7.0	3.5	2.3	1.8	1.4	1.2
70	7.5	3.7	2.5	1.9	1.5	1.3
65	8.0	4.0	2.7	2.0	1.6	1.4
60	8.7	4.4	2.9	2.2	1.8	1.5

* Based on 20,000 seeds per pound.

PLANTING 1-YEAR-OLD CROWNS

The use of 1-year-old crowns for establishing an asparagus plantation is the oldest method employed in California and accounts for most of the acreage currently (1980) in production.

Crowns are plants grown from seed in a field nursery. Young crowns are dug after one full growing season, preferably in mid-winter while they are dormant, and should be transplanted immediately into the production field. In growing areas where inclement weather may prevent planting while crowns are dormant, they are dug in winter and held in cold storage until planted.

Some growers specialize in growing asparagus crowns for sale, but where large acreages are to be planted many prefer to grow their own crowns in their own nurseries.

Time of planting

In the Sacramento-San Joaquin Delta, crown planting is done anytime in winter as weather permits. In desert areas of southern California where little rainfall is expected fields may be planted any time in winter; January and February are usually the best months. At that time, soil and climate conditions will usually permit the crowns to be transplanted directly from nursery to field. In either area, however, if cold weather persists and crowns remain dormant in soil for a long time after transplanting, considerable decay and injury to the fleshy roots and rhizomes may occur. Some researchers have found that dipping or dusting the crowns with a fungicide to prevent this decay may be effective, but the results have not been consistent.

Crown planting of asparagus.

Planting method

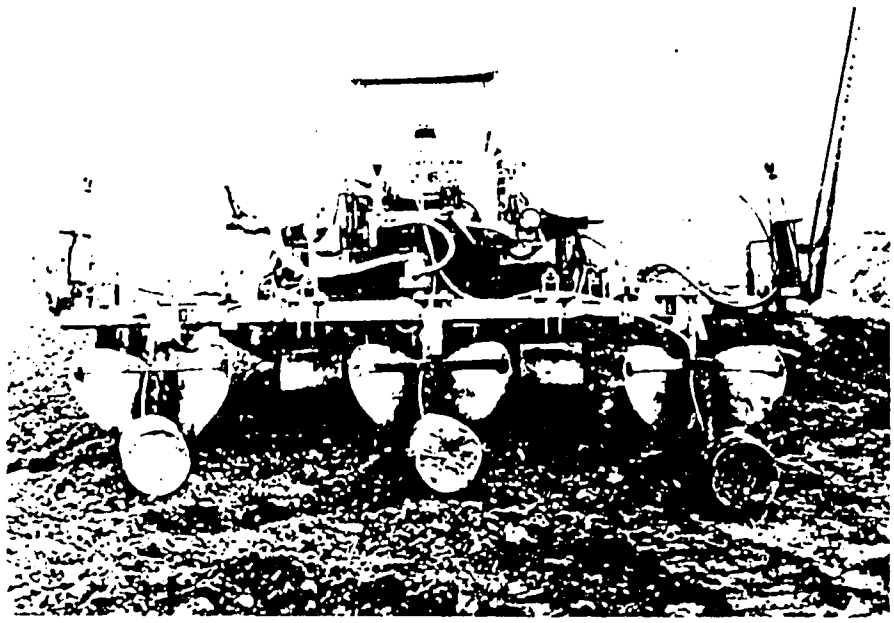
Planting furrows are made with a large, double moldboard plow with extension wings. Single rows are used and furrows are spaced 5 to 6 feet apart. Depth of the furrow should be 6 inches below the level of the field. A heavy object or a large log-chain is usually dragged behind the plow to break the clods and form a smooth seed bed.

Crowns are dropped into the furrow at the desired spacing, usually from a tractor-trailer rig. The crowns are then placed by hand in an upright position and the roots spread out. Studies indicate that although crown survival is not affected by orientation, spear initiation in crowns planted upside down will be delayed and early production reduced. Crowns should be covered with 2 to 3 inches of soil and watered immediately, either by furrow or sprinkler irrigation, to settle the soil around the crowns.

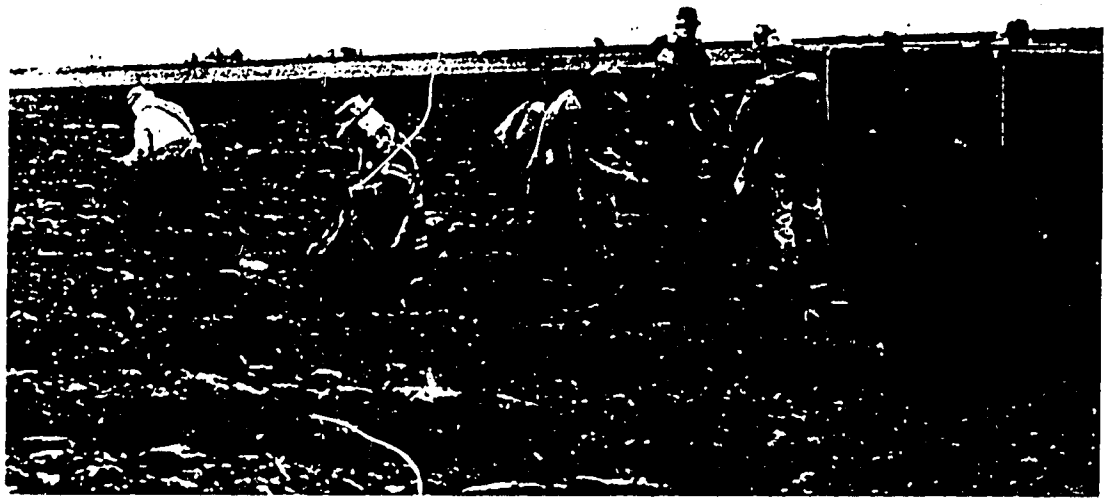
After spears emerge, soil should be moved into the furrow in small quantities. Slowly filling in the furrow as the season progresses also helps to control the weeds.

In-row spacing

Spacing of crowns in-row will vary with the grower. The most common spacing used in the past was 12 inches between plants. Tests show little difference in yield between 12- and 18-inch spacings. Closer spacings give higher yields only during the early life of the beds, and do not appear to be worth the extra costs involved.



Double mold-board plows with clod breakers used to open furrows for crown planting in the Delta.



Crown planting from a trailer.

Irrigation

After the crowns have been covered with approximately 2 to 4 inches of soil, the field should be irrigated to settle the soil around the crowns. If furrow irrigation is used, water should be run in the furrow over the crowns. Sprinkler irrigation may also be used, but may cause a greater weed problem than will furrow irrigation. Subsequent irrigations should be made as needed to sustain normal growth of the plants.

Weed control

Weed control is a problem in most asparagus beds. Cultivation during the early part of the first growing season will help control some weeds. Hand weeding is very expensive and prohibitive in most plantations. Herbicides for both pre-emergence and post-emergence weed control are being tested each year. Consult your local Farm Advisor for the latest information concerning these.

THE ASPARAGUS NURSERY

The objective of a field nursery is to grow the maximum number of well-sized crowns on the least amount of land.

Site selection

A light friable soil is best for early seed germination and seedling growth, and will be an aid in digging and grading operations when the crowns are lifted. Muck soils are satisfactory, but heavy clay soils are difficult to manage and should be avoided. The soil should have good water retention, yet be sufficiently porous to give good drainage. Make sure the planting area has no low spots where water can stand, or emergence will be reduced and plant loss will occur. A soil pH level between 6.5 to 7.5 is desirable.

Time of planting

The nursery should be planted as early in spring as weather permits. Early seeding takes advantage of natural soil moisture for germination and provides the maximum growth period.

Asparagus seed is slow to germinate in cold weather (Table 2) and it often requires several weeks for the plants to emerge. Soaking the seed before planting for 3 to 5 days at temperatures of 86° to 95° F will hasten germination. Seed should be spread on newspapers and partially dried before drilling.

Planting

In a nursery, asparagus seeds usually are planted in single rows on raised beds spaced between 18 and 30 inches apart, but flat planting with similar between-row spacing can be used. Seeding depth is 1 to 1 1/2 inches. In sandier soil, growers prefer to plant 1 1/2 to 2 inches deep to insure adequate soil moisture.

Seed should be sown with a commercial precision planter.

Spacing

Equal spacing between plants is important in the nursery. Crowded plants have a tendency to produce smaller crowns than those spaced farther apart. Plants should be seeded about 3 inches apart within the row. If the seed is sown more thickly, the plants may develop small, intertwining roots and be difficult to separate without injury at digging time. Because of high labor costs it is not economically feasible to thin seedling after emergence.

Irrigation

Adequate moisture is essential for good germination. Sprinkler and furrow irrigation are both satisfactory for the asparagus nursery. However, care must be used in making irrigation furrows in flat plantings so as not to disturb the seed rows. Subsequent irrigations should be made as needed to keep soil moist but not saturated.

Weed control

Weed control is a problem in most asparagus nursery beds. Many growers prefer to fumigate soil in the nursery before planting as this may eliminate much of the weed problem. A pre-emergence spray such as paraquat also can be applied to the soil to keep down the weed growth. Contact herbicides should not be used after seedlings appear.

For latest information on fumigation and chemical weed control, contact your County Farm Advisor.

TABLE 5. POUNDS OF SEED REQUIRED AT VARIOUS IN-ROW SPACINGS, BETWEEN-ROW SPACINGS AND GERMINATION RATES IN AN ASPARAGUS NURSERY.*

In-row spacing (inches)		2	3	4	5	6
Plants per foot (in row)		6	4	3	2.4	2
Germination (%)	Between-row spacing (inches)	Pounds of seed required per acre				
100	15	10.5	7.0	5.2	4.2	3.5
	18	8.7	5.8	4.4	3.5	2.9
	21	7.5	5.0	3.7	3.0	2.5
	24	6.8	4.4	3.3	2.6	2.2
95	15	11.0	7.4	5.5	4.4	3.7
	18	9.2	6.1	4.6	3.7	3.1
	21	7.9	5.3	4.1	3.1	2.6
	24	6.9	4.6	3.5	2.8	2.3
90	15	11.6	7.8	5.8	4.6	3.9
	18	9.7	6.5	4.9	3.9	3.2
	21	8.3	5.5	4.3	3.3	2.8
	24	7.3	4.9	3.7	2.9	2.4
85	15	12.3	8.2	6.2	4.9	4.1
	18	10.3	6.8	5.2	4.1	3.4
	21	8.8	5.9	4.5	3.5	3.0
	24	7.8	5.2	3.9	3.1	2.6
80	15	13.1	8.7	6.6	5.2	4.4
	18	10.9	7.3	5.5	4.4	3.6
	21	9.3	6.2	4.8	3.7	3.2
	24	8.2	5.5	4.1	3.3	2.8
75	15	13.9	9.3	7.0	5.6	4.7
	18	11.6	7.8	5.8	4.7	3.9
	21	10.0	6.7	5.1	4.0	3.4
	24	8.7	5.8	4.4	3.5	3.0
70	15	14.9	10.0	7.5	6.0	5.0
	18	12.5	8.3	6.2	5.0	4.2
	21	10.7	7.1	5.5	4.3	3.6
	24	9.3	6.2	4.7	3.7	3.2
65	15	16.1	10.7	8.1	6.4	5.4
	18	13.4	9.0	6.7	5.4	4.5
	21	11.5	7.7	5.9	4.6	3.9
	24	10.1	6.7	5.1	4.0	3.4
60	15	17.4	11.7	8.7	7.0	5.8
	18	14.5	9.7	7.3	5.8	4.9
	21	12.5	8.3	6.4	5.0	4.2
	24	10.9	7.3	5.5	4.4	3.6

*Based on 20,000 seeds per pound.

TABLE 4. PLANT POPULATIONS AT VARIOUS IN-ROW SPACINGS, BETWEEN-ROW SPACINGS, AND GERMINATION RATES IN AN ASPARAGUS NURSERY.

In-row spacing (inches)		2	3	4	5	6
Plants per foot (in-row)		6	4	3	2.4	2
Germination (%)	Between-row spacing (inches)	Plants per acre				
100	15	209,088	139,392	104,544	83,635	69,696
	18	174,240	116,160	87,120	69,696	58,080
	21	149,348	99,565	76,674	59,739	49,782
	24	130,680	87,120	65,340	52,272	43,560
95	15	220,092	146,728	110,046	88,036	73,364
	18	183,410	122,273	91,705	73,364	61,136
	21	157,208	104,805	80,709	62,883	52,402
	24	137,557	91,705	68,778	55,023	45,852
90	15	232,320	154,880	116,160	92,927	77,440
	18	193,600	129,066	96,800	77,440	64,533
	21	165,942	110,627	85,193	66,376	55,313
	24	145,200	96,800	72,600	58,080	48,400
85	15	245,985	163,990	122,922	98,394	81,995
	18	204,988	136,658	102,494	81,995	68,329
	21	175,703	117,135	90,204	70,281	58,567
	24	153,741	102,494	76,870	61,496	51,247
80	15	261,360	174,240	130,680	104,543	87,120
	18	217,800	145,200	108,900	87,120	72,600
	21	186,685	124,456	95,842	74,673	62,227
	24	163,350	108,900	81,675	65,340	54,450
75	15	278,784	185,856	139,392	111,513	92,928
	18	232,320	154,880	116,160	92,928	77,440
	21	199,130	132,753	102,232	79,652	66,376
	24	174,240	116,160	87,120	69,696	58,080
70	15	298,697	199,131	149,348	119,478	99,565
	18	248,914	165,942	124,457	99,565	82,971
	21	213,354	142,235	109,534	85,341	71,117
	24	186,685	124,457	93,342	74,674	62,228
65	15	321,673	214,449	160,836	128,669	107,224
	18	268,061	178,707	134,030	107,224	89,353
	21	229,766	153,176	117,960	91,906	76,587
	24	201,046	134,030	100,523	80,418	67,015
60	15	348,480	232,230	174,240	139,391	116,160
	18	290,400	193,600	145,200	116,160	96,800
	21	248,913	165,941	127,790	99,565	82,970
	24	217,800	145,200	108,900	87,120	72,600

Digging crowns

December and January are the best months for digging crowns in California. Delay digging until the ferns are dead, the crowns are dormant, and the tops can be cut with a mower and removed from the field. Lift the crowns from the soil with a modified potato digger—this will shake roots free of most of the soil and make separation easier. To avoid crown injury, make sure that digging is not too shallow.

Crowns are graded by hand while being separated. It pays to plant only medium and large crowns that have large buds and have not been injured by digging. Large crowns weigh approximately .13 to .15 of a pound (135 to 150 pounds per thousand crowns) and they should have several well-developed bud clusters. Experiments (in New Jersey) have shown no significant difference in yield of marketable spears between plantings of large crowns and medium crowns.

Crown storage

Crowns should be transplanted into the permanent bed as soon as possible after digging. In many areas this is not possible because of adverse weather conditions in winter and early spring. If conditions do not allow immediate transplanting, store crowns loosely in a well-ventilated warehouse at a temperature of 35°F. Drying and freezing of the crowns should be avoided, as severe damage or complete loss can result. Crowns that must be held dormant for any great length of time usually are loosely packed in bulk bins and held in controlled cold storage. Many growers dip their plants in a Benlate solution before storage, although no statistical advantage in plant survival has been found.

Typical variability in nursery-grown 1-year-old crowns.

ARTICLE P5.

INTRODUCCION

Los esparragos han sido uno de los cultivos principales de California por más de 80 años. La Producción hoy es solamente de esparrago verde-esparrago blanco ya no es cultivado en California.

El método tradicional de siembra, todavía el más ampliamente utilizado, es el de sembrar coronas (plantas de 1 año) producidas en un vivero de campo. Sinembargo, recientemente algunos agricultores han estado transplantando las plantillas de 10-a-12 semanas plantas tiernas usualmente cultivadas en un invernadero. Estas plantas se desarrollan hasta la etapa de corona productiva después de colocarse en los campos. Por varios años se defendió la siembra directa con semilla y todavía se usa donde se desean extremamente grandes poblaciones de plantas. En este método,la semilla se siembra en el campo de producción.

Todos los tres métodos pueden usar léchos levantados o siembras planas. En la mayoría de los casos, las plantas o la semilla son sembradas en surcos que, por muchos meses, son gradualmente llenados con tierra según la planta va creciendo y desarrolandose. De esta manera, los sistemas de plantas resultantes se sitían profundos (de 6 a 9 pulgadas) en el suelo por el tiempo en que comienza la producción comercial de las puntas de esparragos. Una excepción a esta práctica con plantillas sembradas directamente en lechos alzados superficiales en áreas deserticas.

Ciertos suelos favorecen la producción de esparragos, y ya que este cultivo perenne va atar la tierra por 10 a 15 años se le debe de dar una consideración cuidadosa a la selección del campo. Sinembargo, no importa cual sea el método de siembra toda la preparación preliminar de tierra es básicamente la misma, consistiendo usualmente en una nivelación de tierra donde sea necesario, surcando.

Cada método de siembra tiene sus propias ventajas y desventajas particulares pero parece que el método de transplante de platillas se va a tornar predominante, especialmente con el advenimiento de la semilla híbrida escasa y más cara. El transplante permite un desarrollo rápido y uniforme de la plantación comercial y una producción de alguna manera más temprana.

Este folleto delinea cada uno de los tres métodos de siembra.

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SELECCION DEL CAMPO Y PREPARACION DE LA TIERRA

El esparrago es un perenne y la tierra donde se va a cultivar va estar atada por 10 a 15 años,asi que se tiene que hacer una consideración cuidadosa sobre el lugar seleccionado para la plantación.

El esparrago es bastante adaptable a una amplia gama de tipos de suelos Se cultiva comercialmente en los suelos de turba (estircol) del Delta en algunos suelos barrrosos a lo largo de la costa y en el Valle Imperial, y en los suelos muy arenosos en el Valle Coachella. Los suelos sueltos y arenosos son mejores para una producción temprana en Primavera.

El pH del suelo debería estar entre 6.5 y 7.5, o cerca de neutral, para producción máxima. Los suelos ácidos abajo de 6.5 suprimen el crecimiento de la planta y reducen los rendimientos. Comparado con otras verduras, los esparragos son bastante tolerantes a las sales.

Los esparragos son un cultivo de raiz profunda y se recomiendan suelos con un perfil profundo y buen drenaje. El campo debe tener condiciones de suelos uniformes-tierras veteadas y texturas de suelos variables va a dificultar el riego y la retención uniforme de la humedad del suelo. Se deben evitar suelos de perfil superficieal, duros o con drenaje pobre.

El riego es requerido en todas las áreas de producción de esparragos en toda California. Donde el agua es aplicada por riego de surco, los campos deben ser bastante planos para asegurarse un buen movimiento vertical y lateral. Donde se usa riego por aspersión, la inclinación de la tierra debe estar libre de partes hondas donde el agua podría acumularse.

Hay que tratar de seleccionar un campo libre de malezas perennes como lo son campanillas de la mañana, ciertas graminaceas y otras, ya que estas son difíciles de controlar después de que el campo ha sido establecido, y estas tienden a esparcierse rápidamente.

Una vez se ha seleccionado el campo, hay que hacer cualquier nivelación de tierra que sea necesaria, después arar profundamente para estar listos de hacer los surcos o formar los lechos para la época de siembra.

La incorporación de grandes cantidades de abono orgánico ya sea estiercol o composta o ambos en los lechos finales de semilla es sugerida en mucha de la vieja literatura, y aún hoy hay ventajas para esta práctica si estos abonos orgánicos son disponibles. Sinembargo, esto no es ni necesario ni práctico en las grandes extensiones de tierra en California.

TRANSPLANTANDO LAS PLANTAS DE SEMILLERO

El transplante de las plantas de semillero hacia el campo es el método más reciente recomendado para establecer una plantación de esparragos en California. Este método está rápidamente ganando popularidad y se está utilizando ampliamente por los cultivadores de esparragos a travéz de todo el estado.

Las plantillas generalmente se producen en invernaderos y, cuando tienen cerca de 10 a 12 semanas, son transplantadas a los campos comerciales. Las plantillas jovenes pueden ser transplantadas mecánicamente, y asi se reducen costos de transplante. Estudios indican que se puede esperar un índice de supervivencia del 92 al 98 por ciento.

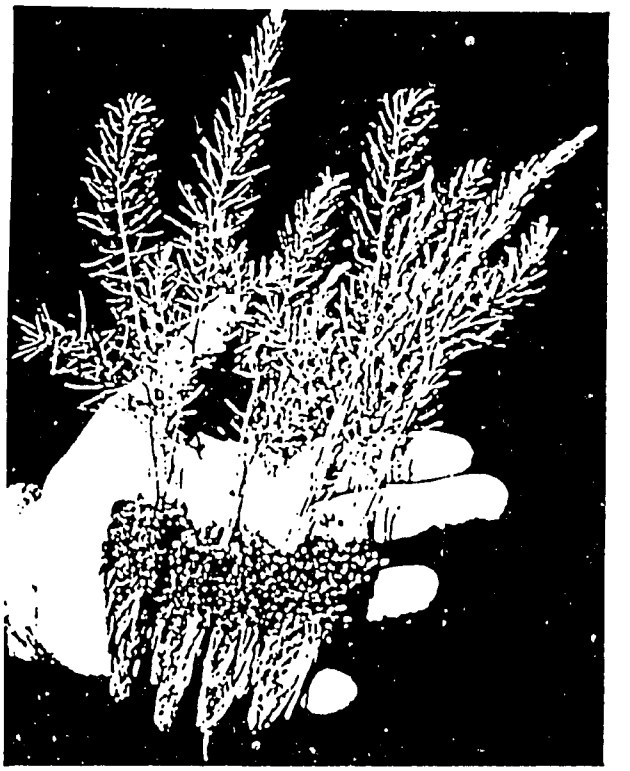
Cultivando los Transplantes de las Plantas de Semillero

Cualquier agricultor que tenga facilidades de un vivero puede producir plantillas, pero la práctica comercialmente común es que un vivero las cultive especializandose en transplantes. Una ventaja de la producción de invernadero es que el agricultor está listo para transplantar al final del invierno o al principio

de la primavera, cualquiera mientras lo permitan las condiciones del tiempo. Esto utiliza el período de crecimiento más largo posible en la primera temporada.

Para las siembras en el campo al final de la primavera o en el otoño, los transplantes de plantillas se han cultivado con éxito en casas "enlatadas" o al aire libre.

Los transplantes pueden ser cultivados en macetitas de musgo, a pesar de que para obtener un uso más eficiente del espacio del invernadero la mayoría de los viveros usan bandejas pre-formadas que tienen una densidad de planta de 1 planta por cada 1.65 pulgadas cuadradas. La mezcla del suelo debe ser porosa (e. 1 parte de musgo para 1 parte de arena gruesa) para asegurar un buen drenaje. Las semillas son sembradas 1/4 a 1/2 pulgada de profundidad, una semilla por cada espacio.



Proper size of seedling (10 to 12 weeks old) for transplanting.

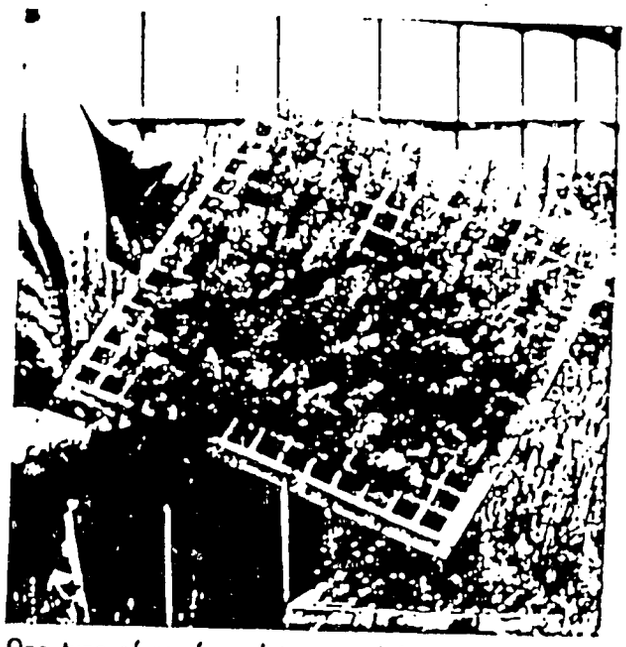
Plantillas de tamaño adecuado (10-12 semanas de vida) para transplantar

A plantation recently established with transplants.

Una plantación recientemente establecida con transplantes

Una temperatura de invernadero fluctuando entre 65° F como mínimo en la noche y 85° F como máximo en el dia provee buena germinación y crecimiento de la planta.

El riego y la fertilización necesita variar con las condiciones climaticas existentes, la mezcla del suelo, y la edad de las plantillas. Los requerimientos nutrientes iniciales pueden obtenerse incorporando un fertilizante completo conteniendo micronutrientes a la mezcla del suelo. Después de que emergen las plantillas, se deben incorporar aplicaciones adicionales de fertilizante líquido al agua del riego según sea necesario. Debido a la naturaleza porosa de la mezcla, las plantillas deben ser regadas diariamente.

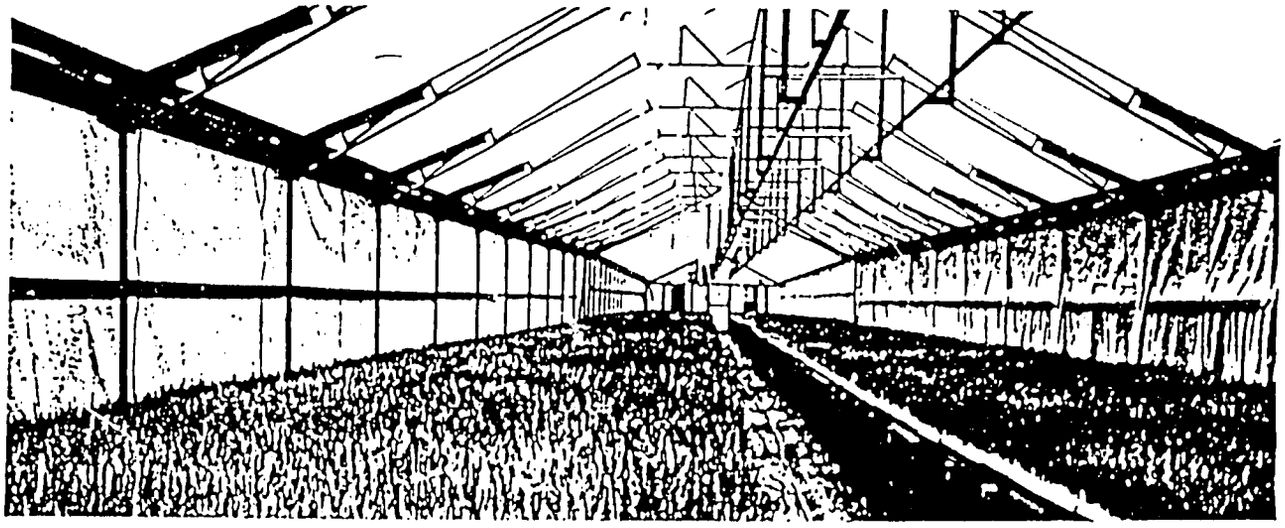


One type of pre-formed tray used for growing transplants in greenhouse.

Un tipo de bandejas pre-formadas utilizadas para cultivar transplantes en un invernadero.

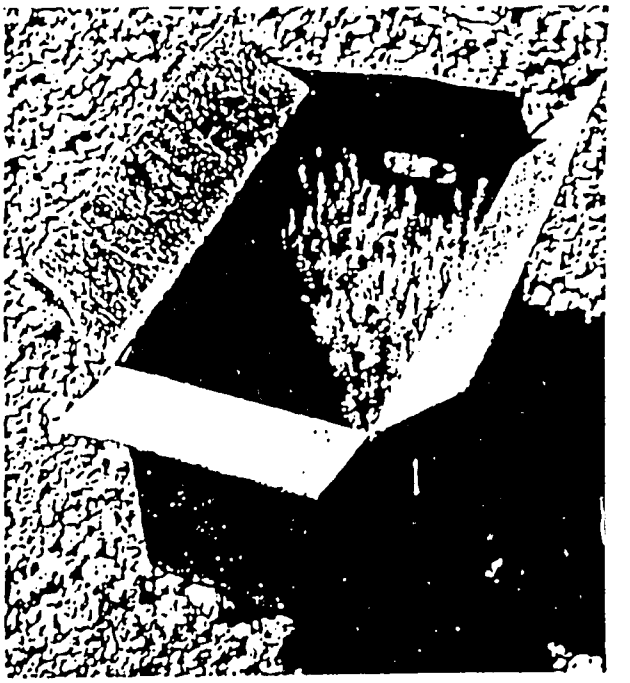
Tiempo de resiembra

El tiempo más favorable para la resiembra en el campo en los valles



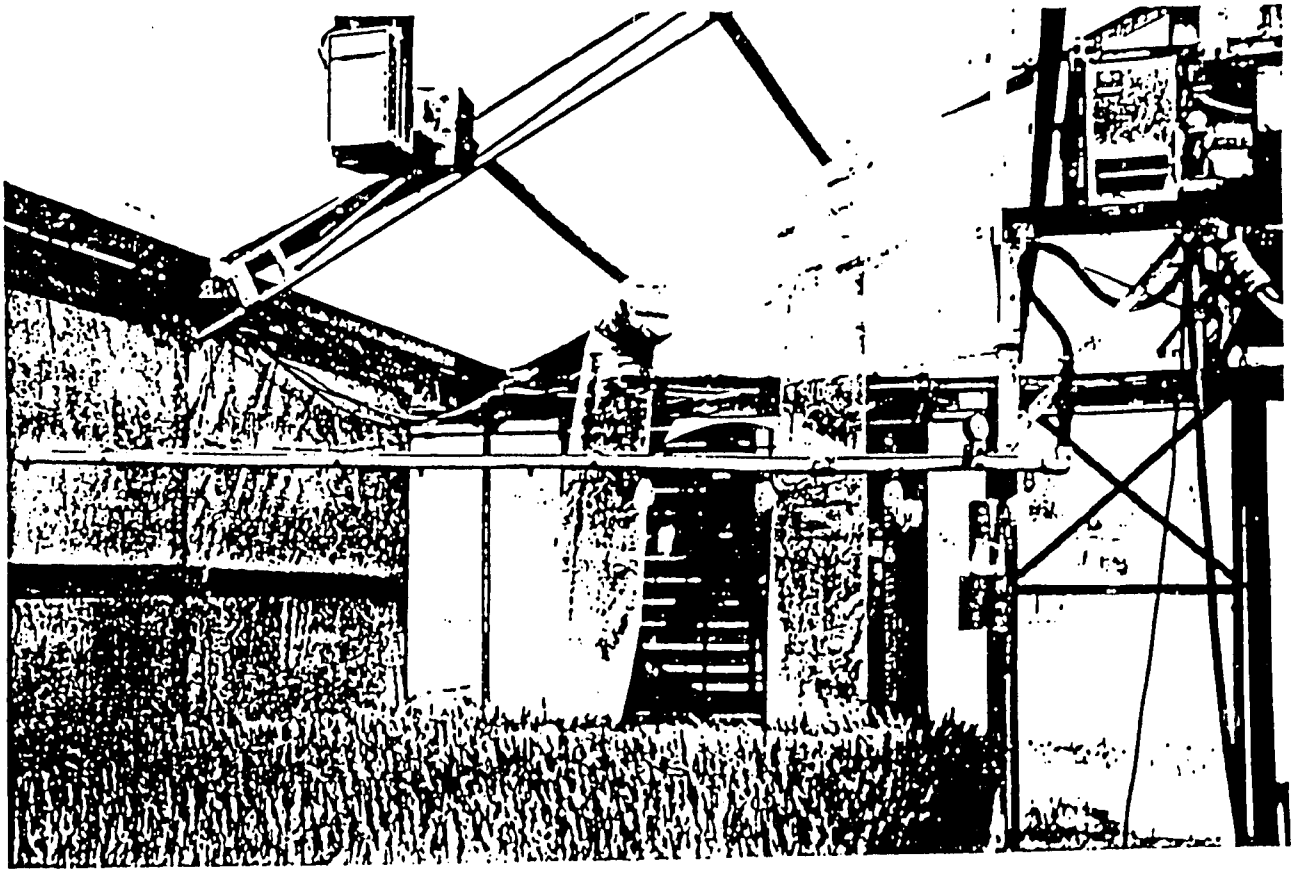
Growing transplants in the greenhouse.

Cultivando transplantes en un invernadero



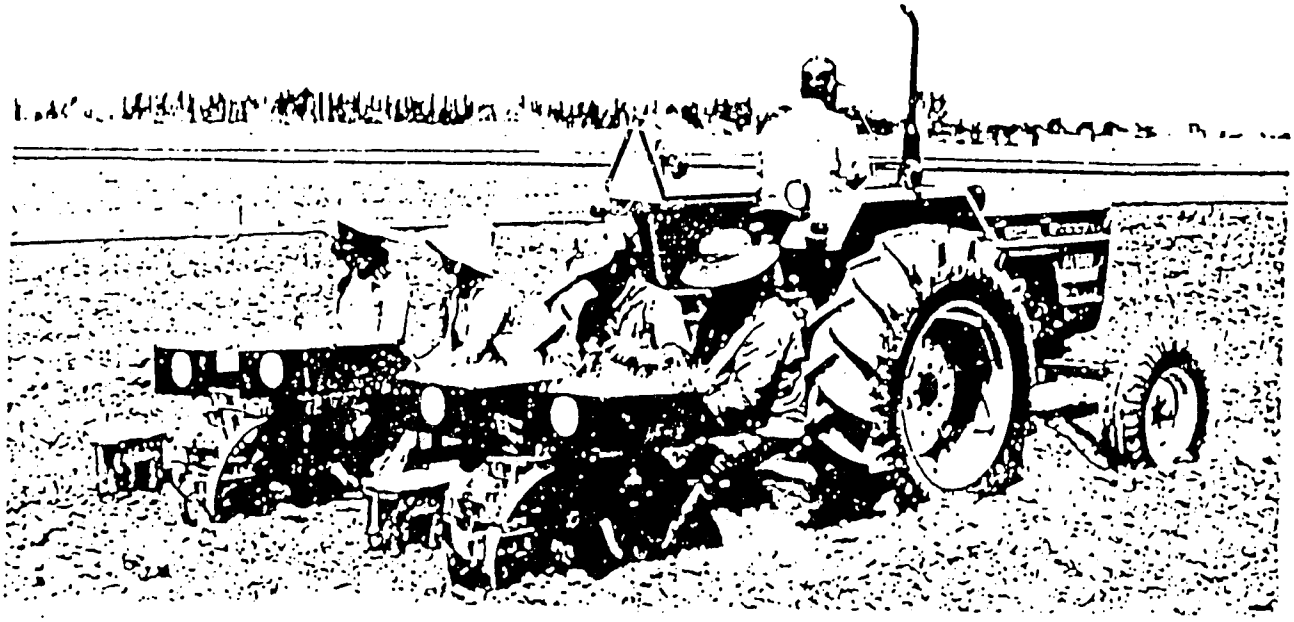
Moisture-resistant box for packing seedlings for transporting to field.

Caja resistente a la humedad para empacar plantillas para transplantarlas en el campo.



Overhead irrigation and fertilizer application for seedlings in greenhouse.

Riego aereo y aplicación de fertilizante para plantillas en el invernadero.



Transplanting asparagus seedlings.

Transplantando plantillas de esparragos.

desérticos es en Febrero hasta Abril. En el Valle de San Joaquin, el mejor tiempo es desde Marzo hasta Mayo. En el Delta, se transplanta mejor desde Marzo a travez de Mayo. Próximo a los meses de primavera, el otoño es el próximo tiempo más satisfactorio para transplantar, especialmente en la parte sur del estado.

Las plantillas se transportan a los campos ya sea en bandejas en las cuales han sido cultivadas (las plantas se sacan de estas en el campo) o en cajas resistentes a la humedad en las cuales se han colocado en los invernaderos.

Las plantitas de semillero deberan ser transplantadas tan pronto sea posible después de embarcarlas desde el invernadero, pero las plantas mantenidas húmedas y frescas van a permanecer viables y van a mostrar muy poco o ningún daño físico por varios dias.

Transplantando

Los surcos para la siembra se cortan para el campo preparado de 6 a 8 pulgadas de profundidad con arado doble, o preferiblemente se forman como lechos. Después se siembran las plantillas en la parte honda del surco. Para obtener mejores resultados, las partes hondas de los surcos deben de tener tierra suelta y permitir sepultar completamente las raices de las plantas.

La siembra se puede hacer a mano o a máquina. Muchos cultivadores han adaptado equipos de transplante vegetal capaz de manejar dos y tres surcos.

Distancias en los espacios

Para la producción de esparragos verdes, una distancia de 5-o-6 pies entre el surco es común en California. Una distancia de 5 pies es la usada más comúnmente en el sur de California, mientras que la de 6 pies es preferida por la mayoría de los que cultivan en el Delta.

TABLA 1. NUMERO DE PLANTILLAS O CORONAS QUE SE NECESITAN PARA SEMBRAR 1 ACRE DE ESPARRAGOS A DIFERENTES DISTANCIAS EN-SURCO EN LAS FILAS INDIVIDUALES DE 5 PIES.

Distancia En-Surco (pulgadas)	4	6	8	10	12	14	16	18
Número de plantillas o coronas por pié	3.0	2.0	1.5	1.2	1.0	0.9	0.8	0.7
Número de plantillas o coronas por acre	26,135	17,424	13,068	10,454	8,712	7,405	6,534	5,808

Las distancias de los espacios en los surcos van a variar con el agricultor.

La distancia más comúnmente usada es de 12 pulgadas entre plantas. Algunos agricultores prefieren distancias más cortas. Otros siembran cada 18 pulgadas. Pero asi como aumenta la edad de los lechos, todas las distancias tienden a igualarse en rendimiento a casi el de la distancia de 12 pulgadas.

Riego

Regar inmediatamente después de la siembra para fijar el suelo firmemente alrededor de las raices y prevenir disecación de las plantas. Ya sea riego por surco o por aspersión con flujo suave sobre la base de las plantas para evitar lavarlas fuera del suelo.

Después del riego inicial, hay que mantener los campos húmedos hasta que emergan las puntas del suelo. El riego subsiguiente deberá hacerse según sea necesario para mantener suficiente humedad para prevenir desecación y sostener un crecimiento normal.

Control de Maleza

El control de la maleza es el problema más difícil de enfrentar durante el período de crecimiento inicial. Usar ya sea nebulizadores resguardados con herbicidas de contacto, o métodos de siembra mecánicos para controlar la maleza fuera de los surcos de las plantas.

Las malezas anuales alrededor de las plantas van a ser cultivadas a medida que el surco sea gradualmente llenado con tierra durante la época de cultivo. Varias labores de deshierba a medida que sean necesarias para el control de la maleza y removimiento de la tierra son mejores que mover grandes cantidades a un tiempo. Al final de la primera temporada la superficie del campo debería estar casi totalmente plana, con únicamente un pequeño riego en el surco todavía colocado a lo largo de la fila de plantas.

Sprinkler irrigation following transplanting.

Riego por Aspersión después de transplantar

SIEMBRA DIRECTA

Al sembrar directamente, la semillas de esparrago deben ser sembradas con precisión a las distancias deseadas y directamente a los campos comerciales. Esto evita tener que cultivar y mantener un invernadero y hoyando y transplantando las plantillas de semillas o coronas en los campos. A pesar de que se ha probado en todas las áreas de producción de California, es más bien usada en las áreas desérticas y costeras del sur de California.

La siembra directa es más ventajosa donde los agricultores utilizan densidades de plantas en exceso de 100,000 plantas por acre. También le da al agricultor más libertar para escoger fechas de siembra, sinembargo, el período de germinación lento, de 4-a-5 semanas en los meses frios de primavera pueden causar preocupación en el agricultor acerca de obtener las plantas. La mejor germinación se logra entre los 77 y los 86º F.

La desventaja principal de sembrar directamente con semillas es la dificultad de controlar malezas que emergen con las plantillas tiernas.

Tiempo de Siembra

En los valles desérticos de California (Imperial, Palo Verde, y Coachella), la siembra directa generalmente comienza a principios de Febrero y termina en Abril. En las áreas más frescas de la costa, la siembra directa ha tenido éxito por el término de varios meses--Abril hasta Julio. En la porción sur del Valle de San Joaquin, se ha cultivado con semilla desde finales de Febrero hasta principios de Marzo. En el Delta de Sacramento-San Joaquin, la época más favorable para cultivar directamente con semilla ha sido desde finales de Marzo hasta el fin de Abril.

En las áreas desérticas los agricultores también han tenido éxito sembrando en otoño en Agosto y Septiembre. Las plantitas que emergen van a pasar el invierno sin daños severos al follaje en las áreas que tienen climas más suaves de invierno. Para llenar los surcos con tierra se puede empezar después de que las nuevas puntas de esparragos comienzan a emerger en la primavera.

Método de Siembra

Los agricultores de esparragos generalmente siembran ya sea en lechos levantados (algunos agricultores en los valles Imperial y Coachella siembran en lechos similares a aquellos utilizados para otros cultivos de verduras) o en surcos pre-formados de fondo plano.

El primer método se usa exclusivamente en áreas desérticas. Los lechos se hacen cortando los surcos regados, generalmente en centros de 5 pies, en los campos preparados. Los lechos resultantes entre los surcos se siembran con dos a cinco filas de semillas. La semilla se siembra sólamente de 3/4 de pulgada a 1 pulgada de profundidad--esto permite penetración se calor solar para promover germinación y proveer cultivos anticipados una vez los lechos estén en producción. Sinembargo, las plantas permanecen en una profundidad superficial y el promedio de vida del lecho generalmente es considerablemente más corto que cuando se siembra en el fondo de los surcos.

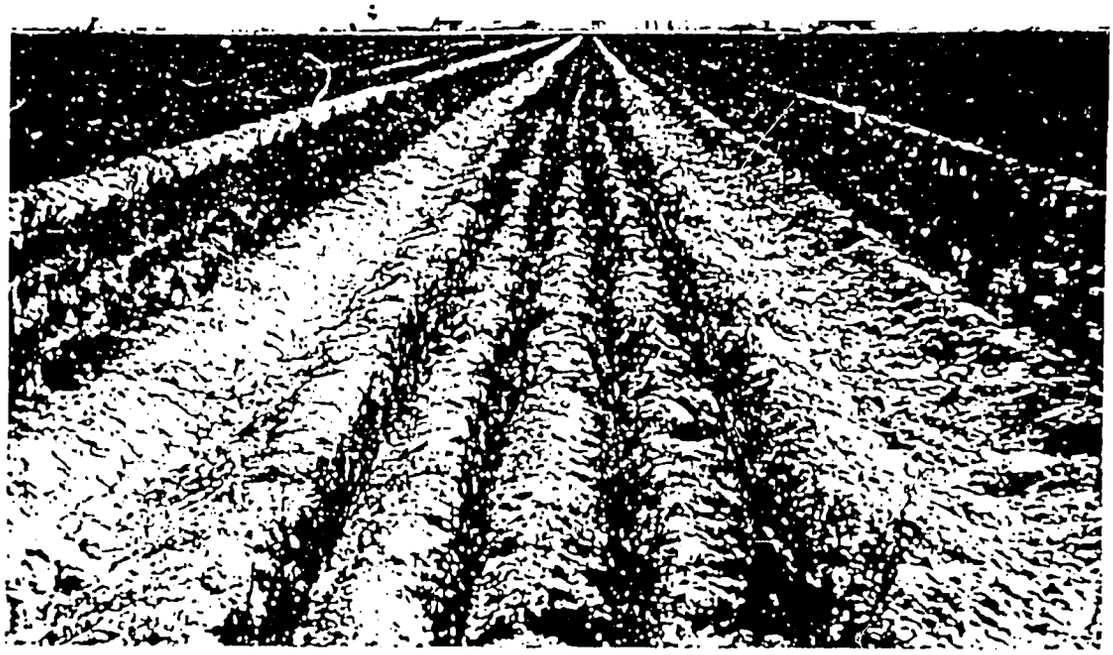
En las siembras de surcos, los surcos de fondos planos de centros de 5 pies son cortados entre 6 a 8 pulgadas por debajo de la superficie del suelo preparado.

Las siembras se hacen en las hondanadas planas. A medida que las plantas crecen, el suelo se hala de los lados de los surcos para llenarlo y formar un lecho alzado.

TABLA 2. DIAS PARA EL SURGIMIENTO DE LAS PLANTILLAS DE ESPARRAGOS A VARIAS TEMPERATURAS DE SUELO.[1]

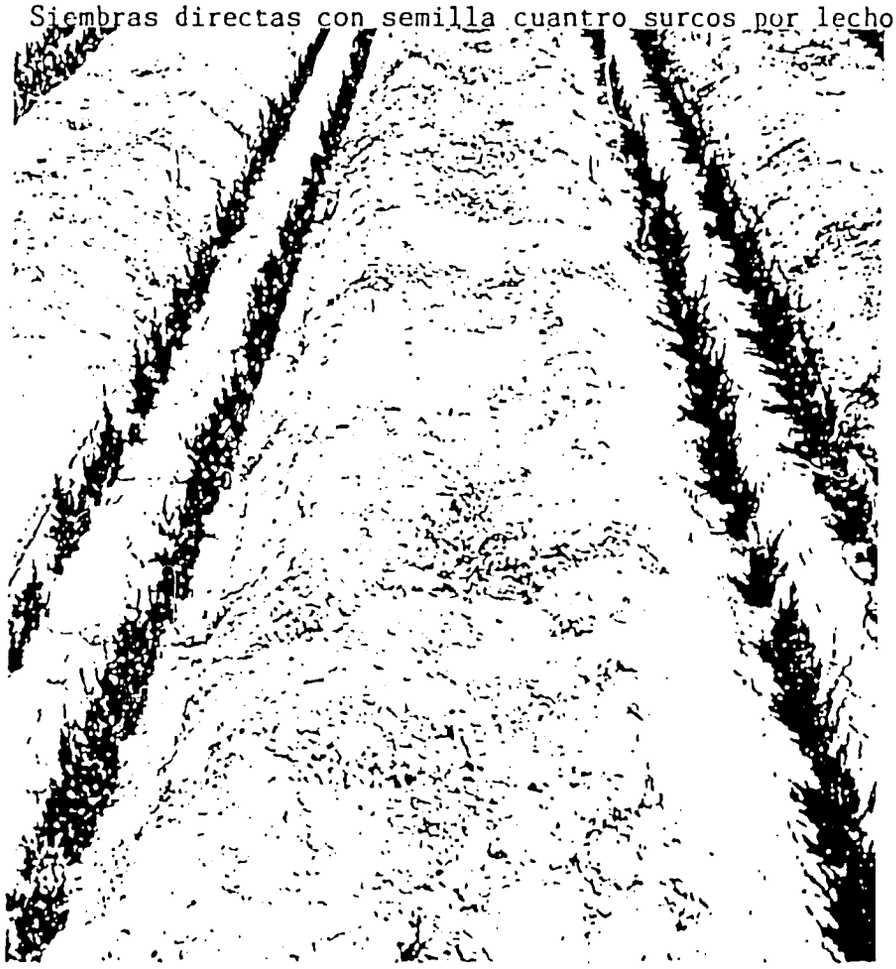
Temperatura de Suelo Fº	32	41	50	59	68	77	86	95	104
Dias para surgimiento	x	x	53	24	15	10	11	19	28

[1]Dato de J.F. Harrington, Dept. de Cultivos Vegetales Univ. Calif., Davis.
x Poca o ninguna germinación



Direct-seeded four-rows-per-bed in Imperial Valley.

Siembras directas con semilla cuantro surcos por lecho, Valle Imperial.



Direct-seeded double-row-per-bed.

Siembra directa con semilla doble fila por lecho.

Ultimadamente, este movimiento de tierra crea surcos de riegoen ambos lados de los lechos completos y deja las coronas produciendo profundamente en el suelo. Dichos campos son productivos por 10 a 15 años.

Los lechos en la parte sur del estado son generalmente sembrados en los centros de 60 pulgadas, mientras que la mayoría de los agricultores en el área del Delta prefieren la distancia de 72 pulgadas.

Riego

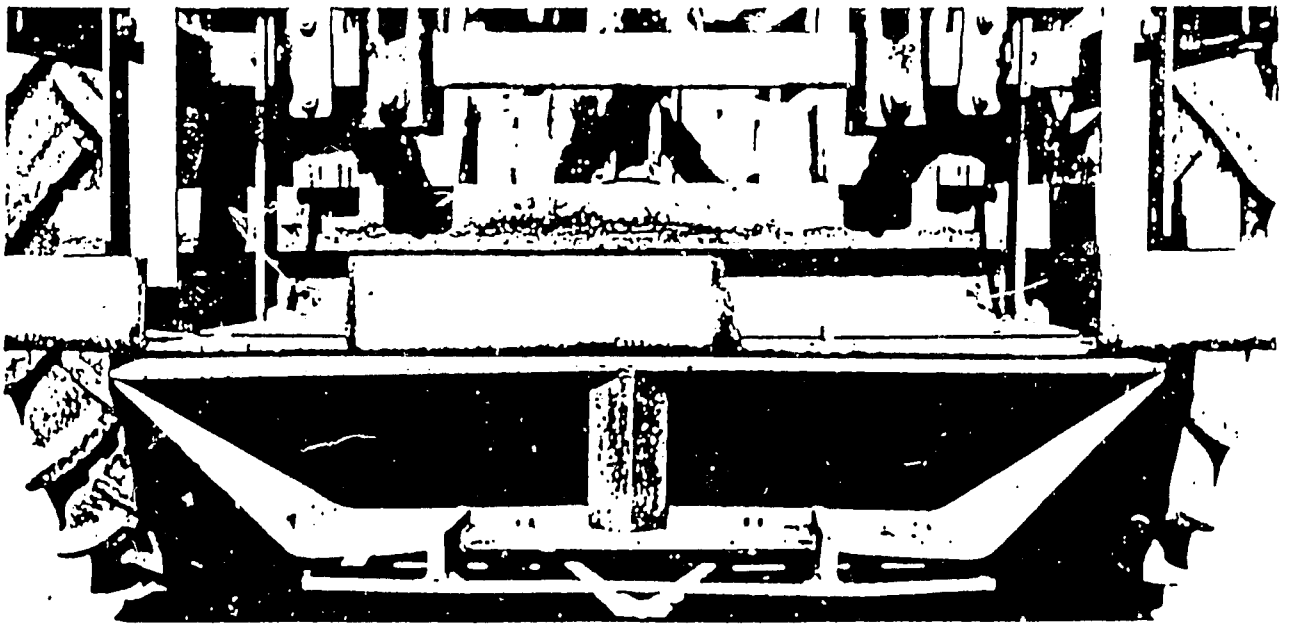
Si la mezcla de suelos al tiempo de la siembra no es adecuada para la germinación, hay que regar para mantener el suelo húmedo pero no saturado. Ambos riego por surco o aspersión han sido satisfactorios para la germinación y surgimiento de los esparragos. De los dos métodos, nosotros sugerimos el riego por aspersión; después, si se desea, convertirlo a riego por surco después de que la planta esté establecida.

Si se usa riego por surco para la germinación, hacer correr el agua cuidadosamente sobre las filas de semilla al fondo de los surcos--especialmente en suelos livianos y arenosos--para evitar que se laven. El lavarse no debería ser un problema si se hace un pequeño surco de riego al fondo de la represa cuando los lechos de siembra se están formando. El flujo de agua también puede ser regulado con pipas con compuertas u otros métodos para prevenir que se laven. El surgimiento puede ser retardado o reducido en partes del campo donde el agua tiende a estancarse. En suelos más pesados, el costramiento puede ser un problema.

Control de Maleza

El control de maleza es un gran problema cuando se siembra el esparrago directamente con semillas porque los costos de la deshierba manueal pueden ser prohibitibos. Ciertos químicos han dado resultados satisfactorios en el control de maleza cuando se aplican en el presurgimiento con buen equipo bien calibrado utilizado con precisión. Las nuevas herbicidas para ambos pre-surgimiento y post-surgimiento se están probando cada año. Consulte a su Asesor de Finca para información actualizada.

Ciertas prácticas de cultivo también se han usado para controlar maleza. Debido a que la semilla del esparrago germina lentamente, Usted puede nebulizar el campo con herbicidas de contacto, como son aceite de zanahoria, 1 o 2 días antes de que surgan las plantillas. Esto va a destruir las plantillas de malezas existentes. Otra aplicación de herbicida de contacto, usando un resguardo para la



One-row bed shaper.

Formador de lechos de una fila

protección de las plantillas de esparragos, puede ser oportuna después de 1 mes de que las plantan han surgido. Una vez las plantas tienen 1-1/2 pies de altura, las hierbas anuales y malezas por lo general no van en detrimento de las puntas de esparragos.

Las malezas anaules que aparecen al final de la temporada van a ser destruidas cuando la tierra se mueva de los canales sobre las filas de esparragos a medida que se hagan los nuevos lechos para la próxima temporada.

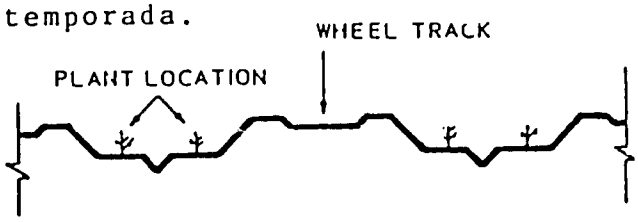


Fig. 1. Cross section of a typical bed used for direct seeding.

Fig.1.Sección transversal de un lecho típico utilizado para siembra directa con semilla.

La maleza perenne deberá ser destruida antes de sembrar o estas van a ser una continua dificultad para el agricultor.

Se contruyen canales especiales en una operación con arados de dobre molde o arado sembrador y rastras. Los fondos de los surcos planos son casi de 24 pulgadas de ancho. Cada uno se siembra con dos filas con una distancia de 8 a 12 pulgadas entre ellas. Al hacer los lechos, muchos agricultores agregan una pieza con forma de "V" en el centro del fondo. Esto fonma una canaleta de 4 pulgadas de ancho por 2 pulgadas de

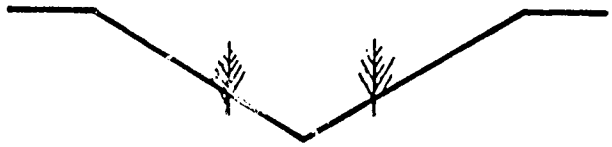
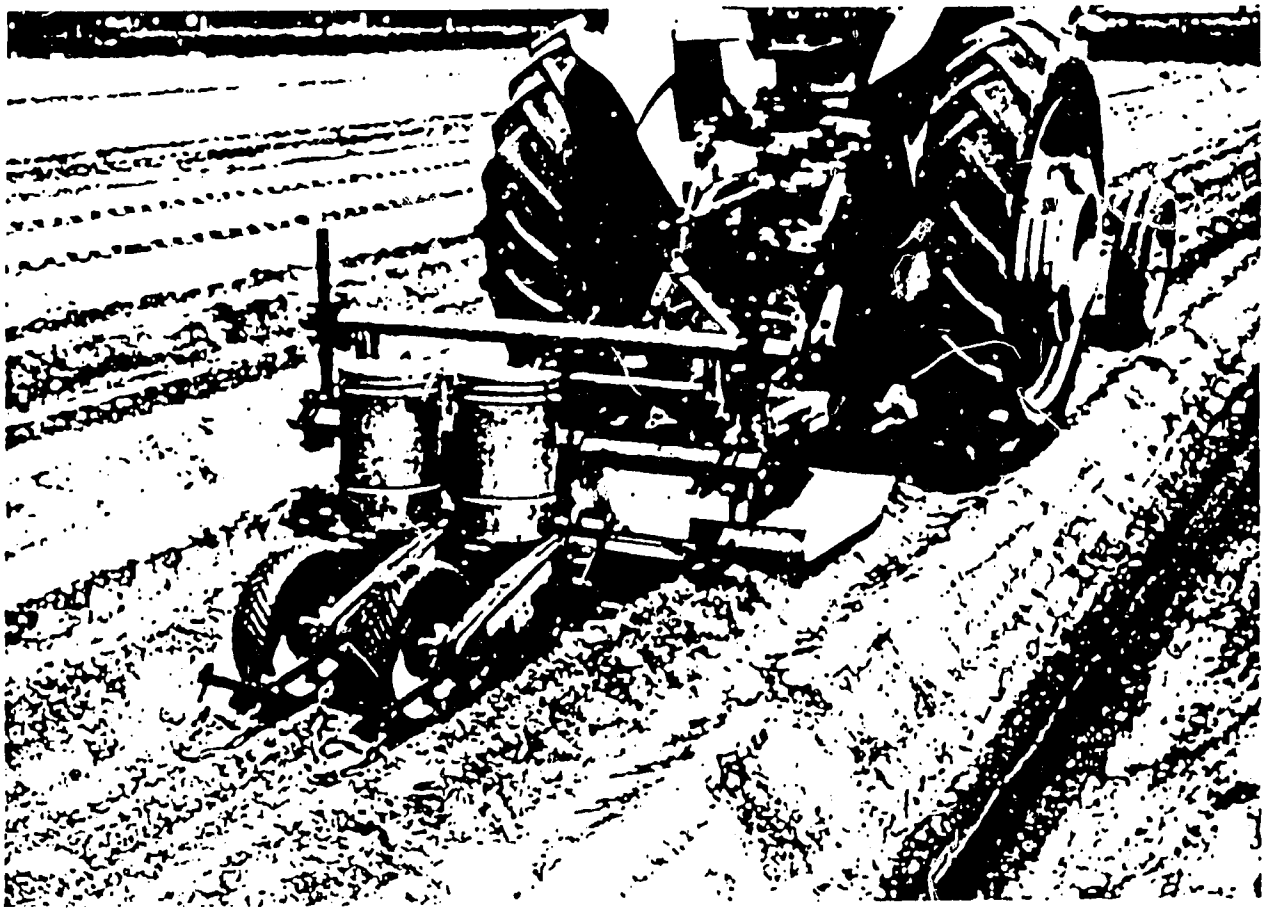


Fig. 2. Angle planter seeding.

Fig.2 Siembra plantada en ángulo.



One-row bed shaper with planters mounted.

Formador de lechos de una fila con sembradores montados.

profundidad para permitir un riego anticipado sin que se laven las semillas.

La siembra se hace a 3/4 hasta 1 pulgada de profundidad con sembradores de precesión. Para colocar mejor la semilla, la rapidez de la siembra no debe exceder 2 millas por hora. Sembradores precisos montados en rastras cubriendo tres lechos de 60 pulgadas pueden sembrar 3 acres por hora.

Algunas siembras se han hecho a los lados de las canaletas sembrando directamente con sembradores de ángulo.

Area del Delta. Al sembrar directamente en los surcos, los agricultores en el Delta han mostrado una preferencia de 6 pies de distancia entre las filas en vez de cinco pies. También, debido al asentamiento en los suelos con mucha materia orgánica, muy a menudo es necesario cortar los surcos más profundos de 6 a 8 pulgadas y sembrar más profundo que 1 pulgada.

Distancia

La mayoría de los agricultores que siembran directo con semilla lo hacen en surcos preformados, dos filas por lecho con distancias entre la fila de 3 a 6 pulgadas. Esta distancia requiere de aproximadamente 2 a 3 libras de semilla por acre. Sinembargo, algunos agricultores en el área del desierto prefieren sembrar sobre lechos alzados utilizando 2 a 5 filas por lecho, lo cual da una población en exceso de 100,000 plantas por acre.

TABLA 3. CANTIDAD DE SEMILLA QUE SE NECESITA PARA SIEMBRA-DIRECTA DE ESPARRAGOS (LECHOS DE 5-PIES) A VARIAS DENSIDADES DE PLANTAS Y PORCENTAJES DE GERMINACION.

Distancia en-fila (pulgadas)	1	2	3	4	5	6
Número de Plantas por pié	12	6	4	3	2.4	2
Número de Plantas por acre	104,544	52,272	34,848	26,136	20,908	17,424
% de Germinación	Libras de Semillas que se requieren por acre*					
100	5.2	2.6	1.8	1.3	1.1	0.9
95	5.5	2.7	1.9	1.4	1.1	0.9
90	5.8	2.9	2.0	1.5	1.2	1.0
85	6.2	3.1	2.1	1.6	1.3	1.0
80	6.6	3.3	2.2	1.7	1.3	1.1
75	7.0	3.5	2.3	1.8	1.4	1.2
70	7.5	3.7	2.5	1.9	1.5	1.3
65	8.0	4.0	2.7	2.0	1.6	1.4
60	8.7	4.4	2.9	2.2	1.8	1.5

* Basado en 20,000 semillas por libra.

SEMBRANDO CORONAS DE 1 AÑO

El uso de coronas de 1 año de vida para establecer una plantación de esparragos es el método más antiguo empleado en California y registra la mayoría de las tierras actualmente (1980) en producción.

Las coronas son plantas reproducidas por semilla en un vivero a campo libre. Las nuevas coronas se sacan de la tierra después de una temporada completa de crecimiento, preferiblemente, en la mitad del invierno mientras están inactivas, y deben de ser trasnplantadas inmediatamente en los campos de producción. En las áreas de cultivo donde el clima inclemente pueda prevenir sembrar mientras las coronas están inactivas, se sacan de la tierra en invierno y se mantienen guardadas en frio hasta ser sembradas.

Algunos agricultores se especializan en cultivar coronas de esparragos para la venta, pero donde se tienen que sembrar grandes áreas muchos prefieren cultivar sus propias coronas en sus propios viveros.

Tiempo de Siembra

En el Delta Sacramento-San Joaquin, la siembra de las coronas se hace durante cualquier tiempo en la estación del invierno según lo permita el clima. En las áreas desiertas del sur de California donde se espera poca lluvia los campos pueden sembrarse cualquier tiempo en el invierno; Enero y Febrero son por lo general los mejores meses. Ya en esa época, las condiciones de suelo y clima por lo general van a permitir que las coronas sean transplantadas directamente del vivero al campo. En cualquier área, si el clima frio persiste y las coronas permanecen inactivas en el suelo por mucho tiempo después de haber sido transplantadas, puede ocurrir un considerable deterioro y daño en las raíces carnosas y las rizomas. Algunos investigadores han encontrado que el pulverizar o sumergir las coronas con un fungicida puede prevenir este deterioro efectivamente, pero los resultados no han sido consistentes.

Siembra de Coronas de Esparragos.
Crown planting of asparagus.

Método de Siembra

Los surcos se siembran con un arado largo con tabla de doble molde y alas extensivas. Se usan filas individuales y los surcos se hacen con una distancia de 5 a 6 pies entre ellos. La profundidad de los surcos debe de ser de 6 pulgadas por debajo del livel del campo. Un objeto pesado o una cadena larga y grande se arrastra generalmente después del arado para romper los terrones de tierra y formar lechos de semilleros parejos.

Las coronas se dejan caer dentro de los surcos a la distancia deseada, generalmente con equipo de tractor-trailer. Las coronas después se colocan a mano en posición recta y las raices esparcidas. Los estudios indican que a pesar de que la supervivencia de las coronas no se ve afectada por la orientación, la iniciación de las puntas de las coronas que se han sembrado al revéz se va a retrasar y se va a ver reducida la primera producción. Las coronas deben de ser cubiertas con 2 a 3 pulgadas de tierra y ser inmediatamente regadas, ya sea con riego por surco o por aspersión, para fijar el suelo alrededor de las coronas.

Después de que las puntas han salido, la tierra se debe agregar al surco en pequeñas cantidades. Lentamente llenando el surco a medida que progrese la temporada y esto ayuda a controlar la maleza.

La Distancia En-la-Hilera

Las distancias entre las coronas en las hileras van a variar con el agricultor. Las distancias más comúnmente usadas en el pasado eran 12 pulgadas entre cada planta. Las pruebas muestran poca diferencia en el rendimiento entre la distancia de 12 y 18 pulgadas. Distancias más cercanas dan rendimientos mayores solamente durante la primera etapa de vida de los lechos; y no parece que valga la pena los costos extras en los cuales se incurre.

Riego

Después de que las coronas han sido cubiertas con aproximadamente 2 a 4 pulgadas de tierra, los campos deben ser regados para fijar la tierra alrededor de las coronas. Si se usa riego de surco, el agua debe hacerse correr en el surco sobre las coronas. También se puede usar riego por aspersión, pero puede causar un mayor problema de maleza de lo que causaría el riego por surco. Reigos subsequentes deben hacerse a medida que se necesiten para mantener el crecimiento normal de las plantas.

Control de Maleza

El control de maleza es un problema en la mayoría de los lechos de esparragos. Cultivar durante la primera parte de la primera temporada de cultivo va a ayudar para el control de algunas malezas. La deshierbada a mano es muy cara y prohibitiba en la mayoría de las plantaciones. Se están probando cada año herbicidas para controlar ambas malezas de pre-surgimiento y post-surgimiento. Consulten su Asesor local para tener las últimas informaciones concernientes.

EL VIVERO DE ESPARRAGOS

El objetivo de un vivero en el campo es reproducir el número máximo de coronas de buen tamaño en la mínima cantidad de espacio de tierra.

Selección del Lugar

Una tierra suelta, liviana y desmenuzable es lo mejor para la germinación de las semillas y crecimiento de las plantillas, y va a ser de ayuda cuando se hagan las operaciones de cavar y hacer pasos a nivel cuando se levanten las coronas.Las tierras abonadas con estiercol son satisfactorias, pero las tierras pesadamente barrosas son difíciles de trabajar y deben de ser evitadas. La tierra debe tener buena retención de agua, pero ser lo suficiente porosa para tener buen drenaje. Asegurarse que el área de siembra no tenga hundimientos donde el agua se pueda estancar, o el surgimiento se va a ver reducido y van a ocurrir pérdidas de plantas. Un nivel de pH de suelo entre 6.5 y 7.5 es lo deseado.

Tiempo de Siembra

El vivero debe ser sembrado tan temprano en la primavera como lo permita el clima. Una siembra anticipada toma ventaja de la humedad natural del suelo para la germinación y provee el período de máximo crecimiento.

La semilla de esparrago es lenta para germinar en clima frio (Tabla 2) y muy a menudo requiere de varias semanas para que las plantas surgan. El remojar las semillas antes de sembrar por 3 a 5 días a temperaturas de 86º a 95º F va apresurar la germinación. Las semillas deben ser esparcidas sobre papel periódico y ser secadas parcialmente antes de sembrar.

Siembra

En un vivero, las semillas de esparragos generalmente son sembradas en filas individuales sobre lechos alzados con una distancia de 18 a 30 pulgadas entre si, pero una siembra plana con distancias similares entre los surcos puede ser utilizada. La profundidad de la siembra es de 1 a 1 1/2 pulgadas. En suelos más arenosos, los agricultores prefieren sembrar a 1 1/2 a 2 pulgadas de profundidad para asegurarse una humedad de suelo adecuada.

Las semillas deben ser sembradas con un plantador comercial de precisión.

Distancias

Es importante tener distancias iguales entre las plantas en el vivero. Las plantas que están muy apuñadas tienen tendencia a producir coronas más pequeñas de aquellas que estan más distanciadas. Las plantas deben ser sembradas más o menos 3 pulgadas de distancia dentro del surco. Si las semillas son sembradas más densamente, las plantas pueden desarrollar raices pequeñas y entrelazadas y va a ser difícil separarlas sin dañarlas al momento de sacarlas. Debido a los altos costos de mano de obra no es economicament factible ralear los semilleros después de que las plantillas han surgido.

Riego

Una humedad adecuada es esencial para una buena germinación. Riego de aspersión o surco son ambos satisfactorios para el vivero de esparragos. Sinembargo, se debe tener cuidado en hacer surcos de riego en siembras planas para no causar estorbos en los surcos de semilla. Los riegos subsecuentes deben hacerse a medida que se necesiten para mantener la tierra húmeda pero no saturada.

Control de Maleza

El control de maleza es un problema en la mayoría de los viveros de esparragos. Muchos agricultores prefieren fumigar la tierra en el vivero antes de sembrar ya que esto puede eliminar mucho del problema de maleza. Una nebulización de presurgimiento como es paraquat puede ser también aplicada a la tierra para mantener bajo el crecimiento de maleza. Los herbicidas de contacto no deben ser utilizados después de que aparezcan las plantillas

TABLA 4, POBLACION DE PLANTAS A VARIAS DISTANCIAS EN-FILA, DISTANCIAS ENTRE LOS SURCOS, Y PROPORCION DE GERMINACION EN UN VIVERO DE ESPARRAGOS.

Distancias en-fila (pulgadas)		2	3	4	5	6
Plantas por pie (en-fila)		6	4	3	2.4	2
% de Germinación	Distancias entre filas (pulgadas)	Plantas por acre				
100	15	209,088	139,392	104,544	83,635	69,696
	18	174,240	116,160	87,120	69,696	58,080
	21	149,348	99,565	76,674	59,739	49,782
	24	130,680	87,120	65,340	52,272	43,560
95	15	220,092	146,728	110,046	88,036	73,364
	18	183,410	122,273	91,705	73,364	61,136
	21	157,208	104,805	80,709	62,883	52,402
	24	137,557	91,705	68,778	55,023	45,852
90	15	232,320	154,880	116,160	92,927	77,440
	18	193,600	129,066	96,800	77,440	64,533
	21	165,942	110,627	85,193	66,376	55,313
	24	145,200	96,800	72,600	58,080	48,400
85	15	245,985	163,990	122,922	98,394	81,995
	18	204,988	136,658	102,494	81,995	68,329
	21	175,703	117,135	90,204	70,281	58,567
	24	153,741	102,494	76,870	61,496	51,247
80	15	261,360	174,240	130,680	104,543	87,120
	18	217,800	145,200	108,900	87,120	72,600
	21	186,685	124,456	95,842	74,673	62,227
	24	163,350	108,900	81,675	65,340	54,450
75	15	278,784	185,856	139,392	111,513	92,928
	18	232,320	154,880	116,160	92,928	77,440
	21	199,130	132,753	102,232	79,652	66,376
	24	174,240	116,160	87,120	69,696	58,080
70	15	298,697	199,131	149,348	119,478	99,565
	18	248,914	165,942	124,457	99,565	82,971
	21	213,354	142,235	109,534	85,341	71,117
	24	186,685	124,457	93,342	74,674	62,228
65	15	321,673	214,449	160,836	128,669	107,224
	18	268,061	178,707	134,030	107,224	89,353
	21	229,766	153,176	117,960	91,906	76,587
	24	201,046	134,030	100,523	80,418	67,015
60	15	348,480	232,230	174,240	139,391	116,160
	18	290,400	193,600	145,200	116,160	96,800
	21	248,913	165,941	127,790	99,565	82,970
	24	217,800	145,200	108,900	87,120	72,600

TABLA 5. LIBRAS DE SEMILLA QUE SE REQUIEREN A VARIAS DISTANCIAS EN LA FILA, DISTANCIAS ENTRE-FILAS Y PROPORCION DE GERMINACION EN UN VIVERO DE ESPARRAGOS*

Distancias En-fila (pulgadas)		2	3	4	5	6
Plantas por pie (en-fila)		6	4	3	2.4	2
% de Germinación	Distancias entre las filas	Libras de semillas requeridas por acre				
100	15	10.5	7.0	5.2	4.2	3.5
	18	8.7	5.8	4.4	3.5	2.9
	21	7.5	5.0	3.7	3.0	2.5
	24	6.8	4.4	3.3	2.6	2.2
95	15	11.0	7.4	5.5	4.4	3.7
	18	9.2	6.1	4.6	3.7	3.1
	21	7.9	5.3	4.1	3.1	2.6
	24	6.9	4.6	3.5	2.8	2.3
90	15	11.6	7.8	5.8	4.6	3.9
	18	9.7	6.5	4.9	3.9	3.2
	21	8.3	5.5	4.3	3.3	2.8
	24	7.3	4.9	3.7	2.9	2.4
85	15	12.3	8.2	6.2	4.9	4.1
	18	10.3	6.8	5.2	4.1	3.4
	21	8.8	5.9	4.5	3.5	3.0
	24	7.8	5.2	3.9	3.1	2.6
80	15	13.1	8.7	6.6	5.2	4.4
	18	10.9	7.3	5.5	4.4	3.6
	21	9.3	6.2	4.8	3.7	3.2
	24	8.2	5.5	4.1	3.3	2.8
75	15	13.9	9.3	7.0	5.6	4.7
	18	11.6	7.8	5.8	4.7	3.9
	21	10.0	6.7	5.1	4.0	3.4
	24	8.7	5.8	4.4	3.5	3.0
70	15	14.9	10.0	7.5	6.0	5.0
	18	12.5	8.3	6.2	5.0	4.2
	21	10.7	7.1	5.5	4.3	3.6
	24	9.3	6.2	4.7	3.7	3.2
65	15	16.1	10.7	8.1	6.4	5.4
	18	13.4	9.0	6.7	5.4	4.5
	21	11.5	7.7	5.9	4.6	3.9
	24	10.1	6.7	5.1	4.0	3.4
60	15	17.4	11.7	8.7	7.0	5.8
	18	14.5	9.7	7.3	5.8	4.9
	21	12.5	8.3	6.4	5.0	4.2
	24	10.9	7.3	5.5	4.4	3.6

* Basado en 20,000 semillas por libra.

Para tener las últimas informaciones sobre fumigaciones y control químico de maleza, contacte a su Asesor Local.

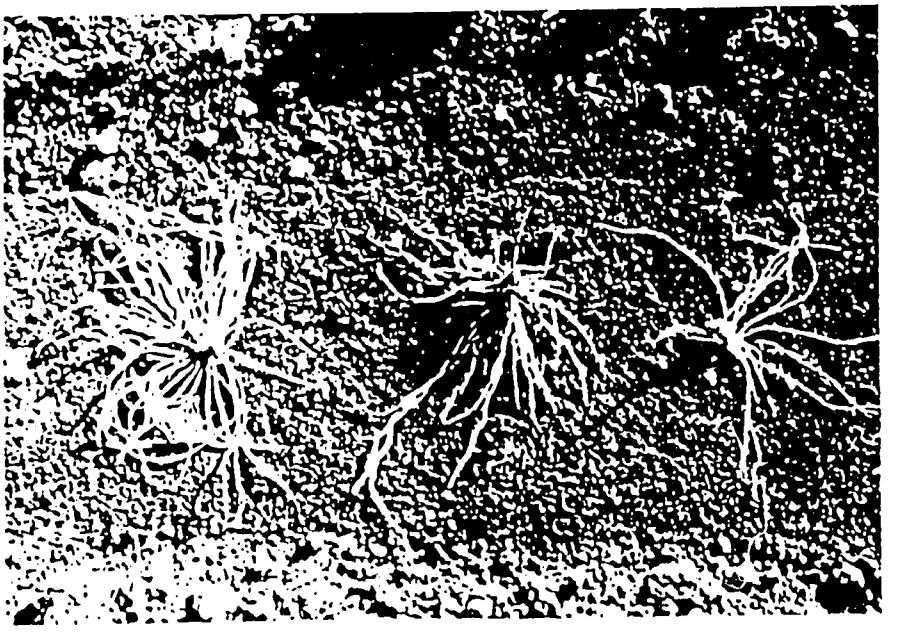
Sacando las Coronas

Diciembre y Enero son los mejores meses para sacar las coronas en California. Atrasar sacarlas hasta que los helechos estén muertos, las coronas estén inactivas, y la parte de arriba pueda ser cortada con una segadora y ser removidas del campo. Alze las coronas de la tierra con un sacador de papas modificado--esto va a sacudirle a las raices la mayor parte de la tierra y hacer más fácil la separación. Para evitar daños a las coronas, asegurarse que al sacarlas no se holle muy superficialmente.

Las coronas son graduadas a mano mientras se estan separando. Pago sembrar sólo coronas medianas y grandes que tienen brotes grandes y que no han sido dañadas al sacarlas. .13 a .15 de una libra (135 a 150 libras por cada millar de coronas) y estas deben de tener racimos de brotes. Experimentos (en New Jersey) han mostrado que no hay una diferencia significativa en el rendimiento de la puntas comercializables entre siembras de coronas grandes con relación a coronas medianas.

Almacenamiento de Coronas

Las coronas deben ser transplantadas en los lechos permanentes tan pronto sea posible después de haberlas sacado. En muchas áreas esto no es posible debido a las condiciones adversas de climas durante el invierno y los primeros dias de primavera. Si las condiciones no permiten transplantar inmediatamente, almacenar las coronas sueltamente en una bodega bien ventilada a una temperatura de 35º F. Debe evitarse que las coronas se sequen y se congelen, ya que esto puede resultar en daños severos o pérdida completa. Las coronas que deben permanecer inactivas por cualquier lapso de tiempo generalmente son empacadas sueltamente en cajones de gran capacidad y mantenidas en un almacenamiento controladamente frio. Mucho agricultores sumergen sus plantas en una solución de Benlate antes de almacenarlas, a pesar de que no se ha encontrado ninguna ventaja en la sobrevivencia de las plantas.



Typical variability in nursery-grown 1-year-old crowns.

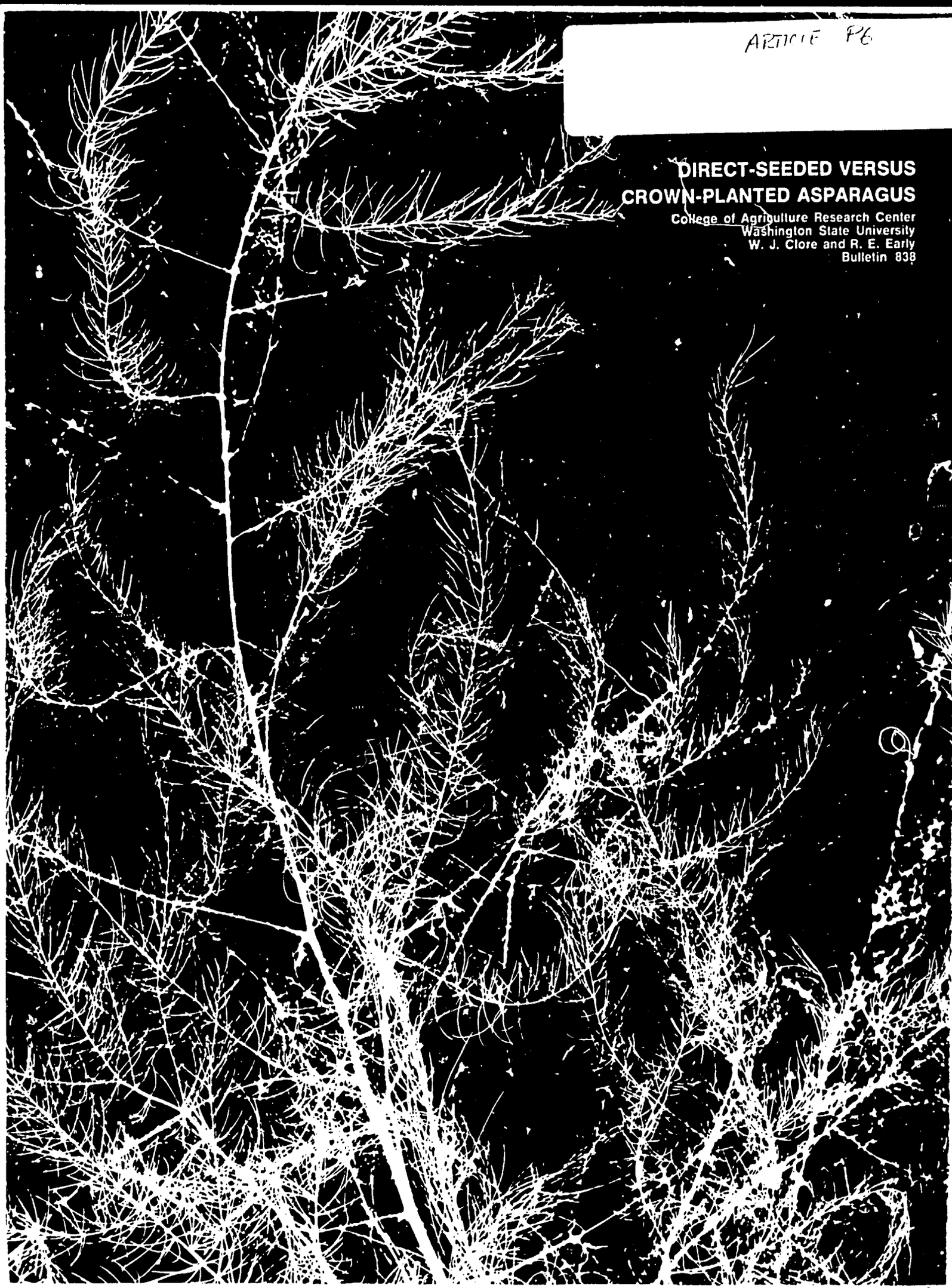
Variabilidad típica en coronas de 1 año cultivadas en vivero.

ARTICLE P6

DIRECT-SEEDED VERSUS CROWN-PLANTED ASPARAGUS

College of Agriculture Research Center
Washington State University
W. J. Clore and R. E. Early

Bulletin 838



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DIRECT-SEEDED VS. CROWN-PLANTED ASPARAGUS

W. J. Clore and R. E. Early[1]

INTRODUCTION

Asparagus (*Asparagus officinalis* L.) has customarily been seeded in nursery plantings for concentrated production of crowns to be used for planting sizable acreages of asparagus the following year. In an effort to reduce costs and increase yields, seeding in the bottom of listed furrows was first effectively done in 1958 by Hanna (4) of the University of California at Davis. He found for the first 6 years the direct-seeded planting yields were higher than crown plantings. Spears were larger for the first 5 years in the crown plantings. Subsequent cuttings showed no significant difference in yield or spear size. Similar responses have been reported orally for 3- and 4-year-old commercial plantings in other areas of California. More recently, a Michigan study (11) showed that asparagus from seed yielded as much as that from crowns after the third year, but spears were appreciably smaller.

