EWUP TECHNICAL REPORT NO. 24

AGRICULTURAL PESTS AND THEIR CONTROL
GENERAL CONCEPTS

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November 1982

EGYPT WATER USE AND MANAGEMENT PROJECT

22 El Galaa St., Bulak, Cairo, Egypt

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Prepared under support of

WATER DISTRIBUTION RESEARCH INSTITUTE, WATER RESEARCH CENTER

MINISTRY OF IRRIGATION, GOVERNMENT OF EGYPT

Contracting agencies

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ABSTRACT

This report presents a survey of the major pests which attack crops in the various agricultural settings found on EWUP's pilot project sites. It gives a general description of the pests, as well as the control measures for cotton, maize, wheat and barley, and vegetable crops.

The paper then gives a detailed description of insects harmful to vegetable crops in El-Mansuriya area. This description includes the major host of the pest, signs of infestation, life cycle of the insect, and prescribed methods for its control.

The paper concludes with a description of pest control activities actually carried out on EWUP pilot project sites. The results were very successful and the yield considerably increased. The methods recommended are for a combined method of control, with the minimum use of chemicals wherever possible.

63 pages , 4 tables.

مستخلـــــــــص

مممم

يعرض هذا التقرير حصرا لأهم الآفات التى تصيب المحاصيل فى الأراضـــى الزراعية المختلفة الموجودة فى المناطق الأرشادية لمشروع تطوير الرى . ويعطى فكرة عامة عن الآفات وطرق مقاومتها فى حاله القطن والذرة والقمح والشعير والخضروات .

ثم يعرض التقرير ايضا وصفا تفصيليا للحشرات الضارة بالخضروات فـــى منطقة المنصورية . ويتضمن هذا الوصف العائل الأساسى للآفة ، وعلامات الاصابة بها ودورة حياتها والطرق المفضلة لمكافحتها .

فى النهاية يحتوى التقرير على شرح لمحاولات مكافحة الحشرات التى تمت فعلا فى مناطق المشروع الارشادية والتى ادت الى نتائج ناجحة وحققت زيـادة فى الانتاجية . وقد كانت الطرق الموصى باستعمالها تختص بمكافحة عـــــدة آفات معا باستعمال أقل كمية من الكيماويات بقدر المستطاع .

٦٣ صفحـــة ، ٤ جـــــداول

TABLE OF CONTENTS

LIST OF TABLES

ACKNOWLEDGEMENT

The author wishes to express his thanks and appreciation for the considerations made to this paper by the staff of the Egypt Water Use and Management Project, and to the field teams at Mansuriya, Kafr el-Sheikh and El-Minya.

The Project is funded jointly by the Arab Republic of Egypt, and by the United States Agency for International Development. The United States Agency for International Development in Egypt is under the directorship of Mr. Michael P. W. Stone. Mr. Robert Fulton is the United States Agency for International Development Project Officer for the Egypt Water Use and Management Project.

The Egypt Water Use and Managment Project is implemented under the auspices of the Ministry of irrigation's Water Management and Irrigation Technologies Research Institute and in collaboration with both the Ministry of Irrigation and the Ministry of Agriculture through the Soil and Water Research Institute and the Agriculture Economics Institute, which provide the Project with personnel services.

The Consortium for International Development, with executive offices in Tucson, Arizona, is the United States Agency for International Development Contractor for the Project. American Project personnel are drawn from the faculties of Colorado State University, the lead American University taking part in the Project, Oregon State University, New Mexico State University, and Montana State University. The Project Director is Dr. Hassan Wahby and the Project Technical Director is Dr. Eugene Quenemoen. Dr. E. V. Richardson is the Campus Project Coordinator at Colorado State University.

I. INTRODUCTION

Insects were well-established on earth long before mankind. When man started to practice agriculture, he was faced with the problem of protecting his crops from pest attacks - a problem he still faces. Both people and insects compete for the same resources. Pests reduce crop yields, lower the quality of crops and increase the cost of agricultural production. Considerable time, effort and money is spent on their control. In addition, chemicals used to control pests bear the blame for a good part of today's environmental pollution.

Different estimates of the economic loss caused by pests have been suggested. It is generally estimated that world agriculture suffers an annual loss caused by pests amounting to some 10% of field crops, 20-40% of fruit crops, 20% of vegetable crops, and 20% of grain and other stored products. In Egypt, it is estimated that the annual loss caused by insects and plant diseases to major crops amounts to more than L.E. 60 million. Despite all the control measures taken, cotton yield in Egypt suffers a reduction of about 7-10% as a result of infestation by cotton bollworms alone. Several cases are known in the world where cotton production was entirely terminated in countries or regions because of the fact that the cost of pest control made it impossible, economically, to continue producing the crop.

Furthermore, with the explosive increase in population and with the social and economic progress, human requirements have increased both in quantity and in quality. Intensive and extensive agriculture and the continuous alteration of the environment which has produced conditions more favorable to the increase of insects and pathogens are gradually increasing the gravity of the confrontation between man and pests. As pests increase in abundance and distribution, the fight grows more and more intense.

It is becoming obvious that if man is to continue his civilization, and his very existence, he must win this fight against agricultural pests, yet he must use the least injurious and most enlightened methods of control in the fight.

II. PESTS AND THEIR TYPES

A pest is a species of organism that has increased in number to exceed the economic injury level. This means that the same species may not be condemned as a pest everywhere in the world. It may be an injurious pest in one area, and an organism with no significant economic consequences in another, depending on the density of its population. This is an important point that should be considered in designing pest control programs, since control measures - and especially the application of chemical pesticides - should not be used unless the numbers pass the economic injury threshold.

Pests which are injurious to plant crops may be divided into the following general categories:

A. Pests Belonging to the Plant Kingdom:

1. Weeds: These are higher plants which grow where they are not desired and often compete for resources with economic crops.

2. Parasitic plants: These are also higher plants which live totally or partially as parasites on economic crops.

3. Some species of algae.

4. Parasitic fungi.

5. Bacteria.

B. Pests Belonging to the Animal Kingdom:

1. Vertebrates: Including rodents, bats, birds and certain other animals.

2. Invertebrates: The main group of invertebrates of economic importance, as plant pests, are the Arthropoda which include insects, ticks and mites.

Insects have the highest number of species within the animal kingdom, estimated at more than 5 million, out of which only one million species are known and identified. At least 10,000 species of insects are known to be injurious to agriculture in different areas of the world. Within this category, the groups with more important economic significance are insects and mites.

3. Nematoda.

4. Parasitic protozoa.

C. Viruses:

Although this class of biological pests exists, the present paper is restricted to problems relating to pests listed under II above.

III. METHODS OF PEST CONTROL

Before trying to control any pest, a thorough study of conditions which might have proved favorable for an explosive increase in its population should be conducted. Such a study should include the biology and life history of the pest, its behavior, seasonal history, and reaction to differences in the environment. The knowledge gained from such studies is essential for formulating an efficient control program while at the same time minimizing the possibility of short- and long-term hazards. Such knowledge also helps in forecasting the time and degree of future infestations so that adequate control measures may be appropriately prepared in advance.

An important point to be considered is the fact that most present major agricultural pests in the world are of foreign origin which gained entry either before the establishment of plant

quarantine services or accidentally after that establishment. This is true in Egypt, where almost all pests and diseases of crop plants have gained entry from abroad. This fact shows the undeniable importance of plant quarantine regulations in plant protection systems. The economic basis for quarantine is that it is better to undergo considerable inconvenience and initial expense in order to exclude, or at least to delay, a pest from entering the country. Once a pest has gained entry, there is no limit to the damage cost in revenues and in time that the country will have to bear. Nevertheless, it has to be recognized that, with the increasing volume of foreign exchanges in agricultural commodities, more means of rapid transport and the growing need for imports, it is impossible to totally and permanently control the introduction of foreign pests and diseases. All that can be hoped for by enforcing strict plant quarantine regulations is to reduce the number and rate of foreign pest introductions to a minimum.

Several methods of pest control are presently being practiced. Among the most important of these methods are the following:

A. Cultural Control

This is a cheap and technologically undemanding method of pest control. It includes:

1) Early production of crops: In many cases this procedure helps to reduce the rate of infestation, even to the point of totally eliminating infestation. It also helps to prevent later generations of pests from finding adequate and appropriate food supplies. This leads to a sharp decrease in the numbers of hibernating individuals and consequently weakens the following generations which will appear in the new season.

Early production can be achieved with early-producing varieties and the use of certain agricultural practices that accelerate ripening. Early production helps to reduce infestation with leafworms and bollworms in cotton, corn borers in maize, late season infestations by aphids and spider mites in several crops, and in many other cases.

2) Crop rotation: An appropriate crop rotation can stop the increase of pest population densities by making their host plants unavailable. Such rotations help in the control of corn borers, the sugarcane mealybug, several vegetable insects and many others.

3) Crop arrangement: Crops should be arranged in such a way that hosts of important pests should be separated as much as possible. One example is the high infestation by the medfly, *Ceratitis capitata*, in orchards with mixed host trees. It is advisable that different hosts of the medfly should not be grown together in the same orchard.

4) "Bait" plants: One method is to grow a less important and more attractive plant to take the infestation away from the main crop. These "trap" plants must be destroyed, however, before they become breeding grounds and spread infestation to the main crop. Growing a few corn plants in sugarcane fields, for example, will reduce the infestation of the canes with borers. A few ratoon cotton plants in a cotton field also help to reduce infestation by bollworms in the main crop.

5) New varieties: The development of more tolerant, or less susceptible varieties of plants can be worked out with the help of plant breeders through hybridization and selection. This procedure has been used often to combat plant diseases, and there are also several examples of strains resistant to plant pests such as corn borers, bollworms, and alfalfa aphids.

6) Soil management: Different procedures of soil management have important effects on pest control. Some examples are:
   a. Deep ploughing and hoeing result in the killing of many soil-inhabiting insect larvae and pupae by burying them, exposing them to natural enemies or exposing them to unfavorable physical conditions. It was proved in Egypt that larvae and pupae of the cotton leafworm, *Spodoptera littoralis*, which live in clover fields, are drastically reduced in numbers after ploughing.

b. Infestation by *Thrips tabaci* in cotton can be reduced by hoeing and weeding, and by repeated irrigation of the infested cotton field at short intervals.

c. Infestation of the potato tuber-moth, *Phthorimaea operculella*, is reduced by burying the sown tubers at a level of about 12-15 cm. On hoeing, exposed tubers should be covered and cracks should be filled so that tubers are not exposed to infestation.

d. To combat the woolly apple aphid, *Eriosoma lanigela*, apple trees should be surrounded with a layer of sand about 8 cm deep. Filling the soil cracks reduces the infestation by preventing aphids from crawling into the subterranean parts of the tree for infestation or hibernation.

e. In the case of infestation by the bean fly, *Agromyza phaseoli*, the first hoeing should be done as early as possible.

7) Water management: Irrigation and water management affect both plant and pest. Excessive irrigation may encourage vegetative growth and increase infestation by certain pests, especially leaf-feeding insects. In Egypt, it is observed that with heavily irrigated cotton, the infestation with leafworm moths is accordingly heavy. Many farmers refrain from irrigating their cotton fields during the peak of the moth abundance and, in this way, reduce egg-depositing in their fields. Irrigation of clover fields is prohibited after the first week of May so that low humidity and high temperature in the soil will reduce the number of emerging cotton leafworm moths. Repeated irrigation of cotton fields infested with cotton thrips, on the other hand, is said to reduce infestation or even control it. Irrigation also helps plants to form side roots which replace main roots affected by infestation.

8) Sanitation: Removal of weeds and crop residuals, especially in the pest hibernation period, helps to reduce infestation.

Cleaning crop stores, for example, can reduce infestations by stored insects: removal of maize stalks which host corn borers; removal of wheat residues that host saw-fly; burning of cotton-bolls which host bollworms; burying or burning infested and fallen fruit infested with fruit flies. Removing post-season growths of host plants eliminates an appropriate host early in the season which would have supported an overbridging generation.

