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**DIVERSIFIED AGRICULTURE RESEARCH PROJECT  
RESEARCH GRANTS: ABSTRACTS**

1991 - 1993

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**DIVERSIFIED AGRICULTURE RESEARCH PROJECT**  
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DEPARTMENT OF AGRICULTURE  
UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT  
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## PREFACE

The Diversified Agriculture Research Project (DARP) is funded by the United States Agency for International Development (USAID). Its purposes are to strengthen the Department of Agriculture in order to help diversify crop production and raise farmer incomes. During the extension phase of the Project, 1991 to 1993, one of the contributions of the Project has been to facilitate the use of Special Project Funds in support of over forty different activities of the Department of Agriculture. The funds were managed by the technical assistance contractor, Development Alternatives, Inc. (DAI).

One of the areas of support where Special Project Funds were found to be useful was research. The concept of research grants was adopted whereby DARP could provide financing to assist the implementation of specific research activities related to diversified cropping. Thirteen grants were given to the Research Division, two to the Plant Quarantine Service, one to the Botanical Gardens Division, and one to the Division of Agricultural Economics. Among the many kinds of inputs required by research officers, the project paid for laboratory chemicals and glassware, as well as field labor and materials.

This report contains the abstracts from all 16 research projects. Many of these activities are not set to reach a conclusion within the life-of-project, but will continue on as a part of the on-going research agenda of the Department of Agriculture. As will be seen, a surprising number relate to horticultural crops. Many have the purpose of controlling particular pests and plant diseases known to be of importance in Sri Lankan agriculture. Others deal with such areas as plant breeding, tissue culture, seed production, cropping patterns, and post-harvest handling.

The abstracts were edited and prepared for publication by Dr BMK Perera, Research Officer and Dr S Nagarajah, Additional Deputy Director of Research. Results of this research were presented at a Department of Agriculture Workshop held on 4 August, 1993, with about 100 persons in attendance.

## TABLE OF CONTENTS

1. Cross-protection against passion fruit mottle virus .....	1
2. Diagnosis and control of some important fungal diseases in improving apple and pear production in the up country region ..	2
3. Studies on the leaf twister disease (LTD) in red onion (shallot).....	3
4. Optimum stage of harvesting and techniques for ripening of banana .....	5
5. Latex exudation in mangosteen ( <i>Garcinia mangostana L.</i> ).....	6
6. Physico-chemical and cooking quality of food legumes and coarse grain (FLCG) crops .....	7
7. Effect of Plant Growth Regulators on Cucurbitaceae Crop Production.....	8
8. Varietal development of leafy vegetables...	9
9. Management of mealybug wilt in pineapple..	10
10. Resistance of pests to insecticides .....	12
11. Pests affecting the foliage and cut-flower industry.....	13
12. The influence of environmental factors on the development of chilli narrow leaf disorder .....	15
13. Weaning of tissue-cultured <i>Anthurium andreaeanum</i> plantlets .....	16
14. Use of tuberlets as planting material in seed tuber production of potato .....	17
15. An economic study on the conservation farming system at Muthukandiya .....	18
16. Tissue culture of <i>Ficus benjamina</i> .....	20
17. Pre-basic seed potato production.....	21

**CROSS-PROTECTION AGAINST PASSION FRUIT MOTTLE VIRUS  
IN PASSION FRUIT**

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Passion fruit (*Passiflora edulis f. flavicarpa*) is an economically important and popular fruit crop in the wet zone of Sri Lanka. Virus diseases are a major constraint to cultivation of this crop. Among the virus diseases, the most common virus affecting the crop in the wet zone has been identified as the passion fruit mottle virus (PFMV). Other virus diseases identified in the area are passion fruit ringspot virus, *passiflora caerulea* yellow fleck virus and passion fruit woodiness virus. Reciprocal serological studies have shown that the latter 3 viruses are 'pathotypes' of strains of PFMV. Infected plants show reduced growth leading to yield reduction.

A technique referred to as 'cross-protection' is widely used in some parts of Australia to reduce the damage due to virus infection. In this technique, a healthy plant is protected from getting infected with a severe strain of a virus by inoculating it with a mild strain of the same virus.