The asparagus direct seeded at Davis was spaced about 1 inch apart in the row. The question arose whether this might be too close under Washington conditions and might result in thinner spears. Earlier spacing studies (1,3,5,10) were all conducted with planted crowns and showed rather consistently that yields increase as spacing between plants decreases. Spears were thinner (1,2,3,5,10) at 12-inch crown spacing than at greater spacings, but the reduction in size was of no practical significance. Moran and Isaacs (6) later reported that the 6-inch spacing was superior to 12-, 18- and 24-inch spacings in number of spears and total weight of asparagus produced per acre. They found that the greater number of spears per plant in wide spacings did not compensate for the fewer plants per acre. Also spears were heavier at 18- and 24-inch plant spacings than at 6- to 12-inch spacings.

Takatori et al. (8,9) and Sims et al. (7) describe the precision and attention necessary in establishing direct-seeded plantings of asparagus. Important factors to consider are field selection, cultivars, time and method of planting, fertilizing, seedbed preparation, seeding equipment, seeding rate and depth, weed control and irrigation.

Research to determine the value of direct seeding asparagus on irrigated farm land in semiarid areas of Washington was begun in 1968. Results are reported for the first 8 years of this research.

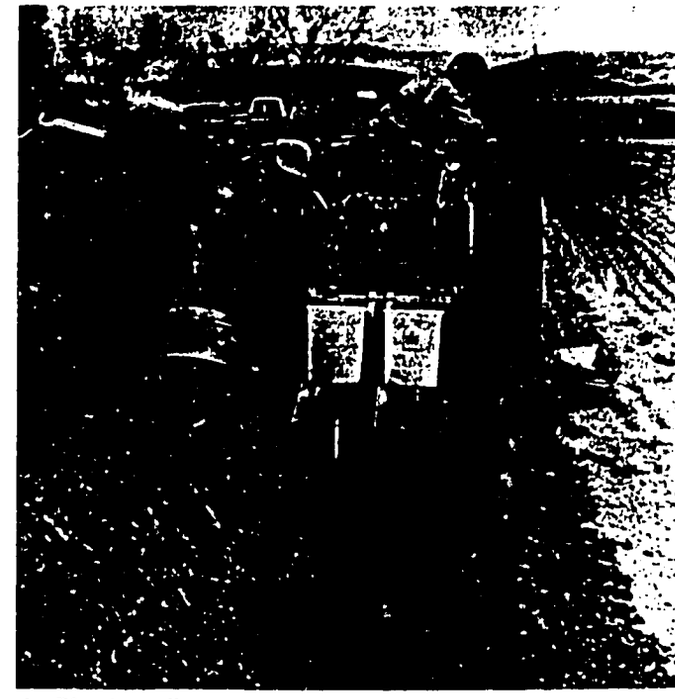
METHODS AND PROCEDURE

The research was done on the "Upper Unit" of the Irrigated Agriculture Research and Extension Center located on the Roza Project. The soil is a Ritzville over Sagemoor 36 to 60 inches to bedrock. Before planting, the field was irrigated and 240 lb of ZnMnS plus 640 lb of NH_4NO_3 per acre were applied broadcast. The field was disced, plowed 12 inches deep, packed, and harrowed, and laid off in alternate 20-foot borders and 50-foot plots. Asparagus planting methods, rows per plot, plant spacings and number of plants on an acre basis are listed in table 1. All treatments were replicated three times in a randomized complete block design.

On April 5, 1968, asparagus crowns of the variety 500-W, each weighing about 0.08 lb, were planted in single and double rows in furrows 10 inches deep. Seeded plots were planted on May 16, using two IH F-185 planters (with seed plate No. 3639-H) attached to a 27-inch wide lister plow that opened furrows to a depth of 6 inches. Seed of the asparagus variety 500-W was planted at a depth of 2 inches (fig. 1), and spaced 3 inches apart in the row. Seed sized between 7/64 and 9/64 screens was used.

A ditcher shovel placed between the planters had a pipe drag attached to it which made an open smooth furrow for irrigation. Irrigations were made on May 20, June 11, and July 2. Subsequent irigations were made at about 3-week intervals. Weeds in the row were controlled with Standard Oil solvent #325 applied 3 times at 3-week intervals. Some hand hoeing was necessary alongside the single rows and between the double rows.

By mid-July, asparagus seedlings were 4 to 6 inches tall. At that time plants were removed to establish the



1. Direct seeding asparagus in a double row with two IH F-185 planters.

[1] Horticulturist and research technologist, respectively, department of horticulture. Both authors are stationed at the Irrigated Agriculture Research and Extension Center, Prosser. Dr. Clore recently retired. Acknowledgment is given the Washington Asparagus Growers Association for grant funds partially supporting these studies. Work was done under project 0173.

Table 1. Asparagus planting method, number of rows per plot, plant spacing and number of plants per acre

Planting method	No. rows per plot[1]	Distance between rows feet	Distance between plants within row inches	No. plants per acre
1. Crowns	3-double	5	12	17,424
2. Crowns	4-single	4	12	[illegible],890
3. Direct-seeded	3-double	5	3	69,696
4. Direct-seeded	3-double	5	6	34,848
5. Direct-seeded	3-double	5	9	23,232
6. Direct-seeded	4-single	4	3	43,560
7. Direct-seeded	4-single	4	6	21,780
8. Direct-seeded	4-single	4	9	14,520

[1] Sets of double rows were spaced on 5-foot centers, and individual rows in each set were 14 inches apart.

desired spacings of 3, 6, and 9 inches between plants. Plants from the thinning were used to replace missing plants where required.

After the asparagus tops had turned brown in the late fall, the field was disced-leveled, fertilized with 100 lb of nitrogen per acre as ammonium nitrate, and harrowed. Starting in 1970, diuron was applied in the winter to control weeds the next growing season. All dormant season operations (chopping of the fern, applying fertilizer, and cultivating and ditching) were completed before the herbicide was applied.

Simazine was applied in alternate years to obtain a broad spectrum of weed control and to minimize the accumulation of herbicide residue. The sodium salt of 2,4-D was usually applied in the spring to control Russian thistle (*Salsola kali* L. var. *tenuifolia* Tausch). Irrigations of 4- to 6-acre-inches were usually applied at 3- to 4-week intervals from the end of the harvesting period until mid-October.

Conventional asparagus knives were used to hand-cut all spears so they had not less than 5 inches of green and 2 inches of white. Immediately after cutting, spears were taken to a workroom for grading. Spear counts and weights were obtained for each plot on all asparagus sorted into No. 1 and No. 2 marketable grades. No. 1 asparagus consisted of sound spears with a 3/8-inch minimum diameter 5 inches from the tip with the green color extending at least 4½ inches below the tip. Grade details and definition of terms are as used in "Washington Asparagus Growers Association Contract of Sale to Processor."

The data were subjected to a statistical analysis of variance and evaluated by Duncan's Multiple Range Test.

RESULTS

Crown-planted asparagus produced more fern growth than the direct-seeded plantings in October of the first year (fig. 2a). Fern growth of the direct-seeded asparagus averaged 20 to 24 inches and the fern from the crowns averaged 48 inches in height. By the end of the second season, there was little apparent difference in the total fern growth between crown-planted and direct-seeded asparagus (fig. 2b).

In 1970 (the first harvest year), spears emerged earlier from the direct-seeded plots than from the crown-planted plots (fig. 3). A total weight of 1.25 tons/acre of asparagus was harvested from both the direct-seeded plots and the crown-planted plots in 1970. However, the direct-seeded plots produced 1.25 tons/acre by April 25, while the crown-planted plots had to be harvested until May 15 to obtain the same yield. Also, the direct-seeded plots required only 15 cuttings while 30 cuttings were necessary to obtain the same weight of spears from the crown-planted plots.

Except for the first cutting year (1970), all harvesting periods began the first week in April. Cuttings were not extended beyond May 21 for the first two harvest seasons. During the remaining years, cuttings were discontinued between June 15 and 21. For the last 4 years of the study, beds were cut 48 to 64 times; the highest yields were obtained in 1975 with the fewest cuttings.

Total harvested tons per acre

Except for the first cutting year, significant differences were found among treatments (table 2). The usual order of yields with some marked variations in 1973 and 1974 was (in decreasing order):

1. direct-seeded, double row at 3, 6, and 9 inches in the row
2. direct-seeded, single row at 3, 6, and 9 inches in the row
3. transplanted crowns, double row
4. transplanted crowns, single row.

In all years except 1972 and 1975, the yields of the direct-seeded, double row at 3, 6, and 9 inches plots were significantly higher than the yields of all other treatments. Only in 1971 were the yields of the double row 6- and 9-inch seedings significantly less than the direct-seeded, double row at 3 inches.

Generally there were marked differences in yields of direct-seeded, double row 3, 6, and 9-inch plots and transplanted crowns. Only direct-seeded, single row 3-inch plots were superior to transplanted crowns in single rows.

Marketable tons per acre

For this report, the No. 1 and No. 2 grades were combined and reported as marketable asparagus. Marketable yields followed a trend similar to the ungraded yields. There were no significant differences between the direct-seeded, double row spacings for the years 1971 through 1975 and the total marketable yield for all years.

Except for direct-seeded, single row 3-, 6-, and 9-inch spacings in 1972, all single rows yielded less than the same spacings in double rows.

No differences in total or marketable yields were obtained between single row and double row transplanted crowns in any year. Only in 1972 did the direct seeded, single row plants outyield both double and single row transplanted crowns.

Percent marketable weight

The greatest differences in usable asparagus occurred during the first cutting year between transplanted crowns (66.1% marketable by weight) and direct-seeded (73.4%) plots. The greatest differences in percentages of usable asparagus between years occurred on direct-seeded plots between 1970 (73.4%) and 1974 (62.4%). Three years (1971, 1972 and 1975) out of six showed no significant difference in the percent of marketable asparagus. The average of all treatments showed the same percent of marketable asparagus (68.9%) except direct-seeded, single row 3- and 6-inch plantings (66.8%).

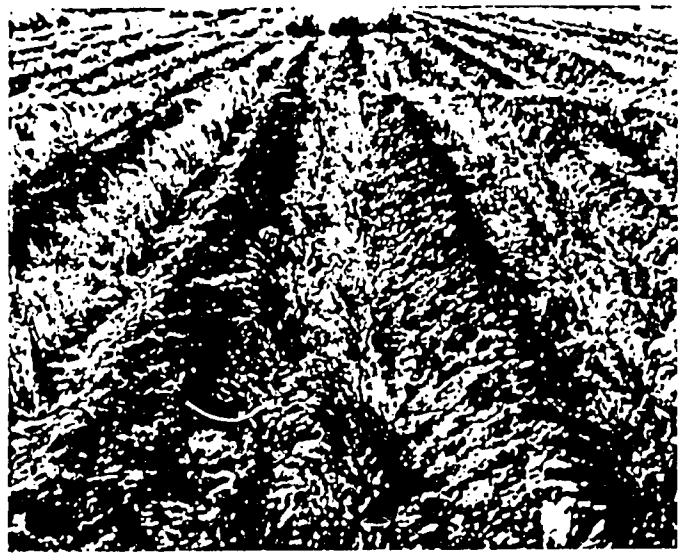
Spear weight

No difference in spear weight between plantings was found for 1970 and 1975. The transplanted crown, single row consistently produced the largest spears in all years, and spears were significantly larger in 1971, 1972 (except transplanted crown, double row) and 1973 (except transplanted crown, double row and direct-seeded, double row 9-inch spacing). In 1974, transplanted crown, single row spear weights were superior only to those of the direct-seeded, single row 3-, 6-, and 9-inch spacings.

The lowest spear weight was produced from direct-seeded, single row 3-and 6- inch spacings.

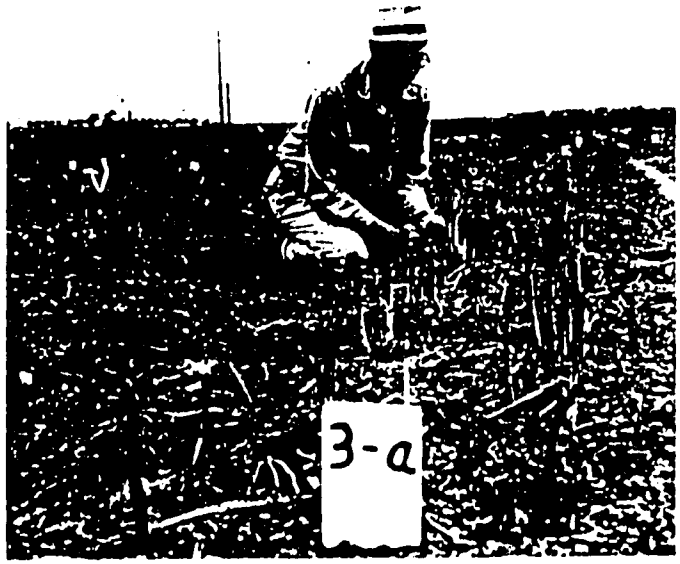
DISCUSSION

The higher marketable yields from 3-, 6- and 9-inch plant spacing in double rows is probably due to the denser plant populations (69,696; 34,848 and 23,232 per acre, respectively). Double rows of direct-seeded asparagus, spaced 3, 6 and 9 inches apart produced 4.35, 5.19 and 3.32 tons more per acre, respectively, than the same spacings of asparagus in single rows. Single rows direct-seeded and both single- and double-row



2a. Growth of asparagus in direct-seeded double row (foreground) compared to growth of asparagus in crown-planted rows (background) in October, 1968.

2b. At the end of the second season, the growth of the direct-seeded asparagus on the left was nearly equal to the growth of the crown-planted asparagus on the right.



3. In 1970, spears emerged earlier in the direct-seeded, double row (3-inch spacing) plot in the center than in the crown-planted plot on the left.

Table 2. A 6-year cutting comparison of single- and double-row transplanted asparagus crowns with that of direct-seeded asparagus (CV.500 W) for the period 1970-75 (planted in 1968)

Plantings	Years Harvested 1970	1971	1972	1973	1974	1975	Total
				Total Untrimmed Tons/Acre			
				Single Rows 4' Spacing (four 50' rows/plot)			
Transplanted Crowns (12" apart)[1]	1.13NS	2.04e[3]	4.53c	4.86c	4.79c	5.88c	23.22d
Direct Seeded (3" in row)[2]	1.35NS	3.51cd	6.62ab	4.95c	4.65c	7.26abc	28.32bc
Direct Seeded (6" in row)[2]	1.35NS	3.43cde	6.87ab	4.58c	3.97c	7.20c	26.40cd
Direct Seeded (9" in row)[2]	1.22NS	3.27cde	6.35b	4.75c	4.67c	6.64bc	26.89cd
				Double Rows (14" apart) on 5' Centers (Three 50' rows/plot)			
Transplanted Crowns (12" apart)[1]	1.26NS	2.26de	5.00c	5.28bc	4.90bc	6.04c	24.74cd
Direct Seeded (3" in row)[2]	1.28NS	4.61a	7.27a	6.53a	6.34a	8.17a	33.74a
Direct Seeded (6" in row)[2]	1.29NS	4.06b	7.08ab	6.39a	6.17a	7.80ab	32.79a
Direct Seeded (9" in row)[2]	1.15NS	3.67bc	6.82ab	6.05ab	5.90ab	7.72ab	31.29ab
				Marketable Tons/Acre			
				Single Rows 4' Spacing (four 50' rows/plot)			
Transplanted Crowns (12" apart)[1]	0.73NS	1.43d	3.20b	3.39bc	3.18bc	4.12c	16.06b
Direct Seeded (3" in row)[2]	1.01NS	2.48c	4.44a	3.00c	2.73c	4.91abc	18.57b
Direct Seeded (6" in row)[2]	0.98NS	2.47c	4.49a	2.83c	2.42c	4.14c	17.33b
Direct Seeded (9" in row)[2]	0.88NS	2.42c	4.43a	2.99c	2.90c	4.62bc	18.23b
				Double Rows (14" apart) on 5' Centers (Three 50' rows/plot)			
Transplanted Crowns (12" apart)[1]	0.83NS	1.60d	3.53b	3.63abc	3.15bc	4.17c	16.90b
Direct Seeded (3" in row)[2]	0.93NS	3.01ab	5.00a	4.24a	4.03a	5.72ab	22.93a
Direct Seeded (6" in row)[2]	0.94NS	2.95ab	4.97a	4.25a	3.99a	5.44ab	22.52a
Direct Seeded (9" in row)[2]	0.86NS	2.64bc	4.80a	4.09ab	3.81ab	5.36ab	21.55a
				Pounds/100 Spears			
				Single Rows 4' Spacing (four 50' rows/plot)			Average
Transplanted Crowns (12" apart)[1]	6.01NS	5.97a	6.30a	6.23a	6.35a	6.16NS	6.17a
Direct Seeded (3" in row)[2]	4.90NS	4.66c	5.23c	5.12c	5.32d	5.72NS	5.16d
Direct Seeded (6" in row)[2]	4.87NS	4.75c	5.22c	5.20c	5.44cd	5.67NS	5.19cd
Direct Seeded (9" in row)[2]	5.06NS	5.02bc	5.51bc	5.52bc	5.62bcd	5.94NS	5.44bcd
				Double Rows (14" apart) on 5' Centers (Three 50' rows/plot)			
Transplanted Crowns (12" apart)[1]	5.84NS	5.30b	5.99ab	5.89ab	5.92abc	5.85NS	5.63bc
Direct Seeded (3" in row)[2]	5.68NS	5.17b	5.57bc	5.62b	5.85abc	5.91NS	5.53bcd
Direct Seeded (6" in row)[2]	5.07NS	5.25b	5.66bc	5.70b	5.91abc	5.95NS	5.59bcd
Direct Seeded (9" in row)[2]	5.12NS	5.24b	5.61bc	5.88ab	6.02ab	6.08NS	5.66b

	No. of Cuttings		No. of Cuttings
[1] 1970 - Cut March 30 to May 15	30	[2] 1970 - Cut March 30 to April 15	15
1971 - Cut April 9 to May 21	32	1971 - Cut April 9 to May 21	32
1972 - Cut April 7 to June 17	60	1972 - Cut April 7 to June 17	60
1973 - Cut April 2 to June 16	64	1973 - Cut April 2 to June 16	64
1974 - Cut April 5 to June 15	61	1974 - Cut April 5 to June 15	61
1975 - Cut April 21 to June 20	48	1975 - Cut April 21 to June 20	48

[3] Means in the same column with a common letter are not significantly different (P=0.05) by Duncan's Multiple Range Test

transplanted crowns produced the lowest yields. With few exceptions, the double row, direct-seeded plots outyielded all other plots after the first cutting year.

The sustained production of direct-seeded asparagus in this study perhaps was due to the higher plant populations and the fact that the plants had developed in place from seed. Also, seedlings grown undisturbed, in contrast to nursery-dug crowns for planting, are likely to be stronger and freer of disease. Further, with the greater number of plants per acre, a substantial loss of plants can occur without a reduction in yield, as in all probability the stronger plants will survive.

SUMMARY

Direct-seeded asparagus and 1 year-old crowns planted the same year produced the same yield in the third season. After the first season's cutting, the direct-seeded, double row plots produced more marketable asparagus in nearly all the following years.

Direct seeding asparagus in double rows was superior to direct seedings in single rows or crown planting in either single or double rows.

At the end of 6 cutting years, direct-seeded, double row plantings (3, 6, and 9 inches in the row) outyielded all direct-seeded, single row plantings at the same in-the-row spacings or crowns planted in either single or double rows. For the 6-year cutting period, all direct-seeded, double row plantings averaged 4.29 tons/acre more than single row plantings. The direct-seeded, double row plantings averaged 5.43 tons/acre more marketable asparagus than the double row crown plantings.

The percent marketable spears was as high for double row, direct-seeded plantings as for single and double row, crown plantings.

The best spear size was consistently produced in the single row, crown planting (6.17 lb/100 spears). However, the remaining plantings produced acceptable sizes varying from 5.16 to 5.66 lb/100 spears.

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COMMERCIAL GROWING OF ASPARAGUS

FARMER'S BULLETIN NO. 2232 / U.S. DEPARTMENT OF AGRICULTURE

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Cover Illustration.—Asparagus spear being cut for market.

This Bulletin Supersedes Farmers' Bulletin No. 1646, "Asparagus Culture."

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Commercial Growing of Asparagus

Prepared by Northeastern Region, Agricultural Research Service.[1]

Asparagus is a valuable early vegetable and an important perennial crop. It is healthful and palatable as a fresh vegetable as well as a canned or frozen product.

California leads all other States in asparagus production, followed by New Jersey and Washington. Illinois, Massachusetts, Michigan, Oregon, and Maryland produce significant but much smaller quantities for fresh consumption. Illinois, Michigan, Maryland, Delaware, and Oregon grow progressively smaller tonnages for canning and for freezing.

The total acreage of commercial asparagus in the United States—approximately 150,000 acres—has changed little in the last decade. Average yields are 2,200 to 2,600 pounds per acre.

Far more asparagus is grown for processing than for sale as a fresh product. This gap is expected to become even wider. Increasing amounts are grown for canning.

[1] The help of J. Howard Ellison in preparing this publication is acknowledged. He is a research specialist in vegetable crops at Rutgers University, New Brunswick, N.J.

CLIMATIC AND SOIL REQUIREMENTS

Asparagus grows wild in many places where the seed has been scattered by wind, water, birds, and other carriers. Although the plant is grown in home gardens in nearly all sections of the country, conditions for commercial production are limited. Asparagus is a native of temperate regions and cultivation is most successful where low temperatures or drought stops growth of the plant and gives it a rest period.

Commercial asparagus culture should not be undertaken in areas where the plant continues to grow throughout the year. If the plant does not have a rest period, the shoots may become less vigorous and more spindly each year.

Yields in Southern States are often only one-third to one-half as great as yields in Northern States. Nutrition, cultural practices, and other factors may contribute to these differences; but it is believed that the lack of a winter rest period in the South is mainly responsible. In some sections that have mild winter temperatures and low rainfall the required rest period can be

induced by drought. In the Imperial Valley of California, for example, asparagus is given its rest period by withholding irrigation water.

Asparagus can be grown on many kinds of soil, but good drainage is essential. The asparagus plant has an extensive root system and for maximum development must have an open well-drained soil. The best types of soil for permanent plantings are deep, loose, and light, such as mucks and light sandy loams. Since early-spring growth depends on the reserve food in the fleshy roots, the soil should allow full development of the storage roots. These roots may reach a length of more than 10 feet. Where early growth is important, a soil that warms up readily in the spring is essential.

Very light sandy or gravelly soils having a porous subsoil should be avoided. The moisture-holding capacity of such soils is too low for profitable asparagus production. Soils having a gravelly or hardpan subsoil are also undesirable. Many of the commercial asparagus soils of the South have a light sandy topsoil underlain by clay. Heavy soils are not the best, but they may be satisfactory for asparagus if they are not so heavy that they bake. Heavy soils are more difficult to work, and they warm up slowly.

Asparagus is found growing naturally on the banks of streams and near salt marshes, where the salt content of the soil is high and the reaction somewhat alkaline. It does well in moist places, if the water table does not come within 4 feet of the surface.

Asparagus will thrive in soils having a salt content too high for many other crop plants, but it will not tolerate extreme acidity. Soils ranging from slightly acid to slightly alkaline are best for asparagus. Land known to be very acid should have an application of lime to make the reaction nearly neutral before planting asparagus.

Asparagus has a broad tolerance to various salts. This makes it possible to grow asparagus on land that is too alkaline for other crops. However, the yields are likely to be lower and the life of the planting shorter on such land than where soils are nearly neutral in reaction.

FERTILIZING BEFORE PLANTING

The long time that the land is occupied by asparagus planting makes it highly desirable that the soil be fertile, free of weeds, and put into the best condition before plants are set. The fertilizer practice depends on local soil and climatic conditions.

Asparagus thrives best in soils well supplied with humus. In mineral soils, the application of some organic material may be more important than the addition of nitrogen, phosphorus, and potassium. Peat and muck soils may need the addition of only one or more of the fertilizing elements to put them in a good state of fertility. Some organic soils need no fertilizer before plants are set.

Organic matter may be supplied in the form of animal manure or, better still, by turning under a green crop. Cowpeas, soybeans, vetch, or clover are preferred because they

add some nitrogen to the soil. Small-grain crops such as rye, wheat, oats, or barley can also be used.

In turning under a green manure crop, attention should be given to its effect on the nitrogen supply in the soil. To keep nitrogen available growers should apply a nitrogen fertilizer to aid in the decomposition process. Leguminous green-manure crops turned under while green and succulent decompose more rapidly than woody material and are less likely to cause nitrogen starvation during decomposition. Green manure should be turned under the season before asparagus crowns are set.

In general, the longer the land has been in cultivation the greater is the need for one or more of the fertilizer elements. Soils in the eastern part of the country are more likely to require high rates of commercial fertilizer than western soils. Specific rates are determined by soil analysis. The fertilizer should be broadcast and thoroughly mixed with the soil. The application of part of the commercial fertilizer may be delayed until after the crowns are set. This part should be applied along the rows and worked into the soil by cultivation.

If a legume is turned under as a green-manure crop, less nitrogen will be required in the commercial fertilizer. Furthermore, soil origin and climatic conditions influence soil fertility and fertilizer requirements. Because of many such variables, no single fertilizer practice is best under all conditions.

MAINTAINING FERTILITY

Asparagus plantings should be fertilized every year except where trials indicate otherwise. Fertilizer needs and practices vary according to locality, soil type, cultural practices, and the time of season that fertilizers are applied.

Research has shown that potash is the most important fertilizer element for growing asparagus on soils in the Atlantic Coastal Plains areas. An effective formula is to apply 1,600 pounds of 5-10-15 fertilizer. This supplies 80 pounds nitrogen, 160 pounds phosphorus, and 240 pounds potash per acre. Where asparagus is grown on deep, fertile soils, the need to apply fertilizer is diminished.

The time of season when fertilizers are applied is not important in relation to yield. Previously, growers divided fertilizer into a two-part application: The first was applied before growth started in the spring, the remainder at the end of the cutting season. The latter application was made to stimulate top growth and storage of reserve food in the roots. However, this split-application does not produce an increase in yield over the same fertilizer applied either before or after cutting. Also, where 1,600 pounds per acre of a 5-10-15 fertilizer is used prior to the harvest season, there is no need for sidedressing. If potash is applied at a low rate in the spring, yields can be increased by applying a sidedressing of potash at a rate of 100 pounds per acre in early August. The value of a nitrogen sidedressing during the cutting season is questionable.

Tests in the eastern United States have demonstrated that ridge culture of asparagus increases yield. This yield increase results from pro-

duction of larger spears. However, the most productive yields can be obtained by using ridge culture in combination with the application of a fertilizer high in potash and an effective herbicide. The recommended rate, as previously stated, is 1,600 pounds per acre of a 5-10-15 fertilizer. Applications of 1.6 pounds of monuron per acre should be made twice annually to control weeds. Probably the greatest benefit derived from use of a herbicide is the avoidance of root damage by not having to use a cultivator in the field.

Fertilizer application in the spring can be either the broadcast, over-the-row, or band method. In the broadcast method the fertilizer is applied about 3 inches deep with a grain drill. Over-the-row method consists of applying the fertilizer in 18-inch-wide strips and then working it into the soil by discing. In band placement, the fertilizer is applied about 3 inches deep on each side of the row. Research shows that the over-the-row method is superior in the early stage of a planting and the broadcast method after the eighth cutting season.

Research has also demonstrated that tissue analysis of fern (brush) from plots can be used as a diagnostic aid to determine the correct fertilizer formulation for a particular type soil.

Asparagus needs calcium. It thrives best on soils having a pH of 6.0 to 6.5. Many eastern soils require regular applications of lime to maintain the calcium content and proper soil reaction. As much as 1,000 to 2,000 pounds of limestone may be required annually for a period of years until the calcium content becomes fairly high. Many eastern soils are also low in magnesium. Where this is the case, apply a dolomitic lime high in magnesium.

VARIETIES

There are only a few varieties of asparagus, and their varietal differences are not well defined. Male and female flowers are borne on different plants. This dioecious condition results in a constant mixing of strains in the field which makes it difficult to obtain seed that will produce plants uniform in type and true to varietal characteristics. Since the crowns are propagated almost wholly from seed, wide variation may appear in any lot of crowns unless special effort is made to isolate the seed-producing plants from the pollen-producers. Where more than one variety is grown for seed, careless handling of seed stocks soon results in mixture and in less distinct varietal differences.

Because of these facts and because the bed or field to be planted will last for many years, care in selecting planting stock is important.

Asparagus varieties are of two general types based on the color of the spears. The more important group includes the varieties Mary Washington, Martha Washington, Reading Giant, Palmetto, and Argenteuil. Spears of this group become dark green in sunlight. The less important group includes such varieties as Conover's Colossal and Mammoth White. These produce light-green or whitish spears. These

light-colored varieties should not be mistaken for white (blanched) asparagus that is grown for canning. The whiteness required for these canned spears is produced by covering the crowns of either the light-green or dark-green varieties with a ridge of soil several inches deep. The blanched spears are cut just as they break through the soil and before they are exposed to sunlight.

The more rust-resistant Mary Washington and Martha Washington varieties have replaced the older light-green varieties and the dark-green variety, Palmetto. Reading Giant and Argenteuil have also largely been replaced by the Washington varieties.

Besides rust resistance, the Washington varieties have high commercial quality. They are fully equal or superior to other leading varieties on the market in earliness, vigor of growth, and size and quality of shoot. They are also more uniform in size, shape, and color than the old standard varieties; and they produce large spears.

Since 1940, several selections of Washington-type asparagus have been introduced. These selections are reported to be partially resistant to rust, but none is immune to rust when conditions favor rust development. Of these, California 500, developed in that State, is the most extensively grown in the West. Seneca Washington and Waltham Washington were developed in the East. New Jersey Approved was developed in that State by the selection of early, vigorous plants which were moved to an isolated area for seed production. Only first generation seed from the selected plants is recommended.

In establishing a new planting it is important to use one of the rust-resistant varieties, especially in localities subject to rust epidemics. In fact, many nurserymen and plant growers now list only the varieties resistant to asparagus rust. More information on rust is given in this bulletin in the section on asparagus diseases.

GROWING AND HANDLING CROWNS

Where a large acreage of asparagus is to be planted, a grower should raise his own plants. The advantages far outweight the disadvantages: (1) The grower can select his own source of seed; (2) it usually costs less to grow large quantities of crowns than to buy them; (3) special care can be exercised to produce large healthy crowns; (4) selection can be practiced and only the best crowns transplanted; (5) the crowns can be transplanted soon after digging with less injury from exposure and drying.

The first essential in growing crowns is to buy good seed of the desired variety. The crossing that occurs in the field, as already mentioned, adds greatly to the difficulty of obtaining seed of known quality. Unless special care is exercised in the selection and handling of both the seed-bearing and the pollen-bearing plants, the seedlings may be somewhat variable.

Seed capable of producing high-yielding crowns can be obtained only by the selection of high-yield-

ing parents. High-yielding male and female plants should be selected and isolated in such a way that the selected female plants receive pollen only from the selected males. Seed obtained from parents selected and protected in this way will produce crowns capable of a much higher average yield than seed from unprotected field-grown parents. But even a small difference in yield per crown resulting from careful selection of seed stock may mean great difference in profit over the lifetime of the planting.

Close attention must be given the seedbed if good results are to be obtained. Land virgin to asparagus should be used for the seedbed to avoid Fusarium root-rot (see "Diseases", page 19). The soil should be worked until it is free of clods; germination is likely to be poor in a rough, cloddy soil. A finely pulverized, well-prepared seedbed permits the seed to come into closer contact with soil particles, thereby hastening and improving germination.

Asparagus seed is slow to germinate; plants appear above ground in 4 to 6 weeks, depending on soil temperature, moisture, and depth of covering. Asparagus seed absorbs water slowly at temperatures below 70° F.; and if dry seed is planted in cold soil, several weeks may be required for the seedlings to appear. Germination of asparagus seed can be hastened by soaking the seed in water. Seed so treated, however, must be handled properly or more loss than gain may result. Seed should be soaked at a temperature of 85° to 90° F. for 4 or 5 days. After soaking, the seed must be dried and planted at once. Otherwise, decay organisms may develop and damage the seed. For best results, soaked seed should be planted in moist soil.

Asparagus seed should be planted early in the spring, as soon as the soil becomes warm enough for germination. The best soil temperature for germination is betwen 75° and 85° F. Below 70° germination is very slow.

Early planting lengthens the growing season and makes it possible for larger crowns to develop. In the Imperial Valley of California, asparagus seed is often planted late in January or early February; in the North, frequently in late May; and in New Jersey, in early April.

If germination is known to be good, seed should be planted thinly. It is better to allow enough space for plants at seeding time than to attempt to thin them later. Thinning is difficult, and if the crowns are grown so close together that the roots are interwoven, they are hard to separate after digging. Moreover, thin seeding saves time and reduces root injury in separating the crowns. The best spacing can be obtained by planting with a mechanical seeder, which can be adjusted to drop a single seed at regular intervals.

In growing asparagus crowns for field planting, seed should be planted in rows 24 to 30 inches apart and 10 to 12 seeds per foot of row. At this rate, 1 to 2 pounds of seed will grow enough crowns to plant an acre.

Depth of planting depends upon the type of soil and the moisture conditions. The heavier the soil, the

shallower the seed should be covered. Seed is covered primarily to provide proper moisture for germination. In light peat the seed may have a 3-inch cover; in sandy loam 1½ inches is enough, provided the soil is sufficiently moist for germination.

Weeds should be controlled by cultivation, by use of herbicides, or by a combination of the two. Cultivation should be shallow, especially late in the season, to prevent injury to the developing roots.

Before the crowns are dug, the old tops should be cut and removed so they will not interfere with the digging. A potato digger is best for lifting asparagus crowns. U-shaped blades may cut the roots too short, and a plow makes too much work in separating crowns from the soil. In digging the crowns care should be exercised to avoid injuring the roots. If the plants are lifted without injuring the tips of the fleshy roots, the roots will continue to elongate after being transplanted. Since the fleshy roots are essentially storage organs, it is important that their development be checked as little as possible.

Crowns should be set as soon as possible after they are dug. If it is necessary to keep the crowns for a period before setting them out, they should be stored in a dry, protected place at a temperature near 40° F. Crowns should not be stored in pits; they may be injured by heating. And they should not be allowed to dry out excessively.

Experiments conducted in California showed that yields from dried crowns were much less than those from crowns not permitted to dry out. Although greatest reduction occurred during the first cutting season, the injurious effect of drying the roots was still apparent in the second season.

STARTING THE PLANTING

Local climatic conditions must be considered in determining the best time to plant crowns. In most sections of the country asparagus crowns are set as early in the spring as the soil can be worked. In some parts of the South and in the Delta and Imperial Valley districts of California, where climatic conditions are favorable, the roots are set late in the fall or during the winter. Fall and winter planting is necessary in some districts because heavy rains may interfere with spring planting. Spring planting is preferred in the North because fall-planted roots may be injured by cold before they become established.

Age, Size, and Sex of Crowns

One-year-old crowns are the most desirable for setting. Under some conditions the grower may be justified in planting small, 2-year-old crowns, but crowns more than 2 years old should never be used. Divisions of old crowns are entirely unsuited for setting a new bed. Two-year-old crowns should not be used unless there is sufficient space in the nursery row for proper development. More productive plantings can be obtained by using 1-year-old roots. Where the crowns are grown very close together, the fleshy roots may be injured in separating the crowns. Severe root

injury materially reduces the yield in following years.

It is profitable to grade asparagus crowns on the basis of size and vigor, and to keep only the largest and best developed roots for planting. All small, weak crowns and those having many small buds should be discarded. They tend to produce a high percentage of unsalable spears. A desirable root for planting has a large, well-developed root system with large buds well distributed over the crown.

Female plants produce larger spears than male plants, but male plants produce a larger number of spears with a greater total weight. The difference is so small, however, that it seems advisable for the grower to pay particular attention to the selection of large, vigorous 1-year-old roots and leave the matter of sex to chance. Sex cannot be determined in most plants until the second year of growth.

Soil Preparation

The soil in which asparagus crowns are to be set should be plowed deep and worked down by thorough disking. Furrows for the crowns can be opened with a double moldboard plow or some other suitable implement (fig. 1). The depth of the furrow will depend on the soil type. A deeper furrow is required in loose soil than in heavy soil because the crowns are set 6 to 12 inches deep in loose soil and only 3 or 4 inches deep in heavy soil.

Planting Distances

Planting distances are best determined by the grower. The distances depend on whether white (blanched) or green asparagus is to be grown, the type of cultivation to be practiced, the section of the country, soil conditions, and the size of the planting.

Green asparagus does not require as much space between rows as white asparagus. Asparagus that is blanched by keeping soil ridged over the crowns should be spaced about 7 to 8 feet between rows to provide enough soil to form the ridge. For growing green asparagus the distance between rows is preferably 4 to 5 feet. If green asparagus is to be marketed early in the season and blanched asparagus from the same bed is to be marketed later in the season, the rows should be spaced for growing the blanched product.

Spacing between plants for green asparagus must be adjusted to local conditions. Twelve-inch spacing in rows 4 to 5 feet apart is suitable for the east coast and the Midwest. In

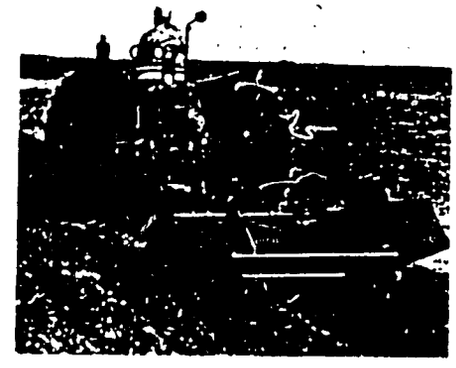

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Figure 1.—This implement is a type used to open furrows for setting asparagus crowns. The blade can be adjusted to make furrows of the proper depth.

California, 12 inches between plants is preferred in rows 5 feet apart for green and 8 feet apart for white asparagus.

A large percentage of small spears will be produced if crowns are set too close together. Too much space between plants reduces yields even though the spears are larger.

Setting the Crowns

Deep planting of crowns, formerly a general practice, is no longer recommended. In loose, light, organic soil, such as muck, crowns should be planted deeper than in the heavier mineral soils. Most commercial plantings in light soils are made at a depth of about 8 inches. In mineral soils it is doubtful whether it is a good practice to set deeper than 4 inches. Experiments in Massachusetts in mineral soil showed that the loss of plants after setting increased from 11 percent at 4 inches to 34 percent at 8 inches.

Wild asparagus plants are known to do well with no more covering over the crown than resulted from the natural covering of the seed. This indicates that home-garden asparagus probably can be obtained from crowns which grow from seed and are not even transplanted. Where deep planting is practiced it is best to cover the crowns to a depth of only 2 or 3 inches at planting time and to increase the covering by filling in the planting furrows gradually as the shoots develop.

Although careful spreading of the roots is a good practice and should be done in small plantings, generally no attempt is made to spread the roots in large plantings, as it requires considerable time and labor.

CULTIVATION AND CARE

Cultivation should begin soon after the crowns are planted and should continue throughout the season at intervals frequent enough to keep down weeds. Any stirring of the soil should be shallow, since serious injury to the roots may result from deep cultivation. This is especially true after the root system has become extensive and the crowns have grown near the surface. Tractor-mounted cultivators are used on large plantings and are satisfactory if properly adjusted. When crowns are planted in deep furrows it is a good practice to fill soil into the furrows at intervals. This filling also gives weed control in the rows during the year the crowns are planted. After the first season some hand hoeing is necessary to keep down weeds near the plants. Any working of the soil close to the crowns during the cutting season must be shallow and carefully done to avoid injuring the developing spears.

If white, or blanched, asparagus is grown, the rows must be ridged to cover the crowns with several inches of soil. The soil over the crowns must be deep enough for the spears to attain the desired cutting length before reaching the surface. To keep the crowns properly covered it may be necessary to renew the ridges at least every 2 weeks.

If green asparagus is grown, a very low ridge is suitable. The crown of the asparagus plant increases in thickness and thus comes

a little nearer the surface each year, so that slight ridging may be necessary when the crowns have come very close to the surface. Too shallow covering of the crowns subjects them to excessive heat during hot weather. This heat causes the tips of the spears to open before the spears reach the desired length and reduces their market value.

At the end of the cutting season, the asparagus beds should be thoroughly cultivated, the ridges leveled, and the planting given flat culture for the remainder of the season. The ridges can be leveled with a disk harrow. On large plantings the work of leveling the ridges, like many other field operations, is done with implements especially designed for the job.

Growers do not agree on the best method of handling the stalks (brush) that grow up after the cutting season. In parts of the North, they let the stalks stand overwinter so that they will hold the snow and prevent soil blowing. Stalks are then disked into the soil in the spring. Some growers cut off and either remove or burn the stalks as soon as the berries begin to mature. This prevents the scattering of seed. However, the stalks must not be cut off before they have manufactured and transferred to the fleshy roots enough reserve food to assure a vigorous growth of spears the following year. For this reason it is desirable to let the stalks stand until they are dead. Burning brush robs the soil of much needed organic matter. Mature, dormant stalks are easy to incorporate into the soil everywhere except in the Imperial Valley of California. There they may have to be shredded before plowing them under.

Intercropping is often practiced by growers who want income from their asparagus beds the first year or two after the crowns are set. This practice is not recommended, however, and most successful growers do not intercrop.

The control of weeds is one of the most costly practices in the production of asparagus. Several herbicides have proved very efficient and economical in controlling weeds in this crop.

Winter annual weeds can be effectively controlled with 1.3 pounds of dinoseb per acre. It is applied in 10 to 40 gallons of water after the asparagus is dormant in the fall but prior to weed emergence. Established broadleaf winter weeds can be killed in the early stages of growth with the same treatment.

Summer annual broad-leaved weeds and grasses can be effectively controlled with monuron [3-(*p*-chlorophenyl) - 1,1 - dimethylurea]. The herbicide should be applied at 1 to 2 pounds in 40 gallons of water per acre in the early spring after disking but before emergence of the spears. The lower rate should be used on light sandy soils and the higher rate on heavy soils.

Perennial grasses in asparagus fields can be controlled with dalapon (2,2-dichloropropionic acid). It has proved effective as a directed spot spray for control of small areas of perennial grasses such as quack-

grass, Bermuda grass, and Johnson grass.

WHEN AND HOW LONG TO HARVEST

The age at which asparagus plants are ready for harvest and the length of the cutting season differ in various sections of the country. Where the growing season is long and relatively cool—in California, for example—spears may be harvested at an earlier age.

In areas having a long, cool season, growers can cut asparagus for 2 to 3 weeks after crowns have been set for a full year—without injuring plants. The cutting period in the second harvest year may be extended to 6 to 8 weeks in these sections, and up to 12 weeks in following years.

Where growing seasons are short and warm, spears normally should not be harvested until after the crowns have had 2 full years of growth. Cutting should then be limited to a period of 3 to 5 weeks. The cutting period for the fourth and following years is usually 6 to 8 weeks.

When asparagus beds decline in production and yield a large proportion of small spears prematurely, the trouble can often be traced back to overcutting during the previous seasons. When such a condition develops it may be beneficial to shorten the cutting season and give particular attention to fertilization and care while the plants make top growth. As the beds grow older, however, the proportion of small spears increases, even in well cared for beds.

PROFITABLE PRODUCTIVE PERIOD

The establishment of a new asparagus planting involves much labor and expense. Adding a few years to the productive life of the bed therefore may be of considerable economic importance. If properly cared for, a planting normally will produce profitable yields for 10 to 15 years. On very fertile soil and with special care, a bed may remain profitable for 20 or more years.

Asparagus yields can be expected to increase for several years following the setting of the crowns. After reaching the peak, profitable yields may continue under favorable conditions up to 12 to 15 years. Then the yield is likely to decline. It is generally desirable to renew the planting after 10 to 12 years. The new bed should be started 2 or 3 years in advance of plowing up the old one, so that it will be yielding profitably before the old bed is abandoned. It may be advisable to renew portions of large plantings each year until the entire acreage has been replaced. Old asparagus beds should not be used for new plantings because of the build-up of the Fusarium wilt pathogen.

Climatic conditions, soil texture, soil fertility, planting distances, diseases, insects, and cultural and harvesting methods determine the number of years an asparagus bed will remain productive. Although very light soils are ideal for maxi-

mum production for several years, beds in lights soils are likely to be shorter lived than those in heavier soils.

Continued high production requires that the beds be kept free from diseases and insects. By interfering with top growth after the cutting season, diseases and insects reduce the amount of reserve materials stored in the fleshy roots and rhizome. Any reduction of the normal reserve food supply will reduce the succeeding crop.

Improper cultural practices may interfere with crown development and shorten the life of bed.

HARVESTING THE CROP

Three classes of asparagus, based on the color of spears, are marketed. Spears may be entirely green, green with white butts, or entirely white. Green asparagus is in greatest demand for the fresh market, but canning asparagus may be either green or white. Nearly all the green asparagus is harvested with a little white on the butt end. Entirely green spears are cut at the surface and do not keep as well as those cut below the surface. Since the underground part of the stem is more woody than that above ground, it loses moisture less rapidly than the tender green part and adds to the keeping quality of the spear.

Asparagus shoots grow very rapidly and require frequent cutting, especially if the temperature is high. Early in the season the shoots may require cutting only every third day. But as the growth becomes more active, spears may have to be cut twice a day. This is particularly true if the asparagus is growing on very light, warm soil.

Green asparagus spears should be cut 9 to 10 inches long, and at least half of the length should be above ground. The underground part is fibrous and unpalatable. When cutting, always use an asparagus knife, and take care to avoid injury to the young spears developing underground. The spears should not be cut closer than 2 inches from the crown to avoid injury to the developed buds on the rhizome. Knife injury to buds and immature shoots causes them to develop into crooked spears (fig. 2).

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Figure 2.—The deformed spear on the left is a typical result of cutting-knife injury to young shoots. Growth is slowed down on the injured side of the young shoot, and the spear develops with a pronounced crook. Shoots damaged by cutworms are deformed in the same way.

N-36346

Figure 3.—This crew is cutting and placing spears directly in boxes in one pass through the field. Spears are removed from the field only a few minutes after being cut.

Marketable spears can be cut without injuring the developing shoots. Place the knife near the shoot to be cut, force it straight down to the desired depth, then tilt it to make the cut. Many young shoots may be damaged if the knife is forced into the ground at an angle. (See cover illustration.) Asparagus shoots should not be cut above ground so that stubs remain. Stubs interfere with harvesting and may injure the hand of the cutter. Spears should be removed from the field as soon as possible after cutting (fig. 3).

The scarcity and increasing cost of hand labor has caused many growers to mechanize their operations. Some growers have used machines successfully for cutting asparagus. Mechanization is expected to increase as machines are improved.

PREPARATION FOR MARKET

Asparagus loses its edible quality very rapidly after it is harvested. Sugar content declines and the amount of fibrous material increases. These changes take place most rapidly during the first 24 hours after harvesting. This is particularly true in white asparagus.

Deterioration goes on at all temperatures, but it is much slower near 32° F. Because of the rapid loss in quality at high temperatures, asparagus must be moved from the field, bunched, packed, and placed in a cool atmosphere as soon as possible after it is cut. Spears should be protected from the sun as much as possible if they are harvested during very warm weather.

Asparagus is generally prepared for market by grading, trimming, and tying the stalks in bunches

weighing 2 to 2½ pounds. Because certain eastern markets prefer a small bunch, some asparagus is either packed in 1-pound bunches by the producer—or the large bunches are divided into smaller ones by the retailer. Field-run and low-grade asparagus is sometimes packed in crates without grading or bunching. In some localities even first-grade asparagus is shipped loose in crates. However, care in grading, bunching, tying, and wrapping should add considerably to the selling price of an asparagus crop.

Storing the Crop

Usually, fresh asparagus is stored temporarily only when the market is overstocked. It can be kept successfully for about 3 weeks at 36° F. and 95 percent relative humidity. After 5 to 7 days in transit, the safe storage period will decrease. If the storage period is to be 10 days or less, spears can be stored at 32°; if held longer at this temperature, asparagus is subject to chilling injury. At high temperatures (particularly above 40°), the spears will grow, develop decay, and lose their vitamin content, tenderness, and flavor. To avoid this deterioration, asparagus should be cooled immediately after cutting. This is ordinarily done by hydrocooling.

During transit and storage, the butts of asparagus are placed on wet moss (fig. 4) or other moist, absorbent material to prevent loss of moisture and maintain freshness of

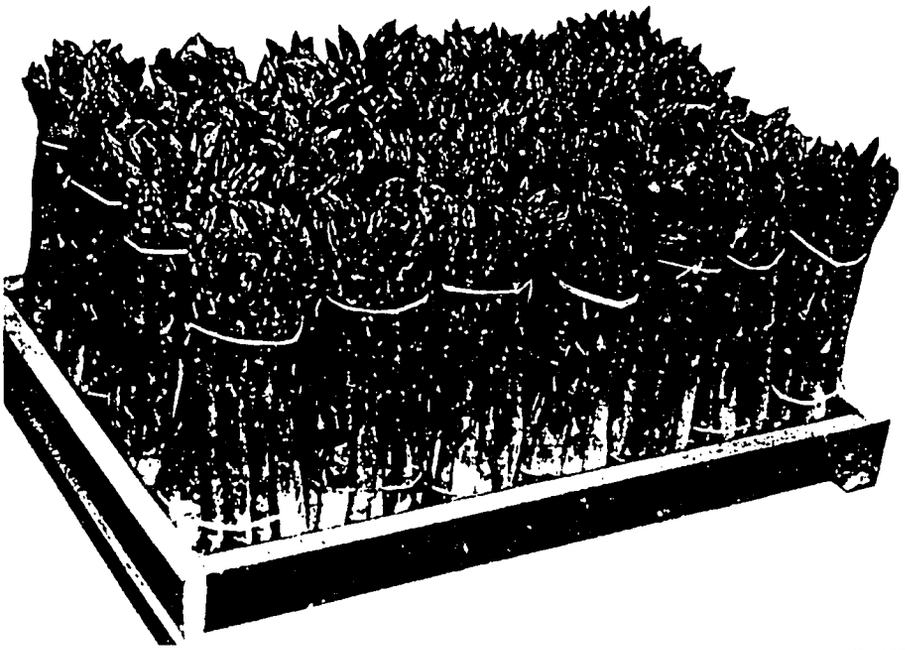

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Figure 4.—Bunches of asparagus are placed on damp moss in a flat to keep them fresh.

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Figure 5.—An inspector selects a representative sample from a shipment of asparagus and inspects it to determine the grade. Grading procedures vary in different parts of the country and for different markets.

the spears. In storage, asparagus bunches are sometimes set in water in shallow trays or pans.

Bacterial soft rot is the principal cause of decay in storage. It may occur at either the tip or butt of the asparagus.

Grading the Spears

The U.S. Department of Agriculture has established market grades (fig. 5) for asparagus. Information on the latest grades may be obtained by writing to the Consumer and Marketing Service, U.S. Department of Agriculture, Washington, D.C. 20250.

Asparagus is marketed chiefly under two grades, U.S. No. 1 and U.S. No. 2. Asparagus not meeting the specifications required by these grades is considered as unclassified. Asparagus is graded primarily for freshness, length and diameter of the spear, proportion of the spear that is green, and the amount of damage due to dirt, diseases, and insect or mechanical injury.

Current specifications classify asparagus on diameter of spears as follows: Very small, less than $\frac{5}{16}$ inch; small, between $\frac{5}{16}$ and $\frac{8}{16}$ inch; medium, between $\frac{8}{16}$ and $\frac{11}{16}$ inch; large, between $\frac{11}{16}$ and $\frac{14}{16}$ inch; and very large, above $\frac{14}{16}$ inch. Present standards permit the trimmed bunches to vary in length from 7 to 10½ inches.

Washing, Bunching, and Tying

White asparagus is usually washed. Spears are placed in wire-bottomed trays or baskets and doused a few times in a vat of water. Green asparagus should not be washed, unless a considerable amount of soil adheres to the spears. If it is necessary to remove soil from the butt end of green asparagus, the butts only should be doused in a vat of water. Care should be taken not to wet the tips. The stalks should then be laid with the butt downward on a sloping surface to drain before they are bunched. Asparagus keeps best if it is not wet.

Where asparagus is grown in large quantities for commercial purposes, it is essential to have a mechanical buncher for holding the stalks while they are being bunched and tied. There are various devices on the market for this purpose (fig. 6).

Many growers have machinery that cuts the spears to the desired

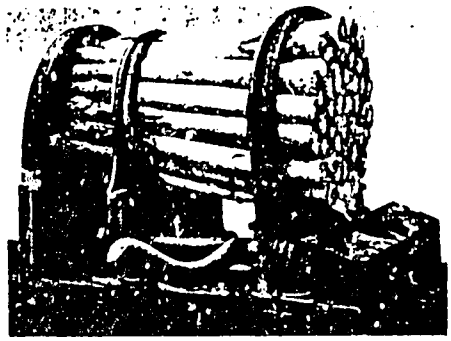

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Figure 6.—One type of asparagus-bunching device. Note that the spears have been cut to a uniform length.

length, but some of the trimming is done by hand. A large number of spears can be trimmed at one operation by placing them in a frame that holds all the tips even. The extra length of stem is then cut off with a large knife. Where a small bunching machine is used the spears are usually cut to the desired length while held in the buncher.

The tightest and most attractive bunches are made by tying near each end (fig. 4). A single tie near the center permits slipping and makes an unattractive bunch. Raffia, twine, and tying tape are the materials most commonly used for tying the bunches. Tying tape is the most expensive, but it is recommended. Raffia does not have the neat appearance of tape, and twine is likely to cut the spears if tied very tight. Tape is available in various colors, and sometimes grades of asparagus are indicated by the color of tape. Only good grades of tape having fast colors should be used. Any discoloring of the spears from dye may lower the market value.

There is some shrinkage in asparagus after it is bunched, especially if it has a high water content before bunching. Bunches should be tied as tight as possible without injuring the spears to avoid loosening as a result of shrinkage.

Many growers and shippers market an attractive product by wrapping bunches in parchment paper so that only the tips of the spears extend above the paper. The wrapper usually bears the name and address of the grower or shipper. This is a good way to advertise a high-quality product.

Packing and Shipping

Shipping crates differ from one growing area to another. The most commonly used crate is pyramidal in form (fig. 7), having two compartments each holding six 2- to 2½-pound bunches. A typical pyramidal crate used in California is 11 inches deep, 9 inches wide at the top, 11 inches wide at the bottom, and 18 inches long. A similar crate is used in Georgia and the Carolinas. The tendency in most States is toward this type of crate, but the dimensions may vary. The pyramidal crate makes an excellent shipping container because the shape conforms to the taper of the bunches and prevents them from shifting about during shipment. The bottoms of the crates are usually lined with a type of paper that holds water or with a layer of damp moss. The butts of the bunches are placed in the water or on the moss. When packed in this way and kept at a temperature just above freezing, asparagus can be

shipped a long distance and will keep for several days without serious loss of quality.

In the early part of the cutting season when the yield is small and the product is sold in nearby markets, asparagus is shipped without refrigeration, either by express or by motortrucks. However, after the cutting becomes heavy and carlot shipments begin, most of the asparagus is shipped under refrigeration.

INSECT PESTS

Asparagus Beetles

Asparagus beetles cause more widespread damage to asparagus in this country than any other insect. There are two species—the asparagus bettle (*Crioceris asparagi* (L.)) and the spotted asparagus beetle (*Crioceris duodecimpunctata* (L.)).

The adult of the asparagus beetle is about ¼ inch long, metallic blue to black with orange to yellow markings. It overwinters in the adult stage in protected places—old asparagus stalks, under debris along fence rows, or in nearby woodlands. Emergence occurs early in the spring about the time asparagus shoots appear. The young tips are damaged by beetle feeding and egg laying. The eggs are normally dark in color and attached singly on end. Feeding injury or the presence of eggs seriously reduces the market value of asparagus.

Eggs are also laid on the mature plants later in the season. They hatch in about 1 week, depending upon the temperature, into soft-bodied larvae or grubs about ⅓ inch long when full grown. The larvae are olive green to dark gray with black head and legs. After about 10 days to 2 weeks, the larvae drop from the plants and enter the ground where they pupate. In another week or two the new adults emerge from the soil. Two or more generations may develop during the season, depending upon weather conditions.

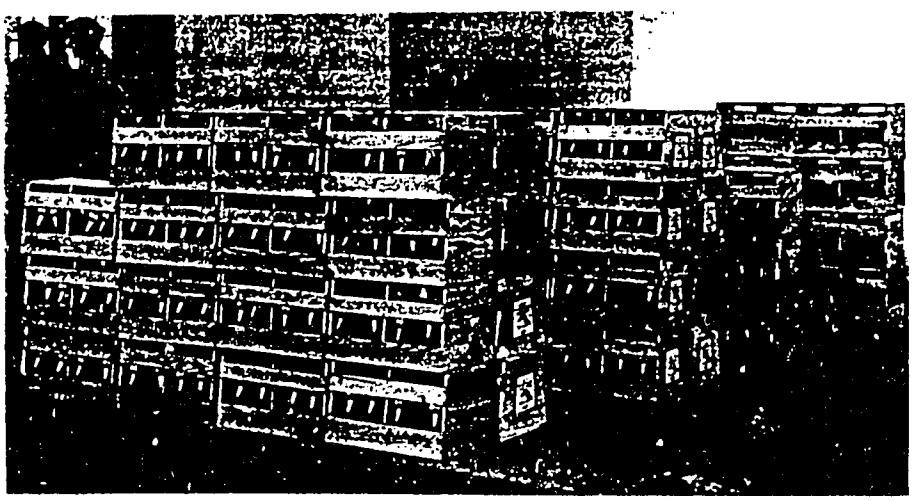

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Figure 7.—Asparagus packed in pyramidal crates.

Heavy populations of larvae and adults will soon defoliate large areas. Because the asparagus beetle does not thrive during hot dry weather, it does most of its damage in the spring and early summer.

The adults of the spotted asparagus beetle are reddish orange, and they each have 12 black spots on their backs. These beetles normally appear a little later in the spring than the adults of the asparagus beetle. The eggs are slightly smaller than those of the other species. They usually do not appear until late in the season when the berries are starting to form on the asparagus plants. The larvae are orange. They feed primarily inside the berries. The life history is similar in many respects to that of the asparagus beetle.

Control measures for both asparagus beetle and the spotted asparagus beetle are the same.

During the cutting season, apply 1-percent rotenone dust at 30 pounds per acre—or rotenone spray containing 3 pounds of 5-percent rotenone powder per acre. In preparing the rotenone spray, mix the powder with a small amount of water until a thin even paste is obtained. Add this mixture to the water in the spray tank with the agitator going. Malathion dust or spray at 1¼ pounds, or carbaryl dust or spray at 2 pounds of active ingredient per acre, may also be used.

For control of asparagus beetles after the cutting season or on plantings not being harvested, use carbaryl dust or spray at 2 pounds of active ingredient per acre.

All applications should be thorough and uniform. Repeat as often as needed, about every week or 10 days.

Cutworms

Cutworms of more than one species occasionally cause damage to asparagus by cutting off the shoots underground or by feeding on the tips of the spears as they appear above ground. Damaged tips may develop into crooked spears (fig. 2). Cutworm larvae may be dull gray, brown, or black, and either striped or spotted. They are stout, soft bodied and smooth, and they grow to 1¼ inches long. They curl up tightly when disturbed.

Carbaryl applied for control of asparagus beetles provides adequate control of cutworms.

Thrips

Thrips sometimes are pests of asparagus. They are small active insects that can easily go unobserved unless a close examination is made. Their size makes it possible for them to hide in the head of the tip or under the bracts on the stem. Their presence in large numbers on asparagus at the time of harvest may render the tips unacceptable for market.

Control thrips on asparagus by applying malathion dust or spray at 1¼ pounds of active ingredient per acre.

Garden Symphylan

The garden symphylan (*Scutigerella immaculata* (Newp.)), also known as the garden centipede, is

destructive to asparagus. It is neither a centipede nor an insect. It is a slender, white creature up to 3/8 inch long having 12 pairs of legs when full grown. The young is smaller and has fewer legs. It eats numerous tiny holes in the underground portions of the plants.

Flooding is recommended in California for control of this pest. Land known to be infested prior to planting should be flooded for one week during the summer before planting the asparagus.

When flooding is not practical, it is suggested you contact your county agricultural agent or State agricultural experiment station for recommendations for pre-plant pesticide applications. Where infestations have developed in established fields, efforts to control the symphylans with side dressings or drenches have met with limited success. Unless so stated on the label, application of pesticides as a side dressing or a drench for symphylan control are not recommended.

DISEASES

Asparagus Rust

Asparagus is subject to a number of diseases. Asparagus rust, caused by the fungus *Puccinia asparagi*, is one of great economic importance. Rust was first reported in 1896 in New Jersey, Delaware, Long Island, N.Y., and New England. It later appeared in practically all areas where asparagus is grown. The presence of the disease depends on environmental conditions. Rust spores require moisture for germination; the disease is much more destructive in areas of high humidity and heavy rainfall than in low moisture areas.

Asparagus rust normally is seen first as numerous small reddish-yellow spots on the main stems near the ground and on the very slender branches of the stalks that grow up after the cutting season. The red spots are pustules containing seed-like bodies, or spores, that reproduce the fungus. These pustules burst and release large numbers of rust spores. These spores have the appearance of reddish or rust-colored powder. The wind scatters the spores rapidly; and if sufficient moisture is present, they may infect all the plants in the field.

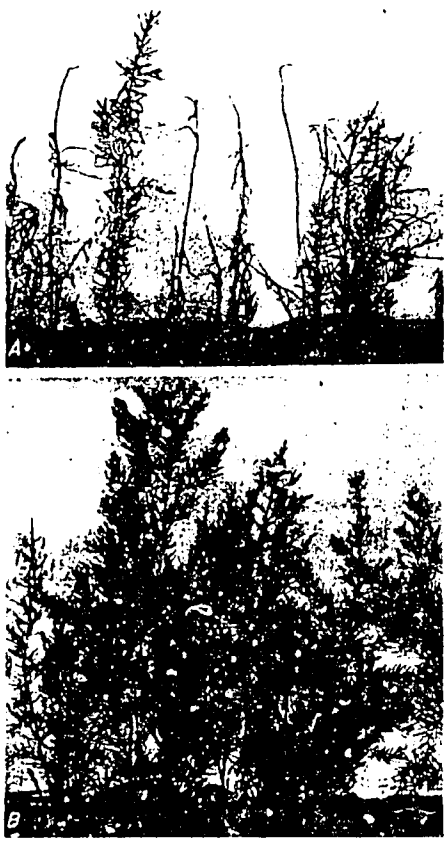

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Figure 8.—A, Seedlings of Argenteuil asparagus, showing some resistance to rust; B, the highly rust-resistant Washington asparagus.

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Figure 9.—An old asparagus field killed out by rust (foreground). The new field of the Reading Giant variety on the left was grown as a breeding field for rust-resistance work.

Asparagus rust causes the tiny needlelike branches of the stems to fall and the affected plants present a naked appearance (fig. 8, *A*). When the attack is severe, the entire field may ultimately become brown and appear dead (fig. 9). The effect of rust is not directly evident on the marketed product because damage to top growth occurs primarily after the harvest season. Injury to the brush slows the manufacture of food, and the plants are either killed or go into the winter in a starved condition. As a result, the succeeding crop suffers a reduction in the size and number of shoots produced.

The most effective way to control asparagus rust is to plant resistant varieties. When first introduced by the U.S. Department of Agriculture, Martha Washington and Mary Washington varieties generally showed a high resistance to rust. In recent years, however, losses have occurred from rust on varieties reported to be either Mary or Martha Washington. Either high rust resistance has not been maintained in some stocks of these varieties or there are strains of the rust fungus to which they are not highly resistant. When buying any variety of the Washington type, growers should obtain information regarding the previous performance of the stock with respect to rust resistance.

Because rust has been reported on even the resistant varieties, growers should take measures to protect all plantings by eliminating sources of rust infection. The two main sources of infection are wild asparagus plants growing in the vicinity of cultivated beds and seedlings that are allowed to grow up in the field before the cutting season is over.

Wild asparagus carries the rust overwinter, and in the spring spores scatter and infect the plants. Seedlings that are allowed to grow up in the field during the cutting season also provide the disease organisms an opportunity to develop and multiply into great numbers of spores. Sources of infection can be eliminated by digging and burning

all wild plants, and by preventing the top growth of shoots in the field until after the cutting season.

New beds should be planted with rust-resistant strains and located as far as possible from the old beds. The new plantings can be further protected if they are located so that prevailing winds will not blow from the direction of established plantings. In the fall the top growth should be removed from the 1-year-old beds that are to be cut the next year.

The removal of the top growth from mature beds in the fall is not necessary in rust control. The spring stage of rust will not occur in fields where the tops are left overwinter and disked into the soil in the spring. It will occur, however, if tops are allowed to start growing before the cutting season is over.

Spraying with fungicides to control rust has met with varied success in different locations. Zineb can be used at the rate of 1.5 to 2.25 pounds of active ingredient per 100 gallons of water. Apply immediately after last harvest; repeat at 10-day intervals as long as necessary. In young fields not to be harvested, start when disease first appears in the area. Maneb may also be used to control rust on asparagus.

Fusarium Root Rot

Fusarium root rot, caused by the fungus, *Fusarium oxysporum f. asparagi*, is common in all areas where asparagus is grown in the United States. It generally attacks the feeder rootlets and weakens and kills many plants, thus reducing stand and yield. Rarely does it produce wilt symptoms, except on young shoots of seedlings.

Fusarium fungus builds up in the soil when the first bed is planted in the field, and the disease persists for many years. It is especially troublesome for seedbeds planted on the same soil in subsequent years.

Yields on replanted land are reduced more by Fusarium root rot year after year than by rust, because rust may occur one year and not the next.

Asparagus shoots infected with Fusarium root rot may show a brown discoloration of their surface. These spears are usually unfit for market.

The best control for Fusarium root rot is to avoid using old asparagus soil. Research is underway in California and New Jersey to develop Fusarium-resistant strains of asparagus.

PRECAUTIONS

Pesticides used improperly can be injurious to man and animals. Use them only when needed and handle them with care. Follow the directions and heed all precautions on the labels.

Some States have special restrictions on the use of certain pesticides. Before applying pesticides, check State and local regulations.

Keep pesticides in closed, well-labeled containers in a dry place. Store them where they will not contaminate food or feed, and where children and animals cannot reach them. Promptly dispose of empty pesticide containers; do not use for any other purpose.

When handling a pesticide, wear clean, dry clothing.

Avoid repeated or prolonged contact of pesticide with your skin.

Wear protective clothing and equipment if specified on the container label. Avoid prolonged inhalation of pesticide dusts or mists.

Avoid spilling a pesticide concentrate on your skin, and keep it out of your eyes, nose, and mouth. If you get a concentrate on your skin, wash it off immediately with soap and water. If you spill a concentrate on your clothing, remove the clothing immediately and wash the skin thoroughly. Launder the clothing before wearing it again.

Carbaryl, malathion, and rotenone can be used safely without special protective clothing or devices if they are in diluted dust or water-spray forms.

Do not apply rotenone, malathion, or carbaryl within 1 day before harvest. Do not repeat carbaryl applications within 3 days.

After handling a pesticide, do not eat, drink, or smoke until you have washed your hands and face. Wash any exposed skin immediately after applying a pesticide.

Avoid drift of pesticide to nearby wildlife habitats, bee yards, crops, or livestock. Do not apply pesticide under conditions favoring drift from the area to be treated.

Many pesticides are highly toxic to fish and aquatic animals. Keep pesticides out of all water sources such as ponds, streams, and wells. Do not clean spraying equipment or dump excess spray material near such water.

Do not apply pesticides to plants during hours when honey bees and other pollinating insects are visiting them.

Have empty pesticide containers buried at a sanitary land-fill dump, or crush and bury them at least 18 inches deep in a level, isolated place where they will not contaminate water supplies.

It is difficult to remove all traces of herbicides from equipment. For this reason, do not use the same equipment for applying herbicides that you use for insecticides and fungicides.

WARNING

Recommendations for use of pesticides are reviewed regularly. The registrations on all suggested uses of pesticides in this publication were in effect at press time. Check with your County Agricultural Agent or State Agricultural Experiment Station to determine if these recommendations are still current.

PROTECT

Use Pesticides Safely

FOLLOW THE LABEL

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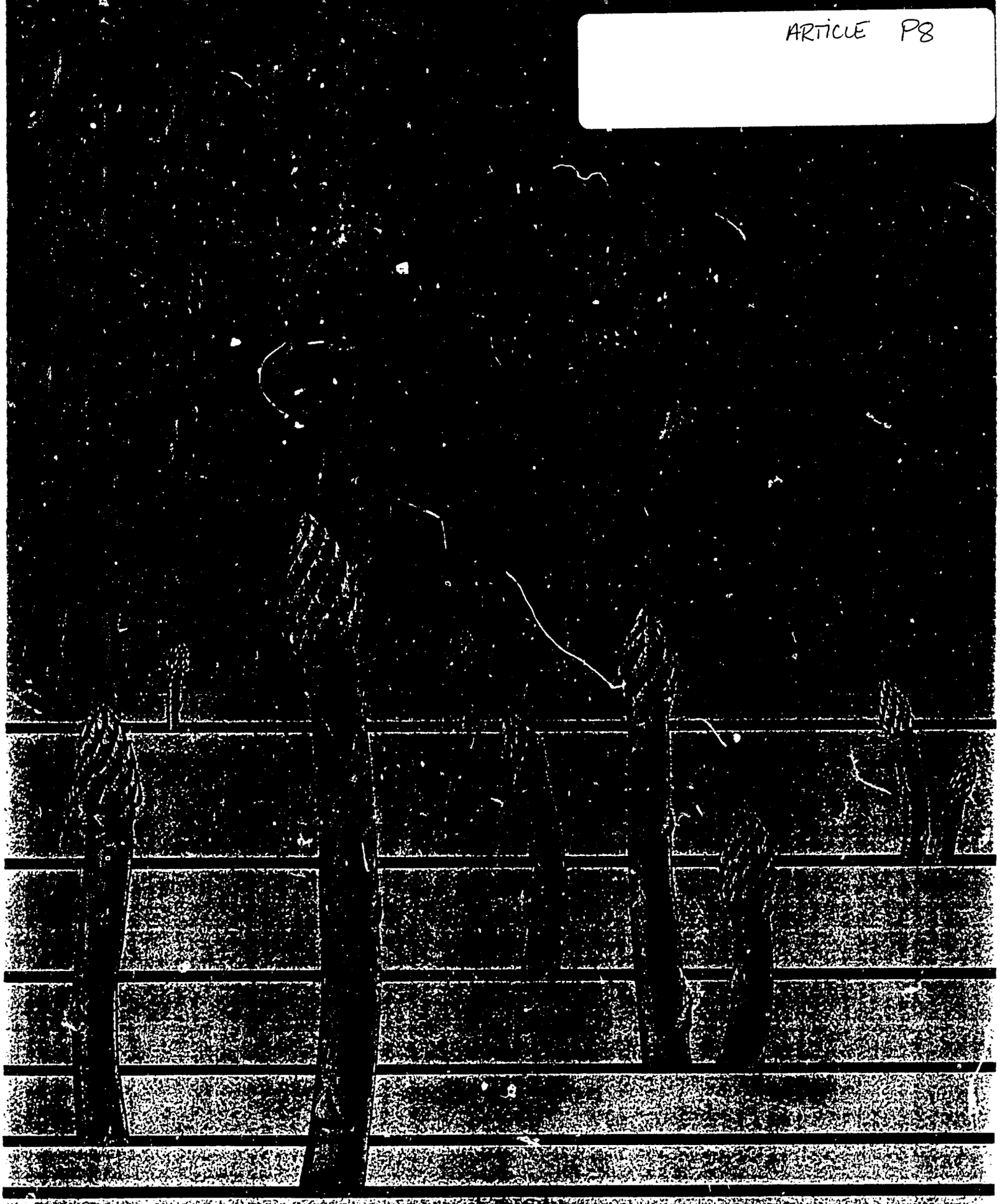

Cooperative Extension, College of Agriculture, Washington State University, Pullman, Washington

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Washington Asparagus Production Guide

Introduction

Asparagus production in Washington is important not only to the asparagus industry, but to the economy of the state itself. Based on the dollar value of the crop to growers, asparagus has consistently ranked in the top 20 crops of economic importance to the state.

The actual economic impact of the asparagus industry goes beyond its farm gate value. Most of the asparagus produced in Washington is processed. The value added to a commodity that is processed within the production area ranges from a three- to a ninefold increase. Using the lower of these figures, the value of the asparagus crop to the economy of Washington is about $75,000,000. Nationally the Washington asparagus industry ranks a close second to California and accounts for over 30 percent of the total national production.

Until 1977, new plantings equaled plowdowns, giving Washington a relatively constant producing acreage of 21,000 acres. However, increased plantings between 1978 and 1980 have resulted in sharply increased acreage.

The major areas of production are concentrated in southcentral Washington with some recent expansion into central Washington.

General Considerations

The decision to produce asparagus is one that should be thoroughly investigated before deciding to plant. This publication has been prepared to address the cultural practices that must be considered to produce asparagus successfully. Equally important are crop marketing decisions and labor requirements.

The major share of the asparagus produced in Washington is processed. Therefore, the major market outlet for individual producers is a processor.

Within Washington, the market for asparagus to a processor is strongly influenced by the Washington Asparagus Growers Association. The association bargains with processors on behalf of its member growers, establishing preseason annual price, quality, and other marketing specifications. However, some processors do not negotiate contracts with growers.

The demand for and availability of harvest labor is a major consideration in the decision to produce asparagus. Increases in asparagus acreage within a production unit, geographical area, and the industry as a whole must allow for increased labor requirements. Migrant labor is the primary source of labor for hand harvesting. Labor housing needs and other arrangements must be considered before the planting and production begin, although some mechanical harvesting has been done with limited success. If mechanical harvesting is to be done, cultural practices, including bed size and configuration, planting methods, and weed control methods specific to mechanical harvesting, must be considered.

Soil and Planting Site

Asparagus favors a deep, well-drained loamy sand, sandy loam, or loam soil. Check for wireworms before planting, particularly when planting in old pasture or alfalfa fields. If needed, apply control measures prior to planting. All alfalfa should be killed the fall prior to planting either by mechanical crowning or with an approved herbicide. Planting in soil which is one year removed from turning under alfalfa is recommended. Collect soil samples according to WSU specifications and have the soil samples analyzed for nutrient recommendations. Asparagus can survive under poor soil conditions and is often planted in these sites. However, since the plant is a perennial and

long lived, it pays to plant asparagus on the best soil possible. Avoid sites known to have high water tables. While a high water table may not affect shallow rooted plants in a nursery, mature stands of asparagus may be adversely affected, particularly if water table rises to within three feet of the surface.

Varieties

For a new planting, it is profitable to plant newer, high yielding, high quality varieties. The variety 500 W from Salinas, California, has performed consistently well in Washington. The two varieties "WSU 1" and "WSU 2" developed by Washington State University promise to provide high yields, early production, consistency from generation to generation and greatly improved spear size. When available in commercial quantities, F-1 seed from tissue cultured parents of "WSU 1" and "WSU 2" will produce uniformly high yielding plants. If asparagus must be planted in a field previously planted to asparagus, Mary Washington strains which were selected in Washington, seem to perform better than other varieties. The Mary Washington variety originated outside Washington state, but the strains that have been locally selected have some degree of disease tolerance, particularly to *Fusarium*.

New varieties from other states may perform well for several years but they usually deteriorate rapidly in most areas. Local exceptions exist, so a trial acreage should be considered for a particular site if you are considering these new varieties.

Establishing an Asparagus Bed

NURSERY-CROWN PLANTING

Nursery Culture

Fertilizer. Nitrogen recommendations outlined in Washington State University (WSU) Fertilizer Guide *Irrigated Asparagus* (FG 12) under the heading "For New Planting" may be used as a general guide for nitrogen requirements for asparagus nurseries. The recommendations for phosphorus, potassium, zinc, and sulfur from this guide may also be followed.

Seeding. Use only high quality seed that has been properly treated to reduce seed-borne diseases. Information on reliable sources of treated seed may be obtained from the Washington State Asparagus Growers Association or from a processor.

Asparagus seed may be planted from late April through early June. Earlier seeding allows a longer period for root and crown development but may increase disease problems. Later seeding results in faster germination and fewer weed problems in the nursery bed.

Space the seed no closer than 1 or 2 inches apart in the row, and 1-2 inches deep. Use the 2 inch depth in loose dry soil. The distance between rows will depend upon the growers' equipment (Figs. 1, 2) and how the planting is to be managed. Twenty-two inches is the most common spacing between rows. At these spacings, 8-12 pounds of seed per acre will be required.

Weed Control. Growers should take steps to

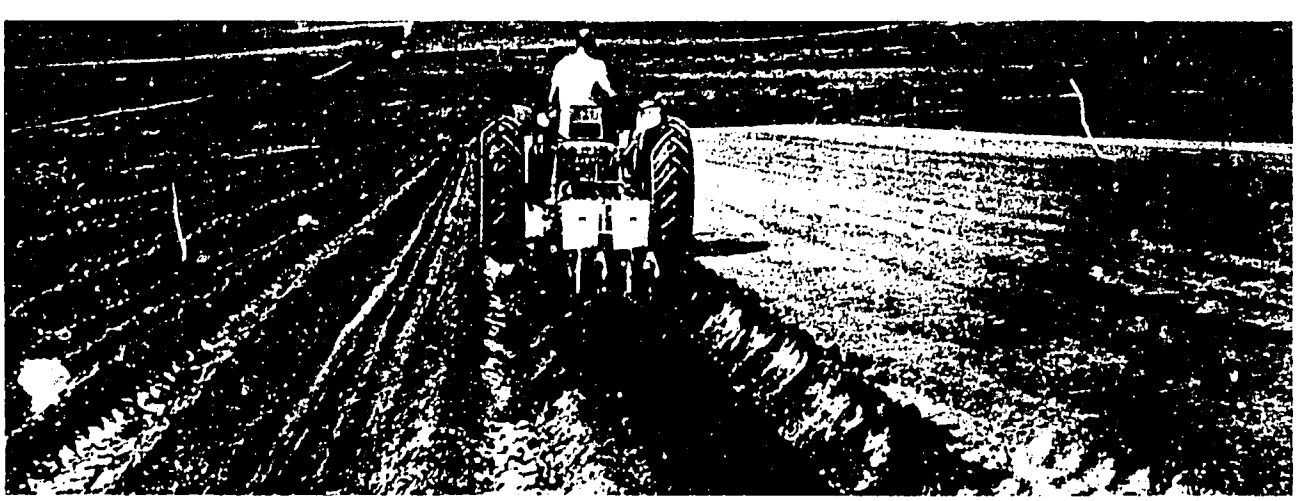

Fig. 1—Direct seeding of asparagus in a commercial field. Similar planting equipment and furrow spacing are used in nursery seeding.

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Fig. 2—Nursery seedlings in the fall of the seeding year.

eliminate or greatly reduce weeds—especially perennial weeds—before planting asparagus. Once the crop is planted the options for weed control are reduced. Weeds are frequently the main cause of crop failure in new plantings. Weeds can be controlled by cultivation and/or with herbicides. Approved herbicides are listed in the current Washington State University *Weed Control Handbook*, or EM 4620 *Chemical Weed Control in Asparagus*. Several hand weedings may also be required in most nurseries, even with the use of herbicides.

Irrigation. Adequate moisture is essential for germination, and good moisture in the top 12 inches of soil should be maintained. Frequent, light applications of water will produce better crown development and a more fibrous root system than less frequent, heavier irrigations.

Winter Care. At the end of the growing season, hill the plant rows with 2 to 4 inches of soil to protect the crowns from winter injury.

Digging. In the spring of the year following planting, cut and remove the old tops so they will not interfere with digging the crowns. Avoid injuring the crowns during digging. Leave 8-12 inches of storage roots. Some buds may have appeared before the crowns can be dug, but crowns should be dug before many buds have started to grow.

Storage. Plant crowns as soon as possible after they are dug. Avoid storing roots in a pile longer than a few days. Protect piled crowns from temperature extremes, either from freezing or excessive drying from the sun.

Crown Planting (First Year)

Crowns. Select and plant only good quality crowns. The extra cost of selecting good quality crowns will be more than offset by a more uniform stand and greater yield.

A good one-year-old crown should weigh 0.1 pound or more and have a cluster of well-formed and well-distributed buds. Crowns with large roots and two or more bud clusters will start growing more quickly and develop faster (Fig. 3). Discard damaged, diseased, or very small crowns.

Fertilizer. Follow recommendations outlined in Washington State University (WSU) Fertilizer Guide *Irrigated Asparagus* (FG 12). Nitrogen recommendations are included under the heading "For New Planting." The recommendations in FG 12 for phosphorus, potassium, zinc, and sulfur apply to both new and established asparagus plantings.

Planting. Furrows for the crowns can be opened with a double-moldboard plow or some other suitable implement.

For single row crown plantings the furrows should be 8-12 inches deep and approximately 54 inches apart, depending upon machinery.

Treat the crowns with a fungicidal dip before planting to prevent fungus infection. Consult your county Extension agent for latest information on approved fungicides.

Asparagus crowns should be planted with the buds up. They should be spaced alternately on both sides of the furrow approximately 6-9 inches apart, about 1 1/3-2 plants per running foot (see Figs. 4-6).

