# VEGETABLE PRODUCTION (BRUMDEC) - REVIEW & PROPOSED SHORT-TERM ADAPTIVE PRODUCTION ORIENTED RESEARCH PROGRAMME

IICA/JAMAICA
Miscellaneous Publication #320
ISSN-0534-5391

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by

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January 1982

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## Introduction

The Black River Upper Morass Development Company Limited (BRUMDEC), a wholly owned subsidiary of the Jamaica National Investment Co. Ltd., (JNIC), is the legally authorized executing agent of the Black River Morass Reclamation Project. The project is concerned with the development of approximately 11,000 acres of land in the Elim and Barton Isle area of St. Elizabeth. The Company plans to cultivate onions, peas and beans, vegetables, rice, cotton, pineapple, cassava, mango, citrus, coffee, plantains, and peanuts.

The general objectives of the project provide for the initiation of research and development for introducing improved agricultural production techniques, and to provide technical assistance to the farmers in the area. In order to achieve this objective, BRUMDEC has signed an agreement with the Inter-American Institute for Cooperation on Agriculture (IICA) for the provision of five (5) Consultants in the areas of:

Rice Production
Grain Production
Vegetable Crop Development
Irrigation and Drainage Management
Farm Management

With respect to vegetable crop development, the consultant is required to prepare a programme of adaptive production oriented research aimed at solving the problems which obtain in vegetable production in the project area. Problems to be addressed include appropriateness of vegetable crops and varieties within the context of:

(i) Jamaican consumer acceptance
(ii) Soil/Water considerations

(iii) Seasonality of production
(iv) Culture and harvesting characteristics
(v) Weed, pest and disease associations
(vi) Seed production
(vii) Fertilizer regimes
(viii) Crop density and yields

## 2. Background

In order to develop the programme to achieve the desired objectives, it was necessary to review all the reports and recommendations pertaining to the project, to become acquainted with work done in vegetable production in Jamaica and in other countries with similar conditions as existing in the project. Discussions were held with the other consultants, BRUMDEC personnel, Ministry of Agriculture staff and other knowledgeable persons including farmers who have been involved in vegetable production.

### 2.1. Location

The Black River Morasses are divided into the Upper Morass and the Lower Morass. They are located in the parish of St. Elizabeth in the western part of Jamaica near the south coast. The Upper Morass which is the area being developed by the project consists of approximately 11,000 acres (4,451 hectares) of agricultural land. It is situated between Maggotty in the north and Lacovia in the south.

### 2.2. Climatic Conditions

Climatic conditions as it pertains to vegetable production is important in determining times of planting and harvesting, irrigation cycles, plant protection methods etc. Unfortunately, this type of information for the project is almost non-existent and figures from other locations have had to be taken as indications of what is likely to occur within the project

2.2.1. Rainfall

The table below shows the average monthly precipitation of the Santa Cruz area for the years 1931-1960.

| Month | Inches | MM |
|---|---|---|
| January | 2.9 | 73.66 |
| February | 2.9 | 73.66 |
| March | 4.2 | 106.68 |
| April | 8.6 | 218.44 |
| May | 11.1 | 281.94 |
| June | 5.9 | 149.86 |
| July | 5.2 | 132.06 |
| August | 9.4 | 238.76 |
| September | 8.8 | 223.52 |
| October | 12.7 | 322.58 |
| November | 6.9 | 175.26 |
| December | 2.9 | 73.66 |

*Source: Statistical Yearbook of Jamaica - 1979

The figures indicate a bimodal pattern with the rains falling in April and May, and the main rainy season starts in September and goes on into November. A marked dry season occurs from the end of November through the end of March. However, the pattern is known to vary significantly from year to year.

2.2.2. Temperature

Temperature records for the project are not available as are the records for the areas in close proximity. The meteorological records for Jamaica as a whole indicate that in spite of elevation, the warmest months are July and August and the coolest January and February. Near sea leavels the maximum, minimum and daily temperatures are 86°F (30°C), 70°F (21°C), and 78°F (25.6°C) respectively.

### 2.2.3. Humidity

The comments made about the records of temperature for the project also apply to the humidity. The table below shows the range of relative humidity for the Kingston area. The figures indicate that all through the year during the evenings, the relative humidity is over 80%. It is lowest during the day during the months of December to March which more or less coincides with the dry season.

Range of Mean Relative Humidity (1969 - 1978)

| Hour | January | February | March | April | May | June |
|---|---|---|---|---|---|---|
| 7 a.m. | 86-80 | 86-78 | 85-75 | 81-75 | 84-76 | 84-73 |
| 3 p.m. | 66-59 | 66-59 | 71-60 | 71-63 | 72-63 | 73-60 |

| Hour | July | August | September | October | November | December |
|---|---|---|---|---|---|---|
| 7 a.m. | 82-63 | 84 /6 | 88-81 | 90-82 | 87-79 | 86-77 |
| 3 p.m. | 65-52 | 78-60 | 74-65 | 75-66 | 72-64 | 69-58 |

* Source: Statistical Yearbook of Jamaica, 1979

## 2.3. Major Soil Types in the Project Area

### 2.3.1. Morass Peat Soil - 152

The Morass Peat Soil - 152 is the most wide-spread soil in the project occupying approximately 2,900 acres. It is derived under swampy conditions from the sawgrass Cladium jamaicance and other related sedges. It is reported to be similar to sawgrass peat found in the Negril swamps, Everglades of Florida and many other parts of the tropics. Depending on the level of the water-table, solid black peat forms at mat on the surface which overlies rotting vegetation mixed with water in various forms of decomposition, to depths varying from one foot (0.3m) to over seven feet (2.10 m), until bluish grey clay and sandy clay is encountered (4,7).