In this study, apparently mild strains of passion fruit viruses were collected from farmers' fields in surveys carried out in different passion fruit growing areas. These virus samples were evaluated in the greenhouse and selections were made for further investigation. A few of these mild strains were then 'challenged' with severe strains of PFMV by inoculating healthy passion fruit seedlings with mild strain followed by inoculation with a severe strain. These 'double inoculated' plants at present are being evaluated for their growth and yield performance. Promising mild strains will be multiplied and tested in farmers' fields.

'Cross-protection' is a simple and easy technique that could be adopted with a little basic training. Once the identification of a suitable mild strain is made this method could be widely adopted to protect the passion fruit crop from severe yield reduction due to PFMV.

**DIAGNOSIS AND CONTROL OF SOME IMPORTANT FUNGAL DISEASES IN  
IMPROVING APPLE AND PEAR PRODUCTION IN UP COUNTRY**

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Apple and pear were once popular fruits grown on a commercial scale in the up country regions. Despite the favourable climatic conditions prevailing in these areas, these fruit crops are rapidly losing their place as economically important crops.

Decline of cultivation of apple and pear could be attributed to competition with the imported varieties, inferior fruit quality, non-adoption of improved cultural practices, poor management and epidemic diseases.

Most apple trees suffer from powdery mildew (*Podosphaera leucotricha*), scab (*Venturia inaequalis*) and pink stem (*Nectria cinnabarina*). Common diseases that affect pear trees are scab (*Venturia pirina*) and pink stem (*Nectria cinnabarina*). In the past there was no planned research programme to develop control measures for these disease problems. The main objective of the present project was to assess these diseases and identify effective fungicides for their control.

A field survey was carried out in Nuwara Eliya and part of Badulla. This was followed by diagnostic tests and spraying trials which were carried out at Regional Agricultural Research Centre, Bandarawela and Agricultural Research Centre, Rahangala, from June 1992 to June 1993.

Four fungicides (Terbuconazole, Benomyl, Bitertanol and Isoprothiolane) used alone and the same fungicides followed by an application of Maneb and a control (untreated) were the treatments included in the field trial.

The results showed that compared to powdery mildew and scab, pink stem is the most devastating disease in apple and pear, specially during the rainy season.

Climatic factors had no effect on the incidence of powdery mildew and scab, in both apple and pear trees.

Terbuconazole effectively controlled all three diseases. The effect of Terbuconazole could be maintained by a follow-up application of Maneb, which is a contact fungicide. Terbuconazole may be substituted by Benomyl or Bitertanol with a follow-up application of Maneb.

A well-planned spray schedule with suitable fungicides could be adopted to control these common diseases affecting apple and pear trees in the up country region.

**STUDIES ON THE LEAF TWISTER DISEASE (LTD) IN  
RED ONION (SHALLOT)**

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At present, more than 40% of red onion produced in Sri Lanka comes from the Kalpitiya peninsula in the Puttalam District. Regosol is the main soil type in the region and the climate is characterized by a high daily average temperature (27 °C). The main rainy season is from October to January, and is characterized by overcast skies and high rainfall with a distinct peak in November. Crops grown in this area are irrigated daily using about 20 mm of water per irrigation. Overhead irrigation using hoses enables plants to withstand the midday heat.

In the late 1980s, a disease of red onion of unknown etiology was reported from Kalpitiya. Symptoms of this disease were chlorosis followed by curling and twisting of leaves, abnormal elongation of the neck region and rotting of bulbs which subsequently caused the collapse of the plant.

Investigations enabled to identify *Fusarium oxysporum* f. sp. *cepae*, isolated from diseased plants, as the causal agent of LTD (Inoculation tests satisfied the Kock's postulate).

A survey of diseases conducted in the Kalpitiya region during 1992/93, showed that bulb rot caused by *Fusarium* spp., LTD caused by *F. oxysporum* f. sp. *cepae* and another very destructive disease also showing chlorosis, twisting and curling of leaves are the most important diseases in red onion, in the region. The symptoms of the latter disease are very similar to that of 'Seven curls' reported in onion. Acervuli of *Colletotricum* are always observed on lesions of the neck region and also on leaf blades of affected plants. However, an inoculation test has to be performed to confirm whether *Colletotricum* is the causal agent of this disease.

Bulb rot caused by *Fusarium* spp. was observed throughout the year and disease incidence was not much influenced by rains. LTD was also recorded year round, but high disease incidence of LTD was observed during the months of heavy rainfall, specially during November. 'Seven curls' disease was observed only during maha and was very destructive in some fields. The overhead method of irrigation used in the region could have aggravated the problem by spreading the inoculum and also by increasing the humidity in the crop stand.