Avoid walking or driving on uncovered crowns. Cover the crowns immediately with 3-4 inches of loose soil. Covering with too much soil can kill the crowns. The loose soil covering the crowns should be firmed by either driving down the furrows with a small tractor or by applying 1-2 inches of water by sprinkler irrigation.

Irrigation. After firming the soil, rill irrigation may be used down the planted furrow. Be careful not to wash the soil away from the crowns. Two or three irrigations can be made in the planted furrow before establishing separate irrigation furrows between rows. Usually, four or more irrigations will be needed during the first season. If sprinkler irrigation is used, insure the soil is moistened to the depth of the crowns with each application.

Filling Furrows. As the asparagus shoots develop, several cultivations can be used to fill in the furrows until the field is level. Cultivations can be timed to control new weed growth, but care must be taken not to cover the developing asparagus fern.

Weed Control. It is critical that perennial weeds are eliminated or greatly reduced before establishing beds. Weeds are implicated in the spread of diseases, are hosts for insects and may interfere with harvest, in addition to their direct competition for water, light, and nutrients. Weeds are controlled by cultivation and smothering as the plant furrow is filled. Properly timed, mechanical weeding is very effective for weed control between rows and, if the equipment is run fast enough, soil will be thrown into the planted furrow. Try to cover weeds as they begin to emerge. Refer to EM 4620, *Chemical Weed Control in Asparagus* for herbicides to use on first year asparagus. Be sure that any herbicide use is approved by the processor to whom the crop will be sold.

Fern Incorporation. Beat or shred the fern after it becomes fully brown either in the late fall or early spring. Disk or rotovate no deeper than four inches when working in the fern.

Second Year Bed

Fertilizer. Follow the recommendations outlined under the heading "For Established Planting" in Washington State University Fertilizer Guide *Irrigated Asparagus* (FG 12).

Weed Control. Consult the Washington State *Weed Control Handbook*, or EM 4620, *Chemical Weed Control in Asparagus*. Some processors also have a list of pesticides that can and cannot be used on asparagus. Be sure to check with your processor, grower association, or county Extension agent before applying pesticides.

Cutting. Beds are often cut five or six times during the second year. Good first year vigor and spear size are necessary in determining whether or not to harvest the second year.

Irrigating. Six or more irrigations may be required during the second season. Apply water when the soil begins to show low soil moisture at the 12-inch depth.

Fern Incorporation. Same as for first year.

Fig. 3—Healthy asparagus crown with well-formed bud clusters and roots.

DIRECT SEED TRANSPLANT

This method consists of a seedling nursery in the same field and with the spacing of the final planting. Rather than digging and hand planting the crowns after the first season's growth, a transplanting machine is used to dig the crowns, list the furrow, plant, and cover the crowns in a one pass operation.

Several factors are important when considering this method.

- the field needs to be relatively level,
- intensive care is required of the first year planting from seed (especially weed control and irrigation management),
- an entire field is out of production for 1 year as opposed to a small nursery,
- greater yields during the first years of harvest,
- less expensive compared to crown planting, and
- planting does not require hand labor.

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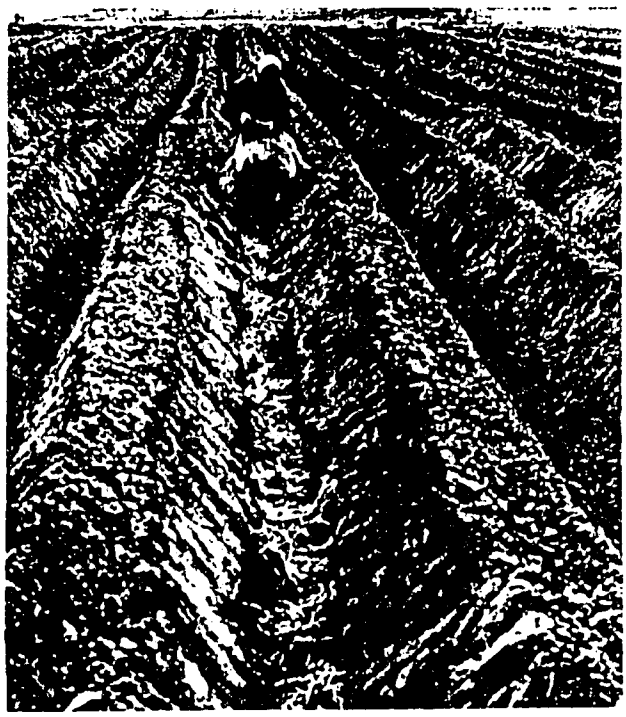

Fig. 4—Field worker placing crowns in furrow made with a lister.

Fig. 6—Crown placement in handworked furrow. Crowns are placed alternately on either side of the furrow, as shown in Fig. 5.

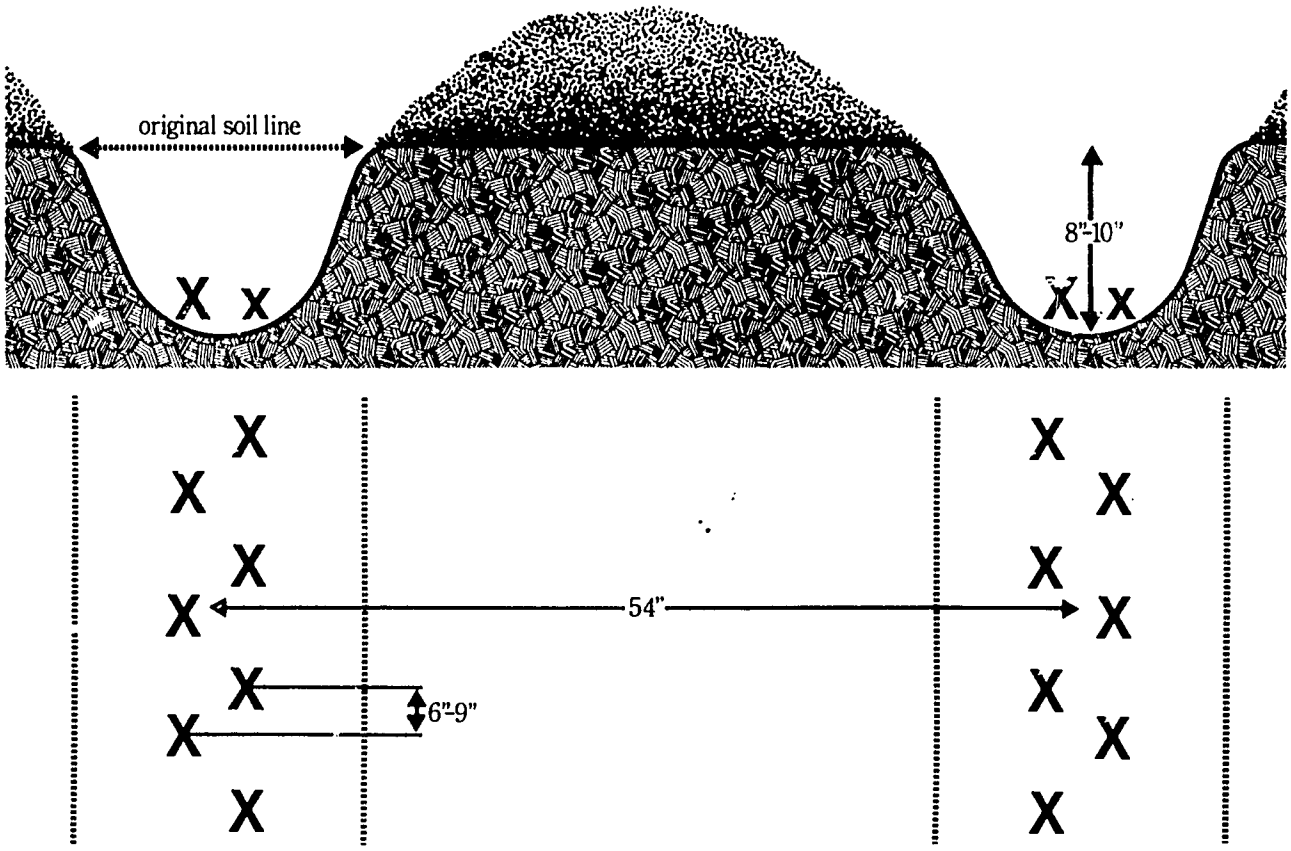

Fig. 5—Spacing of asparagus crowns in furrows. After crowns are planted, soil removed from the furrows is used to fill in the furrows as the asparagus shoots develop until the field is level.

Seeding Year (Similar to Nursery)

Seeding. Seeding in this method varies from conventional nursery planting in that row spacing is the same as desired for final bed spacing, usually 54 inches seeds planted 3-4 inches apart in the rows.

Fertilizer/Weed Control/Irrigation/Winter Care. Same as for nursery under nursery-crown planting method. The fern does not need to be removed prior to transplanting.

Transplant Year

Most transplanting done by a custom operator. Arrangements should be made prior to seeding in the field.

Fertilizer/Weed Control/Irrigation/Fern Incorporation. Same as for first year crown planting under nursery-crown planting method.

Second Year Bed

Fertilizer/Weed Control/Irrigation/Cutting/Fern Incorporation. Same as for second year crown planting under nursery-crown planting method.

DIRECT SEEDING IN THE FURROWS

This method consists of listing in the field in the same manner as crown planting. The seed is then planted in the bottom of the furrow.

This is not a common planting method in Washington state. Growers have found that it is difficult to irrigate and to control weeds properly.

Culture of an Established Asparagus Cutting Bed

CULTURAL PRACTICES

Winter Care

Beat or disk down the fern after it becomes fully brown in late fall or early spring. Normally, the fern is not removed or burned because it adds organic matter equivalent to 8 tons per acre of manure if supplemented with nitrogen.

After beating down of the fern, hill enough soil over the asparagus crowns so that subsequent cultural operations can be carried out without injuring the crowns. Asparagus crowns thicken, spread, and grow a little nearer the surface each year. Therefore, young asparagus beds may require little, if any, hilling, while other beds require some hilling to cover the crowns adequately.

Broadcast 60 to 100 pounds of actual nitrogen per acre on the bed after the ferns are beaten down. Usually an application of nitrogen alone is adequate to maintain established asparagus beds. Consult Washington State University Fertilizer Guide *Irrigated Asparagus* (FG 12) for additional information on fertilization.

After fertilization and herbicide application (where chemical weed control is part of the program) incorporate plant residue, herbicide and fertilizer with shallow disking or rotovation. Deep rotovation can injure crowns. Leave furrows for irrigation.

Weed Control

See Washington State University *Weed Control Handbook,* or EM 4620, *Chemical Weed Control in Asparagus* for information on herbicides and specific weed problems. When soil active herbicides are used, hill, fertilize, apply herbicide and incorporate if required by the label. Further hilling should not be done because it would negate the effect of the herbicide. If herbicides are not used, cultivate or harrow beds thoroughly before spear begin to grow. Hilling the soil can be used to smother weeds in the plant row. Hilling is usually started two to three weeks after harvesting begins, and is repeated only when necessary to control weeds.

Cutting Instructions

Size and length of the asparagus spear (Fig. 7) is important in grading the crop. Check with your processor or buyer on what grade and length spear is required. Fresh market specifications are generally different than processing specifications. Take care when cutting asparagus to avoid injuring the young spears developing underground. If spears are cut too close to the crown, the crown buds will be injured. To insure maximum yields, cut spears to full length to meet grade after trimming.

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Picking Up Asparagus

Remove the harvested spears from the field as soon as possible after cutting to minimize weight and quality loss. Cutter-carried containers help minimize loss of cut asparagus by allowing immediate removal of asparagus from the field. After harvest, hold asparagus in a cool, shady place and deliver to handlers or processors with a minimum of delay, preferably not over four hours.

Length of Cutting Season

Discontinue cutting not later than June 20, regardless of spear size. Cutting must be stopped early enough to allow for good fern growth, and to allow the crowns to accumulate food reserves for the next cutting season. Overcutting will seriously weaken crowns, reduce long-term yields and may result in a plant which is more susceptible to disease. An appreciable reduction in spear diameter before June 20 is an indication to stop harvesting.

Irrigation

During the cutting season. One or two irrigations should be adequate if kept weed free.

Postharvest. Thorough irrigation during the growing season reduces the need for early irrigation before the next cutting season. Because asparagus plants do not wilt from drought, extra care must be exercised to be sure there is adequate soil moisture throughout the season. Because the crowns are fairly deep in the soil, examine the soil at the 12-24 inch depth to determine irrigation needs. Shallow or sandy soils will need to be irrigated 8-12 times a year. On deep, sandy loam or loamy soils, 3-6 irrigations per year should be adequate.

Postharvest

At the end of the cutting season, disk or rotovate beds if weeds or asparagus seedlings are a problem, or follow an herbicide program outlined in EM 4620, *Chemical Weed Control in Asparagus.* Wherever possible, disking or rotovating should be avoided since these practices reduce fern growth.

Fig. 7—Emerging spears of varying size. Desirable size and length of harvested spears will vary depending on use. Spears of preferred sizes are indicated by arrows.

INSECT PESTS

Asparagus Beetles

In Washington two species are involved. The common asparagus beetle, *Crioceris asparagi,* has blue-black wing covers with three large, yellowish, square-shaped spots along each side, and reddish margins. The 12-spotted asparagus beetle, *Crioceris duodecimpunctata,* is red-orange with six prominent black spots on each wing cover. Both overwinter in protected locations (brush, trash, etc.) as adults and emerge with the first warm days in the spring. The common asparagus beetles start laying eggs in April on spears or ferns. The eggs are dark colored and appear to stand on end on the plant tissue. The larvae are a dull blue-gray with black head capsules. The presence of eggs, larvae, or larval feeding injury on spears is considered a contaminant resulting in cullage. Larvae feeding on the fern can seriously injure newly established beds and reduce the vigor of a mature stand. There are two to five generations per season, depending on location.

The 12-spotted asparagus beetle usually lays eggs on the berries. The newly hatched larvae chew into the berry. As many as three berries are required for the development of one larva. There are usually two generations per season. This species is mainly a problem where seed production is important.

Asparagus Aphid

The asparagus aphid, *Brachycolus asparagi,* is a newly introduced pest of asparagus in Washington, first observed and identified in late August 1979. It apparently is restricted to asparagus as a host.

Eggs are laid in the fall (September to November) on the fern. They are green when first laid but after one to two days become shiny black. Apparently the eggs fall to the ground during the winter and hatch the following spring. Fundatrix females (stem mothers) were observed on fern growth during the last week of April. The first winged aphids appeared about mid-May. The number of generations per season and the reproductive potential remains to be determined. Also, the distance that winged aphids may travel is unknown. It seems they are mobile enough so that the known infestation could spread to any asparagus grown in eastern Washington.

Symptoms of aphid injury include a marked stunting of fern growth. Shoots are greatly shortened with the fern forming a dense clump of bushlike growth 4-6 inches above the ground (Fig. 8). Aphid injury on full-grown ferns may appear as tufts of dark green, tight growth with a smokey or dusty cast.

The greatest damage seems to occur to the younger plants. Seedlings and one-year-old plants may be killed directly. Older plants show a range of responses, from weakened plants with a few shoots to those showing essentially no effects. Early season examination of one- or two-year-old crowns of older plants infested with aphids the preceding fall showed a decaying condition with no buds present. Although the roots were succulent and appeared healthy, the plant was technically dead.

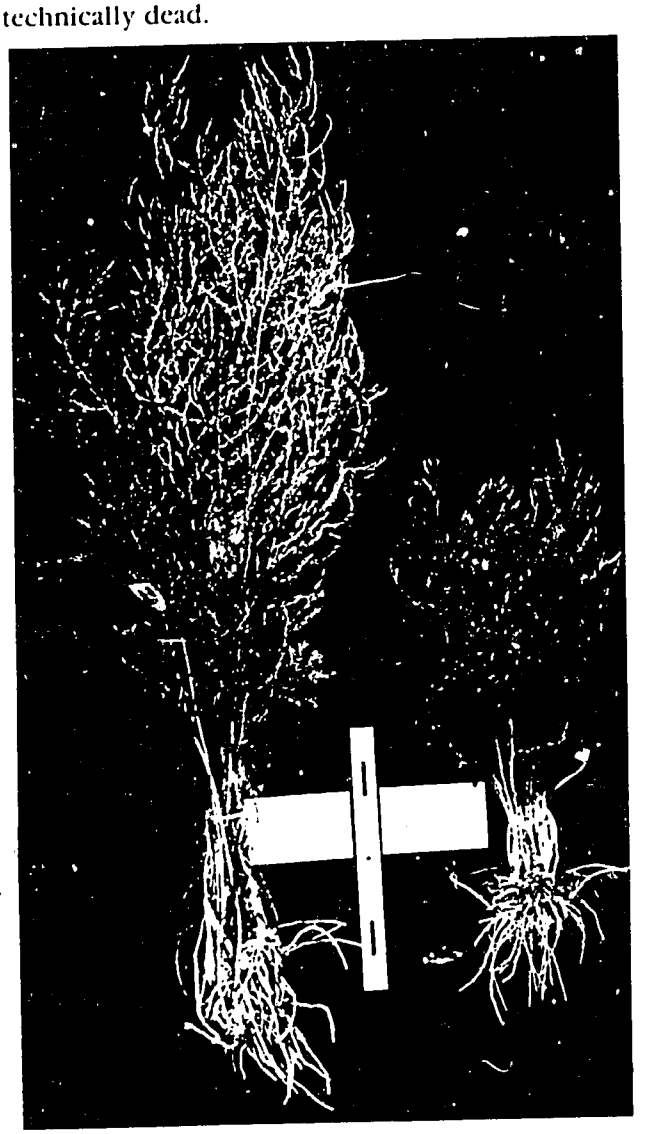

Fig. 8—Healthy (left) and aphid injured asparagus plants. Note the marked stunting of the fern and the dense, bush-like growth.

A large number of natural enemies including ladybird beetles, parasitic wasps, syrphid larvae, and lacewing larvae have been observed feeding on colonies of asparagus aphids. However, the likelihood of natural enemies providing adequate protection to prevent aphid toxin from harming the plant is unlikely. The best protection against the aphid is with the use of chemical sprays. See EB 0788, *Asparagus Aphid* for the latest recommendation.

Cutworm

Two cutworms are found in central Washington. The first to appear in the cutting season is the spotted cutworm, *Amathes c-nigrum,* which is characterized by its general brownish color and a pair of dark hash marks toward its rear end. This cutworm frequently injures the spears by feeding on the tips (late April to early May).

The redback cutworm, *Euxoa ochrogaster,* appears about mid-May and may be present until late June. Feeding injury by the redback cutworm usually occurs to the side of spears at or below the ground line. Often, much of the injury is in the white portion of the spear. Heavy infestations result in chewed or severed stems of new shoots and may occasionally remove all above-ground growth. If portions of asparagus rows produce no new growth where you would expect a plant to be, carefully examine the loose soil for cutworms. They may vary from 1/2 inch to nearly 2 inches long.

Recent evidence shows an association between weeds in asparagus fields and cutworm infestations. This may be an additional incentive for weed control as well as a clue for determining the location of a cutworm population in an asparagus field.

Symphylans

Symphylans are small white (up to 3/8 inch long) centipede like animals with nocturnal habits. Small asparagus roots may be eaten entirely; larger roots have round feeding punctures. The punctures in root and stem tissue are a clue to an infestation if adults cannot be found by digging.

Symphylans have not been a widespread problem in Washington. Isolated infestations have been found which were generally associated with heavy (silt or loam) soils.

Wireworms

Wireworms are elongate, cylindrical (1/2-1/4 inch long), and vary from bright yellow to brown. They have a small brown or black head and three pairs of short legs. Wireworms are the larval stage of "click beetles" and may spend 2-6 years as larvae, depending on the availability of food and soil conditions.

Wireworms feed on new roots and may kill young plants. Populations of one or more per square foot may seriously reduce asparagus stands. Wireworms may be serious pests for one or two years in ground which previously grew an established crop such as alfalfa or pasture. They are most easily found in late summer, fall, or in spring when soil moisture is good and soil temperatures are 45-55°F. As the soil becomes hot and dry, wireworms migrate downward so that it is often hard to find them during dry summer weather, even in severely infested fields.

DISEASES

Asparagus Rust

Asparagus rust, caused by the fungus *Puccinia asparagi,* is a problem some years in Washington asparagus production areas. The presence of the disease depends upon environmental conditions. Asparagus rust is usually much less destructive in areas of low rainfall and humidity than in high moisture areas. Rust incidence is higher in young nonharvested fields because of early ferning.

Asparagus rust causes the needlelike branches of the stem to fall and the plants to appear naked. Ultimately, the field may turn brown. Asparagus rust is usually seen first next to the ground as small, red-yellow pustules on the stalks that grow up after harvest.

Resistant varieties are available but the level of resistance may vary with different stocks of varieties. Some fungicides have helped control rust in areas where asparagus rust occurs.

Fusarium Wilt
Root and Crown Rot

One or more closely related asparagus diseases are attributed to *Fusarium* species. The fungi generally attack feeder rootlets, weaken and kill many plants. Thus, asparagus stands and yield are reduced.

Fusarium populations build up in soil when the first bed is planted. *Fusarium* is a good soil inhabitant and therefore old asparagus land should not be

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used for nurseries or replanted to asparagus. There is recent evidence that the *Fusarium* is carried on the seed and infection takes place very soon after the seed germinates. Seed treatments have been developed that effectively reduce seedling infection.

When asparagus is seeded on infested soil seedlings may damp-off. Needles near the tip of the primary shoots of young crowns infected with *Fusarium* turn yellow and the growing point dies. Eventually, the whole stem turns yellow.

In established beds, the disease is usually noticed about one month after the cutting period when certain elongated stalks become yellow and die. One or two shoots of a crown may be affected while the others appear normal or the entire hill may be killed. Diseased plants are usually scattered throughout the field. Reddish brown lesions may appear at and below the soil line of yellowed shoots. Diseased plants usually possess a large number of dried-out roots distributed over the old and new portions of the crown. Early stages of root infection may show up as numerous, reddish brown to purple, firm, elliptical lesions. Vascular discolorations are present in roots and crowns and in scattered vascular bundles of the stem base. This discoloration may occur for distances up to two feet into the stalk, but it usually is restricted to the basal regions of the stalk.

Practical control at present for *Fusarium* wilt is to avoid using old asparagus soil. Use seed treatment to eliminate *Fusarium*, or plant the Mary Washington variety. Mary Washington is not totally resistant to *Fusarium* wilt but it is the most tolerant variety available for Washington conditions. However, the horticultural characteristics of Mary Washington are not as desirable as those of the newer Washington State University varieties.

By Robert Thornton, extension horticulturist; William Ford, area extension agent; and Ray Coyier, research horticulturist, with assistance from the Washington Asparagus Growers Association. Walter Cone, research entomologist; Robert Parker, extension agronomist; and Otis Maloy, extension plant pathologist. Published in furtherance of the acts of May 8 and June 30, 1914. Washington State University Cooperative Extension, J. D. Young, Director, and the U.S. Department of Agriculture cooperating. Extension programs and employment are available to all without discrimination. Published January 1982.

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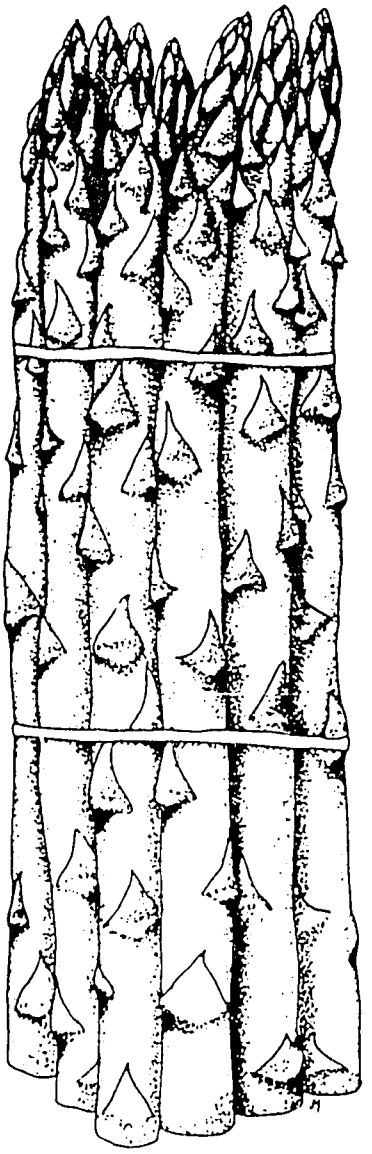
ASPARAGUS PRODUCTION



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The authors are Frank H. Takatori, Department of Plant Sciences, Specialist in the Experiment Station, Riverside; Frank D. Souther and James I. Stillman, Staff Research Associates, Department of Plant Sciences, Riverside; and Brian Benson, Staff Research Associate, Department of Vegetable Crops, Davis.

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ASPARAGUS CULTURE IN CALIFORNIA

INTRODUCTION

This bulletin, written for both the established asparagus grower and the beginner, presents the latest information on asparagus growing: methods of establishing new plantations and cultural practices in maintaining a productive planting. Recent research findings on factors that affect California asparagus production are also summarized.

ASPARAGUS INDUSTRY

Asparagus is one of the important field crops grown in California. The principal commercial growing areas are the Sacramento, San Joaquin, Salinas, Imperial, and Coachella valleys and Orange County. (Figure 1 shows a 5-year-old commercial planting; figure 2 shows a 4-year-old asparagus crown.) Also, because it is adaptable to a wide range of soil and climatic conditions, asparagus is grown in small acreages or backyard gardens throughout the state.

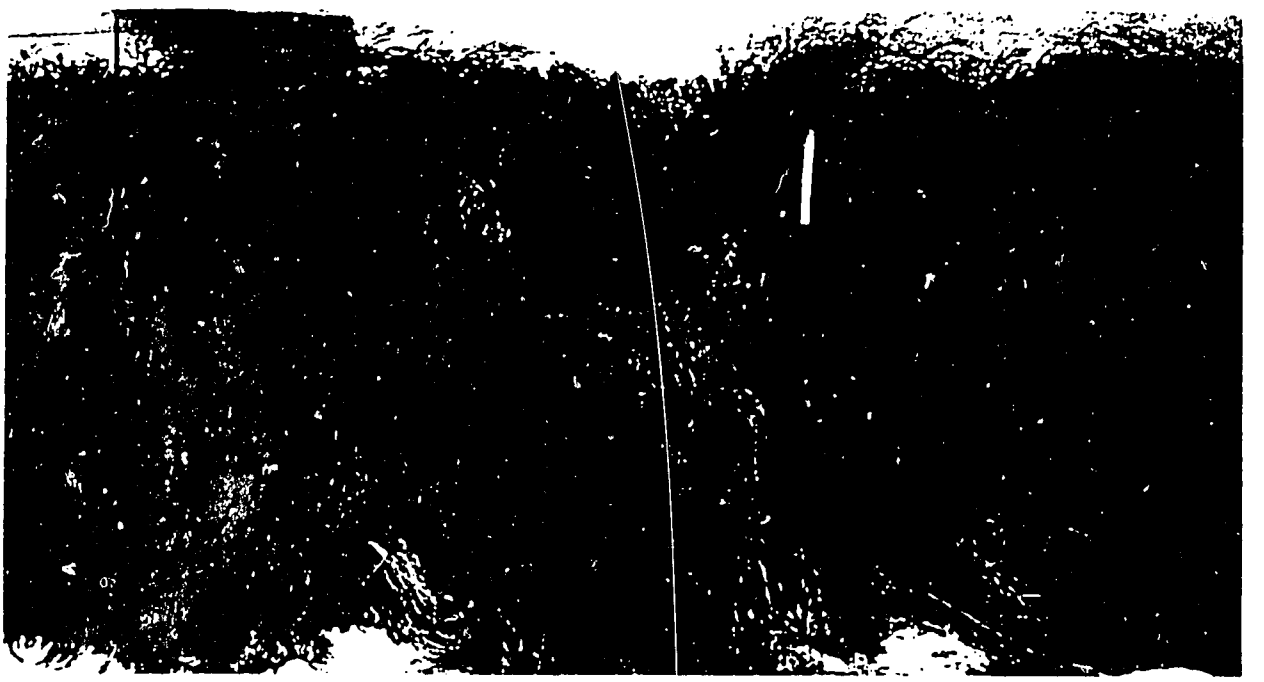

Fig. 1. A 5-year-old asparagus field with rows planted on 5-foot centers. (Note the 12-inch stake in the fern.)

Fig. 2. Cross-section of a 4-year-old asparagus crown. "A" indicates normal orientation.

With approximately 40 percent of the total U.S. asparagus acreage, California provides nearly 50 percent of the total U.S. production and 70 percent of the fresh market asparagus. In 1974, California had 44,000 acres of asparagus on approximately 200 farms (table 1). Overall production was 127.9 million pounds of marketable asparagus valued at more than $36 million. Of the total produced, 60.8 million pounds were marketed as fresh green asparagus and 67.1 million as processed asparagus. Approximately 90 percent of the processed asparagus produced in California that year was grown in the Sacramento-San Joaquin Delta area.

During the early 1960's the average annual production of white asparagus in California was approximately 60 million pounds. However, white asparagus production has been low in California since 1970.

Asparagus is comparatively free from insect pests and most diseases and does not need the highly specialized maintenance required by most cultivated crops. However, establishing a commercial plantation entails considerable time, labor, and expense. The grower receives no income until the first harvest two years after planting. A good supply of labor is a critical requirement in asparagus production, because all operations in growing and harvesting the crop at least partially depend on hand labor. Mechanical harvesters are not widely used.

CLIMATE AND SOILS

Asparagus is grown in California on sandy to heavy clay soils and in cool coastal to extremely hot desert climates. However, for maximum production the requirements are more restrictive.

In greenhouse tests at Riverside, the air temperature was maintained at 85° to 90°F during the day and 75°F during the night. Soil temperatures ranged from 45° to 95°F at 10° increments. Both root growth and fern growth were inhibited at soil temperature below 55° and above 85°F. Optimum root and fern growth occurred at soil temperatures between 65° and 85°F.

Where earliness of production is important, sandy textured soils are best because they warm up more rapidly than heavy textured soils. Spear initiation occurs at soil temperatures above 50°F. However, growth and elongation of the spears are controlled primarily by air temperature, not by soil temperature.

Asparagus requires fairly deep soil for good yields. A high water table is especially detrimental to good vigorous growth and, when it occurs during the growing season, usually contributes to death of the plants. Soil excavation studies (Benson, 1972) showed that generally 35 percent of the asparagus root system is in the top foot of soil, and that many of the roots extend below the 5-foot level.

The soil should be thoroughly prepared before planting; there is no opportunity for further preparation afterwards. Because it is expensive and difficult to control perennial weeds in an established planting, as many as possible should be destroyed during the preparation period before planting.

TABLE 1. ASPARAGUS ACREAGE HARVESTED, PRODUCTION, AND VALUE (1967 to 1974)

Year	U.S.	California		
	Acreage	Acreage	Quantity	Value
	1,000 acres	*1,000 acres*	*million pounds*	*1,000 dollars*
1967	129.1	50.2	140.6	26,146
1968	125.4	46.7	149.4	28,627
1969	123.8	44.7	129.6	26,414
1970	119.9	42.9	133.0	26,775
1971	118.5	43.0	137.6	33,452
1972	121.3	45.7	155.4	36,620
1973	122.8	47.7	126.0	33,618
1974	112.5	44.0	127.9	36,940

SOURCES: California Asparagus Growers Association Industry Report, 1973.
California Crop and Livestock Reporting Service, 1975.

VARIETY SELECTION

The principal asparagus variety grown in California is U.C. 72. Other varieties grown in limited acreages are U.C. 66, U.C. 309, U.C. 500W, U.C. 711, U.C. 500, Mary Washington, and Brock's Special. All U.C. lines are related to the Mary Washington variety, which was introduced into California in the late 1800's or early 1900's.

Varieties U.C. 72 and U.C. 66 are sister lines developed by G. C. Hanna, formerly with the Department of Vegetable Crops of Davis. They possess a high degree of tolerance to the *Fusarium* diseases in California. Introduction of these varieties made it possible to replant old asparagus plantations that had developed high *Fusarium* infestations. In numerous comparative field tests, the production performance of the U.C. lines has been superior to that of imported lines.

Brock's Special was developed in the Imperial Valley for the growing conditions characteristic of that hot desert area.

Fig. 3. A U.C. 157 asparagus plant.

In the fall of 1975, U.C. 157 (fig. 3), a new hybrid line, was released for commercial use. In field trials, U.C. 157 showed earliness in production, multispear initiation, uniformity in color and size, and greater total production than present commercial lines. Check with the U.C. Cooperative Extension farm advisors in your county for future releases and availability of seed.

ESTABLISHING A PLANTATION

Commercial asparagus plantations may be established either by the traditional crown-planting method or by direct seeding. Both systems are used successfully in California.

With crown planting, asparagus seed is sown in a nursery, and the seedlings are grown for one season. One-year-old crowns are dug during the winter or early spring and transplanted into the field. Two advantages of this method are that a large number of crowns can be grown in a limited area, and the crowns may be inspected and graded before their final placement in a commercial plantation. Weak or small crowns can be discarded.

By the direct-seeding method, asparagus seed is precision planted at the desired spacing directly in the commercial field. This system eliminates the task and cost of growing and maintaining a nursery, digging the crowns, and replanting them. Also, it is more economical and easier to establish a high-density commercial plantation by direct seeding than by crown planting.

Both methods require two years from the time of planting in the commercial field until the first harvest can be made. Frequently, the crown-planted fields are harvested for a limited time the first season after transplanting, but this practice should be dictated by the vigor of the plants and is not recommended as a general practice.

Plant spacing

In experiments conducted from 1932 to 1939 by G. C. Hanna (1947) at Davis, higher yields were obtained from crowns spaced 12 inches apart in-row than from wider spacing (fig. 4). As the crowns grew older, yields from all the wider spacings approached those obtained from the 12-inch spacing. No difference in spear size occurred at any of the spacings tested. The plantings were single row per bed on 5-foot centers.

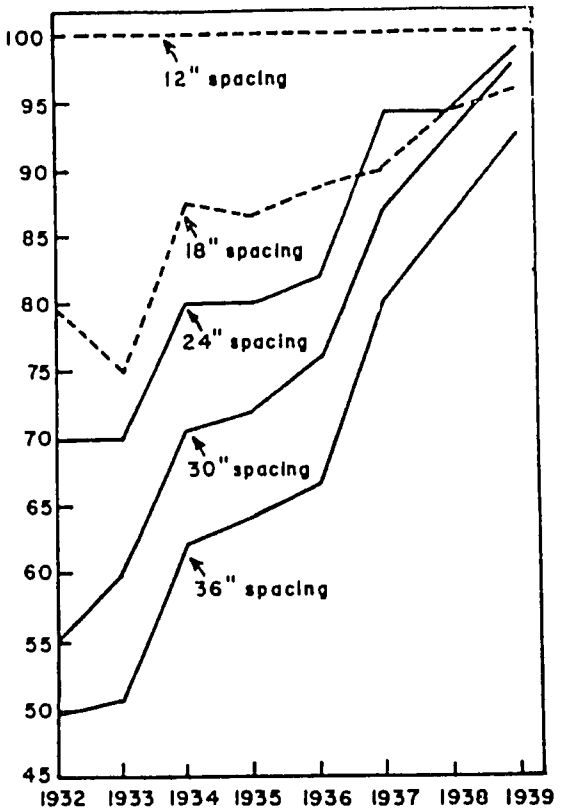

Fig. 4. Ryer Island experiments showing percentage of yield at various spacings.

In another field test (1958-1970) Hanna compared direct-seeded plants spaced 2 inches apart with crowns 12 inches apart. The 2-inch spacing resulted in a significantly greater number and total weight of spears for the first six years, but no differences between the two treatments occurred during the remaining seven years (figs. 5 and 6). As shown in figure 7, the average spear size was smaller in the 2-inch spacing during the first five harvest seasons, but spear size did not differ in subsequent harvest seasons (Takatori, 1971).

The influence of in-row spacing of 2, 4, 6, and 8 inches on production was tested at Riverside from 1968 to 1975 (Takatori, 1975). The field was direct-seeded on 5-foot center beds with two rows per bed. All plantings were made with an initial in-row spacing of 2 inches and thinned to the proper stand the first year.

The 2-inch spacing gave the highest yield of spears and total weight for the six-year harvest period. The differences among spacings of 2, 4, and 6 inches were small and not significant. The yield from the 8-inch spacing was significantly lower than that from the other treatments (table 2).

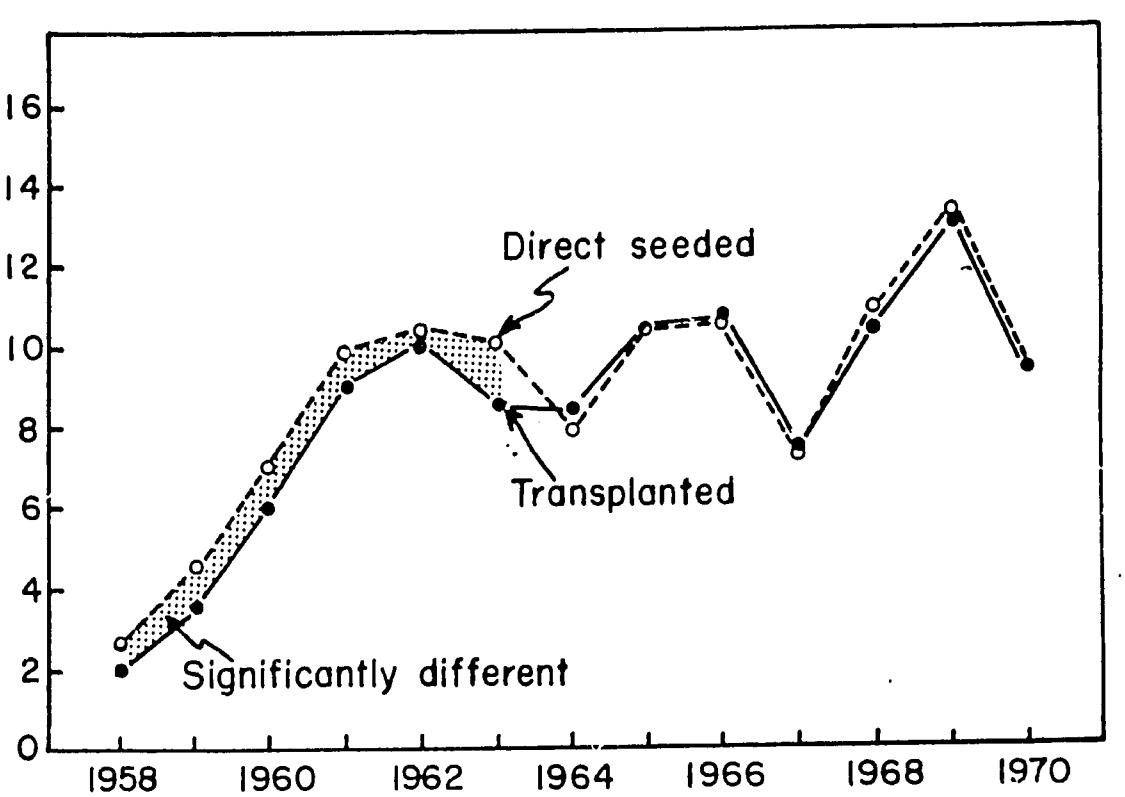

Fig. 5. Yield of direct-seeded asparagus in 2-inch spacing compared with that of transplanted crowns in 12-inch spacing over a 13-year period. Variety 309 was used.

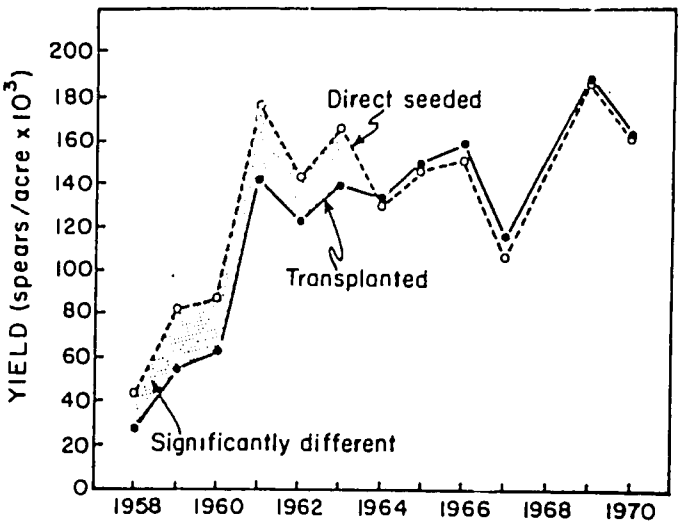

Fig. 6. Number of spears per acre from direct-seeded asparagus in 2-inch spacing compared with that from transplanted crowns in 12-inch spacing over a 13-year period. Variety 309 was used.

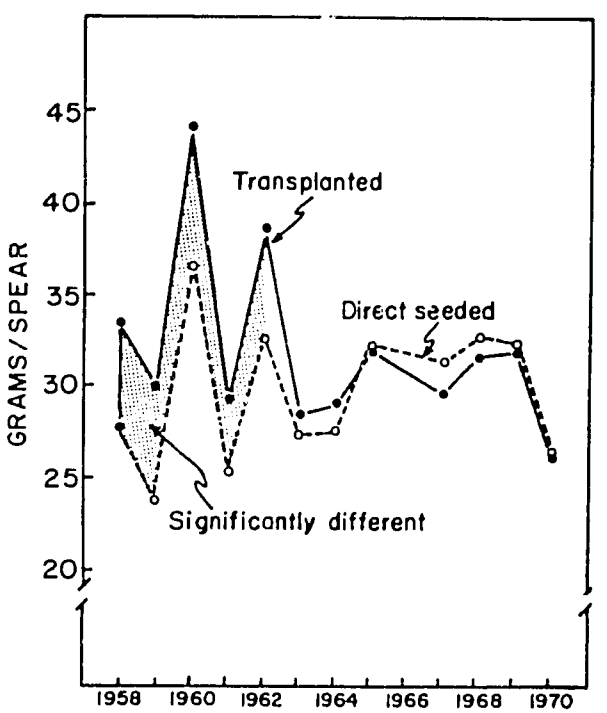

Fig. 7. Weight per spear of direct-seeded asparagus in 2-inch spacing compared with that of transplanted crowns in 12-inch spacing over a 13-year period. Variety 309 was used.

The average spear size of plants 2, 4, and 6 inches apart was smaller than that of plants 8 inches apart. As shown in table 3, the differences in spear size among the four spacings were large the first season but decreased as the plantings aged. Little or no difference in spear size occurred during the sixth harvest season.

Another test (Takatori, Souther, and Stillman, 1975), comparing plantings with one, two, or three rows per bed and a broadcast planting, was made at Riverside from 1966 through 1972 (fig. 8). The four plantings represent densities of 40,000, 80,000, 120,000, and 160,000 plants per acre, respectively.

The yield both in number of spears and in total weight was larger in the double, triple, and broadcast plantings than the single-row planting (table 4). The yield differences between the two- and three-row plantings were small and nonsignificant. The yields in the single-row and the broadcast plantings were significantly lower than those of the other two.

Quality was determined by spear diameter in the following three grades: large, more than 0.75 inch; medium, 0.50 to 0.75 inch; and small, 0.25 to 0.50 inch. All spears smaller than 0.25 inch in diameter were discarded.

Each season the single- and double-row plantings produced spears with the largest average size (table 4). The two treatments were not significantly different. Both produced similar percentages of large spears, but the double-row beds produced more spears because of the higher plant density (table 5). Except for the first harvest season, the double-row planting produced the lowest percentage of small spears.

Crown depth

Planting depth, or the depth of soil cover over crowns during the harvest period, affects earliness of production, total production, and spear size.

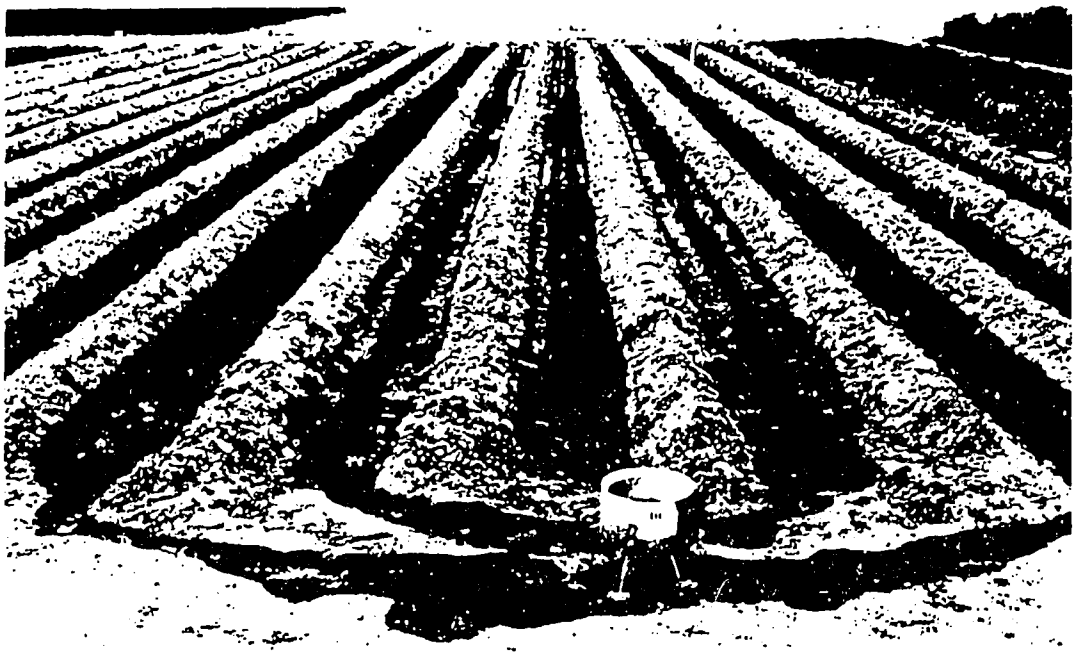

Fig. 8. Direct seeding experiment showing one, two, and three rows per bed and broadcast bands.

TABLE 2. INFLUENCE OF DIFFERENT IN-ROW PLANT SPACING ON SIZE AND YIELD OF GREEN ASPARAGUS (1970 to 1975)

Row spacing	Yield according to size of spear:			
	Large	Medium	Small	Total
inches		*pounds per acre*		
2	5,260	14,090	7,000	26,350
4	5,120	14,000	7,080	26,200
6	5,170	13,320	6,220	25,710
8	6,020	11,740	4,810	22,570

TABLE 3. INFLUENCE OF IN-ROW PLANT SPACING ON SPEAR WEIGHT (1970 to 1975)

Row spacing	Average weight/spear in:					
	1970	1971	1972	1973	1974*	1975
inches				*grams*		
2	10.18	14.85	19.03	20.04	—	15.70
4	12.32	14.96	18.69	19.93	—	16.59
6	13.29	16.98	20.75	20.86	—	16.01
8	14.19	17.78	20.99	22.68	—	16.43

*Harvested for 70 days; no data collected.

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TABLE 4. INFLUENCE OF VARIOUS PLANT DENSITIES ON TOTAL YIELD OF MARKETABLE ASPARAGUS (1968 to 1972)

Year	Yield at following plant densities/acre: 40,000 (single-row/bed)	80,000 (double-row/bed)	120,000 (triple-row/bed)	160,000 (broadcast/bed)
		Spears/acre		
1968	39,630	50,160	63,160	60,920
1969	67,300	87,590	114,600	104,900
1970	50,090	65,720	85,170	73,490
1971	110,450	137,690	154,120	142,730
1972	137,170	170,760	179,260	170,120
		Pounds/acre		
1968	1,630	2,000	2,270	2,220
1969	2,600	3,360	4,360	3,890
1970	1,640	2,250	2,810	2,360
1971	4,450	5,570	5,890	5,240
1972	5,970	7,760	7,270	6,790

TABLE 5. EFFECT OF PLANT DENSITY ON NUMBER AND PERCENTAGE OF MARKETABLE SPEARS ACCORDING TO SIZE (1968 to 1972)

Treatment	Spears per acre: Large	%	Medium	%	Small	%
1-row/bed	34,400	8.5	190,400	47.1	179,600	44.4
2-row/bed	44,600	8.7	245,000	47.9	221,800	43.4
3-row/bed	39,700	6.6	260,900	43.6	297,300	49.7
broadcast/bed	33,300	5.9	242,300	43.3	284,300	50.8

TABLE 6. THE INFLUENCE OF PLANTING DEPTH ON THE YIELD OF DIRECT SEEDED ASPARAGUS (1972)

Planting depth (inches)	No. spears harvested/acre	Weight: lb./acre	gm/spear
2	176,800	5,800	14.1
6	153,600	6,390	18.1
12	100,900	4,620	20.7

In 1969, plantings were made at Riverside (Takatori, Stillman and Souther, 1974) in preformed basins 2, 6, and 12 inches deep. The plants were grown the first season in open furrows with no additional soil cover. During the second season, soil from the ridges was moved over the plants to establish plantings with soil cover depths of 2, 6, and 12 inches.

Each subsequent season the plants with 2 inches of soil cover began production one week earlier than those with 6 inches of cover, and two weeks earlier than those with 12 inches. Earliness was based on the time required to produce 10,000 marketable spears per acre.

The number of marketable spears harvested decreased with planting depth (table 6). Over a 60-day harvest period, the number of spears in plantings 2 inches deep was nearly twice that of plantings 12 inches deep. Most of this increased production occurred during the first three weeks of harvest, when the deeper plantings produced few spears.

Yield in pounds per acre (table 6) was largest in the 6-inch-deep plantings. They produced nearly as many spears per acre as the 2-inch-deep plantings and had almost as large an average spear size as the 12-inch-deep plantings. Also, the 2- and 6-inch-deep plantings were only one week apart in production earliness.

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Spear size markedly increased with the deeper plantings. Large spears accounted for only 3.75 percent of the total produced by 2-inch plantings and 16.02 percent of the spears harvested from 12-inch-deep plantings (table 7). The girth of spears increased as they grew upward through the soil. In 2-inch-deep plantings, the spear has a tendency to taper immediately after emerging from the soil.

TABLE 7. THE INFLUENCE OF PLANTING DEPTH ON SIZE OF ASPARAGUS SPEARS (1972)

Planting depth	Percent of total number of spears:		
	Large	Medium	Small
Inches			
2	4	37	59
6	10	49	41
12	16	50	34
	Percent of total spear weight:		
2	9	50	41
6	22	55	23
12	29	52	18

Planting depth or soil cover influences spear size only during harvest. In controlled, lath-house tests initiated in 1970 at Riverside, soil cover was added over the crowns during the harvest period; the crowns were grown the rest of the year with 2 inches of soil cover. Spear size increased with depth of cover. Results of subsequent *in-vitro* studies indicate the spear enlargement is a light-related function: spears enlarge when grown in darkness. The physical presence of soil over crowns was not necessary to obtain a spear diameter increase in the *in-vitro* studies.

CROWN PLANTING

Nursery

Seed should be planted as early in the spring as possible to permit the development of good vigorous crowns (fig. 9). The seed may be drilled at a rate of 5 to 10 pounds per acre, depending on row spacing and seed size. Usually, seed are planted approximately 1 inch deep in rows 20 inches apart. The final in-row plant spacing should be 3 to 4 inches to facilitate digging, separation of crowns, and grading. A good nursery should yield between 80,000 and 100,000 usable crowns per acre, which would be sufficient to plant 5 to 10 acres, depending on spacing used in the plantation.

Field preparation

Furrows are made with a large double-moldboard plow. Often, a weight is dragged along the bottom of the furrow to break clods and smooth the bottom (fig. 10). The distance between rows for the production of green asparagus is usually 5 feet. This spacing, however, varies with the individual grower. Many existing successful fields are planted as narrow as 4 feet and as wide as 6 feet between centers.

If white asparagus is to be cut, the distance between rows is usually 7 or 8 feet, providing enough soil to build a ridge over the crowns.

Fig. 9. Typical variability in nursery-grown 1-year-old crowns.

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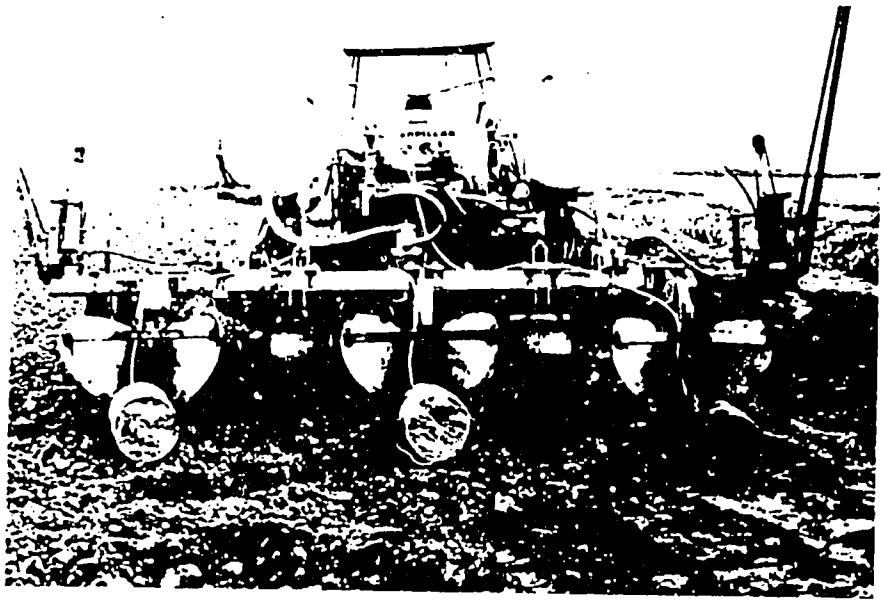

Fig. 10. Double-moldboard plows with clod breakers used to open furrows in crown planting.

Transplanting

Crowns should be transplanted as soon as possible after they are dug from the nursery. If weather conditions do not permit planting at the time of digging, and the waiting period may be lengthy, the crowns should be removed from the field and stored in a well-ventilated warehouse.

Growers use several methods to plant crowns in the field. However, the crowns usually are hauled to the field in a trailer and dropped by hand into rows at the desired spacing (fig. 11). Each crown should be placed in the furrows with the buds facing upward.

The crowns are covered with approximately 2 to 4 inches of soil and are irrigated through the furrows over the crowns. The practice of driving a tractor over the covered crowns to seat them is not recommended, because it can damage the crowns.

Fig. 11. Crown planting of asparagus.

Crown orientation

Orientation of the crown at planting time influences the earliness of spear emergence in the spring, the production of marketable spears, and the upward growth of the crown. However, crown orientation does not affect the survival of the plant.

In a field test begun at Riverside in 1962, (Souther, Takatori, and Stillman, 1974) one-year-old asparagus crowns were placed in the following positions: buds upright with the roots spread; crowns placed on one side with the roots extended horizontally away from the buds; buds upright with the root system folded under the crown; crows upside down.

Every crown, irrespective of orientation, initiated spears and continued to develop throughout the experiment. Spear emergence after planting and during the subsequent two seasons was delayed from crowns initially positioned upside down as compared with the other crown orientations.

Yield of marketable spears by weight and number was significantly lower for crowns planted upside down than for the other three crown orientation plantings. Yields of crowns planted in the other three positions did not differ (figs. 12 and 13).

All crowns produced upward growth each season. Those planted on one side had the greatest upward growth (fig. 14). Next in upward growth were those planted upside down. Crowns planted with roots folded under had the slowest upward growth. After three years, crowns planted on one side and upside down had grown upward 3 to 3½ inches; those planted in the upright position or with roots folded under grew 2 to 2½ inches upward.

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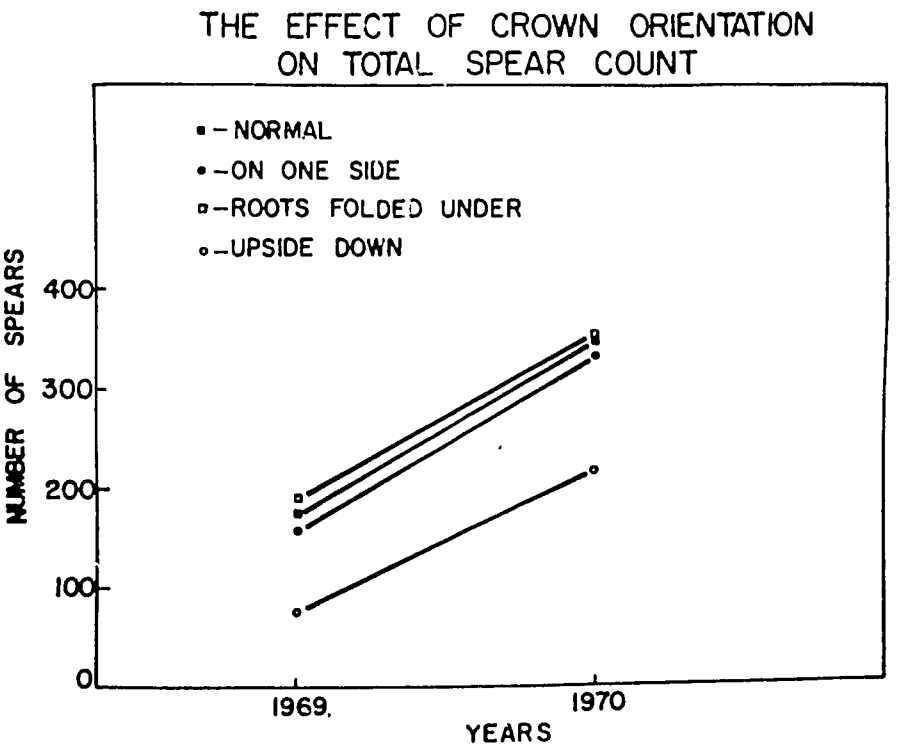

Fig. 12. The effect of crown orientation on total spear count.

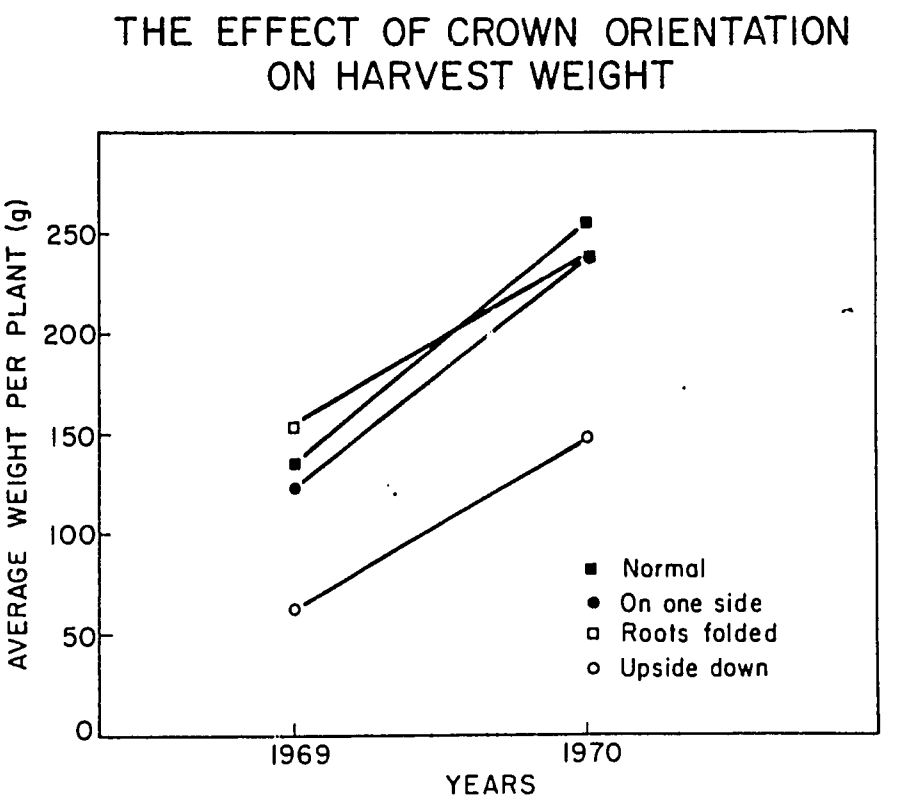

Fig. 13. Effect of growth orientation on harvest weight.

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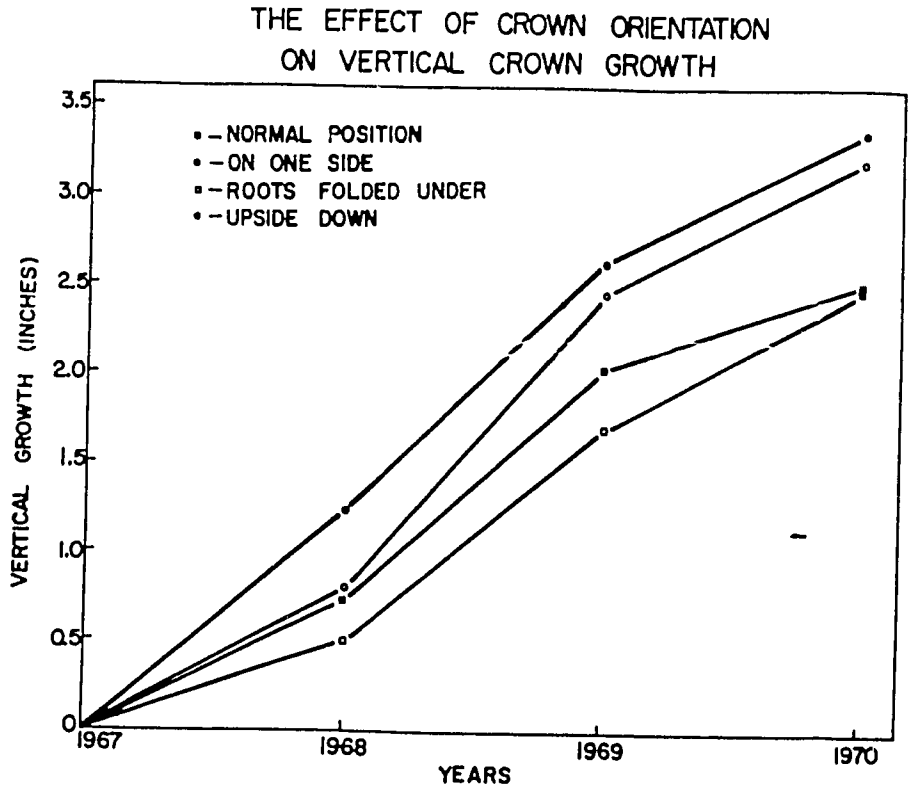

Fig. 14. Effect of crown orientation on vertical crown growth.

DIRECT SEEDING

Direct-seeding for establishing an asparagus plantation is used most frequently in the southern California desert and coastal areas, where high plant populations are desired.

Field preparation

Many growers direct-seed on raised beds or on the flat surface, as with other row crops. However, special preformed planting furrows are recommended, because they provide sufficient soil to cover the crowns during subsequent seasons and ensure that the crowns are buried below the soil surface.

Flat-bottom furrows spaced on 5-foot centers 5 to 7 inches below the original ground level are generally used. The initial furrows are made with a double-moldboard plow, and the bed is formed with a sled-mounted bed shaper (fig. 15). Precision planters are usually mounted behind the bed shaper so that bed spacing and planting are done in one operation. A formed bed with a level firm ridge between the rows is necessary to facilitate the movement of equipment through the field.

Planting date

The usual practice in all asparagus production areas is to direct-seed as early in the spring as weather and field conditions permit. This practice allows maximum crown growth and development during the first growing season. However, in southern California, where the mild winter weather provides a longer growing season than in most other production areas, direct-seeded plantings may be made throughout the season with reasonable success and with only minor changes required in the standard cultural practices.

March, April, July, and September planting dates were compared in three Riverside tests in 1968 (Takatori, Stillman, and Souther, 1971). Percent germination was about the same for the four planting dates. However, because asparagus seeds germinate slowly during cool weather, seedlings took three to four weeks to emerge in the March and April plantings compared with two weeks in the July and September plantings. No differences in the rate of emergence or percent germination occurred between furrow-irrigation and sprinkler-irrigated plantings.

Fig. 15. Spray shield used in applying herbicide sprays over young seedlings.

Physical measurements taken at the end of the first growing season showed that plants seeded after July made only limited growth the first season (table 8). The growth inhibition of the July and September plantings was caused by extremely hot weather during the initial seedling growth period and by the short growing period from the date of planting to the onset of cool winter temperatures.

Before the second growing season, soil from the ridges was moved over the seedlings from the four planting dates to a depth of 6 inches. As shown in table 8, the small seedlings from the September plantings did not survive, and the stand for the July plantings was drastically reduced.

In subsequent fall plantings where no soil was moved over the plants after the first growing season, little or no loss in stand occurred. In late summer or fall plantings, soil may be moved gradually into the furrow during the second growing season after the plants are 1 to 2 feet tall.

TABLE 8. EFFECT OF FOUR PLANTING DATES ON ASPARAGUS GROWTH AND STANDS (1968)

Item measured	Average growth per plant when planted in:			
	March	May	July	September
Seedlings after one season's growth:				
Canes (no.)	9.5	6.0	3.0	2.0
Fern length (in.)	16.9	13.0	3.5	1.5
Fern weight (gm)	16.5	8.1	.3	.2
Storage roots (no.)	39.5	21.5	4.2	3.0
Storage root weight (gm)	39.5	13.2	.5	.2
Estimations of established stands, second season:				
Spears/1 ft. beds (no.)	21.9	15.3	1.4	0.0
Plants/1 ft. beds (no.)	4.9	4.2	2.2	0.0

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TABLE 9. ASPARAGUS SIZE AND PRODUCTION AS AFFECTED BY FIVE PLANTING DATES (1970 and 1971)

Planting date	Number of spears/acre according to size:							
	Marketable		Large		Medium		Small	
	1970	1971	1970	1971	1970	1971	1970	1971
					thousands			
1968:								
March	66.1	92.5	1.5	4.0	16.7	37.2	48.0	51.3
May	58.9	78.8	1.1	5.1	16.1	33.0	41.7	40.7
July	27.6	59.1	0.3	4.9	6.0	27.3	21.3	26.8
September	0	0	0	0	0	0	0	0
1969:								
March	10.1	90.6	0	3.1	0.6	36.4	9.5	51.0

As shown in table 9, yield was significantly greater in the early spring plantings than in the late plantings. One reason was the loss of stand in late plantings. Also late plantings had younger and therefore smaller plants. The March, May, July, and September plantings had 24, 21, 19, and 17 months growth, respectively, before first harvest.

Included in table 9 are results of the first harvest 12 months after the March 1969 planting. Production and size of marketable spears were very small the first season. No large spears and few medium grade ones were obtained; it is questionable whether harvesting 12 months after planting would be economical. Total spear production in the second harvest season was good, but overall spear size was again smaller for the March 1969 planting than for the 1968 plantings.

Planting

Direct seeding may be done with any type of precision planter that provides an in-row spacing of three plants per foot. Usually, two rows per furrow spaced 8 to 12 inches between rows are used. This should provide a final plant density of approximately 40,000 plants per acre. Depth of planting should be approximately 1 inch.

Adequate moisture should be maintained during the germination period. Apply an irrigation after planting, and keep the soil moist to prevent crusting. Both furrow and sprinkler irrigation have been satisfactory for asparagus germination and emergence, but sprinkler irrigation is preferable during germination because it facilitates soil moisture control. In furrow-irrigated plantings, the water may run over the seed row, but special care should be exercised to prevent the water from standing long on the seed. Whenever possible, a small irrigation furrow is made in the bottom of the planting basin for the water to run.

Weed control

Weed control is a major problem in direct-seeded asparagus because hand-weeding costs may be prohibitive. When applied pre-emergence, certain chemicals have given satisfactory weed control. New pre-emergence and post-emergence herbicides are being tested each year. Consult your U.C. Cooperative Extension farm advisor for the most recent information.

A field can be sprayed with a contact herbicide immediately before asparagus seedlings emerge. A month or two after emergence, another contact herbicide application may be desirable; use a plant shield to protect the seedlings (fig. 15).

Most growers move some soil from the ridge into the basin during the growing season to control weeds, repeating the operation until the basins are nearly filled by the end of the first season. However, this procedure is not necessary, because the entire ridge can be moved after the fern is dead. Weeds appearing later in the season are not detrimental to the seedlings and will be destroyed the following season when the soil is moved from the ridge over the asparagus plants to prepare the beds.

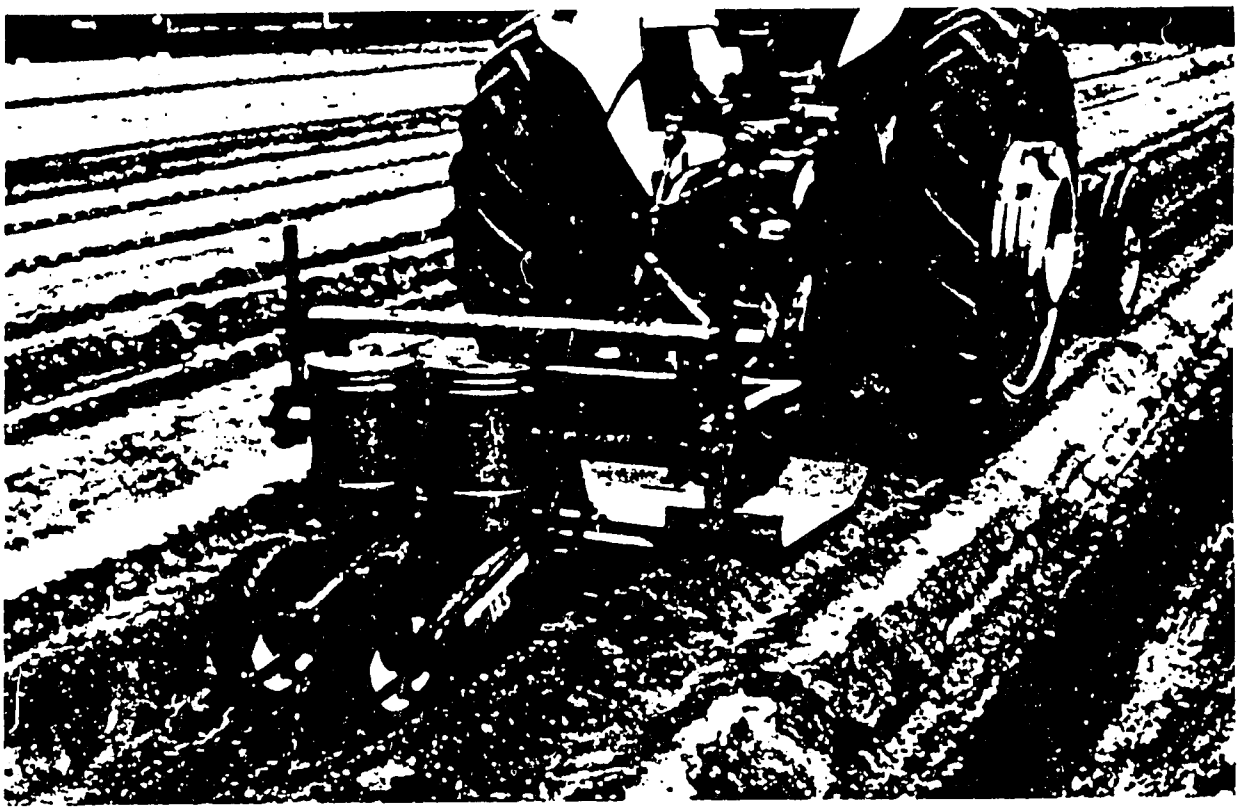

Fig. 16. Bed shaper with precision planters mounted.

PLANTATION MANAGEMENT

Bed preparation

Each year just before harvest, the cutting beds should be reshaped. This is usually done by throwing soil up on each side of the beds from the furrows. The tops of the beds containing this loose soil are rototilled and then smoothed and shaped with a bed shaper. Care must be used to avoid rototilling too deeply and injuring crowns that might be near the soil surface.

Some growers reshape their beds again after the harvest season is over to control weeds and also to loosen the soil surface where it is caked.

Cultivation

Generally, established asparagus plantations are cultivated very little. Shallow cultivation is sometimes used to control weeds and to break up a caked soil surface for better water penetration during furrow irrigation. Deep cultivation should be avoided; it destroys roots and decreases yields.

Fertilization

The University of California Agricultural Experiment Station has conducted asparagus fertilization trials throughout the state during the past several years. Some yield increases occurred in most of the experiments but were not large enough to be significant.

Since a crop of asparagus does remove nutrients from the soil each year, some fertilizer should be applied. A general recommendation is to apply 100 pounds of nitrogen, 50 pounds of phosphorus, and 100 pounds of potassium per acre before preparing the field for asparagus planting. Usually nitrogen is also applied annually, at 100 pounds, especially in mineral soils. This additional nitrogen usually is applied immediately after the cutting season ends, but some growers prefer to apply it before cutting begins. Still others prefer to split the application, applying one-half before cutting begins and one-half after it ends.

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Irrigation

Furrow irrigation is normally used in all California asparagus production areas except the Delta. However, some growers are beginning to use drip irrigation on small acreages. In the Delta, subirrigation is still used, although furrow irrigation is becoming common there also.

Asparagus plantations usually are irrigated every ten to fourteen days in the spring; alternate furrows are used during the harvest season. During springs with more than average rainfall, the frequency of irrigation should be adjusted accordingly. The summer schedule should be every seven to ten days. Each irrigation should be long enough to wet the soil several feet deep.

Irrigation is usually stopped in October so that the plants will become dormant. The fern then dries and can be removed before spear growth begins again the following spring.

Fern disposal

In the past, burning was the most common method of fern (brush) disposal. In addition to getting rid of trash on the beds, burning helped control insects and disease.

Burning is no longer permitted in most of California and likely will be stopped in all of the state in the near future. One alternative disposal method commonly used today is to use a rotary mower to mow the fern as soon as it is brown in the fall and allow it to decompose on the ground during the winter. Another method is to mow the fern with a sickle-bar mower in the fall and to leave it until the field is worked before harvesting in the spring. Both methods leave undesirable trash on the beds, which interferes with the harvesters. Some growers use a forage chopper to cut the fern, which then is loaded onto trucks and removed to a dump.

Salt

Asparagus has a high tolerance for salt. It is grown successfully in desert areas where the salt level of soils is quite high. No damage symptoms have been identified in asparagus that could be attributed to salt. In past years some growers in the eastern United States used rock salt on their asparagus plantations for weed control, but that practice has been discontinued.

Smog

Asparagus appears to be quite smog resistant, and no known smog damage symptoms have been identified. Preliminary tests in a smog chamber at Riverside showed no visible damage to plants subjected to extended high levels of smog.

PESTS AND DISEASES OF ASPARAGUS

Diseases

Rust. Rust is more prevalent in coastal California than in drier inland areas. High humidity with warm temperatures is conducive to rust infestations. This disease causes brown rusty spots to appear on spears and fern branches. When the infestation is severe, the entire field appears to have a brown rusty color. At the present time there are no known rust resistant varieties.

Fusarium. Fusarium species are prevalent throughout the state in asparagus plantations. Studies in progress indicate that the presence of *Fusarium* is more critical in younger plants than in older crowns. It is believed that older crowns become somewhat more tolerant to the disease. The studies also indicate that extending the harvest period too long, thereby weakening the crowns, contributes greatly the plant's susceptibility to *Fusarium* species.

Insects

Asparagus is relatively free from insect pests in California.

Garden centipede. In the past, the garden centipede was a major pest on white asparagus. The importance of this pest has declined in recent years due to the large cutback in California white asparagus production that has occurred.

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Asparagus beetle. Although the asparagus beetle is found wherever asparagus is grown, it usually is not a serious pest in California. Some local infestations do occur, however, and control measures are required to prevent serious injury to the plantation. Usually the infestation and resulting injury are more prevalent on younger plantings than on older established plantings.

Thrip. Young seedlings in nurseries as well as in direct-seeded fields are susceptible to infestations of thrips. The entire top of the small seedling will turn brown and die and the plant will be seriously injured or killed, if the thrip attack is not controlled

Cicada. Some cicada infestations continue to occur, especially in the Coachella and Imperial valleys. Several studies of cicadas have been conducted, but neither the extent of their damage to asparagus nor adequate measures to control them have been determined to date.

HARVESTING

Hand

Asparagus is harvested as early as spears emerge in the spring. Cutters go over the field and harvest by hand any spears of sufficient length. Early in the season the cutters may go through the fields every five or six days, but during the peak harvest period many fields are cut every day or every other day.

Fresh-market asparagus spears are cut 10 to 12 inches long. Usually the cutters do not harvest according to the length of green alone but harvest spears about 2 inches below the soil surface.

Marketable spears must have compact heads and good green color. During periods of high temperature, the heads tend to open early. Consequently, the spears must be harvested sooner than in areas with cooler weather.

Many methods are used to transport cut spears from the field to the grading or holding shed. Early in the season when the yield is small, cutters may use some form of basket to carry spears they harvest from the field. When production is heavier, the spears are placed in small piles along a sled row and picked up in a motorized cart. Whether the spears are loaded into lug boxes or small bins for transporting to the grading sheds, the spears are oriented so that they all face in one direction.

Fig. 17. Hand harvesting asparagus.

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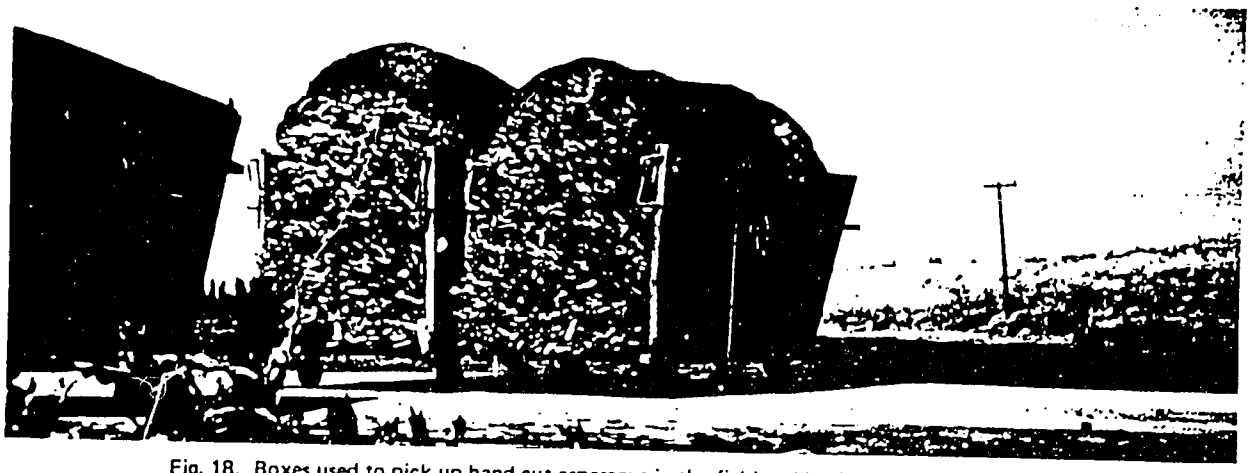

Fig. 18. Boxes used to pick up hand-cut asparagus in the field and haul it to the packing shed.

Mechanical harvesting

Very little California asparagus is mechanically harvested today. No selective harvesters have been perfected that are economically feasible to use so long as adequate hand harvesters are available. Some "non-selective" harvesters are being used on a limited scale to harvest asparagus for processing, but such machines are not practical for fresh-market harvesting.

Time and duration of harvest

Each production area has an optimal or "normal" harvest period. It is determined by the length of the growing season and by the requirement of a sufficient growth period after each annual harvest for plants to synthesize and store sugar reserves for the next season. Reducing or limiting the regeneration period by extending the cutting period can weaken the plants and contribute to the collapse of the plantation.

Cutting periods of 30, 60, 90, and 120 days were compared in tests at Riverside from 1963 to 1969 (Takatori, Stillman, and Souther, 1970). The tests included 60-day harvest periods throughout the growing season plus combinations of spring and fall harvests.

A 60-day harvest period during the spring produced the largest total yield both in number of spears and weight (tables 10 and 11). Plants harvested for 90 and 120 days during this same period produced heavily the first season, but production declined with each successive harvest.

Fig. 19. Loss of stand caused by extending harvest period too long.

TABLE 10. INFLUENCE OF TIME AND DURATION OF CUTTING SEASON ON THE WEIGHT OF ASPARAGUS SPEARS (1965 to 1969)

Treatment*	Cutting season		Weight of marketable spears (lb./acre)					
Number	Period	Day..	1965	1966	1967	1968	1969†	Total
					thousands			
1	Feb-March	30	1.3	0.6	2.9	3 1	4.2	12.1
2	Feb-April	60	2.7	4.0	5.3	5.7	3.6	21.3
3	Feb-Mary	90	4.1	3.3	3.5	3.5	1.4	15.8
4	Feb-June	120	4.9	2.7	2.2	2.3	0.7	12.7
5	June-July	60	0.8	0.9	0.7	0.8	1.0	4.2
6	July-Aug	60	1.8	1.5	0.9	0.7	1.3	6.2
7	Aug-Sept	60	1 7	2.5	1.3	1.1	1.8	8.4
8	Sept-Oct	60	2.5	2.9	2.1	1.1	2.5	11.1
9	Feb-March Aug-Sept	60	3.5	2.1	2.6	3.5	3.2	14.9
10	Feb-March Sept-Oct	60	2.6	2.4	2.7	2.6	2.5	12.8

*All treatments on 60-inch beds, crowns spaced 24 inches apart.
†All treatments harvested for 2 months during spring 1969.