The Morass Peat Soil has a slightly acid reaction. The potash, phosphate and magnesium content of the soil appear to be medium and adequate for most crops. The analytical data indicate a very high calcium content (3,162 to 10,714 ppm Ca within the top 6 inches (2.4 cm).

It is felt that the high calcium content is likely to contribute to manganese, iron and zinc deficiencies (4).

2.3.2. Four Paths Series of Soils - Four Paths Clay 203 and Four Paths Loam - 204

The Four Paths Series of soils are the second most widespread soils after the Morass Peat Soil. This series together with the Linstead Clay Loam - 61 and other old alluvial soils are found in large areas of the parish of St. Elizabeth. They are generally acid, deeply weathered, strongly leached and infertile in most parts.

2.3.2.1. The Four Paths Clay - 203 has a good depth of friable strongly structured top soil in the project area, mottling does not begin to appear until 2-3 feet (0.6-0.9 m). The zinc, copper and boron content of this soil is considered to be adequate and manganese - high (15).

2.3.2.2. The Four Paths Sandy Loam - 204, because of the fact that the highly mottled sub-soil is barely covered by a layer of sand or gravel is considered as the most infertile soil of the project. Drainage through the soil is poor as is it's moisture retention capacity (4).

2.3.3. Cashew Clay Loam - 151

The Cashew Clay Loam appears to be derived from alluvium and underlies the Morass Peat in most of the Morass. The soil is an acid heavy clay and may be regarded as being a moderate fertility. Phosphate and potash are both very low whilst calcium and magnesium are considered to be adequate (4).

2.3.4. Wallens Clay - 9

Wallens Clay in the project area is derived from yellow alluvial material. The external drainage is slow and internal drainage regarded as adequate. The top soil is neutral to slightly alkaline with the alkalinity and calcium content increasing with depth. Phosphate is low in some areas and adequate in others where phosphate was previously applied to the crop. Potash is generally low and magnesium adequate (1,4).

2.3.5. Minor Soils: Linstead Clay Loam - 61
Cave Valley Clay - 116

2.3.5.1. Linstead Clay Linstead Clay - 61 is an acid inland basin. Its properties include poor drainage, high acidity and low phosphate and potash. Manganese and copper are considered to be adequate and zinc and boron low. (4, 15).

2.3.5.2. Cave Valley Clay - 116 is alkaline in reaction with adequate amounts of calcium and manganese, and phosphate and potash being low.

2.4. Cropping Pattern for Major Soils within the Project

2.4.1. Morass Peat Soil - 152

Information supplied by the staff of the Ministry of Agriculture in St. Elizabeth indicates that certain vegetables were successfully cultivated on the Morass Peat Soil within the project during the period 1974-1977 (12). Onions and irish potatoes have been reported to have been grown with limited success in the Negril area (4). In the Everglades peat in Florida which is considered to be similar to the Morass Peat, tomatoes, carrots and particularly the leafy vegetables are being successfully grown (9).

In the utilization of this soil for vegetable production, it is recommended that the peat should be ploughed to a depth of 8 inches (3.1 cm). It is also recommended that ripping should be done to take out weed roots and tubers, land preparation should be done with small tractors and planting done on beds in the flat (3).

2.4.2. Four Paths Series of Soils

2.4.2.1. The Four Paths Clay - 203 is considered to be suitable for a wide range of acid loving crops, including sugar cane, citrus, pineapple, food crops, pasture and tobacco which have been successfully grown in other parts of Jamaica. Within the project, this soil is being utilized for the cultivation of sugar-cane, peanuts, red peas, cassava and for pasture (4).

2.4.2.2. The Four Paths Loam - 204, within the project area is mainly under pasture. Pineapple and tobacco have been suggested as possible crops. The utilization of this soil for vegetables requires certain management practices e.g. deep cultivation to break the clay pan, graded drains, planting on raised beds, liming and addition of organic matter (13).

2.4.3. Cashew Clay Loam - 151

Rice growing has been recommended for the Cashew Clay Loam - 151 because of the poor internal and external drainage. Sugar cane with extensive irrigation and pasture with or without drainage have been suggested as alternative crops.

2.4.4. Wallens Clay - 9

The Wallens Clay - has been utilized within the project for rice and sugar. It has been suggested that if it becomes necessary to change the cropping pattern, bananas and food crops should be considered if adequate drainage can be provided.