The effect of three fungicides, viz Thiram, Thiophonate methyl and Tiabedazole on the growth of *F. oxysporum* f.sp. *cepae* was tested on potato-dextrose agar with streptomycin (PDAS). The PDAS with 10 ppm of Thiophonate methyl suppressed the growth of the fungus compared to the other two fungicides. These fungicides were also screened, as seed treatments and soil pre-treatments, at 3 locations in the Kalpitiya peninsula. But, the treatment effects were not statistically significant probably due to the low % disease incidence (DI) in trial plots. Soil treatment with Thiophonate methyl gave a yield increase in all three locations.

Thiophonate methyl may be tentatively recommended to reduce DI of LTD in farmers' fields. However, it is not advisable to recommend soil treatment with fungicides under conditions in Kalpitiya in view of the possible pollution hazard due to contamination of ground water.

**OPTIMUM STAGE OF HARVESTING AND TECHNIQUES FOR  
RIPENING OF BANANA**

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Banana is a major fruit crop which is grown widely in Sri Lanka on a year round basis. Postharvest losses are estimated to be around 10-30%. It is possible to reduce these losses significantly if the fruits are harvested at the right stage and ripened using simple techniques. At present, banana is harvested at various stages judging by the appearance of the bunch. The maturity indices used at present are based on the angularity or fullness of the fingers. The present study was conducted to determine the relationship between angularity of the fingers, their fullness and the maturity of the bunch.

The popular variety 'embul' was used for the experiment. Ripening was induced by the use of 500-1000 ppm of ethephon and calcium carbide at the rate of 5 g/20 l of spray. Physico-chemical characteristics of the fruits were also studied.

The study showed that the earliest stage at which 'embul' should be harvested is 70 days from the opening of the first bract after emergence of the bunch.

Fruits of light three quarter (70 days after emergence) and light full three quarter (80 ± 5 days) ripen only with the use of ripening agents. Untreated fruits harvested at these stages fail to ripen to optimum eating quality.

## LATEX EXUDATION IN MANGOSTEEN (*Garcinia mangostana* L.)

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Mangosteen is an important and delicious fruit belonging to the Guttiferae family. It is popular locally and also has an export potential. The presence of latex (a yellow resinous substance) is a characteristic feature of the genus, *Garcinia*. Generally, the latex present in the rind of the fruit dries on ripening. If the latex comes into contact with the pulp the fruits acquire a bitter taste. In addition, the latex exudates on the fruit rind affect the appearance of the fruit and reduce its quality and marketability.

This study was conducted to identify factors responsible for the internal and external latex exudation in mangosteen.

Experiments were carried out to test the effect of covering of unopened flower buds, insecticide application, and pricking of the peduncle and rind at flower opening and 15 days after.

Covering of fruits at the flower bud stage showed a distinct reduction in external latex exudation while application of insecticides partially reduced it. Pricking of the rind of the fruit and the peduncle at the flower bud stage as well as 15 days after flower opening reduced internal latex exudation.

Two insects that may be responsible for external latex exudation were collected for identification. Internal exudation may be the result of nutritional imbalance of the tree and the adverse effects of fluctuation of the water table.

Results of experiments with borax and lime showed that addition of lime could reduce the incidence of internal latex exudation. The study will be continued to gather further data to draw valid conclusions on the effect of plant nutrients on the incidence of internal latex exudation.

**PHYSICO-CHEMICAL AND COOKING QUALITY OF FOOD LEGUMES  
AND COARSE GRAIN (FLCG) CROPS**

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Samples of FLCG crops were collected from different regions and analyzed for moisture content, crude protein, fat and fibre, hydrolysable carbohydrates and reducing sugar.

The crude protein content of legumes varied from 17-28%. Highest protein containing coarse grain was 'kaha meneri' (14.8%). The crude fat content varied from 2-4% in legumes and from 2-9% in coarse grains. The starch content was higher in coarse grains than in legumes. The amount of reducing sugar present in FLCG crops was low (0.6-1.4%). The highest crude fibre content of 14% was recorded for 'kaha meneri', while the lowest content was found in 'ratu thiringu'.