TABLE 11. INFLUENCE OF TIME AND DURATION OF CUTTING SEASON ON THE NUMBER OF SPEARS (1965 to 1969)

Treatment*	Cutting season		Number of marketable spears/acre					
Number	Period	Days	1965	1966	1967	1968	1969†	Total
					thousands			
1	Feb-March	30	16.8	7.7	40.0	50.9	80.9	196.3
2	Feb-April	60	39.5	51.2	66.7	104.7	76.3	338.4
3	Feb-May	90	62.7	58.0	64.9	83.4	40.7	309.7
4	Feb-June	120	78.7	51.1	41.5	56.0	15.7	242.9
5	June-July	60	17.1	27.7	20.6	30.4	27.9	123.7
6	July-Aug	60	33.3	53.9	28.3	31.1	38.6	185.1
7	Aug-Sept	60	39.9	69.3	51.2	41.1	47.7	249.1
8	Sept-Oct	60	60.8	75.8	80.2	45.5	65.7	328.0
9	Feb-March Aug-Sept	60	71.7	49.7	58.7	82.1	70.8	343.0
10	Feb-March Sept-Oct	60	49.4	66.7	56.0	70.1	61.1	303.5

*All treatments on 60-inch beds, crowns spaced 24 inches apart.
†All treatments harvested for 2 months in spring 1969.

Reduced yield where the harvest extended beyond 60 days resulted from a loss in stand caused by the extreme cutting stress placed on the plants. Greenhouse studies showed that cutting stress on asparagus plants is associated with the destruction of the storage root system.

The yield from 60-day harvests during June, July, August, and September was considerably lower than that from a 60-day harvest in the spring. The yield loss in "off-season" harvests was caused primarily by the reduced production of marketable spears due to the extreme hot weather. During the summer more than 50 percent of the spears were discarded as culls — characterized by loose heads, branching, severe tapering of the spears, and small diamater.

Taking into consideration all the factors favorable to maximum yield in spear numbers and size, it is recommended that the harvest period be around 60 days in the spring.

Fresh market

Fresh market asparagus is usually graded and packed by the growers and marketed under their own or a cooperative label. Grading is in conformance with Agricultural Code of Calif. Sec. 810.5. The two types of packs most commonly used in California for fresh market are known as loose pack and bunch pack. In recent years, individually wrapped packs have been introduced to appeal to the consumer.

In a loose pack, the spears are trimmed to 9 inches in length and placed in a pyramid crate. A standard pyramid crate contains 30 pounds of asparagus irrespective of grade. However, in recent years a half crate containing 15 pounds has been introduced. A cardboard carton is sometimes used for air-freighting asparagus. A moist, absorbent paper material is placed on the bottom of the crate to prevent drying of the spears. Space is left at the top of the crate to accommodate any elongation of the spears during transit. The graded asparagus is inspected for conformity with the Agricultural Code of California pertaining to shipments of fresh asparagus.

The packed crates are sent immediately through a cooling system, usually a water bath maintained at near freezing temperatures, and then stacked in a cold storage chamber until shipment to market.

Processing

Asparagus to be delivered to processors is trimmed to a 7-inch length and must have a minimum of 3½ inches of green. The asparagus is taken from the field boxes, put through the shed and trimmed to length, washed, and placed in containers for shipment to the processor. The processor does the grading.

Fig. 20. Interior of an asparagus packing shed.

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Establishment and Production Costs for Asparagus in South Central Washington, 1983

Farm Business Management Reports

NOTE

Costs and returns vary from one farm to the next. They also vary over time for any particular farm. This is due to differences in:

- Capital
- Labor and management resources
- Machinery
- Growing practices
- Enterprise size
- Crop yields
- Input prices
- Commodity prices

Cost can also be calculated differently for different uses. To avoid drawing unwarranted conclusions for any particular farm, the user must consider the assumptions used in this analysis. If they don't fit the situation, adjustments must be made.

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ESTABLISHMENT AND PRODUCTION COSTS FOR ASPARAGUS IN SOUTH CENTRAL WASHINGTON, 1983[1]

Daniel J. Kirpes, Raymond J. Folwell, Jerald A. Gefre,
John W. Schorr, and George Tamaki[2]

INTRODUCTION

This publication presents projected 1983 costs and returns for establishing and producing asparagus in south-central Washington using the seeded-transplant method and the seeded-lift-drop method.

The estimates do not represent a particular farm; instead, they represent costs and returns under the specific assumptions adopted for the study. We recommend that the blank space on the right of the various tables be used to estimate costs and returns for your enterprise. Also, local Cooperative Extension Agents and fieldmen should be consulted for recommendations on field operations and operating inputs.

BUDGET ASSUMPTIONS

The following assumptions were used:

1. The asparagus enterprise is a well-managed, 40-acre crop grown on a 180-acre diversified farm.

2. A surface (rill) irrigation system is used.

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[1]The work reported here was done by the Washington State University, College of Agriculture and Home Economics Research Center, Department of Agricultural Economics. Work was conducted under Project 0473 in cooperation with the U.S. Department of Agriculture, Agricultural Research Service.

[2]Respectively, Research Associate and Professor of Agricultural Economics, Department of Agricultural Economics, Washington State University; Agricultural Research Technician, Yakima Agricultural Research Laboratory, USDA, Yakima; Field Services Representative of the Washington Asparagus Growers Association, Sunnyside; and Research Entomologist (Deceased), Yakima Agricultural Research Laboratory, USDA, Yakima.

3. The crop is established in a nursery stock year. Accumulated costs for the three establishment years, minus receipts from partial yields the second and third year, are amortized over a 15-year production life at 11% interest.

4. New purchase costs as of late 1982 are used for all machinery and equipment. While this results in an overestimate of current production costs, it provides an indication of the enterprise's ability to generate the earnings needed to replace depreciable assets. Recent increases in the prices paid for new machinery and equipment mean that depreciation claimed on assets purchased earlier substantially understates the amount of capital required for asset replacement. When an enterprise is evaluated to determine its long-run viability, it is important to consider its ability to replace assets on a new cost basis. All of the machinery is assumed to be held for 10 years before trading. The tractors are given a salvage value of 29.5 % of purchase cost and all other machinery has a salvage value of 17.7% of purchase cost. Depreciation = (purchase cost minus salvage value) ÷ years held. Personal property taxes on machinery are estimated to be 1.2% of average value ($12.00 per $1000 of value). Cost of housing machinery was calculated at 1% of average value. The interest rate was 13% and the insurance rate was .6% of average value of the machinery.

5. The irrigation water charge is $37.50 per acre, which is the current rate for the Roza Irrigation District.

6. The property tax assessment is the current rate for Benton County. The first year assessment of $800 per acre is for Class One open-space-taxation classified land at a tax of $9.60 per acre. For the remaining years, the assessment is $1800 per acre for land and asparagus plants resulting in a tax of $21.60 per acre.

7. All land is assumed to be owned by the operator, operating capital is assumed to cost 13%, and all investment capital is assumed to cost 11%.

8. 1983 prices for selected inputs:

Labor	$ 5.00/hour
Gasoline	$ 1.28/gallon
Diesel (minus highway taxes)	$ 1.07/gallon
Nitrogen fertilizer	$ .30/pound
Phosphate fertilizer	$ .32/pound
Zinc fertilizer	$ 1.00/pound
Asparagus Seed	$10.00/pound
Paraquat	$12.88/quart
2,4-D	$ 5.50/pound AI (Active Ingredient)
Linuron (Lorox)	$ 7.00/pound AI
Disyston	$ 7.87/pound AI
Diruon (Karmex)	$ 5.40/pound AI
Simazine (Princep)	$ 3.58/pound AI
Trifluralin (Treflan)	$11.25/pound AI
Glyphosate (Roundup)	$18.00/pound AI

9. Purchase prices for the machinery compliments used during the establishment and production years and the number of years held before trading are:

100 HP wheel tractor	$38,000	10 years
60 HP wheel tractor	$17,000	10
3/4 ton pickup	$11,000	10
3-18" plow	$ 4,900	10
13' disk	$ 6,900	10
3-row cultivator	$ 3,600	10
5' rotovator	$ 5,000	10
12' rolling harrow	$ 5,500	10
3-row planter	$ 4,500	10
Rotary mower	$ 5,525	10
PTO sprayer	$ 2,100	10
Swamping cart	$ 100	10
1-row Lilliston	$ 3,600	10

Other assumptions are detailed in the text and tables.

DISCUSSION

Transplant Method

The estimated costs of establishing asparagus nursery stock for transplanting are shown in Table 1. It was assumed that the nursery acreage was planted with 22 inch row widths. All of the asparagus crowns will be dug and sold at the end of the nursery stock year. It is estimated that the revenue generated from this nursery stock would be $1400 per acre with 100 thousand crowns per acre at $14.00 per thousand. Table 1 lists the operation, tooling activity, and month as well as all fixed and variable costs. Table 2 summarizes the individual cost items. The variable costs total $673.41 per acre and the fixed costs total $249.79 per acre for a per acre cost of $923.20. The net land rent under fixed costs can be considered an opportunity cost in terms of income foregone by investing in asparagus.[3]

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[3] While the owner-operator obviously will not experience a land rental cost, the cost represents the minimum returns the owner-operator must have to justify growing this crop on the land himself. This net rental return represents the income the owner-operator foregoes by producing this crop on the land himself rather than renting it to a tenant. As a result of investing his capital in land, the farmer receives both current returns from his crop production activities and any long-term land value appreciation. However, the farmer would continue to receive land value appreciation even if he rented the land out. Consequently, the appropriate land charge for growing the crop himself is only the net rent lost. As used in this publication, the land cost is termed an opportunity cost to indicate that it is not an out-of-pocket expense, but rather a return that is foregone as a result of choosing to use the land to grow this crop. To determine the profitability of crop production relative to other activities, the owner-operator will want to consider these foregone returns, or opportunity costs, along with the usual production expense.

Tables 3 and 4 detail the cost associated with establishing asparagus in the transplant year. It was assumed that the row width would be 54 inches with 20 thousand crowns per acre. The crowns are purchased at $14.00 per thousand, or $280 per acre. Respectively, the variable, fixed, and total costs are $952.23, $252.69, and $1,204.92 per acre for the transplant year.

The second year establishment costs are shown in Tables 5 and 6. In the second year, a small crop of 200 pounds per acre is cut and sold for $.40 per pound, or $80 per acre. The variable costs are $331.17 for preharvest and $45.48 per acre for harvest costs. The fixed costs include an interest charge of $132.54 per acre on the first year's investment. It was assumed that these monies could have been reinvested and earned 11%. The total fixed cost amounts to $365.40 per acre. The total second year costs per acre are $742.06.

Third year establishment costs are reported in Tables 7 and 8. In the third year, 1500 pounds of asparagus spears are cut and sold for $.40 per pound, or $600 per acre. The hand harvesting cost is the largest variable cost in the third year. The interest on the accumulated investment amounts to $205.37 per acre. The variable, fixed, and total cost per acre are $545.66, $438.23 and $983.89, respectively.

The annual costs for the asparagus operation in full production are in Tables 9 and 10. The total variable costs are $723.67 per acre. It is assumed that a yield of 3000 pounds per acre was harvested and sold for $.40 per pound, or $1200 per acre. Of the $514.85 per acre fixed cost, the amortized establishment cost of $313.00 represents the largest fixed cost item. The amortized establishment cost per acre is calculated by taking the total investment cost for the three establishment years minus the revenue generated in the second and third years for a net investment cost of $2250.87 per acre. This net investment cost is multiplied by the amortization factor (.13906) for 15 years at 11%, for an amortized cost of $313 per acre. The per acre total cost for fully producing asparagus is $1269.54.

Lift-Drop Method

In this method of establishing asparagus, the field is seeded in the proper row widths during the nursery stock year. The following year the asparagus crowns are mechanically dug and replanted at a lower soil depth. The costs associated with the lift-drop nursery stock year are shown in Tables 11 and 12. The total cost is $705.65 per acre. The costs for the first year after the nursery-stock for the lift-drop method are listed in Tables 13 and 14. The variable, fixed, and total costs per acre are $442.40, $296.72, and $739.13, respectively. The nursery-stock investment cost of $705.65 per acre produces a $77.62 interest cost in the first-year of establishment. The second and third-year establishment costs (Tables 5-8) are the same for the lift-drop method as the transplant method except for the interest charge on the investment. Also, the production costs of established asparagus will be the same (Tables 9 and 10) for both methods except for the charge for amortizing the establishment costs.

Comparison of Methods

Table 15 summarizes the net investment for the establishment years. The transplant and lift-drop methods are examined separately. The total investment cost for the transplant method is $2250.87 per acre after three years. Since the crowns were purchased and planted in the first year, the nursery stock year costs were not included. The total investment cost for the lift-drop method is $2546.41 per acre after four years.

Production Returns

Table 16 summarizes the average production year receipts, costs and profitability per acre for asparagus. The transplant and lift-drop methods have differing amortized establishment costs which result in differing profit levels. The profit per acre assuming a 3000 pound yield at $.40 per pound, is a negative $69.54 and $110.64, respectively, for the transplant and lift-drop methods.

The profit levels given varying prices and yields are examined in Table 17. The profit levels to the left of the black line are negative at the indicated prices and yields. At a price of $40 per hundredweight, a yield of 3300 pounds per acre would be required for a positive profit level.

TABLE 1. 1983 ESTIMATED PER ACRE COSTS OF ESTABLISHING ASPARAGUS NURSERY STOCK FOR TRANSPLANTING (22" ROWS)

OPERATION	TOOLING	MONTH	MACH. HOURS	LABOR HOURS	TOTAL FIXED COST	VARIABLE COST: FUEL, OIL, LUBE, AND, REPAIRS	VARIABLE COST: MACH. LABOR	VARIABLE COST: SERVICE	VARIABLE COST: MATERIALS	TOTAL VARIABLE COST	TOTAL COST
					$	$	$	$	$	$	$
SPRAY WEEDS	60 HP. PTO SPRAYER	APR	0.15	0.18	2.31	1.24	0.90		67.50	69.64	71.95
DISK	100 HP. 13' DISK	APR	0.20	0.24	10.51	2.55	1.22			3.77	14.28
PLOW	100 HP. 3-18" PLOW	APR	0.60	0.73	26.96	7.44	3.65			11.09	38.05
FERTILIZE	CUSTOM APPLICATION	APR						5.00	88.00	93.00	93.00
PREPARE SEEDBED	100 HP. 12' ROLLING HARROW (2X)	APR	0.57	0.69	31.74	7.20	3.47			10.67	42.40
RILL IRRIGATE		MAY-AUG		3.60	7.74	2.70	18.00	37.50		58.20	65.94
PLANT	60 HP. 3-ROW PLANTER	MAY	0.21	0.26	4.90	1.78	1.30		100.00	103.08	107.98
DITCH MAINTENANCE	HAND LABOR	MAY						0.50		0.50	0.50
SPRAY WEEDS	60 HP. PTO SPRAYER	MAY	0.15	0.18	2.31	1.24	0.90		12.88	15.02	17.33
SPRAY WEEDS	60 HP. PTO SPRAYER	JUNE	0.15	0.18	2.31	1.24	0.90		5.50	7.64	9.95
CULTIVATE	60 HP. 3-ROW CULTIVATOR	JUNE	0.21	0.26	4.45	1.74	1.30			3.04	7.49
SPRAY WEEDS	60 HP. PTO SPRAYER	JULY	0.15	0.18	2.31	1.24	0.90		7.00	9.14	11.45
CULTIVATE	60 HP. 3-ROW CULIVATOR	JULY	0.21	0.26	4.45	1.74	1.30			3.04	7.49
SPRAY INSECTS	60 HP. PTO SPRAYER	JULY	0.15	0.18	2.31	1.24	0.90		7.87	10.01	12.32
SPRAY WEEDS	60 HP. PTO SPRAYER	AUG	0.15	0.18	2.31	1.24	0.90		7.00	9.14	11.45
CULTIVATE	60 HP. 3-ROW CULTIVATOR	AUG	0.21	0.26	4.45	1.74	1.30			3.04	7.49
HOE WEEDS	HAND HOEING	AUG						30.00		30.00	30.00
SPRAY INSECTS	60 HP. PTO SPRAYER	SEPT	0.15	0.16	2.31	1.24	0.90		7.87	10.01	12.32
CULTIVATE	60 HP. 1-ROW LILLISTON	SEPT	0.69	0.83	9.89	5.54	4.16			9.70	19.60
BEAT FERNS	60 HP. ROTARY MOWER	MAR	0.37	0.45	6.54	3.37	2.23			5.60	12.14
DIG CROWNS	CUSTOM DIGGING	MAR						100.00		100.00	100.00
PICKUP	3/4 TON	MAR	0.25	0.28	2.41	1.97	1.39			3.35	5.76
MISCELLANEOUS	TEL., UTIL., LEGAL, ACCTG., ETC.	MAR						60.00		60.00	60.00
INTEREST	OPERATING CAPITAL	SEASON						44.70		44.70	44.70
TAXES	REAL ESTATE	ANNUAL			9.60						9.60
LAND	NET RENT	SEASON			110.00						110.00
TOTAL PER ACRE			4.59	9.12	249.79	46.47	45.62	277.70	303.62	673.41	923.20

TABLE 2. SUMMARY OF THE PER ACRE COSTS OF ESTABLISHING ASPARAGUS NURSERY STOCK FOR TRANSPLANTING (22" ROWS)

	UNIT	PRICE OR COST/UNIT	QUANTITY	VALUE OR COST	YOUR FARM
VARIABLE COSTS				$	
ROUNDUP	LBS.	18.000	3.75	67.50	_____
CUST. FERT. APPL	ACRE	5.000	1.00	5.00	_____
NITROGEN	LBS.	0.300	100.00	30.00	_____
PHOSPHATE	LBS.	0.320	150.00	48.00	_____
ZINC	LBS.	1.000	10.00	10.00	_____
ASPARAGUS SEED	LBS.	10.000	10.00	100.00	_____
DITCH MAINT.	HR.	5.000	0.10	0.50	_____
IRRIG. CHARGE	ACRE	37.500	1.00	37.50	_____
PARAQUAT	QT.	12.880	1.00	12.88	_____
2,4-D	LBS.	5.500	1.00	5.50	_____
LOROX	LBS.	7.000	1.00	7.00	_____
DISYSTON	LBS.	7.870	1.00	7.87	_____
LOROX	LBS.	7.000	1.00	7.00	_____
HAND HOEING	HR.	5.000	6.00	30.00	_____
DISYSTON	LBS.	7.870	1.00	7.87	_____
CUSTOM DIGGING	ACRE	100.000	1.00	100.00	_____
MISCELLANEOUS	ACRE	60.000	1.00	60.00	_____
MACHINERY REPAIR	ACRE	6.26	1.00	6.26	_____
MACHINERY FUEL	ACRE	1.28	1.00	1.28	_____
MACHINERY LUBE	ACRE	0.19	1.00	0.19	_____
TRACTORS REPAIR	ACRE	6.66	1.00	6.66	_____
TRACTORS FUEL	ACRE	25.55	1.00	25.55	_____
TRACTORS LUBE	ACRE	3.83	1.00	3.83	_____
IRRIGATION REPAIR	ACRE	2.70	1.00	2.70	_____
LABOR(TRACTOR & MACHINERY)	HOUR	5.00	5.52	27.62	_____
LABOR(IRRIGATION)	HOUR	5.00	3.60	18.00	_____
INTEREST ON OP. CAP.	DOL.	0.13	343.85	44.70	_____
TOTAL VARIABLE COST				$ 673.41	_____
FIXED COSTS				$	
MACHINERY DEPRECIATION	ACRE	22.91	1.00	22.91	_____
MACHINERY INTEREST	ACRE	21.29	1.00	21.29	_____
MACHINERY INSURANCE	ACRE	4.59	1.00	4.59	_____
TRACTORS DEPRECIATION	ACRE	30.05	1.00	30.05	_____
TRACTORS INTEREST	ACRE	35.88	1.00	35.88	_____
TRACTORS INSURANCE	ACRE	7.73	1.00	7.73	_____
IRRIGATION DEPRECIATION	ACRE	6.48	1.00	6.48	_____
IRRIGATION INTEREST	ACRE	1.26	1.00	1.26	_____
TAXES (LAND)	ACRE	9.60	1.00	9.60	_____
LAND (NET RENT)	ACRE	110.00	1.00	110.00	_____
TOTAL FIXED COSTS				$ 249.79	_____
TOTAL COSTS				$ 923.20	_____

TABLE 3. 1983 ESTIMATED PER ACRE COSTS OF ESTABLISHING ASPARAGUS (TRANSPLANT YEAR--54" ROWS)

OPERATION	TOOLING	MONTH	MACH. HOURS	LABOR HOURS	TOTAL FIXED COST	VARIABLE COST: FUEL,OIL, LUBE,AND, REPAIRS	VARIABLE COST: MACH. LABOR	VARIABLE COST: SERVICE	VARIABLE COST: MATERIALS	TOTAL VARIABLE COST	TOTAL COST
					$	$	$	$	$	$	$
SPRAY WEEDS	60 HP, PTO SPRAYER	OCT	0.15	0.18	2.31	1.24	0.90		67.50	69.64	71.95
FERTILIZE	CUSTOM FERT. APPLIC.	MAR						5.00	88.00	93.00	93.00
PLOW	100 HP, 3-18" PLOW	MAR	0.60	0.73	26.96	7.44	3.65			11.09	38.05
DISK	100 HP, 13' DISK	MAR	0.20	0.24	10.51	2.55	1.22			3.77	14.28
DITCH MAINTENANCE	HAND LABOR	APR						0.50		0.50	0.50
LISTING	CUSTOM LISTING	APR						30.00		30.00	30.00
SORTING CROWNS	CUSTOM SORTING	APR						40.00		40.00	40.00
DIPPING CROWNS	CUSTOM DIPPING	APR						20.00		20.00	20.00
PLANTING	CUSTOM PLANTING	APR						85.00	280.00	365.00	365.00
PLANTING	PLANTING SUPERVISION	APR						10.00		10.00	10.00
COVER ROOTS	60 HP, DRAGGING BOARD	APR	0.52	0.62	5.07	4.16	3.12			7.28	12.35
SPRAY WEEDS	60 HP, PTO SPRAYER	APR	0.15	0.18	2.31	1.24	0.90		5.50	7.64	9.95
SPRAY WEEDS	60 HP, PTO SPRAYER	MAY	0.15	0.18	2.31	1.24	0.90		7.00	9.14	11.45
CULTIVATE	60 HP, 1-ROW LILLISTON	MAY	0.69	0.83	9.89	5.54	4.16			9.70	19.60
RILL IRRIGATE	MAY-SEPTEMBER			4.80	10.32	3.60	24.00			27.60	37.92
HAND HOEING	HAND LABOR	JUNE						30.00		30.00	30.00
CULTIVATE	60 HP, 1-ROW LILLISTON (2X)	JUNE	1.38	1.66	19.78	11.09	8.32			19.41	39.19
SPRAY INSECTS	60 HP, PTO SPRAYER	JUNE	0.15	0.18	2.31	1.24	0.90		1.18	3.32	5.63
SPOT SPRAY	60 HP, PTO SPRAYER	JUNE	0.15	0.18	2.31	1.24	0.90		6.30	8.44	10.75
CULTIVATE	60 HP, 1-ROW LILLISTON	JULY	0.69	0.83	9.89	5.54	4.16			9.70	19.60
SPRAY WEEDS	60 HP, PTO SPRAYER	JULY	0.15	0.18	2.31	1.24	0.90			2.14	4.45
CULTIVATE	60 HP, 1-ROW LILLISTON	AUG	0.69	0.83	9.89	5.54	4.16			9.70	19.60
HAND HOEING	HAND LABOR	AUG						30.00		30.00	30.00
SPOT SPRAY	60 HP, PTO SPRAYER	AUG	0.15	0.18	2.31	1.24	0.90		6.30	8.44	10.75
SPRAY INSECTS	60 HP, PTO SPRAYER	SEPT	0.15	0.18	2.31	1.24	0.90		7.87	10.01	12.32
CULTIVATE	60 HP, 1-ROW LILLISTON	SEPT	0.69	0.83	9.89	5.54	4.16			9.70	19.60
PICKUP	3/4 TON	SEPT	0.25	0.28	2.41	1.97	1.38			3.35	5.76
MISCELLANEOUS	TEL.,UTIL.,LEGAL,ACCTG.,ETC.	SEPT						60.00		60.00	60.00
INTEREST	OPERATING CAPITAL	SEASON						43.62		43.62	43.62
TAXES	REAL ESTATE	ANNUAL			9.60						9.60
LAND	NET RENT	SEASON			110.00						110.00
TOTAL PER ACRE			6.89	13.11	252.69	62.91	65.55	354.12	469.65	952.23	1204.92

TABLE 4. SUMMARY OF THE PER ACRE COSTS OF ESTABLISHING ASPARAGUS (TRANSPLANT YEAR--54" ROWS)

	UNIT	PRICE OR COST/UNIT	QUANTITY	VALUE OR COST	YOUR FARM
VARIABLE COSTS				$	
ROUNDUP	LBS.	18.000	3.75	67.50	----------
CUST. FERT. APPL	ACRE	5.000	1.00	5.00	----------
NITROGEN	LBS.	0.300	100.00	30.00	----------
PHOSPHATE	LBS.	0.320	150.00	48.00	----------
ZINC	LBS.	1.000	10.00	10.00	----------
DITCH MAINT.	ACRE	5.000	0.10	0.50	----------
CUSTOM LISTING	ACRE	30.000	1.00	30.00	----------
SORTING CROWNS	ACRE	40.000	1.00	40.00	----------
DIPPING CROWNS	THOU	1.000	20.00	20.00	----------
CUSTOM PLANTING	ACRE	85.000	1.00	85.00	----------
ASPARAGUS CROWNS	THOU	14.000	20.00	280.00	----------
PLANTING SUPERVISION	HR.	5.000	2.00	10.00	----------
2,4-D	LBS.	5.500	1.00	5.50	----------
LOROX	LBS.	7.000	1.00	7.00	----------
HAND HOEING	HR.	5.000	6.00	30.00	----------
DISYSTON	LBS.	1.180	1.00	1.18	----------
ROUNDUP	LBS.	18.000	0.35	6.30	----------
HAND HOEING	ACRE	5.000	6.00	30.00	----------
ROUNDUP	LBS.	18.000	0.35	6.30	----------
DISYSTON	LBS.	7.870	1.00	7.87	----------
MISCELLANEOUS	ACRE	60.000	1.00	60.00	----------
MACHINERY REPAIR	ACRE	7.79	1.00	7.79	----------
MACHINERY FUEL	ACRE	1.28	1.00	1.28	----------
MACHINERY LUBE	ACRE	0.19	1.00	0.19	----------
TRACTORS REPAIR	ACRE	9.21	1.00	9.21	----------
TRACTORS FUEL	ACRE	35.51	1.00	35.51	----------
TRACTORS LUBE	ACRE	5.33	1.00	5.33	----------
IRRIGATION REPAIR	ACRE	3.60	1.00	3.60	----------
LABOR(TRACTOR & MACHINERY)	HOUR	5.00	8.31	41.55	----------
LABOR(IRRIGATION)	HOUR	5.00	4.80	24.00	----------
INTEREST ON OP. CAP.	DOL.	0.13	335.57	43.62	----------
TOTAL VARIABLE COST				$ 952.23	----------
FIXED COSTS				$	
MACHINERY DEPRECIATION	ACRE	21.87	1.00	21.87	----------
MACHINERY INTEREST	ACRE	20.33	1.00	20.33	----------
MACHINERY INSURANCE	ACRE	4.38	1.00	4.38	----------
TRACTORS DEPRECIATION	ACRE	31.09	1.00	31.09	----------
TRACTORS INTEREST	ACRE	37.12	1.00	37.12	----------
TRACTORS INSURANCE	ACRE	7.99	1.00	7.99	----------
IRRIGATION DEPRECIATION	ACRE	8.64	1.00	8.64	----------
IRRIGATION INTEREST	ACRE	1.68	1.00	1.68	----------
TAXES (LAND)	ACRE	9.60	1.00	9.60	----------
LAND (NET RENT)	ACRE	110.00	1.00	110.00	----------
TOTAL FIXED COSTS				$ 252.69	----------
TOTAL COSTS				$1204.92	----------

TABLE 5. 1983 ESTIMATED PER ACRE COSTS OF ESTABLISHING ASPARAGUS (SECOND YEAR)

OPERATION	TOOLING	MONTH	MACH. HOURS	LABOR HOURS	TOTAL FIXED COST	VARIABLE COST: FUEL,OIL, LUBE,AND, REPAIRS	VARIABLE COST: MACH. LABOR	VARIABLE COST: SERVICE	VARIABLE COST: MATERIALS	TOTAL VARIABLE COST	TOTAL COST
					$	$	$	$	$	$	$
BEAT FERNS	60 HP, ROTARY MOWER	MAR	0.37	0.45	6.54	3.37	2.23			5.60	12.14
FERTILIZE	CUSTOM FERT. APPLIC.	MAR						5.00	24.00	29.00	29.00
APPLY HERBICIDE	60 HP, PTO SPRAYER	MAR	0.15	0.18	2.31	1.24	0.90		30.31	32.46	34.77
ROTOVATE	60 HP, 5' ROTOVATOR	MAR	0.69	0.83	17.60	5.85	4.16			10.00	27.61
DITCH MAINTENANCE	HAND LABOR	MAR						0.50		0.50	0.50
RILL IRRIGATE	APRIL-SEPTEMBER			4.80	10.32	3.60	24.00	37.50		65.10	75.42
CUT	HAND HARVEST (APRIL-MAY)	MAY						26.00	3.46	29.46	29.46
SWAMP	60 HP, TRAILER	MAY	0.44	0.54	5.93	3.33	2.69			6.02	11.96
HARVEST	HARVEST SUPERVISION	MAY						10.00		10.00	10.00
SPOT SPRAY	60 HP, PTO SPRAYER	JUNE	0.01	0.02	0.23	0.12	0.09		4.50	4.71	4.95
CULTIVATE	60 HP, 1-ROW LILLISTON	JUNE	0.69	0.83	9.89	5.54	4.16			9.70	19.60
INSECT CONTROL	CUSTOM SPRAYING	JULY						5.00	11.80	16.80	16.80
SPOT SPRAY	60 HP, PTO SPRAYER	AUG	0.01	0.02	0.23	0.12	0.09		6.30	6.51	6.75
INSECT CONTROL	CUSTOM SPRAYING	SEPT						5.00	11.80	16.80	16.80
PICKUP	3/4 TON	SEASON	5.00	5.50	48.20	39.43	27.50			66.93	115.14
MISCELLANEOUS	TEL.,UTIL.,LEGAL,ACCTG.,ETC.	SEASON						60.00		60.00	60.00
INTEREST	OPERATING CAPITAL	SEASON						7.03		7.03	7.03
TAXES	REAL ESTATE	ANNUAL			21.60						21.60
INVESTMENT	INTEREST ON ACCUMULATED INVESTMENT	SEASON			132.54						132.54
LAND	NET RENT	SEASON			110.00						110.00
TOTAL PER ACRE			7.37	13.16	365.40	62.62	65.82	156.03	92.18	376.66	742.06

TABLE 6. SUMMARY OF THE PER ACRE COSTS OF ESTABLISHING ASPARAGUS (SECOND YEAR)

	UNIT	PRICE OR COST/UNIT	QUANTITY	VALUE OR COST	YOUR FARM
VARIABLE COSTS					
PREHARVEST				$	
CUST. FERT. APPL	ACRE	5.000	1.00	5.00	----------
NITROGEN	LBS.	0.300	80.00	24.00	----------
DITCH MAINT.	HR.	5.000	0.10	0.50	----------
PRINCEP	LBS.	4.480	3.00	13.44	----------
TREFLAN	LBS.	11.250	1.50	16.88	----------
ROUNDUP	LBS.	18.000	0.25	4.50	----------
CUSTOM SPRAYING	ACRE	5.000	1.00	5.00	----------
DISYSTON	LBS.	7.870	1.50	11.80	----------
ROUNDUP	LBS.	18.000	0.35	6.30	----------
CUSTOM SPRAYING	ACRE	5.000	1.00	5.00	----------
DISYSTON	LBS.	7.870	1.50	11.80	----------
MISCELLANEOUS	ACRE	60.000	1.00	60.00	----------
IRRIG. CHARGE	ACRE	37.500	1.00	37.50	----------
MACHINERY REPAIR	ACRE	12.67	1.00	12.67	----------
MACHINERY FUEL	ACRE	25.60	1.00	25.60	----------
MACHINERY LUBE	ACRE	3.84	1.00	3.84	----------
TRACTORS REPAIR	ACRE	2.49	1.00	2.49	----------
TRACTORS FUEL	ACRE	9.64	1.00	9.64	----------
TRACTORS LUBE	ACRE	1.45	1.00	1.45	----------
IRRIGATION REPAIR	ACRE	3.60	1.00	3.60	----------
LABOR(TRACTOR & MACHINERY)	HOUR	5.00	7.83	39.13	----------
LABOR(IRRIGATION)	HOUR	5.00	4.80	24.00	----------
INTEREST ON OP. CAP.	DOL.	0.13	54.00	7.03	----------
SUBTOTAL, PRE-HARVEST				$ 331.17	----------
HARVEST COSTS				$	
HARV-HAND CUSTOM	LBS.	0.130	200.00	26.00	----------
HAND TOOLS	ACRE	3.460	1.00	3.46	----------
HARV-SUPERVISION	HR.	5.000	2.00	10.00	----------
MACHINERY REPAIR	ACRE	0.19	1.00	0.19	----------
TRACTORS REPAIR	ACRE	0.58	1.00	0.58	----------
TRACTORS FUEL	ACRE	2.23	1.00	2.23	----------
TRACTORS LUBE	ACRE	0.33	1.00	0.33	----------
LABOR(TRACTOR & MACHINERY)	HOUR	5.00	0.54	2.69	----------
SUBTOTAL, HARVEST				$ 45.48	----------
TOTAL VARIABLE COST				$ 376.66	----------
FIXED COSTS				$	
MACHINERY DEPRECIATION	ACRE	33.72	1.00	33.72	----------
MACHINERY INTEREST	ACRE	31.35	1.00	31.35	----------
MACHINERY INSURANCE	ACRE	6.75	1.00	6.75	----------
TRACTORS DEPRECIATION	ACRE	7.80	1.00	7.80	----------
TRACTORS INTEREST	ACRE	9.32	1.00	9.32	----------
TRACTORS INSURANCE	ACRE	2.01	1.00	2.01	----------
IRRIGATION DEPRECIATION	ACRE	8.64	1.00	8.64	----------
IRRIGATION INTEREST	ACRE	1.68	1.00	1.68	----------
TAXES (LAND)	ACRE	21.60	1.00	21.60	----------
INTEREST ON INVESTMENT	ACRE	1204.92	0.11	132.54	----------
LAND (NET RENT)	ACRE	110.00	1.00	110.00	----------
TOTAL FIXED COSTS				$ 365.40	----------
TOTAL COSTS				$ 742.06	----------

TABLE 7. 1983 ESTIMATED PER ACRE COSTS OF ESTABLISHING ASPARAGUS (THIRD YEAR)

OPERATION	TOOLING	MONTH	MACH. HOURS	LABOR HOURS	TOTAL FIXED COST	VARIABLE COST: FUEL,OIL, LUBE,AND, REPAIRS	VARIABLE COST: MACH. LABOR	VARIABLE COST: SERVICE	VARIABLE COST: MATERIALS	TOTAL VARIABLE COST	TOTAL COST
					$	$	$	$	$	$	$
BEAT FERNS	60 HP, ROTARY MOWER	MAR	0.37	0.45	6.54	3.37	2.23			5.60	12.14
FERTILIZE	CUSTOM FERT. APPLIC.	MAR						5.00	24.00	29.00	29.00
APPLY HERBICIDE	60 HP, PTO SPRAYER	MAR	0.15	0.18	2.31	1.24	0.90		30.31	32.46	34.77
ROTOVATE	60 HP, 5' ROTOVATOR	MAR	0.69	0.83	17.60	5.85	4.16			10.00	27.61
DITCH MAINTENANCE	HAND LABOR	MAR						0.50		0.50	0.50
RILL IRRIGATE	APRIL-SEPTEMBER			4.80	10.32	3.60	24.00	37.50		65.10	75.42
CUT	HAND HARVEST (APRIL-MAY)	MAY						195.00	3.46	198.46	198.46
SWAMP	60 HP, TRAILER	MAY	0.44	0.54	5.93	3.33	2.69			6.02	11.96
HARVEST	HARVEST SUPERVISION	MAY						10.00		10.00	10.00
SPOT SPRAY	60 HP, PTO SPRAYER	JUNE	0.01	0.02	0.23	0.12	0.09		4.50	4.71	4.95
CULTIVATE	60 HP, 1-ROW LILLISTON	JUNE	0.69	0.83	9.89	5.54	4.16			9.70	19.60
INSECT CONTROL	CUSTOM SPRAYING	JULY						5.00	11.80	16.80	16.80
SPOT SPRAY	60 HP, PTO SPRAYER	AUG	0.01	0.02	0.23	0.12	0.09		6.30	6.51	6.75
INSECT CONTROL	CUSTOM SPRAYING	SEPT						5.00	11.80	16.80	16.80
PICKUP	3/4 TON	SEASON	5.00	5.50	48.20	39.43	27.50			66.93	115.14
MISCELLANEOUS	TEL.,UTIL.,LEGAL,ACCTG.,ETC.	SEASON						60.00		60.00	60.00
INTEREST	OPERATING CAPITAL	SEASON						7.03		7.03	7.03
TAXES	REAL ESTATE	ANNUAL			21.60						21.60
INVESTMENT	INTEREST ON ACCUMULATED INVESTMENT	SEASON			205.37						205.37
LAND	NET RENT	SEASON			110.00						110.00
TOTAL PER ACRE			7.37	13.16	438.23	62.62	65.82	325.03	92.18	545.66	983.89

TABLE 8. SUMMARY OF THE PER ACRE COSTS OF ESTABLISHING ASPARAGUS (THIRD YEAR)

	UNIT	PRICE OR COST/UNIT	QUANTITY	VALUE OR COST	YOUR FARM
VARIABLE COSTS					
PREHARVEST				$	
CUST. FERT. APPL	ACRE	5.000	1.00	5.00	----------
NITROGEN	LBS.	0.300	80.00	24.00	----------
DITCH MAINT.	HR.	5.000	0.10	0.50	----------
PRINCEP	LBS.	4.480	3.00	13.44	----------
TREFLAN	LBS.	11.250	1.50	16.88	----------
ROUNDUP	LBS.	18.000	0.25	4.50	----------
CUSTOM SPRAYING	ACRE	5.000	1.00	5.00	----------
DISYSTON	LBS.	7.870	1.50	11.80	----------
ROUNDUP	LBS.	18.000	0.35	6.30	----------
CUSTOM SPRAYING	ACRE	5.000	1.00	5.00	----------
DISYSTON	LBS.	7.870	1.50	11.80	----------
MISCELLANEOUS	ACRE	60.000	1.00	60.00	----------
IRRIG. CHARGE	ACRE	37.500	1.00	37.50	----------
MACHINERY REPAIR	ACRE	12.67	1.00	12.67	----------
MACHINERY FUEL	ACRE	25.60	1.00	25.60	----------
MACHINERY LUBE	ACRE	3.84	1.00	3.84	----------
TRACTORS REPAIR	ACRE	2.49	1.00	2.49	----------
TRACTORS FUEL	ACRE	9.64	1.00	9.64	----------
TRACTORS LUBE	ACRE	1.45	1.00	1.45	----------
IRRIGATION REPAIR	ACRE	3.60	1.00	3.60	----------
LABOR(TRACTOR & MACHINERY)	HOUR	5.00	7.83	39.13	----------
LABOR(IRRIGATION)	HOUR	5.00	4.80	24.00	----------
INTEREST ON OP. CAP.	DOL.	0.13	54.09	7.03	----------
SUBTOTAL, PRE-HARVEST				$ 331.17	----------
HARVEST COSTS				$	
HARV-HAND CUSTOM	CWT.	13.000	15.00	195.00	----------
HAND TOOLS	ACRE	3.460	1.00	3.46	----------
HARV-SUPERVISION	HR.	5.000	2.00	10.00	----------
MACHINERY REPAIR	ACRE	0.19	1.00	0.19	----------
TRACTORS REPAIR	ACRE	0.58	1.00	0.58	----------
TRACTORS FUEL	ACRE	2.23	1.00	2.23	----------
TRACTORS LUBE	ACRE	0.33	1.00	0.33	----------
LABOR(TRACTOR & MACHINERY)	HOUR	5.00	0.54	2.69	----------
SUBTOTAL, HARVEST				$ 214.48	----------
TOTAL VARIABLE COST				$ 545.66	----------
FIXED COSTS				$	
MACHINERY DEPRECIATION	ACRE	33.72	1.00	33.72	----------
MACHINERY INTEREST	ACRE	31.35	1.00	31.35	----------
MACHINERY INSURANCE	ACRE	6.75	1.00	6.75	----------
TRACTORS DEPRECIATION	ACRE	7.80	1.00	7.80	----------
TRACTORS INTEREST	ACRE	9.32	1.00	9.32	----------
TRACTORS INSURANCE	ACRE	2.01	1.00	2.01	----------
IRRIGATION DEPRECIATION	ACRE	8.64	1.00	8.64	----------
IRRIGATION INTEREST	ACRE	1.68	1.00	1.68	----------
TAXES (LAND)	ACRE	21.60	1.00	21.60	----------
INTEREST ON INVESTMENT	ACRE	1866.98	0.11	205.37	----------
LAND (NET RENT)	ACRE	110.00	1.00	110.00	----------
TOTAL FIXED COSTS				$ 438.23	----------
TOTAL COSTS				$ 983.89	----------

TABLE 9. 1983 ESTIMATED PER ACRE COSTS OF PRODUCING ASPARAGUS

OPERATION	TOOLING	MONTH	MACH. HOURS	LABOR HOURS	TOTAL FIXED COST	VARIABLE COST: FUEL, OIL, LUBE, AND, REPAIRS	VARIABLE COST: MACH. LABOR	VARIABLE COST: SERVICE	VARIABLE COST: MATERIALS	TOTAL VARIABLE COST	TOTAL COST
					$	$	$	$	$	$	$
BEAT FERNS	60 HP, ROTARY MOWER	MAR	0.37	0.45	6.54	3.37	2.23			5.60	12.14
FERTILIZE	CUSTOM FERT. APPLIC.	MAR						5.00	24.00	29.00	29.00
APPLY HERBICIDE	60 HP, PTO SPRAYER	MAR	0.15	0.18	2.31	1.24	0.90		30.31	32.46	34.77
ROTOVATE	60 HP, 5' ROTOVATOR	MAR	0.69	0.83	17.60	5.85	4.16			10.00	27.61
DITCH MAINTENANCE	HAND LABOR	MAR						0.50		0.50	0.50
RILL IRRIGATE	APRIL-SEPTEMBER			4.80	10.32	3.60	24.00	37.50		65.10	75.42
CUT	HAND HARVEST (APRIL-MAY)	MAY						390.00	3.46	393.46	393.46
SWAMP	60 HP, TRAILER	MAY	0.44	0.54	5.93	3.33	2.69			6.02	11.96
HARVEST	HARVEST SUPERVISION	MAY						10.00		10.00	10.00
SPOT SPRAY	60 HP, PTO SPRAYER	JUNE	0.01	0.02	0.23	0.12	0.09		4.50	4.71	4.95
CULTIVATE	60 HP, 1-ROW LILLISTON	JUNE	0.69	0.83	9.89	5.54	4.16			9.70	19.60
INSECT CONTROL	CUSTOM SPRAYING	AUG						5.00	11.80	16.80	16.80
SPOT SPRAY	60 HP, PTO SPRAYER	AUG	0.01	0.02	0.23	0.12	0.09		6.30	6.51	6.75
PICKUP	3/4 TON	SEASON	5.00	5.50	48.20	39.43	27.50			66.93	115.14
MISCELLANEOUS	TEL., UTIL., LEGAL, ACCTG., ETC.	SEASON						60.00		60.00	60.00
INTEREST	OPERATING CAPITAL	SEASON						6.85		6.85	6.85
TAXES	REAL ESTATE	ANNUAL			21.60						21.60
INTEREST	AMORTIZED INVESTMENT COST	SEASON			313.00						313.00
LAND	NET RENT	SEASON			110.00						110.00
TOTAL PER ACRE			7.37	13.16	545.87	62.62	65.82	514.85	80.38	723.67	1269.54

TABLE 10. SUMMARY OF THE PER ACRE COSTS OF PRODUCING ASPARAGUS

	UNIT	PRICE OR COST/UNIT	QUANTITY	VALUE OR COST	YOUR FARM
VARIABLE COSTS					
PREHARVEST				$	
CUST. FERT. APPL	ACRE	5.000	1.00	5.00	_____
NITROGEN	LBS.	0.300	80.00	24.00	_____
DITCH MAINT.	HR.	5.000	0.10	0.50	_____
PRINCEP 1/	LBS.	4.480	3.00	13.44	_____
TREFLAN	LBS.	11.250	1.50	16.88	_____
ROUNDUP	LBS.	18.000	0.25	4.50	_____
CUSTOM SPRAYING	ACRE	5.000	1.00	5.00	_____
DISYSTON	LBS.	7.870	1.50	11.80	_____
ROUNDUP	LBS.	18.000	0.35	6.30	_____
MISCELLANEOUS	ACRE	60.000	1.00	60.00	_____
IRRIG. CHARGE	ACRE	37.500	1.00	37.50	_____
MACHINERY REPAIR	ACRE	12.67	1.00	12.67	_____
MACHINERY FUEL	ACRE	25.60	1.00	25.60	_____
MACHINERY LUBE	ACRE	3.84	1.00	3.84	_____
TRACTORS REPAIR	ACRE	2.49	1.00	2.49	_____
TRACTORS FUEL	ACRE	9.64	1.00	9.64	_____
TRACTORS LUBE	ACRE	1.45	1.00	1.45	_____
IRRIGATION REPAIR	ACRE	3.60	1.00	3.60	_____
LABOR(TRACTOR & MACHINERY)	HOUR	5.00	7.83	39.13	_____
LABOR(IRRIGATION)	HOUR	5.00	4.80	24.00	_____
INTEREST ON OP. CAP.	DOL.	0.13	52.69	6.85	_____
SUBTOTAL, PRE-HARVEST				$ 314.19	_____
HARVEST COSTS				$	
HARV-HAND CUSTOM	CWT.	13.000	30.00	390.00	_____
HAND TOOLS	ACRE	3.460	1.00	3.46	_____
HARV-SUPERVISION	HR.	5.000	2.00	10.00	_____
MACHINERY REPAIR	ACRE	0.19	1.00	0.19	_____
TRACTORS REPAIR	ACRE	0.58	1.00	0.58	_____
TRACTORS FUEL	ACRE	2.23	1.00	2.23	_____
TRACTORS LUBE	ACRE	0.33	1.00	0.33	_____
LABOR(TRACTOR & MACHINERY)	HOUR	5.00	0.54	2.69	_____
SUBTOTAL, HARVEST				$ 409.48	_____
TOTAL VARIABLE COST				$ 723.67	_____
FIXED COSTS				$	
MACHINERY DEPRECIATION	ACRE	33.72	1.00	33.72	_____
MACHINERY INTEREST	ACRE	31.35	1.00	31.35	_____
MACHINERY INSURANCE	ACRE	6.75	1.00	6.75	_____
TRACTORS DEPRECIATION	ACRE	7.80	1.00	7.80	_____
TRACTORS INTEREST	ACRE	9.32	1.00	9.32	_____
TRACTORS INSURANCE	ACRE	2.01	1.00	2.01	_____
IRRIGATION DEPRECIATION	ACRE	8.64	1.00	8.64	_____
IRRIGATION INTEREST	ACRE	1.68	1.00	1.68	_____
TAXES (LAND)	ACRE	21.60	1.00	21.60	_____
AMORTIZED ESTAB. COST	ACRE	2250.87	0.13906	313.00	_____
LAND (NET RENT)	ACRE	110.00	1.00	110.00	_____
TOTAL FIXED COSTS				$ 545.87	_____
TOTAL COSTS				$1269.54	_____

1/ IT IS RECOMMENDED THAT IN ALTERNATE YEARS KARMEX BE APPLIED AT 3 LBS/ACRE.

TABLE 11. 1983 ESTIMATED PER ACRE COSTS OF ESTABLISHING ASPARAGUS NURSERY STOCK FOR THE LIFT-DROP METHOD

OPERATION	TOOLING	MONTH	MACH. HOURS	LABOR HOURS	TOTAL FIXED COST	VARIABLE COST: FUEL, OIL, LUBE, AND REPAIRS	VARIABLE COST: MACH. LABOR	VARIABLE COST: SERVICE	VARIABLE COST: MATERIALS	TOTAL VARIABLE COST	TOTAL COST
					$	$	$	$	$	$	$
SPRAY WEEDS	60 HP, PTO SPRAYER	OCT	0.15	0.18	2.31	1.24	0.90		67.50	69.64	71.95
DISK	100 HP, 13' DISK	APR	0.20	0.24	10.51	2.55	1.22			3.77	14.28
PLOW	100 HP, 3-18" PLOW	APR	0.60	0.73	26.96	7.44	3.65			11.09	38.05
FERTILIZE	CUSTOM APPLICATION	APR						5.00	88.00	93.00	93.00
PREPARE SEEDBED	100 HP, 12' ROLLING HARROW (2X)	APR	0.57	0.69	31.74	7.20	3.47			10.67	42.40
PLANT	60 HP, 3-ROW PLANTER	MAY	0.21	0.26	4.90	1.78	1.30		25.00	28.08	32.98
DITCH MAINTENANCE	HAND LABOR	MAY						0.50		0.50	0.50
RILL IRRIGATE	MAY-AUGUST			3.60	7.74	2.70	18.00	37.50		58.20	65.94
SPRAY WEEDS	60 HP, PTO SPRAYER	MAY	0.15	0.18	2.31	1.24	0.90		12.88	15.02	17.33
SPRAY WEEDS	60 HP, PTO SPRAYER	JUNE	0.15	0.18	2.31	1.24	0.90		5.50	7.64	9.95
CULTIVATE	60 HP, 3-ROW CULTIVATOR	JUNE	0.21	0.26	4.45	1.74	1.30			3.04	7.49
SPRAY WEEDS	60 HP, PTO SPRAYER	JULY	0.15	0.18	2.31	1.24	0.90		7.00	9.14	11.45
CULTIVATE	60 HP, 3-ROW CULIVATOR	JULY	0.21	0.26	4.45	1.74	1.30			3.04	7.49
SPRAY INSECTS	60 HP, PTO SPRAYER	JULY	0.15	0.18	2.31	1.24	0.90		7.87	10.01	12.32
SPRAY WEEDS	60 HP, PTO SPRAYER	AUG	0.15	0.18	2.31	1.24	0.90		7.00	9.14	11.45
CULTIVATE	60 HP, 3-ROW CULTIVATOR	AUG	0.21	0.26	4.45	1.74	1.30			3.04	7.49
HOE WEEDS	HAND LABOR	AUG						30.00		30.00	30.00
SPRAY INSECTS	60 HP, PTO SPRAYER	SEPT	0.15	0.18	2.31	1.24	0.90		7.87	10.01	12.32
CULTIVATE	60 HP, 1-ROW LILLISTON	SEPT	0.69	0.83	9.89	5.54	4.16			9.70	19.60
PICKUP	3/4 TON	SEASON	0.25	0.28	2.41	1.97	1.38			3.35	5.76
MISCELLANEOUS	TEL., UTIL., LEGAL, ACCTG., ETC.	SEASON						60.00		60.00	60.00
INTEREST	OPERATING CAPITAL	SEASON						14.30		14.30	14.30
TAXES	REAL ESTATE	ANNUAL			9.60						9.60
LAND	NET RENT	SEASON			110.00						110.00
TOTAL PER ACRE			4.22	8.68	243.25	43.09	43.40	117.30	258.62	462.40	705.65

TABLE 12. SUMMARY OF THE PER ACRE COSTS OF ESTABLISHING ASPARAGUS NURSERY STOCK FOR THE LIFT-DROP METHOD

	UNIT	PRICE OR COST/UNIT	QUANTITY	VALUE OR COST	YOUR FARM
VARIABLE COSTS				$	
ROUNDUP	LBS.	18.000	3.75	67.50	_____
CUST. FERT. APPL	ACRE	5.000	1.00	5.00	_____
NITROGEN	LBS.	0.300	100.00	30.00	_____
PHOSPHATE	LBS.	0.320	150.00	48.00	_____
ZINC	LBS.	1.000	10.00	10.00	_____
ASPARAGUS SEED	LBS.	10.000	2.50	25.00	_____
DITCH MAINT.	HR.	5.000	0.10	0.50	_____
IRRIG. CHARGE	ACRE	37.500	1.00	37.50	_____
PARAQUAT	QT.	12.880	1.00	12.88	_____
2,4-D	LBS.	5.500	1.00	5.50	_____
LOROX	LBS.	7.000	1.00	7.00	_____
DISYSTON	LBS.	7.870	1.00	7.87	_____
LOROX	LBS.	7.000	1.00	7.00	_____
DISYSTON	LBS.	7.870	1.00	7.87	_____
MISCELLANEOUS	ACRE	60.000	1.00	60.00	_____
HAND HOEING	HR.	5.000	6.00	30.00	_____
MACHINERY REPAIR	ACRE	5.48	1.00	5.48	_____
MACHINERY FUEL	ACRE	1.28	1.00	1.28	_____
MACHINERY LUBE	ACRE	0.19	1.00	0.19	_____
TRACTORS REPAIR	ACRE	6.18	1.00	6.18	_____
TRACTORS FUEL	ACRE	23.70	1.00	23.70	_____
TRACTORS LUBE	ACRE	3.55	1.00	3.55	_____
IRRIGATION REPAIR	ACRE	2.70	1.00	2.70	_____
LABOR(TRACTOR & MACHINERY)	HOUR	5.00	5.08	25.40	_____
LABOR(IRRIGATION)	HOUR	5.00	3.60	18.00	_____
INTEREST ON OP. CAP.	DOL.	0.13	109.98	14.30	_____
TOTAL VARIABLE COST				$ 462.40	_____
FIXED COSTS				$	
MACHINERY DEPRECIATION	ACRE	21.23	1.00	21.23	_____
MACHINERY INTEREST	ACRE	19.74	1.00	19.74	_____
MACHINERY INSURANCE	ACRE	4.25	1.00	4.25	_____
TRACTORS DEPRECIATION	ACRE	28.84	1.00	28.84	_____
TRACTORS INTEREST	ACRE	34.43	1.00	34.43	_____
TRACTORS INSURANCE	ACRE	7.42	1.00	7.42	_____
IRRIGATION DEPRECIATION	ACRE	6.48	1.00	6.48	_____
IRRIGATION INTEREST	ACRE	1.26	1.00	1.26	_____
TAXES (LAND)	ACRE	9.60	1.00	9.60	_____
LAND (NET RENT)	ACRE	110.00	1.00	110.00	_____
TOTAL FIXED COSTS				$ 243.25	_____
TOTAL COSTS				$ 705.65	_____

TABLE 13. 1983 ESTIMATED PER ACRE COSTS FOR FIRST-YEAR ASPARAGUS USING THE LIFT-DROP METHOD

OPERATION	TOOLING	MONTH	MACH. HOURS	LABOR HOURS	TOTAL FIXED COST	VARIABLE COST: FUEL,OIL, LUBE,AND, REPAIRS	VARIABLE COST: MACH. LABOR	VARIABLE COST: SERVICE	VARIABLE COST: MATERIALS	TOTAL VARIABLE COST	TOTAL COST
					$	$	$	$	$	$	$
BEAT FERNS	60 HP, ROTARY MOWER	MAR	0.37	0.45	6.54	3.37	2.23			5.60	12.14
FERTILIZE	CUSTOM FERTILIZER APPLIC.	MAR						5.00	30.00	35.00	35.00
LIFT-DROP	CUSTOM LIFT-DROP	MAR						95.00		95.00	95.00
SPRAY WEEDS	60 HP, PTO SPRAYER	MAR	0.15	0.18	2.31	1.24	0.90		16.88	19.02	21.33
INCORP. HERB.	60 HP, 1-ROW LILLISTON	MAR	0.69	0.83	9.89	5.54	4.16			9.70	19.60
DITCH MAINTENANCE	HAND LABOR	APR						0.50		0.50	0.50
RILL IRRIGATE	APRIL-SEPTEMBER			5.40	11.61	4.05	27.00	37.50		68.55	80.16
CULTIVATE	60 HP, 1-ROW LILLISTON	APR	0.69	0.83	9.89	5.54	4.16			9.70	19.60
SPRAY WEEDS	60 HP, PTO SPRAYER	APR	0.15	0.18	2.31	1.24	0.90		7.00	9.14	11.45
CULTIVATE	60 HP, 1-ROW LILLISTON	MAY	0.69	0.83	9.89	5.54	4.16			9.70	19.60
SPRAY INSECTS	60 HP, PTO SPRAYER	JUNE	0.15	0.18	2.31	1.24	0.90		7.87	10.01	12.32
CULTIVATE	60 HP, 1-ROW LILLISTON	JUNE	0.69	0.83	9.89	5.54	4.16			9.70	19.60
SPOT SPRAY	60 HP, PTO SPRAYER	JUNE	0.01	0.02	0.23	0.12	0.09		6.30	6.51	6.75
HAND HOE	HAND LABOR	JUNE						30.00		30.00	30.00
CULTIVATE	60 HP, 1-ROW LILLISTON	JULY	0.69	0.83	9.89	5.54	4.16			9.70	19.60
SPOT SPRAY	60 HP, PTO SPRAYER	AUG	0.01	0.02	0.23	0.12	0.09		6.30	6.51	6.75
CULTIVATE	60 HP, 1-ROW LILLISTON	AUG	0.69	0.83	9.89	5.54	4.16			9.70	19.60
SPRAY INSECTS	60 HP, PTO SPRAYER	SEPT	0.15	0.18	2.31	1.24	0.90		7.87	10.01	12.32
CULTIVATE	60 HP, 1-ROW LILLISTON	SEPT	0.69	0.83	9.89	5.54	4.16			9.70	19.60
PICKUP	3/4 TON	SEPT	0.25	0.28	2.41	1.97	1.38			3.35	5.76
MISCELLANEOUS	TEL.,UTIL.,LEGAL,ACCTG.,ETC.	SEPT						60.00		60.00	60.00
INTEREST	OPERATING CAPITAL	SEASON						15.26		15.26	15.26
TAXES	REAL ESTATE	ANNUAL			9.60						9.60
INVESTMENT	INTEREST ON ACCUMULATED INVESTMENT	SEASON			77.62						77.62
LAND	NET RENT	SEASON			110.00						110.00
TOTAL PER ACRE			6.06	12.70	296.72	53.41	63.52	243.26	82.21	442.40	739.13

TABLE 14. SUMMARY OF THE PER ACRE COSTS FOR FIRST-YEAR ASPARAGUS USING THE LIFT-DROP METHOD

	UNIT	PRICE OR COST/UNIT	QUANTITY	VALUE OR COST	YOUR FARM
VARIABLE COSTS				$	
CUST. FERT. APPL	ACRE	5.000	1.00	5.00	_____
NITROGEN	LBS.	0.300	100.00	30.00	_____
CUST. LIFT-DROP	ACRE	95.000	1.00	95.00	_____
TREFLAN	LBS.	11.250	1.50	16.88	_____
DITCH MAINT.	ACRE	5.000	0.10	0.50	_____
IRRIG. CHARGE	ACRE	37.500	1.00	37.50	_____
LOROX	LBS.	7.000	1.00	7.00	_____
DISYSTON	LBS.	7.870	1.00	7.87	_____
ROUNDUP	LBS.	18.000	0.35	6.30	_____
HAND HOEING	HR.	5.000	6.00	30.00	_____
ROUNDUP	LBS.	18.000	0.35	6.30	_____
DISYSTON	LBS.	7.870	1.00	7.87	_____
MISCELLANEOUS	ACRE	60.000	1.00	60.00	_____
MACHINERY REPAIR	ACRE	6.87	1.00	6.87	_____
MACHINERY FUEL	ACRE	1.28	1.00	1.28	_____
MACHINERY LUBE	ACRE	0.19	1.00	0.19	_____
TRACTORS REPAIR	ACRE	7.53	1.00	7.53	_____
TRACTORS FUEL	ACRE	29.12	1.00	29.12	_____
TRACTORS LUBE	ACRE	4.37	1.00	4.37	_____
IRRIGATION REPAIR	ACRE	4.05	1.00	4.05	_____
LABOR(TRACTOR & MACHINERY)	HOUR	5.00	7.30	36.52	_____
LABOR(IRRIGATION)	HOUR	5.00	5.40	27.00	_____
INTEREST ON OP. CAP.	DOL.	0.13	117.42	15.26	_____
TOTAL VARIABLE COST				$ 442.40	_____
FIXED COSTS				$	
MACHINERY DEPRECIATION	ACRE	19.23	1.00	19.23	_____
MACHINERY INTEREST	ACRE	17.88	1.00	17.88	_____
MACHINERY INSURANCE	ACRE	3.85	1.00	3.85	_____
TRACTORS DEPRECIATION	ACRE	19.14	1.00	19.14	_____
TRACTORS INTEREST	ACRE	22.86	1.00	22.86	_____
TRACTORS INSURANCE	ACRE	4.92	1.00	4.92	_____
IRRIGATION DEPRECIATION	ACRE	9.72	1.00	9.72	_____
IRRIGATION INTEREST	ACRE	1.89	1.00	1.89	_____
TAXES (LAND)	ACRE	9.60	1.00	9.60	_____
INTEREST ON INVESTMENT	ACRE	705.65	0.11	77.62	_____
LAND (NET RENT)	ACRE	110.00	1.00	110.00	_____
TOTAL FIXED COSTS				$ 296.72	_____
TOTAL COSTS				$ 739.13	_____

TABLE 15. SUMMARY OF THE NET INVESTMENT FOR THE ESTABLISHMENT YEARS FOR ASPARAGUS.

Production Method	Establish. Year	Total Cost (Excluding Invest. Int.)	Investment Interest Cost	Total Cost	Revenue	Investment Cost
Seeded Transplant	N.S.	923.20	0	923.20	1/	---
	1	1204.92	0	1204.92	0	1204.92
	2	609.52	132.54	742.06	80.00	662.06
	3	778.52	205.37	983.89	600.00	383.89
Total						2250.87
Seeded Lift-Drop	N.S.	705.65	0	705.65	0	705.65
	1	661.51	77.62	739.13	0	739.13
	2	609.52	158.93	768.45	80.00	688.45
	3	778.52	234.66	1013.18	600.00	413.18
Total						2546.41

1/The seeded nursery stock used for transplanting was seeded in 22 inch row widths. The revenue generated from this nursery stock would be $1400 per acre with 100 thousand crowns per acre at $14.00 per thousand.

TABLE 16. SUMMARY OF PRODUCTION YEAR RECEIPTS, COSTS AND PROFITABILITY PER ACRE FOR ASPARAGUS

	Transplant	Lift-Drop
Production Level (cwt/acre)	30	30
Price per cwt ($/cwt)	40.00	40.00
Total revenue ($/acre)	1200.00	1200.00
Variable costs ($/acre)	723.67	723.67
Fixed costs:		
Machinery & tractors ($/acre)	101.27	101.27
Land taxes ($/acre)	21.60	21.60
Amortized est. cost ($/acre)	313.00	354.10
Net land rent ($/acre)	110.00	110.00
	545.87	586.97
Total Cost	1269.54	1310.64
Profit = Revenue minus cost ($/acre)	(69.54)	(110.64)

TABLE 17. PROFIT LEVEL ($/ACRE) GIVEN VARYING YIELDS AND PRICES FOR ASPARAGUS*

YIELD CWT/ACRE	PRICE PER CWT $25	$30	$35	$40	$45	$50	$55	$60	$65	$70
25	-579.54	-454.54	-329.54	-204.54	-79.54	45.46	170.46	295.46	420.46	545.46
26	-567.54	-437.54	-307.54	-177.54	-47.54	82.46	212.46	342.46	472.46	602.46
27	-555.54	-420.54	-285.54	-150.54	-15.54	119.46	254.46	389.46	524.46	659.46
28	-543.54	-403.54	-263.54	-123.54	16.46	156.46	296.46	436.46	576.46	716.46
29	-531.54	-386.54	-241.54	-96.54	48.46	193.46	338.46	483.46	628.46	773.46
30	-519.54	-369.54	-219.54	-69.54	80.46	230.46	380.46	530.46	680.46	830.46
31	-507.54	-352.54	-197.54	-42.54	112.46	267.46	422.46	577.46	732.46	887.46
32	-495.54	-335.54	-175.54	-15.54	144.46	304.46	464.46	624.46	784.46	944.46
33	-483.54	-318.54	-153.54	11.46	176.46	341.46	506.46	671.46	836.46	1001.46
34	-471.54	-301.54	-131.54	38.46	208.46	378.46	548.46	718.46	888.46	1058.46
35	-459.54	-284.54	-109.54	65.46	240.46	415.46	590.46	765.46	940.46	1115.46

*PREHARVEST VARIABLE COST = $314.19 PER ACRE
HARVEST VARIABLE COST = $19.48 PER ACRE PLUS $13.00 PER CWT
TOTAL FIXED COST = $545.87 PER ACRE

ARTICLE P11

A1622

Commercial Asparagus Production

J.A. Schoenemann, L.G. Bundy, L.K. Binning, J.A. Wyman, W.R. Stevenson, K.P. Schmidt and H.C. Harrison

Asparagus is grown for fresh market, especially near urban centers in the southeastern and lakeshore counties. It is well suited for freezing and canning and merits greater consideration as a processing crop in Wisconsin. Most plantings are relatively small. Larger acreages require mechanical harvesting methods.

CULTIVARS

Mary Washington is the most widely grown and generally available cultivar. It tolerates rust and when properly grown produces good yields of high quality spears. 'Waltham Washington' and 'Martha Washington' also tolerate rust but are not as available.

Several hybrid male cultivars have been developed and are in trial plantings in Wisconsin. Two will be available for commercial use—'Jersey Giant' and 'Greenwich'. However, due to seed failure it will probably be 1989 before most growers can obtain seed.

In the interim, three hybrids you may wish to try are 'UC 157', 'Centennial', and 'Rutgers Syn 4', which is composed of 70% male plants.

All three hybrids cost more than conventional, open-pollinated varieties, but they are also substantially higher yielding, giving as much as 1½ times the yield of Waltham Washington and Martha Washington cultivars. Yields from 'Jersey Grant' and 'Greenwich' are approximately double those of open-pollinated cultivars.

SOIL AND FERTILITY

Choose light to medium loams that are deep, fertile, and well drained. Sandy soils produce good yields providing there is adequate irrigation and fertilization, but the asparagus may be hard to clean. Fertilize the first year and near the end of harvest thereafter.

Thorough soil preparation is essential. Fall plowing is best. Determine corrective lime and fertilizer needs by testing the soil. Adjust soils to at least pH 6.6 by using dolomitic limestone, especially on sandy soils. Broadcast fertilizer and any manure or other organic matter, and plow under before planting.

After the first season, broadcast any manure or organic matter and the amount of fertilizer recommended in Table 1. Work into the soil along with old tops as soon as the soil is dry enough but before growth starts. Check boron levels by soil test.

Table 1. Maintenance fertilizer—broadcast annually early in spring

Organic matter	N to apply	Soil test P	P_2O_5 to apply	Soil test K: Sandy and organic soils	Soil test K: Other soils	K_2O to apply
T/A	pounds per acre					
0-20	80	0-150	10	0-400	0-450	20
21-35	60	151-200	5	401-500	451-600	10
36-75	40	Over 200	0	Over 500	Over 600	0
Over 75	20					

On sandy soils, apply half of the nitrogen early in the spring and the remaining half after the last harvest. Reduce the nitrogen recommendations by 4 lb for every ton of manure applied.

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PLANTING

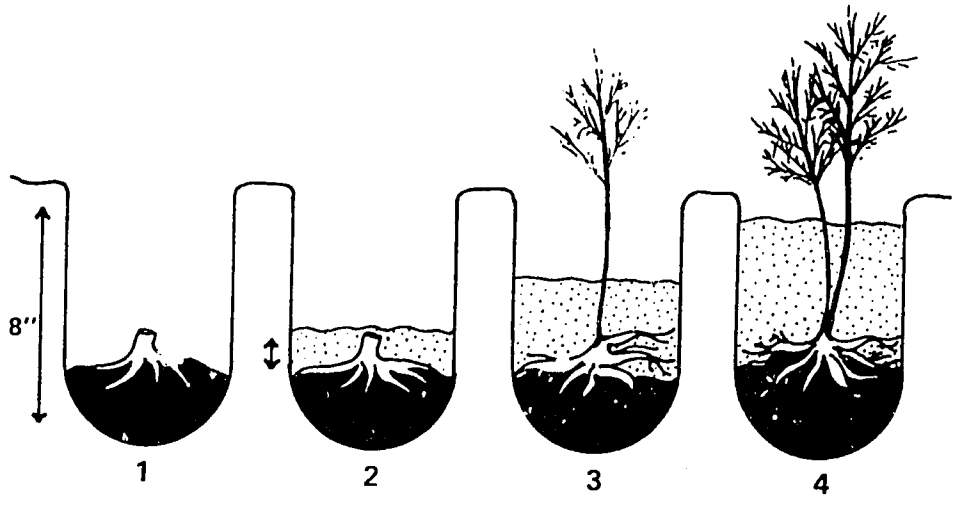
Permanent plantings in Wisconsin are usually started with vigorous, healthy, year-old plants. Direct seeding has been tried in Wisconsin on a limited basis. Some growers may wish to try this method. Plug production of seedlings is also being done on a limited basis and will likely increase in future years as male hybrid seed becomes increasingly available.

To start permanent plantings from direct seeding, sow seeds in double rows 12 inches apart with 5 feet between the double row centers. Plant seeds—1 inch deep with 3 to 4 inches between seeds in the rows—at the bottom of a furrow 18 inches wide and 6 to 8 inches deep. Use 2 to 3 lb seed/A.

To produce plants for transplanting, sow seeds in early spring about 1 inch deep and 2 inches apart in rows 18 to 20 inches apart. This takes 4 to 5 lb seed/A, and each pound produces about 10,000 plants. Seeds germinate best at a soil temperature of 60 to 85° F.

To speed germination, soak seeds in warm water (about 90° F) for 4 to 5 days before planting. Add a few radish seeds to provide early plants to mark the rows for cultivation. Sidedress with 75 to 125 lb ammonium nitrate about mid-June for rapid growth of large vigorous plants. The following spring, lift and reset plants in a permanent location.

One-year-old plants should be dug or plowed out and handled carefully to avoid excessive injury to the crown and fleshy roots. Transplant only large, vigorous, healthy plants. Set plants upright 18 to 24 inches apart in furrows 36 to 48 inches apart and 6 to 8 inches deep. Cover the plants evenly with 2 to 3 inches of soil and fill the furrows gradually as the plants grow. Poor stands result if plants are covered too deeply at the start. Ridge the soil moderately over the rows after the plants are well established.



1. Set the plants upright in wide furrows, 6 to 8 inches deep, with the roots spread.
2. Cover with 2 inches of soil.
3 and 4. Gradually fill the furrow as the plants grow.

WEED CONTROL

Control weeds by proper soil management and careful herbicide use. Avoid planting asparagus in soils infested with perennial weeds, such as Canada thistle, quackgrass, and field bindweed (creeping Jenny), or eliminate these weeds before planting. Of the herbicides described below, only chloramben (Amiben), fluazifop-P-butyl (Fusilade), and terbacil (Sinbar) are registered for use during the establishment year. The rest of the herbicides are registered for use on established asparagus only.

Chloramben (Amiben DS, Liquid, Granular) is registered for use during establishment of seedling asparagus. To control annual weeds, apply 2.7 lb/A of active ingredient (3.6 lb Amiben DS/A, 6 qt Amiben Liquid/A, 30 lb Amiben Granular/A) as soon as

Letters signify formulation types: D—dust, DF—dry flowable, DS—dry soluble, EC—emulsifiable concentrate, L—water soluble liquid, M—microencapsulated, WP—wettable powder.

possible after asparagus seed is planted and before weeds emerge. Do not use Amiben on light sandy soil. After treatment irrigate with 1/2 inch water for maximum weed control. Do not disturb the soil following treatment.

Simazine (Princep 80WP, 4L, Caliber 90) at 2 to 4 lb/A of active ingredient (2.5 to 5 lb Princep 80WP/A, 2 to 4 qt Princep 4L/A, 2.2 4.4 lb Princep Caliber 90/A) will control annual weeds. Apply once annually to established beds in the early spring after disking and before weeds emerge or following harvest after weeds are removed. Spring applications must be made at least 3 days before the first cutting. Use the lower rate on coarse-textured soil or soils low in organic matter. Due to the danger of residue to crops that follow, do not treat asparagus the last season before the bed is destroyed.

Metribuzin (Lexone 4L, DF; Sencor 4, DF) at 1 to 2 lb/A of active ingredient controls most annual weeds. Lexone is registered for a single preemergence application. Sencor is registered for a single preemergence application or a split application preemergence and postharvest. Do not exceed the maximum annual rate of 2 lb active ingredient/A (4 pt Lexone 4L/A, 2.66 lb Lexone DF/A, 4 pt Sencor 4/A, or 2.66 lb Sencor DF/A). Do not apply metribuzin to newly seeded asparagus or to young plants during the first growing season after setting crowns. Check the labels for restrictions on crop rotation.

For a single preemergence treatment, apply 2 to 4 pt Lexone 4L/A, 1.33 to 2.66 lb Lexone DF/A, 2 to 4 pt Sencor 4/A, or 1.33 to 2.66 Sencor DF/A. The correct rate is determined by the soil texture and weeds present. Check the label. Make a single application in early spring before asparagus spears or ferns emerge. If the bed is to be disked, apply after disking. Best results occur if moisture is supplied by rainfall or irrigation within 2 weeks of treatment. Do not apply within 14 days of harvest.

For split applications, apply 1 to 2 pt Sencor 4/A or 0.66 to 1.33 lb Sencor DF/A preemergence before spears or ferns emerge. Apply after disking. Do not apply within 14 days of harvest. Follow with a postharvest application at 2 to 3 pt Sencor 4/A or 1.3 to 2 lb Sencor DF/A. Use the higher rates in areas with severe grass infestation. Do not exceed the maximum annual rate (4 pt Sencor 4/A or 2.66 lb Sencor DF/A) in one crop season. Do not apply until after the last harvest of spears but before fern emergence.

Napropamide (Devrinol 50WP) at 4 lb/A of active ingredient controls annual weeds. Apply 8 lb Devrinol 50WP/A to established asparagus in early spring after disking but prior to weed emergence. Do not apply Devrinol to frozen ground or to soils with more than 10% organic matter. Incorporate or irrigate within 24 hours if no rainfall occurs. Do not apply more than once per season. Do not plant crops not specified on the label within 12 months of the last Devrinol application.

Terbacil (Sinbar 80WP) at 0.8 to 2.4 lb/A of active ingredient (1 to 3 lb Sinbar 80WP/A) controls annual weeds. For asparagus established at least one growing season, apply 1.5 to 3 lb Sinbar 80WP/A prior to spear emergence. Application may be made immediately after clean cutting. Apply before weeds emerge or to small weeds (less than 2 inches tall). Do not harvest asparagus within 5 days of treatment. During the establishment year, Sinbar may be applied to direct-seeded asparagus. Plant seed 1 to 1½ inches deep. Spread a band of activated charcoal directly over the seeding row and follow with a single application 1 to 2 lb Sinbar 80WP/A. Do not use on areas where subsoil or roots are exposed. Do not apply Sinbar to asparagus that is diseased or lacking in vigor. Areas treated with Sinbar may be planted to asparagus 1 year after treatment. Otherwise, do not replant to any other crop within 2 years of last Sinbar application.

Glyphosate (Roundup) at 2 lb/A of active ingredient (2 qt Roundup/A) is particularly effective on perennial grasses such as quackgrass. It is important to apply Roundup at the correct rate and when perennial weeds are at the optimum stage of growth for treatment. This information is included on the label. On established asparagus, apply Roundup after the weeds emerge but before the crop emerges. Do not apply within 1 week before the first spears emerge. Alternatively, apply after the last harvest when all spears have been removed. If spears are allowed to regrow after the last harvest, delay application until ferns have developed. Apply as a directed or shielded spray beneath

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the ferns. Do not spray lower portion of the stems. Roundup is not selective. Direct contact of the spray with asparagus ferns, stems, or spears may result in serious crop injury. Roundup does not provide residual weed control.

Heavy rainfall or irrigation within 6 hours of Roundup treatment may reduce its effectiveness. Heavy rainfall or irrigation within 2 hours of treatment may wash the herbicide off the weed foliage, and repeat treatment may be required. Roundup may react with galvanized steel or unlined steel (except stainless steel) containers to produce a highly combustible hydrogen gas mixture. Read the label carefully before mixing or applying it. Do not plant crops other than those on the label within 1 year of the last Roundup treatment.

Fluazifop-P-butyl (Fusilade 2000) at 0.25 to 0.375 lb/A of active ingredient controls grass weeds after they emerge. Do not apply Fusilade to asparagus from which spears will be harvested within 1 year. Fusilade is only registered for application to *non-bearing* asparagus. Apply Fusilade to actively growing grasses before they exceed the recommended growth stages shown on the label. Treat quackgrass when it is 6 to 10 inches tall. Spray annual grasses when 2 to 8 inches tall and before tillering and/or heading. Use 2 to 3 pt Fusilade 2000 (32 to 48 fl oz Fusilade 2000) per acre. Always add one of the following to finished spray volume: 1% crop oil concentrate or 0.25% nonionic surfactant. Spray to obtain thorough coverage of grass foliage, but not to run-off. Repeat treatments may be necessary for season-long grass control. Control symptoms—loss of vigor, yellowing, and/or reddening and necrosis—are generally observed within 1 to 3 weeks. Do not apply Fusilade if rainfall is expected within 1 hour. Fusilade is currently labeled for application to non-bearing asparagus and for site preparation prior to transplanting.

Alkanolamine salts of 2,4-D (Formula 40) will control morning glory and certain other broadleaf weeds. Apply 1.5 to 2 qt/A in 60 gal of water for ground application. Apply on actively growing weeds, usually in April or May. If spears are present, treat immediately after cutting. Make no more than two applications during the harvest season and these should be spaced at least 1 month apart. Spears contacted by spray may be malformed; cut these spears immediately and discard. Postharvest spraying should only be by ground equipment using drop nozzles to avoid spraying the ferns.

To control quackgrass, apply **dalapon** at 7.5 lb/A of active ingredient (10 lb Dowpon M/A) before the first cutting of asparagus and again 3 weeks later as needed. The quackgrass should have 6 to 8 inches of new growth at treatment. For spot spraying of quackgrass patches, apply 1 lb Dowpon M in 10 gal of water. **Simazine** at 4 lb active ingredient/A will also give some quackgrass control.

Check the *Plant Pest Profiles* available at your county agent's office for more information on asparagus weed control, including herbicide use. Also, consult product labels for further information and follow product directions carefully.

INSECT CONTROL

Asparagus has only a few insect problems. Treatment should only be applied when the insects or their damage is first encountered.

Two asparagus beetles, the common and the twelve-spotted, damage asparagus by gnawing holes in the spears, laying eggs, and feeding on the top of seedlings or older plants. Both the adults and the greyish wormy larvae will damage plants. Apply one of the following insecticides up to 1 day before harvest at the suggested rates of actual insecticide/A: 1 lb carbaryl (Sevin WP, D); 1/4 lb rotenone WP, D; 1 lb malathion WP, EC, D; methoxychlor EC at 2 to 4 lb or 1/2 qt/A (3-day harvest restriction); or permethrin (Ambush) 0.05 to 0.1 lb (3-day harvest restriction).

The blue asparagus aphid will build up on individual plants and cause the plants to wilt and take on a bushy, brooming appearance. Natural enemies of the aphid will often control the problem, or plants can be spot treated with malathion.

Cutworms will feed on developing spears. If cutworms appear, carbaryl (Sevin) bait can be applied at 40 lb of bait/A, or permethrin (Ambush 25WP) can be sprayed at 0.05 to 0.1 lb ai/A.

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DISEASE CONTROL

Asparagus rust is found wherever asparagus is grown and is considered a damaging disease of this crop. All above-ground plant parts are affected. The most destructive phase of the disease is characterized by reddish-brown pustules on stems and leaves. The pustules turn dark brown to black as the season advances. To control asparagus rust, cut infected plants at ground level in late fall or late winter and destroy. Spray with mancozeb 80WP at 2 lb/A as postharvest applications or to young plantings that will not be harvested.

Fusarium root rot weakens or kills asparagus plants and thus reduces stand and yield. The Fusarium fungus incites a reddish-brown discoloration of the water-conducting vessels in roots and stems. Infected plants turn yellow, are stunted, and may wilt especially during warm periods in July and August. Plants produced under ideal conditions for good growth are seldom infected. The disease can be destructive when plants are weakened from overcutting, insect injury, injury from cultivation or herbicides, and from poor growth due to poor soil drainage, improper fertility, drought, or freezing. For control, choice of field location is very important so that plant stress in subsequent years is avoided. Selection of wilt-tolerant varieties can be helpful in control.

HARVESTING

Do not harvest asparagus regularly until the plants are well established in a permanent location. A very light harvest of the larger, thicker spears (two to three cuttings) may be made the second spring after setting plants. Don't take full harvests (up to 6 to 8 weeks) until after the third or fourth season. Harvesting from plants started from direct seedlings should not begin until the fourth season.