9) Manures and fertilizers: All fertilizing elements must be used with caution and in proper balance. Excessive use of nitrogen fertilizers, in particular, can encourage the growth of plants attractive to such cotton pests as the boll weevil, plant bug, bollworm, and leafworm. In Egypt, it has been shown that pest damage increases with excessive use of nitrogenous fertilizers. Correct application of fertilizers, on the other hand, can help to control infestation, such as the use of phosphorus and potash with certain plants, and the strengthening of fruit trees through the use of fertilizers to resist infestations of shoot borers and bark beetles.

10) Host-free period: In some cases, especially if the pest is more or less monophagous, the establishment of a host-free period may help to reduce the infestation.

In order to use this kind of control, it is necessary to distinguish all of the different types of host required by an insect to complete its annual life cycle. The peach aphid, *Myzus persicae*, for instance, spends part of the year mainly on potatoes, another part mainly on peaches and other fruit. Making seasonal hosts unavailable at the proper time will reduce infestation.

B. Mechanical Control

These methods of control include the killing of insects by mechanical means, preventing them from reaching host plants or the appropriate part of the host, trapping, mechanical removal, and several other procedures. Some examples of this method of control are:

1) Hand picking of the egg-masses of the cotton leafworm, *Spodoptera littoralis*. This is an economical way to save the cotton crop from the ravages of this pest.

2) The establishment of ditches filled with water and dusted on both sides with lime (calcium oxide). These prevent the cotton leafworm from migrating from one field to another.

3) Destroying desert locusts by sweeping them into ditches where they are buried or burned.

4) Screening pomegranate fruit on trees with paper, cloth or plastic bags, to prevent the female pomegranate flies from ovipositing on the fruit.

5) Setting tin or wooden traps around apiaries, next to bee-hives, or as upper or side compartments of hives to help control the oriental hornet, *Vespa orientalis*.

6) Setting of various kinds of traps in fields to catch a certain proportion of pest insects, thereby reducing their numbers in the fields.

7) Other mechanical means include the operation of plant quarantine stations for the de-infestation of commodities. This is done by grinding, sieving, mechanical removal by brushing or air pressure, and several other methods.

C. Physical Control

These methods include the manipulation of physical variables, primarily temperature, to control pests. The method most commonly used is to heat plants to a point which will kill the infesting insects. For example:

1) For controlling the pink bollworm, *Pectinophora gossypiella*, picked cotton is required by law to be ginned before Spring and the seeds heated to 55-58°C for five minutes. This will kill any hibernating larvae without affecting the viability of the seeds.

2) Cold storage of certain fruits for several days at temperatures of $0^{\circ}C$ kills eggs and young larvae of fruit flies within those fruits.

3) Tests have indicated that covering land with a tarpaulin during the summer for a period of days causes a considerable increase in the soil temperature. This leads to a higher mortality rate among certain insects, such as the cotton leafworm in the larval and pupal stages. It also contributes to the destruction of some fungus spores.

4) It was previously mentioned that irrigation of clover fields is prohibited in Egypt after the first week of May. This procedure leads to a decrease in humidity and an accompanying increase in soil temperature, killing the pupae of the cotton leafworm and causing malformation and failure to emerge among the moths.

5) In plant quarantine stations, heating and boiling of commodities are frequently used for disinfection.

D. Biological Control

Biological control is the action of parasites, predators and pathogens on a host- or a "prey"-population which produces a general lower equilibrium than would prevail in the absence of these agents.

Sometimes biological control is used alone, or at least without the application of pesticides, but this method is now most often used in combination with chemical controls. Several successful cases of application of parasites and predators are recorded in the world. The following are recorded cases of successful biological control caused by imported natural enemies in Egypt:

a) Control of the fluted mealybug, *Icerya purchasi*, by the coccinellid ladybird beetle *Rodolia cardinalis*.

b) Control of lebek and hibiscus mealybugs by encyrtid parasites.

c) Control of the woolly apple aphid, *Eriosoma lanigera*, by the aphelinid parasite, *Aphelinus mali*.

Microbial pesticides, containing pathogens and their toxins as active ingredients, are now commercially produced and on sale. They are used either alone or in combination with chemical pesticides.

E. Chemical Control

This method refers to the application of poisonous chemicals (pesticides) for the control of pest and disease populations. It is still the only method available when pest populations exceed the economic injury level, making economic loss inevitable. This method of control should be the last resort, however, because its application leads to interference with established ecosystems and can create incalculable problems. These will be discussed in more detail later in this paper.

F. New Approaches in Pest Control

There are several recent, non-conventional approaches for pest control that are being worked out, mostly still on a comparatively small scale. The following are among these methods:

Attractants (including sexual attractants), repellents, antifeedants, chemosterilants, sterilization by irradiation, hormones (such as juvenile hormones) in lethal doses or to inferior mutations, and several others.

Worldwide enthusiasm for experimentation with such methods reflects the feeling that the fight between man and pests requires all of man's ingenuity to win. The question still remains, in fact, as to whether mankind will be able to win this war.

G. Integrated Control

Towards the end of the last World War, a new era in pest control started with the discovery and application of synthetic organic insecticides. Within a short period, these chemicals were in wide use in pest control programs. It must be admitted

that the rapid and widespread adoption of organic pesticides has brought incalculable benefits to mankind. However, through widespread and generally indiscriminate use, these agents have drastically altered the complicated interrelations of agrio-ecological systems, and a number of problems have accordingly resulted:

1) There are many recorded cases of pests developing resistance to insecticides, leading to their reduced effectiveness. In many cases, resistance is already strong enough so that certain insecticides have had to be eliminated from pest control programs.

2) The resurgence of treated species, necessitating repeated pesticide applications. Such repeated outbreaks occur when individuals survive treatment and return to the treated area. There they reproduce unchecked because of the elimination of their natural enemies.

3) Outbreaks of non-target arthropods. These outbreaks usually result from the destruction of the arthropods' natural enemies which otherwise hold down their populations. The more common examples are the increase of mites, aphids, white flies and others in fields treated with certain pesticides.

4) Environmental disruption outside the treated area, resulting in an increase of pest problems on adjacent crops or the creation of pest problems where none existed before.

5) Hazards to pesticide handlers and to nearby persons, livestock and wildlife subjected to contamination by drift.

6) Toxic pesticide residues on food and forage crops and accumulations of harmful pesticide residues within most elements of the environment, including man, domestic animals, wildlife plants, foodstuffs, soil, and water.

With all these problems, it is increasingly apparent that chemical control is not, and cannot be, the only or final means of pest

control. On the contrary, it is now recognized that we need an approach that uses all possible means of control in harmony - an approach called "integrated control".

Integrated control is a pest management system that, in the context of the associated environment and the population dynamics of the pest species, utilizes all suitable techniques and methods available to maintain the pest population at levels below that of economic injury.

To practice the integrated control, thorough research work on pests and other related elements of the environment must be conducted. These studies should aim at obtaining as much information as possible of the biology, ecology, and phenology of the pest, its population dynamics and the biotic and abiotic factors affecting its distribution and abundance. A forecasting system of the outbreak numbers of pests should be developed and economic injury levels of each pest at different conditions should be determined. Generally speaking, "protective treatments" should not be used, and whenever possible, selective pesticides should be preferred. Furthermore, the effect of pesticides on beneficial forms and on other elements of the environment should always be considered.

Chemical pesticides, then, should be used only when nothing else can be done. When applied, only the most specific pesticide in the lowest possible dose and number of applications should be used. The proper timing and placement of pesticidal application can also be of benefit. Disease pathogens, used as microbial pesticides, should also be considered for application, either alone or in combination with lower dosages of chemical pesticide than would be needed alone.

In general, it should always be kept in mind that the ideal chemical pesticide is not one that kills the highest proportion of the pest regardless of what happens to its natural enemies, but one that reduces pest numbers so that the balance is shifted in favor of those natural enemies. In this way, pest numbers will be regulated by natural means, preserving the delicate agrioecological balance.

CASE STUDY: INTEGRATED CONTROL OF COTTON PESTS IN EGYPT

The main cotton pests occurring in Egypt are the following: Cotton leafworm, *Spodoptera littoralis*; pink bollworm, *Pectinophora gossypiella*; cotton thrips, *Thrips tabaci*; mole crickets, *Gryllotalpa*, spp.; cotton aphid, *Aphis gossypii*; cutworm, *Agrotis ypsilon*; lesser cotton leafworm, *S. exigua*; spiny bollworm, *Earias insulana*; and mites, *Tetranychus* spp.

The first two pests listed above - the cotton leafworm and the pink bollworm - are considered as the key pests of cotton in this country. An integrated control program was devised with the aim of attaining an acceptable economic control of cotton pests while restricting as much as possible the use of pesticides and maintaining the natural balance. The main control procedures of cotton pests currently applied in Egypt are summarized here:

A. COTTON LEAFWORM

1) The cotton leafworm is active all year round and attacks cotton, maize, clover and a number of vegetable crops. It overwinters almost exclusively in clover fields. More than 90% of the moths ovipositing in cotton fields for the first brood in May and June emerge from pupae in the soil of adjacent clover fields. In order to minimize infestation in neighboring cotton fields, it is required of law that the last irrigation of clover fields should not exceed 1-10 May. The resulting high soil temperature and low humidity reduces moth emergence and consequently reduces the initial population of the pest in cotton fields, apparently with no harmful effects on their natural enemies.

2) In late Spring, if clover still harbors heavy cotton leafworm infestations, solar oil (a derivative of crude petroleum oil) - in preference to persistent pesticides - is applied with irrigation water at the rate of 30 ℓ per acre. This measure helps reduce the population of the pest and has no harmful effects on beneficial insects. Pesticidal treatments are limited to fields where infestation actually warrants control. No general spray is applied as was done in the past.

3) For control of cotton leafworm in cotton fields, hand-picking of egg masses still proves to be the most efficient control measure. Up to 85% of the egg masses can be picked and destroyed, leading to effective control. The current MOA recommendation for control is to hand-pick egg masses for as long a period as possible. If chemical control also proves necessary, it will be applied after the peak of the predator's abundance in cotton fields, generally in early July.

B. COTTON BOLLWORM

4) An economic injury level has been established for infestation by cotton bollworms at 10% infestation of green bolls in fields close to villages. Each season, beginning in early July, trained Ministry of Agriculture teams periodically inspect cotton fields for the level of bollworm infestation. Chemical control is not allowed in any village unless the economic injury level is attained. This procedure has helped to minimize spraying, delaying unnecessary early spraying and in general reducing the total cotton acreage treated with pesticides.

C. COTTON THRIPS

5) No general protective spray is used against thrips infestation early in the season. An economic injury level (8-12 individuals per seedling) has been determined. Fields with infestations above this level are selected for treatment. Selective treatment has reduced the acreage sprayed from ca. one million acres in the early sixties to ca. one hundred thousand acres in recent years. Chemical treatment early in the season has a deleterious effect on the pests' natural enemies.

At least partially due to the practices mentioned above, several encouraging phenomena in cotton agroecosystem in Egypt have been observed in the last few years. Among these phenomena are the following:

(1) Cotton leafworm infestations are coming under control.

(2) Early season infestations have been, in most cases, declining over the last few years.

(3) Loss of cotton yield caused by bollworm infestations declined from about 20% in the 1950's to about 5-8% since the late 1960's.

(4) The average yield per acre fluctuates, but generally yields are higher. A record yield of 334 kg of baled cotton per acre was obtained in 1969.

Finally, it should be emphasized that the integrated method of pest control has worked so well in so many situations and areas of the world that there is no doubt as to its advantages. Every method used should be evaluated for its long-term as well as short-term results. Although the use of chemical pesticides in agriculture is here to stay, we should understand that what is needed is their "wise" rather than "wide" application.

IV. MAJOR FIELD CROP INSECTS AND THEIR CONTROL

Cotton, maize, rice, wheat, barley and sugarcane are the major field crops in Egypt. These crops, however, are subject to infestation by a number of pests which - if not controlled - cause considerable losses in yields. The following is a review of major insects and various measures for their control.