In this study the different methods for processing of groundnut seed were also investigated. Batches of groundnut were subjected to soaking in solutions of sodium bicarbonate and sodium chloride of different concentrations. The duration of soaking was also varied. Treated groundnut seed was roasted and sensory evaluation tests were carried out for consumer preference. Data showed that soaking groundnut in a 15% brine solution for one hour and blanching in the same solution was the best treatment for salted, blanched and roasted groundnut.

EFFECT OF PLANT GROWTH REGULATORS  
ON CUCURBITACEA CROP PRODUCTION

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Experiments were conducted at Regional Agricultural Research Centre, Aralaganwila in Yala 1992 and Maha 1992/93 to investigate the possibility of using plant growth regulators to improve the yield of some cucurbitaceae vegetable crops. Luffa cv LA 33 (Luffa acutangula L.) Cucumber cv LY 58 (Cucumis sativus L.) and Butternut cv Waltham Cross (Cucurbita moschata) were treated with Naphthalene Acetic Acid (NAA), Ethereal and PaclabutrAZOL. Yield, growth, flowering and fruiting behavior of these crops were monitored. In later experiments butternut was treated with a combination of Ethereal and PaclabutrAZOL to investigate their interactive effects on crop growth and fruit yield.

Application of 100 ppm Ethereal increased the yield of Luffa. Application of NAA and PaclabutrAZOL at 200 and 60 ppm respectively did not have any influence on fruit yield of Luffa. Butternut treated with 100 ppm PaclabutrAZOL produced the highest yield compared to other treatments. However, butternut yields were lower in this experiments due to unfavourable climatic conditions prevailed during the conduct of experiment. PaclabutrAZOL retarded the growth of vines and gave it a strong vigor to overcome unfavourable conditions. Application of 100 ppm Ethereal significantly increased Cucumber yield over the untreated control. However, PaclabutrAZOL and NAA applications reduced the yield compared to control.

Combined applications of Ethereal and PaclabutrAZOL together or one followed by the other in one day intervals did not have any influence on butternut yield compared to Ethereal treated control. Combined applications retarded the vine growth without affecting yield showing the possibility to increase plant density in order to increase the yield.

In all experiments it was generally observed that Ethereal improved fruit yield. NAA had no influence on yield though it modified the growth and flowering behavior of test crops. PaclabutrAZOL retarded vine growth of cucumber and butternuts without affecting fruit yield or fruit size.

## VARIETAL DEVELOPMENT OF LEAFY VEGETABLES

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Consumption of leafy vegetables with at least two major meals a day is a significant feature in the country's dietary habit. The per capita consumption of leafy vegetables per year is about 4.5 kg. These are rich in minerals and vitamins. In spite of their importance, leafy vegetables have in the past received very little attention of the researchers.

Many leafy vegetables are produced year round in gardens popularly known as 'keera kotuwa' in Colombo and its suburbs. These plots supply leafy vegetables to the Colombo city.

Mukunuwenna, gotukola and kankun are the popular leafy vegetables, and many different cultivars are being cultivated by farmers. However, no systematic study has been undertaken to identify and characterize these cultivars.

The present investigation was launched to study a germplasm collection of mukunuwenna, gotukola and kankun. The collection comprised cultivars available with farmers in Anuradhapura, Puttalam, Kurunegala, Polonnaruwa, Matale, Kandy, Kegalle, Gampaha, Colombo, Ratnapura, Kalutara, Galle, Matara and Hambantota districts. Material available with the various research stations was also collected. These were multiplied in pots and subsequently grown in field observational plots. Yield, leaf, flower and plant characters were studied.

This study revealed that cultivation of leafy vegetables has shifted from Colombo and its suburbs to other districts. This is particularly true for gotukola, where large extents are cultivated in the Puttalam, Kurunegala, Anuradhapura, Kegalle and Gampaha districts.

The present study has helped to identify 9 mukunuwenna, 6 gotukola and 3 kankun cultivars. The identification of cultivars and their characterization are important for programmes designed to improve varieties with respect to yield, quality and resistance/tolerance to pests and diseases. Pests and diseases appear to be one of the major constraints to increasing the production of leafy vegetables. Selection of cultivars to suit different farming situations is also an important aspect that has to be given due consideration in future research.

## MANAGEMENT OF MEALYBUG WILT OF PINEAPPLE

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It is known from previous research that the density of ants in pineapple stands is related to the incidence of the wilt disease. It has also been observed that spider numbers are high in fields with low ant populations. Spiders are key predators of mealybugs and their activity may be hindered by the presence of ants. Previous research by the author has shown that clean-weeding tends to reduce the ant and spider populations compared to slashing of weeds or keeping them unweeded.