To harvest for fresh market, cut the spears 1 to 2 inches below ground when spears are 6 to 8 inches tall, or just before the leaf bracts at the tip begin to open. Spear diameters should range from 3/8 to 3/4 inch. There are knives designed for cutting asparagus below ground and baskets suitable for handling the spears.

For home use or processing, cut or break spears at the soil surface. This avoids injuring spears still below the surface and eliminates having to remove and dispose of the tough, unpalatable, lower part of the spear. Breaking or cutting above ground may be equally profitable for grower and processor when prices are properly adjusted. This method might also be used when asparagus is sold in small consumer packages. However, cut the bases squarely and evenly as you prepare the spears for sale.

Fresh asparagus keeps best at 32° to 36° F and 95% relative humidity. Asparagus is highly perishable. Market as soon as possible after harvest.

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SOME THOUGHTS ON THE LENGTH OF ASPARAGUS CUTTING SEASON

By Darrel Bienz, Professor and Horticulturist

Washington State University

Pullman, WA

At this time of year asparagus growers face the dilemma of when to stop harvesting. On one hand, a few extra days of harvest might help to pay off one more debt; on the other those few extra pounds that an extended harvest might produce are not worth jeopardizing the planting for future years.

It is well to remember that the asparagus planting is like a business. The earnings come from the fern in the form of carbohydrates which are manufactured in green plant tissue in the presence of light, carbondioxide, water, and warm temperature. As in a business, some of the "earnings" of the asparagus plant are used in the day-to-day living of the plant--in the growth of its ferns and roots, in the energy necessary to translocate water and mineral elements, and in the myriad other functions essential to keeping the plant alive. Also, as with business, if conditions are favorable, the asparagus plant will produce a surplus of plant food "earnings" which are stored as a "savings account" of carbohydrates in the fleshy roots. From the savings account "dividends" in the form of harvested spears are paid to the owner and stockholders. Again, as with a business, if too many "dividends" are dispersed (that is, if the harvest season is too long), there may not be enough "capital" (stored food) remaining to grow the vigorous fern required for the following year's crop.

Research in California has shown that the storage roots of most healthy asparagus plants possess excellent resistance to Fusarium rot by their ability to form a layer of resistant wound periderm tissue that restricts the fungus to surface lesions. When plants are stressed by overcutting some of the storage roots disintegrate internally. Such roots lose their ability to restrict infections; the fungus readily moves into them and continues on through the water-conducting tissue of the plant into the crown.

During six years in the 1960's and early 1970's Dr. Clore conducted an experiment at Prosser in which maximum long-term yields were achieved by cessation of cutting by June 21st. Based on Dr. Clore's research and long-time grower observation the general recommendation for asparagus cutting in Central Washington is "don't cut beyond June 20th, and cease cutting whenever the spears become noticeably smaller".

There is some risk in relying heavily on a specific date for cessation of asparagus cutting. Date of shoot initiation from the crown depends on winter and early spring temperature, and elongation of the spear depends on the temperature after spears emerge. The temperature during all but one of the years of Dr. Clore's study were considerably below the normal spring temperature for Central Washington. Also, at "lay-by" weeds were chemically controlled in Dr. Clore's experiment, so the field was not cultivated. Not cultivating at "lay-by" reduces utilization of food reserves by the equivalent of 10 to 14 days cutting, compared to the amount that would be used with the usual cultural practices. Also there is some evidence that the newer California and WSU cultivars have a somewhat earlier more concentrated production than do older cultivars. The year-by-year decline of plantings noted by some growers of these cultivars may result from lowering of disease resistance by overcutting during the early years of establishment.

All this means that June 20 should be considered as the latest harvest cut-off date. Several of the most successful growers in the state never cut beyond June 10. This year, 1983, we had a mild winter and one of the earliest beginnings of asparagus harvest on record. Although the spring weather has been somewhat cool, harvest in most areas has proceeded at a relatively normal pace. This means that the part of the food reserve "bank account" in the fleshy roots of the asparagus planting that can safely be cut for grower "dividends" may be dispersed somewhat earlier this season.

As a general recommendation, a grower should consider "lay-by" whenever he has achieved a yield equal to the average of his yields of past years in a field that had relatively heavy fern last fall. He should cease cutting even earlier in any field or part of the field in which fern growth was weak last year, or whenever the cut spears become noticeably smaller.

The vigor of the previous season's fern growth is the best easily seen measure of potential yield. Growers should observe and keep a written record of the relative vigor of fern growth in their fields compared to that of previous years and compared to the vigor in fields of other growers.

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ARTICLE H L

Twice-a-Year Harvesting of Asparagus[1]

Campbell Institute for Agricultural Research
Villagran, Guanajuato, Mexico

Abstract. Asparagus plantings in the Bajio area of Mexico were managed to provide 2 harvest periods, i.e., 2 vegetative periods and 1 dormant period per year. Cumulative yields for a 5-year period were substantially higher from the plots harvested twice annually than those from a conventional spring harvest schedule.

In the major production areas of the United States, asparagus generally is harvested for a period of 8 to 14 weeks during the spring. After the spring harvesting period, the plants are allowed to grow in order to accumulate food reserves for the next crop. Following the summer growth period, the plants may remain dormant for 20 to 25 weeks depending on the location. In the Bajio area of Mexico near Villagran, Guanajuato, it has been observed that asparagus plants remain dormant for only about 15 weeks during the winter. This suggested the crop might be harvested in the spring for several weeks, allowing the foliage to grow for approximately 3 months and cutting it again for a summer harvest. The foliage could grow then during the fall until it became dormant. This way we had 2 harvest periods, i.e., 2 vegetative periods and 1 dormant period each year. This paper reports results from an experiment designed to compare asparagus yields from a conventional spring harvesting schedule with a spring plus summer schedule in the Bajio area. Recently, Takatori et al (1) reported results on yields and plant vigor influenced by time and duration of cuttings. Results indicated better yields by harvesting a continued 60-day period than 1 month in the spring and 1 month in the fall.

Crowns of the cultivar 'UC-309' were planted February 1, 1961, at Villagran, Guanajuato, Mexico. The experiment consisted of 2 harvesting schedules, each replicated 6 times in a randomized block design. In one schedule, the asparagus was harvested only during the spring, while the other schedule was harvested in the spring and summer.

In an effort to establish certain limits with respect to dates and duration of the harvesting periods, changes were made during the first 3 years – 1962 through 1964. Yields from these early years are not reported. In general, the spring harvesting period extended from early March to late April, and the summer period from early August to early September. Foliage was normally green and full grown when removed for summer harvests.

Fertilization practices were changed during the experiment. From 1961 to 1964, an application of 100-44-42 lb. per acre of N,P,K was applied annually. During 1965 and 1966 this annual application was supplemented with an addition of 50 lb. per acre of N. In 1967 the experiment was fertilized with 160-52-50 lb. per acre of N,P,K. The plots harvested semi-annually received 200 lb. per acre of supplemented N after the summer harvest. In 1968 and 1969 the experiment was fertilized with 200 lb. per acre of N after each harvest season. The experiment was irrigated at intervals of 3 to 4 weeks as required.

The asparagus was harvested according to processing standards, and yields are reported in lb. per acre of marketable spears. Except for 1965, the combined yield from the spring plus summer harvesting schedule was greater than from the spring-only schedule, although the difference was not statistically significant in 1967 (Table 1). During the 5 year period, the combined yield from the spring plus summer harvesting schedule was approximately 65% greater than from the spring-only schedule.

Results obtained to date indicate substantially higher asparagus yields might be achieved in the Bajio area if the crop is managed to provide a spring plus summer harvesting period. In addition to higher annual yields, the split harvesting season offers definite advantages for the processing and fresh market industries.

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Table 1. Asparagus yields obtained from a spring and a spring plus summer harvesting schedule. (1965-1969).

	Harvesting schedule (weeks harvested)			Asparagus yield (lb./acre)		
Year	Spring	Summer	Total	Spring	Summer	Total
1965	6	0	6	4,170		4,170a[2]
	6	3	9	1,890	1,377	3,267b
1966	7	0	7	4,720		4,720A
	7	3	10	3,984	2,363	6,347B
1967	7	0	7	6,389		6,389
	7	4	11	4,344	2,978	7,322
1968	7	0	7	4,412		4,412a
	7	4	11	4,487	8,608	13,095b
1969	7	0	7	6,166		6,166a
	7	4	11	6,309	6,366	12,675b
Total	34	0	34	25,857		25,857a
	34	18	52	21,014	21,692	42,706b

[2]Total yield pairs followed by different lower case and capital letters differ significantly at the 5% and 1% level, respectively, according to Duncan's Multiple Range Test.

[1]Received for publication June 29, 1970

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ARTICLE H3

J. Amer. Soc. Hort. Sci. 105(3):332–335. 1980.

Effect of Harvest Duration on Yield and on Depletion of Storage Carbohydrates in Asparagus Roots[1]

D. R. Shelton and M. L. Lacy
Department of Botany and Plant Pathology, Michigan State University, East Lansing, MI 48824

Additional index words. oligosaccharides, *Asparagus officinalis*

Abstract Harvesting a young planting of asparagus (*Asparagus officinalis* L.) for 4 or 6 weeks the second year after transplanting 1-year-old crowns, followed by harvesting for 8 or 10 weeks the third year, reduced yields significantly the fourth year. Carbohydrate levels in asparagus storage roots decreased during harvest and continued to decrease after harvest during fern production. Carbohydrate levels increased in storage roots after stalks had matured, and were restored to preharvest levels by mid- to late summer. All treatments possessed comparable levels of storage carbohydrates by the end of the season. Asparagus storage carbohydrates were identified as fructose-oliposaccharides, which varied considerably in size, mobility, and percent fructose and glucose. The largest oligosaccharides were composed of ∿ 90% fructose, ∿ 10% glucose; molecular weights did not exceed 4,000.

[1]Received for publication August 9, 1979. Michigan Agricultural Experiment Station Journal Article Number 9119.
The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper must therefore be hereby marked *advertisement* solely to indicate this fact.

Asparagus yields have experienced a general decline in Michigan since 1970, although total production has increased because of expanded area planted (6). The reasons for the decline in yield are not well understood, but are probably due to environmental and biological stresses. The effects of

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these stresses on asparagus vigor have not been extensively studied.

Asparagus plants produce and store carbohydrates during one growing season for overwintering and for initiation of bud, spear, and fern growth the following season (8). Carbohydrate levels in asparagus plants are, presumably, directly related to plant vigor and hence to growth and yields. Previous studies on the effect of length of harvest on subsequent yields of asparagus indicated that a harvest period of 7-9 weeks was most desirable (2, 4, 5, 11, 12). However, such studies took several years to complete, and recommendations were for an average year, without taking into account current season conditions. The purpose of these studies was to investigate the effect of different harvest periods on fluctuations of storage carbohydrates in asparagus plants throughout the growing season, to determine whether carbohydrate levels were a reliable index of subsequent yields, and to determine the nature and structure of the storage carbohydrate(s).

Methods and Materials

A 2-year-old asparagus plot (started with 1-year-old crowns 'Mary Washington') was divided into 1.5 × 7.7 m plots replicated 5 times. Plots were harvested for periods of 0, 2, 4, or 6 weeks, and spears were counted and weighed. Storage roots were sampled for total soluble carbohydrates every 1-2 weeks from April 9 to October 29 by collecting 15-20 cm soil cores containing root segments about 15 cm from the center of the crowns. Two to 3 plants from each plot were sampled on each sampling date and four core samples were taken per crown. Storage root segments were dried at 96°C for 12 hr, then ground in a Wiley Mill. Soluble carbohydrates were extracted from 1 g dried tissue in a Sorvall Omni-mixer in 100 ml distilled water at 4,400 r.p.m. and filtered. Total carbohydrates were determined by a modified anthrone reagent method (7). One ml of extract solution was mixed with 9 ml of anthrone reagent, placed in a boiling water bath for 15 min., then immediately cooled in an ice bath. Optical density was measured at 620 nm with a Bausch and Lomb Spectronic 20 spectrophotometer. Carbohydrate concentrations were determined using a standard curve derived from sucrose. In the second year, the harvest periods of 0, 2, 4, or 6 weeks were extended by 4 weeks each, so that the plots were harvested for 4, 6, 8, or 10 weeks. In the third year, all plots were harvested for 6 weeks.

A 1-year-old asparagus plot (previously planted with 1-year-old crowns) was divided into 1.5 × 18.0 m plots replicated 5 times. Plots were harvested for periods of 0, 3, or 6 weeks. Three to 6 plants were removed from the soil every 1-2 weeks from April 14 through September 9, 1977, thoroughly washed, weighed, and storage roots were severed from the rhizome. Randomly chosen storage roots were cut into 2.5-4.0 cm segments, dried at 96°C for 12 hr, ground in a Wiley Mill, and processed as previously described, with the exception that fructose was substituted for sucrose in deriving the standard curve.

A 0.5 g sample of dried ground storage root tissue was extracted with 100 ml boiling 80% ethanol in a Sorvall Omnimixer at 10,800 r.p.m. for 5 min. The solution was filtered, evaporated to dryness, and redissolved in 1-2 ml distilled water. Aliquots of solution were streaked on Whatman 3MM chromatography paper and developed in 7 propanol:1 ethyl acetate:2 water (3) for periods of 4, 12, or 24 days. Oligosaccharides were detected by applying N.E.P. ketose-specific indicator and heating at 100°C for 2 min (1). Oligosaccharides were extracted from chromatograms with double distilled water, filtered, then hydrolized with 1 N HCl at 52-54°C for 1 hr. The HCl was neutralized with dry $AgCO_3$ until the precipitate darkened, and then the precipate was washed with 100 μl acetic anhydride and 2 ml dry methanol, and evaporated to dryness in a vacuum desiccator. Samples were trimethylsilylated overnight with 50 μl of Tri-Sil Z and analyzed with either a Perkin Elmer 900 gas chromatograph equipped with a 3.7 m 3% SE-30 glass column or a Perkin Elmer 910 equipped with a 3.7 m SP-2100 glass column (10). Temperature programming was 140°-200° on the P.E. 900 and 120°-180° on the P.E. 910 (4 min at 120° or 140° followed by increases of 2° min^{-1}). Flow rate was 50 ml N/min; injection port and detector temperatures were 260°. Standards of inulin and sucrose were run with each batch.

Molecular weight was estimated using Bio-Gel P-4 and P-6 400 mesh exclusion beads, packed in separate 1 cm diameter columns to bed heights of 23 cm. Flow rate was 3.2 ml/hr; the void volume was 3.6 ml as determined with blue dextran. Fractions were analyzed for carbohydrate by a modified anthrone technique as described above.

Results

Harvesting asparagus plots for 4 or 6 weeks in the second year after transplanting crowns, and for 8 or 10 weeks the following year, reduced yields significantly the fourth year after transplanting (Table 1). Percentage of marketable size spears (> one cm in diameter 12 cm from the tip) was lowest in plots harvested for the longest period of time. Storage carbohydrates (% of dry weight) decreased gradually through the harvest periods (April-May), (Fig. 1). One to 2 weeks following harvest, carbohydrate levels decreased rapidly as shoots were

Table 1. Effect of length of harvest period on 'Mary Washington' asparagus yield in subsequent years.

Length of harvest (weeks)			1978 yields		
1976[z]	1977	1978	No marketable[y] spears/ha × 10^3	Yield of marketable spears (kg/ha)	Marketable spears (%)
0	4	6	155 a	3120 a	65 a
2	6	6	130 a	2640 a	65 a
4	8	6	99 b	1955 b	58 ab
6	10	6	84 b	1706 b	55 b

[z]Plots were first harvested 2 years after transplanting 1-year-old crowns.

[y]Spears > 1 cm in diameter.

[x]Mean separation within columns by Duncan's multiple range test, 5% level.

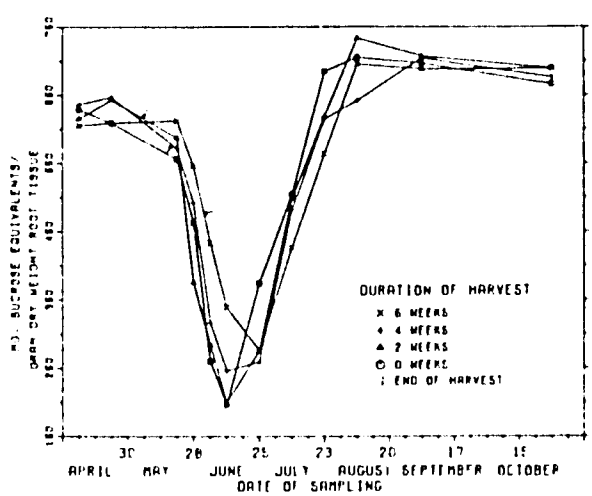

Fig. 1. Amounts of soluble carbohydrates in storage roots of a 2-year-old asparagus planting harvested for 0, 2, 4, or 6 weeks

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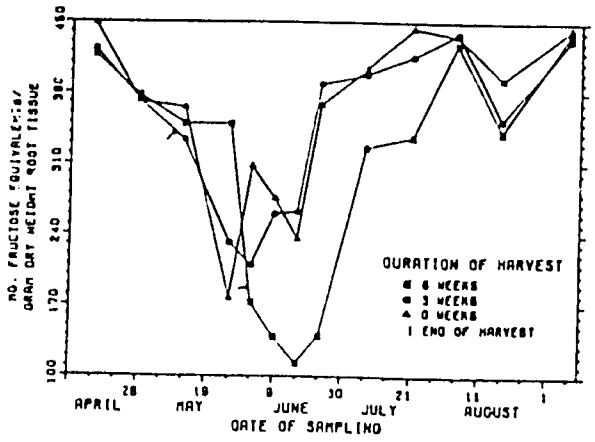

Fig. 2. Amounts of soluble carbohydrates in storage roots of a 1-year-old asparagus planting harvested for 0, 3, or 6 weeks.

produced, reaching a minimum in early June. Then carbohydrate levels increased rapidly, reaching peak levels in mid- to late-August. Thereafter, carbohydrate levels gradually decreased. The integrity of the different harvest periods was disrupted due to several nights of freezing temperatures for 2 weeks in April 1976, during the initial harvest period. The full effects of this cold period on storage carbohydrate production or utilization are not known. Significant differences in percent storage carbohydrate could only be demonstrated between the 6 week harvest and the other 3 harvest periods during that part of the season when carbohydrate levels were declining rapidly. Carbohydrate levels in plants harvested for 6 weeks were consistently higher for 3 weeks after harvest and reached a minimum 1 to 2 weeks later than carbohydrate levels in plants which were harvested for 0, 2, or 4 weeks, indicating that more reserve carbohydrate was utilized in producing full size ferns than in producing 17-25 cm spears which were snapped off before they could fully elongate.

In the second experiment, where entire crowns were dug and sampled, percent storage carbohydrate decreased through harvest and after harvest during shoot production, then increased rapidly, reaching peak levels in mid- to late-summer (Fig. 2). Percent storage carbohydrate of plants harvested for 0 or 3 weeks leveled off in late May to early June, then increased and peaked in late July to early August, while percent storage carbohydrate of plants harvested for 6 weeks leveled off 2 to 3 weeks later than plants harvested for 0 or 3 weeks.

Table 2. Ratios of fructose:glucose in hydrolyzates of oligosaccharid eluted from chromatograms developed for 4, 12, or 24 days.

Band eluted from chromatogram	Glucose[z] (%)	Estimated ratio of fructose:glucose
1	33	2:1
2	26	3:1
3	22	4:1
4A	25	–[x]
4B	26	–
5A	20	–
5B	21	–
6[y]	15	–
7	15	–
8	15	–
9	14	–
10	10	9:1

[z]Loss of fructose during acid hydrolysis necessitated multiplying level of percent fructose by a constant derived from loss of fructose from molecule (sucrose and/or inulin) of known composition.

[y]Bands 6, 7, 8, and 10 were eluted from both 12 and 24 day developed chromatograms. Values are the average of both determinations.

[x]Ratios of glucose:fructose not estimated due to suspected oligosaccharide heterogeneity and fructose lability.

Total storage root dry weight from plants harvested for 6 weeks was significantly less from mid-June to early September than for plants harvested for 0 or 3 weeks (Fig. 3).

Paper chromatography revealed a number of oligosaccharides varying in size and mobility, all containing ketose sugars. Twelve distinct oligosaccharide bands were eluted from one or more of the chromatograms. Gas chromatography of hydrolyzates revealed that the eluted oligosaccharides were composed predominantly of fructose and, to a lesser extent, glucose (Table 2). Ratios of fructose to glucose ranged from 2:1 for the oligosaccharide with the greatest mobility to 9:1 for the oligosaccharide(s) with the least mobility (no movement from the origin). Exact ratios for most of the oligosaccharides were impossible to estimate due to the heterogeneity of oligosaccharides within bands and the lability of fructose during acid hydrolysis. Gel exclusion chromatography indicated that the molecular weight of the largest oligosaccharides did not exceed 4,000 (Table 3).

Discussion

Results concerning the effect of length of harvest on seasonal fluctuations of storage carobhydrates are in close agreement

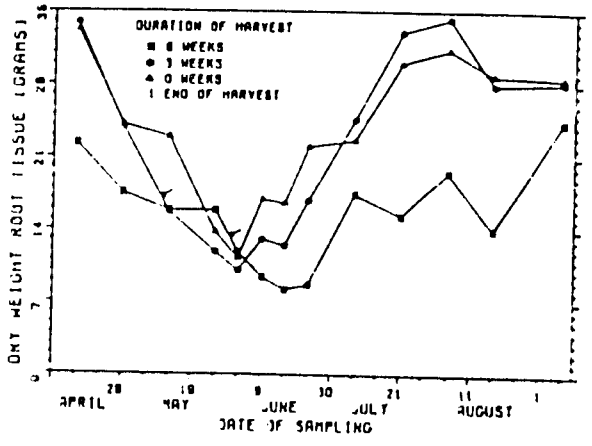

Fig. 3. Effect of length of harvest on storage root dry weight.

Table 3. Molecular weight determination of oligosaccharides extracted from asparagus storage roots.

Fraction[z]	Amount (ml)	Optical density[y] Exclusion limit 4000 (Bio-Gel P-4)	6000 (Bio-Gel P-6)
1	3	0[w]	0
2	0.7[x]	0	0
3	0.7	0.275	0

[z]1 mg of material in 0.1 ml of distilled water was applied to the top of the column.

[y]Carbohydrates were detected by the anthrone method. Optical density of solutions was read at 620 nm in a Bausch and Lomb Spectronic 20 spectrophotometer.

[x]Approximates the void volume.

[w]Each value is the average of 2 determinations

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with those of Scott et al. (8) obtained in South Carolina, although he incorrectly identified the storage carbohydrate as sucrose. Carbohydrates in storage roots were reduced during harvest and were depleted even more severely during the initial fern production period. Storage carbohydrates were replenished after the fern had matured and had begun to produce sufficient carbohydrate for translocation and assimilation. The effect of extending harvest was to increase the severity of carbohydrate depletion, and to decrease the number of days available through the rest of the season for the production of storage carbohydrates for the succeeding year's growth.

In the second experiment, there was a 6 week period (late July to early September) during which there were no significant differences in percent storage carbohydrate, yet plants harvested for 6 weeks had significantly less total root dry matter than plants harvested for 0 or 3 weeks. It appeared that storage root formation was inhibited by the longer harvest period without the percent storage carbohydrate being significantly affected. Our results indicated that harvest should not begin until 2 complete years following transplanting have passed, and should not exceed 7-9 weeks after the planting is well established.

Asparagus storage carbohydrates are fructo-oligosaccharides, contrary to the report by Scott et al. (8). That fructo-oligosaccharides have existed in asparagus roots has been known since 1909; however, due to problems with methodology, estimates of composition and size have remained tentative. Gas chromatography and gel exclusion chromatography in this study clearly indicated that parent oligosaccharides consisted of ∿ 10% glucose, and ∿ 90% fructose, with molecular weights not exceeding 4,000. Shiomi et al. (9) performed structural analyses of fructo-trisacchardies through pentasaccharides from asparagus roots; however, structural analyses of the larger oligosaccharides have yet to be attempted.

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ARTICLE H4

SYNOPSIS OF AGRICULTURAL CODE PROVISIONS FOR PACKING ASPARAGUS

Issued by

E. B. Eby - San Joaquin County Agricultural Commissioner

The following is a brief outline submitted to assist you in properly packing your market asparagus. For more complete and detailed information, please call this office or refer to the California Food and Agricultural Code.

Asparagus Defects - Do not pack asparagus with the following defects:
Asparagus that is wilted, crushed, or badly broken;
Asparagus that is badly spreading, or with badly seeding tips;
Asparagus that is decayed;
Asparagus that is damaged by dirt, disease, insects, or mechanical injury.

ASPARAGUS, SIZE, DESIGNATIONS. Asparagus which is classified according to the following size designations shall be graded to comply with the following individual stalk size designations:

(a) Colossal size means stalks which are not less than 16/16 of an inch in diameter.
(b) Jumbo size means stalks which are not less than 13/16 of an inch in diameter.
(c) Extra Large size means stalks which are not less than 10/16 of an inch in diameter.
(d) Large size means stalks which are not less than 7/16 of an inch in diameter.
(e) Standard size means stalks which are not less than 5/16 of an inch in diameter.
(f) Small size means stalks which are not less than 3/16 of an inch in diameter.

"Diameter" measurement shall mean the widest portion of the cross section measured at the largest point of the stalk.

The size designation requirements as herein established shall apply to all stalks of asparagus in each container, except that in the case of the Colossal, Jumbo, Extra Large, Large, Standard and Small sizes 10%, by count, of the stalks in any container may be smaller than the size designation specified.

COLOR REQUIREMENTS - Not more than 1 1/2 inches of white showing, beginning at the cut end, except 20% in any container may have more than 1 1/2 inches of white providing not more than 5% of this amount exceeds 3 inches of white in length, based on 9" spear measured from tip. Containers of asparagus marked with the word "white" may not have more than 5% of the stalks with more than 1 1/2 inches of color other than white. Containers marked "long green" and "tall green" or similar descriptive terms would indicate 80% of the stalks could have no more than one inch of white. Containers marked "all green" would indicate that 80% of the stalks could have no white showing.

MARKING REQUIREMENTS - Each container shall be marked with the following on the prinicpal display panel: (Principal display panel would mean one end of each container.)

(a) Name and Address, including zip code;
(b) Product Identity statement;
(c) Quantity statement net wt;
(d) Proper Size (The word "Size" must accompany the size designation.)
(e) Color-designation shall be on principal display panel.

Asparagus which is badly crooked and marked with the designation "crooks" need not bear any bunch or size designation terms.

DECEPTIVE PACK - Growers and packers are warned to guard against deceptive packing of asparagus. A properly packed crate of asparagus has all the various sizes and quality represented in the face or outside layer. Do not face the pack with larger stalks of asparagus than there are in the interior of the pack. Remember the exposed layer of asparagus or facing should always be a true representation of the unexposed asparagus in every respect.

STOCKTON OFFICE 944-2225

ARTICLE H5

STATE OF WASHINGTON
DEPARTMENT OF AGRICULTURE

RULES RELATING TO STANDARDS FOR ASPARAGUS

I, C. Alan Pettibone, Director of the Department of Agriculture of the state of Washington, by hearing held in Pasco, Washington, on February 26, 1985, pursuant to RCW 34.04, do hereby promulgate the following rules:

Chapter 16-409 WAC

WAC 16-409-015 DEFINITIONS. (1) "Clean" means that the asparagus is free from excessive dirt, dust, residue or foreign matter.

(2) "Fresh" means that the stalk is not limp or flabby.

(3) "Well trimmed" means that at least two-thirds of the butt of the stalk is smoothly trimmed in a plane approximately parallel to the bottom of the container and that the butt is not stringy or frayed.

(4) "Fairly well trimmed" means that at least one-third of the butt of the stalk is smoothly trimmed in a plane approximately parallel to the bottom of the container and that the butt is not badly stringy or frayed.

(5) "Diameter" means the greatest thickness of the stalk measured at a point approximately one inch from the butt.

(6) "Fairly uniform in length" means that stalks within a container shall vary not more than one and one-half inches in length.

(7) "White" means that portion of the stalk near the butt, which is white in color or light purple over white. White is measured from the extreme tip of the butt to the point of beginning of green color.

(8) "Green" means that portion of the stalk having green color, purplish-green or greenish-purple color, and purple at the tip.

(9) "Damage" means any defect, or combination of defects, which materially detracts from the appearance, or the edible or marketing quality of the stalk.

(10) "Serious damage" means any defect, or combination of defects, which seriously detracts from the appearance, or the edible or marketing quality of the stalk.

(11) "Badly misshapen" means the stalk is so badly flattened, crooked or otherwise so badly deformed that its appearance is seriously affected.

(12) "Fresh asparagus" as used in the standards means a lot of asparagus marketed for the purpose of fresh consumption.

(13) "Lot" means any number of containers of fresh asparagus being offered as a unit for the purpose of inspection, sale, or shipment.

(14) "Shipment" means any number of containers of fresh asparagus transported on a single conveyance from the area of production.

(15) "Field container" means an open lug made of wood, plastic, or similar material and used repetitively for field harvesting. [Order No. 1848, effective April 14, 1985.]

WAC 16-409-020 WASHINGTON STANDARDS--GRADES. (1) Washington extra fancy shall consist of:

(a) Clean, fresh stalks of asparagus, fairly uniform in length, well trimmed, fairly straight, not wilted, and which are free from decay and damage caused by spreading or broken tips, dirt, disease, insects, or mechanical or other means. Stalks shall have at least eighty-five percent green color.

(b) Stalks within individual containers shall meet one of the following designated sizes: Jumbo, large, or standard.

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(2) Washington fancy shall consist of:

(a) Clean, fresh stalks of asparagus, fairly uniform in length, fairly well trimmed, not wilted and not badly misshapen, and which are free from decay and serious damage caused by spreading or broken tips, dirt, disease, insects, mechanical or other means. Stalks shall have at least eighty-five percent green color.

(b) Each stalk shall have a diameter of not less than four-sixteenths inch.

(3) Washington consumer pack shall consist of:

(a) Clean, fresh stalks of asparagus and may be of random length, which are fairly straight, not wilted and which are free from decay and damage caused by spreading or broken tips, dirt, disease, insects, mechanical or other means. Stalks shall show not more than one and one-half inches of white.

(b) Each stalk shall have a diameter of not less than four-sixteenths inch.

(4) Culls.

(a) Asparagus which is not graded in conformity with Washington extra fancy, Washington fancy, Washington consumer pack, or U.S. No. 1, or U.S. No. 2 shall be designated as "culls."

(b) Culls shall not be marketed if more than ten percent by count of the stalks show white in excess of two inches.

(5) Any lot of fresh asparagus, including "culls" marketed within the state of Washington, shall have not more than ten percent of stalks with white in excess of two inches, nor more than ten percent of stalks which are less than four-sixteenths inch in diameter. [Order No. 1848, effective April 14, 1985.]

WAC 16-409-030 TOLERANCES FOR DEFECTS, COLOR, DIAMETER AND TRIM. (1) In order to allow for variations incident to proper grading and handling in the Washington extra fancy, Washington fancy, and Washington consumer pack grades, the following tolerances are provided as specified:

(a) Ten percent by count, for stalks failing to meet the requirements of the grade other than for trim and color requirements, including therein, not more than one percent for stalks affected by decay.

(b) An additional ten percent, by count, for stalks having less than the specified amount of green color.

(c) An additional ten percent, by count, for stalks not meeting trim requirements.

(2) In order to allow for variations in diameter and length incident to proper sizing in the Washington extra fancy, Washington fancy, and Washington consumer pack grades, the following tolerance is provided as specified: Ten percent, by count, for stalks failing to meet the required minimum and maximum diameter, and/or length, as defined under, "fairly uniform in length" and "size designations." [Order No. 1848, effective April 14, 1985.]

WAC 16-409-035 APPLICATION OF TOLERANCES. Individual samples are subject to the following limitations: PROVIDED, That the averages for the entire lot are within the tolerances specified for the grade.

(1) For a tolerance of ten percent or more, individual samples shall contain not more than one and one-half times the tolerance specified.

(2) For a tolerance of less than ten percent, individual samples shall contain not more than double the tolerance specified.

(3) One decayed or otherwise defective stalk, one poorly trimmed stalk, one poorly colored, and one off-size stalk shall be permitted in any sample. [Order No. 1848, effective April 14, 1985.]

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WAC 16-409-060 WASHINGTON STANDARDS--SIZE DESIGNATIONS. In addition to the statement of grade:

(1) Washington extra fancy grade lots shall be designated as Washington extra fancy jumbo or Washington jumbo, Washington extra fancy large or Washington large, or Washington extra fancy standard or Washington standard. Ninety percent, by count, of the stalks in any lot shall conform to the following diameters for such designations:

(a) Washington extra fancy jumbo or Washington jumbo shall be stalks thirteen-sixteenths inch in diameter or larger.

(b) Washington extra fancy large or Washington large shall be stalks seven-sixteenths inch in diameter or larger.

(c) Washington extra fancy standard or Washington standard shall be stalks six-sixteenths inch in diameter or larger.

(2) Washington fancy grade lots shall be designated by minimum diameter: PROVIDED, That when at least ninety percent, by count, of the stalks in any lot are four-sixteenths inch in diameter or larger, the lot may be designated as Washington fancy small or Washington small.

(3) Washington consumer pack grade lots shall be designated by minimum diameter. Stalks shall be four-sixteenths inch in diameter or larger.

(4) U.S. No. 1 grade lots shall be designated as Washington jumbo, Washington large, or Washington standard, or may be designated by minimum diameter.

(5) U.S. No. 2 grade lots shall be designated as Washington small or may be designated by minimum diameter. [Order No. 1848, effective April 14, 1985.]

WAC 16-409-065 CONTAINERS. (1) Fresh asparagus shall be marketed in containers which are clean and free from dirt, trash, and visible contaminates.

(2) Fresh asparagus of the Washington extra fancy, Washington fancy, U.S. No. 1, and U.S. No. 2 grades shall be marketed in pyramid type containers with moisture pads.

(3) Fresh asparagus of the Washington consumer pack grade shall be marketed in pyramid type containers with moisture pads, or in fibre-board or wooden "western lug" containers having inside dimensions of approximately seven, by eleven and one-half, by eighteen inches, or capacity of thirteen hundred fifty to fifteen hundred fifty cubic inches.

(4) Pyramid type containers shall contain thirty pounds, fifteen pounds, or six kilograms net weight.

(5) Western lugs shall contain not less than twenty pounds net weight.

(6) Culls shall be marketed in wooden pyramid containers with moisture pads.

(7) Fresh asparagus in field containers shall not be marketed.

(8) The director may allow the use of containers not specified in subsections (2), (3), (4), (5), and (6) of this section, as experimental containers for the purpose of test or trial marketing. [Order No. 1848, effective April 14, 1985.]

WAC 16-409-070 MARKING REQUIREMENTS. (1) Containers shall be conspicuously and legibly marked with the name and address of the grower, packer, or distributor, the grade, and net weight, and a size designation or diameter size as defined in WAC 16-409-060 (1), (2), (3), (4), and (5).

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(2) The grade and size designation shall be marked in letters at least three-eighths inch in height.

(3) The following abbreviations of grade and size designation shall be acceptable: Washington may be abbreviated as Wash. or WA. Extra fancy may be abbreviated as ex fcy or extra fcy. Fancy may be abbreviated as fcy. Large may be abbreviated as lge. Standard may be abbreviated as std.

(4) The use of U.S. No. 1 or U.S. No. 2 grade markings shall be permitted subject to WAC 16-409-085.

(5) If culls are marketed, the word "culls" shall be conspicuously and legibly marked in letters at least one inch in height and shall be predominant in size over other markings.

(6) All required markings shall be placed on one end of the container, and may be duplicated on opposite end of container. [Order No. 1848, effective April 14, 1985.]

WAC 16-409-075 EXEMPTION. Any individual shipment of fresh asparagus shall be exempted from the requirements of WAC 16-409-020 through 16-409-060, 16-409-065 (2), (3), (4), (5), (6), and (8); and 16-409-070 when:

(1) The shipment consists of asparagus for home use and not for resale.

(2) The shipment does not exceed two hundred fifty pounds net weight. [Order No. 1848, effective April 14, 1985.]

WAC 16-409-085 ADOPTION OF UNITED STATES STANDARDS AS WASHINGTON STATE STANDARDS. In addition to the standards for asparagus as set forth in this chapter the United States standards for grades of fresh asparagus, as they apply to U.S. No. 1 and U.S. No. 2, are hereby adopted as additional standards for the state of Washington for asparagus: PROVIDED, That U.S. No. 1 shall be not less than six-sixteenths inch in diameter and shall meet or exceed Washington extra fancy grade and U.S. No. 2 shall be not less than four-sixteenths inch in diameter and shall meet or exceed Washington fancy grade. [Order No. 1848, effective April 14, 1985.]

C. Alan Pettibone

C. Alan Pettibone
Director of Agriculture

Signed at Olympia Washington
March 15, 1985

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FRESH ASPARAGUS QUALITY AS AFFECTED BY FIELD CUT AND HOLDING CONDITIONS

J. W. Nelson *S. R. Drake* *G. H. Carter* *R. E. Early*

College of Agriculture Research Center Washington State University

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Summary

In the past, field grades for asparagus have been based on a 7.0-inch spear with a minimum of 5.0 inches of green and 2.0 inches or less white butt. Recently, a new procedure of field grading has been proposed to include a grade for all green spears with a minimum length of 5.5 inches. The purpose of this study was to determine what effects this new grade of field cut has on the quality of asparagus. Asparagus cultivar U.C. 500-W was harvested and sorted into two diameters (3/8-5/8 and 5/8-7/8 inches), two field grades (7.0 inches with a white butt and 5.5 inches all green) and each placed in direct sun or shade for 3, 6 and 9 hr.

Shear force values were affected by spear diameter and holding conditions, but not by length of field cut. Moisture and ascorbic acid content were affected by all conditions. The 7.0-inch field cut retained more moisture and vitamin C than the 5.5-inch cut. Spears held in the sun lost more moisture and ascorbic acid than those held in the shade. Quality was best in asparagus held in the shade prior to processing for a period of less than 6 hr, regardless of length of field cut.

This Bulletin and the Authors

J. W. Nelson was a student in the department of food science and technology, Washington State University. He is now a physical science technician with the USDA Agricultural Research Service.

S. R. Drake is a food technologist, Agricultural Research Service, U.S. Department of Agriculture and a member of the faculty of the department of food science and technology.

G. H. Carter and R. E. Early are research technologists, department of horticulture. Drake, Carter and Early are stationed at the university's Irrigated Agriculture Research and Extension Center, Prosser.

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Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the USDA or Washington State University, and does not imply its approval to the exclusion of other products that could also be suitable.

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FRESH ASPARAGUS QUALITY AS AFFECTED BY FIELD CUT AND HOLDING CONDITIONS

J. W. Nelson, S. R. Drake, G. H. Carter, and R. E. Early

Introduction

Asparagus, *Asparagus officinalis* L. ranks fourth in value among vegetable crops grown in Washington. Field grades for the past several years have been based on a 7.0-inch spear with a minimum of 5.0 inches of green and 2.0 inches or less of white butt. Recently, a new procedure of field grading has been proposed. This new grade is based on an all-green spear with a minimum length of 5.5 inches. Controversy has arisen over comparisons of the quality of asparagus graded by the new and old methods.

Excessive fiber can make asparagus undesirable. Forty percent of the USDA quality grade of canned and frozen asparagus is "character" in which fiber is an important consideration. Smith and Kramer (14) determined that fiber content increases gradually from the tip to the butt of the spear, increasing very rapidly beyond the "snapping" point of the spear. Werner, et al. (18) indicated that the fibrousness of asparagus could be estimated accurately with the shear-press. Wiley, et al. (19) using the shear-press, estimated fiber content of asparagus and found that the results correlated well with those from sensory panels. Clore, et al. (2) determined that the number of spears per sample, spear diameter, length of green and pre-harvest temperature markedly affected shear press values, but cultivar did not. The effect of cultivar on shear force depended on the number and size distribution of the spears produced. Sosa-Coronell, et al. (13) found a difference in fiber content due to cultivar by using the blender method.

Dame, et al. (3) found that asparagus stored at room temperature and sprayed occasionally with water increased in weight while asparagus stored under dry cool conditions and in the sun lost weight. He also reported ascorbic acid losses regardless of storage conditions, and that ascorbic acid concentration was greater in small diameter spears (3/8-5/8 inches) than in larger diameter spears (5/8-7/8 inches).

This study was begun to determine if there is a quality difference in methods of field grading, what role if any the white butt portion may play, and to determine the effects of field holding condition on the field grades.

Experimental

Asparagus for this study was obtained from a planting at the Washington State University Irrigated Agriculture Research and Extension Center, Prosser. Asparagus was not irrigated during the harvest period. Asparagus cultivar U.C. 500-W was harvested with a minimum of 5.5 inches of green. Spears were sorted for diameter at a point 5.0 inches from the tip into two size groups, 3/8-5/8 inches and 5/8-7/8 inches. These groups are equivalent to the medium and large grades used for frozen asparagus (17).

Each diameter group was divided into two lots. One lot retained the white butt and the second lot was cut as all-green asparagus 5.5 inches from the tip. Asparagus from each diameter and length was subjected to simulated field holding conditions of direct sunlight or shade for 3, 6, or 9 hr. The experiment was replicated three times a week for seven weeks. The mean temperature during the 7 weeks was 75.6 F in the sun and 70.8 F in the shade. The highest temperature was 88 F in the sun and 75 F in the shade. Humidity averaged 52.1% during this same period.

Peak-force measurements were determined with a Food Technology Corporation Texture Test System equipped with a single blade CA-1 cell (18, 19). All peak force readings were made at ½-inch intervals on spear samples beginning at 5.0 inches and advancing to 4.0 inches from the tip. Peak force values are reported in kg of force required to shear 5 spears of 3/8-5/8-inch diameter and 4 spears of 5/8-7/8-inch diameter. Seven peak-force values were taken for each size diameter length of cut, field condition, and exposure time each week. A total of 2,940 spears of 3/8-5/8-inch diameter and 2,352 spears of 5/8-7/8-inch diameter were tested.

The entire top 4.0-inch portion of the spears was blended and subsequently used for ascorbic acid and moisture determinations. Ascorbic acid was determined by the method of Loeffler and Ponting (9) in duplicate for each diameter, length of cut, holding condition, and exposure time each week. Moisture was determined in triplicate for all conditions by weight difference after 24 hr in a vacuum oven at 70 C and 660 mm Hg vacuum.

Results

Shear

Medium spears 3/8-5/8-inch in diameter (table 1) had significantly greater shear force values than the large 5/8-7/8-inch diameter spears[1] when sheared 5.0 inches from the tip, and significantly lower shear force values when sheared at 4.0 inches. Shear force values increased with holding time; they increased more if held in the sun than in the shade. At 4.0 inches from the tip, a significant difference was found between field cuts. The all-green spears required more shear force than the spears with white butts.

Moisture

Moisture content (table 1) was significantly less in the medium than in large spears, but no significant difference in moisture loss was found between the two field cuts. Asparagus lost moisture when left in sunlight but did not lose significant amounts if stored in shade up to 9 hr (table 2). The all-green spears lost moisture faster than those with the white butt when held in the sun.

[1] Hereafter, the two diameters will be referred to simply as medium or large spears.

Table 1. Mean moisture, ascorbic acid and shear forces of asparagus variety U. C. 500-W with different lengths of cut, holding conditions, and diameters

Treatment type	Pct moisture	Ascorbic acid mg/100 g	Max peak-force readings at designated intervals from the tip 5.0 in	4.5 inc	4.0 in
Length of cut, inches					
5.5 all green	89.29[a**1]	49.93[a*]	96.44[NS]	80.83[NS]	72.83[b*]
7.0 white butt	89.52[b]	52.50[b]	99.02	79.48	71.06[a]
Holding condition					
Shade	89.76[b**]	53.39[b**]	92.90[a**]	76.84[**]	69.22[a**]
Sun	89.05[a]	49.04[a]	102.56[b]	83.47	74 68[b]
Holding Time					
3 hours	89.73[a**]	50.66[a**]	85.20[a**]	73.89[a**]	68.02[a**]
6 hours	89.27[b]	56.78[b]	93.62[a]	79.50[a]	71.58[ab]
9 hours	89.21[b]	46.20[c]	114.37[b]	87.08[b]	76.25[bc]
Size diam inches					
3/8-5/8 (med)	89.15[a**]	56.21[b**]	100.63[b*]	79.40[NS]	69.22[a**]
5/8-7/7 (large)	89.66[b]	46.22[a]	94.83[a]	80.91	74.68[b]

[1]Spacing means separated by Duncan's Multiple Range Test. Any two means in the same column and same treatment type that do not share a common letter are significantly different at the 5% level(*) or the 1% level (**).

Table 2. Percent moisture of fresh asparagus as affected by the interaction of length of cut, time and holding conditions

Length inches	Storage time	Storage conditions Sun	Shade
5.5 all green	3 hr	89.38 b A[1]	89.91 b B
5.5 all green	6 hr	88.79 a A	89.58 b B
5.5 all green	9 hr	88.43 a A	89.70 b B
7.0 white butt	3 hr	89.65 b A	90.00 b B
7.0 white butt	6 hr	89.13 a A	89.60 b B
7.0 white butt	9 hr	88.97 a A	89.78 b B

[1]Spacing means separated by Duncan's Multiple Range Test. Within a given length, small letters denote differences due to storage time; capital letters denote differences due to storage conditions. Any two means that do not share a common letter are significantly different at the 5% level.

Ascorbic Acid

The medium spears had significantly more ascorbic acid than the large spears (table 1). Asparagus held in the sun lost more ascorbic acid than asparagus held in the shade. Ascorbic acid increased at 3 to 6 hr, then decreased at 6 to 9 hr.

Discussion

Shear

Studies have shown shear peak force to give a significant indication of the fiber content or fibrousness of asparagus (1, 5, 6, 7, 10, 11, 13). Others have reported that smaller diameter asparagus spears have a higher shear force than the large diameter spears (2, 3). Our results confirm these reports with shear force values taken 5.0 inches from the tip; however, 4.0 inches from the tip, the reverse is true. The shear values of the smaller spears decreased faster acropetally than the larger spears, causing this difference in quality. The smaller spears would therefore produce a more tender "tip-style" frozen product than the larger spears.

Holding the asparagus in the shade rather than in direct sunlight slowed down deterioration, perhaps by decreasing the rate of respiration and therefore slowing the rate of fiber development (6). Asparagus maintained turgidity up to 6 hr when held in the shade, but became tough and lost turgidity after this time. The length of field cut had no effect on toughness of the asparagus during storage. All cut ends developed a callused and filthy appearance which required recutting of all spears for a quality product. The 5.5-inch field cut would therefore be limited to a length of 5.0 inches or less for processing.

Moisture

The 91.7% moisture content of asparagus reported by the USDA (15) is greater than we found (89.7%). How-

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ever, our results were substantiated by a soluble solids content of 8.7% and by an ascorbic acid content nearly twice the USDA, ARS figure. A probable cause was thought to be lack of irrigation during the harvest period. However, in comparing the asparagus after irrigation, no difference in moisture content was found. The value differences were most likely due to the weather while the asparagus was growing. The cool, cloudy 1976 growing season caused slow growth, which encourages high fiber and low moisture content. Dame et al. (3) also reported that U.C. 500-W is usually higher in fiber and lower in moisture than other varieties.

It appears that moisture loss of at least 0.50% occurs prior to any loss in asparagus quality due to an increase in fibrousness. If the moisture loss can be minimized by holding in the shade, or by other means, asparagus quality will be maintained.

Ascorbic Acid

Post-harvest storage of asparagus spears in the sun decreased the ascorbic acid content from 53.39 mg/100 g to 49.04 mg/100 g or 8.2%. This confirms the results of Ezell and Wilcox with other wilted vegetables (4). Ascorbic acid content increased during 3 to 6 hr of storage and then decreased after 9 hr of storage. This increase may be due to a concentration effect, the moisture loss being faster during this period than the ascorbic acid loss. Between 6 and 9 hr, the moisture loss was not significant; however, the ascorbic acid content decreased 20% during this same period. High moisture content might protect the ascorbic acid. The USDA (15) reports ascorbic acid in asparagus to be 33 mg/100 g. Results (table 1) show our asparagus had 53 mg/100 g, a concentration that would fulfill the Minimum Recommended Daily Allowance. Asparagus appears to be an excellent source of vitamin C if handled properly. Other fruits and vegetables have been found to have more ascorbic acid when grown in the Pacific Northwest (5). Also, U.C. 500-W is a variety reported to be high in ascorbic acid. (3).

Conclusion

A quality asparagus product can be produced regardless of length of cut if the product is properly stored and cut ends are removed before processing. Traditional 7.0-inch cut asparagus with a white butt appears to have the advantage of retaining more moisture and vitamin C than the 5.5-inch cut asparagus, particularly under adverse conditions often met in the field.

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ARTICLE W1

INSECT AND NEMATODE CONTROL RECOMMENDATIONS FOR

Asparagus, Egg Plant, Okra, Peppers, and Sweet Corn

Compiled by:
Nick C. Toscano, Entomologist, Cooperative Extension, Riverside

Contributors:
V. Burton, Cooperative Extension, Davis
J. Radewald, I. Thomason, and N. Toscano, Cooperative Extension, Riverside
D. Johnson, Cooperative Extension, Parlier
N. McCalley, Cooperative Extension, Monterey County
M. Stimmann, Berkeley

Division of Agricultural Sciences
UNIVERSITY OF CALIFORNIA
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How to Improve Pest Control

Failure to control an insect, mite, or disease is often blamed on the pesticide used, even though frequently the cause lies elsewhere. Among the more common reasons for failure are:

- Delaying applications until pests become too large or too numerous.
- Making applications with insufficient gallonage or clogged and/or poorly arranged nozzles.
- Selecting the wrong pesticide.

For more effective pest control:

- Inspect fields regularly. Keep alert to pest buildup. Frequent examinations (at least twice per week) help determine the proper timing of the next application. Be aware of your own pest situation — do not apply controls simply because your neighbor does.
- Strive for adequate coverage of plants. Aphids, mites, lepidopterous larvae (worms), and diseases are serious pests, primarily because they occur beneath leaves, which protect them from spray deposit or dust particles. Improved control can be achieved by adding and arranging spray nozzles so that the application is directed toward the plants from the sides as well as the tops. In some cases, nozzles should be arranged so that the application is directed beneath the leaves. As the season progresses and plant size increases, so does the need for increased spray gallonage to ensure adequate coverage. Applying sprays with sufficient volume and pressure is important.
- Select the correct pesticide. Know the pest(s) to be controlled, and choose the recommended pesticide and application rate. When in doubt, consult your county farm advisor.

ABBREVIATIONS

AI	active ingredient
EC	emulsifiable concentrate
gal	gallon(s)
lb	pound(s)
pt	pint(s)
S	soluble
SP	soluble powder
WP	wettable powder
/	per
%	percent

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ASPARAGUS

PESTS	WHEN TO TREAT	PESTICIDE	COMMERCIAL NAME	FORMULATION AND PERCENT ACTIVE INGREDIENT	USE RATES (DOSAGE/ACRE)	COMMENTS
Symphylid (garden centipede)	Summer (before planting)	Flood during the summer, utilizing a minimum area in levees. It is essential that soil be completely covered for 2-weeks				
	Preplant treatment only	Fonofos	Dyfonate	Granular, 10%	30 to 100 lb	Broadcast. Incorporate into soil to a depth of 6 to 9 with standard cultivation equipment. Do not harvest for 30 days.
Darkling ground beetle, cutworm	During cutting period	Carbaryl*†	Sevin*†	Bait, 5%	40 lb	Irrigate, allow field to drain, then apply bait. Do not repeat application within 3 days. Do not treat within 1 day of harvest.

* Permit from County Agricultural Commissioner required for purchase or use.

† Do not apply when bees are present. Do not use if there is a danger of drift to nearby beehives or if there is a possibility of drift to other crops in bloom.

ASPARAGUS

ENVIRONMENTAL PROTECTION AGENCY LIMITATIONS ON USE OF CHEMICALS SUGGESTED IN THIS PUBLICATION

Chemical	Interval required between last application and planting or harvest	Tolerance (parts per million)	Dosage (pounds actual material per acre)
Dyfonate (Fonofos)	30 days: broadcast application; incorporate into soil	0.5	10.0 (Use restricted to California)
Sevin (Carbaryl)	1 day; apply during cutting season; do not repeat application within 3 days	10.0	2.0

OKRA

PESTS	WHEN TO TREAT	PESTICIDE	COMMERCIAL NAME	FORMULATION AND PERCENT ACTIVE INGREDIENT	USE RATES (DOSAGE/ACRE)	COMMENTS
Root-knot nematode	Soil fumigation prior to planting	1,3-dichloropropene	Telone II	Liquid, 92%	See label for instructions	
		EDB, Ethylene dibromide	Soilbrom 85	Liquid, 12 lb/gal, 84.5%	6 gal	
Cutworm		Carbaryl*†	Sevin*†	Bait, 5%	20 to 40 lb	No time limitations.

* Permit from County Agricultural Commissioner required for purchase or use.

† Do not apply when bees are present. Do not use if there is a danger of drift to nearby beehives or if there is a possibility of drift to other crops in bloom.

OKRA

ENVIRONMENTAL PROTECTION AGENCY LIMITATIONS ON USE OF CHEMICALS SUGGESTED IN THIS PUBLICATION

Chemical	Interval required between last application and planting or harvest	Tolerance (parts per million)	Dosage (pounds actual material per acre)
Ethylene Dibromide	Preplant soil treatment	30.0	108.0
Sevin (Carbaryl)	No time limitations	10.0	2.0
Telone II	Preplant soil treatment	Non-food use	—

PEPPERS

PESTS	WHEN TO TREAT	PESTICIDE	COMMERCIAL NAME	FORMULATION AND PERCENT ACTIVE INGREDIENT	USE RATES (DOSAGE/ACRE)	COMMENTS
Root-knot nematode	Soil treatment at least 14 days before planting	1,3-dichloropropene	Telone II	Liquid, 92%	See label for instructions	
		EDB, Ethylene dibromide	Soilbrom 85	EC, 12 lb/gal, 84.5%	6 gal	
Cutworm, darkling ground beetle	Seedling stage and when causing damage	Carbaryl*†	Sevin*†	Bait, 5%	40 lb	No time limitation.
		Trichlorfon**	Dylox**	Bait, 5%	20 lb	Apply a minimum of 21 days prior to harvest
Aphid	When present in damaging numbers	Methomyl*†	Lannate*† Nudrin*†	SP, 90%	½ lb	Will also control beet armyworm and give some control of corn earworm. Do not apply within 10 days of harvest. Reentry period — 24 hours
				Liquid, 1.8 lb/gal, 24.1%	1 qt	
		Endosulfan*‡	Thiodan*‡	EC, 3 lb/gal, 33.7%	1½ to 2⅔ pt	Do not apply within 4 days of harvest
		Acephate	Orthene 75S	SP, 75%	⅔ lb	Will also control cabbage loopers. Do not apply within 7 days of harvest. Sweet peppers only
Pepper weevil	First appearance of pods	Carbaryl*†	Sevin*†	SP, 80%	2⅓ lb	Treat at 7- to 10-day intervals beginning when pods start to set. Continue treatments until no more susceptible green pods are present or the crop is mature. Destroy nightshade plants in winter. No time limitations.

* Permit from County Agricultural Commissioner required for purchase or use.

† Do not apply when bees are present. Do not use if there is a danger of drift to nearby beehives or if there is a possibility of drift to other crops in bloom.

‡ Hazardous to fish.

** Dylox should not be allowed to stand in spray tank as it rapidly hydrolizes to DDUP.

PEPPERS
ENVIRONMENTAL PROTECTION AGENCY LIMITATIONS ON USE OF CHEMICALS SUGGESTED IN THIS PUBLICATION

Chemical	Interval required between last application and planting or harvest	Tolerance (parts per million)	Dosage (pounds actual material per acre)
Dylox (Trichlorfon)	21 days	0.1	1.0 (bait)
Ethylene dibromide	Soil treatment at least 14 days prior to planting	30.0	108.0
Lannate, Nudrin (Methomyl)	10 days	0.2	0.45
Orthene (Acephate)	7 days	4.0	0.5
Sevin (Carbaryl)	No time limitations	10.0	1.0
Telone II (1,3-Dichloropropene)	Preplant soil treatment	Non-food use	—

EGGPLANT

WASH OR WIPE FRUIT CAREFULLY BEFORE SHIPPING TO MARKET						
PESTS	WHEN TO TREAT	PESTICIDE	COMMERCIAL NAME	FORMULATION AND PERCENT ACTIVE INGREDIENT	USE RATES (DOSAGE/ACRE)	COMMENTS
Root-knot nematode	Soil fumigation prior to planting	1,3-dichloropropene	Telone II	Liquid, 92%	See label for instructions	
		EDB, Ethylene dibromide	Soilbrom 85	Liquid, 12 lbs/gal, 84.5%	6 gal	
Corn earworm, hornworm	When present and damaging	Carbaryl*†	Sevin*†	SP, 80%	2½ lb	No time limitations.
Flea beetle	When damaging	Carbaryl*†	Sevin*†	SP, 80%	1¼ lb	No time limitations.
Cutworm		Carbaryl*†	Sevin*†	Bait, 5%	20 to 40 lb	No time limitations.
Aphid	When colonies can be found	Parathion*†	Parathion, Red Top Parathion 4 spray*†	EC, 4 lb/gal, 45%	1 pt	Do not apply within 15 days of harvest
		Mevinphos*†	Phosdrin*†	EC, 4 lb/gal, 47.1%	½ to 1 pt	Do not apply within 2 days of harvest. DO NOT APPLY WITH HAND EQUIPMENT.
		Endosulfan*‡	Thiodan*‡	EC, 2 lb/gal, 24%	1 qt	Do not apply within 1 day of harvest.
Spider mite, whitefly	When colonies present	Parathion*†	Parathion, Red Top Parathion 4 Spray*†	EC, 4 lb/gal, 45%	1 pt	Do not apply within 15 days of harvest.
		Mevinphos*†	Phosdrin*†	EC, 4 lb/gal, 47.1%	1 pt	Do not apply within 2 days of harvest.

* Permit from County Agricultural Commissioner required for purchase or use.

† Do not apply when bees are present. Do not use if there is a danger of drift to nearby beehives or if there is a possibility of drift to other crops in bloom.

‡ Hazardous to fish.

EGGPLANT
ENVIRONMENTAL PROTECTION AGENCY LIMITATIONS ON USE OF CHEMICALS SUGGESTED IN THIS PUBLICATION

Chemical	Interval required between last application and planting or harvest	Tolerance (parts per million)	Dosage (pounds actual material per acre)
Ethylene Dibromide	Soil treatment prior to planting	30.0	108.0
Parathion	15 days	1.0	0.5
Phosdrin (Mevinphos)	2 days	0.25	0.5
Sevin (Carbaryl)*	No time limitations	10.0	2.0
Telone II (1,3-Dichloropropene)	Preplant soil fumigation	Non-food use	—

SWEET CORN

PESTS	WHEN TO TREAT	PESTICIDE	COMMERCIAL NAME	FORMULATION AND PERCENT ACTIVE INGREDIENT	USE RATES (DOSAGE/ACRE)	COMMENTS
Wireworm, seed corn maggot	No adequate recommendation available					
Cutworm, darkling ground beetle	When damaging; usually seedlings	Carbaryl*†	Sevin*†	Bait, 5%	40 lb	No time limitations.
Armyworm	When damaging; usually seedlings	Carbaryl*†	Sevin*†	SP, 80%	2½ lb	No time limitations.
Flea beetle	When damaging; usually seedlings	Carbaryl*†	Sevin*†	SP, 80%	2½ lb	No time limitations.
Corn earworm	Individual ear treatment for moderate to heavy populations	Carbaryl*†	Sevin*†	Dust, 5%	40 lb	Use a stencil brush. Daub each ear. Make 5 to 7 applications at 2- to 3-day intervals as necessary or until silks stop growing.
	Ground power spraying—for light to moderate populations; apply 1 to 2 days before silks appear	Carbaryl*†	Sevin*†	SP, 80%	2½ lb	No time limitations.
	1 to 2 days before silks appear	Methomyl*	Lannate*, Nudrin*	Liquid, 1.8 lb/gal, 24.1%	1 to 2 pt	Do not feed treated fodder to livestock within 3 days after last application. No time limitation on corn for fresh market.
				SP, 90%	¼ to ½ lb	
Fall armyworm	When damaging	Carbaryl*†	Sevin*†	Dust, 10%	20 lb	No time limitations.
				SP, 80%	2½ lb	

* Permit from County Agricultural Commissioner required for purchase or use.

† Do not apply when bees are present. Do not use if there is a danger of drift to nearby beehives or if there is a possibility of drift to other crops in bloom.

SWEET CORN

ENVIRONMENTAL PROTECTION AGENCY LIMITATIONS ON USE OF CHEMICALS SUGGESTED IN THIS PUBLICATION

Chemical	Interval required between last application and planting or harvest	Tolerance (parts per million)	Dosage (pounds actual material per acre)
Lannate, Nudrin (Methomyl)	No time limitation for fresh-market corn; do not feed treated fodder to livestock within 3 days of application	0.1	0.45
Sevin (Carbaryl)	No time limitations	100 (forage) 5 (kernels and cob)	2.0

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CAUTION

PLANT
PESTICIDE USE WARNING — READ THE LABEL

CAUTION

Pesticides are poisonous and must be used with caution. READ the label CAREFULLY BEFORE opening a container. Precautions and directions MUST be followed exactly. Special protective equipment as indicated must be used.

STORAGE: Keep all pesticides in original containers only. Store separately in a locked shed or area. Keep all pesticides out of the reach of children, unauthorized personnel, pets and livestock. DO NOT STORE with foods, feeds or fertilizers. Post warning signs on pesticide storage areas.

USE: The suggestions given in this publication are based upon best current information. Follow directions: measure accurately to avoid residues exceeding tolerances, use exact amounts as indicated on the label or lesser amounts given in this publication. Use a pesticide only on crops, plants or animals shown on the label.

CONTAINER DISPOSAL: Consult your County Agricultural Commissioner for correct procedures for rinsing and disposing of empty containers. Do not transport pesticides in vehicles with foods, feeds, clothing, or other materials, and never in a closed cab with the vehicle driver.

RESPONSIBILITY: The grower is legally responsible for proper use of pesticides including drift to other crops or properties, and for excessive residues. Pesticides should not be applied over streams, rivers, ponds, lakes, run-off irrigation or other aquatic areas except where specific use for that purpose is intended.

BENEFICIAL INSECTS: Many pesticides are highly toxic to honey bees and other beneficial insects. The farmer, the beekeeper and the pest control industry should cooperate closely to keep losses of beneficial species to a minimum.

PROCESSED CROPS: Some processors will not accept a crop treated with certain chemicals. If your crop is going to a processor, be sure to check with the processor before making a pesticide application.

POSTING TREATED FIELDS: When worker safety reentry intervals are established be sure to keep workers out and post the treated areas with signs when required indicating the safe reentry date.

PERMIT REQUIREMENTS: Many pesticides require a permit from the County Agricultural Commissioner before possession or use. When such compounds are recommended in this publication, they are marked with an asterisk (*).

PLANT INJURY: Certain chemicals may cause injury or give less than optimum pest control if used at the wrong stage of plant development; in certain soil types; when temperatures are too high or too low; the wrong formulation is used; and excessive rates or incompatible materials are used.

PERSONAL SAFETY: Follow label directions exactly. Avoid splashing, spilling, leaks, spray drift or clothing contamination. Do NOT eat, smoke, drink, or chew while using pesticides. Provide for emergency medical care in advance.

Pest control regulations for pest management are highly subject to change. It is important that you periodically contact your local farm advisor or U.C. Cooperative Extension specialist in order to be informed of revisions or additions to the material discussed in this publication.

To simplify information, trade names of products have been used. No endorsement of named products is intended, nor is criticism implied of similar products which are not mentioned.

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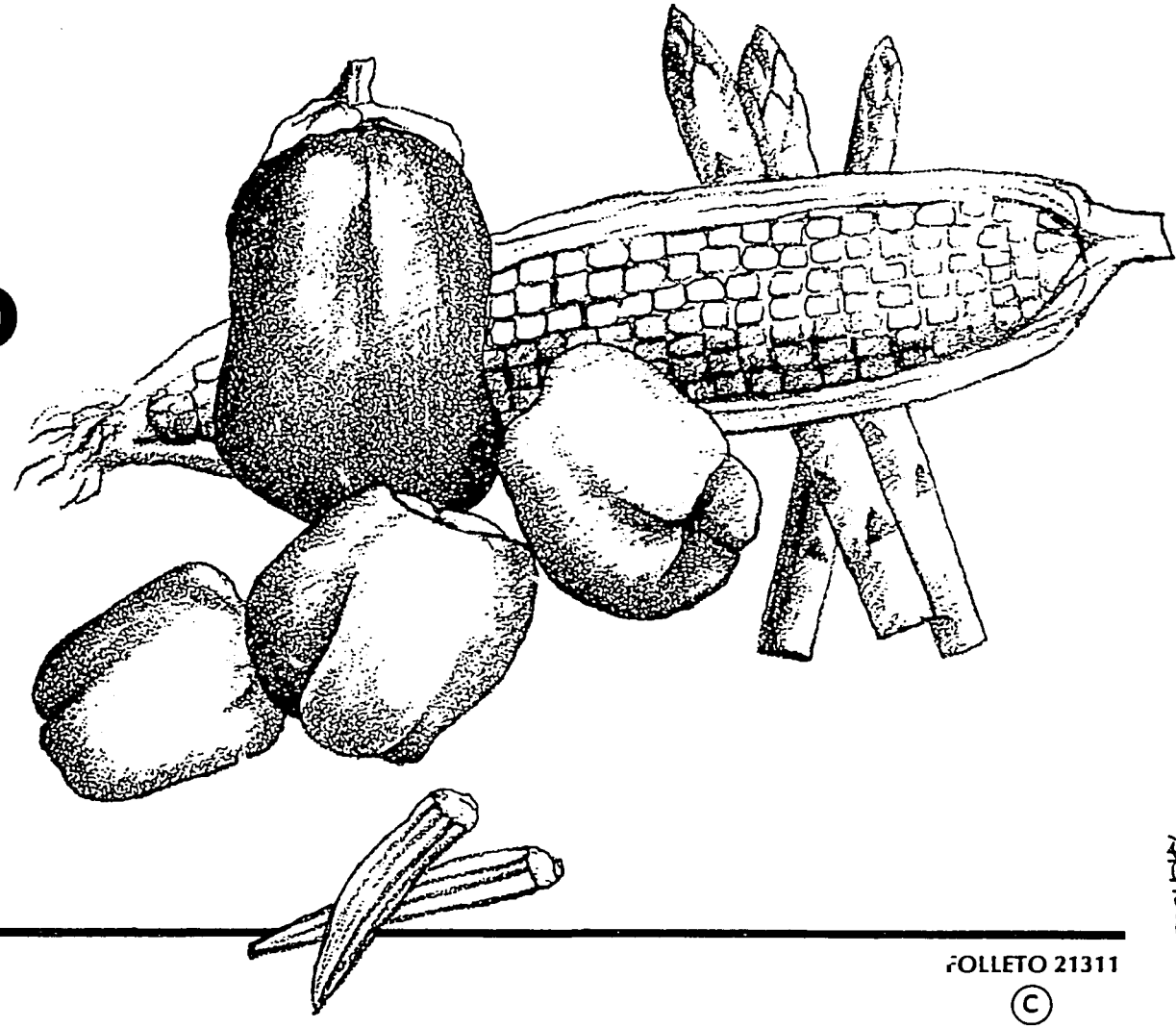
Recomendaciones para el control de insectos y nemátodos en los cultivos de

- ESPÁRRAGOS
- BERENJENAS
- QUINGOMBÓ
- CHILES
- MAÍZ DULCE



Cooperative Extension
Division of Agricultural Sciences
UNIVERSITY OF CALIFORNIA

FOLLETO 21311

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Spanish translation of Leaflet 21140, *Insect and Nematode Control Recommendations for Asparagus, Eggplant, Okra, Peppers, and Sweet Corn*

Article W2

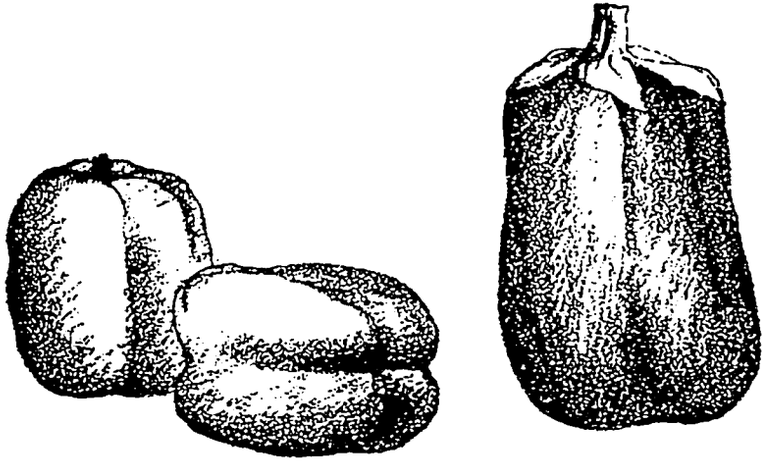
Cómo mejorar el control de plagas

Cuando los esfuerzos destinados a controlar insectos, ácaros o enfermedades fracasan, la culpa a menudo se atribuye al pesticida utilizado, aunque la causa sea otra. Entre las razones más comunes de fracaso, se destacan las siguientes:

- Demora en aplicar el pesticida. La aplicación es ineficaz porque la plaga es muy numerosa o se ha extendido demasiado.
- Aplicaciones insuficientes por falta de volumen o boquillas tapadas o mal distribuidas.
- Uso de un pesticida inadecuado.

Para lograr un control de plagas más efectivo, siga estos pasos.

- Inspeccione los campos periódicamente. Observe si hay señales de plagas y los daños ocasionados. Las frecuentes visitas al campo (dos veces por semana, como mínimo) ayudan a determinar el momento apropiado para la próxima aplicación. Manténgase alerta y actúe según las condiciones de su campo; no aplique pesticidas simplemente porque su vecino lo hace.
- Trate de cubrir bien las plantas. Los pulgones, ácaros, gusanos y enfermedades son plagas serias porque atacan el envés de las hojas y es difícil cubrir estas áreas con polvos o rocíos. Para un mejor control, agregue y disponga las boquillas para que apliquen el pesticida por arriba y por los costados de las plantas. En algunos casos las boquillas deben regularse para aplicar el pesticida por debajo de las hojas. A medida que avanza la temporada y aumenta el tamaño de las plantas, se necesita más cantidad de producto químico para cubrir bien las plantas. Recuerde que es importante rociar utilizando el volumen y la presión adecuados.
- Escoja el pesticida apropiado. Determine qué plaga(s) desea controlar y escoja el pesticida y la dosis de aplicación adecuados. Si tiene dudas sobre cualquiera de estos puntos, consulte al consejero agrícola de su condado.



Recopilado por Nick C. Toscano, Entomólogo, Extensión Cooperativa, Riverside. Los colaboradores son V. Burton, Extensión Cooperativa, Davis; J. Radewald, I. Thomason y N. Toscano, Extensión Cooperativa, Riverside; D. Johnson, Extensión Cooperativa, Parlier; N. McCalley, Extensión Cooperativa, condado de Monterey; y M. Stimmann, Davis. Traducción de Irene Tenney.

Abreviaturas utilizadas

AI	Ingrediente activo	S	Soluble
EC	Concentrado emulsionable	SP	Polvo soluble
gal	Galón (galones)	WP	Polvo humectable
lb	Libra(s)	/	Por
pt	Pinta(s)	%	Por ciento

ESPÁRRAGOS

Plagas	Época de tratamiento	Pesticida	Marca comercial	Formulación y porcentaje del ingrediente activo	Uso Dosis/Acre	Observaciones
Centípedo de jardín	Verano (antes de plantar)	Inunde durante el verano, usando un área mínima en los diques. Es indispensable que el suelo esté completamente cubierto durante 2 semanas.				
	Tratamiento de pre-siembra únicamente	Fonofos	Dyfonate	Granulado, 10%	30 a 100 lb	Aplique al voleo. Incorpore al suelo con equipo de cultivo común a una profundidad de 6" a 9". No coseche durante 30 días.
Escarabajo terrestre, gusano trozador	Durante el período de corte	Carbaryl*† §	Sevin*†	Carnada, 5%	40 lb	Riegue, espere a que el agua haya drenado y aplique la carnada. No vuelva a aplicar hasta que hayan pasado 3 días. No aplique el pesticida un día antes de la cosecha.

* Se requiere autorización o permiso del Comisionado Agrícola del condado para su compra o uso.

† No aplique este pesticida cuando las abejas están presentes. No use este pesticida si hay peligro de que el viento arrastre el producto químico a colmenas o cultivos en flor cercanos.

§ Los componentes químicos de los pesticidas se dan en su idioma original para facilitar la lectura de las etiquetas y la identificación de los productos.

Limitaciones de la Agencia de Protección del Medio Ambiente para el uso de los productos químicos recomendados en esta publicación

Producto químico	Intervalo requerido entre la última aplicación y la plantación o cosecha	Tolerancia (partes por millón)	Dosis (libras de material activo por acre)
Dyfonate (Fonofos)	30 días; aplicación al voleo; incorpore al suelo	0,5	10,0 (Uso restringido a California)
Sevin (Carbaryl)	1 día; aplique durante la época de corte; no repita la aplicación hasta pasados 3 días	10,0	2,0

BERENJENAS

Plagas	Época de tratamiento	Pesticida	Marca comercial	Formulación y porcentaje del ingrediente activo	Uso Dosis/Acre	Observaciones
Nemátodo de nódulo radicular	Fumigación del suelo antes de plantar	1,3-dichloro-propene	Telone II	Líquido, 92%	Siga las instrucciones de la etiqueta.	
		EDB, Ethylene dibromide	Soilbrom 85	Líquido, 12 lb/gal, 84,5%	6 gal	
Gusano elotero, gusano de cuerno	Presencia y daños de la plaga	Carbaryl*†	Sevin*†	SP, 80%	2½ lb	Sin límite de tiempo
Pulga saltona	Daños presentes	Carbaryl*†	Sevin*†	SP, 80%	1¼ lb	Sin límite de tiempo
Gusano trozador		Carbaryl*†	Sevin*†	Carnada, 5%	20 a 40 lb	Sin límite de tiempo
Pulgón	Presencia de colonias	Parathion*†	Parathion, Red Top Parathion, 4 spray*†	EC, 4 lb/gal, 45%	1 pt	No aplique 15 días antes de la cosecha.
		Mevinphos*†	Phosdrin*†	EC, 4 lb/gal, 47,1%	½ a 1 pt	No aplique 2 días antes de la cosecha. NO APLIQUE CON EQUIPO DE MANO.
		Endosulfan*‡	Thiodan*‡	EC, 2 lb/gal, 24%	1 qt	No aplique 1 día antes de la cosecha.
Arañita, mosca blanca	Presencia de colonias	Parathion*†	Parathion, Red Top Parathion, 4 spray*†	EC, 4 lb/gal, 45%	1 pt	No aplique 15 días antes de la cosecha.
		Mevinphos*†	Phosdrin*†	EC, 4 lb/gal, 47,1%	1 pt	No aplique 2 días antes de la cosecha.

* Se requiere autorización o permiso del Comisionado Agrícola del condado para su compra o uso.

† No aplique este pesticida cuando las abejas están presentes. No use este pesticida si hay peligro de que el viento arrastre el producto químico a colmenas o cultivos en flor cercanos.

‡ Peligroso para los peces.

\# Antes de enviarlas al mercado, las berenjenas deben lavarse o limpiarse cuidadosamente.

Limitaciones de la Agencia de Protección del Medio Ambiente para el uso de los productos químicos recomendados en esta publicación

Producto químico	Intervalo requerido entre la última aplicación y la plantación o cosecha	Tolerancia (partes por millón)	Dosis (libras de material activo por acre)
Ethylene dibromide	Tratamiento del suelo antes de la siembra	30,0	108,0
Parathion	15 días	1,0	0,5
Phosdrin (Mevinphos)	2 días	0,25	0,5
Sevin (Carbaryl)	Sin límite de tiempo	10,0	2,0
Telone II (1,3-dichloropropene)	Fumigación del suelo antes de la siembra	No se aplica a los cultivos	

QUINGOMBÓ

Plagas	Época de tratamiento	Pesticida	Marca comercial	Formulación y porcentaje del ingrediente activo	Uso Dosis/Acre	Observaciones
Nemátodo de nódulo radicular	Fumigación del suelo antes de la siembra	1,3-dichloro-propene	Telone II	Líquido, 92%	Siga las instrucciones de la etiqueta.	
		EDB, Ethylene dibromide	Soilbrom 85	Líquido, 12 lb/gal, 84,5%	6 gal	
Gusano trozador		Carbaryl*†	Sevin*†	Carnada, 5%	20 a 40 lb	Sin límite de tiempo

* Se requiere autorización o permiso del Comisionado Agrícola del condado para su compra o uso.

† No aplique este pesticida cuando las abejas están presentes. No use este pesticida si hay peligro de que el viento arrastre el producto químico a colmenas o cultivos en flor cercanos.

Limitaciones de la Agencia de Protección del Medio Ambiente para el uso de los productos químicos recomendados en esta publicación

Producto químico	Intervalo requerido entre la última aplicación y la plantación o cosecha	Tolerancia (partes por millón)	Dosis (libras de material activo por acre)
Ethylene dibromide	Tratamiento del suelo antes de la siembra	30,0	108,0
Sevin (Carbaryl)	Sin límite de tiempo	10,0	2,0
Telone II	Tratamiento del suelo antes de la siembra	No se aplica a los cultivos	——

CHILES

Plagas	Época de tratamiento	Pesticida	Marca comercial	Formulación y porcentaje del ingrediente activo	Uso Dosis/Acre	Observaciones
Nemátodo de nódulo radicular	Tratamiento del suelo por lo menos 14 días antes de plantar	1,3-dichloro-propene	Telone II	Líquido, 92%	Siga las instrucciones de la etiqueta.	
		EDB, Ethylene dibromide	Soilbrom 85	EC, 12 lb/gal, 84,5%	6 gal	
Gusano trozador, escarabajo oscuro de la tierra.	Después de la germinación y cuando hay daños presentes	Carbaryl*†	Sevin*†	Carnada, 5%	40 lb	Sin límite de tiempo
		Trichlorfon ‖	Dylox ‖	Carnada, 5%	20 lb	Aplique por los menos 21 días antes de la cosecha.
Pulgón	Colonias numerosas y dañinas	Methomyl*†	Lannate*†, Nudrin*†	SP, 90%	½ lb	También controla los gusanos soldados y, en parte, los gusanos eloteros. No aplique 10 días antes de la cosecha. Intervalo de espera — 24 horas
				Líquido, 1,8 lb/gal, 24,1%	1 qt	
		Endosulfan*‡	Thiodan*‡	EC, 3 lb/gal, 33,7%	1½ a 2⅔ pt	No aplique 4 días antes de la cosecha.
		Acephate	Orthene 75S	SP, 75%	⅔ lb	Controla también al falso medidor. No aplique 7 días antes de la cosecha. Chiles dulces únicamente.
Barrenillo del chile	Primera aparición de los frutos	Carbaryl*†	Sevin*†	SP, 80%	2⅓ lb	Trate con intervalos de 7 a 10 días; comience cuando los frutos empiezan a establecerse. Continúe los tratamientos hasta que no haya más frutos verdes susceptibles o los frutos hayan madurado. Destruya la hierba mora en invierno. Sin límite de tiempo.

* Se requiere autorización o permiso del Comisionado Agrícola del condado para su compra o uso.

† No aplique este pesticida cuando las abejas están presentes. No use este pesticida si hay peligro de que el viento arrastre el producto químico a colmenas o cultivos en flor cercanos.

‡ Peligroso para los peces.

‖ El pesticida Dylox no debe permanecer en los tanques de rociar, porque se hidroliza formando DDUP.

Limitaciones de la Agencia de Protección del Medio Ambiente para el uso de los productos químicos recomendados en esta publicación

Producto químico	Intervalo requerido entre la última aplicación y la plantación o cosecha	Tolerancia (partes por millón)	Dosis (libras de material activo por acre)
Dylox (Trichlorfon)	21 días	0,1	1,0 (carnada)
Ethylene dibromide	Tratamiento del suelo por lo menos 14 días antes de la siembra	30,0	108,0
Lannate, Nudrin (Methomyl)	10 días	0,2	0,45
Orthene (Acephate)	7 días	4,0	0,5
Sevin (Carbaryl)	Sin límite de tiempo	10,0	1,0
Telone II (1,3-dichloropropene)	Tratamiento del suelo antes de la siembra	No se aplica a los cultivos	

MAÍZ DULCE

Plagas	Época de tratamiento	Pesticida	Marca comercial	Formulación y porcentaje del ingrediente activo	Uso Dosis/Acre	Observaciones
Gusano de alambre, gusano de los granos de maíz		No se conoce un producto adecuado.				
Gusano trozador, escarabajo oscuro de la tierra	Por lo general, daños a las plantitas	Carbaryl*†	Sevin*†	Carnada, 5%	40 lb	Sin límite de tiempo
Gusano soldado	Daños a las plantitas	Carbaryl*†	Sevin*†	SP, 80%	2½ lb	Sin límite de tiempo
Pulga saltona	Daños a las plantitas	Carbaryl*†	Sevin*†	SP, 80%	2½ lb	Sin límite de tiempo
Gusano elotero	Tratamiento individual por mazorca en caso de poblaciones moderadas o numerosas	Carbaryl*†	Sevin*†	Polvo, 5%	40 lb	Use un cepillo para "stencil". Pinte cada mazorca. Haga de 5 a 7 aplicaciones con intervalos de 2 ó 3 días, según sea necesario o hasta que las hebras dejan de crecer.
	Rociado terrestre a motor para poblaciones moderadas o numerosas; aplique 1 ó 2 días antes de la aparición de las hebras.	Carbaryl*†	Sevin*†	SP, 80%	2½ lb	Sin límite de tiempo
	1 ó 2 días antes de la aparición de las hebras	Methomyl*	Lannate*, Nudrin*	Líquido, 1,8 lb/gal, 24,1%	1 a 2 pt	No alimente al ganado con el forraje tratado hasta que pasen 3 días de la última aplicación. Sin límite de tiempo para el maíz que se vende como hortaliza fresca.
				SP, 90%	¼ a ½ lb	
Gusano soldado	Daños	Carbaryl*†	Sevin*†	Polvo, 10%	20 lb	Sin límite de tiempo
				SP, 80%	2½ lb	

* Se requiere autorización o permiso del Comisionado Agrícola del condado para su compra o uso.