A. COTTON INSECTS

Cotton is the most important agricultural crop in Egypt. The area devoted to cotton over the last few years has varied between 1.4 and 1.6 million acres per year. It is still considered the backbone of the national economy in spite of recent attempts at industrialization and crop diversification.

This crop is highly susceptible to arthropod infestations which attack all parts of the plant and are active throughout the growing season.

The important pests of cotton in Egypt are classified as follows:

Early-season pests:

1. Cutworms
2. Cotton thrips
3. Cotton aphids

Mid-season pests:

4. The cotton leafworm
5. The lesser cotton leafworm

Late-season pests:

6. The pink bollworm
7. The spring bollworm

The cotton leafworm and pink bollworm are considered the key threats to the cotton crop in Egypt. The following is a brief account of cotton pests.

1. Cutworms *(Agrotis ypsilon)*

Several species of cutworm are found in Egypt. The greasy cutworm *Agrotis ypsilon* is the most common.

The greasy cutworm is a cosmopolitan species which cuts off seedlings of many plants while satisfying its appetite. This insect cuts young cotton plants at or near the surface of the soil in two.

The female moth of this insect lays its eggs singly or in small groups on the leaves or stems of cotton seedlings, or on weeds in cotton fields. One female may lay as much as 2000 eggs. Eggs hatch within 3 to 7 days. Young larvae feed on the plant foliage and reach maturity after 3-5 weeks depending on weather conditions. Full-grown larvae are grey-to-brown above, with faint lighter stripes. They reach about 5 cm. in length and are found in the daytime in the soil. They often curl up when disturbed. They pupate in the soil in mud cells a few centimeters below the soil surface. Pupal duration lasts two to three weeks in Summer. Pupae have a wide range of host plants among field crops.

Control Measures:

a. Early ploughing of cotton fields in order to expose the soil to sun for a reasonable time, allowing it to dry before cotton is sown.

b. Spraying of infested fields by insecticides. A list of the recommended chemicals for the control of all cotton insects during the 1979 growing season in Egypt is supplied at the end of this review.

2. Cotton Thrips (*Thrips tabaci* Lind)

Thrips attack the leaves and terminal buds of cotton seedlings. Infestation may be slight and in scattered areas, or it may spread over a whole field of cotton. Severely infested plants may be stunted and the stand of cotton may be reduced to such a level that resowing is necessary.

Larvae and adult thrips attack the cotton plant by piercing the tissue of the leaves and feeding on the cell sap.

Heavy infestation gives the plants a silvery appearance. Later the leaves become dark olive or brown in color, shrivel, and fall off. Early-sowing cotton varieties are less subject to infestation than late-sowing varieties. Proper irrigation and fertilization allow the plant to tolerate infestation.

Control:

Spraying of infested fields with recommended insecticides.

3. Cotton Aphid (*Aphis gossypii* Glover)

Cotton seedlings are subjected to infestation with the cotton aphid during April and May. Infestation on developed cotton plants is also not uncommon.

Aphids can be seen in good number on the lower surface of cotton leaves. They are relatively large in size, and green or olive-green in color. With its piercing, sucking mouthpart, the insect sucks the plant sap. As a result, infested leaves of cotton seedlings curl. When cotton is attacked by aphids in late summer, the pest usually infests the leaves and growing tops. With heavy infestation, leaves become reddish and then yellowish, and

may fall off. Fungus growth associated with the honey-dew excretion of the aphids can be seen covering the infested plant parts.

A result of aphid infestation is the smaller size of developed bolls and a decrease in cotton yield.

Control:

Spraying of infested cotton fields by the recommended insecticides.

4. Cotton Leafworm (*Spodoptera littoralis* Bois)

The cotton leafworm is the most serious cotton pest in Egypt. It is extremely phytophagous, having a wide range of host plants among field crops.

Eggs of *S. littoralis* are laid in masses on the underside of cotton leaves. The number of eggs in one mass varies between 250 and 350 eggs and one female may lay between 1000 and 2000 eggs.

Eggs hatch after a period of 2 to 4 days and newly hatched larvae feed first on the leaf where the egg mass is deposited. After a few days, larvae are scattered to attack the leaves of the whole plant. Larvae devour the leaves completely and make their way into young shoots and flower buds. Growth of infested plants is retarded, and as a result the crop yield is affected, particularly if flower buds or bolls are infested.

The larval duration lasts about 15 to 20 days. Full-grown larvae leave the plant and burrow into the soil to a depth of 2 to 3 cm. in order to pupate. The pupal stage lasts between 7 and 15 days.

The cotton leafworm is active all year, but Winter generations develop slowly in comparison with Summer generations. In general, the insect has 7 generations a year, three of them on cotton.

Control measures:

a. Hand-picking of egg masses has proved to be a reasonable, efficient control measure when done during June and July. This method, although laborious, saves the troubles which accompany the use of chemicals.

b. Chemical control is used when larvae of different ages are seen scattered on cotton leaves in the field.

5. Lesser Cotton Leafworm (*Spodoptera exigua*)

This insect is very similar in feeding habits to the cotton leafworm, but is less harmful to cotton plants. It appears in cotton fields early in the season. It lays its eggs either on the lower surfaces of plant leaves or on the leaves of certain weeds in the cotton fields. Eggs are laid in masses of 20 to 70 eggs each. One female moth may lay as many as 500 eggs.

Eggs hatch after 2 to 4 days and young larvae feed first on the lower leaf epidermis. When they grow up they pierce the leaves and sometimes devour the whole leaf, except the ribs.

Larvae reach maturity after 10 to 15 days. They pupate in the soil and moths emerge after about a week.

Control Measures:

This insect is controlled in the same manner as the cotton leafworm: egg-masses are hand-picked along with those of the cotton leafworm, and the same chemicals are effective in controlling both insects.

6. Pink Bollworm (*Pectinophora gassypiella*)

Larvae of the pink bollworm feed upon cotton squares, blooms and seeds within the growing boll. In addition to the destruction of lint and seeds, the quality of the picked lint in heavily infested fields is also lowered. As a result of infestation, fungi find an easy entry to the bolls through the holes made by the larvae, causing the whole boll or one of the locules to rot.

In some cases, squares are completely destroyed and shed. If the infested square does not shed, a rosette bloom results. Such blooms have petals tied together with silken threads. They do not open normally. The rosette bloom is a typical sign of pink bollworm infestation.

Infestation by the first generation of the pink bollworm starts as early as May or June and increases gradually with the advancement of the cotton season and the development of the plant. The

peak of abundance of this insect in Egypt occurs during September. Percentages of infestation range from about 1% in June to 90% in September, if no control measures are followed.

Female moths of the pink bollworm lay from 50 to 300 eggs over a period of 8 days. Eggs hatch in 4 to 5 days. The larvae feed inside cotton squares, blooms or bolls for 10 to 14 days and then pupate in the soil. Normally, 8 days are required for pupal development. Larvae of the pink bollworm pass a period of diapause of varying lengths in a full-fed state. This period is termed the "resting stage". Most of the diapausing larvae pass the winter in the bolls in which they have developed. However, some may pass the winter in the cotton seeds, in the trash in fields or at gins or in cracks in the soil. A larva may hibernate in a single seed or it may pull two hollowed-out seeds together and unite them by spinning a continuous cocoon within the cavity of the two seeds.

Some diapausing larvae may not pupate until in their second year of life.

Control Measures:

A. Cultural Methods:

1. Early-maturing varieties of cotton escape high infestation late in the season.

2. Early sowing, for early maturity.

3. Collecting and burning infested bolls after the cotton season is over helps to reduce the source of infestation for the following year.

4. Seeds of cotton are heated for 5 minutes in cotton gins to a temperature of 56 to 59^{o}C. The ginning season should end before April.

B. Chemical Control:

Cotton is sprayed periodically three to four times to control both the pink and the spiny bollworms. The first application starts when the infestation reaches 10% in green bolls in the

field (about mid-July). More than one insecticide is used per field to avoid or delay the development of resistance to the insecticides used. Certain chemicals (effective also on the cotton leafworm) are used when cotton is infested with the latter insect late in the season. The recommended insecticides are listed below.

7. Spring Bollworm (*Earias insulana* Bois)

In its younger stages, the spiny bollworm commonly attacks terminal growing points, feeding on unexpanded leaflets and tiny squares. Older larvae attack the well-developed squares, larger flower buds and small bolls.

The spiny bollworm tends to foul a boll more than a pink bollworm does. This is perhaps due to the fact that the spiny worm is bigger in size and feeds more on the unripe cotton fibers. Furthermore, it attacks more than one boll to complete its development, while the pink bollworm feeds and develops in one boll only. The presence of dirty excrement inside and outside the bolls and the large irregular entrance holes make it easy to identify the work of this pest.

In spite of the fact that the individual spiny worm is more destructive than the individual pink worm, the population of the spiny bollworm in Egypt is very much less than the population of the pink bollworm. The density of the spiny bollworm population, however, is increasing considerably in Southern Egypt, and the ratio between the insects may now be in favor of the spiny bollworm south of Qena Governorate.

Eggs of the spiny bollworm are usually deposited on the bolls and small leaves and buds at the growing points of the main stem and branches. Eggs are laid singly, and possibly also in pairs.

One female lays about 200 eggs. During summer, eggs hatch within 3 to 4 days. The larva completes its development in two weeks during summer and in a somewhat longer time in colder conditions.

The full-grown spiny bollworm leaves the bolls and seeks a site to spin its cocoon. This may occur anywhere on the plant or among fallen leaves below the plant. The pupal duration lasts between 9 and 11 days. The insect has 5 to 6 generations a year.

Table 1. INSECTICIDES RECOMMENDED IN EGYPT FOR THE CONTROL OF COTTON INSECTS

1979 SEASON

Insect	Insecticides
Cutworm	Endrin 50% W.P., 1 kg/*fed* or Endrin 19.5% e.c., 2.5 *ℓ/fed.*
Cutworms Aphid and thrips Aphid + spider mites	Endrin/Bedrin, 1.5 *ℓ/fed* Kalthane S, 1 *ℓ/fed* Golecron 50%, 0.5 *ℓ/fed* or Folimat 80%, 0.5 *ℓ/fed* or Kelval 40%, 0.5 *ℓ/fed* or Zolon 30% W.P., 0.5 kg/*fed*
Thrips	Novacron 40%, 400 cm^3/*fed* or Tamaron 50%, 500 cm^3/*fed* or Folimat 80%, 250 cm^3/*fed* or Endrin/Bedrin 20:20, 1.5 *ℓ/fed* or Azodrin 40%, 500 cm^3/*fed* or Kalthane S, 1 *ℓ/fed*
Cotton leafworm or lesser leafworm	Cyolane, 1.5 *ℓ/fed*
Bollworms and late infestation of cotton leafworm	Cytrolane, 1.75 *ℓ/fed* or Dursban 40.8% e.c., 1 *ℓ/fed* or Endrin/Bedrin, 2.5 *ℓ/fed* or Tamaron/Gusathion, 2 *ℓ/fed* or Novacron 40%, 1.5 *ℓ/fed* or Gusathion 20%, 3 *ℓ/fed.*

B. MAIZE INSECTS

Maize is one of the most important cereal crops in Egypt. It is the main crop used for bread-making in most rural areas. Furthermore, green maize plants are used as a forage crop for cattle. This crop, however, is susceptible to a large number of pests which cause an average reduction to its yield amounting to 25 percent.

The most important corn pests are:

(i) Corn Borers:

Three borers are known to attack maize in Egypt. They are destructive to the maize crop, particularly in Lower Egypt and in the northern part of the country. Their damage differs greatly according to the date of sowing, to the prevailing borer where the maize is sown, and the environmental conditions.

a. Pink Borer (*Sesamia cretica* Led.)

The pink borer (*Sesamia cretica* Led.) is common all over the country. It attacks sugarcane and other graminous weeds in addition to maize.

Life Cycle and Nature of Infestation:

Female moths lay their eggs in masses of 15 to 20 eggs on corn that is 15 to 35 days old. No eggs are laid on corn older than 35 days, except late in the season when eggs of the last generation are laid. Larvae from the particular eggs undergo hibernation. Egg masses are laid on the inner surface of the leaf-sheath of the first three leaves on the plants. Eggs of one cluster are separated and are arranged mostly in two irregular longitudinal rows. The egg is nearly round in shape and slightly less than 1 mm in diameter.