In the present study, the weeding treatments used were clean-weeding, slashing and use of coconut coir dust as a mulch. Ants were collected from pitfall traps and identified.

Weekly data collected from the trial confirmed the observation that the ant and spider numbers are low in the clean-weeded plots compared to the slash-weeded plots. The plots with coir dust mulch had lower ant and spider numbers than in the slash-weeded plots.

Ant numbers were observed to increase with time. Of a total of 10-12 species, only 4 were found to associate with mealybugs. Of these, only 2 species of small black ants (*Paratrechina longicornis* and *Pheidole* sp.) were most commonly associated with the pineapple mealybugs. Of the 4 ant species only *Pheidole* sp. possesses a sting and could repel spiders. Spiders were observed to co-exist with the non-stinging small species of black ant - *Paratrechina longicornis*.

Ant control is a vital step in the management of the pineapple wilt disease. A baited formulation of a formicide - Hydramethylnon (trade name - 'Amdro') is being tested for acceptance by the ants. It was observed that this bait is accepted by the *Pheidole* sp., but not by the other 3 species.

This method of control could last as long as one year since the poisoned bait is carried by the foraging ants to the queen and the entire colony is killed. With the queen eliminated, the chances of re-establishment of the colony would be remote. Direct sprays of suitable insecticides could effect quick kill of only the foraging ants which constitute only a small part of the colony. Control by direct sprays would last only for a short period since the ant colonies would quickly re-establish.

Pineapple yield from the clean-weeded plots was higher than that for the other treatments. As compared to the slash-weeded plots, the yield from the clean-weeded plots was remarkably high - more than 3 times that of the slash-weeded plots.

The following tentative recommendation could be used to manage the wilt disease:

Prior to planting, dip-treat the butt end of pineapple suckers first with Mancozeb (1 oz in 10 water) let dry and then dip-treat with an insecticide (Profenofos or Prothiofos - 1 oz. in 10 1 water). Clean weed to keep down ant numbers and increase the fruit yield. After the harvest, spray a suitable insecticide to kill ants and mealybugs that build up with time. Use an acceptable baited insecticide to kill ant colonies.

## RESISTANCE OF PESTS TO INSECTICIDES

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Sri Lankan farmers depend largely on chemicals to control insect pests of vegetables. Often, they complain of the failure of recommended pesticides to control target pests, and as a result tend to increase the dosage and the frequency of pesticide applications. This leads to increasing of the cost of pest control, development of more resistant pest populations and adverse environmental consequences. The present study was carried out to determine whether the failure of pest control using insecticides was due to the development of resistance to commonly used pesticides.

Susceptibility of three insect pests (*Plutella xylostella*, *Spodoptera litura* and *Aphis craccivora*) to commonly used recommended pesticides was investigated under controlled conditions (23-27°C, RH % of 75-80 and a 12-hour photoperiod). For each insect species a reference strain was obtained from an area with a record of little or no pesticides use. Field populations of the above insect pests were collected from different locations recording intensive vegetable cultivation with the use of high levels of pesticides, in Kandy, Matale, Kegalle and Nuwara Eliya districts. Reference colonies and different populations of the above insect species were exposed to relevant insecticides using Topical application and Potter's spray tower methods. The mortality of 4<sup>th</sup> instar larvae was recorded for each reference colony and insect pest population collected from the above districts, after the application of insecticides. The regression equation, I.D. value and the diagnostic dose were estimated using Probit analysis. Insecticide susceptibility level for each pest population was compared with the baseline data obtained from the respective reference colony.

Results revealed that the populations of *S. litura* collected from Kandy, Matale, Nuwara Eliya and Kegalle have not developed resistance to the insecticide, Methomidophos. The populations of *P. xylostella* collected from Kandy and Matale recorded very low survival above the diagnostic dose, while 2% survival was recorded for the Nuwara Eliya population. However, even this population showed susceptibility to higher concentrations of the insecticide. Two insecticides (Dimethoate and Oxydemeton methyl) tested on 3 populations of *A. craccivora* collected from Kandy and Matale showed no indications of development of resistance to these insecticides. The results show that the failure of the insecticides to control pests mentioned above is due to incorrect use of pesticides and not due to the development of resistance.