† No aplique este pesticida cuando las abejas están presentes. No use este pesticida si hay peligro de que el viento arrastre el producto químico a colmenas o cultivos en flor cercanos.

Limitaciones de la Agencia de Protección del Medio Ambiente para el uso de los productos químicos recomendados en esta publicación

Producto químico	Intervalo requerido entre la última aplicación y la plantación o cosecha	Tolerancia (partes por millón)	Dosis (libras de material activo por acre)
Lannate, Nudrin (Methomyl)	Sin límite de tiempo para el maíz fresco; no alimente al ganado con el forraje tratado hasta que pasen 3 días de la última aplicación.	0,1	0,45
Sevin (Carbaryl)	Sin límite de tiempo	100 (forraje); 5 (granos y marlo de maíz)	2,0

Las disposiciones que rigen el control de plagas cambian con frecuencia. Por este motivo, comuníquese periódicamente con su consejero agrícola local o con el especialista de la Extensión Cooperativa de la Universidad de California para informarse de las modificaciones o agregados al presente material.

ATENCION

PRECAUCIONES PARA EL USO DE LOS PESTICIDAS APLICADOS A LAS PLANTAS—LEA LA ETIQUETA

ATENCION

Los pesticidas son substancias venenosas y deben usarse con mucho cuidado. LEA CUIDADOSAMENTE LA ETIQUETA ANTES de abrir el envase, y SIGA EXACTAMENTE LAS INSTRUCCIONES. Además de estas precauciones, use el equipo especial que indica la etiqueta.

ALMACENAMIENTO: Guarde los pesticidas en sus envases originales. Para almacenarlos, guárdelos bajo llave en lugares cerrados, y manténgalos fuera del alcance de los niños, las personas no autorizadas, los animales domésticos y el ganado. NO GUARDE los pesticidas junto con los alimentos para las personas o los animales, ni con los fertilizantes. Coloque carteles de advertencia en las zonas o lugares donde guarda los pesticidas.

USO: Los usos que se recomiendan en este folleto se basan en las últimas informaciones recibidas. Siga las instrucciones con exactitud; mida las cantidades con cuidado para evitar los residuos que exceden la tolerancia fijada; use las cantidades indicadas en la etiqueta o las cantidades menores que figuran en esta publicación. Utilice el pesticida adecuado para el tipo de cultivos, plantas o animales que indica la etiqueta.

ELIMINACIÓN DE LOS ENVASES: Consulte al Comisionado Agrícola de su condado para obtener información sobre cómo debe enjuagar y eliminar los envases vacíos de los pesticidas que ha utilizado. No transporte los pesticidas en un vehículo que contiene comida, alimentos para los animales, ropa u otros materiales. Nunca lleve pesticidas en el compartimiento para pasajeros ni en la cabina cerrada del conductor.

RESPONSABILIDADES: El cultivador es responsable del uso de los pesticidas, de los efectos que puedan tener sobre otros cultivos o propiedades y del exceso de residuos. Los pesticidas no deben aplicarse sobre los ríos, arroyos, lagos, estanques, canales de riego ni demás áreas acuáticas, excepto cuando su uso para dicho propósito así lo indique.

INSECTOS BENEFICIOSOS: Muchos pesticidas son sumamente tóxicos para las abejas y demás insectos beneficiosos. El agricultor, el apicultor y las empresas dedicadas al control de plagas deben colaborar para reducir al mínimo la destrucción de las especies beneficiosas.

PROCESAMIENTO DE COSECHAS: Algunas plantas de procesamiento no aceptan aquellas cosechas tratadas con determinados pesticidas. Si su cosecha debe ser enviada a una planta de procesamiento, comuníquese con los encargados de recibirla para averiguar cuáles son los pesticidas que no debe usar. Obtenga la información antes de aplicar cualquier tipo de pesticida.

CARTELES DE ADVERTENCIA EN LOS CAMPOS TRATADOS: En los casos en que se indica un período de espera antes de regresar al campo tratado, coloque carteles indicadores en las zonas donde se ha aplicado el pesticida. Dichos carteles deben indicar la fecha de regreso, es decir, el momento cuando los trabajadores pueden volver al campo sin correr riesgos.

PERMISOS OBLIGATORIOS: En algunos casos es necesario solicitar un permiso especial al Comisionado Agrícola del condado para poseer o utilizar ciertos pesticidas. En nuestro folleto, los compuestos que requieren dicho permiso han sido marcados con un asterisco (*).

DAÑOS A LAS PLANTAS: Ciertas substancias químicas pueden causar daños o resultar ineficaces para combatir las plagas. Esto ocurre cuando los pesticidas se aplican en una determinada etapa de desarrollo de las plantas, en ciertos tipos de suelo, cuando hace demasiado frío o demasiado calor, cuando se usa una formulación incorrecta y cuando se utilizan cantidades excesivas o materiales incompatibles.

SEGURIDAD PERSONAL: Siga exactamente las instrucciones de la etiqueta. Evite salpicaduras, derrames, pérdidas, desvíos de rocío y contaminación de la ropa. NUNCA coma, fume, beba ni mastique nada mientras use un pesticida. Antes de utilizar un pesticida, asegúrese que ha tomado las precauciones necesarias y que el servicio médico de emergencia cuenta con los medios para atender a los accidentados.

Para simplificar la información, se han usado marcas conocidas de productos. Esto no implica el respaldo de los productos nombrados ni la crítica de productos no mencionadas.

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Asparagus Integrated Pest Management

Dennis A. Johnson, Daniel F. Mayer, Robert Parker and Gaylord I. Mink

Diseases, insects and weeds damage asparagus and affect production in Washington. Fusarium wilt and crown rot, rust, the asparagus aphid, the common asparagus beetle, cutworms, and many species of broadleaf and grassy weeds reduce asparagus yields. Growers use a variety of cultural practices and pesticides to manage asparagus pests.

In 1982, Washington State University Cooperative Extension and the Washington Asparagus Growers' Association initiated an integrated pest management program for asparagus. Objectives of the program are to improve timing of pesticide applications and to coordinate growing practices and pest control strategies for asparagus pests. The program should help improve pest control, reduce the cost of controlling pests, and increase asparagus yields.

How The Program Works

A field scout visits asparagus fields of participating growers at two-week intervals to monitor pests. The scout moves through fields in a pattern of two V's or a W (Fig. 1), sampling for rust, asparagus aphid, common asparagus beetle, cutworms, weeds, and beneficial insects. The scout gives or mails a written report to the grower after completing sampling and aphid extraction. The grower can then base pest management practices on the population levels of the pest.

Descriptions and management practices follow for diseases and pests that affect asparagus in Washington State.

DISEASES OF ASPARAGUS

Rust

Asparagus rust, caused by the fungus *Puccinia asparagi*, occurs sporadically in eastern Washington. This disease can cause severe damage when weather is favorable.

Symptoms and disease cycle. Rust first appears in the spring. It produces three different types of pustules during the growing season. The first pustules to appear on plant foliage, *aecia* (Fig. 2), are usually sparse and easily overlooked. These are oval in shape, and light orange in color. The blisters are raised at first; later the center of the pustule sinks as it ages. These pustules may form on volunteer asparagus, on plants in young uncut beds, and in seedlings growing in commercial beds. The spring pustules give rise to the repeating, or summer pustule stage, *uredia* (Fig. 3), an early source of inoculum (spreading spores) for rust epidemics.

The most commonly noticed pustules are the *uredia* that appear on fern foliage from early to late summer. Summer stage pustules arise as blisters, and rupture the outer layer to expose brownish-red powdery spores. These wind-borne spores infect healthy plants. Repeated infections of the wind-borne summer spores occur every 10 to 14 days during wet weather and can be very damaging. Sprinkler irrigation also contributes to the spread of the disease.

Pustules with black spore masses, called *telia* (Fig. 4), replace the spore-spreading summer stage pustules in early fall. Spores overwinter in these fall pustules and give rise to a new disease cycle in the spring.

Control. An important step in managing rust is preventing the

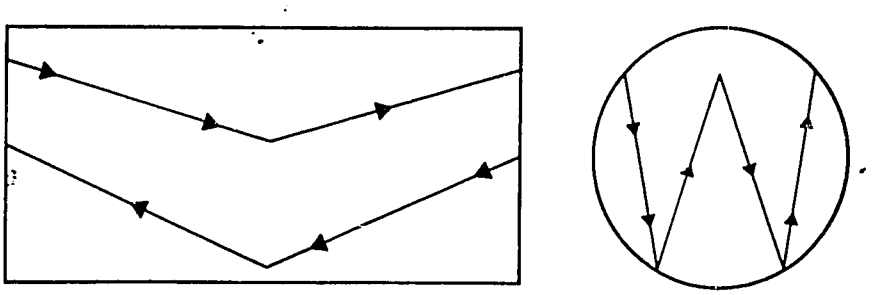
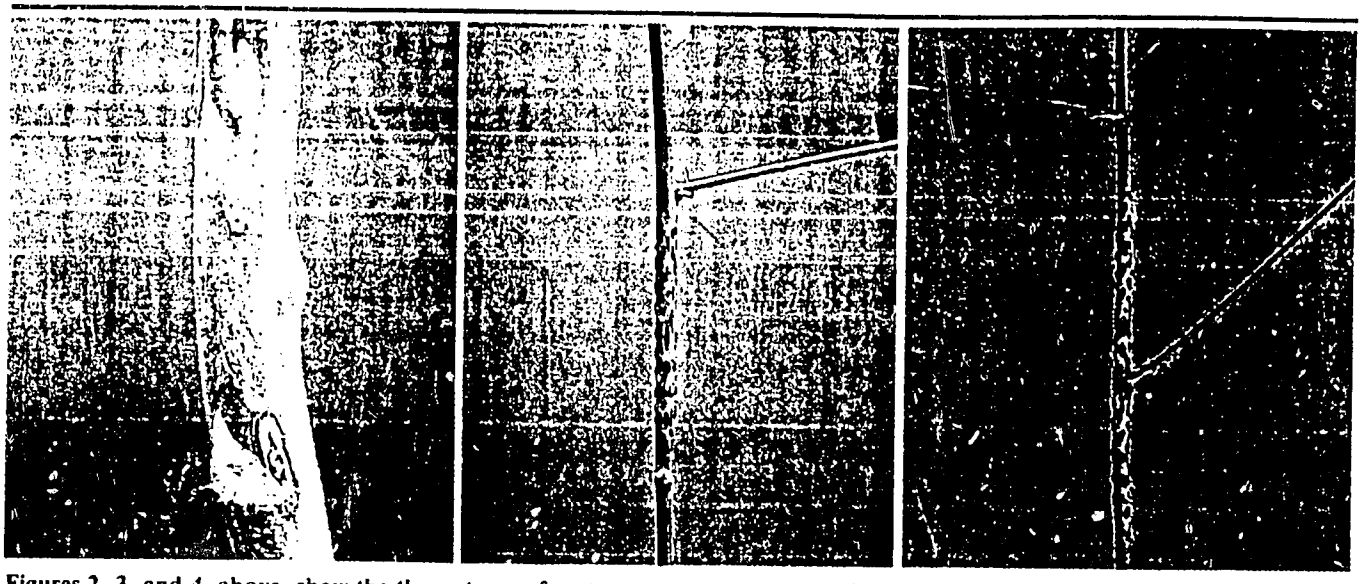


Fig. 1. Field scouts use these V or W patterns to sample asparagus fields for pests. The patterns may be used for rectangular or circular shaped fields.



Figures 2, 3, and 4, above, show the three stages of rust on asparagus spears and asparagus ferns. The early spring stage of rust (*aecia*) as it appears on asparagus, left; summer pustules of rust (*uredia*) shown on asparagus fern, center; and the overwintering black masses of rust (*telia*), again on asparagus fern, right.

development of *aecia*, the early spring pustules. Cutting spears regularly until early summer eliminates one summer spore source. However, *aecia* develop on nonharvested plants, such as volunteers, seedlings, and those in new beds, providing a source of summer inoculum. In newly established fields that are not harvested, rust severity can be especially high because of the availability of spreading spores and early development of the fern.

Growers can control rust by preventing growth of volunteer plants during the cutting season and by isolating seedling beds from commercial fields. Avoid planting asparagus beds in areas with poor air drainage, or where dew frequently occurs, since moisture on plant foliage favors rust development.

Resistant and moderately resistant varieties retard rust development, even though they may become infected. Delmonte 361, Jersey Giant, and Jersey Centennial are resistant; UC 157 is moderately resistant; selections of Mary Washington range from moderately susceptible to susceptible; and WSU-1 is susceptible to rust.

Fungicide applications may be necessary some years. Monitor fields carefully and regularly during midsummer for spore-forming *uredia*. A small number of these pustules can rapidly produce high levels of disease. Apply a labeled fungicide, mancozeb (Dithane M-45 or Manzate 200), when these pustules are easily found before late summer. Fungicides are not effective after high levels of disease are reached or when the black pustule stage forms in the fall.

Stemphylium Purple Spot

Symptoms. The fungus, *Stemphylium vesicarium*, sometimes causes small, slightly sunken, purple spots on asparagus spears just before harvest (Fig. 5). Asparagus ferns also become infected, showing tan to brown lesions from ⅛- to ½-inch in length with dark purple margins (Fig. 6).

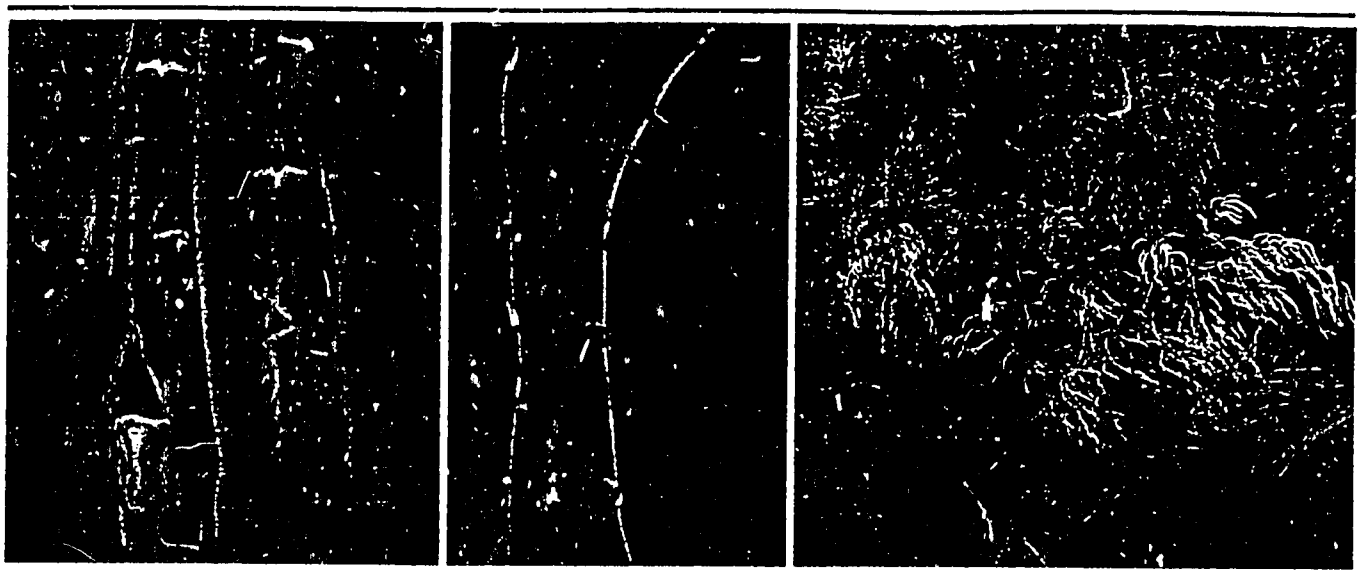
The fungus needs moist conditions from dew or rain to infect plants. The fungus enters asparagus through wounds and plant breathing pores (stomata). More severe purple spot occurs on spears during the early part of the harvest season following wet weather and cool temperatures. When rainfall ceases and temperatures warm, purple spot infections fail to develop.

Control. Applying fungicide to spears is not a satisfactory method of controlling purple spot. Fungicides, if applied near harvest, would leave a residue. Because new spears emerge daily, it would be impractical to cover and protect all plant tissue surfaces.

Destroying overwintering sources of inoculum such as old, infected ferns and plant debris will reduce disease incidence on spears. Completely burying infected ferns by cultivation during the fall or early winter will reduce inoculum levels and subsequent infections the next spring. However, take care not to create conditions that favor blowing sand, because infections readily occur through wounds. Planting cover crops that reduce windblown sand may aid in disease control.

Fusarium Wilt and Fusarium Crown Rot

Fusarium wilt, caused by *Fusarium oxysporum F.* sp. *asparagi*, and Fusarium crown rot, caused by *F. moniliforme*, are widespread in Washington. High incidences of these diseases cause decline of asparagus stands and loss of grower profits. Plant



Figures 5 and 6, above, show Stemphylium purple spot of asparagus on asparagus spears just before harvest, left; and on asparagus fern, center; Figure 7 shows plants with yellowed stalks dying prematurely in the field from Fusarium wilt, right.

stress, virus infection, high soil temperature and light soils increase the disease problem.

The Fusarium fungi, which live in the soil, are easily spread on contaminated seed.

Symptoms. Infected seedlings may fall over on the ground, due to destruction of seedling tissue near the soil line. This process is called damping off. On young infected crowns, needles near the tip of primary shoots turn yellow, and the growing point dies. The entire stem will eventually turn yellow and die.

On mature plants, a distinct wilt occurs that is most noticeable in the heat of July and August. Infected stalks turn yellow and die (Fig. 7). One or two shoots of a crown may show symptoms while the others appear normal, or the entire hill may yellow and die. Usually scattered throughout the field, affected plants may be more numerous in low areas or on sandy slopes. Reddish-brown lesions may appear at and below the soil line of yellowed shoots. A reddish-brown discoloration is evident in the vascular tissue of the crown and roots. Large, fleshy storage roots may become hollow and limp; crowns rot or eventually die.

Control. Treat seed and crowns with a fungicide (Benlate). Avoid old asparagus soil for producing crowns and establishing permanent plantings. Also avoid soil with corn debris until the corn material has decomposed. Manage asparagus stands to reduce plant stress. Common causes of plant stress are overcutting, drought, overwatering, insect injury, inadequate weed management, disease, and soil compaction. To eliminate avenues for infection, be as careful as possible during tillage practices to avoid wounding fleshy roots and crowns.

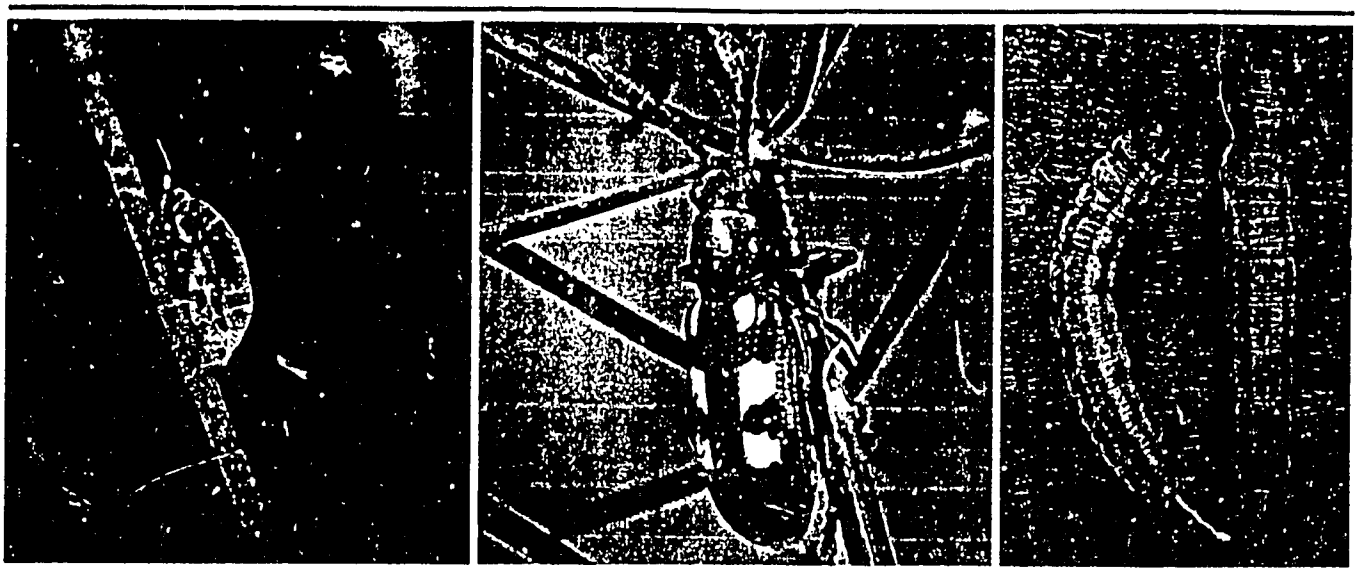
Virus-Induced Stand Decline

Three different viruses, which cause stand decline, can be isolated from asparagus in Washington. These are tobacco streak virus (TSV), asparagus virus-1 (AV-1), and asparagus virus-2 (AV-2).

Symptoms. Each virus reduces plant vigor and productivity. Plants infected by TSV are stunted and produce small spears. Growth of plants infected by either AV-1 or AV-2 alone may be reduced by as much as 20%. Plants infected with both AV-1 and AV-2 decline and die, usually within 2 to 3 years after double infection. Symptoms of virus-induced decline resemble decline caused by many other factors, especially fusarium wilt. Research suggests that asparagus plants infected with AV-2 become much more susceptible to fusarium wilt than non-infected plants. None of these viruses can be diagnosed on the basis of symptoms alone.

Disease cycle. AV-1 is spread by many common aphid species that feed briefly on spears, but which do colonize asparagus ferns. These include the green peach and potato aphids, both of which are omnipresent in the spring and fall. AV-1 is not transmitted by the asparagus aphid. In the Yakima Valley, AV-1 infects nearly all commercial and volunteer asparagus plants within 5 to 7 years.

AV-2 is seedborne and appears to be transmitted through pollen. The incidence of AV-2 in commercial seed lots ranges from trace levels to above 50%. Because virus-infected seedlings usually survive, many young plants will be infected when planted if the incidence of AV-2 is high in a given seed lot. As AV-1 is spread into the field over the succeeding years, plants which become infected with both viruses begin to decline and die. Since AV-2 can also spread within fields, the number of double infected, declining plants increases pro-



Figures 8, 9, and 10 show insects which attack asparagus. The asparagus aphid, above left, is a powdery gray-green; the colorful adult asparagus beetle, center, attacks an asparagus fern. Redback cutworm larvae, right, attack spears from mid-May through June.

gressively with time, and the stand decreases.

Although TSV has been found in a few fields, its mode of spread is unknown. In other Washington crops, TSV is spread by the common flower thrip.

Control. Because AV-1 is generally distributed throughout eastern Washington and is easily spread by a variety of aphids that visit asparagus only briefly, it is virtually impossible to control. Although pollinating insects are suspected of spreading AV-2, no effective control practices are known. However, virus-induced stand decline can be reduced substantially, perhaps eliminated, in isolated fields by the use of virus-free seed. Although virus-free seed is not currently being produced, methods are available to test seed lots for the presence of AV-2 prior to planting.

INSECT PESTS OF ASPARAGUS

Asparagus Aphid

The asparagus aphid, *Brachycorynella asparagi*, was first found in Washington in 1979. This pest now occurs throughout the asparagus growing region.

Aphids are about 1/16-inch long, powdery gray-green to green, and lack cornicles (Fig. 8). Eggs are green to black. Overwintering eggs are laid in the fall (September to November) on asparagus fern. Eggs hatch in the spring. The first winged females appear about mid-May. Winged and wingless aphids are produced throughout the summer. There are several generations. All life stages appear on asparagus; no other plant host is known.

Aphids feed in the axils of the ferns where the leaves join the stem. They cause a marked stunting of fern growth. Heavily infested plants have a large number of severely stunted, (Bonzai effect), blue-gray shoots around the base of the plant, and an abundance of aphid honeydew is present. Seedlings and one-year-old plants may be killed.

Sampling should be carried out when plants are in the fern stage. Collect one secondary branch from each of 200 plants and count the number of aphids found on each. Or, place the branches together in a paper bag for 2 or 3 days so the aphids die and fall off the shoots. Dump the bag contents on a sheet of white paper and count the dead aphids. Treat the field if any aphids are found during June. An average of 5 or more aphids per plant found during August will probably cause damage. The field should be treated. Destruction of dormant foliage in the fall and shallow rototilling of the field in the spring greatly reduce aphid populations. Malathion at 2 pounds active ingredient per acre is registered for control of asparagus aphid. Di-Syston at 1 pound active ingredient per acre, applied in mid-September, probably provides the best chemical control of the aphid.*

Asparagus Beetles

The common asparagus beetle, *Crioceris asparagi*, can reduce asparagus yields or contaminate plants, resulting in cullage.

Adult beetles have blue-black wing covers with three yellow spots along each side and reddish margins (Fig. 9). Larvae are dull blue-gray with black head capsules. Beetles overwinter as adults, and the females begin laying eggs on asparagus spears in April. There are two to five generations per year.

*A special local needs registration (WA840036) has been granted for this use in Washington under Section 24(c), FIFRA.

Asparagus spears damaged by asparagus beetles or found with beetle eggs on them are culls. Beetle feeding on fern can injure newly established beds and reduce vigor of mature stands.

Sample in fields when plants are in the fern stage. Count the number of beetles found on 200 plants per field. If there is an average of five beetles per plant, the field should probably be treated with an insecticide. Malathion, methomyl, methoxychlor, Sevin XLR and rotenone are registered for control of asparagus beetle.

Cutworms

Two cutworm species are found in asparagus fields (Fig. 10). Spotted cutworm, *Amathes c-nigrum*, larvae are found feeding usually near the spear tips during late April and early May. The brownish larvae have a pair of dark hash marks on the rear end. Redback cutworm, *Euxoa ochro-gaster*, larvae are found feeding on spears from mid-May through late June. They usually feed on the side of spears, at or below the ground line. Larvae are pale yellow to dark red and up to 2 inches long when full grown.

Monitor fields for cutworm damage to spears during the cutting season and look for poor producing crowns. If plants are not producing adequate new growth, examine the soil around crowns for cutworms. Permethrin (Pounce Ambush) at 0.1 pound active ingredient per acre provides excellent control. Methomyl, Sevin* and Sevin bait are also labeled for cutworm control on asparagus. Weeds and cutworms are associated, since female moths prefer to lay their eggs on weeds. Good weed control will reduce cutworm populations in asparagus fields.

Bee Poisoning

Honeybees forage blooming asparagus fields. Do not apply any pesticides hazardous to bees to fields being foraged by honeybees.

WEED CONTROL IN ASPARAGUS

Weeds are a serious problem in asparagus production. They compete with asparagus plants for light, moisture, nutrients, and interfere with harvesting, thus reducing yields. Unlike many other crops, asparagus is a poor competitor against weeds. The crop does not produce much shade until late in the growing season. All types of weeds infest asparagus, including annual and perennial grasses, and annual, biennial, and perennial broadleaves. Mechanical cultivation has been used effectively to control early season weeds, but cannot be continued after cutting begins without loss of spear production.

Without the use of herbicides, asparagus rows usually must be cultivated and hilled during and after the cutting season to control annual weeds. Each cultivation during the cutting season causes the loss of from five to seven days of spear production. Mechanical cultivation methods and loss in production are even more costly for control of quackgrass, bermudagrass, or other perennial weeds.

Using herbicides which will control both broadleaf and grass weeds is a cost-effective alternative to cultivating during the cutting and growing season. In recent years, several herbicides have been registered for weed control in asparagus. All asparagus-registered herbicides (Table 1) have certain characteristics that have restricted their use. For more information regarding the use of herbicides in asparagus, consult EB 1145, *Chemical Weed Control in Asparagus*. When using any herbicide, read and carefully follow the directions given on the label. Table 2 indicates the expected response of selected weeds to the herbicides mentioned in Table 1.

*Sevin XLR is registered for use on asparagus, but not for cutworms. It is effective, and can be used legally for this purpose, provided all other label directions are followed.

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Table 1.
Herbicides available for use during establishment of direct-seeded and crownplanted asparagus:

Common Name	Trade Name	Remarks
Paraquat	Paraquat Plus, Gramoxone	Apply to growing weeds before crop emerges.
Chloramben	Amiben	Apply before emergence of weeds and crop. Direct seeded asparagus only.
2,4-D Sodium Salt	2,4-D Sodium Salt	Apply to weeds less than 2 inches tall.
Linuron	Lorox	Apply preemergence to asparagus planted with carbon band or postemergence to crop.
Terbacil	Sinbar	Apply preemergence to asparagus planted with carbon band.
Fluazifop	Fusilade	Apply to actively-growing grass weeds.

Herbicides available for use in established asparagus:

Glyphosate	Roundup	Apply to actively-growing weeds prior to crop emergence, after last harvest or after ferning.
2,4-D Sodium Salt	2,4-D Sodium Salt	Apply to actively-growing broadleaf weeds.
2,4-D Alkanolamine Salt	Formula 40	Apply to actively-growing broadleaf weeds.
Dicamba	Banvel	Apply to actively-growing broadleaf weeds.
Dalapon	Dowpon Dalapon	Apply to actively-growing grass weeds.
Diuron	Karmex Direx Diuron	Apply during fall or spring at least 4 weeks prior to asparagus emergence and/or after harvest.
Linuron	Lorox	Apply prior to or after weed and asparagus emergence.
Metribuzin	Sencor Lexone	Depending on product, apply before asparagus emerges, or as a split application, preemergence and after harvest.
Simazine	Princep Sim-Trol	Apply in fall. following fall reworking of field.
Napropamide	Devrinol	Apply in fall or spring prior to crop and weed emergence.
Trifluralin	Treflan	Apply and incorporate in winter or early spring before crop emerges and/or after harvest.

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Table 2.
Weed response to selected herbicides

This chart may serve as a guide in the selection of some of the herbicides registered on asparagus. Plant response may be altered by growing conditions, genetic variations, soil type, pH, organic matter, and rates of application.

Rates necessary to obtain the control suggested may vary from season to season and may differ among geographical areas.

GRASS WEEDS	Chloramben	Dicamba	2,4-D	Diuron	Glyphosate	Linuron	Metribuzin	Napropamide	Paraquat	Simazine	Terbacil	Trifluralin
Barnyardgrass	○	■	■	●	●	▲	○	●	▲	●	○	●
Crabgrass	●	■	■	●	●	●	○	●	●	▲	■	●
Green foxtail	○	■	■	●	●	■	○	●	●	○	■	●
Yellow foxtail	○	■	■	●	●	■	○	●	●	○	●	●
Sandbur		■	■	▲	●		□	●	▲	▲	○	●
BROADLEAF WEEDS												
Black nightshade	●	●	●	●	●	●	□	■	●	●	●	■
Common lambsquarters	○	●	●	●	●	○	●	●	○	●	●	○
Hairy nightshade	●	●	●	●	●	●	□	■	●	●	●	■
Kochia	○	○	○	■	●	■	○		●	○	○	○
Mallow		●	■	▲	●	■	●	□	■	●	●	■
Pigweed	○	●	●	●	●	●	●	●	●	●	●	●
Prickly lettuce	●	●	●	●	●	●	●	○	●	●	●	■
Prostrate knotweed	●	●	■	●	●	■	●	●	▲	●	●	●
Puncturevine		●	●	■	●	■	○	▲	●	■	▲	▲
Purslane	●	●	○	●	●	●	○	●	●	●	●	●
Russian thistle	●	●	○	■	●	■	●	▲	●	□	●	▲
Smartweed	▲	●	■			■	●			●		■
Wild buckwheat		●	■	●	●	□	○			●		■
Volunteer asparagus	■	●	■	■	▲	■	▲	□	□	▲	○	▲

● = Good Control; ○ = Good-Fair Control; ▲ = Fair Control; □ = Fair-Poor Control; ■ = Poor Control.

By Dennis A. Johnson, Extension Plant Pathologist; Daniel F. Mayer, Extension Entomologist; Robert Parker, Extension Weed Scientist; and Gaylord I. Mink, Plant Pathologist, Washington State University Irrigated Agriculture Research and Extension Center, Prosser.

▲Warning The law requires that pesticides be used as the label directs. Uses against pests not named on the label and low application rates are permissible exceptions. If there is any apparent conflict between label directions and the pesticide uses suggested in this publication, consult your county Extension Agent.

Use pesticides with care. Apply them only to plants, animals, or sites listed on the label. When mixing and applying pesticides, follow all label precautions to protect yourself and others around you. It is a violation of the law to disregard label directions. If pesticides are spilled on skin or clothing, remove clothing and wash skin thoroughly. Store pesticides in their original containers and keep them out of the reach of children, pets, and livestock.

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EB1383

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ARTICLE W24

EB1418

PURPLE SPOT AND STEMPHYLIUM LEAF SPOT OF ASPARAGUS

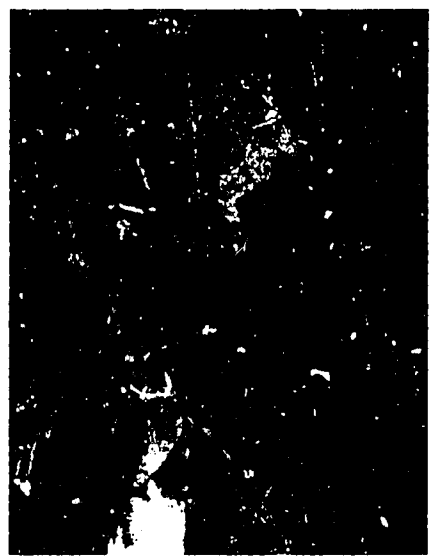
A fungus, *Stemphylium vesicarium*, causes the disease called purple spot on asparagus spears. Symptoms consist of elliptical, slightly sunken lesions or spots 1/32 to 1/16-inch across, and up to 1/8-inch long. Spots often occur on only one side of the spear. Lesions or spots are purple, or brown in the center (especially larger lesions) with a purple margin. Although purple spot does not affect the internal tissue of the spear, infected spears are frequently rejected from fresh market sales.

The fungus also infects the asparagus fern. At that stage, the disease is called Stemphylium leaf spot. On the fern, the disease appears as tan to brown lesions from 1/8- to 1/2-inch in length with dark purple margins. Needles will drop when infections are severe.

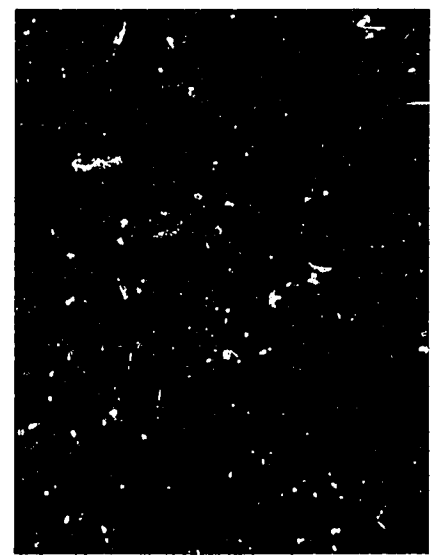
Moisture from rain, dew, or sprinkler irrigation triggers conditions which encourage infection. Therefore, the disease is most prevalent on spears following cool, wet, spring weather. Dry weather during the harvest season checks disease development.

The fungus enters the plant through breathing pores called stomata and through wounds such as those caused by blowing sand. In controlled experiments, infections are more numerous on wounded plants. Wounds produced by blowing sand serve as points of infection for up to 48 hours after injury.

The fungus survives the winter in infected debris from the previous season's crop. Purple spot is more prevalent when summer fern growth remains on the soil surface at harvest.



Stemphylium purple spot appears on asparagus spears just before harvest.



On ferns, the fungus causes Stemphylium leaf spot.

Control

Destroying overwintering sources of inoculum such as infected ferns and plant debris will reduce disease incidence on spears the following spring. Burn or completely bury infected ferns by cultivation in late fall to reduce inoculum levels and subsequent infections. This practice is especially important in fields where purple spot has been a problem, or where heavy infections occurred on the fern the previous summer.

Be careful not to damage spear tissue or reduce cover and wind barriers that keep sand from blowing across the field. Infections readily occur through wounds. Also avoid wounding crowns, since damage sites provide avenues for infection by the Fusarium fungi.

Applying fungicides to spears is not a satisfactory method for control of purple spot. Chemicals applied near harvest leave a residue. Protection for all plant surfaces is impractical, because new spears emerge daily.

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Article W5

Extension Bulletin 1148

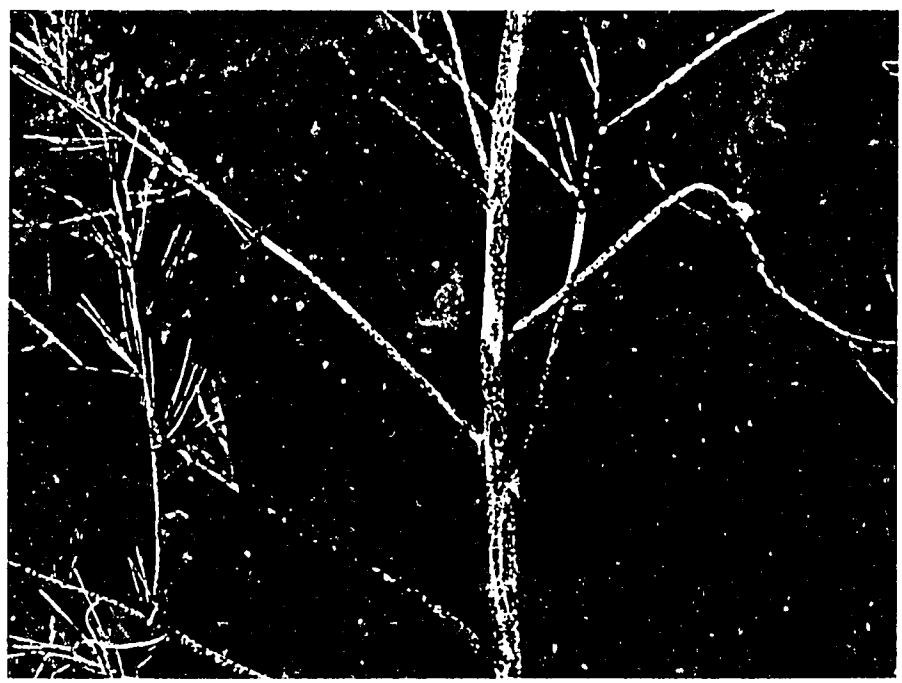
ASPARAGUS RUST

Asparagus rust occurs sporadically in eastern Washington but can cause severe damage when conditions for rust are favorable. Severe rust infections reduce plant vigor, increase water loss from the plant, and cause the fern stage to prematurely ripen. Storage reserves are reduced in the crown and yields are subsequently reduced the following spring.

Asparagus rust is caused by the fungus *Puccinia asparagi*. This rust fungus attacks only asparagus and onions.

Rust is first seen in the spring and produces three different types of pustules during the growing season. The first pustules to appear on plant foliage are usually sparce and are easily overlooked. These oval, yellowish pustules contain honey-yellow colored, pinpoint spots (pycnia) surrounded by various numbers of small cupped structures (aecia). These pustules are formed on volunteer asparagus, on plants in young uncut beds and in seedlings allowed to grow in commercial beds. Aecia give rise to the repeating or summer pustule stage (uredia) and are an early source of inoculum for rust epidemics.

The most commonly noticed pustules are the uredia (photo), which are formed on fern foliage from early to late summer. Uredia arise as blisters rupture the epidermis and expose brownish-red powdery spores. These spores are wind borne and infect healthy plants. Repeated infections of the uredial stage occur every 10-14 days during favorable weather and can be very damaging. Rain, dew, and sprinkler irrigation contribute to disease development.



Summer pustules (uredia) on asparagus stem.

Pustules with black spore masses (telia) replace the uredia in early fall. Spores in these pustules survive through the winter and give rise to pycnia in the spring.

Control of asparagus rust can usually be achieved by preventing the development of aecia in early spring. Aecia are eliminated on spears that are regularly cut until early summer. However, aecia develop and provide a source of summer inoculum on non-harvested plants such as volunteers, seedlings, and those in new beds.

Control measures include not allowing volunteer plants to grow during the cutting season and isolating beds of seedlings from commercial fields. Asparagus beds should not be established in areas with poor air drainage and where dews frequently occur since these conditions favor growth and development of rust.

Resistant and moderately resistant varieties retard rust development, even though they may become infected; such varieties should be planted when available.

Applications of fungicides may be necessary some years. Growers are advised to monitor fields carefully and regularly during midsummer for uredia. A very small number of uredia can rapidly increase to high levels of disease. Apply the fungicide, mancozeb, if uredia are found before late summer. Fungicides are not effective after high levels of disease are reached or when the black pustule stage, telia, is formed in the fall.

Cooperative Extension College of Agriculture Washington State University Pullman, Washington

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Extension Bulletin 0788
February 1981

insect answers

ASPARAGUS APHID

The asparagus aphid, *Brachycolus asparagi*, was found infesting asparagus in Washington for the first time in 1979. Aphid feeding caused serious stand reductions of commercial fields planted that year and the year before.

Description and Life History

Both wingless and winged aphids are small, about 1/16 inch (1 mm), and powdery gray-green to green in color. A tail-like protuberance (cauda) at the end of the abdomen has parallel sides. Very reduced cornicles are the most distinguishing feature (Fig. 1) because other aphids have prominent cornicles.

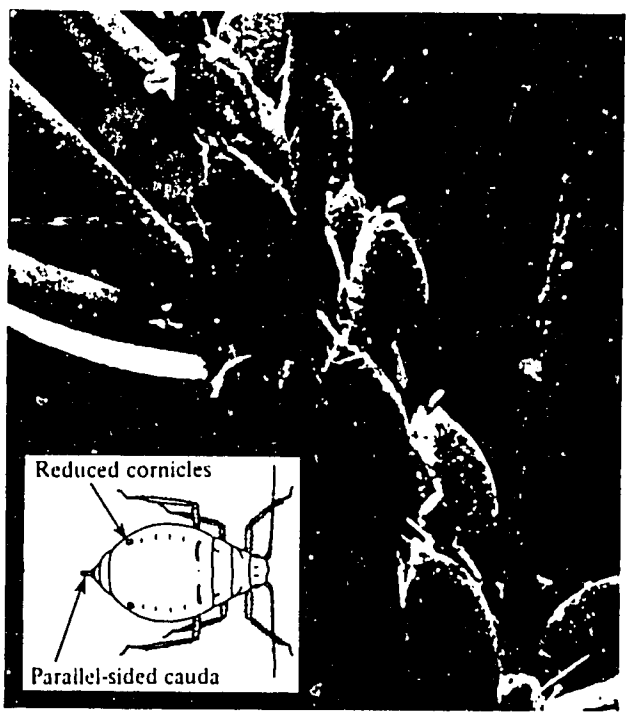

Fig. 1. Asparagus aphids on asparagus fern.

Fig. 2. Tufted fern above; normal fern below.

Fig. 3. "Bonzai effect" of asparagus with aphid infestation.

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The overwintering stage is the egg. Shiny green eggs which turn black within a few hours are laid on ferns in the fall, and fall to the ground during the winter. The aphids have four instars or life stages, and pass the summer as nymphs and females which give birth to living young. Winged and wingless forms are produced throughout the summer with the first winged aphids appearing in mid-May. Winged males develop and eggs are laid as fall yellowing of the asparagus plants occurs. All life stages are found on asparagus; no alternate host is necessary to complete the life cycle. Ornamental Asparagus species are being tested to determine if they serve as hosts.

Damage

Asparagus aphids feed on ferns in the axils where the leaves join the stem. Within three to seven days after they begin to feed the growth between stem nodes shortens, giving leaves on affected stems a tufted appearance (Fig. 2). Heavily infested plants are easily noticed due to the large number of severely stunted, blue-gray shoots ("Bonzai effect") around the base of the plant (Fig. 3). Drops of honeydew are present on shoots where aphids are feeding.

When mature plants are attacked, there is extensive stunting and shriveling of shoots. In seedlings, an infestation causes dwarfing, shriveling, and often death.

Aphid colonies have not been found on marketable spears. Feeding occurs only on the ferns.

Control

Because the asparagus aphid is a fern-feeder, growers should pay close attention to protecting the fern, whether early in the season for young asparagus or late June or July, for mature stands.

Malathion may be used at 2 pounds active ingredient per acre when aphids first appear on fern. This rate is higher than the rate on most labels. However, some companies have been granted Washington State registrations which permit the higher rate. Adequate spray coverage is important. Applications may be repeated as needed.

If Disyston (disulfoton) is cleared for use in 1981 it may be used at 1 pound active ingredient per acre. The number of times a field may be treated and the interval between applications have not been determined. Check with the local county agent or grower association for further details.

Early season (March, April) fern management may be important in integrated control. If early season ferns are not permitted to grow, first generation females may not be able to reproduce in the fields. However, winged aphids may migrate into fields from wild asparagus plants or from ferns in other fields around mid-May.

Vanelle Peterson, Extension Entomology Assistant, and Wyatt W. Cone, Entomologist, WSU Research and Extension Center, Prosser.

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PROTECT

Use Pesticides Wisely
FOLLOW THE LABEL

Use pesticides with care. Read the label and follow its directions. Never smoke while using pesticides and avoid breathing the spray or dust. Wear natural rubber gloves when handling pesticides. Wash hands and face carefully with soap and water after applying. If insecticides are spilled on skin or clothing remove contaminated clothing and wash skin thoroughly. Store pesticides in their original containers and be sure labels remain on the containers. Keep containers away from food or feed and out of reach of children or irresponsible persons.

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IRRIGATED ASPARAGUS

for Central Washington

Asparagus is somewhat unique in its fertility requirements. Although the nutrient removal is very low in the harvested spears, the storage capacity for these nutrients in the roots, crown, and ferns is surprisingly high. This would imply that the requirement for nutrients may be very high during establishment and very low after the first two or three seasons.

The following data adopted from various sources, illustrate the point:

	N	P_2O_5	K_2O
Removal in 4 tons harvested spears	37	12	27
Stored in roots, crown, and ferns, lbs/acre	200-300	100-150	300-400

These guidelines are based on relationships which have been established between WSU soil tests and yield responses. The suggested rates will be reasonably accurate for your field provided (1) the soil samples properly represent the area to be fertilized and (2) provided you filled in the information sheet which you sent with your samples.

FOR NEW PLANTING

This table gives N fertilizer rates for different crop residue situations.

Nitrogen (N)

If history on previous cropping was:	Apply this amount of N (lbs/acre):
New land	280
Corn or small grain, residue removed	220
Corn or small grain, straw to be plowed under	260
Potatoes or sugar beets	200
Beans or peas	200
Alfalfa, no top growth	180
Alfalfa, considerable top growth to be plowed under.	140
Vetch or other legume green manure	140

Note: Be sure soils are at a high fertility level prior to planting new asparagus. It is a good practice to plow under a green manure crop such as alfalfa or vetch, or to plow under 10 or more tons per acre of barnyard manure. Plow under (deeply) all fertilizer materials.

Phosphorus (P) and Potassium (K)

Phosphorus deficiency is rare in asparagus. Crop removal of P by asparagus is very small.

If WSU soil test reads (use the value nearest your test value):	Apply this amount–lbs/acre (adjust rate up or down depending on your actual test value):
ppm of Phosphorus (P)	P_2O_5
2	300
4	200
6	160
8	100
10	10
more than 10	0
ppm of Potassium (K)	(K_2O)
30	240
60	192
90	144
120	96
more than 120	0

Phosphorus and potassium fertilizers should be injected about 6 inches deep between rows in fall or early spring.

Sulfur (S)

There is no WSU soil test for S for irrigated areas. Areas irrigated from the Roza Canal of the Yakima valley may occasionally be deficient because of low S content in the water. In the Columbia Basin and other areas of the Yakima Valley, the S content is sufficient for crop requirements. If S is known to be deficient, apply fertilizer at a rate which will supply 60 lbs S per acre.

Zinc (Zn)

Zn deficiency in asparagus has been demonstrated in central Washington, but the problem is rare. Where the soil test for Zn is below 0.8 or on new land where leveling has exposed limy subsoil, apply Zn fertilizer, before planting, at a rate which will supply 20 lbs Zn per acre.

Salinity

Soil salinity (total soluble salts) is determined on all irrigated central Washington soil samples sent to WSU. A salinity level of 4 to 6 mmhos/cm may indicate a salinity problem and further tests should be made. A salinity level above 6 may indicate a serious salinity problem. If a problem exists, refer to EB 0909, *Managing Saline Soils in Central Washington*, or consult with your county Extension agent.

Boron (B)

B deficiency is uncommon in Washington asparagus. When the soil test for B is below 0.5, apply B fertilizer at a rate which will supply 4 lbs B per acre.

FOR ESTABLISHED PLANTING

For the first three years, 100 lbs/acre of N, broadcast and incorporate in late fall or early spring or inject at the end of the cutting season. Incorporate all plant residues shallow enough to avoid crown damage. After three years, apply 40 to 80 lbs/acre of N annually. For all other nutrients, use guide for new planting.

GENERAL COMMENTS

Other elements: Other than N, P, K, Zn, and S, research has not shown a need for additional fertilizer materials for asparagus in central Washington. Even when the soil test shows low boron values, boron fertilizers have not given yield responses. The practice of applying mixes of various elements "for insurance" is not recommended.

IMPORTANT: Fertilizers are of little value where other factors are limiting. For high yields, follow good management practices regarding irrigation, pest control, etc.

Prepared by A. I. Dow (retired), Walt Core (retired), A. R. Halvorson, Extension Soil Scientist, and R. L. Dyck, Assistant Horticulturist, all of Washington State University. Cooperative Extension programs and employment are available to all without discrimination. Revised March 1982.

ARTICLE WS

CENTRAL IRRIGATED WASHINGTON WEED CONTROL GUIDE

WEED CONTROL IN ASPARAGUS

EB 1145

Robert Parker, Extension Weed Scientist

Weeds are a serious problem in asparagus production. They compete with the asparagus for light, moisture, nutrients, and interfere with harvesting, thus reducing yields. Unlike many other crops, asparagus is a very poor competitor against weeds since the crop does not produce much shade until late in the season. All types of weeds infest asparagus, including annual and perennial grasses and annual, biennial, and perennial broadleaves. Mechanical cultivation has been used effectively to control early-season weeds, but cannot be continued after cutting begins without loss of spear production.

Without the use of herbicides, asparagus rows usually must be cultivated and hilled during and after the cutting season to control the annual weeds. Each cultivation during the cutting season causes the loss of 5 to 7 days of spear production. To control quackgrass, bermudagrass, or other perennial weeds, the control methods and loss in production are even more costly, and control is never complete.

Use of herbicides that will control both broadleaf and grass weeds are a viable alternative to repeated cultivations during the cutting and growing season. In recent years, several herbicides have been registered for weed control in asparagus. All can help to control weeds in asparagus, but all have certain characteristics that have restricted their use.

The following herbicides are registered for controlling weeds in asparagus. Herbicide rates are expressed as pounds active ingredient (ai) or acid equivalent (ae) per acre, depending upon the chemical nature of the herbicide. Read and follow the herbicide label for complete use directions.

CONTROL OF ANNUAL GRASS AND BROADLEAF WEEDS DURING ESTABLISHMENT OF DIRECT-SEEDED OR CROWN-PLANTED ASPARAGUS

PARAQUAT *(Paraquat Plus, Gramoxone)*

Do not apply within 18 months of harvest.

Apply .5 to 1 pound ai per acre to weed foliage *prior to emergence* of asparagus.

Add non-ionic surfactant suggested by manufacturer at 8 ounces per 100 gallons spray solution. Apply 50 to 100 gallons of spray solution per acre. Weeds emerging after treatment will not be controlled. Asparagus plants emerged at time of application will be injured. Do not apply to soils lacking clay minerals; i.e., peat, muck, pure sand, artificial planting media. Use protective clothing when handling and avoid breathing spray mist. Flush spray equipment thoroughly after use each day. Paraquat is corrosive to aluminum.

CHLORAMBEN *(Amiben)*

Apply 3 pounds ae per acre prior to emergence of asparagus and weeds.

Use on direct-seeded asparagus only. Overhead moisture is required to move the herbicide into the soil after treatment. Irrigate with .5 inch to .75 inch overhead irrigation within 24 hours after application. This treatment will control weeds for 6

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to 8 weeks. Weeds that emerge in late summer may become troublesome.

2,4-D Sodium Salt

Apply 1 pound ae per acre to actively growing broadleaf weeds less than 2 inches tall.

Use not less than 50 gallons of water carrier per acre with low nozzle pressure (25 psi). A surfactant can be added if desired. Do not allow spray to drift onto susceptible crops. Some injury to the seedling asparagus may occur.

Linuron *(Lorox)*

Apply 1 to 2 pounds ai per acre after asparagus seed has been planted and activated carbon has been applied over seed row or make one or two applications at .5 to 1 pound ai per acre when ferns are 6 to 18 inches tall.

In the Columbia River Basin, use linuron only if the crop is sprinkler irrigated.

For preemergence use of linuron on direct-seeded asparagus, plant seed 1.5 inches deep in coarse soils and 1 inch deep in fine soils. *During the planting operation*, spray activated carbon as a 1-inch band on the soil surface *directly* over seed rows at a rate of 300 pounds per acre (broadcast basis: equivalent to 5.6 pounds per acre of crop where row spacing is 54 inches). Follow with linuron as a single broadcast spray.

Use the lower herbicide rate on coarse soils and the higher rate on finer soils. Do not use on sand, loamy sand, or on soils of less than 1% organic matter. Sufficient overhead moisture (.5 to 1 inch on moist soils, 1 to 2 inches on dry soils) is necessary to move the chemical into the soil after treatment. Best results are obtained when overhead moisture occurs within 2 weeks of application. If moisture is insufficient to incorporate the herbicide, a shallow cultivation should be made while weeds are small enough to be controlled by mechanical means. Do not disturb the activated carbon band. Unless otherwise directed do not replant to any crop within one year after application.

For postemergence use on direct-seeded or newly-planted crowns, apply to weeds less than 4 inches tall. *Do not use surfactant.* Do not exceed 2 pounds ai per acre per year.

Terbacil *(Sinbar)*

Apply .8 to 1.6 pounds ai per acre after asparagus seed has been planted and activated carbon has been applied over seed row.

On direct-seeded asparagus, plant seed 1.5 inches deep in coarse soils and 1 inch deep in fine soils. *During planting operation*, spray activated carbon as a 1-inch band on the soil surface *directly* over seed rows at a rate of 300 pounds per acre (broadcast basis: equivalent to 5.6 pounds per acre of crop where row spacing is 54 inches), following with terbacil as a single broadcast spray.

Use the lower rate on coarse soils and the higher rate on fine soils. Do not use on gravelly soils, eroded areas where subsoil is exposed, or on soils with less than 1% organic matter. Sufficient overhead moisture (.5 to 1 inch on moist soils, 1 to 2 inches on dry soils) is necessary to move the chemical into the soil after treatment. Best results are obtained when overhead moisture occurs within 2 weeks of application. If moisture is insufficient to incorporate the herbicide, a shallow cultivation should be made while weeds are small enough to be controlled by mechanical means. Do not disturb the activated carbon band. Do not replant to any other crop within two years after application, except asparagus which may be planted one year after application.

CONTROL OF ANNUAL AND PERENNIAL GRASSES INFESTING ESTABLISHED ASPARAGUS NOT TO BE HARVESTED FOR AT LEAST ONE YEAR

Fluazifop *(Fusilade 4E, Fusilade 2000)*

Apply .5 pound ai per acre to the foliage of actively growing grasses. *Note:* The Fusilade 4E formulation is to be replaced by Fusilade 2000. When Fusilade 2000 is used, apply .25 pound ai per acre.

Apply as a directed spray with 1% crop oil (1 gallon per 100 gallons spray solution) or 0.25% nonionic

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surfactant (1 quart per 100 gallons spray solution) when susceptible grasses are in the labeled growth stage and actively growing. Perennial grasses may require 2 applications. Annual bluegrass, and all fine fescues resist treatment. Do not apply to asparagus that will be harvested within 1 year after treatment. Do not apply to grasses which are stressed due to moisture, temperature, herbicide, or mechanical injury. Do not apply fluazifop to grasses which have tillered, formed seed heads, or exceeded recommended growth stages for treatment.

CONTROL OF ANNUAL BROADLEAF WEEDS AND REDUCTION OF PERENNIAL BROADLEAF WEEDS IN ESTABLISHED ASPARAGUS

2,4-D Sodium Salt

Apply 2 pounds ae per acre to actively growing weeds.

Apply no more than two times during the cutting season. Apply first about May 1, and again about 6 weeks later. For control of Russian thistle, spray before the weed is 2 to 3 inches tall. Use a surfactant at 16 ounces per 100 gallons of spray solution. Use low nozzle pressure (25 psi) and not less than 50 gallons of water carrier per acre. Field bindweed and Canada thistle are usually more susceptible to 2,4-D after the cutting season. Postharvest applications should be directed to the base of the asparagus fern with drop nozzles. Do not allow spray to drift onto susceptible crops.

2,4-D Alkanolamine Salt *(Vertac Formula 40)*

Apply 1.4 to 1.9 pounds ae per acre to actively growing weeds.

Apply no more than two times during the cutting season. Apply first about May 1, and again about 6 weeks later. *Consult with your processor or buyer before using 2,4-D alkanolamine during the cutting season.* Some processors may not accept asparagus treated with this herbicide.

For control of Russian thistle, spray before the weed is 2 to 3 inches tall. Additional surfactant is not needed. Use with low nozzle pressure (25 psi) and not less than 50 gallons of water carrier per acre. Field bindweed and Canada thistle are usually more susceptible to 2,4-D after the cutting season. Postharvest applications should be directed onto weed foliage at the base of the asparagus fern with drop nozzles. Do not allow spray to drift onto susceptible crops. Fern contacted by spray will be burned.

Dicamba *(Banvel)*

Apply .25 to .5 pound ae per acre when weeds are actively growing.

Dicamba may be tank mixed with 2 pounds ae per acre of 2,4-D. Apply no more than one time per season. To minimize exposure of asparagus spears apply with ground sprayer in 40 to 60 gallons of water per acre immediately after asparagus has been cut. Wait at least 24 hours after treatment before harvesting. When temperatures are above 80°F/27°C at time of application, moderate "crooking" of spears may result. Do not allow spray to drift onto susceptible crops.

CONTROL OF QUACKGRASS AND BERMUDAGRASS IN ESTABLISHED ASPARAGUS

Dalapon *(Dowpon-M)*

Apply 14.8 pounds ae per acre to the foliage of actively-growing quackgrass or bermudagrass. This amount of dalapon can be applied as a single treatment before or after the cutting season or as two treatments of 7.4 pounds ae per acre. The first before the cutting season and the second 3 to 4 weeks later.

Note: During the cutting season, dalapon should be applied immediately after cutting. Use no more than 1 pint of surfactant per 100 gallons of spray. Postharvest applications must be directed under the fern growth to avoid crop injury.

CONTROL OF ANNUAL AND PERENNIAL BROADLEAF AND GRASS WEEDS IN ESTABLISHED ASPARAGUS

Glyphosate *(Roundup)*

Apply .75 to 3.75 pounds ae per acre to actively

growing weeds prior to crop emergence, or after the last harvest and all spears have been removed, or as a delayed treatment after ferns have developed. Consult the label for specific rates of application. Roundup contains 3 pounds ae per gallon.

Do not apply preharvest applications within a week before the first spears emerge.

Postharvest applications should be directed or shielded to avoid contacting the ferns, stems, or spears. Glyphosate may injure asparagus seriously if it contacts any part of the plant.

Do not allow spray to drift onto nearby crops. Do not use or store glyphosate in galvanized or mild steel tanks.

CONTROL OF ANNUAL GRASS AND BROADLEAF WEEDS IN ESTABLISHED ASPARAGUS

Caution: For reasons not fully understood, some soil residual herbicides under certain conditions may be phytotoxic to asparagus. We have noted phytotoxicity to some ferns, particularly on fields sprinkler irrigated. The most pronounced symptoms have been observed on asparagus grown in sandy soils, in areas with shallow topsoil, where the crowns and/or feeder roots are shallow, or where the asparagus has been under some stress.

DIURON *(Karmex, Direx, Diuron)*

Apply 2.4 to 3.2 pounds ai per acre anytime the soil is not frozen from fall up to 4 weeks before asparagus emergence in the spring.

Use the higher rate during the first year of application, and the lower rate in subsequent years. If treatment is delayed until late winter, incorporation of the chemical into the top 1 to 2 inches of soil may compensate for lack of rain to move the herbicide into the soil. Incorporation will also kill any annual weeds already established at the time of treatment. Do not replant to any other crop within 2 years following the last application.

In alternate years, apply simazine to enhance weed control and to reduce residue accumulation of diuron.

LINURON *(Lorox)*

Apply 1 to 2 pounds ai per acre prior to crop and weed emergence or .5 to 1 pound ai per acre after crop and weeds emerge.

In the Columbia River Basin, use linuron only if the crop is sprinkler irrigated.

For preemergence application to crop and weeds, use the lower rate on coarse soils and the higher rate on finer soils. Do not use on sands, loamy sands, or on soils with less than 1% organic matter. Sufficient overhead moisture (.5 to 1 inch on moist soils; 1 to 2 inches on dry soils) is necessary to move the chemical into the soil after treatment. If moisture is insufficient, shallow cultivation may be substituted.

For postemergence use after crop and weed emergence, apply to weeds less than 4 inches tall before the cutting season or immediately after a cutting. May be applied up to four times. *Do not use a surfactant.* Do not exceed 4 pounds ai per acre per year. Do not harvest treated asparagus within 1 day of the last application.

METRIBUZIN *(Sencor, Lexone)*

Note: The labels for use of Sencor and Lexone differ. Read them carefully.

Apply 1 to 2 pounds ai per acre as a single preemergence broadcast spray in early spring before asparagus emerges, or apply as a split application of .5 to 1 pound ai per acre preemergence and .5 to 1.5 pounds ai per acre after harvest. *Do not* exceed a total of 2 pounds ai per acre per year. On loamy sands and sands under sprinkler irrigation do not apply more than .5 pound ai per acre per application and limit initial irrigation after application to no more than .5 inch.

Do not apply within 14 days of harvest. Do not use on newly seeded asparagus or on young plants during the first growing season after setting crowns. Use the lower rate for control of broadleaf weeds listed on the label. Use the higher rate in fields with a history of severe infestations of grasses and for maximum residual control. Metribuzin needs to be moved into the soil with overhead moisture;

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or, under rill irrigation, weed control is enhanced with shallow incorporation.

For postharvest application, apply before weeds are 3 inches tall. Clean cutting is not required prior to postharvest application, but apply prior to fern development.

Sencor may be applied as a preemergence and postharvest application through center-pivot, permanent solid-set, or self-propelled wheel-move systems.* Apply in .25 to .75 inch (depending on soil type) of water per acre and only through those systems that apply water uniformly and have appropriate antisiphon and check valves to prevent contamination of the water source. Consult EM 4532, *Sprinkler Application of Herbicides.*

SIMAZINE *(Princep, Simazine, Sim-Trol)*

Apply 2.4 to 3.2 pounds ai per acre the first year of application and 1.6 to 2.4 pounds ai per acre in subsequent years.

Apply either after disking in the spring prior to weed emergence, or following harvest after removal of existing weed growth. Spring application must be made at least 3 days before the first cutting.

Do not use under sprinkler irrigation. Field reworking should include shredding of mature plant growth with a rotobeater followed by incorporation of plant residue into the top 2 or 3 inches of soil. If treatment is delayed until late winter or early spring, incorporation of the chemical into the top 1 to 2 inches of the soil may substitute for lack of rain to move the herbicide into the soil. Incorporation will also kill annual weeds established at time of treatment. If barnyardgrass is the main weed problem, use diuron instead of simazine the first year, and follow with 3.2 pounds ai per acre of simazine the next year. Do not apply to shallow, sandy, or gravelly soils. In alternate years, apply diuron for better weed control and to reduce residue accumulations of simazine.

NAPROPAMIDE *(Devrinol 50 WP)*

Apply 4 pounds ai per acre in the fall or any time through early spring prior to weed or crop emergence.

Do not apply to frozen ground. If rain does not fall within 2 weeks of treatment in November through February, the herbicide must be shallowly incorporated or sprinkler irrigated into the soil with sufficient water to wet the soil to a depth of 2 to 4 inches. Napropamide applied before November or after February either must be mechanically incorporated or irrigated into the soil within 24 hours if no rainfall occurs. Research has indicated that under Washington conditions weed control is enhanced with immediate mechanical incorporation regardless of when napropamide was applied. To avoid injury to crops not specified on the label, do not plant other crops until 12 months after the last application.

TRIFLURALIN *(Treflan)*

Apply and incorporate .5 to 2 pounds ai per acre in winter or early spring before spear emergence and/or after harvest is completed.

Rate of application depends upon soil type. Chop and mix crop and weed residue into soil before application. Trifluralin must be soil incorporated to a depth of 2 to 3 inches within 24 hours after application with equipment which will ensure thorough soil mixing. In any single calendar year, do not apply more than 1 pound ai per acre on coarse soils, 1.5 pounds ai per acre on medium soils, and 2 pounds ai per acre on fine soils.

*Washington state label permits use in irrigation systems.

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WEED RESPONSE TO SELECTED HERBICIDES

This chart may serve as a guide in the selection of some of the herbicides registered on asparagus. Plant response may be altered by growing conditions, genetic variations, soils type, pH, organic matter, and rates of application.

Rates necessary to control weeds as suggested may vary from season to season and may differ among geographical areas.

	Herbicide											
	Chloramben	Dicamba	2,4-D	Diuron	Glyphosate	Linuron	Metribuzin	Napropamide	Paraquat	Simazine	Terbacil	Trifluralin
Grass Weeds												
Barnyardgrass	G-F	P	P	G	G	F	F	G	F	G	G-F	G
Crabgrass	G	P	P	G	G	G	G-F	G	G	F	P	G
Green foxtail	G-F	P	P	G	G	P	G-F	G	G	G-F	P	G
Yellow foxtail	G-F	P	P	G	G	P	G-F	G	G	G-F	G	G
Sandbur	-	P	P	F	G	-	F-P	G	F	F	G-F	G
Broadleaf Weeds												
Black nightshade	C	G	F	G	G	G	F-P	P	G	G	G	P
Common lambsquarters	G-F	G	G	G	G	G-F	G	G	G-F	G	G	G-F
Hairy nightshade	G	G	G	G	G	G	F-P	P	G	G	G	P
Kochia	G-F	G-F	G-F	P	G	P	G-F	-	G	G	G-F	G-F
Mallow	-	G	P	F	G	P	G	F-P	P	G	G	P
Pigweed	G-F	G	G	G	G	G	G	G	G	G	G	G
Prickly lettuce	G	G	G	G	G	G	G	G-F	G	G	G	P
Prostrate knotweed	G	G	P	G	G	P	G	G	F	G	G	G
Puncturevine	-	G	G	P	G	P	G-F	F	G	P	F	F
Purslane	G	G	G-F	G	G	G	G-F	G	G	G	G	G
Russian thistle	G	G	G-F	P	G	P	G	F	G	F-P	G	F
Smartweed	F	G	P	-	-	P	G	-	-	G	-	P
Wild buckwheat	-	G	P	G	G	F	G-F	-	-	G	-	P
Volunteer asparagus	P	G	P	F-P	F	P	F	F	F-P	F	G-F	F

G = Good Control
F = Fair Control
P = Poor Control

Use pesticides with care. Apply them only to plants, animals, or sites listed on the label. When mixing and applying pesticides, follow all label precautions to protect yourself and others around you. It is a violation of the law to disregard label directions. If pesticides are spilled on skin or clothing, remove clothing and wash skin thoroughly. Store pesticides in their original containers and keep them out of the reach of children, pets, and livestock.

The law requires that pesticides be used as the label directs. Uses against pests not named on the label and low application rates are permissible exceptions. If there is any apparent conflict between label directions and the pesticide uses suggested in this publication, consult your county Extension agent.

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ARTICLE M1

FACTORS AFFECTING THE SUPPLY AND DEMAND FOR ASPARAGUS IN THE UNITED STATES

S.L. Bbuyemusoke
A.H. Harrington
R.C. Mittelhammer

Agricultural Research Center
Washington State University

Research Bulletin
XB 0918 1982

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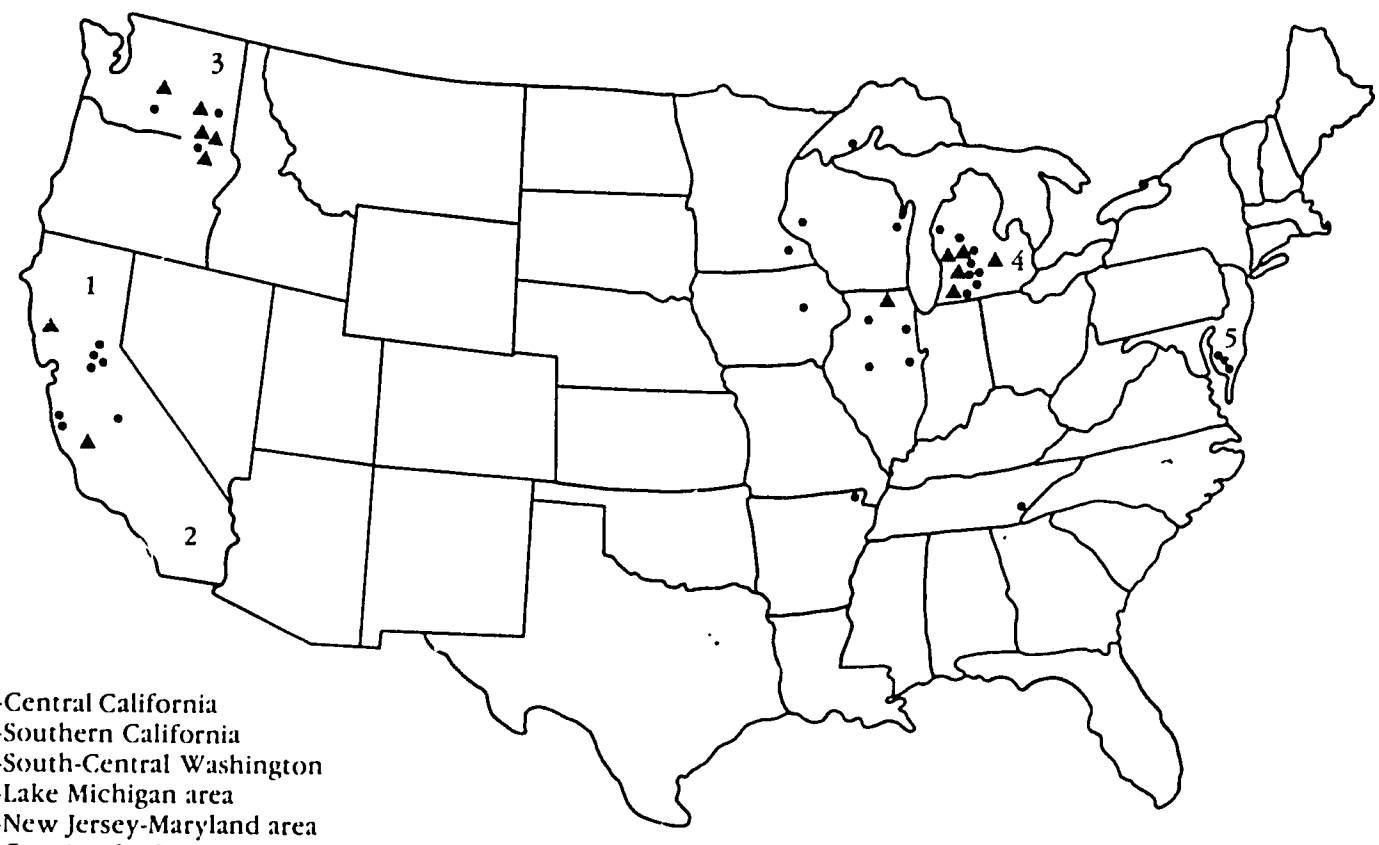
FACTORS AFFECTING THE SUPPLY AND DEMAND FOR ASPARAGUS IN THE UNITED STATES

by

S. L. Bbuyemusoke, A. H. Harrington, and R. C. Mittelhammer

Asparagus is produced in California, Washington-Oregon, Michigan, Illinois, New Jersey, and a few other states. Processing facilities are located in each of the producing areas (figure 1). Asparagus from approximately 2,000 farms is delivered to 50 processors and to many handlers. Handlers sort, trim, and crate fresh asparagus for immediate delivery to consumer markets. Processors transform the asparagus into canned and frozen products. Asparagus is marketed in both fresh and processed form to over 220 million consumers in the United States plus others in countries supplied by exports from the United States.

Marketing of asparagus is coordinated by the negotiations and contractual arrangements of many buyers and sellers—the grower, the processor, the handler, the wholesale buyer, the retailer, the institutional buyer, and the



1—Central California
2—Southern California
3—South-Central Washington
4—Lake Michigan area
5—New Jersey-Maryland area
•—Canning facility
▲—Freezing facility

Figure 1.—U.S. Asparagus producing regions and location of processing facilities.

SOURCES: U.S. International Trade Commission, 1976; The Directory of Canning, Freezing, Preserving Industries, 1978-79; U.S. Department of Agriculture, SRS, CRB, "Usual Planting and Harvesting Dates," Agricultural Handbook No. 251.

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consumer. In all of the negotiated exchanges, the price of the product is central in determining quantities bought and sold. Price influences the volume of asparagus produced and the allocation of the crop among fresh, freezing, and canning outlets as well as influences the level of processed asparagus stocks held.

At the farm level, the pressure of decision regarding prices is felt by bargaining associations and processors. These groups negotiate prior to the harvest and establish both the price and volumes of processed asparagus. Information about factors that affect supplies and demands for asparagus is needed for these negotiations to result in a price that accurately reflects the market value of asparagus and that will induce a volume that ultimately satisfies the demands for processed asparagus products. In particular, guidelines concerning the qualitative and quantitative importance of changes in various supply and demand factors are required.

This study is an attempt to isolate and measure the influences of various factors on supply, demand, and price of asparagus. The method of analysis used in the study is one of constructing a statistical simulation model of the U.S. asparagus industry. Specifically, the model consists of a set of equations statistically estimated from historical data to simulate the behavior of the various participants in the industry.

Due to the complexity of all the interactions in the industry, supply and demand aspects of the industry will first be examined individually. Then supply, allocation between processed and fresh markets, and demands will be drawn together into an interrelated model in which price is important both as an influence on and result of market outcomes.

A MODEL OF THE ASPARAGUS INDUSTRY

Figure 2 depicts the relationships in the U.S. asparagus industry that were examined in this study. In each of the major producing regions, harvested acreage and yield determine the total output. Bargaining associations and processors determine the prices paid for processing asparagus and the amounts processed. The remaining asparagus moves into fresh markets with fresh market prices adjusting to the supplies available and the demands for the product.

Regional outputs, allocations, and prices are aggregated into national totals. Processed asparagus, particularly, and to a lesser extent, fresh asparagus, moves into consumption on a national market. Consumer stocks, imports, and exports also affect the national consumption of both fresh and processed asparagus.

The arrows shown in figure 2 indicate the flow of influence. In several instances, the arrows point in two directions indicating a mutual interaction in which each factor influences the other. For example, negotiations between bargaining associations and processors determine both price and allocation, but the price and allocation are mutually determined with changes in each affecting the other.

In this study, the country is divided into three regions—California, Washington Oregon, and the rest of the United States.

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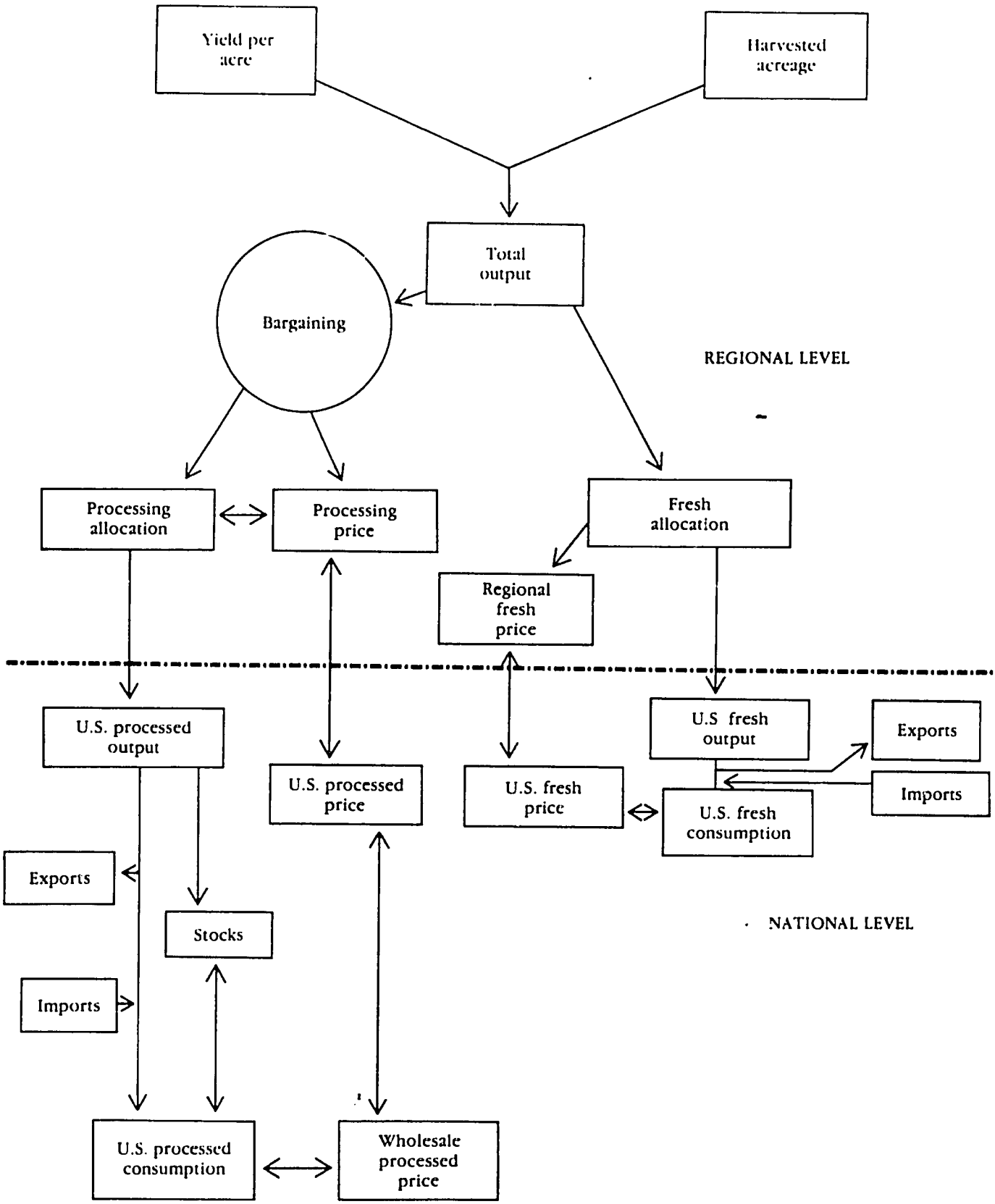

Figure 2. Model of major relationships in the U.S. asparagus industry.

TOTAL OUTPUT

The output of asparagus in any given year is the product of the acreage that is harvested and the average yield per acre, as shown in figure 3:

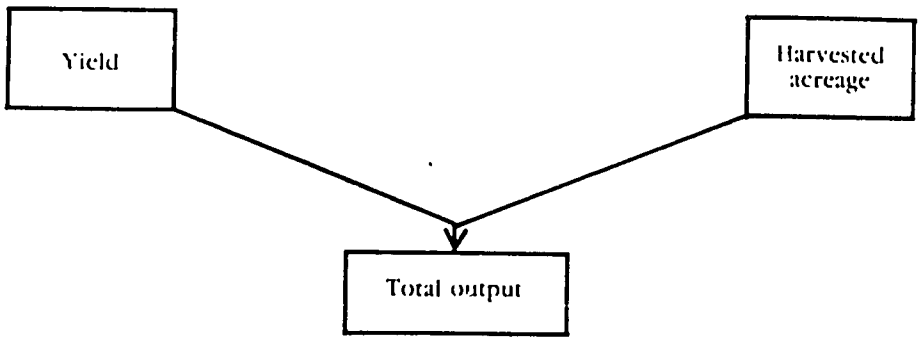

Figure 3. Components of output in a given year.