The incubation period varies between 3 to 7 days, depending upon the temperature. The newly hatched larvae first feed on the egg shell, then bore directly through the stem which, at that time, is composed of rolled leaves surrounding the growing point. Up to this stage, infestation does not show on the outside, but a few days later, small holes can be seen on the leaf blades arranged in transverse rows. On examining an infested plant, the holes through

which young larvae entered the stem can be seen. These lead to the larvae themselves, which feed in tunnels made in the folded leaves which form the stem. The larvae may continue to feed upwards, destroying the growing point of the plant. The plant then withers and can be easily detached. This phenomenon is known as "dead heart."

Infested older plants show external holes which lead to big tunnels in the internodes of the maize stems. These plants are infested by larvae migrating from younger plants, since no eggs are laid on old plants. The borer may also attack the ear, feed on the kernels or bore into the ear cob.

The larvae become fully developed within 3 to 4 weeks. They reach about 3.5 cm in length and have a pinkish color. Pupation takes place inside the plant. The moths emerge 7 to 10 days later and leave the host plant to infest other plants.

Life History:

The number of generations of *Sesamia cretica* under field conditions in this country is not definitely known, although there are some indications that 4 to 5 generations may be presented every year.

The fully grown larvae of the last generation hibernate inside the corn stalks or below the soil level inside corn roots. The larvae may also overwinter in galleries between kernel rows or within the cob-core.

b. Purple-Lined Borer (*Chilo agamemnon* Bles.)

The purple lined borer (*Chilo agamemnon* Bles.)(sometimes called the rice-stem borer) is considered the most injurious pest to maize in Egypt. It is quite common in Lower and Middle Egypt. In 1967, this borer was also reported attacking sugarcane and maize in Sohag Governorate, and recently it reached the northern districts of Qena Governorate in Upper Egypt. It is thought that certain climatic factors, mainly humidity and temperature, have changed in Upper Egypt in the last few years to favor the borer. Changes in the climatic factors are mainly due to converting basin lands to a system of regular cultivation which irrigates in Summer with the reserved water behind the High Dam.

Life Cycle and Nature of Infestation:

The female moth normally lays its eggs on corn plants ranging between 1 and 2.5 months old and rarely at an earlier or a later stage. Eggs are mainly deposited on the upper side of the leaf blades, preferably those near the growing point of the plant. The eggs are flat, oval and pearly white in color, with light shades of yellow-green overlapping. Fifteen eggs, on the average, are found in one egg mass.

Eggs hatch 3 to 6 days after deposition. The newly hatched larvae crawl towards the stem to invade and feed on the leaf sheaths of the lower leaves and frequently in the plant whorl. After 3 to 5 days, the larvae in the second or third instar bore through the stem. They normally invade an internode at a point near the node, then burrow downwards, and - before reaching the lower node - start feeding in a circular manner around the inner periphery of the stem. This girdling phenomenon is a characteristic feature of *Chilo* infestation. It causes weak points so that infested plants break by the action of wind or any other mechanical means.

The loss in crop yield due to girdling reaches its maximum when girdling takes place in a point below the ear before it is formed.

This borer also attacks the ears, tunnelling between kernel rows or through the cob. The size of the ear is greatly reduced if the larvae bores through the ear shank. Larval tunnels also are common at the lower instar nodes of the plant or inside the roots.

The mature larvae is creamy in color with 5 purple longitudinal strips on its dorsal surface. The larval stage may be completed in 15 days and pupation takes place inside the stem. The pupal stage lasts for 5 to 8 days after which the moth emerges.

Seasonal History:

The number of generations is not yet known with certainty, but it appears to be 4 to 6 generations a year. The full-grown larvae of the last generations hibernate in the same overwintering sites as *Sesamia cretica*.

c. European Corn Borer {*Ostrinia nubilalis* (Hbn)}

The European corn borer {*Ostrinia nubilalis* (Hbn)} is common in Lower and Middle Egypt up to Beni Suef Governorate. The northern regions of the Delta are seriously infested, but the degree of infestation gradually decreases to the south.

Life Cycle and Nature of Infestation:

This insect attacks maize when it is at least two feet high, or 35 days after planting. The eggs are normally deposited near the middle rib on the under side of corn leaves in clusters of 15 to 25, overlapping like the scales of a fish.

Clusters are flat and measure approximately 6 mm in diameter. They are waxy and white in color, but eggs that are about to hatch have distinct black centers caused by the black heads of the larvae visible through the translucent shell.

The eggs hatch in 3 to 7 days, depending upon weather conditions. Young larvae then move mainly to the plant whorls and frequently to the leaf sheath. After a few days, leaf feeding can be seen at the base of the leaf blades surrounding the plant whorl. As the larvae reach the instar they burrow into the stalk of the maize plant.

Larvae mostly invade the upper parts of the maize stalks, making tunnels full of sawdust-like frass. Stalk tunnelling results in destruction of food conducting channels. This weakens the plant and reduces the yield.

They may also tunnel in the ear shank and prevent the proper development of the ear. Larvae feed also on the kernels or bore into the ear cob. Tunnelling in those stalks which carry tassels causes the stalks to break or bend down. The lower internodes of the corn plant and the roots are frequently free of insect invasion.

The larvae are greyish or pinkish in color and have dark spots on the dorsal surface (6 on each body segment).

Seasonal History:

It is believed that *Oscrinia nubilalis* has 3 to 4 generations a year in Egypt. This insect overwinters as a fullgrown larvae inside corn stalks, in galleries between kernel rows or inside the cob.

d. Control measures for corn borers:

Mechanical, chemical, cultural or other means of control are based upon the behavior of the pest at injurious stages and its overwitnering sites. Measures practiced in controlling corn borers are:

1. Date of Sowing:

Studies on the relationship between the date of corn sowing and infestation with corn borers in Egypt indicate that:

a. Maize planted as early as late March or during April is subjected to high infestation with *Sesamia cretica*. In most cases, these crops need insecticidal treatments to control this borer. Maize sown in Lower Egypt during March is moderately attacked with *Ostrinia nubilalis*. The infestation by this pest generally does not reach the economic level.

b. Maize planted during May to mid-June is slightly infested with corn borers and normally such crops do not require chemical treatments.

c. Maize sown during July to early August is severely attacked by *Chilo agamemnon* and *Ostrinia nubilalis* and insecticidal applications should be applied to control these insects. Infestation with *S. cretica* on corn sown during this period is mostly low and does not require any control measures. It is suggested, therefore, that farmers should plant their corn from May to early June to avoid high infestation with borers. Maize observation fields are sown in certain districts in the Delta and Middle Egypt to regulate the chemical control of corn borers.

2. Eradication of the Overwintering Larvae:

The larval overwintering inside the corn stalks and in corn stalks and in corn roots left in the field after harvest was mentioned above. Moths of *Sesamia* developing from the hibernating larvae emerge during March and April, while *Chilo*

moths appear during May and *Ostrinia* moths emerge late in April and early in May. Maize stalks used as fuel by the farmers should, therefore, be consumed before March to get rid of the overwintering larvae inside these stalks. Maize roots left in the fields should also be collected and burned when preparing the field for the following crop.

3. Chemical Control:

Four applications are necessary to obtain good control when high infestation with corn borers are expected. The first two applications are mainly done for *Sesamia* control. The first is carried out when maize is 20 days old (or about one foot high) while the second is done 10 days later. Sieving 85% wettable powder at the rate of 3 kg per *feddan* in 150 liters of water is recommended in these applications. The third and fourth applications are carried out when maize is 45 and 60 days old, respectively, and are done mainly to control *Chilo* and *Ostrinia*. DDT 50% wettable powder at the rate of 3 kg per *feddan* in 300 to 400 liters of water is recommended in these two applications. It should be noted that insecticidal application in corn fields is very much easier when corn is planted in rows. It is also of great importance to mention that corn plants treated with recommended chemicals should not be used as food for cattle.

4. Development of Pest Resistant Maize Varieties:

None of the corn varieties in commercial use now in Egypt shows any tendency to resist corn borers. A program is proposed to develop new varieties which resist the borers' attack. A research team consisting of a plant-breeder, an entomologist and a plant pathologist would work together on this project.

5. Biological Control:

A survey of predators and parasites which attack corn borers in Egypt is not yet completed. However, the following is a list of parasites known to attack corn borers:

Trichogramma evanescens	On eggs
Pimpla sp.	On larvae and pupae
Microbracon brevicornis	On larvae and pupae
Apantelels sp.	On larvae of *Sesamia*
Platytelenomus hylas	On eggs of *Sesamia*
Cononorium esemita	On pupae of *Sesamia*

(ii). Corn aphid

Maize can be infested by the corn aphid *Repalosiphum maidis* at any time, but the infestation usually occurs immediately after tasseling. Infested corn shows numerous greenish or greenish-blue aphids on the tassel and upper leaves. Infested corn leaves are frequently mottled with yellowish patches. They soon turn black as a result of heavy fungal growth following the excretion of honey-dew. Under favorable conditions, the aphid will multiply rapidly, and infestation may seriously interfere with the pollination of corn. This insect is most common on corn planted during July and August. It appears in these fields late in August and during September.

Control Measures:

1. Early Planting

   Corn planted during May or early in June is less subject to severe infestation than corn planted during July and August.

2. Cutting the infested tassels as soon as they show infestation and burning them outside the field can control light or moderate infestations. No more than 25% of the tassels should be removed.

3. In cases of heavy infestation, infested corn should be sprayed with melathion 97% at the rate of 1½ liters per *feddan*.

C. RICE INSECTS

Rice is a very important cereal crop in Egypt. It is the second export crop in this country. Its yearly cultivated area has increased recently to reach about 1.2 million acres. Furthermore, rice grows well in newly reclaimed land, where a certain salinity exists in the soil that prevents the successful growth of most other crops.

The Major Insect Problems of Rice in Egypt Are:

1. Bloodworms (*Chironomus* sp.)

Larvae of a certain species of *Chironomus*, commonly called "bloodworms", occur in rice fields in saline soils or if irrigated from drainage canals. Such conditions prevail on the newly reclaimed lands in the northern region of the country.

Chironomus larvae cut and destroy the rootlets of young seedlings in rice nurseries. The affected seedlings lose their attachment to the soil, float on the surface of the water and drift to the corners of the rice plots. Larvae may also feed on the starchy content of the rice grain.

Life Cycle and Seasonal History

Eggs of this insect embedded in gelatinous material are laid by female flies on the surface of the water. They attach themselves to anything floating until they hatch. They may be swept away along with running water into drainage ditches and may fail to hatch if they come to rest on dry land.

The incubation period of eggs ranges between 2.2 and 4.5 days, according to weather conditions. At the end of the incubation period, the small larvae escape by bursting the eggshell and swimming close to the surface of the water.

The larval stage lasts between 12 and 18 days. Shortly before pupation, the thoracic region of the larvae becomes swollen and its segments lose their distinction. The larval cuticle is then retracted and is replaced by the pupal cuticle. The pupae lie half

buried in the mud at the bottom of the water with their thorax and respiratory filaments projecting outwards. The pupal stage lasts between 4 and 8 days according to weather conditions.

As the pupal development comes to an end, the pupa floats to the water surface. A longitudinal split occurs along the thoracic dorsum through which the fly can make her escape. Female flies live for 2 to 3.9 days while males live from 0.4 to 1.5 days.

Mating does not occur in captivity. It occurs while flies are on the wing in swarms hovering near the water surface at dusk.

The insect overwinters as full grown larvae buried in the mud at the bottom of deep pools or water streams.

Hibernation starts around mid-December and ends in early March. The number of generations per year is hard to figure out because of overlapping in the field. Duration of the life cycle suggests, however, that under normal conditions there might be 9 generations per year.

Control Measures:

1. Not planting rice nurseries in saline soils.

2. Sowing seeds on the same day that the rice nursery field is filled with water. This will help rice seedlings to fix themselves in the soil before the larvae attack.