## PESTS AFFECTING THE FOLIAGE AND CUT-FLOWER INDUSTRY

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The present study was conducted to investigate the pest incidence on cut flower and foliage plants. Survey inspections were carried out in cut flower nurseries. Plant species investigated included anthurium, carnation, gardenia, gerbera, gypsophila, hibiscus, orchid, roses and statice. Survey of the incidence of insect pests on foliage plants was carried out in nurseries of major exporters of foliage plants.

Identification of some of the pest species collected from anthurium, gardenia, gerbera, impatient and orchids was not possible and were sent to the Commonwealth Institute of Entomology (CIE), UK.

The foliage plants species surveyed were adiantum, aglonema, alocasia, aralia, areca, asplenium, caryota, codiaeum, cordline, dieffenbachia, dizygotheca, dracaena, ficus, ixora, kalanchos, licula, livistoma, maranta, pandanas, philodendron, phoenix, ploemele, polysia, schefflera, syngonium and yucca.

Damage due to mites is a major problem in almost all plant species, at all locations particularly during the dry period. Identification of the different mite species being not possible locally, the samples collected were sent to the CIE.

The survey revealed that some diseases and pests are common to both cut-flower and foliage nurseries. Some of these are given below:

Plant Species	Pest	Disease organism
Adenium sp.		<i>Fusarium</i> sp. <i>Pythium</i> sp.
Aglonema spp.	<i>Pratylenchus</i> spp. <i>Xiphinema</i> spp. Mites.	<i>Colletotrichum</i> sp. <i>Pythium</i> sp.
Alocasia sp.	<i>Meloidogyne</i> spp.	<i>Pythium</i> sp.
Anthurium spp.	<i>Pratylenchus</i> sp. Whiteflies	
Carnation and <i>Gypsophila</i> spp.	Mites	<i>Alternaria</i> sp. <i>Botrytis</i> sp. <i>Cladosporium</i> sp. <i>Rhizoctoria solani</i> . <i>Stemphylium</i> sp.

<i>Croton</i> spp.	<i>Pratylenchus</i> sp. Mites Whiteflies.	<i>Colletotrichum</i> sp. <i>Curvularia</i> sp. <i>Macrophamia</i> sp. <i>Alternaria</i> sp. <i>Pythium</i> sp. <i>Cladosporium</i> sp. <i>Phytophthora</i> sp. <i>Pythium</i> sp. <i>Sclerotium rolfsii</i>
<i>Dizygotheca</i> sp.	Mites	
<i>Dieffenbachia</i> sp.	Mites	
<i>Dracaena</i> spp.	Mites	
<i>Ficus</i> spp.	Thrips. ( <i>Gynaiko thrips</i> sp.)	
<i>Gardenia</i> spp.	Thrips ( <i>Thrips hawaiiensis</i> *)	
<i>Gerbera</i> spp.	Mealy bugs. Mites Thrips ( <i>Thrips palmi</i> *) Whiteflies	<i>Alternaria</i> sp. <i>Botrytis</i> sp. <i>Colletotrichum</i> sp.  <i>Curvularia</i> sp. <i>Erysiphe</i> sp. <i>Pythium</i> sp. <i>Fusarium</i> sp.
<i>Hibiscus</i> spp.	Aphids	
<i>Impatient</i> sp.	Mites	
<i>Ixora</i> spp.	Mealy bugs. White flies Thrips ( <i>Thrips palmi</i> ) Flower Thrips. ( <i>Dichromothrips</i> sp.)	<i>Cercospora</i> sp.  <i>Curvularia</i> sp.
<i>Pandanus</i> spp.	Mealy bugs Mites	
<i>Palm</i> spp.	Mealy bugs Mites	<i>Curvularia</i> sp.
Roses	Mites	<i>Botrytis</i> sp.
<i>Statice</i> spp.		<i>Alternaria</i> sp. <i>Botrytis</i> sp. <i>Cercospora</i> sp. <i>Pythium</i> sp.
<i>Schiefflera</i> sp.		

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\* recently identified

Often, pesticides are not used in the correct way and this was seen to cause higher phytotoxicity and poor control of most pests. Further, incorrect use of pesticides has caused the building up of resistance even in pests of little importance.

The survey highlighted the need to impart technical know-how on the use of pesticides to private nurserymen.