The total output of asparagus in this country has declined since 1963. Production in 1963 was 3.8 million cwt and in 1979, 1.7 million cwt (figure 4). The decline occurred in all producing areas except Washington. California's production was 2.0 million cwt in 1963 and 0.9 million cwt in 1979. In the rest of the country, the peak production was 1.4 million cwt in 1960. By 1979 this had dropped to 0.4 million cwt.

Washington production has slowly trended upward. In 1954 output was 366,000 cwt. By 1963 output had risen to 479,000 cwt. The 1979 production was 588,000 cwt. The 1979 output represented a decline from the 3 previous years in which production was 672,000 thousand cwt. The decline was due to an aphid infestation.

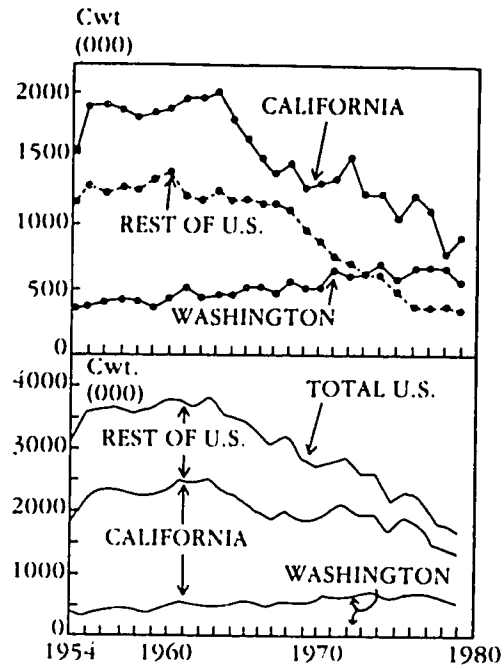

Figure 4. Asparagus production by regions, United States, 1954-1979.

Acreage

Harvested acreage of asparagus in the United States followed the same downward trend as that of production. Harvested acreage was nearly 161,000 acres in 1959. Acreage in 1979 was 80,000, which was one-half of the peak acreage of 20 years earlier (figure 5).

Regional acreages declined in all areas other than Washington. California's acreage declined from about 78,000 acres in 1959 to about 28,000 in 1979. In the rest of the country, other than California and Washington, the acreage in 1959 was about 66,000 acres, while 20 years later it was 30,000.

Washington's acreage grew fairly steadily. In 1954 11,290 acres were harvested, while in 1959 acreage increased to 17,100. Acreage reached a peak in 1974 with 24,500 acres, and then declined to 22,000 in 1979.

The harvested acreage in any year is primarily the result of prior influences. Figure 6 lists some of the important factors that were found to have an important effect on the acreage of asparagus harvested in a given year. The previous year's acreage serves as a base. Incomes from asparagus in prior years influence the acreage in the current year. Profitable incomes from asparagus 2 years ago (t-2) encourage new plantings which would begin to come into production in the current year (t). Also, the level of profitability the previous year (t-1) influences the number of acres of asparagus plowed

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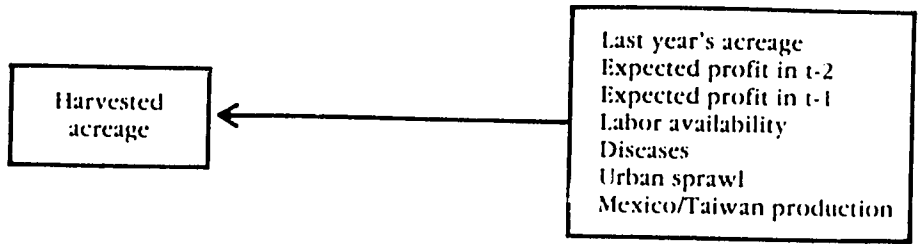

Figure 6. Factors influencing harvested acreage.

up and thus taken out of production. High incomes 2 years ago would be expected to result in expanded acreage harvested in the current year. High incomes the previous year likely would result in smaller-than-"normal" acreage plowed up, and thus harvested acreage in the current year would become larger.

For the statistical analysis, accurate data on profitability were not available, so a ratio of the price of asparagus to the wage rate of hired farm workers was constructed as an indicator of profitability. The wage rate was chosen as a proxy for costs due to the considerable importance of labor in the harvesting of asparagus.

In addition to profitability, however, the physical availability of labor is important. The Bracero program, through which Mexican laborers could enter the country for crop harvests, was terminated in 1965. The analysis attempted to examine the impact of the termination of that program. At the same time, however, mechanical harvesting was begun in the Midwest, and Mexico and Taiwan began significant asparagus production, so that isolating the separate effect of the Bracero program was not accomplished. Other influences on the number of acres harvested are disease and the urban sprawl.

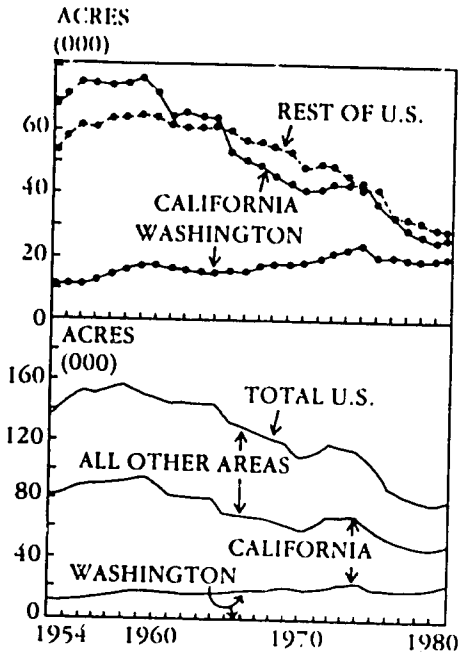

Figure 5. Asparagus acreage, by regions, United States, 1953-1980.

The measurable factors were analyzed in relation to the harvested acreage from 1954 to 1977. In California, acreage was quite responsive to profitability of asparagus, both as indicated in the prior year and in the period 2 years earlier. Increased profitability of 10% in the previous year was reflected in increased harvested acreage of 4%. A 10% increase in profitability 2 years earlier resulted in a 4.5% increase in harvested acreage. The termination of the Bracero program and concurrent events seem to have resulted in about an 8,000 acre reduction in California.

In Washington, acreage showed a smaller response to the profitability measure. A 10% increase in profitability the previous year was reflected in a 1.2% harvested acreage increase. The same increase in profitability 2 years earlier was reflected in a 1.6% acreage increase. The termination of the Bracero program and concurrent events had no measurable effect on Washington acreage.

In the rest of the country even smaller acreage response resulted from changes in profitability. There was a steady decline in acreage over time in these areas, probably as a result of disease and of urbanization. Also, a sharp unexplained drop in acreage occurred in 1976.

Yield per Acre

Yields per acre vary from year to year. In the regions other than California

and Washington, those yields remained close to 20 cwt (1 ton) per acre from 1954 to 1968 (figure 7). Yields declined, however, from 1969 to 1976 and have leveled off at about 12 cwt per acre.

California's yields have varied around 30 cwt per acre since 1961. They had risen from 21 cwt in 1954 to 30 cwt in 1961.

Washington's yield per acre has also varied around 30 cwt. There was a sharp drop in yields from 1956 to 1960, but since then yields have been fairly steady, ranging from 26.9 to 32.5 cwt per acre.

Yield per acre is affected by a number of influences; some of which are measurable. The profitability of production can influence the amount of care and inputs applied to the crop. Also, the age composition of the asparagus fields affects the yield. Typically, yield per acre rises from the 1st year of harvest until about the 11th or 12th year, after which yield decreases. Thus, if all asparagus acreage were mature, from 10 to 14 years old, the average yield would be high, while if a large proportion of the acreage were young or old, the average yield would be low.

Weather, the technological practices used, and disease can influence yields, but are difficult to quantify for analysis. (See figure 8.)

In the analysis, profitability was related to yield. The profitability measure was defined, as before, to be the ratio of the price of asparagus to the wage rate. In both California and Washington a 10% increase in profitability resulted in about a 2% increase in yield. In the other producing regions the effect was even greater—a 10% increase in profitability resulted in about a 4% increase in yield.

The age composition of the acreage was also a significant influence. An indicator of age composition is the difference between the level of current acreage and that of 5 years ago. A negative difference would reflect few

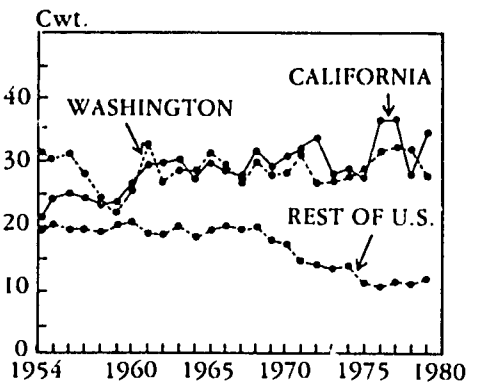

Figure 7. Average asparagus yield per acre, by regions, United States, 1954-1979.

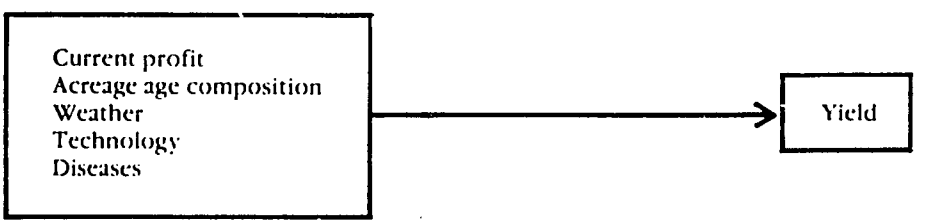

Figure 8. Factors influencing yield.

new plantings or heavy removal of acreage due to age or disease, while a positive difference would reflect heavy plantings in recent years. As the difference increased, yields did decrease, particularly in Washington, reflecting the lower yields on younger beds of asparagus. In California the average monthly temperature during the growing and harvest season of March to June influenced yields. Yields decreased 0.67 cwt for each degree rise in season average temperature.

Apart from the effects of age distribution and profitability, yields increased over time 0.12 cwt per year in California and 0.14 cwt per year in Washington due to advances in technology and management. In the rest of the nation, on the other hand, the trend in yield was downward, about 1

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cwt per year. Part of the decline may be attributed to the decrease in weight harvested that resulted from the shift in harvesting technology, where "snapping" was introduced in place of cutting the asparagus. Part may be the result of gradual encroachment of disease.

DOMESTIC DEMAND

Whereas total output of asparagus is influenced by conditions in the producing areas, demand is the result of the behavior of asparagus consumers in U.S. and export markets. Asparagus is consumed in fresh and in processed forms.

The levels of per capita consumption (for the period from 1947 to 1979) of fresh, frozen, and canned asparagus are shown in figure 9.

Fresh Asparagus

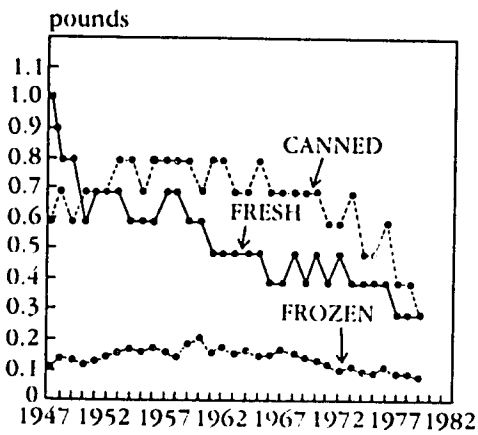

Figure 9. Per capita consumption of canned, fresh, and frozen asparagus, United States, 1947-1979.

Consumption of fresh asparagus in this country is influenced by a number of factors. The size of the population, the income of that population, and the consumer price index (CPI) of goods and services have some influence on all purchases by consumers. For asparagus, these three general factors are combined with two specific factors: the price of fresh asparagus and consumers' tastes and preferences for asparagus. (See figure 10.)

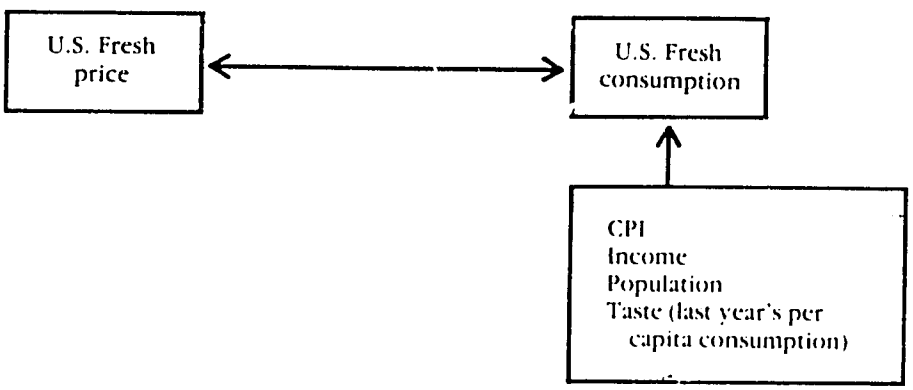

Figure 10. Factors influencing consumption of fresh asparagus.

Prices and availability of substitute vegetables could conceivably affect fresh asparagus consumption, but none were found that had any significant effect. In the analysis, both per capita income and the farm price of fresh asparagus were deflated by the Consumer Price Index to take into account general price inflation. Consumers' tastes and preferences for asparagus were indicated in the analysis by per capita consumption in the previous year. The assumption is that consumers do not change their tastes rapidly and that lagged consumption indicates the level of current tastes.

Fresh asparagus consumption is positively influenced by consumers' incomes. A 1% increase in income per capita (adjusted by the Consumer Price Index) was associated with 0.4% increase in per capita consumption assuming no change in the price of asparagus.

A 1% change in farm price of fresh asparagus was associated with 0.98% change in the opposite direction in per capita consumption, assuming no

change in income. The previous year's consumption had a small but positive effect on current consumption, indicating that consumers' habits exerted a small positive effect on fresh asparagus consumption.

Processed Asparagus

Consumer demand for processed asparagus is influenced by the size of the population, income, tastes and preferences for asparagus, the prices of other processed vegetables, the availability of asparagus on retail shelves, as well as by the price of the processed asparagus, as shown in figure 11.

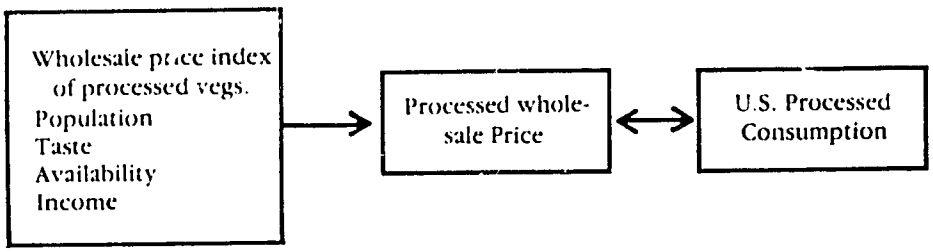

Figure 11. Factors influencing consumption of processed asparagus.

Consumption of processed asparagus is more responsive to income than is the consumption of fresh asparagus. A 1% increase in disposable income per capita was associated with 0.9% increase in per capita consumption, with price remaining unchanged. In contrast, as noted above, a similar change in income was associated with a 0.4% change in fresh asparagus consumption.

The relation of price to consumption of processed asparagus is more inelastic than that for fresh asparagus. A 1% change in price was associated with an opposite 0.6% change in consumption, whereas the response of fresh asparagus consumption to a similar price change was 0.98%. More consumption is encouraged by a 1% decrease in price of fresh asparagus than by a similar decrease in the price of processed asparagus.

Over time, there has been a tendency for per capita consumption of processed asparagus to decline because of a decrease in consumers' tastes and/or because of decreased availability of the product.

LINKING TOTAL SUPPLY TO TOTAL DEMAND

Fresh Asparagus

Consumer response to the price of fresh asparagus was discussed earlier. An implicit assumption was made that a single U.S. fresh asparagus price prevailed, and no mention was made of whether the asparagus supplies were all produced in this country. Figure 12 depicts some of the other interrelationships in the fresh asparagus market which involve regional prices, imports, and exports.

The total consumption in this country does not necessarily equal the national output of fresh asparagus. Part of the output goes into export

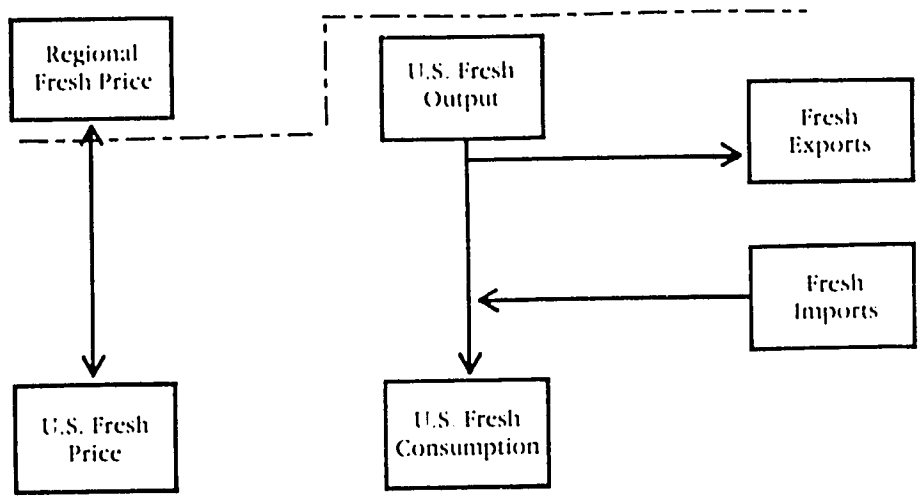

Figure 12. Interrelationships in the fresh asparagus market.

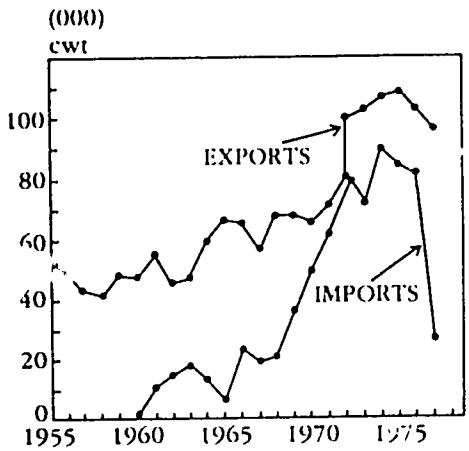

Figure 13. U.S. Exports and imports of fresh asparagus, 1955-1977.

markets. Fresh asparagus is also imported. In 1976 the United States exported 104,310 cwt and imported 82,450 cwt (figure 13).

Most imported asparagus comes from Mexico. During the fall when little asparagus is harvested in the United States supplies come from the Baja area of Central Mexico, but the bulk comes in the early spring from the Mexicali Valley at about the same time as Southern California asparagus is harvested. Exports from the United States have been steadily increasing, primarily to Canadian markets.

The consumers are provided with fresh asparagus through the buying and selling activities of a number of marketing firms. The interrelationships among firms can be illustrated with a diagram of marketing channels (figure 14).

In the marketing channel, shippers, brokers, and wholesalers may export part of the supplies they acquire. Likewise, they and the retail or institutional buyers may import some of their fresh asparagus.

Growers, shippers, and farmers' markets (roadside stands, U-pick) are located in the producing areas. The others in the channel extend into the consumer markets throughout the nation.

Prices paid to the grower for asparagus sold in the fresh market have differed among producing regions, and have varied considerably from year to year (figure 15). Prices in the Eastern producing region (rest of United States) have been higher than those in California and Washington in recent years. This is primarily due to the greater distance from the West Coast to the major population centers in the East. Grower prices in California have generally been higher than those in Washington because of the earlier California harvest resulting in few competitive supplies at initial harvest time.

Subject to a nationwide demand, the price in each region is related to the national average price and to the region's share of the national market. Fresh market prices in the three regions rose and fell together. Each was associated on nearly a one-to-one basis with the national average. As a

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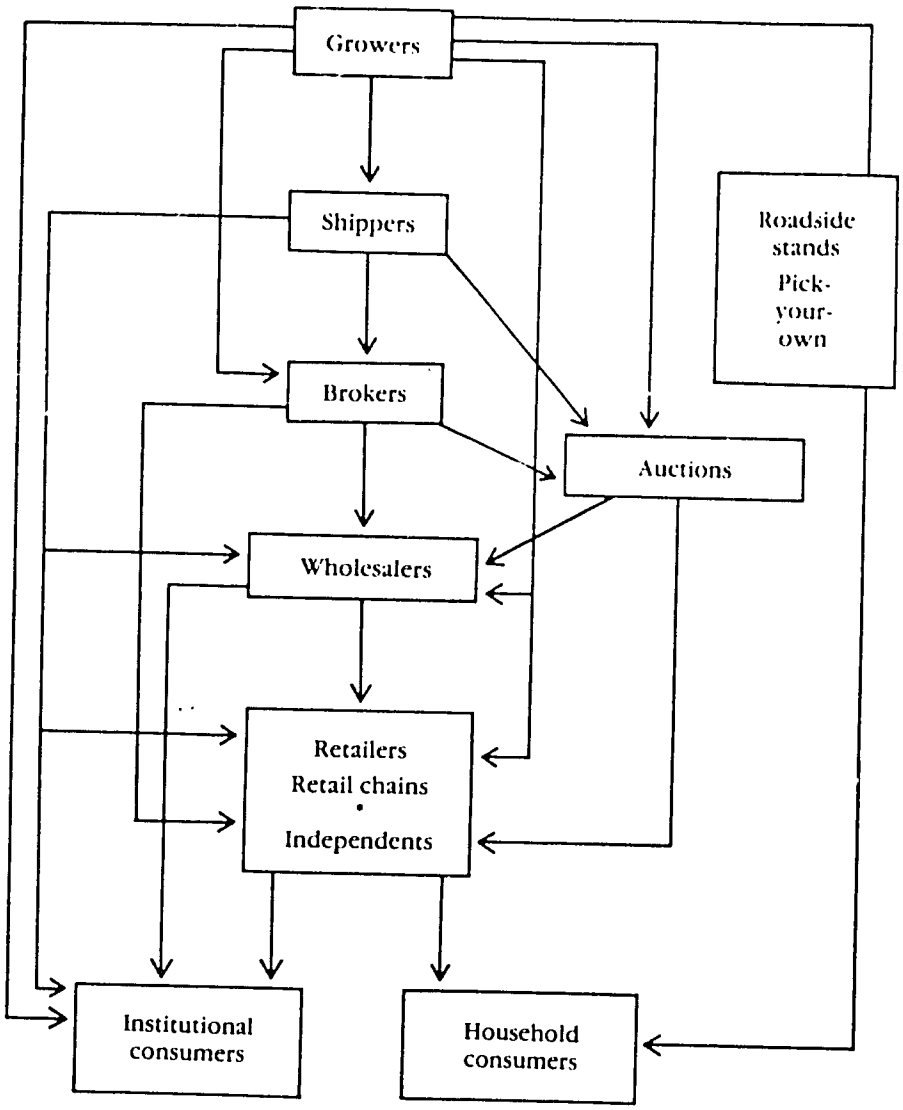

Figure 14. Market channels for fresh U.S.-grown asparagus.

region's share of the total market increased 1%, the price in each region dropped slightly—in California, by 0.11%, in Washington, by 0.15%, and in other regions, by 0.13%.

The sharp inflationary rise beginning in 1974 markedly changed the price relationships between the regions. Fresh asparagus prices in Washington and in the Eastern region dropped in relation to California's price. Because of the rise in transportation costs, the Eastern producing areas have had an increased advantage over the Western growers.

Processed Asparagus

Consumer demand for canned or frozen asparagus is related to supplies through a marketing channel subject to a number of influences. Figure 16 outlines some of the major factors.

Inventories are important in the processing market, whereas they are nonexistent in the fresh asparagus market. Processors' costs include the price paid for the raw asparagus they acquire, but also the cost of containers, fuel, and other needed processing supplies. Likewise there are costs

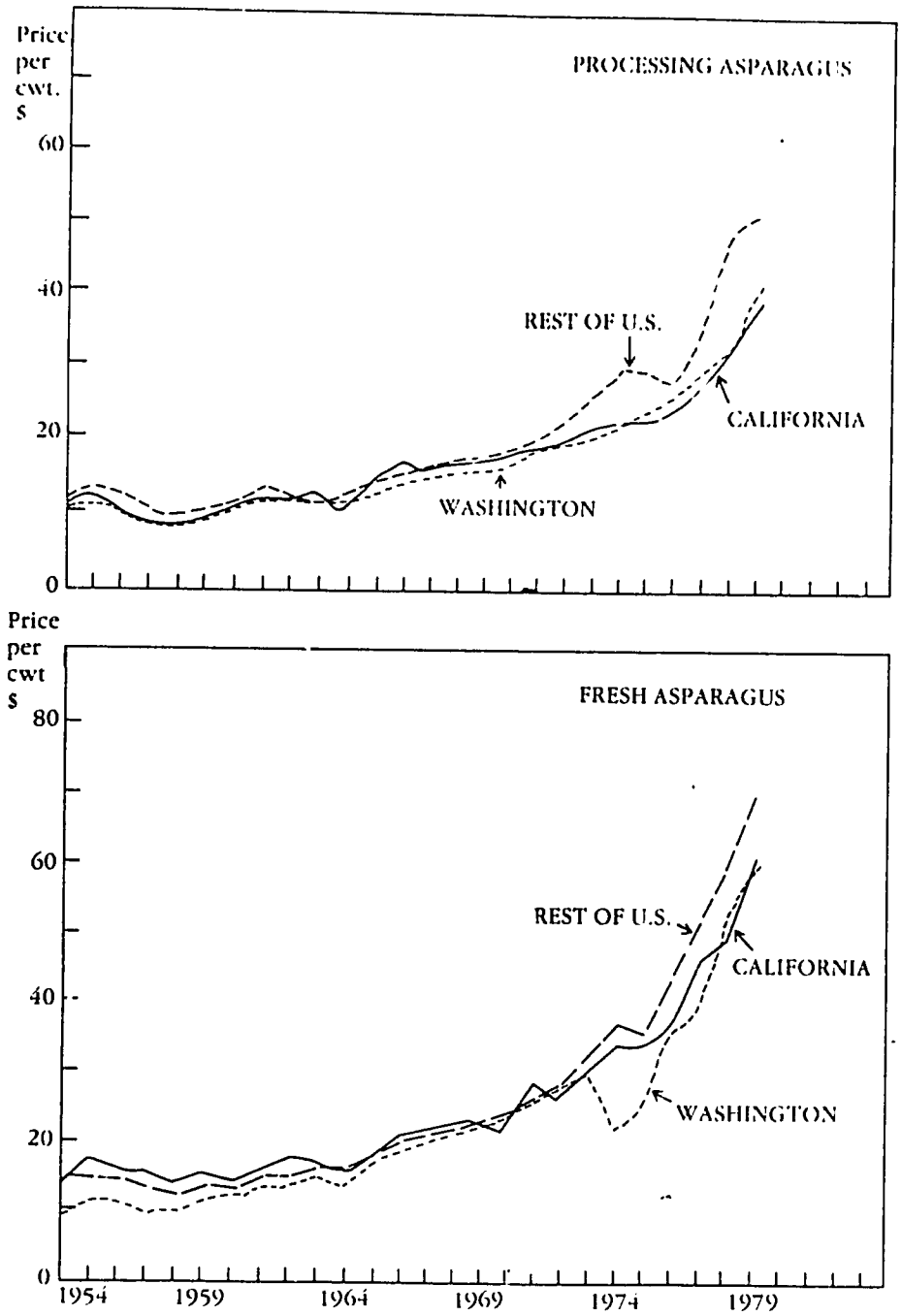

Figure 15. Prices paid growers for asparagus, by regions, 1954-1979.

involved in owning or renting storage facilities for the processed product.

Total consumption of canned or frozen asparagus in any year is affected by the volumes exported or imported and by the rate of drawing down the stocks held in inventory. Changes in stocks, or in imports and exports, as well as changes in costs of processing, influence the attitudes of processors and the price they are willing to offer growers for the raw product. Figure 17 depicts the changes in stocks of canned and of frozen asparagus from 1957 to 1977. Figure 18 presents the exports and the imports of processed asparagus.

The U.S. processing price is an average of the different prices in the produc-

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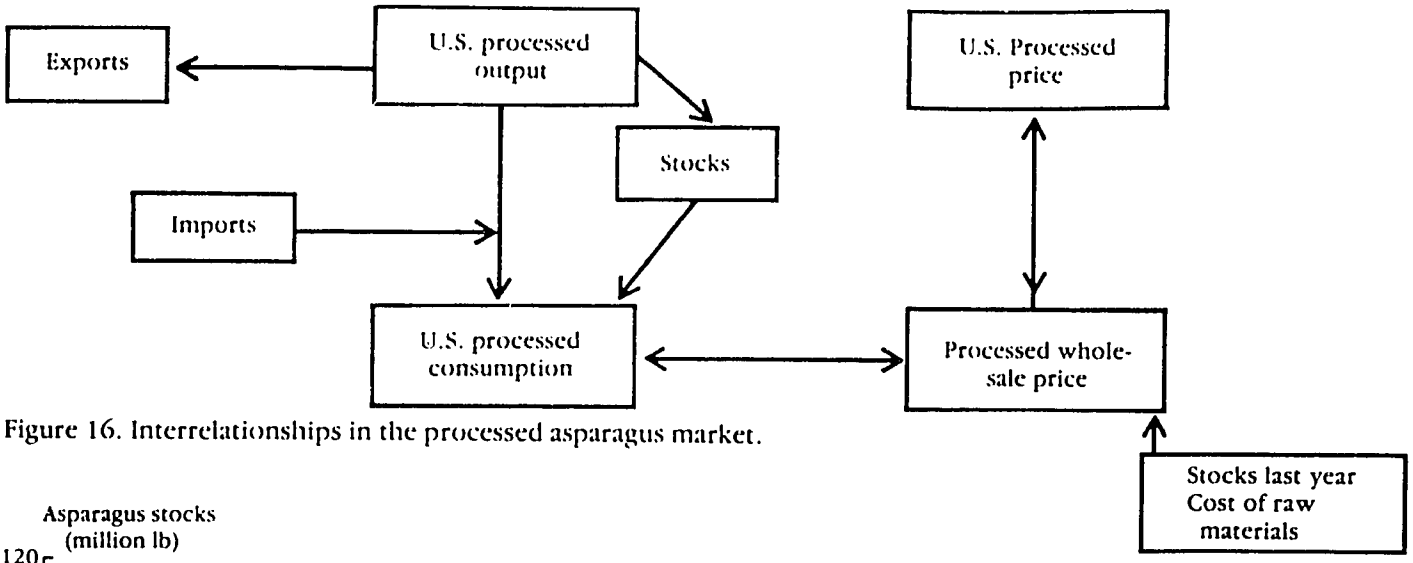

Figure 16. Interrelationships in the processed asparagus market.

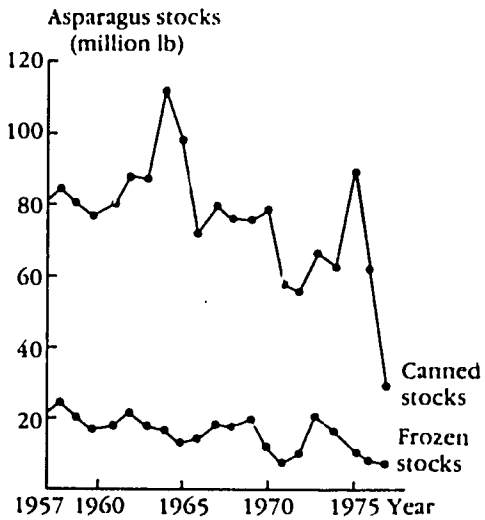

Figure 17. Frozen and canned asparagus January 1 carryin stocks, 1957-77.

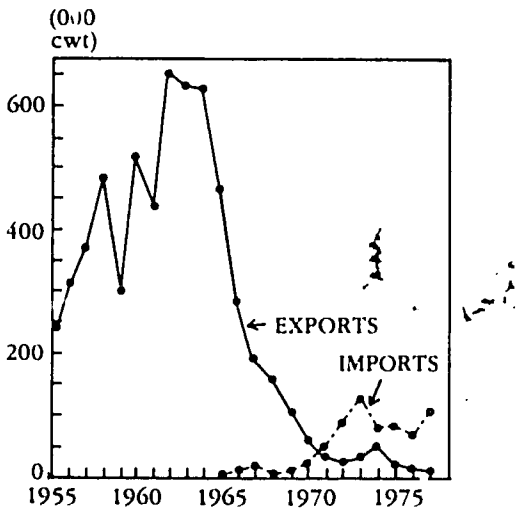

Figure 18. U.S. exports and imports of processed asparagus, 1955-1977.

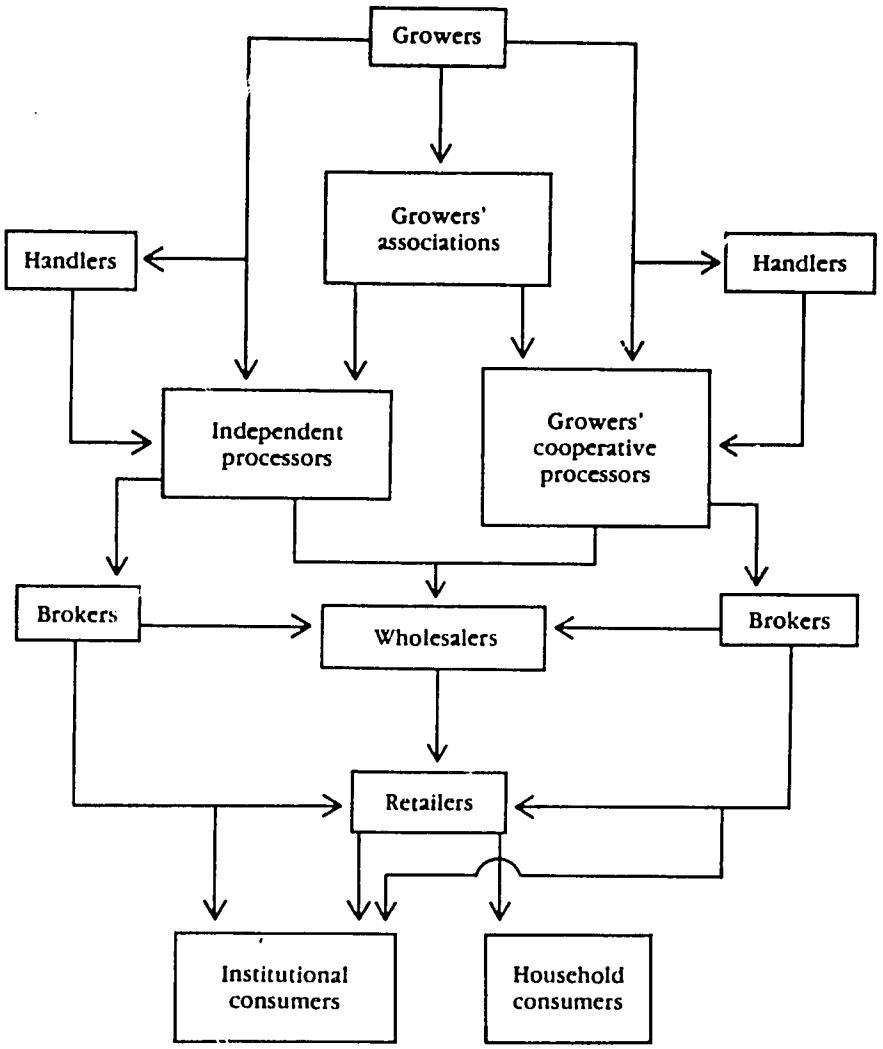

Figure 19. Marketing channels for U.S.-grown processing asparagus

ing regions. Processing plants are located near the areas where production takes place. The processed product is distributed through brokers and wholesalers throughout the country (figure 19).

Bargaining--Supply and Demand Meet

In each region asparagus growers deal with fresh asparagus handlers and asparagus processors. As indicated in figure 19, growers, individually or through associations, negotiate price and quantities with processors. In the fresh market, prices are negotiated between handlers (shippers) and wholesale or retail buyers. Once the processing price is determined by the bargaining negotiations, that price sets a floor to the fresh market price, since supplies can be quickly shifted to processors when fresh prices fall below the processing price. In Washington, handlers (shippers) are involved in the bargaining negotiations for processed price, since handlers sort and trim the asparagus delivered to them, crate the longer spears for the fresh market, and send the shorter spears to the processors.

The wholesale price of processed asparagus was analyzed in relation to the raw product price, an indicator of costs of processing, and the level of carryover stocks. The wholesale price was significantly and positively related to both the price paid to growers for the raw product and an index of processing costs. As the price to growers for the raw product increased 1%, the wholesale price of the processed product rose 0.56%. As the index of processing costs rose 1%, the wholesale price increased 0.27%. As carryover stocks from the previous season increased 1%, however, the wholesale price of canned and frozen asparagus decreased by 0.31%.

In price negotiations, processors and handlers bring to their bargaining for the raw product their impressions of consumer, wholesaler, and retailer buying behavior and their expectations regarding their costs, their inventories, and their market outlets. Growers bring to the bargaining table expectations of their production and harvesting costs, and of the volume of asparagus to be harvested. Also entering the bargaining negotiations are such influences as past trends of prices, of production, and of the allocation of supplies to processing and fresh markets, the levels of carryover stocks of processed asparagus, expectation of exports and of imports, the availability of harvest labor, and the extent of mechanization. Figure 20 illustrates the forces affecting the bargaining process.

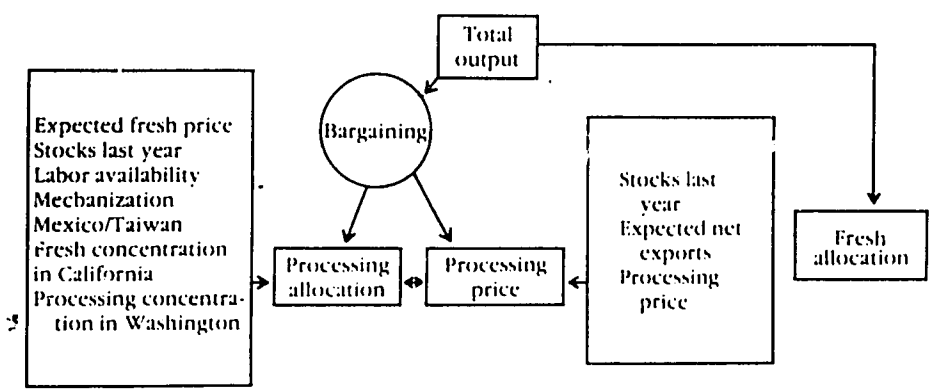

Figure 20. Forces affecting the bargaining process.

Use of the Statistical Model

Figure 21 is a depiction of the total model of forces influencing the U.S. asparagus industry. Note that in the upper half of the figure the influences

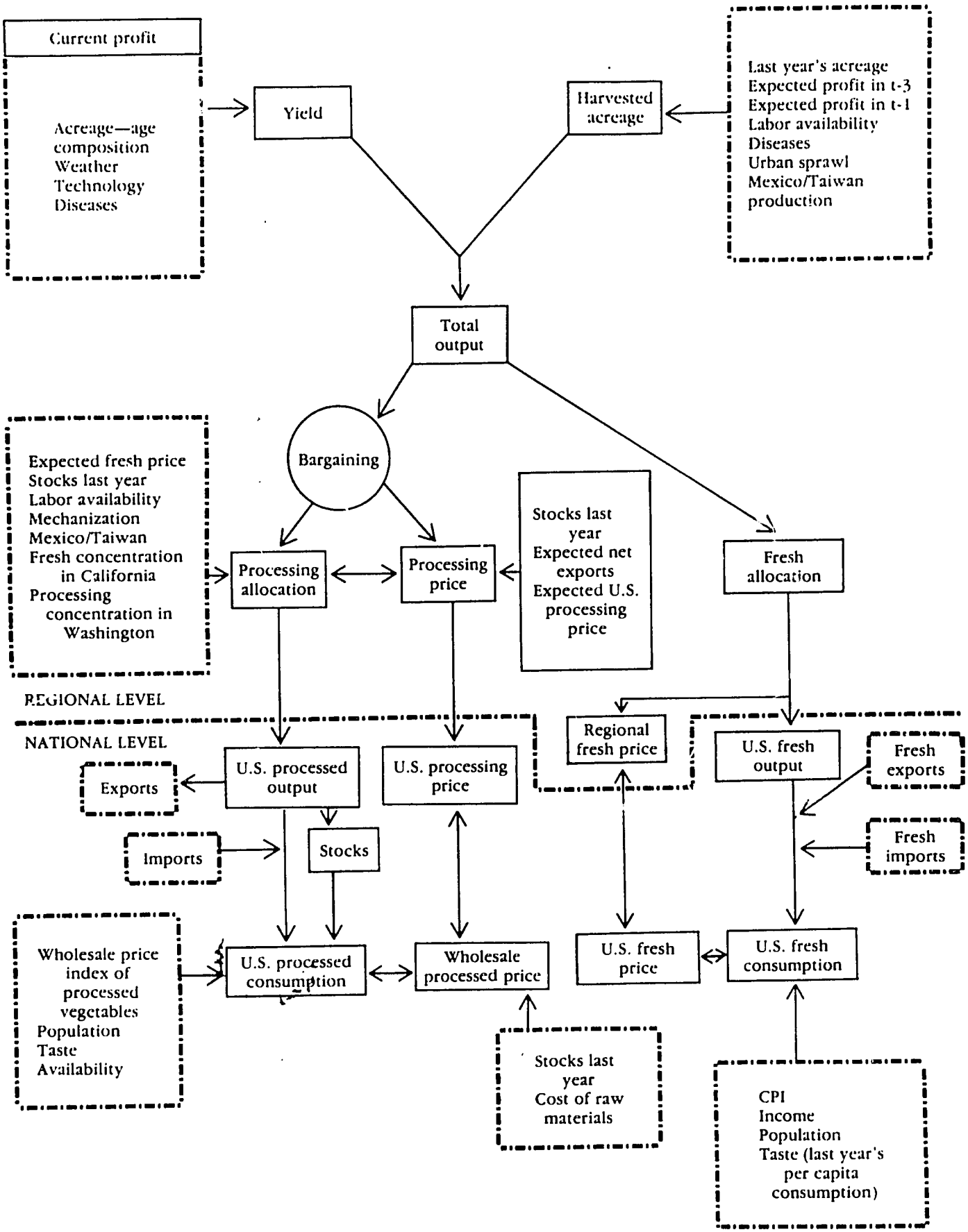

Figure 21. Major relationships in the U.S. asparagus industry.

relate to regions. The lower half represents the national level to which each of the three regions is related.

By using the statistical relationships that have been estimated, the model can simulate changes throughout the entire industry that might result from any given change in a major influencing factor. The relationships have been estimated from past relationships and represent the reactions of the many growers, consumers, handlers, processors, and other industry personnel to market conditions.

Assumptions were made regarding the following basic trends from 1978 to 1985:

- U.S. population to grow 1% each year.
- Consumer and wholesale price indexes to rise 9% each year.
- Wage rates to increase 8% each year in Washington, 9% in California, and 9.6% in the other regions.
- Exports and imports to stay at the average level of the past several years.
- Consumer incomes to rise by 10.5% each year.

With these assumptions for the outside (exogenous) forces, the model simulated the possible interactions and market results in the industry. The major results follow:

- Harvest acreage decreased in California, rose in Washington, and remained about the same in the other region (table 1). Production followed the same trend as acreage in California and Washington, but declined in the other region despite the maintenance of acreage. This resulted from the assumed continuation of the decreasing trend in yields in the East.
- Washington would overtake California in production and would become the major processing region. California, on the other hand, would dominate the fresh market.

Because of the assumed steady rise in population, income, and price levels, asparagus prices would rise significantly (table 2). The Eastern growers would receive higher prices than those in the West. Washington prices would be higher than California for processing asparagus and about the same for fresh asparagus.

The preceding model of the asparagus industry provides a means for simultaneously analyzing a large number of complex interrelationships among growers, processors, handlers, wholesale buyers, institutional buyers, retailers, and consumers. Such an analysis would be extremely difficult without the aid of a mathematical model that could be subjected to computer analysis.

It should be noted, however, that the model described in this publication is itself a simplification. Thus the analysis presented should be viewed as a guide to reality in the asparagus market, but the results should not be regarded as sacrosanct. In particular, predictions of the future depend on

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Table 1. Harvested acreage, production, and allocation of production by region: simulated results, 1978 and 1985.

	1978	1985
Acreage (000)		
California	17.0	22.6
Washington	20.5	25.9
Rest of country	38.4	39.5
Production (000 cwt)		
California	897	729
Washington	699	810
Rest of country	392	250
Quantity Processed		
California	546	202
Washington	620	758
Rest of country	361	242
Total of U.S.	1,572	1,203
Quantity of Fresh		
California	352	528
Washington	80	51
Rest of country	30	8
Total U.S.	462	587

Table 2. Grower prices of fresh and processing asparagus by region: Simulated results, 1978 and 1985.

	Price per cwt			
	Fresh market		Processing	
Area	1978	1985	1978	1985
California	58.63	85.79	36.78	51.94
Washington	55.47	86.92	38.73	55.58
Rest of country	65.03	91.00	42.36	59.65
U.S. Average	58.76	86.44	38.89	55.79

the assumption regarding the levels of forces originating outside of the asparagus industry, and the analysis is based on historical behavior patterns which are subject to change.

Despite its limitations, the model of the asparagus industry provides decision makers with a tool useful in analyzing the effect on the fresh and processed asparagus markets of changes in various influencing factors, taking into account complex interrelationships among industry participants.

S. L. Bbuyemusoke was former Graduate Research Assistant in Agricultural Economics, and now Assistant Professor, University of Liberia; A. H. Harrington is Professor of Agricultural Economics; and R. C. Mittelhammer is Associate Professor of Agricultural Economics, Washington State University.

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ARTICLE M2

MARKETING CALIFORNIA

ASPARAGUS

1986

FEDERAL-STATE MARKET NEWS SERVICE

United States
Department of Agriculture
Agricultural Marketing Service
Market News Branch

State of California
Department of Food & Agriculture
Division of Marketing Services
Bureau of Market News

PREFACE

This publication summarizes available data and information on marketing California asparagus during the 1986 calendar year and includes statistical tabulations for the fresh market and processed portions of the crop. Data are included on fresh market distribution and wholesale values as well as shipping point prices. These statistical records reflect the supply and demand factors that affected the marketing of the 1986 crop.

Data were compiled from various printed reports provided by the Federal-State Market News Service, Agricultural Statistics Board, National Agricultural Statistics Service of the USDA; American Frozen Food Institute, Burlingame, California; National Food Processors Association, Washington, D.C.; and the California Asparagus Growers Association, Stockton, California. We wish to acknowledge and thank these agencies for the data and information furnished by them and used to complete this publication.

Price quotations shown in this summary reflect prices charged by primary shippers at shipping point and wholesalers at terminal markets for the principal packs, varieties, grades and sizes. Prices are for stock of generally good quality and conditions. Price ranges are shown for the majority of sales as reported. Occasional small volume sales, sales of fair or poor quality lots, and labels sold at extreme prices were omitted from this summary in order to clearly reflect general market trends.

Preparation of this summary was made by personnel of the Federal-State Market News Service and includes contributions by Linnis Edwards and Ollie Shane at Stockton, Jack R. Kloth at El Centro, and David E. Vassar and Anita Johnson at Sacramento.

Additional copies of this summary are available at $4.00 per copy. Checks can be made payable to the **Department of Food and Agriculture** and mailed to the following address.

Federal-State Market News Service
1220 N Street, Room 216
Sacramento, California 95814
Phone: (916) 445-5721

Copies of this summary may also be obtained from the following offices.

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2321 West Washington Street
Stockton, California 95203
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El Centro, California 92243
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Note: Current prices and shipment information on asparagus is available from the "California Tender Vegetables, Asparagus and Sweetpotatoes Report" issued by the Stockton Market News Service office, and the "Western Desert Vegetable Report" issued by the El Centro Market News Service office.

Released April 1987

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MARKETING CALIFORNIA ASPARAGUS

Summary of the 1986 Season

An 11% jump in total production led the way for a new record crop value of $75.5 million, up 1% over the previous record set in 1985. Production reached 53,800 tons with over 90% of the crop shipped fresh, while only 5,300 tons were sent to processors.

Fresh market shipments increased 21% as harvesting began extremely early in all producing districts, especially the southern desert valleys where harvested acreage jumped 63%. Overall, statewide acreage increased 7% to 37,800. Yields also showed a modest increase to 1.45 tons per acre.

Fresh market prices averaged $72.10 per hundredweight, 13% lower than in 1985. Processing prices averaged $39.00 per hundredweight, practically the same as during the previous year. The season average price was 9% below that for 1985 at $68.90 per hundredweight.

Fresh market shipments as reported by the Federal-State Market News Service rose over 18% with all producing districts reporting increased volume. California continued to be the nation's leading supplier with nearly 65% of the domestic supply. Washington regained its traditional position as the second leading producer with 24.9 million pounds, a 60% increase from the short 1985 crop. Imports continued to increase in volume with Mexico leading the way with nearly 20 million pounds, up 25% over 1985.

1986 HIGHLIGHTS COMPARED WITH 1985

HARVESTED ACREAGE - STATEWIDE, ALL USES
37,800 vs. 35,300 + 7.1%

YIELD PER ACRE (Hundredweight)
29 vs. 28 + 3.6%

TOTAL PRODUCTION (Hundredweight)
1,096,000 vs. 986,000 + 11.1%

UTILIZATION (Hundredweight)

FRESH MARKET	990,000	vs.	818,000	+ 21.0%
PROCESSING	106,000	vs.	168,000	- 37.0%

SEASON AVERAGE PRICE (Dollars per hundredweight)
68.90 vs. 75.70 - 9.0%

AVERAGE PRICE BY UTILIZATION (Dollars per hundredweight)

FRESH MARKET	72.10	vs.	83.30	-13.4%
PROCESSING	39.00	vs.	38.85	+ 0.4%

CROP VALUE, BY UTILIZATION (Dollars)

FRESH MARKET	71,379,000	vs.	68,139,000	+ 4.8%
PROCESSING	4,134,000	vs.	6,527,000	- 36.7%
TOTAL	75,513,000	vs.	74,666,000	+ 1.1%

FRESH MARKET SHIPMENTS (10,000 pound units)
9,366 vs. 7,897 + 18.6%

FRESH MARKET ARRIVALS AT 22 MAJOR U.S. AND 5 CANADIAN CITIES (10,000 pound units)
4,318 vs. 3,768 + 14.6%

MAJOR MARKETS FOR CALIFORNIA SHIPMENTS (10,000 pound units)

S.F. - OAKLAND	753	vs.	692	+ 9%
N.Y. - NEWARK	605	vs.	549	+ 10%
LOS ANGELES	481	vs.	389	+ 24%
BOSTON	502	vs.	359	+ 29%
PHILADELPHIA	294	vs.	394	- 25%
TORONTO	287	vs.	116	+ 147%

FRESH MARKET IMPORTS FROM MEXICO (10,000 pound units)
1,991 vs. 1,586 + 25%

DISTRICT SHIPPING POINT TRENDS

STOCKTON DELTA: Asparagus shipments for 1986 started on January 19, much earlier when compared with the February 23 start for the previous season. Harvested acreage was 21,065, down from 949 acres from the 22,554 for 1985. Although acreage was down, movement exceeded the previous year by about 240,000 thirty-pound pyramid cartons and crates.

Movement was generally light through February 24, with much heavier production starting up in March. The first f.o.b. price quote was reported on March 3. Demand was light for a 30-pound pyramid carton or crate, large at $20.00, standard $19.00. On March 5, prices lowered $1.00 for both sizes and remained at this level until March 10. On March 14 demand turned good and prices moved to $22.00 for large, standard at $21.00. Prices generally remained unchanged for the remainder of the month. The peak shipment week for the season was March 2-8 when a total of 152,000 cartons and crates were shipped by truck.

Movement for April remained heavy, prices lowering to $20.00 for large and standard at $19.00. On April 7, demand exceeded supply with prices ranging from $20.00-22.00 for large and $19.00-21.00 standard. On April 22, prices lowered under a very light demand to $18.00-20.00 large and standard at $18.00-19.00. By the end of the month large was down to $16.00-18.00 and standard $15.00.

In May, movement started to decline seasonally while prices remained about unchanged. The final f.o.b. price quote for the season was May 16. Demand was very light with large size $16.00, $15.00 for standard. Movement continued to decline when final shipments ended on July 9.

The late summer and early fall harvest started the week of August 3-9 and continued through October 25 with a total of 15,300 cartons and crates shipped.

SALINAS VALLEY: Very light movement started on January 15 compared to February 20 for 1985. Acreage harvested was 4,429, up 578 acres from the 3,851 for the previous year. Due to increased acreage and a long growing season, shipments increased by about 98,000 cartons and crates over last years production.

Shipments remained light through most of February. The first f.o.b. price quote was reported on February 26. Demand was fairly good. Large and standard were quoted at $24.00 for a 30-pound pyramid carton or crate.

Production increased during the month of March. Prices started at $20.00-22.00 with a fairly good demand. On March 18, prices moved up to $26.00-28.00 for both large and standard sizes and generally remained at this level through the end of the month. The peak shipment week for the season was March 2-8 when a total of 61,000 cartons and crates were shipped by truck.

Movement for April was fairly heavy. Demand was generally good through mid-month with prices of $26.00 for both large and standard. Demand turned light and prices lowered by month's end to $15.00-18.00 for both sizes.

Movement started a seasonal decline during May. Prices moved up slightly for the first part to $18.00-20.00. The final f.o.b. report for the season was May 22. Demand was fairly good, with a price of $16.00 for large and standard. Very light shipments continued until June 7.

IMPERIAL COACHELLA VALLEYS AND MEXICO IMPORTS THROUGH CALEXICO: Bearing acreage in the Southern California desert area (Imperial and Coachella Valleys) was up approximately 34% from last year. Yields averaged higher. Prices averaged slightly higher. In the Imperial Valley, approximately 76% was packed loose in pyramid crates while 24% was bunch packed or loose packed in 1/2 pyramid cartons. Most of the 1/2 pyramid cartons were packed early in the season when prices were highest. In the Coachella Valley, most supplies were packed loose in 1/2 pyramid cartons.

Bearing acreage in the Southern California desert area totaled around 5,818 acres compared with 4,335 in 1985. This included around 2,500 acres in Imperial Valley, 2,718 in Coachella Valley and 600 in Palo Verde Valley. Last year acreage in Imperial Valley was around 2,100 acres and in Coachella Valley 2,235 acres. This was the first year of production in the Palo Verde Valley.

The average yield per acre was estimated to be around 1.31 tons or 87 thirty pound crates in Imperial Valley and 1.28 tons or 85 thirty pound crates in Coachella Valley. This compares with last year's yield of 1.08 tons or 72 thirty pound crates in both the Imperial and Coachella Valleys. Acreage and yield figures for the Mexicali Valley of Mexico were not obtained.

Production from the Southern California desert area totaled around 454,427 thirty pound crates including 222,427 from Imperial Valley and 232,000 for Coachella Valley. The Coachella Valley shipments included around 35,000 crates shipped from Blythe. This compares with the total last year of 311,760 thirty pound crates including 150,624 from Imperial Valley

and 161,136 from Coachella Valley. According to the U.S. Department of Agriculture, Plant Protection and Quarantine Service, there were around 10,783,569 pounds or the equivalent of 359,452 thirty pound crates of asparagus from Mexico crossed through the Calexico port of entry to California. This compares with 7,910,918 pounds or the equivaleant of 263,697 thirty pound crates last year.

Very light harvest began in both the Imperial and Coachella Valleys in late December. The first crossings from Mexico through Calexico were on December 30. Movement from all three sections was heaviest during the latter part of February through March. Peak shipment day in Imperial Valley was March 11 when around 7,000 thirty pound crates were shipped. High days in Coachella Valley were March 13-14 and 18 when around 7,000 thirty pound crates were shipped each day. Peak day of imports crossing through Calexico was March 3 when 237,460 pounds or the equivalent of nearly 8,000 thirty pound crates crossed. Final shipments from Imperial Valley were on April 11, six days earlier than last year. Final shipments from the Coachella Valley were on April 12, seven days later than last year. The last crossings from Mexico through Calexico were on April 13, twelve days earlier than last year. Some production in Mexico was diverted to cannery beginning about March 14.

Shipping point prices were reported from February 25 through April 5. The Marketing pattern followed most past seasons. Prices were highest early in the season. Lowest prices were at the end of the season. Quotations for thirty pound pyramid crates, green, loose, large on Monday February 25 were $38.00-40.00 but by mid-week were down to $32.00-34.00. This was a satisfying trading level and trading increased. The market held about steady with the majority of sales at $32.00 through March 15. Prices eased slightly lower on March 18 to range $30.00-32.00. This price level was maintained through April 2. Demand turned lighter and by April 4 the market was down to $22.00-24.00, the lowest of the season. By this time, most growers were in the process of finishing the season. The simple average price for the season for pyramid crates, green, loose large was $31.35, standard $29.60 and small $26.37.

1985 CHILEAN

WHOLESALE TERMINAL MARKETS

BOSTON

ASPARAGUS

13.5 Pound Cartons Bunched

TUES-THURS	Jumbo	Extra-Large	Large	Standard	Small
Oct 2	35.00	-	33.00	30.00	-
9	-	25.00-28.00	25.00-28.00	24.00	26.00
11	-	-	-	-	-
16	30.00	-	25.00-28.00	24.00-26.00	22.00
18	-	-	-	-	-
23	27.00-28.00	17.00-25.00	17.00-25.00	-	-
25	-	-	-	-	-
30	-	-	-	-	-
Nov 1	24.00	24.00	24.00	-	-
6	-	-	-	-	-
8	-	-	-	-	-
13	40.00	40.00	38.00-40.00	30.00-35.00	-
15	35.00-40.00	35.00-40.00	35.00-40.00	-	-
20	40.00	40.00	40.00	-	-
22	-	-	-	-	-
27	-	-	36.00	36.00	-
29	30.00	-	-	-	-
Dec 4	-	33.00-42.00	33.00-34.00	-	-
6	40.00	38.00	38.00	-	-
11					
13	-	35.00-40.00	35.00-40.00	-	-
18	-	-	-	-	-
20	-	-	-	-	-
27	-	-	-	-	-

CHILEAN IMPORTS INCLUDING AIR & BOAT ARRIVALS WEEK ENDING SEPTEMBER 8, 1984 THROUGH JUNE 1, 1985

(10,000 POUND UNITS)

Date	APPLES	APRICOTS	ASPARAGUS	CHERRIES	GRAPES	HONEYDEWS	ONIONS	MXD MISC MELONS
09/08	-	-	-	-	-	-	-	-
09/15	-	-	-	-	-	-	-	-
09/22	-	-	1	-	-	-	-	-
09/29	-	-	17	-	-	-	-	-
10/06	-	-	28	-	-	-	-	-
10/13	-	-	22	-	-	-	-	-
10/20	-	-	9	-	-	-	-	-
10/27	-	-	53	-	-	-	-	-
11/03	-	-	10	1	-	-	-	-
11/10	-	-	24	1	-	-	-	-
11/17	-	-	14	2	-	-	-	-
11/24	-	-	-	-	-	-	-	-
12/01	-	-	11	6	-	-	-	-
12/08	-	4	20	4	-	-	-	-
12/15	-	3	4	7	2	-	-	-
12/22	-	28	7	32	5	-	-	-
12/29	-	22	5	41	119	-	-	-
01/05	-	4	8	19	146	-	-	-
01/12	-	2	2	2	100	-	-	-
01/19	-	7	-	-	272	10	-	-
01/26	-	2	-	-	1201	56	-	-
02/02	-	-	-	-	956	-	-	-
02/09	-	-	-	-	1363	123	[illegible]	35
02/16	24	-	1	-	1319	51	-	19
02/23	87	-	-	-	2015	149	-	24
03/02	298				2319	35	10	38
03/09	905	-	-	-	2298	31	43	32
03/16	672	-	-	-	3448	88	21	20
03/23	479	-	-	-	4152	15	65	47
03/30	380	-	-	-	3477	57	56	31
04/06	72	-	-	-	1982	15	-	-
04/13	227	-	-	-	2908	6	22	14
04/20	64	-	-	-	1276	14	23	-
04/27	488	-	-	-	4127	28	58	8
05/04	246	-	-	-	1773	3	56	1
05/11	168	-	-	-	675	-	6	-
05/18	-	-	-	-	-	-	-	-
05/25	200	-	-	-	185	-	2	-
06/01	-	-	-	-	-	-	-	-
TOTALS	4310	72	236	115	36128	681	362	269

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NEW YORK, 1985

ASPARAGUS

(Pyramid Crates Unless Otherwise Stated)

Mon.	CALIFORNIA 1/2 Cartons 13.5 Pounds Bunched 6s Extra Select and Select	CALIFORNIA 30 Pounds Loose Large	NEW JERSEY Field Run Bunched 12s	WASHINGTON USONE 30 Pounds Loose Large
Jan 2	-	-	-	-
7	-	-	-	-
14	60.00-70.00	-	-	-
21	-	-	-	-
28	-	-	-	-
Feb 4	30.00-35.00	-	-	-
11	-	-	-	-
19	-	-	-	-
25	32.00-36.00	50.00	-	-
Mar 4	22.00-25.00	35.00-40.00	-	-
11	-	44.00-45.00	-	-
18	20.00	40.00	-	-
25	-	38.00-40.00	-	-
Apr 1	-	36.00-38.00	-	-
8	-	25.00-28.00	-	-
15	-	18.00-20.00	-	-
22	-	20.00-22.00	-	25.00-27.00
29	-	20.00-22.00	22.00-23.00	-
May 6	-	20.00-22.00	18.00	25.00-27.00
13	-	24.00-26.00	26.00	26.00-28.00
20	-	18.00-20.00	22.00-24.00	23.00-26.00
28	-	15.00-18.00	18.00-20.00	18.00-22.00
Jun 3	-	-	-	24.00-26.00
10	-	-	-	26.00-28.00
17	-	26.00-28.00	-	32.00
24	-	35.00	-	36.00-40.00
Jul 1	-	40.00	-	-
8	-	-	-	-
15	-	-	-	-
22	-	-	-	-
29	-	-	-	-
Aug 5	-	-	-	-
12	-	-	-	-
19	-	-	-	-
26	-	-	-	-
Sep 3	-	-	-	-
9	-	-	-	-
16	-	-	-	-
23	-	-	-	-
30	-	-	-	-
Oct 7	-	-	-	-
15	-	-	-	-
21	-	-	-	-
28	-	-	-	-
Nov 4	-	-	-	-
12	-	-	-	-
18	-	-	-	-
25	-	-	-	-
Dec 2	-	-	-	-
9	-	-	-	-
16	-	-	-	-
23	-	-	-	-
30	-	-	-	-

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NEW YORK 1985

ASPARAGUS

1/2 Cartons 13.5 Pounds
Loose & Bunched

Mon.	MEXICO Jumbo Extra Large & Large	CHILE Jumbo Extra Large & large
Jan 2	-	-
7	-	-
14	-	-
21	-	-
28	-	-
Feb 4	30.00-35.00	-
11	-	-
19	-	-
25	50.00-52.00	-
Mar 4	-	-
11	23.00-24.00	-
18	-	-
25	-	-
Apr 1	20.00-22.00	-
8	-	-
15	12.00	-
22	-	-
29	-	-
May 6	-	-
13	-	-
20	-	-
28	-	-
Jun 3	-	-
10	-	-
17	-	-
24	-	-
Jul 1	-	-
8	-	-
15	-	-
22	-	-
29	-	-
Aug 5	35.00-40.00	-
12	23.00-26.00	-
19	14.00-20.00	-
26	14.00-16.00	-
Sep 3	15.00-18.00	-
9	13.00-25.00	-
16	20.00-25.00	30.00-35.00
23	25.00-30.00	30.00-35.00
30	28.00-35.00	28.00-40.00
Oct 7	16.00-20.00	22.00-28.00
15	18.00-26.00	16.00-26.00
21	20.00-24.00	23.00-28.00
28	28.00-30.00	26.00-32.00
Nov 4	26.00-30.00	24.00-30.00
12	32.00	30.00-36.00
18	-	30.00-40.00
25	-	40.00-50.00
Dec 2	-	35.00-44.00
9	-	32.00-38.00
16	-	38.00-45.00
23	-	-
30	-	-

CHICAGO 1985

	ANISE	ARTICHOKES	ASPARAGUS				
	CALIFORNIA	CALIFORNIA	CALIFORNIA		WASHINGTON	MEXICO	CHILE
	ctns 18-30s	ctns 18-60s	crts & ctns loose large 15-lb	30-lb	30-lb crts 3/8" min dia	1/2 Pyramid ctns lge lse	crts & ctns 12-lb lse lg
Jan 7	14.00-15.00	-	-	-	-	-	-
14	14.00	30.00	-	-	-	-	-
21	12.00-14.00	28.00-30.00	-	-	-	-	-
28	-	30.00	-	-	-	-	-
Feb 4	-	-	-	-	-	-	-
11	12.00-13.00	-	-	-	-	-	-
19	12.00-13.00	-	38.00-39.00	-	-	-	-
25	-	-	-	-	-	-	-
Mar 4	-	-	22.00-23.00	-	-	-	-
11	20.00	18.00-24.00	20.00-21.00	-	-	-	-
18	-	20.00-24.00	20.00-21.00	-	-	-	-
25	20.00	22.00-24.00	19.00-20.00	37.00-39.00	-	-	-
Apr 1	-	20.00-24.00	20.00-21.00	42.00	28.00	-	-
8	14.00	12.00-15.00	-	34.00-35.00	23.00	-	-
15	15.00-18.00	9.00-10.00	-	21.00-23.00	23.00	-	-
22	-	-	-	20.00-22.00	25.00	-	-
29	-	-	-	22.00-24.00	24.00-25.00	-	-
May 6	-	6.00- 8.00	-	20.00-22.00	23.00	-	-
13	-	10.00	-	21.00	-	-	-
20	-	10.00	-	23.00	-	-	-
28	-	10.00	-	22.00	-	-	-
June 3	-	10.00-20.00	-	-	-	-	-
10	-	-	-	30.00	-	-	-
17	-	-	-	-	-	-	-
24	-	18.00	-	-	-	-	-
July 1	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-
15	-	15.00-25.00	-	-	-	-	-
22	-	-	-	-	-	40.00	-
29	-	20.00-25.00	-	-	-	40.00	-
Aug 5	-	20.00-25.00	-	-	-	38.00-40.00	-
12	-	15.00-30.00	-	-	-	25.00-28.00	-
19	-	10.00-25.00	-	-	-	24.00-25.00	-
26	-	15.00-20.00	-	-	-	19.00-20.00	-
Sept 3	-	15.00-20.00	-	-	-	-	-
9	-	-	-	-	-	20.00	-
16	-	-	-	-	-	-	-
23	-	12.00-20.00	-	-	-	-	-
30	-	16.00-20.00	-	-	-	18.00	-
Oct 7	-	12.00-16.00	-	45.00	-	20.00	29.00
15	-	8.00-14.00	-	-	-	18.00-20.00	-
21	-	8.00-18.00	-	-	-	18.00	-
28	-	10.00-18.00	-	-	-	-	-
Nov 4	15.00	-	-	-	-	-	-
12	-	18.00-25.00	-	-	-	-	36.00
18	15.00	25.00	-	-	-	-	-
25	12.00-15.00	25.00	-	-	-	-	-
Dec 2	12.00	12.00-20.00	-	-	-	-	-
9	12.00	-	-	-	-	-	-
16	-	20.00-25.00	-	-	-	-	-
23	15.00	25.00	-	-	-	-	-
30	-	-	-	-	-	-	-

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ARTICLE M8

BUSINESSMEN'S GUIDE TO THE US MARKET: ASPARAGUS - Fresh, Chilled

Updated: April 1983

This document represents accurat information to the best of o knowledge at the time of wr ing

However, much of the informa on is subject to change. Therefore users are requested to check wit the AIO, London for a review of this data.

Phone: 01 499 0024

Size of Market (Consumption):

Year	Metric Tons
1980	435
1981	521
1982	500
1983	613
1984	866

of which:

Country of Origin	1980	1981	1982	1983	1984
UK production	1	1	1	1	1.0
USA	301	394	299	261	240.0
South Africa	21	34	41	35	56.2
Hungary	31	12	1	1	1.3
France	9	23	19	51	21.2
Italy	32	37	14	3	3.7
New Zealand	19	10	8	4	21.9
Other countries	51	10	-	16	12.3
Belgium/Luxembourg	-	-	3	-	-
Netherlands	-	-	26	-	7.6
Spain	-	-	13	104	384.1
Australia	-	-	33	25	44.8
Canada	-	-	18	9	-
Mexico	-	-	11	71	38.1
Chile	-	-	13	31	33.8

Import Duties:

Full rate (applicable to USA, South Africa, New Zealand, Australia, Mexico, Chile, Hungary) --- 16%

No duty applicable to imports from any EEC country.

Wholesale Prices - Pence per kilogram

	USA	South Africa	New Zealand	Homegrown Class I	Homegrown Class II
July 1980	-	-	-	357.2	138.9
Oct 1980	-	414.2	350.4	-	-
Feb 1981	374.0	-	-	-	-
May 1981	236.6	-	-	211.2	160.6
July 1981	-	-	-	263.8	183.7
Oct 1981	440.0	363.0	396.8	-	-
Feb 1982	551.2	-	-	-	-
May 1982	325.9	-	-	304.0	223.6
May 1983	374.9	-	-	-	-
Dec 1983	-	352.0	440.0	-	-
May 1984	264.0	-	-	-	-

Marketing/Distribution/Selling:

All imported product is brought in by importers/wholesalers. Some of these have their own distributiion network and others appoint a distributor to get the product into retail level. At retail level asparagus is sold in supermarkets, greengrocers (fruit and vegetable shops), Department Store food halls and market stalls. The product is sold both pre-packed and loose and is priced on a per lb basis. Average retail price in May 1983 is £3.00 per lb.

Principal Importers/Wholesalers:

Griffin & Brand (European) Ltd
Trophy House
Blackhorse Road
London SE8 5HY
Tel: 01 692 1007
Telex: 892076
Contact: Mr. A.J. Elliott
Managing Director

P. Weiser (London) Ltd
Unit B, Western Trading Estate
Trading Estate Road
Park Royal
London NW10 7LU
Tel: 01 961 3192
Telex: 916402
Contact: Mr. Paul Weiser
Managing Director

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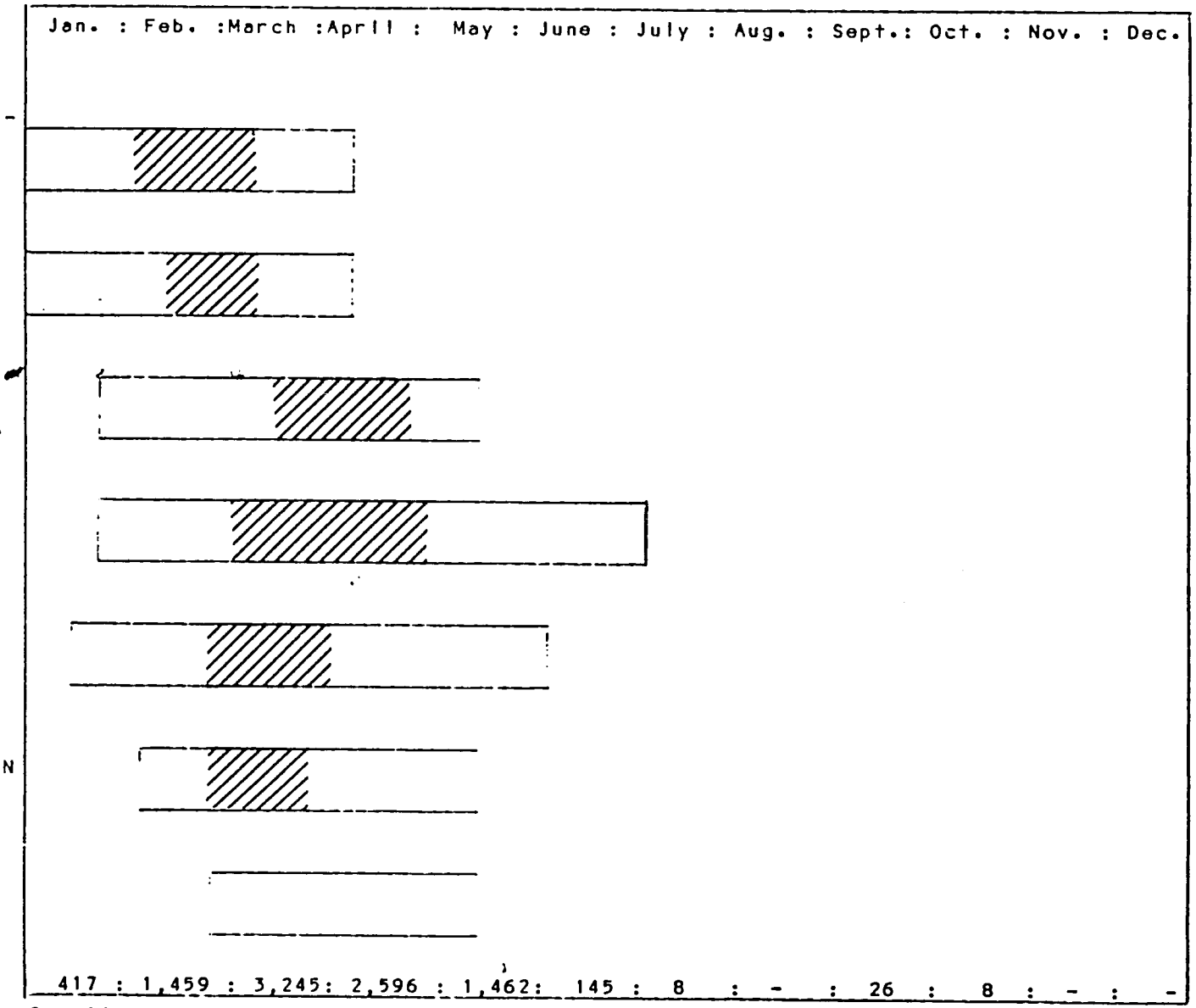
Mack & Edwards Distributors
Church Road
Paddock Wood
Kent
Tel: 089283 3366
Telex: 95215
Contact: Mr. W.J. Patay
Fresh Produce Buyer

J.D. Sims Ltd
Borough Market
London SE1 9AW
Tel: 01 407 0756
Telex: 8955386
Contact: Mr. Keith Sims
Managing Director

doc: asparagu

CALIFORNIA SHIPPING PERIODS BY DISTRICTS FOR FRESH MARKET ASPARAGUS CALENDAR YEAR 1986



SHIPPING DISTRICTS	SHIPMENTS 10,000 LB. UNITS	SHARE OF TOTAL PERCENT
PALO VERDE-COACHELLA VALLEYS	829	8.9
IMPERIAL VALLEY	1,115	11.9
SOUTHERN CALIFORNIA	306	3.3
STOCKTON DELTA	4,823	51.5
SALINAS VALLEY	1,662	17.7
SAN JOAQUIN VALLEY	500	5.3
SACRAMENTO VALLEY	131	1.4
	9,366	100.0

Compiled from Federal-State Market News Service shipment data.

Most active shipping period.

TABLE 1. FRESH MARKET ASPARAGUS SHIPMENTS, BY ORIGIN, BY CARRIER, BY MONTH, 1986

Origin and Carrier	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
						10,000 pound units							
California													
Air	-	-	-	-	-	-	-	-	-	-	-	-	-
Piggyback Van	-	-	4	-	-	-	-	-	-	-	-	-	4
Truck	417	1,459	3,241	2,596	1,462	145	8	-	26	8	-	-	9,362
Total	417	1,459	3,245	2,596	1,462	145	8	-	26	8	-	-	9,366
Arizona													
Truck	17	40	64	11	-	-	-	-	-	-	-	-	132
Washington													
Truck	-	-	-	995	1,065	430	-	-	-	-	-	-	2,490
Imports													
Argentina	-	-	-	-	-	-	-	-	-	3	1	-	4
Australia	-	-	-	-	-	-	-	-	-	1	-	1	2
Chile	6	-	-	-	-	-	-	-	6	296	60	48	416
Dominican Republic	-	-	-	-	-	-	-	-	-	1	-	-	1
Mexico													
Air	-	-	-	-	-	3	13	7	24	14	-	-	61
Truck	282	668	317	9	2	14	148	192	150	120	8	20	1,930
Netherlands	-	-	-	-	-	-	-	-	-	-	-	1	1
New Zealand													
Air	-	-	-	-	-	-	-	-	-	5	1	9	15
Peru													
Air	-	1	-	-	-	-	-	-	-	-	-	-	1
Taiwan	-	-	-	-	-	-	-	-	-	4	-	-	4
Total	288	669	317	9	2	17	161	199	180	444	70	79	2,435
Total Domestic Supply	722	2,168	3,626	3,611	2,529	592	169	199	206	452	70	79	14,423

Compiled from shipment records provided by the Transportation Reports Section, Fruit and Vegetable Division, Market News Branch, Agricultural Marketing Service, U.S. Department of Agriculture, Washington, D.C.

TABLE 2. FRESH MARKET ASPARAGUS SHIPMENTS FROM CALIFORNIA DISTRICTS, BY CARRIER, BY MONTH, 1986

District and Carrier	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
	10,000 pound units												
Imperial Valley													
Truck	215	495	369	36	-	-	-	-	-	-	-	-	1,115
Palo Verde - Coachella Valleys													
Truck	160	414	255	-	-	-	-	-	-	-	-	-	829
South Coast													
Rail-Truck	-	-	4	-	-	-	-	-	-	-	-	-	4
Truck	12	49	96	116	29	-	-	-	-	-	-	-	302
Total	12	49	100	116	29	-	-	-	-	-	-	-	306
San Joaquin Valley													
Truck	-	43	241	176	40	-	-	-	-	-	-	-	500
Salinas Valley													
Truck	28	201	652	460	304	17	-	-	-	-	-	-	1,662
Stockton Delta													
Truck	2	257	1,591	1,754	1,049	128	8	-	26	8	-	-	4,823
Sacramento Valley													
Truck	-	-	37	54	40	-	-	-	-	-	-	-	131
California Total													
Piggyback Van	-	-	4	-	-	-	-	-	-	-	-	-	4
Truck	417	1,459	3,241	2,596	1,462	145	8	-	26	8	-	-	9,362
Total	417	1,459	3,245	2,596	1,462	145	8	-	26	8	-	-	9,366

Compiled from shipment data collected at Federal-State Market News Service offices in California.