3. Rice sown with seeds previously soaked in water for 48 hours and left for another 48 hours until the emergence of rice rootlets has a better chance of escaping infestation.

4. Not irrigating rice nurseries from drainage canals.

5. Draining water from rice nurseries for one or two days to reduce the insect population. This does not seriously affect the rice seedlings.

6. Applying 5% granular Diazinon or 10% granular Sevin, each at the rate of 6 kg per acre in rice nurseries.

2. Rice Stem Borer (*Chilo agamemnon* Bles.)

Rice in Egypt is subjected to rather severe infestations by the rice stem borer. Before the 1965 season, rice infestation by this borer was too low to be considered of economic importance. It has recently been found, however, that the infestation has increased considerably. Approximately 10% of the rice yield is being lost in certain years due to the borer attack.

Losses in rice yield due to the borer differ greatly in different localities, with different rice varieties, and in accordance with the degree of nitrogen fertilizer used.

Nature of Infestation

Eggs of this borer are laid in clusters of about 20 eggs each on rice leaves or on the green stem. After hatching, larvae feed for a few days on the leaf sheaths and then invade the stem, generally from below. They tunnel into the stem and cause one of the following symptoms:

1. They destroy the growing point of plants before heads are developed, causing what is termed "dead heart." Plants with "dead heart" yield nothing.

2. If heads are developed, the rice borer may feed into the head stem detaching it from the main stem of the plant. Such heads wither and die before seeds are formed. This phenomenon is termed "white heads."

   No yield is expected from such plants. Infected heads look white, sound heads are still green.

3. Stems may be infested, but sound heads containing seeds still develop. In this case, the yield is only slightly affected.

Life and Seasonal History

Life history of this insect was described above under Corn Pests (p. 24). The insect passes approximately 3 generations on rice in the field, and full grown larvae overwinter in rice stubble and in rice straw.

Control Measures:

1. The rice variety Nahda is less subject to infestation than other commercial varieties cultivated in Egypt.

2. Rice planted early in the season (up to May 15) is less subject to infestation by the borer than late rice plantings.

3. The infestation increases with increases in the rate of nitrogen fertilizers.

4. Lindane or Diazinon, both in granular form, are two effective insecticides against this pest.

D. WHEAT AND BARLEY INSECTS

Wheat and barley are attacked by several insects, none of which, however, causes severe losses. The most important insects which attack wheat and barley are:

1. Black Cutworm (*Agrotis ypsilon*)

The cutworm is a pest that affects wheat and barley in certain regions of Egypt.

Larvae feed on the lower part of the stem just above the soil surface. The infested plant is cut off, falls and dies. Cutworm infestation is mostly light, however, and can be controlled by tilling the fields.

2. Wheat Stem Sawfly (*Cephus tabidus*)

Wheat stem sawfly is common in wheat fields all over the country. The losses caused by this insect, however, do not exceed 1 percent. The adult females lay their eggs by thrusting them into the plant tissues on the upper parts of the wheat stem. The larvae feed within the stem, boring down through the joints until they reach the lower parts of the plant close to the soil surface. Here, they cut right around the stem causing the plant to break off before the kernels are formed. The larvae then plugs itself into the base of the plant forming a chamber in which it estivates.

Control Measures:

Ploughing under infested stubble after harvest is the best method of control. Solid-stemmed varieties of wheat are also more resistant.

3. *Cnephasia* sp. (fam. Tortricidae)

This insect is common on wheat and barley in the Delta and Middle Egypt as far south as Beni Suef. It is most common in Sharqeya Province, where considerable damage has been observed.

Young larvae of the first and second instars mine into wheat and barley leaves. When they grow up, they leave the mines and attack the plant itself. They feed on the stem below the ear and before kernels are formed. The ears dry off while free ears are still green. Larvae may also feed on the kernels causing partial damage to the ear. This insect attacks also flax and some graminous weeds. No control measures are recommended.

E. SUGARCANE INSECTS

Sugarcane is the only crop planted in Egypt for sugar production. Molasses, alcohol, vinegar, and some other materials are by-products of the sugar industry. The area planted with sugarcane has been increased recently to reach about 210,000 *feddans* and is increasing steadily. Around 90% of this area is located in Upper Egypt in the Qena and Aswan Governorates, while the rest is cultivated in Middle Egypt in the Minya Governorate.

The most important sugarcane pests are:

1. Sugarcane Borers

Out of the three borers mentioned for maize, two are also known to attack sugarcane. These are the pink borer and the purple-lined borer.

a. Pink Borer

This insect is common on sugarcane throughout the country. Eggs are laid in clusters on the inner surface of the lower leaf sheath of young sugarcane plants, and sometimes on the gramineous weeds in sugarcane fields. The nature of infestation of this insect on sugarcane is very similar to that described for maize. "Dead hearts" caused by this insect are very common in infested sugarcane fields. Infestation of the growing points of young sugarcane plants, however, might also have the effect of accelerating the development of new shoots.

b. Purple-Lined Borer

This insect is quite destructive to sugarcane plants and causes considerable losses to this crop.

Eggs of this insect are laid in clusters on both sides of leaf blades. After hatching, larvae move towards the stem. They usually feed on the leaf sheaths for a few days before they invade the stem. The infestation of sugarcane stems is similar to that described above, p.25, in relation to corn stalks. Tunnelling in sugarcane stems, however, is a direct decrease in the yield. The amount of juice and sugar obtained from infested joints is less than that obtained from free joints.

Occurrence of this insect was formerly limited to the Delta and Middle Egypt, but, this insect has now invaded sugarcane in Assyût, Sohag and the northern part of the Qena Governorate. It is feared that the insect might extend southward to cover Qena and Aswan Governorates, where most sugarcane is cultivated.

A recent survey of this borer indicated that the infestation has reached an average of 12% (measured by the number of infested joints out of the total number of joints examined) in Middle Egypt and 5% in the northern Qena Governorate.

The degree of infestation by the borer differs with different varieties and different locales. The insect is very sensitive to the humidity in the environment, and sugarcane grown in heavy soils or in areas where there is no drainage tends to be more infested than sugarcane grown in light soils with good drainage. For the same reason, sugarcane planted in wide rows is less subject to infestation than that planted in narrow rows.

The life cycle of the borer is described above, p.23. The infestation of sugarcane is almost the same as that of corn.

Control Measures:

The following measures are used to control sugarcane borers:

1. Planting of relatively resistant varieties of sugarcane, particularly in areas where high infestations of the borers are expected.

2. Eliminating weeds from sugarcane fields to decrease borer infestation. (Borer eggs are sometimes laid on the gramineous weeds in sugarcane fields, and the developing larvae feed on the weeds for a short time before they attack sugarcane plants.

3. Eradicating borer larvae overwintering in corn stalks, corn roots and rice and sugarcane stubbles.

4. Improving the drainage in sugarcane fields plus irrigating properly.

5. Using chemical controls. Chemical control of the borer in sugarcane fields is a hard task. Sugarcane plants become crowded in the field after the month of July due to narrow rowing, so that the application of any insecticide after July becomes almost impossible. Most of the borer's activities in sugarcane fields occurs from July to October. Experiments using several insecticides against sugarcane borers were successful, however, when the cane was planted in wider rows.

2. Sugarcane Aphid (*Rhopalocephum maidis*)

The sugarcane aphid is not considered a serious pest for sugarcane as far as damage to cane plants is concerned. This insect, however, is known to be a carrier of sugarcane virus disease.

No control measures are recommended for this pest on sugarcane.

3. Sugarcane Mealybug

The sugarcane mealybug is a small, oval, pink insect covered with a thin layer of powdery wax. It is common on sugarcane stalks, particularly around nodes and under leaf sheaths. It is more common on stubble cane than on plant cane.

It damages cane plants by sucking the plant juice, and interfering with sugar crystallization.

Control Measures:

1. Planting free cane seed pieces.
2. Cleaning fields thoroughly of weeds.
3. Burning the dry sugarcane leaves in the field after harvest.
4. Using a four-year rotation; one year of cane, two years of stubble, and one year of legumes.

4. Field Rat (*Arvicanthis niloticus*)

The field rat is a rodent with a body length of 17-19 cm and a tail length of 12-15 cm. It is common in the Egyptian fields, but most common in Upper Egypt, particularly in sugarcane fields.

The rat multiplies rapidly, its pregnancy period ranges between 18 and 20 days. The rat gives birth to 5 to 6 young at a time and these reach maturity in 75 days. The female gives birth 3 to 7 times a year and the rats live 35 to 70 months.

Sugarcane fields are good shelters for the rats. They make their holes in the fields and live by feeding on cane plants. They chew the plants, preferring the lower joints. Damage to sugarcane caused by rats is estimated at 8 percent. Wounds in cane plants made by rats also give easy access to fungi and bacteria.

Control Measures:

Rat control should be continuous throughout the year and not confined to sugarcane fields. It should be done on a large scale, covering whole infested areas.

(i) Rat Traps:

Rat traps are a good method for controlling rats in houses or small gardens, but are not practical under field conditions where large numbers of rats are found. Where traps are used, there should be different kinds of baits, and these should be renewed periodically. Place traps where rats are most common.

(ii) Poison Baits:

A poison bait of zinc phosphide is recommended for rat control, using corn seeds, lentils or watermelon seeds as a carrier. Zinc phosphide is used at the rate of 30 gr per kg of seeds. When watermelon seeds are used, they are soaked in water for 18-24 hours. Corn and lentil seeds are boiled in water until they are nearly cooked. The water is drained and the chemical is added and mixed thoroughly. Oil is then added to the bait at the rate of 10 cc per kg.

Poison baits should be prepared and delivered to the field just before sunset. Zinc phosphide is a very toxic chemical, and bait should be prepared and handled with great care.

A new chemical named "Warfarin" has proved to be effective against rats. This chemical is less poisonous than zinc phosphide and has no repellent odour. It kills the rats after 4 days by causing internal haemorrhage.

5. White Grub (of beetle *Pentoden bispinosus*)

The white grub of this beetle is known to attack sugarcane plants in Egypt. Larvae feed on the underground parts of the cane plants. They attack the seed pieces making big tunnels inside the joints. Poor cane stand and less shooting are expected in the infested areas. Cane seedlings are also affected by larvae feeding on their roots.

Infestation by the grubs is more common when the soil is rich in organic matter or when an excess of manure is added.

Control Measures:

1. Deep ploughing which exposes the soil to the sun for a long period dries the soil and cleans the field of plant residues. This kills many of the larvae in the soil.

2. Mixing the soil with aldrin, dieldrin or chlordane just before planting is also very effective against grub infestation.

V . Survey of Pests Infesting Vegetables and Crops in Beni Magdul and El-Hammami, El-Mansuriya Governorate, with Recommendations for Their Control

As a first step in developing a program of pest control in El-Mansuriya, a survey of the pests infesting vegetables and crops in the sites of Beni Magdul and El-Hammami was undertaken. The study identified the major pests and their hosts, noted symptoms of infestation, the life history of the pests and the damage they caused. Finally, several control measures were recommended for each pest.

The study was designed to give Mansuriya farmers a complete picture of the pests which were infesting their crops. It was conducted in preparation for the establishment of a school for pest control, to be set up in Mansuriya's Project building. Finally, since it was done under the auspices of the Egypt Water Use and Management Project (EWUP), the study was particularly interested in the role that water management can play in the control of agricultural pests.

A. Methods and Materials

Starting in July of 1979, weekly trips were made to the Beni Magdul and El-Hammami sites to collect samples of vegetables and crops grown in Mansuriya. These trips were continued for an entire year, ending in July 1980. Samples were random, and were stored in

plastic bags. They were transferred to the author's laboratory at the Pest Control Department in Dokki, where they were examined under a binocular microscope. The results of these investigations are given in the following tables.

B. Results

1. Effect of soil moisture content on the pupal duration and moth emergence of the cotton leafworm (*Spodoptera littoralis*).

Field observations (primarily of berseem crops) showed that the full-grown larvae preferred to build their cocoons for pupation on ridges or elevated ground which was comparatively dry. Further laboratory tests were carried out to investigate the role of soil moisture content and different temperatures on pupal duration and rate of moth emergence.