THE INFLUENCE OF ENVIRONMENTAL FACTORS  
ON THE DEVELOPMENT OF CHILLI NARROW LEAF DISORDER

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The chilli narrow leaf disorder (CNLD), characterized by acute retardation of development of leaf lamina tissues, proliferation of axillary shoots and reduced pod set was found to be transmissible by infected soil or soil water. The objective of this project was to determine the influence of environmental factors and soil amendments on the causal factor of the disorder, and thereby elucidate the nature of the factor involved.

Infected soil samples were subjected to temperatures ranging from 15-80°C for 2-6 hours. It was found that the factor responsible for CNLD was not affected due to a 2-hour exposure to a temperature ranging from 15-60°C. The survival was reduced when soil samples were subjected to a temperature of 60°C for 3 hours and to 70-80°C for 2-3 hours. The factor was completely inactivated after a 4-hour exposure to 60°C.

The factor was also inactivated when activated charcoal, urea and (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> were incorporated into the soil.

It was also noted that the factor survives whether the soil is kept under air-dried or flooded conditions. Further research is needed to arrive at firm conclusions regarding the nature or control measures of CNLD.

## WEANING OF TISSUE-CULTURED *Anthurium andreanum* PLANTLETS

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S.A. KRISHNARAJAH

One of the major reasons affecting the commercial viability of the tissue culture industry is the high rate of senescence of plantlets once they are taken out of the special container with the medium and transferred to the field. This could be avoided by keeping tissue-cultured plantlets in a growth chamber with a well-regulated environment. However, the cost involved may be beyond the reach of average growers. Appropriate technology was used to construct a growth chamber in which the RH, light and the temperature could be maintained at the desired level.

Experiments conducted with anthurium plantlets in the growth chamber showed that high RH (80-90%) along with low light intensity (2500 lux) gave better results compared to keeping the plantlets at the same RH level but at a higher light intensity (5000 lux). High light intensity resulted in higher disease incidence.

Of the various media tested charcoal, brick pieces, coir dust and sand mixed at the ratio of 1:1:2:1 proved to be better than top soil and sand used at the ratio of 2:1, for achieving higher rates of plant survival.

**USE OF TUBERLETS AS PLANTING MATERIAL IN SEED  
TUBER PRODUCTION OF POTATO**

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The quality of seed tubers is vital to potato production. Therefore, to ensure a high quality, seed tubers are produced at high elevations under strict phyto-sanitary conditions. This makes seed tubers expensive and planting material accounts for 60% of the cost of cultivation in potato.

The diameter of seed tubers fall within the range of 28-45 mm. Bigger tubers (ware tubers) and smaller tubers (tuberlets, 'chats') are rejected on the basis of their size, even if they come from a well-managed field. Hence, 20-30% of the harvested high quality tubers is not used as seed potato, but considered as consumption tubers.

The present investigation was launched to determine the feasibility of using tuberlets as planting material. The study dealt with determining the optimum plant density and fertilizer requirement when tuberlets are used as planting material.

Three spacings (60 cm x 25 cm, 45 cm x 25 cm and 25 cm x 25 cm) and three planting densities (1, 2 and 3 tuberlets/hill) were tested in a 3 x 3 factorial experiment laid out in a RCB design with 3 replicates. The study was carried out at the Agricultural Research Station, Sita Eliya during maha 92/93. The experiment was conducted under standard management conditions. Both the fresh tuber weight and the number of large, medium and small tubers were recorded.

The results indicate that tuberlets can be successfully used as planting material in both seed and consumption tuber production, at the conventional planting density of 65,000 plants/ha (60 cm x 25 cm; 1 plant/hill).

**AN ECONOMIC STUDY ON THE CONSERVATION  
FARMING SYSTEM AT MUTHUKANDIYA**

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The Muthukandiya Dryland Development Project (MDDP) was designed to develop about 2600 ha of unirrigable highland and about 800 ha of irrigated lowland. The size of the irrigated allotment per family was 1 ha with a separate homestead of 0.3 ha. The highland allotment was a 2.4 ha block of land with a clay-lined farm pond to collect run-off water for supplementary irrigation, for intensive cultivation of crops, in an area of not less than 0.2 ha, on a year round basis.

The main objectives of the present study, carried out in the MDDP, were to compare the profitability of conservation farming (CF) systems, assess the efficiency of resource use of adopters and non-adopters of CF technology, examine the impact CF on the sustainability of farming, compare the impact of new technology on the structure of crop production functions and policy implications.