TABLE 3. ARRIVALS OF FRESH MARKET ASPARAGUS AT THE 22 MAJOR U.S. AND 5 CANADIAN CITIES, BY ORIGIN, BY CARRIER, 1986

City	Calif.	N.J.	Wash.	Canada	Chile		Mexico		New Zealand		Other	Total
	Truck				Air	Boat	Air	Truck	Air	Boat	a/	
	10,000 pound units											
EASTERN												
Atlanta, Ga.	56	-	3	-	-	7	-	34	-	1	-	101
Balt., Md.-Wash., D.C.	252	10	37	-	-	9	-	30	-	-	-	338
Boston, Mass.	502	3	173	-	2	21	5	66	8	-	2	782
Buffalo, N.Y.	76	1	18	-	-	2	-	2	-	-	2	101
Cincinnati, Oh.	58	-	22	-	-	2	-	26	-	1	3	112
Columbia, S.C.	8	1	-	-	-	-	-	1	-	-	-	10
Detroit, Mich.	43	-	9	-	-	1	-	48	-	-	6	107
N.Y., N.Y.-Newark, N.J.	605	9	58	-	352	37	45	66	2	-	8	1,182
Philadelphia, Pa.	294	14	143	-	2	12	1	40	-	-	6	512
Pittsburgh, Pa.	48	4	11	-	-	3	-	4	-	-	-	70
Total	1,942	42	474	-	356	94	51	317	10	2	27	3,315
WESTERN												
Chicago, Ill.	210b/	-	34	-	-	5	-	52	-	1	14	316
Dallas, Tex.	44	-	7	-	-	3	-	48	-	-	1	103
Denver, Colo.	106	-	37	-	-	-	-	2	-	-	4	149
Los Angeles, Calif.	481	-	83	-	2	12	1	105	32	-	3	719
New Orleans, La.	12	-	-	-	-	-	-	1	-	-	-	13
St. Louis, Mo.	82	-	11	-	-	2	-	10	-	-	1	106
S. Fran.-Oakland, Calif.	753	-	97	-	1	-	-	103	27	1	-	982
Seattle-Tacoma, Wash.	184	-	197	-	-	-	-	10	-	3	1	395
Total	1,872	-	466	-	3	22	1	331	59	5	24	2,783
TOTAL U.S.	3,814	42	940	-	359	116	52	648	69	7	51	6,098
CANADA												
Montreal, Que.	103	17	24	30	-	-	-	16	-	-	8c/	198
Ottawa, Ont.	14	-	9	15	-	-	-	-	-	-	-	38
Toronto, Ont.	287	1	15	145	-	-	-	20	-	-	80c/	548
Vancouver, B.C.	92	-	65	1	-	-	-	5	-	-	12c/	175
Winnipeg, Man.	8	-	7	13	-	-	-	2	-	-	-	30
Total	504	18	120	204	-	-	-	43	-	-	100	989
TOTAL U.S. & CANADA	4,318	60	1,060	204	359	116	52	691	69	7	151	7,087

Compiled from arrival data provided by the Transportation Reports Section, Fruit and Vegetable Division, Market News Branch, Agricultural Marketing Service, U.S. Department of Agriculture, Washington, D.C.

a/ Includes: Australia, Colorado, Delaware, Illinois, Indiana, Kentucky, Maryland, Massachusettes, Michigan, New Mexico, New York, Netherlands, and Peru.

b/ Includes rail-truck 4

c/ Imports (unspecified)

TABLE 4. F.O.B. SHIPPING POINT PRICES FOR ASPARAGUS FROM THE IMPERIAL-COACHELLA VALLEYS AND MEXICAN IMPORTS THROUGH CALEXICO, CALIFORNIA, 1986

Date		Pyramid Crates/Cartons - Loose Pack, 30 lbs.			1/2 Pyramid Cartons/Crates - Loose Pack, 15 lbs.		
		Large	Standard	Small	Large	Standard	Small
		Dollars per container					
Jan.	27	30.00-32.00	30.00	27.00-30.00	15.00-16.00	14.00-15.00	12.00-13.00
	28	28.00-30.00	26.00-30.00	24.00-28.00	14.00-15.00	13.00-15.00	12.00-13.00
	29	28.00-30.00	26.00-30.00	24.00-28.00	14.00-15.00	13.00-14.00	12.00
	30	28.00-30.00	26.00-30.00	24.00-26.00	14.00-15.00	13.00-14.00	11.00-12.00
	31	28.00-30.00	26.00-30.00	24.00-26.00	14.00-15.00	13.00-14.00	11.00-12.00
Feb.	3	28.00-30.00	26.00-30.00	24.00-26.00	14.00-15.00	13.00-14.00	11.00-12.00
	4	28.00-30.00	26.00-30.00	23.00-26.00	14.00-15.00	13.00-14.00	12.00
	5	28.00-30.00	26.00-30.00	23.00-26.00	14.00-15.00	13.00-14.00	12.00
	6	30.00-32.00	28.00-30.00	24.00-28.00	14.00-16.00	13.00-15.00	12.00-14.00
	7	30.00-34.00	28.00-33.00	24.00-28.00	15.00-17.00	14.00-16.00	12.00-14.00
	10	32.00-34.00	30.00-33.00	28.00-30.00	16.00-17.00	15.00-16.00	14.00-15.00
	11	34.00-40.00	32.00-38.00	28.00-36.00	18.00-19.00	17.00-19.00	14.00-17.00
	12	34.00-40.00	32.00-38.00	26.00-36.00	18.00-19.00	17.00-19.00	14.00-17.00
	13	36.00-42.00	36.00-40.00	30.00-36.00	18.00-20.00	17.00-20.00	14.00-18.00
	14	35.00-42.00	35.00-40.00	28.00-36.00	18.00-20.00	17.00-20.00	14.00-17.00
	17	HOLIDAY					
	18	36.00-38.00	34.00-36.00	28.00-30.00	18.00-19.00	17.00-18.00	14.00-16.00
	19	30.00-34.00	28.00-32.00	24.00-28.00	15.00-17.00	15.00-16.00	12.00-14.00
	20	26.00-30.00	25.00-28.00	22.00-26.00	14.00-16.00	13.00-15.00	12.00-13.00
	21	26.00-28.00	24.00-26.00	18.00-24.00	13.00-14.00	12.00-14.00	10.00-11.00
	24	23.00-28.00	22.00-26.00	18.00-22.00	12.00-14.00	11.00-13.00	9.00-11.00
	25	23.00-26.00	22.00-24.00	18.00-22.00	12.00-13.00	11.00-13.00	9.00-11.00
	26	21.00-26.00	21.00-24.00	18.00-20.00	10.00-12.00	10.00-12.00	8.00-10.00
	27	21.00-25.00	20.00-24.00	18.00-20.00	10.00-12.00	10.00-12.00	8.00- 9.00
	28	20.00-24.00	20.00-24.00	18.00-20.00	10.00-12.00	10.00-12.00	8.00- 9.00
Mar.	3	21.00-24.00	20.00-24.00	18.00-20.00	10.00-12.00	10.00-12.00	8.00-10.00
	4	21.00-24.00	20.00-24.00	18.00-20.00	10.00-12.00	10.00-12.00	8.00-10.00
	5	20.00-24.00	20.00-23.00	16.00-20.00	10.00-12.00	10.00-11.00	8.00- 9.00
	6	20.00-24.00	19.00-23.00	16.00-20.00	9.00-12.00	9.00-11.00	8.00- 9.00
	7	20.00-24.00	18.00-23.00	17.00-20.00	10.00-12.00	9.00-11.00	8.00- 9.00
	10	20.00-26.00	18.00-24.00	18.00-21.00	10.00-12.00	10.00-11.00	-
	11	20.00-26.00	20.00-24.00	18.00-21.00	10.00-12.00	10.00-11.00	-
	12	20.00-26.00	20.00-25.00	18.00-21.00	10.00-12.00	10.00-12.00	-
	13	22.00-26.00	20.00-25.00	18.00-21.00	10.00-12.00	10.00-12.00	-
	14	22.00-26.00	20.00-25.00	18.00-21.00	10.00-12.00	10.00-12.00	-
	17	24.00-26.00	22.00-25.00	20.00-21.00	-	-	-
	18	25.00-26.00	23.00-[illegible]	-	-	-	-
	19	25.00-30.00	25.00-[illegible]	-	-	-	-
	20	25.00-30.00	25.00-[illegible]	-	-	-	-
	21	25.00-30.00	25.00-28.00	-	-	-	-
		LAST REPORT					

Compiled from f.o.b. reports issued by the Federal-State Market News Service office at El Centro, California.

TABLE 5. F.O.B. SHIPPING POINT PRICES FOR ASPARAGUS FROM THE SALINAS DISTRICT, 1986

Date		Demand	30 Lb. Pyramid Crates or Cartons: Jumbo	Large	Standard
			Dollars per container a/		
Feb.	26	Fairly Good	20.00-23.00	20.00-23.00	20.00-23.00
	27	Good	22.00	22.00	22.00
	28	Good	22.00	22.00	22.00
Mar.	3	Fairly Good	20.00-22.00	20.00-22.00	20.00-22.00
	4	Fairly Light	20.00-22.00	20.00-22.00	20.00-22.00
	5	Fairly Good	20.00-21.00	20.00-22.00	20.00-22.00
	6	Fairly Good	20.00-21.00	20.00-22.00	20.00-22.00
	7	Fairly Good	20.00-22.00	20.00-22.00	20.00-22.00
	10	Fairly Good	20.00-22.00	22.00	22.00
	11	Fairly Light	20.00-22.00	22.00	22.00
	12	Fairly Good	20.00-22.00	22.00	22.00
	13	Jumbo Fairly Light, Others Good	20.00	23.00-24.00	23.00-24.00
	14	Very Good	20.00-24.00	24.00	24.00
	17	Good	24.00-26.00	24.00-26.00	24.00-26.00
	18	Very Good	24.00-26.00	26.00-28.00	26.00
	19	Exceeds Supply	26.00-28.00	26.00-28.00	26.00-28.00
	20	Exceeds Supply	26.00-28.00	26.00-28.00	26.00-28.00
	21	Far Exceeds Supply	26.00-28.00	26.00-28.00	26.00-28.00
	24	Good	26.00-28.00	26.00-28.00	26.00-28.00
	25	Good	24.00-26.00	26.00-28.00	26.00-28.00
	26	Jumbo Fairly Light, Others Very Good	24.00-26.00	26.00	26.00-28.00
	27	Jumbo Fairly Good, Others Very Good	24.00-26.00	26.00	26.00-28.00
	28	Very Good	24.00-26.00	26.00	26.00-28.00
	31	Fairly Good	24.00-26.00	26.00	26.00
April	1	Light	22.00-24.00	26.00	26.00
	2	Jumbo Fairly Light, Others Fairly Good	22.00-24.00	24.00-26.00	24.00-26.00
	3	Fairly Good	20.00-22.00	22.00-24.00	22.00-24.00
	4	Very Good	20.00-22.00	20.00-24.00	20.00-24.00
	7	Exceeds Supply	20.00-24.00	24.00-26.00	24.00-26.00
	8	Exceeds Supply	20.00-24.00	24.00-26.00	24.00-26.00
	9	Very Good	20.00-24.00	26.00	26.00
	10	Exceeds Supply	20.00-24.00	26.00	26.00
	11	Exceeds Supply	20.00-24.00	26.00	26.00
	14	Good	20.00-24.00	26.00	26.00
	15	Fairly Good	21.00-24.00	26.00	26.00
	16	Fairly Good	20.00-24.00	26.00	26.00
	17	Good	20.00-24.00	26.00	26.00
	18	Good	20.00-24.00	26.00	26.00
	21	Fairly Light	20.00-24.00	24.00	24.00-26.00
	22	Very Light	20.00-22.00	22.00-24.00	24.00
	23	Very Light	20.00	20.00-22.00	22.00
	24	Light	18.00-20.00	20.00	20.00-22.00
	25	Fairly Good	18.00-20.00	20.00	20.00-22.00
	28	Light	18.00-20.00	18.00-20.00	18.00-20.00
	29	Very Light	18.00-20.00	18.00-20.00	18.00-20.00
	30	Light	15.00-18.00	15.00-18.00	15.00-18.00
May	1	Light	15.00-18.00	15.00-18.00	15.00-18.00
	2	Fairly Light	15.00-18.00	15.00-18.00	15.00-18.00
	5	Fairly Good	15.00-18.00	16.00-18.00	16.00-18.00
	6	Fairly Good	15.00-18.00	16.00-18.00	16.00-18.00
	7	Fairly Good	16.00-18.00	17.00-18.00	17.00-20.00
	8	Good	18.00	18.00-20.00	18.00-20.00
	9	Good	18.00-20.00	18.00-20.00	18.00-20.00
	12	Fairly Light	18.00-20.00	18.00-20.00	18.00-20.00
	13	Light	18.00	18.00	18.00
	14	Very Light	18.00	18.00	18.00
	15	Very Light	16.00-18.00	16.00-18.00	16.00-18.00
	16	Very Light	16.00-18.00	16.00-18.00	16.00-18.00
	19	Very Light	14.00-16.00	14.00-16.00	15.00-18.00
	20	Light	16.00	16.00	16.00
	21	Light	16.00	16.00	16.00
	22	Fairly Good	16.00	16.00	16.00
				LAST REPORT	

Compiled from f.o.b. reports issued by the Federal-State Market News Service office at Stockton, California.

a/ Hydrocooling and palletizing extra.

TABLE 6. F.O.B. SHIPPING POINT PRICES FOR ASPARAGUS FROM THE STOCKTON DELTA DISTRICT, 1986

Date		Demand	30 Lb. Pyramid Crates or Cartons		
			Jumbo	Large	Standard
			Dollars per container a/		
Mar.	3	Light	21.00-22.00	20.00	19.00
	4	Fairly Light	20.00-21.00	18.00-20.00	17.00-19.00
	5	Fairly Good	20.00	18.00	17.00
	6	Good	19.00	18.00	17.00
	7	Good	19.00-20.00	18.00-20.00	17.00-19.00
	10	Fairly Good	20.00-22.00	20.00	19.00
	11	Fairly Good	20.00-22.00	20.00	19.00
	12	Fairly Good	20.00-22.00	20.00	19.00
	13	Fairly Good	22.00	22.00	21.00
	14	Good	22.00	22.00	21.00
	17	Good	22.00	22.00	21.00
	18	Very Good	22.00	22.00	21.00
	19	Exceeds Supply	22.00	22.00	21.00
	20	Exceeds Supply	22.00	22.00	21.00
	21	Exceeds Supply	22.00	22.00	21.00
	24	Very Good	22.00	22.00	21.00
	25	Very Good	22.00	22.00	21.00
	26	Very Good	22.00	22.00	21.00
	27	Very Good	22.00	22.00	21.00
	28	Very Good	22.00	22.00	21.00
	31	Fairly Light	22.00	22.00	21.00
April	1	Light	22.00	22.00	21.00
	2	Fairly Good at Lower Prices	20.00	20.00	19.00
	3	Good	20.00-21.00	20.00	19.00
	4	Very Good	20.00-21.00	20.00	19.00
	7	Exceeds Supply	22.00	20.00-22.00	19.00-21.00
	8	Exceeds Supply	22.00	20.00-22.00	19.00-21.00
	9	Exceeds Supply	22.00	20.00-22.00	19.00-21.00
	10	Exceeds Supply	22.00	22.00	21.00-22.00
	11	Exceeds Supply	22.00	22.00	21.00-22.00
	14	Good	22.00	22.00	21.00-22.00
	15	Good	22.00	22.00	21.00-22.00
	16	Fairly Good	22.00	22.00	21.00-22.00
	17	Good	22.00	22.00	21.00-22.00
	18	Good	22.00	22.00	21.00-22.00
	21	Fairly Light	20.00-22.00	20.00-22.00	19.00-21.00
	22	Very Light	-	18.00-20.00	18.00-19.00
	23	Fairly Light	-	18.00	17.00
	24	Fairly Light	-	18.00	17.00
	25	Fairly Light	-	18.00-20.00	17.00
	28	Very Light	-	18.00	17.00
	29	Very Light	-	16.00	15.00
	30	Light	-	16.00	15.00
May	1	Light	-	16.00	15.00
	2	Fairly Light	-	16.00	15.00
	5	Fairly Good	-	16.00	15.00
	6	Fairly Light	-	16.00	15.00
	7	Fairly Light	-	16.00	15.00
	8	Fairly Good	-	16.00	15.00
	9	Fairly Good	-	16.00	15.00
	12	Fairly Light	-	16.00	15.00
	13	Light	-	16.00	15.00
	14	Very Light	-	16.00	15.00
	15	Light	-	16.00	15.00
	16	Very Light	-	16.00	15.00

- LAST REPORT

Compiled from f.o.b. reports issued by the Federal-State Market News Service Office at Stockton, California.

a/ Hydrocooling and palletizing extra.

TABLE 7. WHOLESALE MARKET PRICES FOR CALIFORNIA ASPARAGUS AT LOS ANGELES AND SAN FRANCISCO, BY WEEKS, 1986

Midweek Date		South/Central/Imperial Valley Districts: Select: 13.5 pound bunch	15 pound bunch	Large: 30 pound loose	Midweek Date		All Calif. Dist. Large: 30 pound loose
		Dollars per crates or cartons					
		LOS ANGELES					SAN FRANCISCO
January	2	-	50.00	-	January	3	-
	9	-	-	-		8	38.00
	16	24.00-25.00	30.00	-		15	25.00
	23	18.00-20.00	20.00-23.00	-		22	23.00-25.00
	30	22.00-24.00	25.00-26.00	30.00-35.00		29	36.00
February	6	22.00-26.00	16.00-17.00	34.00-36.00	February	5	36.00
	13	-	-	45.00-50.00		12	37.00
	20	26.00-30.00	-	40.00-45.00		19	40.00-45.00
	27	14.00-16.00	13.00	18.00-25.00		26	25.00-26.00
March	6	16.00-17.00	-	23.00-25.00	March	5	22.00-25.00
	13	15.00-17.00	-	20.00-23.00		12	22.00-25.00
	20	17.00-20.00	-	28.00-30.00		19	24.00-25.00
	27	24.00-26.00	-	28.00-30.00		26	24.00-25.00
April	3	18.00-19.00	-	25.00-28.00	April	2	23.00-25.00
	10	15.00-17.00	-	25.00-30.00		9	23.00-25.00
	17	18.00	-	28.00-30.00		16	23.00-25.00
	24	-	-	23.00-27.00		23	23.00-25.00
						30	23.00-25.00
May	1	-	-	21.00-25.00	May	7	23.00-25.00
	8	-	-	21.00-23.00		14	23.00-25.00
	15	-	-	21.00-23.00		21	23.00-25.00
	22	-	-	18.00-21.00		28	23.00-25.00
	29	-	-	18.00-24.00			
June	5	-	-	20.00-22.00	June	4	18.00
	12	-	-	26.00-29.00		11	22.00
	19	-	-	32.00-35.00		18	30.00
	26	-	-	-		25	35.00
July	3	-	-	-	July	2	35.00
	10	-	-	-		9	-
	17	-	-	-		16	-
	24	-	-	-		23	-
	31	-	-	-		30	-
August	7	-	-	-	August	6	-
	14	-	-	-		13	-
	21	-	-	-		20	28.00-30.00
	28	-	-	-		27	25.00-28.00
September	4	-	-	-	September	3	25.00-28.00
	11	-	-	-		10	-
	18	-	-	-		17	-
	25	-	-	-		24	24.00-25.00
October	2	-	22.00-23.00	-	October	1	30.00
	9	-	21.00	-		8	30.00
	16	-	18.00-20.00	-		15	23.00-24.00
	23	-	18.00-20.00	-		22	22.00
	30	-	-	-		29	22.00
November	6	26.00	-	-	November	5	22.00
	13	28.00-29.00	-	-		12	21.00-22.00
	20	-	-	-		19	25.00-26.00
	26	-	-	-		26	27.00-28.00
December	4	-	-	-	December	3	-
	11	-	-	-		10	29.00
	18	-	-	-		17	-
	24	-	40.00-50.00	-		24	55.00
	31	-	40.00-42.00	-		31	55.00

Compiled from wholesale market summaries issued by the Federal-State Market News Service offices at Los Angeles and San Francisco, California.

TABLE 8. WHOLESALE MARKET PRICES FOR CALIFORNIA ASPARAGUS AT BOSTON, CHICAGO, AND NEW YORK, EACH MONDAY, 1986 a/

Date		Boston		Chicago		New York	
				Loose, Large			
		30 Pounds	15 Pounds	30 Pounds	15 Pounds	30 Pounds	15 Pounds
				Dollars per carton/crate			
January	6	-	-	-	-	-	-
	13	-	40.00-45.00	-	50.00	-	40.00
	21	-	24.50-26.00	-	25.00	-	-
	27	-	17.50	-	24.00	-	24.00-25.00
February	3	-	17.50-18.00	40.00	20.00	-	17.00-18.00
	10	37.00	-	40.00	-	35.00-40.00	20.00-22.00
	17	45.00-48.00	-	44.00-45.00	-	-	-
	24	28.00-32.00	14.00-15.00	35.00-38.00	-	34.00-36.00	-
March	3	24.00-28.00	-	27.00-30.00	18.00	22.00-28.00	-
	10	24.00-27.00	-	30.00-31.00 a/	16.00-17.00 a/	27.00-28.00	-
	17	27.00-29.00	-	25.00-27.00	-	24.00-25.00	-
	24	28.00-30.00	-	30.00-34.00	-	28.00-32.00	-
	31	32.00-34.00	-	33.00-35.00	-	32.00-34.00	-
April	7	33.00-35.00	-	27.00-31.00	-	30.00-32.00	-
	14	26.00-30.00	-	30.00	-	30.00-32.00	-
	21	28.00-30.00	-	30.00-32.00	-	32.00-35.00	-
	28	22.00-24.00	-	25.00-26.00	-	23.00-25.00	-
May	5	23.00-24.00	-	22.00-25.00	-	20.00-22.00	-
	12	22.00-25.00	-	-	12.00-13.00	24.00-26.00	-
	19	23.00-26.00	-	19.00-20.00	-	20.00-23.00	-
	26	-	-	-	-	20.00	-
June	2	-	-	-	-	22.00-24.00	-
				LAST REPORT			

Compiled from wholesale market wires issued by Federal-State Market News Service offices at Boston, Massachuettes; Chicago, Illinois; and The Bronx, New York.
a/ Extra large.

TABLE 9. PRODUCTION, PRICE AND CROP VALUE OF CALIFORNIA ASPARAGUS BY UTILIZATION, 1984-1986

Utilization	Production 1984	Production 1985	Production 1986	Average Price Per Unit 1984	Average Price Per Unit 1985	Average Price Per Unit 1986	Crop Value 1984	Crop Value 1985	Crop Value 1986
	1,000 cwt.			Dollars per cwt.			1,000 dollars		
Fresh Market	739	818	990	74.40	83.20	72.10	54,982	68,139	71,379
Processing	116	168	106	41.50	38.90	39.00	4,814	6,527	4,134
Total/Average	855	986	1,096	69.90	75.70	68.90	59,796	74,666	75,513

Compiled from "California Vegetable Review Issued January 30, 1987 by the California Agricultural Statistics Service, Sacramento California.

TABLE 10. CANNED GREEN ASPARAGUS, U.S. SUPPLY STOCKS AND SHIPMENTS, 1984-1986 a/

Supply Stocks	1984	1985	1986	% Change One Year Ago
		Actual Cases		
Carryover, March 1	685,000	792,000	785,000	- 1
Pack	2,548,000	2,752,000	2,815,000	+ 2
Total Supply	3,233,000	3,544,000	3,600,000	+ 1
Stocks, October 1	1,833,000	2,051,000	1,166,000 b/	-43
Shipments March 1 to October 1	1,400,000	1,493,000	2,434,000 b/	+63

Compiled from National Food Processors Association Statistical Report for January 1, 1986 issued at Washington, D.C.
a/ Green only; does not include white asparagus.
b/ January 1, 1987 data

TABLE 11. CANNED GREEN ASPARAGUS PACK, BY CONTAINER, 1986

	24-8 Ounce	48-1 Picnic	24-15 Ounce	24/300 Cans	6-5 Squat	6-10 Instl.	Misc. Tin and Glass	Total Green
Actual Cases	240,000	a/	b/	2,075,000	c/	54,000	446,000	2,815,000

Compiled from National Food Processors Association Statistical Report for October 1, 1986 at Washington, D.C.
a/ Combined in miscellaneous total.
b/ Combined in 24-300.
c/ Combined in 6-10.

TABLE 12. FROZEN ASPARAGUS PACKED IN THE U.S., BY STYLE AND BY CONTAINER SIZE CLASSIFICATION 1983-1986

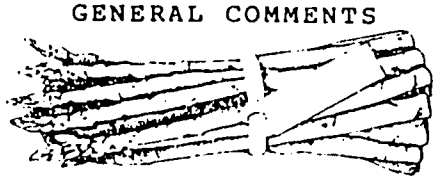
Pack and Container	1983	1984	1985	1986 a/
		1,000 pound units		
Pack Style				
Spears	7,563	7,776	9,778	7,610
Cuts	6,036	7,323	10,212	9,052
Container Size				
Retail	4,666	4,263	5,201	5,641
Food Service	8,134	8,168	9,102	7,730
Bulk	1,387 b/	2,668	5,687	3,291
Total Pack	13,599	15,099	19,990	16,662

Compiled from data provided by the American Frozen Food Institute, Burlingame, California.
a/ Preliminary.
b/ Includes 588 carryover from 1982.

ARTICLE M3

MARKETING WASHINGTON ASPARAGUS - 1986 CROP

GENERAL COMMENTS



WEATHER, GROWING & HARVESTING CONDITIONS: Bed preparation and planting began on March 20th. Harvest began in the warmest areas April 2nd. It peaked as temperatures increased, but supplies were limited by sub-freezing temperatures on April 24th and 25th. Temperatures were cooler than normal during the first part of May with temperatures dropping as low as 25 degrees on May 2nd. Harvest continued as temperatures increased, reaching an unseasonably warm 102 degrees on May 30th. After two weeks of hotter than normal weather, temperatures regulated in June as harvest wound down until the last shipments were made on June 27th.

PRODUCTION: The 1986 Washington asparagus crop was estimated at 30,000 harvested acres with a total production of some 780,000 cwt., down 4% from 1985. Average yield was 26 cwt. per acre, down from 28 cwt. per acre in 1985. Total value of the crop was also down 7% from 1985 to $39.7 million.

MARKETING: First f.o.b. reports came on April 11th with 30 pound pyramid crates, 85% or more green, 7-8 or 9 inch cut, Washington Extra Fancy, large and standards selling for $24.00-25.00. The market declined until it hit a season low of $18.00-19.00 from May 20-23rd. As supplies dwindled, the market climbed to it's high and close of $28.00-30.00 on June 24-25th.

Marketing of Washington Extra Fancy jumbo's began April 28th with that size earning the same rate as large and standards opening at $21.00-22.00 and closing May 7th at $21.00-22.00.

Washington 20 pound Consumer Pack cartons opened on April 11th at a season high of $9.00-10.00. Like the others, supplies of the Consumer Packs were shut off due to cold temperatures on April 24-25th. It declined only slightly throughout the season hitting a low of $8.50-9.00 on June 3-12th and closing on June 12th at that price.

F.o.b. sales of Washington Consumer Pack 1/4 inch minimum, 1 1/2 maximum white, random length, 30 pound pyramid crates began April 11th at $21.00. The market declined and closed at a season low of $16.00-17.00 on April 17th.

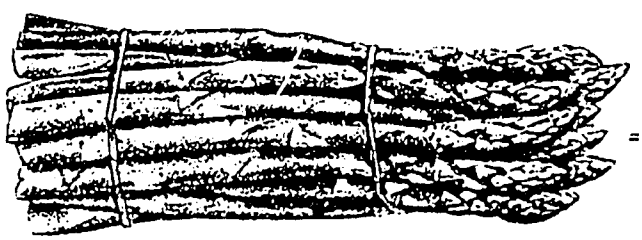
Quality opened very high and remained generally good throughout the season. During the very hot spells as the season wound down, heavy diversion to processors was necessary to keep the quality of the fresh crop manageable.

SHIPMENTS: 1986 was a record year for shipments of fresh asparagus from Washington, with a total of 24.9 million pounds compared to 15.27 million in 1985 and 21.04 million in 1984, the previous record. Peak movement was during the week ending April 26th when 3.9 million pounds were shipped. Average weekly shipments for the season were about 1.9 million pounds. 726,672 - 30 pound crates made up 82% of the fresh shipments; the remaining 18% was shipped in 156,754 - 20 pound cartons.

A S P A R A G U S 1/
AREA, YIELD PER ACRE, PRODUCTION & VALUE
1985 AND 1986

Production of asparagus in the major producing states is estimated at 2.15 million cwt. (97.5 thousand metric tons), 4% more than a year ago. Harvested acreage is placed at 89.9 thousand acres (36.4 thousand hectares), a 5% increase from 1985. The yield is estimated at 24 cwt. per acre, the same as last year.

STATE	AREA PLANTED 1985	AREA PLANTED 1986	AREA HARVESTED 1985	AREA HARVESTED 1986	YIELD PER ACRE 1985	YIELD PER ACRE 1986
	acres				cwt.	
California	35,300	37,800	35,200	37,500	28	29
Michigan	20,000	21,000	19,200	20,500	12	12
New Jersey	2,000	2,000	1,900	1,900	19	19
Washington	31,000	32,000	29,000	30,000	28	26
TOTAL	88,300	92,800	85,300	89,900	24	24



STATE	PRODUCTION 1985	PRODUCTION 1986	VALUE PER CWT. 1985	VALUE PER CWT. 1986	VALUE TOTAL 1985	VALUE TOTAL 1986
	1,000 cwt.		dollars		1,000 dollars	
California	986	1088	75.70	67.20	74,666	73,083
Michigan	230	246	58.40	58.20	13,423	14,311
New Jersey	36	36	68.70	64.60	2,473	2,326
Washington	812	780	52.30	50.80	42,443	39,660
TOTAL	2,064	2,150	64.40	60.20	133,005	129,380

1/ Includes fresh market and processing.

A S P A R A G U S

WEEKLY SHIPMENTS FROM APRIL 12, 1986 THRU JULY 12, 1987

Amounts are shown in 10,000 pound units

	APRIL			MAY					JUNE				JULY		
	12	19	26	3	10	17	24	31	7	14	21	28	5	12	TOTAL
WASHINGTON															
Piggypack	—	4	—	—	—	—	—	—	—	—	—	—	—	—	4
Truck	121	345	388	277	287	255	181	201	207	151	41	31	—	—	2485
ARIZONA															
Truck	8	—	—	—	—	—	—	—	—	—	—	—	—	—	8
CALIFORNIA - NORTHERN															
Truck	8	14	15	14	15	13	6	—	—	—	—	—	—	—	85
CALIFORNIA - CENTRAL															
Truck	614	516	530	520	412	337	265	157	82	36	20	5	8	2	3504
CALIFORNIA - IMPERIAL VALLEY															
Truck	12	—	—	—	—	—	—	—	—	—	—	—	—	—	12
Total Calif.	634	530	545	534	427	350	271	157	82	36	20	5	9 8	2	3601
MEXICO															
Truck Import	5	—	—	—	—	—	—	—	2	—	—	9	21	37	74
TOTAL															
Piggyback	—	4	—	—	—	—	—	—	—	—	—	—	—	—	4
Truck	763	875	933	811	714	605	452	358	289	187	61	36	8	2	6094
GRAND TOTAL MOVEMENT															
Domestic & Import	768	879	933	811	714	605	452	360	289	187	61	45	29	39	6172

All 1986 figures are subject to revision...

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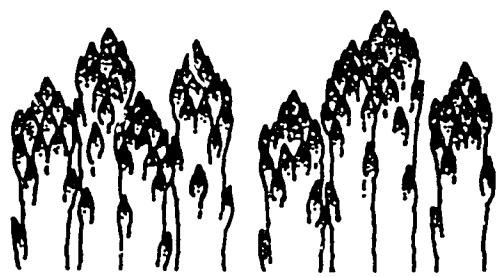
A S P A R A G U S

Rail & Truck Arrivals in 22 U.S. & 5 Canadian Cities
APRIL - MAY - JUNE----1986 CROP-----10,000 Lb. Units

	CALIF.	N.J.	WASH.	MEXICO	OTHER	T O T A L
Atlanta	27	--	2	--	--	29
Baltimore-Washn DC	96	10	37	--	--	143
Boston	198	3	173	--	1	375
Buffalo	47	1	18	--	1	67
Chicago	127	--	34	--	13	174
Cincinnati	22	--	22	--	3	47
Columbia	2	1	--	--	--	3
Dallas	26	--	6	2	--	34
Denver	35	--	37	--	4	76
Detroit	22	--	8	--	6	36
Los Angeles	233	--	80	2	--	315
New Orleans	7	--	--	--	--	7
New York-Newark	296	9	56	--	1	362
Philadelphia	145	14	143	1	4	307
Pittsburgh	25	4	11	--	--	40
St. Louis	40	--	11	--	1	52
San Francisco-Oakland	476	--	78	--	--	554
Seattle-Tacoma	33	--	190	--	1	224
TOTAL	1857	42	906	5	35	2845
5 C A N A D I A N C I T I E S - - -						
Montreal	61	17	24	--	29	131
Ottawa	3	--	9	--	15	27
Toronto	146	1	15	--	113	275
Vancouver	53	--	64	--	1	118
Winnipeg	4	--	7	--	12	23
TOTAL	267	18	119	--	170	574

U.S. EXPORTS OF FRESH ASPARAGUS TO SELECTED DESTINATIONS
Current Month, Current Marketing Season and Last Season
(Units in Metric Tons)

COMMODITY REGION/COUNTRY (Beg. Mktg Year)	AUGUST 1985	AUGUST 1986	SEASON TO DATE PREVIOUS	SEASON TO DATE CURRENT	LAST FULL SEASON
FRESH ASPARAGUS.....(Oct)	4	8	6	13	5,087
Canada.....	1	6	3	10	1,946
European Com.-Ten...	--	--	--	--	447
Other W. Europe.....	2	--	2	--	191
E. Asia & Pacific...	--	--	--	1	2,398
Japan.....	--	--	--	1	2,257
Latin America, Exc. Carribean.....	--	--	--	--	101
Bermuda & Carribean.	1	--	1	--	3
Other.....	--	1	--	1	--



U.S. IMPORTS OF ASPARAGUS FROM SELECTED COUNTRIES
Current Month, Current Marketing Season and Last Season
(Units in Metric Tons)

COMMODITY REGION/COUNTRY (Beg. Mktg Year)	DECEMBER 1985	DECEMBER 1986	SEASON TO DATE PREVIOUS	SEASON TO DATE CURRENT	LAST FULL SEASON
FRESH ASPARAGUS.....(Oct)	713	828	2,049	2,8[illegible]	9,924
Mexico.....	181	124	1,092	1,068	8,670
CANNED ASPARAGUS.....(Apr)	116	84	1,878	1,586	2,595
China (Taiwan).....	82	44	624	1,131	899
Mexico.....	2	--	1,033	208	1,332

SOURCE: USDA, Foreign Agricultural Service

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A S P A R A G U S
LOWER YAKIMA VALLEY AND WALLA WALLA DISTRICTS
Daily f.o.b. Prices - - - 1986 Crop

	30# Pyramid Crates 85% or more green 7 - 8 - 9 inch cut Washington Extra Fancy		1/4" Min. - 1 1/2" Max. White Random Length WA. Consumer Packs	
	JUMBO	STANDARD	30# CARTONS	20# CARTONS
April				
11	24.00-25.00	24.00-25.00	21.00	9.00-10.00
14	24.00-25.00	24.00-25.00	21.00	9.00
15	24.00	24.00	20.00-21.00	9.00
16	24.00	24.00	20.00-21.00	9.00
17	24.00	24.00	20.00-21.00	9.00
18	24.00	24.00	20.00-21.00	9.00
21	22.00	22.00	18.00-19.00	8.50-9.00
22	21.00-22.50	21.00-22.50	16.00-18.00	8.50-9.00
23	20.00-22.50	20.00-22.50	16.00-17.00	8.50-9.00
24	No Prices Reported...			
25	Supplies Insufficient To Report...			
28	21.00-22.00*	21.00-22.00*	----	9.00-9.50
29	19.00-21.00*	19.00-21.00*	----	9.00-9.50
30	19.00-21.00*	19.00-21.00*	----	9.00-9.50
May				
1	19.00-21.00	19.00-21.00		9.00-10.00
2	20.00-21.00	20.00-21.00		9.50
5	19.00-21.00	19.00-21.00		9.00
6	20.00	20.00		9.00
7	19.00-21.00	19.00-21.00		9.00
8	19.00-21.00	19.00-21.00		9.00
9	19.00-21.00	19.00-21.00		9.00
12	19.00-20.00	19.00-20.00		9.00
13	19.00-20.00	19.00-20.00		9.00
14	19.00-20.00	19.00-20.00		9.00
15	19.00	19.00		9.00
16	18.50-19.00	18.50-19.00		9.00
19	18.50-19.00	18.50-19.00		9.00
20	18.00-19.00	18.00-19.00		9.00
21	18.00-19.00	18.00-19.00		9.00
22	18.00-19.00	18.00-19.00		9.00
23	18.00-19.00	18.00-19.00		9.00
26	holiday	holiday		holiday
27	19.00	19.00		9.00
28	19.00-20.00	19.00-20.00		9.00
29	19.00-20.00	19.00-20.00		9.00
30	19.00-20.00	19.00-20.00		9.00
June				
2	19.00-20.00	19.00-20.00		9.00
3	20.00	20.00		8.50-9.00
4	21.00-22.00	21.00-22.00		8.50-9.00
5	21.00-23.00	21.00-23.00		8.50-9.00
6	22.00-23.00	22.00-23.00		8.50-9.00
9	24.00	24.00		8.50-9.00
10	24.00	24.00		8.50-9.00
11	24.00	24.00		8.50-9.00
12	24.00	24.00		8.50-9.00
13	25.00	25.00		too few to quote
16	25.00	25.00		
17	25.00	25.00		
18	25.00	25.00		
19	25.00	25.00		
20	25.00	25.00		
23	25.00	25.00		
24	28.00-30.00	28.00-30.00		
25	28.00-30.00	28.00-30.00		

*Includes few Jumbo

ARTICLE X14

REVIEW OF THE SEASON

ASPARAGUS The unusually warm and early spring of 1985 forced asparagus into production at a record setting early date. Typically the harvest begins in early May; however, in 1985 some asparagus had been delivered to a processor in the southwest on April 20th. As most migrant labor crews had not arrived some early fields were not harvested.

The processor price was established at 56 cents per pound on select grade all-green asparagus spears having a maximum length of 7-1/2 inches.

Fresh market tonnage was limited due to the strong processor price, and to very competitive fresh market prices from the west coast. Although daily f.o.b. shipping point prices were not issued by the Market News Service the following prices were recorded: Michigan All-Green hand snapped 30 lb. pyramid crates, loose $21.00-23.00, 10 lb. cartons $6.50-7.00, 10 lb. pyramid cartons $7.50-8.00.

BLUEBERRIES The harvest of blueberries began several weeks earlier than normal in 1985. This was due to the unusally warm spring, which was free of damaging frosts, that is except for an expensive frost on June 15th which damaged fruit in the Grand Junction area.

The harvest began as early as the 24th of June in Southwest Michigan. Sales on 12 film wrapped pints were mostly $10.75-11.00, f.o.b. shipping point. As is typical, prices declined, when the harvest of Blue Crops became active, and sales bottomed-out at $9.00 in mid-July. When the harvest of the Jersey variety began in late July the market became stronger as it became evident that this key variety was "picking-out" short. This was compounded in mid-August by rains which decreased offerings of top quality fruit.

The prices paid by processors for blueberries ranged widely in 1985. According to variety, method of harvest, and quality, prices were reported in a full range from 42 to 85 cents per pound. Many of the purchases were reported from 45 to 58 cents per pound.

TART CHERRIES Thanks to an excellent blossom period and lack of frost Michigan cherry trees produced a better than average crop in 1985. This in effect was the second of two very productive back-to-back crop years. As a consequence of the carry over from 1984 and lagging sales, the market for raw product was established at a weak level in 1985. Prices were settled between tart cherry growers and processors at 28 cents per pound on 92 score cherries.

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ASPARAGUS MICHIGAN, 1985

WEEKLY RECEIPTS OF ASPARAGUS DELIVERED TO MICHIGAN PROCESSORS OR RECEIVING STATIONS (In Pounds)

WEEK ENDING	FROZEN	TOTAL TO DATE FROZEN	CANNED WEEKLY	TOTAL TO DATE CANNED	TOTAL WEEKLY FROZEN & CANNED	TOTAL TO DATE FROZEN & CANNED
Start of season thru April 26	196,286	196,286	559,530	559,530	755,816	755,816
May 4	702,099	898,385	1,309,944	1,869,474	2,012,043	2,767,859
11	1,860,992	2,759,377	2,983,253	4,852,727	4,844,245	7,612,104
18	806,187	3,565,564	1,719,723	6,572,450	2,525,910	10,138,014
25	762,725	4,328,289	1,778,693	8,351,143	2,541,418	12,679,432
June 1	921,434	5,249,723	1,379,822	9,730,965	2,301,256	14,980,688
8	822,845	6,072,568	947,250	10,678,215	1,770,095	16,750,783
15	600,178	6,672,746	631,991	11,310,206	1,232,169	17,982,952
22	240,117	6,912,863	134,674	11,444,880	374,791	18,357,743
TOTAL 1985		6,912,863		11,444,880		18,357,743
			PAST SEASON TOTALS			
1984		5,622,872		13,512,716		19,135,588
1983		4,896,207		10,900,649		15,796,856
1982		5,771,493		10,219,158		15,990,651
1981		3,024,616		8,775,410		11,800,083
1980		5,614,616		10,818,405		16,433,021

UNITED STATES COLD STORAGE HOLDINGS OF FROZEN ASPARAGUS (1000 lbs)
END OF MONTH COLD STORAGE HOLDINGS WITH COMPARISON

YEAR	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1981	6578	5668	4988	5203	9276	11518	10515	10108	8676	7432	6929	5582
1982	4467	3744	3391			13076			10857			8850
1983	7546	6524	5948	9343	9457	12061	11741	11242	10268	9181	7445	6363
1984	5160	4424	3864	4116	7545	12415	10688	9010	8513	7541	7107	5670
1985	4316	3166	2794	4038	14712	16619	16589	15254	13903	11908	10489	8987

Please Note: in 1982 the cold storage figures were released quarterly

ASPARAGUS FOR FRESH MARKET AND PROCESSING 1/

STATE	AREA PLANTED 1983	AREA PLANTED 1984	AREA PLANTED 1985	AREA HARVESTED 1983	AREA HARVESTED 1984	AREA HARVESTED 1985	YIELD PER ACRE 1983	YIELD PER ACRE 1984	YIELD PER ACRE 1985
	ACRES						CWT.		
CALIF	34,200	35,300		34,200	35,200		25	28	
ILL	1,400	1,300		1,400	1,300		10	11	
MICH	20,000	20,000		19,200	19,200		12	12	
N J	2,000	2,000		2,000	1,900		15	19	
WASH	31,000	31,000		29,000	29,000		25	28	
OTHER STS 2/	4,730	4,850		4,130	4,550		10	12	
U S	93,330	94,450		89,930	91,150		21	23	

	PRODUCTION 1983	PRODUCTION 1984	PRODUCTION 1985	VALUE PER CWT. 1983	VALUE PER CWT. 1984	VALUE PER CWT. 1985	VALUE TOTAL 1983	VALUE TOTAL 1984	VALUE TOTAL 1985
	1,000 CWT.			DOLLARS			1,000 DOLLARS		
CALIF	855	986		69.90	75.70		59,796	74,666	
ILL	14	14		75.20	72.40		1,053	1,013	
MICH	230	230		57.90	58.40		13,318	13,423	
N J	30	36		70.90	68.70		2,127	2,473	
WASH	725	812		51.70	52.30		37,454	42,443	
OTHER STS 2/	42	54		64.60	58.70		2,715	3,169	
U S	1,896	2,132		61.40	64.30		116,463	137,187	

UTILIZATION AND STATE	PRODUCTION 1983	PRODUCTION 1984	PRODUCTION 1985	VALUE PER UNIT 1983	VALUE PER UNIT 1984	VALUE PER UNIT 1985	VALUE TOTAL 1983	VALUE TOTAL 1984	VALUE TOTAL 1985
FRESH MARKET	1,000 CWT.			DOLLARS PER CWT.			1,000 DOLLARS		
CALIF	739	818		74.40	83.30		54,982	68,139	
MICH	38	36		66.00	71.00		2,508	2,556	
N J	30	36		70.90	68.70		2,127	2,473	
WASH	217	242		72.60	68.80		15,754	16,650	
OTHER STS 3/	19	16		80.50	77.30		1,529	1,236	
U S	1,043	1,148		73.70	79.30		76,900	91,054	
PROCESSING	TONS			DOLLARS PER TON			1,000 DOLLARS		
CALIF	5,800	8,400		830.00	777.00		4,814	6,527	
MICH	9,600	9,720		126.00	1,118.00		10,810	10,867	
WASH	25,410	28,500		854.00	905.00		21,700	25,793	
OTHER STS 3/	1,880	2,590		191.00	1,137.00		2,239	2,946	
U S	42,690	49,210		927.00	937.00		39,563	46,133	
CANNING	33,475	33,830		930.00	951.00		31,120	32,156	
FREEZING	9,215	15,380		916.00	909.00		8,443	13,977	

1/ ESTIMATES REINSTATED WITH THE 1984 CROP. 2/ IND, MD, MINN, AND OREG.
3/ FRESH MARKET: ILL, IND, MD, AND OREG. PROCESSING: ILL, IND, MINN, AND OREG.

ASPARAGUS

According to the New Jersey Agricultural Statistics Service, asparagus production in New Jersey for fresh market was 36,000 hundredweight in 1986, unchanged from the previous year. There were 2,000 acres planted in 1986, the same as in 1985, with 1,900 acres being harvested. Yield per acre was set at 19 hundredweight, unchanged from the previous year. All asparagus grown in New Jersey is utilized by the fresh market, none for processing.

Weather condition for 1986 can be found on page 7. With warm weather the latter part of March, some very light cutting started on April 4 but did not hit significant volume until midmonth. Supplies were in good volume by the end of the month. May is the peak period in New Jersey with good volume prevailing all month. After the first week of June, supplies began to decline and by the end of the month, season was over.

All of New Jersey's asparagus is sold in 30-pound pyramid crates with twelve 2-1/2-pound bunches. The bulk of the volume is sold across the Vineland and Swedesboro Auctions. See page 11. Note also on this page that the highest prices occurred late in June at the end of the season.

The other major suppliers during April through June are California and Washington State with very little from a few other eastern and midwestern states. On page 9 can be found New Jersey's distribution for the last three years. Philadelphia, New York City, Baltimore and Boston are the main markets for New Jersey asparagus.

NEW JERSEY WHOLESALE PRICES ON LEADING TERMINAL MARKETS 1986

MONDAY 1986	FIELD RUN BUNCHED 12s MOSTLY MEDIUM-LARGE			
	BOSTON	NEW YORK CITY	PHILADELPHIA	PITTSBURGH
4/21	-	-	$25.00-26.00	-
28	-	$20.00-24.00	20.00-22.00	-
5/ 5	$22.00	-	15.00-18.00	-
12	21.00	20.00-22.00	20.00	$21.00-22.00
19	21.00-22.00	22.00-24.00	19.00-20.00	26.00-27.00
26*	18.00	16.00-18.00	-	19.00
6/ 2	20.00	-	-	-
9	-	38.00	25.00-26.00	-

*Tuesday's prices due to Federal holiday on Monday.

A S P A R A G U S

DAILY SWEDESBORO AND VINELAND AUCTION PRICES DURING 1986 SEASON

DATE 1986	SWEDESBORO FIELD RUN MED-LGE CRATES BCHD 12s	PRICE RANGE	WTD AVG	VINELAND FIELD RUN MED-LGE CRATES BCHS 12s	PRICE RANGE	MOSTLY
Mon. 4/28	249	$15.60-17.40	$16.40	-	Unreported	Unreported
29	184	15.80-17.20	16.80	662	$11.50-16.50	$13.50-15.50
30	146	12.60-13.30	12.90	725	12.50-15.75	14.00-15.00
5/ 1	133	13.10-14.30	14.05	620	13.75-17.50	15.00-16.25
2	165	13.80-14.00	13.85	-	No Sale	No Sale
3	164	15.80-17.70	16.70	-	Unreported	Unreported
Sun. 4	-	No Sale		-	No Sale	No Sale
5	102	16.90-18.20	17.50	500	16.75-18.75	17.50-18.50
6	151	17.50-18.30	17.90	690	17.50-19.75	18.25-19.00
7	291	15.00-17.00	16.10	1143	17.00-21.00	18.00-19.75
8	258	17.30-18.20	17.70	870	18.25-20.75	18.75-19.75
9	166	17.40-18.10	17.65	-	No Sale	No Sale
10	82	18.60-20.00	19.20	-	Unreported	Unreported
Sun. 11	-	No Sale		-	No Sale	No Sale
12	205	18.50-21.00	20.15	605	18.25-22.50	20.50-22.50
13	166	20.00-21.20	20.80	565	17.25-25.75	21.00-22.00
14	181	19.10-22.50	21.20	645	20.00-22.25	21.00-22.00
15	156	19.20-21.60	20.70	415	20.00-24.00	21.00-22.25
16	169	20.10-22.40	21.30	-	No Sale	No Sale
17	136	18.00-19.80	18.30	-	Unreported	Unreported
Sun. 18	-	No Sale		-	No Sale	No Sale
19	191	17.20-17.50	17.30	948	12.00-19.75	14.75-16.50
20	132	15.00	-	450	16.50-19.75	17.75-18.75
21	66	16.00-17.70	16.60	530	14.00-21.25	18.25-20.00
22	73	16.50	-	285	14.00-22.50	14.00-15.00
23	125	15.60-16.70	16.10	-	No Sale	No Sale
24	90	16.00-17.00	16.35	600	12.00-18.00	15.50-17.00
Sun. 25	-	No Sale		-	No Sale	No Sale
26	144	16.30-17.10	16.50	450	16.00-21.00	16.75-17.75
27	160	15.50	-	500	13.75-19.00	15.10-16.25
28	142	15.50	-	600	14.25-22.25	17.50-18.50
29	170	16.00-17.20	16.50	510	13.00-20.75	17.50-19.00
30	-	No Sale		-	No Sale	No Sale
31	120	16.50-18.10	16.80	800	16.00-22.50	19.25-20.25
Sun. 6/ 1	-	No Sale		-	No Sale	No Sale
2	115	18.00	-	550	19.75-29.00	22.75-24.00
3	48	24.10-25.50	25.00	185	22.25-26.25	24.75-25.50
4	55	25.00	-	173	25.50-32.00	26.50-28.00
5	21	26.00	-	200	28.50-39.75	35.00-38.25
6	81	25.00	-	-	No Sale	No Sale
7	77	28.20-30.70	29.40	500	22.50-31.50	26.00-27.25
Sun. 8	-	No Sale		-	No Sale	No Sale
9	46	25.00	-	315	23.00-27.00	25.00-26.00
10	46	25.00	-	310	26.00-33.25	28.75-30.25
11	33	26.00	-	200	27.50-31.25	29.25-30.25
12	22	26.00	-	125	25.00-41.50	38.00-41.25
13	5	30.00	-	-	No Sale	No Sale
14	-	-	-	190	31.25-37.75	31.25-34.00
Sun. 15	-	-	-	-	No Sale	No Sale
16	-	-	-	200	29.50-34.50	-
17	-	-	-	228	33.00-35.25	-
18	-	-	-	116	38.50-39.50	-
19	-	-	-	74	30.50-40.25	35.50-40.25
20	-	-	-	-	No Sale	No Sale
21	-	-	-	135	40.25-44.75	-
Sun. 22	-	-	-	-	No Sale	No Sale
23	-	-	-	134	37.75-44.25	-
24	-	-	-	54	43.25-48.75	48.25-48.75
25	-	-	-	37	41.00-46.00	-
26	-	-	-	21	45.00-47.75	-

- 26b

ASPARAGUS

NEW JERSEY AUCTIONS - 12-YEAR (1975-1986) COMPARISON OF SEASON VOLUME OF SALES, SEASON AVERAGE WEIGHTED PRICE AND TOTAL VALUE

AUCTION	1,000 PACKAGE UNITS 1/	SEASON AVERAGE WEIGHTED PRICE PER CRATE	TOTAL VALUE	AUCTION	1,000 PACKAGE UNITS 1/	SEASON AVERAGE WEIGHTED PRICE PER CRATE	TOTAL VALUE
VINELAND:				SWEDESBORO:			
1986	27.9	$20.87	$583.028	1986	4.6	$17.57	$ 79,905
1985	27.1	21.56	584,611	1985	9.3	19.81	183,819
1984	19.6	21.93	428,727	1984	7.2	21.67	156,060
1983	21.2	24.02	508,129	1983	8.2	23.75	194,035
1982	29.4	25.95	762,149	1982	9.7	24.01	232,744
1981	25.5	24.70	629,789	1981	9.3	23.73	219,406
1980	26.1	24.37	636,198	1980	12.1	23.13	279,944
1979	30.1	24.52	738,276	1979	13.2	23.06	304,579
1978	39.8	20.27	806,626	1978	15.2	20.23	306,947
1977	42.4	16.85	714,647	1977	18.2	16.57	300,606
1976	53.8	14.01	752,766	1976	28.6	13.85	396,186
1975	62.4	9.54	595,046	1975	26.5	11.49	304,126

TOTALS FOR ALL NEW JERSEY AUCTIONS

DATE	1,000 PACKAGE UNITS 1/	SEASON AVERAGE WEIGHTED PRICE PER CRATE	TOTAL VALUE
1986	32.5	$20.41	$ 662,933
1985	36.6 2/	21.12	771,943
1984	26.8	21.86	585,217
1983	29.4	23.94	702,164
1982	39.1	25.47	994,893
1981	34.8	24.44	849,256
1980	38.2	23.98	916,142
1979	43.3	24.07	1,042,855
1978	55.0	20.26	1,113,537
1977	60.6	16.77	1,015,253
1976	82.4	13.95	1,148,952
1975	88.9	10.12	899,328

1/ 30-pound container.
2/ Includes .2 at Land'sville.

ASPARAGUS

ASPARAGUS FOR FRESH MARKET AND PROCESSING
ACREAGE, YIELD, PRODUCTION AND VALUE

STATE	AREA PLANTED			AREA HARVESTED		
	1984	1985	1986	1984	1985	1986
	ACRES					
CALIFORNIA	34,200	35,300	37,800	34,200	35,200	37,800
ILLINOIS	1,400	1,300	1,300	1,400	1,300	1,300
MICHIGAN	20,000	20,000	21,000	19,200	19,200	20,500
NEW JERSEY	2,000	2,000	2,000	2,000	1,900	1,900
WASHINGTON	31,000	31,000	32,000	29,000	29,000	30,000
OTHER STATES 1/	4,730	5,150	4,780	4,130	4,850	4,680
U S	93,330	94,750	98,880	89,930	91,450	96,180

	YIELD PER ACRE			PRODUCTION		
	1984	1985	1986	1984	1985	1986
	CWT.			1,000 CWT		
CALIFORNIA	25	28	29	855	986	1,096
ILLINOIS	10	11	8	14	14	10
MICHIGAN	12	12	12	230	230	246
NEW JERSEY	15	19	19	30	36	36
WASHINGTON	25	28	26	725	812	780
OTHER STATES 1/	10	12	13	42	58	62
U S	21	23	23	1,896	2,135	2,230

	VALUE					
	PER CWT.			TOTAL		
	1984	1985	1986	1984	1985	1986
	DOLLARS			1,000 DOLLARS		
CALIFORNIA	69.90	75.70	68.90	59,796	74,666	75,513
ILLINOIS	75.20	72.40	68.10	1,053	1,013	681
MICHIGAN	57.90	58.40	58.20	13,318	13,423	14,311
NEW JERSEY	70.90	68.70	64.60	2,127	2,473	2,326
WASHINGTON	51.70	52.30	52.10	37,454	42,443	40,612
OTHER STATES 1/	64.60	59.60	56.90	2,715	3,458	3,526
U S	61.40	64.40	61.40	116,463	137,476	136,969

1/ 1984 -IN, MD, MN, OR.
1985 -IN, MD, MN, OR.
1986 -IN, MD, MN, OR.

SOURCE: Agricultural Statistics Board, NASS, USDA.

Boston
1986

DATE MONDAY	ANISE CARTONS OR CRATES 24S	ANISE 18S - 20S	ARTICHOKES CARTONS INCLUDES AIR RECEIPTS 48S - 60S	ASPARAGUS BUNCHED OR LOOSE - PYRAMID CRATES INCLUDES AIR RECEIPTS XLARGE - LARGE		WA-XFANCY
	CALIFORNIA	NEW JERSEY	CALIFORNIA	CALIFORNIA	NEW JERSEY	WASHINGTON
JAN 6	15.00-16.00	-	18.00-20.00	-	-	-
13	14.00-15.00	-	16.00-17.00	-	-	-
**21	-	-	10.00-12.00	-	-	-
27	16.00	-	-	-	-	-
FEB 3	14.00	-	16.00-18.00	36.00	-	-
10	14.00	-	20.00	38.00-39.00	-	-
**18	14.00	-	14.00-15.00	45.00-48.00	-	-
24	-	-	10.00-12.00	30.00	-	-
MAR 3	13.00-14.00	-	10.00-11.00	25.00	-	-
10	12.00-12.50	-	8.00-10.00	25.00	-	-
17	12.00	-	9.50-10.00	28.00	-	-
24	12.00-14.00	-	10.00-11.00	30.00	-	-
31	-	-	11.50-12.00	32.00-34.00	-	-
APR 7	-	-	5.00-7.00	32.00-33.00	-	-
14	-	-	8.00	28.00-30.00	-	31.00
21	18.00	-	9.00-10.00	28.00-30.00	-	30.00
28	-	-	12.00	28.00	-	25.00
MAY 5	18.00	-	13.00	23.00	22.00	24.00
12	20.00	-	15.00-20.00	23.00-24.00	21.00	25.00
19	18.00	-	22.00	24.00-25.00	21.00-22.00	25.00
**27	-	-	22.00	-	18.00	23.00
JUN 2	-	-	22.00	-	20.00	23.00-24.00
9	-	-	22.00	-	-	33.00-34.00
16	-	-	12.00-13.00	-	-	30.00-40.00
23	-	-	14.00-15.00	-	-	34.00-35.00
30	-	-	15.00-16.00	-	-	40.00
JUL 7	-	-	14.00	-	-	-
14	-	-	12.00	-	-	-
21	-	-	10.00	-	-	-
28	-	-	10.00	-	-	-
AUG 4	-	-	10.00	-	-	-
11	-	-	-	-	-	-
18	-	-	10.00	-	-	-
25	-	-	-	-	-	-
SEP **2	-	-	19.00-20.00	-	-	-
8	-	-	-	-	-	-
15	-	-	15.00-20.00	-	-	-
22	-	-	20.00	-	-	-
29	-	15.50	15.00	-	-	-
OCT 6	-	14.00-15.00	12.00	-	-	-
**14	-	14.00-15.00	15.00	-	-	-
20	15.00-16.00	13.00	15.00	-	-	-
27	-	12.00	15.00	-	-	-
NOV 3	14.00	12.00	16.00	-	-	-
10	14.00-15.00	12.00	15.00-16.00	-	-	-
17	14.00-15.00	12.00-13.00	14.00	-	-	-
24	15.00	18.00	13.00-14.00	-	-	-
DEC 1	15.00	-	14.00	-	-	-
8	15.00	-	14.00	-	-	-
15	18.00	-	14.00-15.00	-	-	-
22	18.00	-	17.00-18.00	-	-	-
29	18.00	-	18.00	-	-	-

**TUESDAY'S PRICES DUE TO FEDERAL HOLIDAY ON MONDAY.

Boston 1986

DATE MONDAY	ASPARAGUS BUNCHED OR LOOSE - INCLUDES AIR RECEIPTS: 15-16 LB. CARTONS EXTRA LARGE OR LARGE	13.5-LB CARTONS SELECT OR EXTRA FANCY	10-12 LB. CARTONS OR CRATES EXTRA LARGE - LARGE		BEANS 1-1/9 OR 1-BUSHEL CARTONS, CRATES OR HAMPERS: ROUND	GREEN
	CALIFORNIA	MEXICO	CHILE	MEXICO	FLORIDA	GEORGIA
JAN 6	-	-	-	-	22.00	-
13	40.00-45.00	37.00-38.00	-	-	18.00	-
**21	24.00-26.50	17.00-20.00	-	-	18.00	-
27	17.50	16.00-17.00	-	-	16.00	-
FEB 3	18.00	15.00-16.00	-	-	16.00-17.00	-
10	16.00	17.00-17.50	-	-	14.00	-
**18	15.00-16.00	-	-	-	18.00	-
24	14.00-15.00	15.00	-	-	18.00-19.00	-
MAR 3	12.00-13.00	-	-	-	18.00-19.00	-
10	-	-	-	-	18.00-19.00	-
17	-	-	-	-	20.00	-
24	-	-	-	-	24.00	-
31	-	-	-	-	18.00	-
APR 7	-	-	-	-	16.00	-
14	-	-	-	-	17.00-18.00	-
21	-	-	-	-	19.00-20.00	-
28	-	-	-	-	20.00-21.00	-
MAY 5	-	-	-	-	15.00	-
12	-	-	-	-	15.00	-
19	-	-	-	-	16.00	15.00
**27	-	-	-	-	-	11.00-12.00
JUN 2	-	-	-	-	-	-
9	-	-	-	-	-	11.00
16	-	-	-	-	-	-
23	-	-	-	-	-	-
30	-	-	-	25.00	-	-
JUL 7	-	-	-	-	-	-
14	-	29.00	-	-	-	-
21	-	25.00	-	29.00	-	-
28	-	-	-	-	-	-
AUG 4	-	29.00	-	-	-	-
11	-	26.00-28.00	-	27.00	-	-
18	-	-	-	-	-	-
25	-	22.00	-	-	-	-
SEP **2	-	25.00	-	-	-	-
8	-	-	-	-	-	-
15	-	15.00-20.00	-	-	-	-
22	-	-	30.00	26.00	-	-
29	-	-	33.00	24.00	-	-
OCT 6	-	-	28.00-29.00	24.00	-	-
**14	-	-	25.00	20.00	10.00-12.00	14.00-15.00
20	-	-	24.00-25.00	20.00-21.00	16.00-17.00	16.00
27	-	-	20.00-23.00	22.00	18.00-20.00	-
NOV 3	-	-	21.00-22.00	21.00	16.00	15.00-16.00
10	-	-	24.00-25.00	-	12.00	12.00
17	-	-	29.00-30.00	-	8.00-9.00	-
24	-	-	32.00-33.00	-	11.00-12.00	-
DEC 1	-	-	35.00-36.00	-	11.00-12.00	-
8	-	-	30.00	-	12.00-13.00	-
15	-	-	37.00	-	13.00	-
22	-	-	-	-	12.00-13.00	-
29	-	52.00	48.00	-	13.00	-

**TUESDAY'S PRICES DUE TO FEDERAL HOLIDAY ON MONDAY.

CHICAGO 1986

	ARTICHOKES		ASPARAGUS				
	A	CALIFORNIA	WASHINGTON		CALIFORNIA	MEXICO	
	ctns 18-30s	ctns 18-60s	30-lb crates 3/8" min large	standard	crts & ctns 30-lb lse lge	1/2 Pyramid ctns lse lge	crts & ctns 30-lb lse lge
Jan 6	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-
21	16.00	16.00	-	-	-	-	-
27	16.00	-	-	-	-	-	-
Feb 3	16.00	14.00-20.00	-	-	-	-	-
10	-	15.00-22.00	-	-	-	-	-
18	16.00	18.00-22.00	-	-	-	-	-
24	16.00	18.00-20.00	-	-	35.00-38.00	-	35.00-38.00
Mar 3	16.00	18.00	-	-	33.00	-	32.00
10	14.00	10.00	-	-	26.00	-	30.00
17	14.00	8.00-12.00	-	-	25.00-27.00	-	30.00
24	12.00	10.00-15.00	-	-	30.00-34.00	-	-
31	-	8.00-15.00	-	-	33.00-35.00	-	-
Apr 7	10.00-12.00	8.00-15.00	-	-	27.00-31.00	-	-
14	-	8.00-15.00	30.00	-	30.00	-	-
21	-	-	28.00-30.00	28.00-30.00	30.00-32.00	-	-
28	12.00	8.00-15.00	24.00-26.00	-	25.00-26.00	-	-
May 5	-	20.00	24.00-25.00	20.00-22.00	22.00-25.00	-	-
12	-	-	18.00-20.00	-	-	-	-
19	-	-	24.00	-	-	-	-
27	-	22.00-25.00	26.00	26.00	-	-	-
June 2	-	-	24.00	-	-	-	-
9	-	-	-	-	-	-	-
16	-	18.00-25.00	-	-	-	-	-
23	-	22.00-25.00	-	-	-	-	-
30	-	12.00-20.00	-	-	-	-	-
July 7	-	12.00-20.00	-	-	-	-	-
14	-	15.00-20.00	-	-	-	-	-
21	-	10.00-15.00	-	-	-	-	-
28	-	8.00	-	-	-	28.00	-
Aug 4	-	8.00-12.00	-	-	-	25.00	-
11	-	14.00-20.00	-	-	-	24.00	-
18	-	12.00-20.00	-	-	-	-	-
25	-	12.00-20.00	-	-	-	18.00-20.00	-
Sept 2	-	25.00	-	-	-	20.00	-
8	-	-	-	-	-	25.00	-
15	-	15.00-25.00	-	-	-	-	-
22	-	15.00-25.00	-	-	-	26.00	-
29	-	10.00-12.00	-	-	-	24.00	-
Oct 6	-	10.00	-	-	-	20.00-24.00	-
14	-	10.00-18.00	-	-	-	20.00-22.00	-
20	-	10.00-18.00	-	-	-	24.00	-
27	-	10.00-18.00	-	-	-	25.00	-
Nov 3	-	15.00-22.00	-	-	-	-	-
10	-	14.00-15.00	-	-	-	-	-
17	-	15.00	-	-	-	-	-
24	-	12.00-18.00	-	-	-	-	-
Dec 1	12.00	12.00-18.00	-	-	-	-	-
8	12.00	12.00-16.00	-	-	-	-	-
15	-	-	-	-	-	-	-
22	-	22.00	-	-	-	-	-
29	18.00-20.00	18.00-22.00	-	-	-	-	-

Dallas, 1985

1985 THURS.		ARTICHOKES CARTONS 24-36S CALIFORNIA	ASPARAGUS 13 1/2 LB CARTON STANDARD & SMALL CALIFORNIA	WASHINGTON	MEXICO
JAN.	3				
	10				
	17				
	24	32.00			
	31	32.00	29.75		
FEB.	7		29.75		
	14				
	21		2> 28.00		
	28	22.75	1> 38.75		
MARCH	7		1> 37.75		22.00
	14	18.50	1> 37.75		18.75-20.00
	21	19.00	1> 35.75		18.75
	28	18.50-20.00	1> 35.00-35.75		18.75
APRIL	4	18.50-20.00	1> 35.75		
	11	9.50-10.50	1> 24.50-25.00		
	18	9.00- 9.50	1> 20.50-22.00		
	25	9.00	1> 23.50	3> 15.00	
MAY	2	8.00	1> 19.50		
	9	8.00	1> 20.00-21.00		
	16	6.50- 7.50	1> 21.00-22.00		
	23	7.75- 8.00	1> 21.00-22.00	20.00	
	30	10.00-12.00	1> 15.75	20.00	
JUNE	6		1> 15.75		
	13	19.00		1> 26.75	
	20	22.00		1> 31.75	
	27	23.00			
JULY	4				
	11				
	18				29.75
	25				28.00-29.75
AUG.	1	17.00			29.75
	8	17.00			21.50
	15				21.00
	22	14.00			16.50
	29				15.75
SEPT.	5				15.75
	12				14.50-15.75
	19				15.75
	26	16.00-21.00			18.75
OCT.	3	14.00			16.75-18.75
	10	14.00-14.30			19.00-19.75
	17	12.00			21.75
	24	16.50-18.5			18.00-20.75
	31	18.50-20.50			20.00
NOV.	7	20.50-22.00			20.00
	14	24.75-26.00			
	21	25.50-26.00			
	28	HOLIDAY			
DEC.	5				41.50
	12				41.50
	19				42.75
	26				

1> 30 LB CTNS OR CRTS
2> LGE
3> 15 LB CTNS

LOS ANGELES 1985

1985	ARTICHOKES CENTRAL DISTRICT 18-48s Cartons	ASPARAGUS SOUTH/CENTRAL DISTRICTS Crates/Cartons 13.5# bunched Select	ASPARAGUS 15# loose Standard-Extra large	BEANS Improved Ky Wonders 30# crates California	BEANS Mexico	BROCCOLI bunched 14s Cartons Central	BROCCOLI South
JAN. 3		60.00-85.00			10.50-12.00	8.00-8.50	8.00-8.50
10	29.00-31.00	50.00-60.00			12.00-16.50	6.50-8.50	6.50-8.50
17	25.00-31.00	38.00-53.00	35.00-40.00		14.00-16.00	7.00-8.50	7.00-8.50
24	28.00-30.00	30.00-45.00	25.00-40.00		16.00-24.00	9.00-10.00	9.00-10.00
31	25.00-30.00	28.00-45.00			15.00-24.00	7.50-8.50	7.50-8.50
FEB. 7	23.00-29.00	30.00-45.00			27.00-28.00	8.50-11.50	8.50-11.50
14	23.00-30.00	25.00-38.00	25.00-37.00		23.00-27.00	7.00-10.00	7.00-10.00
21	22.00-28.00	22.00-33.00	20.00-30.00		24.00-30.00	6.00-7.00	6.00-7.00
28	22.00	18.00-24.00	18.00-22.00		24.00-27.00	5.50-7.00	5.50-7.00
MAR. 7	18.00-20.00	16.00-22.00			28.00-35.00	9.75-13.00	9.75-13.00
14	20.00	17.00-26.00	15.00-22.00		28.00-30.00	8.00-10.00	8.00-10.00
21	18.00-20.00	17.00-24.00	18.00-21.00		20.00-24.00	9.50-10.00	9.50-10.00
28	15.00-18.00	17.00-20.00	1) 32.00-37.00		18.00-21.00	13.50-14.50	13.50-14.50
APR. 4	10.00-15.00		1) 25.00-32.00		18.00-21.00	9.00-11.00	9.00-11.00
11	7.00-8.00		1) 18.00-24.00		18.00-21.00	6.00-7.50	6.00-7.50
18	6.00-7.00		1) 15.00-21.00		12.00-15.00	5.00-7.00	5.00-7.00
25	6.00-7.50		1) 19.00-22.00	9.00-15.00	15.00-18.00	6.00-6.50	6.00-6.50
MAY 2	6.00-6.50		1) 18.00-20.00	8.00-10.00	15.00	5.00-6.00	5.00-6.00
9	6.00-9.00		1) 18.00-21.00	24.00-28.00	15.00-18.00	5.00-6.00	5.00-6.00
16	6.00-9.00		1) 18.00-21.00	15.00-18.00		6.00-7.50	6.00-7.50
23	6.00-7.00		1) 16.00-20.00	8.00-12.00		5.50-6.50	5.50-6.50
30	13.00		1) 16.00-20.00	7.00-9.00		5.50-6.50	5.50-6.50
JUNE 6	18.00-19.00		1) 19.00-20.00	10.00-12.00		5.50-6.50	5.50-6.50
13	16.00-25.00		1) WA 25.00-27.00	9.00-12.00		5.50-6.00	5.50-6.00
20	23.00-25.00		1) WA 28.00-30.00	8.00-10.00		5.00-6.00	
27	23.00-25.00		1) WA 32.00-36.00	5.00-8.00		5.50-6.00	
JULY Wed. 3	18.00-25.00			6.00-7.00		6.50-8.00	
11	20.00-25.00					8.00-9.50	
18	20.00-25.00					6.00-7.50	
25	23.00-27.00			12.00-15.00		8.00-9.00	
AUG. 1	20.00-32.00			12.00-13.50		8.00-8.50	
8	20.00-32.00		Mx 32.00-33.00	7.00-10.00		6.00-8.00	
15	10.00-24.00		Mx 23.00-31.00	7.00-10.50		5.50-7.00	
22	10.00-25.00		Mx 18.00-23.00	9.00-12.00		5.50-7.00	
29	16.00-18.00		Mx 16.00-18.00	8.00-10.50		7.50-9.00	
SEP. 5	15.00-26.00		Mx 20.00-22.00	5.00-8.00		6.50-7.50	
12	16.00-20.00			6.00-7.00		7.00-9.50	
19	16.00-20.00	1) 40.00-50.00	Mx 20.00-22.00	12.00-16.00		10.00-11.00	
26	14.00		Mx 23.00-25.00	18.00-21.00		7.50-8.50	
OCT. 3	11.00-12.00	24.00-26.00	Mx 28.00	10.00-15.00		7.50-8.50	
10	10.00-12.00	CL 22.00-29.00	Mx 22.00	6.00-8.00		6.50-8.00	
17	8.00-12.00	CL 22.00-30.00	Mx 18.00-22.00	12.00-15.00		7.00-7.50	
24	22.00-24.00	CL 24.00-32.00	Mx 26.00	13.50-18.00		9.00-10.50	9.00-10.00
31	22.00-26.00	CL 26.00-32.00	Mx 26.00	8.00-10.00		6.50-8.50	6.50-8.50
NOV. 7	15.00-26.00	CL 31.00-35.00		8.00-12.00		7.50-9.00	7.50-9.00
14	25.00-26.00	CL 34.00-40.00	Mx 33.00-35.00	18.00-21.00		8.00-9.00	8.00-9.00
21	24.00-26.00	CL 34.00-40.00		12.00-16.00		12.00-12.50	12.00-12.50
Wed 27	24.00-25.00	CL 38.00-40.00	Mx 30.00-34.00	24.00-30.00	24.00-30.00	11.00-13.50	11.00-13.50
DEC. 5	25.00-26.00	CL 35.00-40.00		12.00-15.00	24.00-26.00	6.50-8.50	6.50-8.50
12	15.00-25.00	CL 40.00-44.00			15.00-21.00	8.50-12.00	8.50-12.00
19	16.00-25.00				15.00-18.00	10.00-11.50	10.00-11.50
26	25.00	MX 45.00-48.00			9.00-12.00	9.00-10.50	9.00-10.50

LEGEND OF ABBBREVIATIONS:
1)=30# LOOSE
WA=WASHINGTON
MX=MEXICO 13.5# Loose
CL=CHILE 12# CRATES

A R T I C H O K E S

F. O. B. PRICES KENNEDY AIRPORT, NEW YORK CITY

7 Inch Cartons **Globe Type**

Date TUES-THURS	24-30s	36s	42s	48s	54-60s
Nov 8	-	-	-	-	-
13	18.00-20.00	17.00-18.00	16.00-17.00	-	-
15	12.00-15.00*	12.00-15.00*	12.00-15.00*	-	-
20	-	-	-	-	-
22	-	-	-	-	-
27	-	-	-	-	-
29	-	-	-	-	-

* - Fair Quality

CHILEAN, 1985

A S P A R A G U S

F. O. B. PRICES, KENNEDY AIRPORT, NEW YORK CITY

13.5 Pound Cartons - Bunched

Date TUES-THURS	Jumbo	Extra-Large	Large	Medium (Standard)	Small
Sep 27	-	-	-	-	-
Oct 2	29.00-32.00	28.00-30.00	27.00-29.00	24.00-28.00	20.00-22.00
4	28.00-29.00	27.00-28.00	25.00-27.00	24.00-25.00	22.00-23.00
9	28.00-29.00	27.00-28.00	25.00-26.00	23.00-25.00	22.00-23.00
11	28.00-29.00	27.00-28.00	25.00-27.00	24.00-25.00	22.00-23.00
16	28.00-29.00	27.00-28.00	25.00-26.00	23.00-25.00	22.00-23.00
18	27.00-28.00	26.00-27.00	25.00-26.00	24.00-25.00	20.00-22.00
23	23.00-24.00	21.00-22.00	20.00.00	18.00	16.00.00
25	22.00-24.00	20.00-21.00	19.00-20.00	17.00-18.00	15.00-16.00
30	22.00-24.00	20.00-21.00	19.00-20.00	17.00-18.00	15.00-16.00
Nov 1	25.00-26.00	24.00-25.00	23.00-24.00	22.00-23.00	20.00-22.00
6	30.00-31.00	27.00-28.00	26.00-27.00	25.00-26.00	23.00-24.00
8	35.00-38.00	33.00-37.00	31.00-36.00	30.00-35.00	-
13	38.00-40.00	35.00-36.00	33.00-35.00	31.00-33.00	-
15	38.00-40.00	35.00-36.00	33.00-35.00	31.00-34.00	-
20	38.00-40.00	35.00-37.00	33.00-35.00	32.00-33.00	-
22	-	-	-	-	-
27	37.00-38.00	35.00-36.00	33.00-34.00	30.00-32.00	-
29	36.00-38.00	35.00-37.00	33.00-36.00	30.00-35.00	-
Dec 4	36.00-38.00	35.00-37.00	34.00-36.00	30.00-35.00	-
6	-	-	-	-	-
11	-	-	-	-	-
13	-	-	-	-	-

12.0 pound cartons bunched - Supplies were insufficient to quote

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1985

WHOLESALE TERMINAL MARKETS

CHICAGO

CHILEAN ASPARAGUS

13.5 Pound Cartons - Bunched

TUES-THURS	Jumbo	Extra-Large	Large	(Standard) Medium	Small
Oct 2	-		-	-	-
4	-		-	-	-
9	35.00	32.00-33.00	30.00	28.00	26.00
11	-	-	-	-	-
16	31.00	30.00	29.00	-	-
18	-	-	-	-	-
23	30.00	-	29.00	28.00	-
25	-	-	-	-	-
30	-	-	-	-	-

TUES-THURS	APPLES Granny Smiths Cartons, Tray Pack 88 - 113S	APRICOTS Various Varieties 2 Layer Lugs	CHERRIES Bings - 12 Row & Larger 11 Pound Cartons
Dec 4	-	-	-
6	-	-	-
11	-	-	22.00-24.00
13	-	-	20.00
18	-	20.00-27.00	19.00-23.00
20	-	18.00-25.00	18.00-22.00
27	-	28.00	20.00-21.00
Jan 3	-	-	16.00-17.00
8	-	-	-
10	-	-	-
15	-	-	17.00-18.00
17	-	20.00	17.00-18.00
22	-	21.00	-
24	-	-	-
29	-	-	-
31	-	-	-
Feb 5	-	-	-
7	-	-	-
12	-	-	-
14	-	-	-
19	-	-	-
21	-	-	-
26	-	-	-
28	-	-	-
Mar 5	-	-	-
7	-	-	-
12	-	-	-
14	20.00-21.00	-	-
19	20.00-24.00	-	-
21	16.00-24.00	-	-
26	16.00-22.00	-	-
28	16.00-22.00	-	-
Apr 2	14.00-20.00	-	-
4	14.00-19.00	-	-
9	14.00-19.00	-	-
11	16.00-20.00	-	-
16	14.00-20.00	-	-
18	14.00-20.00	-	-
23	14.00-23.00	-	-
25	14.00-23.00	-	-
30	16.00-24.00	-	-
May 2	16.00-23.00	-	-
7	-	-	-

W H O L E S A L E T E R M I N A L M A R K E T

P I T T S B U R G H

G R A P E S

TUES-THURS	Emperors	Cardinals	Tokays	Almerias
Feb 12	-	-	-	-
14	-	-	-	-
19	-	14.00-15.50	-	-
21	-	15.00-16.00	-	-
26	-	14.00	-	-
28	-	-	-	-
Mar 5	-	-	-	-
7	-	-	-	-
12	-	-	-	-
14	14.00	-	-	-
19	14.00	-	-	-
21	10.00-11.00	-	-	-
26	11.00-12.50	-	-	-
28	11.00-11.50	-	-	-
Apr 2	10.00-11.00	-	-	-
4	11.00	-	-	-
9	11.00	-	-	-
11	10.50-12.00	-	-	12.00
16	12.00	-	-	12.50
18	12.00-13.00	-	-	-
23	13.00-13.50	-	-	13.50
25	12.00-13.50	-	-	12.50-13.
30	-	-	-	-
May 2	13.00-15.00	-	-	13.50-15.
7	13.00-14.00	-	-	13.50-14.
9	14.50-15.75	-	-	15.50-16.
14	13.50-15.00	-	-	15.50-16.

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W H O L E S A L E T E R M I N A L M A R K E T S

CHILEAN L O S A N G E L E S

A S P A R A G U S

13.5 and 12 Pound Cartons

	Jumbo	Extra-Large	Large
Nov 20	-	-	-
22	-	-	-
27	-	-	-
29	-	-	-
Dec 4	-	30.00-38.00	30.00-38.00
6	45.00	40.00	-
11	-	-	-
13	-	-	-
18	-	-	-
20	-	-	-
27	-	-	-
Jan 3	-	-	-
8	-	-	-
10	-	-	-
15	-	-	-

C H E R R I E S

11 Pound Cartons - Mostly Bing

	11-12 Row	and Larger
Nov 20	-	
22	-	
27	-	
29	-	
Dec 4	27.00-30.00	
6	20.00-26.00	
11	18.00-22.00	
13	18.00-22.00	
18	20.00-26.00	
20	-	
27	14.00-20.00	
Jan 3	-	
8	-	
10	-	
15	-	

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WHOLESALE TERMINAL MARKETS
PHILADELPHIA

TUES-THURS	CHERRIES 11 Pound Cartons - 12 Row and Larger: Bings	CHILEAN ASPARAGUS 12 & 13.5 Pound Cartons: Jumbo	Extra Large	Large
Oct 2	-	-	28.00-30.00	26.00-28.00
4	-	-	-	-
9	-	22.00-30.00	20.00-29.00	18.00-28.00
11	-	-	-	-
16	-	28.00	26.00	25.00
18	-	-	-	-
23	-	23.00	22.00	21.00
25	-	-	-	-
Nov 1	-	24.00	23.00	22.00
6	-	-	-	-
8	-	-	-	-
13	-	38.00	37.00	36.00
15	-	-	37.00	35.00
20	-	38.00	39.00-36.00	32.00-34.00
22	-	-	-	-
27	-	38.00	36.00	-
29	-	-	-	-
Dec 4	25.00	-	-	-
6	-	-	-	-
11	-	-	-	-
13	24.00	-	-	-
18	15.00-18.00	-	-	-
20	17.00-18.00	-	-	-
27	-	-	-	-
Jan 3	13.00	-	-	-
8	13.00	-	-	-
10	13.00-14.00	-	-	-
15	13.00-15.00	-	-	-
17	13.00-15.00	-	-	-
22	14.00	-	-	-
24	-	-	-	-
29	-	-	-	-
31	-	-	-	-

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WHOLESALE TERMINAL MARKETS

PITTSBURGH

CHILEAN ASPARAGUS

13.5 Pound Cartons

CHERRIES

11 Pound Cartons
12 Row and Larger Bings

TUES-THURS	Jumbo	Extra-Large	Large	Medium	Bings
Oct 2	36.00	35.00	-	-	-
4	-	-	-	-	-
9	35.00	35.00	32.00	-	-
11	-	-	-	-	-
16	32.00	28.00-31.00	26.00-30.00	24.00	-
18	-	-	-	-	-
23	32.00	31.00	30.00	-	-
25	-	-	-	-	-
30	-	-	-	-	-
Nov 1	25.00	25.00	25.00	-	-
6	-	-	-	-	-
8	-	-	-	-	-
13	-	-	-	-	-
15	-	-	-	-	-
20	-	-	-	-	-
22	-	-	-	-	-
27	-	-	-	-	-
29	-	-	-	-	-
Dec 4	-	-	-	-	-
6	-	-	-	-	25.00
11	-	-	-	-	24.00
13	-	-	-	-	-
18	-	-	-	-	22.00
20	-	-	-	-	22.00
27	-	-	-	-	-
Jan 3	-	-	-	-	-
8	-	-	-	-	-
10	-	-	-	-	-
15	-	-	-	-	-
17	-	-	-	-	-
22	-	-	-	-	-
24	-	-	-	-	-
29	-	-	-	-	-
31	-	-	-	-	-