These tests showed that soil moisture content had little effect on pupal duration, but that sun-dried soils (1.5% moisture content) combined with higher temperatures (mean 26.3°C) reduced moth emergence to 76 percent. This was compared to a moth emergence of 95% at both high and low temperatures in slightly moist soil (moisture content 10%). (See Tables 2 and 3 below).

Table 2. Effect of Soil Moisture Content on the Duration of the Pupal Stage and Rate of Moth Emergence. (Higher Temperature).

Mean Temp. 26.3°C Mean R.H. 61.85%

Soil Moisture Content	Duration of pupal stage in days						% rate of emergence
	Males			Females			
	Max.	Min.	Mean	Max.	Min.	Mean	
1.5%*	13	11	12.0 ± 0.15	12	11	11.65 ± 0.1	76
10%	13	11	12.45 ± 0.14	13	11	11.86 ± 0.13	94
20%	15	11	12.46 ± 0.19	13	11	11.88 ± 0.15	82
30%	13	11	12.4 ± 0.13	15	9	12.2 ± 0.25	82

*) Sun-dried soil

Table 3. Effect of Soil Moisture Content on the Duration of the Pupal Stage and Rate of Moth Emergence. (Lower Temperature).

Mean Temp. 18.4°C Mean R.H. 65.2%

Soil Moisture Content	Duration of pupal stage in days						% of moth emergence
	Males			Females			
	Max.	Min.	Mean	Max.	Min.	Mean	
1.5%*	23	19	21.3 ± 0.29	23	17	20.96 ± 0.28	84
10%	24	21	22.66 ± 0.17	23	19	21.8 ± 0.3	94
20%	25	20	22.7 ± 0.3	25	20	21.8 ± 0.24	82
30%	24	20	22.2 ± 0.23	23	20	21.28 ± 0.29	69

* Sun-dried soil.

TABLE 4: RESULTS OF A SURVEY OF PESTS INFESTING EL-MANSURIYA SITES

Major Pests	Major Hosts	Symptoms of Infestation Life History & Damage to Crop	Recommended Measures for Control
Gryllotaipa erylloptalpa (L) fam: Gryllotalpidae ord: Mole Crickets	F. Solanaceae: tomato, potato F. Leguminoseae: garden pea tomato (*Lycopersicum esculentum*) potato (*Solanum tuberosum*) garden pea (*Pisum sativum*)	Eats roots and stems under the soil. Plants wilt. Removal of soil reveals passages. Migrates vertically to avoid dry surface layer of soil. Infests tubers and destroys them by drilling holes in them. Tubers then rot due to entrance of bacteria, fungi and insects. Damage to yields great. Population density increases on manured lands. Peak population March-October. Summer cultivation more susceptible than winter one. One generation per year.	--poisoned bait using zinc phosphide, 5% (0.75 kg) + 15 kgs crushed maize or rice wetted with water --BHC 20% (0.75 kg)/*fed* --Andrin 19.5% (1.5 liters) /*fed* --Cotton Dust, 8-10 kg/*fed*
Agrotis ypsilon (Rott) Black Cutworm fam: Noctuidae ord: Lepidoptera	F. Solanaceae: tomato, potato	Infests potato plants during March, summer cultivation. Eats stems above and beneath soil. Five overlapped generations per year.	--poisoned bait using DDT/Lindane 3 ls./*fed* + 25 kgs fine yeast + 20 ls. water --Andrin 19.5% 1.5 *ℓ*/*fed*
Euprepocnemis plorans (Charp) Grasshoppers fam: Acrididea ord: Arthoptera	F. Solanaceae: tomato	Eats leaves and blossoms. Peaks May to mid-June. One generation per year.	--Cotton Dust 9 kgs/*fed*

Major Pests	Major Hosts	Symptoms of Infestation Life History & Damage to Crop	Recommended Measures for Control
Phthorimaea operculella (Zeller) Potato tuber Moth fam: Gelechiidae ord: Lepidoptera	F. Solanaceae: tomato, potato, eggplant Eggplant (*Solanum melongena*)	Occurs in temperate regions on ca. 21 hosts, mainly from the family Solanaceae. Infests plants in fields and tubers in storage. Moths lay eggs individually, or in masses of 3-4, on the lower surfaces of leaves or on stems and tubers. Eggs hatch after 4-15 days into young maggots, which drill their passage through the leaves and live between the upper and lower surfaces of the leaf or in the leaf stem. They travel to the plant stems and branches and eat the young leaves, or drill their passage into the tubers, leaving their feces in the passages. These can be clearly seen in masses thrown out of tuber-buds, indicating infestation. The larva spends from 10 to 65 days (due to fluctuation of temperature between 35° and 18°C) until it enters the pupal stage. The pupa is found in a white cocoon between the dry leaves or on the sacks in the storage. It needs from 6 to 44 days (due to the fluctuation of temperature between 38.5 and 13) until it enters adult stage (the moth). The moth has 10 generations (duration prolonged in winter) during the year and does not hibernate The shortest period of generation is	--Spraying potato plants in the summer cultivation with Sevin 85% W.P. 0.4% (1.5 kg /*fed* --Spraying should be repeated after 10 days before harvest. This treatment could be used for the control of both of: *Phthorimaea operculella* (Zeller) and *Heliothis zea* (Boddie) *H. obsoleta* (F.). For the control of *Phthorimaea operculella* (Zeller) in stored potatoes: --1) Stores should be ventilated with their openings covered with fine wire to prevent the entrance of *Phthorimaea operculella* (Zeller) --2) Before storage, the store should be cleaned with 1 liter of solar and 50 grms of soap melted in ½ ℓ of water. This emulsion should be diluted with water at the rate of 1:4. One litre of this dilution is sufficient to spray four square meters of the store. Afterwards, the store should be closed for four days before

Major Pests	Major Hosts	Symptoms of Infestation Life History & Damage to Crop	Recommended Measures for Control
		during June, July and August, while the longest occurs during November and December. Damage: (1) Leaf wilt. (2) Decreases amount of starch in tuber, which becomes dry. (3) Entrances for fungi and bacteria which lead to further damage. Damage is greater in the summer and occurs in the field (from March to May) and in storage (from May to September and October).	being used. (3) The tubers should be inspected from time to time and those which are infested with *Phthorimaea operculella* (Zeller) should be rejected. The sound ones should be dusted with a mixture of Sevin 10% and Orthocid 50% (at the rate of 1:1 for every ton of the tubers. In all cases, DDT W.P. and Cotton Dust should not be used in dusting to avoid toxicity. (4) When storing tubers in refrigerators for the Nili cultivation they should be cleaned with solar and soap, the sound tubers should be stored at 4°C and 85-90% R.H. In order to avoid potato rot, the tubers should not be mechanically damaged by leaving a space of 5 cm. on the top of each basket. These tubers should not be used for cultivation before a period of at least 15 days after storage.
Heliothis obsoleta (F) *H. zea* (Boddie) the American Bollworm, the tomato Fruitworm fam: Noctuidae ord: Lepidoptera	F. Solanaceae: tomato	Infests blossoms and tomato fruits. Damage was significant this year, especially in Fayum Province. Female moth lays individual eggs. Egg small, roundish, can be seen by the naked eye, creamy-whitish when just laid, becomes dark before hatching. Eggs hatch into larvae which feed on different parts of the plant. Larva green or brown and moults 4-5 times before entering pupal stage within 15 days. Pupa in the soil for 12 days until it becomes adult. Duration of generation about one month. It has 4-5 generations per year.	

Major Pests	Major Hosts	Symptoms of Infestation Life History & Damage to Crop	Recommended Measures for Control
Eusophera osseatella (Trait) the eggplant stem borer fam: Puralidae ord: Lepidoptera	F. Solanaceae: potato, eggplant	Female moths lay eggs on the plant. After hatching, larvae enter stem near the soil surface. Drill holes in young branches and stems. Masses of feces and broken pieces of branches appear on surface of plant. Larvae hibernate inside old stems left after harvest. Cause fruit rot and greatly decrease yield.	Spraying of potatoes (especially in the summer cultivation) at the beginning of March or 8 days after cultivation (early summer cultivation) with Sevin 85% W.P. at the rate of 0.4% (1.5 kgs/*fed*) Spraying should be repeated at 10 days intervals if needed (normal summer cultivation) This treatment controls both: *Phthorimaea operculella* (Zeller) and *Eusophera osseatella* (Trait) -Valexon 50%, 0.5% (2 *ℓ/fed*) can be used instead of Sevin.
Spodoptera littoralis (Boisd) cotton leafworm fam: Noctuidae ord: Lepidoptera	All vegetable crops	Eggs hatch into larvae which eat the epidermis of leaves starting from lower surface until reaching upper one. Leaves totally consumed, leading to plant death and sharp decrease in yields Fruit drop off plants, such as eggplant, pepper, watermelon and jews mallow. Infests all vegetable crops throughout the year, especially from July to November. Seven overlapping generations per year.	To control: *Phthorimaea operculella* (Zeller), *Spodoptera littoralis* (Boisd) *Spodoptera exigua* (Hb) (*Laphygma exigua*) (Hb) -Spray with one of the following pesticides: (A) Folaton (Valexon) 50% 0.5%,

Major Pests	Major Hosts	Symptoms of Infestation Life History & Damage to Crop	Recommended Measures for Control
			(2 *ℓ/fed*). (B) Noltran 22.1%, 0.4% (1.6 *ℓ/fed*) (C) Gardona 70% suspension, 0.4% (1.6 *ℓ/fed*)
Spodoptera exigua (Hb) *Laphygma exigua* (Hb) fam: Noctuida ord: Lepidoptera	F. Solanaceae: tomato pepper, and other vegetables *Capsicum frutescens* Pepper	Infests various vegetable crops, especially tomato and pepper. It has 7 overlapping generations per year.	-It is not recommended to use Folaton (Valexon on cabbage, cauliflower and flowering tomatoes unless there is sufficient humidity in the soil to avoid phytotoxicity. -Collect leaves infested with *Spodoptera littoralis* (Boisd.) and destroy egg masses before they hatch. -Spray as soon as eggs hatch. (spraying will be inefficient against late instar larvae). Solution must cover all parts of plant, using 400-600 liters of water/*fed* and high volume sprayers. Minimum period between spraying and harvest should not be less than 15 days. -Consumers are advised to wash fresh vegetables carefully to remove residue of pesticides.

Major Pests	Major Hosts	Symptoms of Infestation Life History & Damage to Crop	Recommended Measures for Control
Aphids (Plant lice) fam: Aphididae ord: Hemiptera	F. Solanaceae: tomato, potatoes, eggplant, pepper F. Cucurbitaceae: squash, sweet melon, cucumber, water-melon F. Leguminoseae: common bean, cowpea	Infests different vegetable crops with 2 peaks, one from February to May, and one from September to November. A sucking, piercing insect which sucks plant's sap and causesleaf curl. Considered as an insect vector responsible for the transmission of viral diseases which cause wilting and death in severely infested young plants. Great damage from secretions of honey-dew, growth of fungi and accumulations of dust. About 52 generations per year.	In the case of infestation with aphids only: Plants should be sprayed with Malathion, 0.15%. -Spraying with water and soap, (0.45% of soap + nicotin sulphate, 40%)at a rate of 0.15%. The solution should reach the insects on the lower surface of the leaf. Spraying should be stopped 2 weeks before harvest. The control of aphids also depresses infestation with tobacco mosaic virus.
Bemisia tabaci (Gen) White fly fam: Aleyrodidae ord: Hemiptera	F. Crucifereae: cabbage, cauli-flower *Cucrbita pepo*: squash *Cucumis melo*: sweet melon *Cucumis sativus*: cucumber	Yellowish-green fly which infests various vegetable crops. Abundant in tomatoes.Nymphs on lower surface of the leaf, flies hide between leaves. Considered as an insect vector responsible for transmission of viral diseases causing young plants to wilt and die if seriously infested. Honey-dew secretions, fungi growth, and dust accumulation cause serious damage. Ten to Twelve overlapped generations per year.	In the case of infestation with aphids, whitefly, jassides, thrips,*Aulacophora foveicollis* and *Epilachna chrysomelina*: The following treatment controls: Aphids, white-fly, jassids, thrips, *Aulacophora foveicollis* and *Epilachna chrusomelina*. Spray plants at an early stage with dimethoate 40% at the rate of 0.125%. Spraying should be repeated if needed.