The package of CF technology used in the MDDP included adoption of soil conservation measures such as contour bunding, planting crops along the contours, mulching etc.

Perennial fruit crops were established in a 1.2-ha block and annual cropping was done on a rotational basis with 0.4 ha of pasture intended to provide fodder for dual purpose (milk/draught) cattle rearing, on a year round basis.

Construction of bunds and initial land preparation was carried out by the project. Farmers were provided with planting material, agricultural tools, two in-calf heifers on credit and a subsidy to develop 0.4 ha of pasture. The comprehensive infrastructure developed by the project included a school, post office, cooperative store, dispensary, veterinary clinic and an Agricultural Productivity Centre to provide agricultural inputs and banking facilities. The project also supported on-farm adaptive research for a period of five years and intensive agricultural extension. In addition, farmers were provided with dry rations for a period of two years.

The study revealed that farmers do not adopt the complete package of CF envisaged by the project. It was found that adopters use resources more efficiently than the non-adopters. Adopters have maintained soil fertility at an acceptable level. They also obtained higher yields and incomes with a better distribution. In general, they have more stability than the non-adopters. Non-adopters depend more on high income cash crops such as sugar cane and tobacco or annual crops such as maize and cowpea. Their incomes

are more vulnerable to vagaries of weather and their fields are subjected to soil erosion.

Lack of an incentive scheme to motivate farmers to manage the perennial crops well, until they are productive, has resulted in delayed income generation from such crops. If a support system for management of perennial crops is implemented during the establishment phase, it should encourage more farmers to grow such crops.

There is an established market only for paddy. Inadequate or absence of market facilities for other crops has driven farmers to sell their produce at very low prices. Some farmers use the pond water to grow a paddy crop in maha.

Cattle are used mainly for draught purposes. Better extension and marketing should lead to better integration of crops and livestock.

Sustainability of agriculture is only one of the many objectives of farmers and policy makers. It is important to recognize the multiplicity of objectives of a farm household, when considering suitable development strategies. Conservation is an investment for the future and its benefits are realized only after a time lag and as a result low-income, resource-poor, subsistence farmers tend to prefer systems which are profitable in the short run.

## TISSUE CULTURE OF *Ficus benjamina*

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Tissue culture techniques enable to obtain a large number of uniform plants required for commercial level production of plants in the floriculture industry. Recent trends indicate that foliage *Ficus* species of plants are in great demand for export purposes. The main production constraint is the lack of technology to produce sufficient planting material to satisfy the export demand.

Apical and axillary buds were used as explants on a basal Murashige and Skoog (MS) medium with 3% sucrose supplemented with 2 levels of benzyl amino purine (BAP) as well as a combination of BAP and 2 ip (N<sup>6</sup> isopentenyl adenine) at 3 levels. *F. triangularis* showed growth of shoots and formation of leaves in a medium supplemented with 5 mg/l of BAP while a level of 1 mg/l induced proliferation of shoots and callus. A medium without hormones induced root formation. Once rooted, these were transferred to a soil medium. The plants require to be acclimatized before transferring to the nursery. For this purpose a lath house was constructed at low cost.

*F. microcarpa* also showed growth of shoots and formation of leaves in a medium with 5 mg/l of BAP. Best performance for *F. benjamina* was observed in a medium with 20 mg/l of BAP and 20 mg/l of 2 ip.

## PRE-BASIC SEED POTATO PRODUCTION

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Restriction on the import of seed potato necessitates the development of a basic seed potato production programme in Sri Lanka to meet national requirements. The conventional method of multiplication using tubers leads to degeneration. Meristem culture offers an excellent alternative means to produce disease free planting material. This material could be used as pre-basic material in a basic seed potato production programme.

In this context, a planned pre-basic seed potato (GO) production of commercial cultivars "Desiree" and "Sita" through meristem culture was initiated at RARC, Bandarawela in 1992. *In vitro* plantlets of these commercial cultivars were raised as mother plants in aphid proof net house at Bandarawela. Stem cuttings were extracted from these mother plants and rooted in rooting medium.

These rooted stem cuttings were used for pre-basic seed production in net houses in high-elevation Farms at Pedro, Udaradella and Sita Eliya. The pre-basic seeds produced are being field multiplied subsequently for the production of basic seeds in these Farms. This programme appears to be a potential alternative method to produce seed potatoes locally.