Major Pests	Major Hosts	Symptoms of Infestation Life History & Damage to Crop	Recommended Measures for Control
Jassids (*Empoasco* sp.) Leaf hoppers fam: Jassidae ord: Hemiptera	*Citrullus vulgaris:* watermelon *Phaseolus vulgaris:* common bean *Vigna sinensis:* cowpea	Infests different vegetable crops. Considered as insect vector responsible for transmission of viral diseases causing wilting and death of young plants. Great damage to vegetable crops. Should be controlled early, in the nursery. Three to four generations per year (*Empoasca discipiens*-Paoli).	Spray at least 3 weeks before harvest. -Plants severely infested with *Aulocophora foveicollis* (Lucas) should be collected and destroyed.
Thrips tabaci (Lind) Thrips fam: Thripidae ord: Thysanopa	*Brassica oleraceae:* cabbage *Brassica oleracea:* cauliflower	Infests leaves, causing silver patches which become dark later. Affects vegetable crops. Plants die when severely infested. Larvae are found in great numbers inside the plant. Infestation from October to April. About 15 generations per year.	
Aulacophora foveicollis (Lucas) *Rahidopalpa foveicollis* (Lucas) fam: Chrysomelidae ord: Coleoptera	F. Cucurbitaceae: squash, sweet melon, cucumber, watermelon	Insect feeds upon leaves and blossoms of plants and destroys them. Plants severely infested wilt and die. Larvae live inside stems and roots. Active from March to November, then hibernate. At end of hibernation, adult female lays eggs on plant stems or on soil surface around plant. After eggs hatch, larvae penetrate stem near the roots, and eat contents of stems and roots. Larvae creamy in color, 1.5 cm in length.	

Major Pests	Major Hosts	Symptoms of Infestation Life History & Damage to Crop	Recommended Measures for Control
Epilachna chrysomelina (F) fam: Coccinellidae ord: Coleoptera		Insect is dark red with 12 black dots on its shield. It eats plant's leaves, and plants die if severely infested. When the leaves become dry, insect migrates to fruit, penetrating and destroying them. Adult insects pass hibernation period hidden in different places. Adult female lays elongated eggs on lower surface of the leaf. After hatching, the small maggots, which are green-yellowish and covered with spines, become pupae after moulting for 4 times. The adult completes its life cycle in one month. It has 5 generations during the year, ending by hibernation.	
Dacus cilliatus (Loew) fam: Trypetidae ord: Diptera	F. Cucurbitaceae : squash, sweet melon, cucumber, watermelon	One of major pests infesting melons. Larvae live inside fruit, causing great damage. (First recorded in Egypt in 1947 at Aswan where it was introduced to Egypt from Sudan. Has now spread from Aswan to Qena, Assyut, Minya, Beni Suef, Giza and the Canal Zone). Bores tiny holes in fruit, which are covered by gummy, yellowish secretion. When severely infested, fruit becomes small, yellowish and rotten because of bacteria and fungi.	-Spray with Diptrex 80% at the rate of 0.5%. -Spray Baitox 100% at the rate of 0.2%. Repeat if needed in areas infested with *Dacus cilliatus* (Loew). -Fruits infested should be collected and destroyed before spraying.

Major Pests	Major Hosts	Symptoms of Infestation Life History & Damage to Crop	Recommended Measures for Control
		Larvae live inside fruit and eat tissues and seeds. Both immature and mature fruit susceptible to attack. Melons are cultivated in Egypt throughout the year. Infestation with *Dacus cilliatus* (Loew) is always serious, but the degree differs among various periods of cultivation. (1) Late Nili Cultivation Fruit of the Nili cultivation (especially cucumber and squash) appear in October and November and are highly susceptible to attack by *Dacus cilliatus*, especially in Giza, Beni Suef, El-Minya and the Canal Zone . The summer cultivation is not seriously attacked in these same areas. (2) Early Winter Cultivation This is the main period of cultivation at Aswan, Kom Ombo, and Qena and the crop (melons, with the exception of squash) is seriously attacked. Fruit appear in January and February. Summer cultivation is not severely attacked in these areas.	
The Bean Fly	F. Leguminoseae	This red fly is always found around melon plants during the day. It is dark yellowish, and the female lays its eggs (5-50)	

Major Pests	Major Hosts	Symptoms of Infestation Life History & Damage to Crop	Recommended Measures for Control
		underneath the surface layer of the fruit skin. The eggs hatch in 4 days and the young maggots penetrate into the fruit tissues, making passages, feeding upon the fruit juice and destroying the seeds. They complete their full growth within two weeks, then they leave the fruit through wide openings. After three weeks, the pupae develop into adult flies and another generation begins.	
Mites			
Mites are very small creatures, generally difficult to see with the naked eye. For that reason, it is necessary to use magnified lenses when working with them. Mites are more closely related to spiders and scorpions than to insects. They differ from insects in many respects: (1) they have neither wings nor antennae, nor compound eyes; (2) their body is formed of two pieces, a thoracic head and an abdomen, while the body of an insect is divided into three parts, head, thorax and abdomen; (3) the majority of mites have four pairs of legs in the adult stage. Yet, mites in general resemble insects in their economic effect on man. Like insects, they affect his health, his animals and his plants. Development in mites is of the incomplete metamorphosis type. Females lay separate eggs, which hatch into larvae that resemble their mothers, except in possessing three pairs of legs. Larvae transform into nymphs which have four pairs of legs, and finally into adults. Females lay a great number of eggs(around 150 in many species) and the life cycle takes around 10-15 days under favorable conditions. For these reasons, mites reproduce quickly. In the last few years, spider mites have created great problems in many parts of the world. Furthermore, the extensive use of the new insecticides against many injurious insects has been very harmful to beneficial insects and mites which prey on red-spider mites.			
Vasates lycopersici (Massee) Bud Mite, *Eriophyid* Mites fam: Eriophyidae ord: Acarina	F. Solanaceae: tomato	Infests tomato plants, causing leaf curl. The leaf loses its color, becomes smaller than usual and wilts, leading to great loss of yield. All stages of this mite: larvae, nymphs and adults, have two pairs of legs only.	-Spray tomato plants with micronized sulphur at the rate of 0.25% (1.5 kgs/*fed*).

Major Pests	Major Hosts	Symptoms of Infestation Life History & Damage to Crop	Recommended Measures for Control
Tetranychus arabicus (Attiah) green form, *Tetranychus cucurbitacearum* (Sayed) red form, Common red spider mite (*T. telarius complex*)	F. Solanaceae: egg plant, potato, pepper F. Leguminoseae: common bean, cowpea, garden pea F. Cucurbitaceae: squash, sweet melon, cucumber, watermelon F. Compositae: artichoke *Cynara scolymus* artichoke	The common red-spider mite infests vegetable crops from May to September. It lives on the lower surface of the leaf in all stages from egg to adult. It sucks the plant's sap, causing leaves to drop off and great damage to yield. The adult is green or red in color with 2 dark dots on either side of the body. The green form, *T. arabicus* (Attiah) is more resistant to pesticides than the red form, *T. cucurbitacearum* (Sayed). It has been established by mating experiments that these are two different species. The *citrus brown mite, Eutetranychus orientalis* (Klein) lives on the upper surface of the leaf in all its stages. It has 18-19 generations, whereas the common red spider mite has about 27 generations per year.	-Spray with micronized Kelthan 35% at the rate of 0.15% (600 gr/*fed*) for the control of: *T. arabicus* (Attiah), *T. cucurbitacearum* (Sayed) and *Eutetranychus orientalis* (Klein). Spraying should be repeated if needed. Kelthan should be added to Sevin used for the control of *Phthorimaes operculells* and *Eurzophore osseatells* in order to prevent damage by spider mite infestations.
Melanagromyza phaseoli (Tryon) The Bean-Fly fam: Agromyzidae ord: Diptera	F. Leguminoseae: common bean, cowpea	A serious pest common to beans and cowpeas. Attacks from seed germination to harvest. Causes plant-wilt, death of plants and great loss of yield. Plant tissues are damaged by penetration of larvae, and plants seriously affected are easily broken and have few green pods. Plants wilt when seriously affected, and aggregations of larvae and pupae	Spraying of plants at an early stage for protection. (In the Nili Cultivation only) with Sevin 85% W.P. at the rate of 0.4% (1.5 kgs/*fed*)once every fortnight until the plant becomes two months old. Spraying should be stopped before blossoming.

Major Pests	Major Hosts	Symptoms of Infestation Life History & Damage to Crop	Recommended Measures for Control
		beneath the epidermis causes tumors between stem and root and under leaf base. Greatest damage caused in young plants, which are more susceptible to fly's attack. Plants severely infested can have 50 maggots and pupae in the stem. Light infestation, where plants apparently sound, may have only a few maggots. Degree of Infestation in the Different Cultivations: (1) Nili Cultivation: Highly infested, especially in late cultivation. Cultivated for dry beans from mid-August in Lower Egypt and a week or two later in Upper Egypt. (2) Winter Cultivation: Infestation less than Nili, cultivated for green pods from mid-November. (3) Summer Cultivation: Little infestation in early cultivation, becoming greater with late cultivation. Cultivated for green pods from mid-February or later in April and early May. Life History: Fly is black, 2.5 mm in length, found in great numbers in early morning and at sunset on the upper surfaces of leaves, but disappearing during the day. It lays its eggs under the lower epidermis of the young leaf. These hatch into small maggots, which	

Major Pests	Major Hosts	Symptoms of Infestation Life History & Damage to Crop	Recommended Measures for Control
		penetrate between the two epidermal surfaces, leaving silvery passages through the leaves to the branches and stem, until they reach the part between stem and root near the soil surface. Duration of larval stage is about one week. The larva pupates under the epidermis of the plant's stem causing tumors in it. The silvery passages of larvae under the epidermis of stem and the tumours of pupae around the plant's stem are important symptoms of infestation. The pupae penetrate into the soil around the stem and also under bases of leaves which become dark, swollen and easily broken. Pupae are also found in dry leaves. The pupa becomes adult (fly) after a period which differs from season to season. The duration of generation is about 3 weeks on the average, but is prolonged in winter. Ten to twelve overlapped generations per year.	
Etiella zinkenella. (Treitschke) fam: Pyralidae ord: Lepidoptera	F. Leguminoseae: cowpea, lima bean	Infestation of cowpea and lima bean green pods by larvae which feed upon seeds before they become dry. Larvae penetrate into green pods and spend about 3 weeks before entering pupal stage. Larvae then leave pod and pupate in the soil at 2-5 cms depth	Spraying with Sevin 85% at the rate of 0.4% (1.5 kgs/*fed*). Spraying should be done at the first sign of infestation.

Major Pests	Major Hosts	Symptoms of Infestation Life History & Damage to Crop	Recommended Measures for Control
		and at a distance of 20-30 cms from plant's stem. After 3 weeks, moth emerges from pupa. After mating, female moth lays eggs on plant's blossoms. The young maggots feed upon blossoms. Nili cultivation is more seriously infested than summer cultivation. This pest is always found from March to September and infests different hosts all over the world. Six to seven generations per year, with hibernation period as pupa.	
Delia alliaria (Sp.n.) the onion maggot fam: Muscidae ord: Diptera *Hylemia antique*	F. Amaryllidaceae: (garlic) *Allium sativum* F. Liliaceae (onion) *Allium cepa*	Adult female lays eggs near plant base. Eggs hatch into maggots which crawl beneath leaves and penetrate bulbs. Maggots feed upon the leaves' contents causing wilt from top to bottom. They make passages near leaves' bases, destroy them, and (in the severe infestation) cause plant's death. They pupate in the soil around the plant. The fly resembles the house-fly in shape and color. Duration of one generation is about 40 days. The peak of infestation is from November to March.	-Spray with Folaton (Valexon) 50% or DDT/Lindane at the rate of 0.5%, late January for the control of *Delia alliaria*, and mid-February for control of thrips.

Major Pests	Major Hosts	Symptoms of Infestation Life History & Damage to Crop	Recommended Measures for Control
Hellula undallis (Fabr) fam: Pyraustidae ord: Lepidoptera	F. Cruciferae: cabbage, cauliflower	One of the most serious pests to cabbage and cauliflower, especially in the nursery. Causes great damage to these plants throughout Egypt. Larvae penetrate into plant stem and feed upon contents. They make passages inside stem and roots. Severe infestation causes plant rot and death. Duration of generation is about one month.	Spray plants twice in the nursery with a 1-week interval, using Gardona 50% W.P. at the rate of 0.4% (1.5 kgs/*fed*). Select sound plants before transfer to field. This treatment controls: *Hellula undalis* (Fabr.) *Pieris rapae* (L.), *Autographa* sp., *Spodoptera littoralis* (Boisd).
Peiris rapae (L.) fam: Peiridae ord: Lepidoptera	cabbage cauliflower lettuce radish turnip	Larvae eat plant leaves, leaving holes of varying shapes. The white butterfly is always found around these vegetables from beginning of October through early summer. Larva (25 cm) has a soft green skin with a yellow line down its back. Both sides of the body have yellowish lines. There are small black dots covering other parts of the body. The insect has about 9 generations per year and is more active in the winter than in summer.	

Spraying should be stopped at least one week before harvest.

Major Pests	Major Hosts	Symptoms of Infestation Life History & Damage to Crop	Recommended Measures for Control
Autographa (phytometra species) semi-looper worms fam: Noctuidae ord: Lepidoptera	cabbage cauliflower lettuce potato garden peas beans garden beet *birseem*	Larvae infest leaves of plant. Larva is green, 3 cms in length, with 3 pairs of ventral legs near to end of body. Larvae expand and contract when in motion. Adult female lays eggs on leaves. These hatch into larvae and feed upon the leaves.	see above, under Hellula Undallis.
Vanessa cardui (L.) fam: Nymphalidae ord: Lepidoptera	F. Mavaceae: Egyptian mallow (*Malva parviflora*) F. Compositae: artichoke	Adult female lays eggs individually on the leaves which hatch into larvae. Larvae feed upon leaves and spin a tiny net to live under. Larvae eat leaves and cause great damage to the leaves and yield. The fully grown larvae is 4 cms long, brown in color with pale yellow strips on either sides and spines on its back. The butterfly is large and brown, with different colors on its wings. It is always found in winter and spring around Egyptian mallow plants.	-Spray with valexon 50% at the rate of 0.5% or Noltran 22.1% at the rate of 0.4%. This controls: *Vanessa cardui* (L.) and *Spodoptera littoralis* (Boisd)

VI . TEST CASES IN THE FIELD

A. El-Mansuriya, Giza Governorate: The White Fly

Pest: *Bemisia tabaci* (gen), the White Fly.
For characteristics, symptoms of infestation, life history, damage and recommended controls, see section v (Table 4).

Problem: Drastic losses in the tomato crop.

In the field:

A number of farmers in Mansuriya followed our instructions by spraying their tomato crops every fortnight for a period of four months: one month in the nursery, and three months in the field. This took place from July through October, 1979.

The spray, Tamaron 66%, was applied at the rate of 1 litre per *feddan*.

Crop increases in the area sprayed were 100% over those realized for the same area the year before.

Experts in the field found some difficulty in persuading farmers to use Tamaron, because many people were frightened of possible side effects of the spray. After experts demonstrated the correct application methods in front of them, several farmers decided to try the spray. In every instance where farmers did apply Tamaron, the increase in yield was so marked that their neighbors were convinced of the spray's efficacy and asked EWUP experts to instruct them in its proper application.

This technique was not used with tomato crops in other areas. A comparison was made to show farmers that the yield in El-Mansuriya where the spray was applied was greater than that from other sites which had not been sprayed. The yield was, in fact, double or more than double that of the non-treated areas.

B. Abu Raya, Kafr el-Sheikh Governorate

1) Cotton leafworm

Control: solar oil

In late spring, solar oil (a derivative of crude petroleum oil) was applied *with irrigation water* at the rate of 30 ℓ per acre. This measure helped to reduce the population of the pest, and had no harmful effects on beneficial insects. Pesticidal treatments were limited to those fields where infestation warranted further control measures.

Control: hand-picking of egg masses

It was determined that the hand-picking of cotton leafworm egg masses was an efficient control measure in the cotton fields of Abu Raya. It was possible to pick off about 85% of the egg masses. For this reason, we recommend that hand-picking of egg masses be continued over as long a period as possible for the most effective control of the pest. If further chemical control appears necessary, it will come after the peak in abundance of cotton predators, which normally takesplace in early July.

Through a program of combined mechanical (hand-picking of egg masses), chemical (application of solar oil) and biological (drying of clover field breeding grounds) methods, it was possible to control damage caused to the cotton crop on the Kafr el-Sheikh pilot site by the cotton leafworm.

2) Pink bollworm

The second major pest threatening the cotton crop in Abu Raya was the pink bollworm, for which an economic injury level was established in fields at the site of 10% infestation of green bolls.

Beginning in early July of each season, trained teams from the PLANT PROTECTION RESEARCH INSTITUTE of the MINISTRY OF AGRICULTURE periodically inspect cotton fields to determine the level of bollworm infestation. The Ministry does not authorize the use of

chemical controls unless infestation reaches the economic injury level. This minimizes the overall use of chemicals by eliminating unnecessary spraying and spraying which might occur too early in the season.

3) Thrips

No general protective spray was used against thrips early in the season. Observation showed that an infestation level of 8 to 12 individuals per seedling was economically significant.

Through a program of integrated pest control in Abu Raya:

1. cotton leafworm infestation are coming under control
2. early season infestations are almost eliminated
3. the loss in total cotton yield due to bollworm infestation has decreased from ca. 20% to ca. 5-8%.

4) Corn borers

For characteristics, symptoms of infestation, life history, damage and recommended controls, see IV, B i .

Problem: Low yields from corn crop due to corn borer infestation.

EWUP experts devised an integrated program of mechanical, chemical and cultural control measures. Exact measures were affected by the seasonal abundance of the pests, their feeding habits and the resulting injurious stages to corn plants, and the location of their overwintering sites.

An evaluation of conditions in Abu Raya showed that the following measures should be adopted:

1. Sowing of corn should be done during May and early June.
2. Overwintering larvae of corn borers could be eliminated by burning corn stalks which had been left in the field.
3. Application of the chemical Sevin 85% to the fields in the amount of 1 kg per *feddan*.

When this was done in Kafr el-Sheikh, the resulting corn crop was on the average 25% greater than that of the year before.

Researchers also conducted a survey of the biological predators and parasites which attack corn borers in the Kafr el-Sheikh area, and which could be used in their control. Results of the survey showed:

Trichogramma evanescens	--on eggs of corn borers
Pimpla sp.	--on larvae and pupae
Microbracon brevicornis	--on larvae and pupae
Apanteles sp.	--on larvae of *Sesamia cretica*
Platytelenomus hylas	--on eggs of *Sesamia cretica*
Conomorium eremita	--on pupae of *Sesamia cretica*

It is recommended that further studies be done to develop varieties resistant to corn borers.

5) Rice stem borers

For characteristics, symptoms of infestation, life history, damage and recommended controls, see Section V,C.

Control: Combined program of control used against the rice stem in Abu Raya:

1. Farmers were instructed to use Rice Variety NAHDA, which is less subject to infestation by the rice stem borer than other commercial varieties in Egypt.

2. Rice was planted early in the season, before May 15. Farmers who planted early found that their rice was less subject to infestation than that of farmers who planted later.

3. The rate of nitrogen fertilizers was reduced.

4. Granular *Lindane* and *Diazinon* were applied as effective chemical insecticides against the rice stem borer.

5. Farmers were advised not to plant rice nurseries in saline soils.

6. Seeds were sown on the same day the rice nursery fields were filled with water. This helped the rice seedlings to fix themselves in the soil before being attacked by larvae.

7. Farmers were instructed not to irrigate their rice fields from drainage canals.

8. It was found that draining the water from rice nurseries for a period of one or two days was effective in reducing the insect population and did not seriously affect the rice seedlings.

9. Rice seeds which had been soaked in water for 48 hours and then left for another 48 hours until the emergence of rootlets before sowing had a better chance to escape infestation.

C. Abyuha, El-Minya Governorate: Sugarcane borers

For characteristics, symptoms of infestation, life history, damage and recommended controls, see Section IV, E.

Control: Combined program of controls used against sugarcane borers in El-Minya site:

1. EWUP experts introduced relatively resistant varieties of sugarcane into the area, particularly where past experience showed that a high infestation rate was likely.

2. Weeds were eliminated from the sugarcane fields.

3. The drainage system was improved in sugarcane fields, and proper on-farm water management introduced, reducing the sugarcane borer infestation.

4. Chemical controls.

Any program of chemical control is a hard task in sugarcane fields as they are presently planted in Egypt. Because of the narrow rowing, the fields become quite crowded after the month of July and it is impossible to apply insecticide. This is a significant factor, since most of the borer's activity occurs between July and October. EWUP researchers recommended the planting of cane in wider rows for better pest control.

AMERICAN EQUIVALENTS OF EGYPTIAN ARABIC TERMS AND MEASURES COMMONLY USED IN IRRIGATION WORK

Land Area	in *sq meters*	in *acres*	in *feddans*	in *hectares*
1 acre	4,046.856	1.000	0.963	0.405
1 *feddan*	4,200.833	1.038	1.000	0.420
1 hectare(ha)	10,000.000	2.471	2.380	1.000
1 *sq* kilometer	100 x 104	247.105	238,048	100.000
1 *sq* mile	259 x 106	640.000	616.400	259.000

Water Measures	*feddan*-cm	*Acre*-feet	*Acre*-inches
1 billion m^3	23,809,000.000	810,710.000	
1,000 m^3	23.809	0.811	9.728
1,000 m^3/*feddan* (= 238 mm of rainfall)	23.809	0.781	9.372
420 m^3/*feddan* (= 100 mm of rainfall)	10.00	0.328	3.936

Other Conversions

1 *ardeb* = 198 liters = 5.62 bushels (U.S)
1 *ardeb/feddan* = 5.41 bushels/acre
1 kg/*feddan* = 2.12 lb/acre
1 donkey load = 100 kg
1 camel load = 250 kg
1 donkey load of manure = 0.1 m^3
1 camel load of manure = 0.25 m^3

Egyptian Units for Field Crops

Crop	Eg. Unit	in kg	in lbs	in bushels
Lentils	*ardeb*	160.0	352.42	5.87
Clover	*ardeb*	157.0	345.81	5.76
Broad beans	*ardeb*	155.0	341.41	6.10
Wheat	*ardeb*	150.0	330.40	5.51
Maize, Sorghum	*ardeb*	140.0	308.37	5.51
Barley	*ardeb*	120.0	264.32	5.51
Cottonseed	*ardeb*	120.0	264.32	8.26
Sesame	*ardeb*	120.0	264.32	
Groundnut	*ardeb*	75.0	165.20	7.51
Rice	*dariba*	945.0	2081.50	46.26
Chick-peas	*ardeb*	150.0	330.40	
Lupine	*ardeb*	150.0	330.40	
Linseed	*ardeb*	122.0	268.72	
Fenugreek	*ardeb*	155.0	341.41	
Cotton(unginned)	*metric qintar*	157.5	346.92	
Cotton(lint or ginned)	*metric qintar*	50.0	110.13	

Egyptian Farming and Irrigation Terms

fara = branch
marwa = small distributer, irrigation ditch
masraf = field drain
mesqa = small canal feeding from 10 to 40 farms
qirat = cf. English "karat," A land measure of 1/24 *feddan*, 175.03 m^2
qaria = village
sahm = 1/24th of a *qirat*, 7.29 m^2
saqia = animal powered water wheel
sarf = drain (vb.), or drainage. See also *masraf*, (n.)