2.4.5. Minor Soils

Of the minor soils, only the Linstead Clay Loam - 61 is considered to be suitable for vegetables. The management practices recommended for this soil when they are to be utilized for vegetables are essentially similar to that of the Four Paths Loam - 204. Within the project, this soil is being fully utilized for sugar cane and as such not available for vegetable production.

2.5. Water Management

2.5.1. Irrigation

The Harza Report (3) indicated that even during the months of high total rainfall, the distribution was often so uneven that the availability in the root zone was depleted by evapotranspiration. From this,

it was inferred that supplementary irrigation may be needed during any month of the year. It was recommended that the Class IIIt and Class IId (peat soil) should be irrigated by a sprinkler system and the remaining Class II soils by flood, furrow or sprinkler irrigation. Mention was made of the fact that mole drains are being used in a number of countries to irrigate peat soils, and in Florida mole drains are being used in combination with open drains.

It has been suggested that two crops of short duration can be cultivated in a year if sown at the appropriate time during the spring and fall season (11). For vegetables on the peat the following was recommended.

| Crop | Growth Period |
|---|---|
| Carrot | April-June, September-November |
| Cabbage | September-November |
| Watermelon | September-November |
| Onion (green) | April-May, September-October |
| Onion (bulb) | April-June, September-November |

Because of the fact that most of the vegetable production in Jamaica has been geared to coincide with the rainy seasons, this often results in a few months of surpluses (gluts) and many months of shortages. Many of the vegetable crops which are presently only being grown during the rainy seasons can be profitably grown all year round with supplementary irrigation (14). A project of the magnitude of BRUMDEC must gear itself to take care of the periods of shortage within the local markets when prices would also be advantageous. Presently none of the irrigation facilities for the vegetables are in place either on the Morass Peat or the Four Paths Series.

### 2.5.2. Water Table

Subsidence of peat soils due to oxidation of the organic matter and shrinkage is regarded as the most important factor in their good management. Maintenance of high water and regular flooding is

recommended as measures to reduce the rate of shrinkages (1,4). The recommended depth of the water table for maximum yield of certain vegetables grown in peat soils, e.g. Morass Peat are:

| Crop | Feet | Meters |
|---|---|---|
| Tomatoes | 1.5 - 2.0 | 0.41 - 0.61 |
| Beans & Peas | 1.5 - 2.0 | 0.45 - 0.61 |
| Cabbage | 1.5 - 2.0 | 0.45 - 0.61 |
| Carrots | 2.0 | 0.61 |
| Corn (sweet) | 2.0 - 2.5 | 0.61 - 0.75 |
| Lettuce | 2.5 - 3.0 | 0.75 - 0.90 |
| Onions | 2.0 - 2.5 | 0.61 - 0.75 |

## 2.6. Fertilizer Practices

As vegetable production is not being done presently on any of the soils of the project, no observations could have been made on the effect of fertilizer practices on production. The recommendations of the Ministry of Agriculture for the Four Paths Loam - 204 (13) and that of Harza (3) for the Morass Peat - 152 are shown below:

### 2.6.1. Mineral soils e.g. Four Paths Loam - 204

2.6.1.1. Fruit/vegetables e.g. tomatoes, okra, egg plant, snap beans, peppers, sweet corn, cucumber etc. Five (5) cwt. of 7-14-14 applied one week before planting

2.6.1.2. Root vegetables e.g. carrots, beets, radish. Four (4) cwt. of 6-18-27 or 12-14-12 applied one week before planting.

2.6.1.3. Leafy vegetables e.g. cabbage, lettuce, cauliflower, celery. Three (3) cwt. of 7-14-14 applied prior to planting plus three (3) cwt. sulphate of ammonia applied as a side-dressing, 3 weeks after planting.

2.6.1.4. Onions. Six (6) cwt. of 7-14-14 or 4 cwt. of 12-24-12 applied seven (7) days before planting plus two (2) cwt. of sulphate of ammonia applied as side dressing 6-8 weeks after planting.

2.6.2. Morass Peat Soil - 152

2.6.2.1. Onions, carrots, beets, etc. Muriate of potash, 900 lbs per acre per crop. Triple superphosphate, 300 lbs per acre per crop. One half of the fertilizer is to be applied as a basal application, and the remainder in three or more applications.

2.6.2.2. Tomatoes, cabbage and lettuce etc. Muriate of potash, 400 lbs per acre per crop. Triple superphosphate, 400 lbs per acre per crop. One half of the fertilizer as basal application and the remainder in three or more applications.

2.6.3. Micro-Nutrients

With few exceptions all the major alluvial soils including the Four Path Series are fairly well supplied with the micro-nutrients e.g. zinc, manganese, copper and boron (15). The application of micro-elements to crops grown on alluvial soils is not generally advocated. However, for the peat soils, micro-nutrients are considered to be necessary for successful production of vegetables. Hewitt (4) recommends are pre-plant amendments in the last stages of land preparation, the application of 15 lbs of copper, 10 lbs of manganese, 4 lbs of boron, and 5-7 lbs of zinc per acre. Except for zinc, a similar recommendation has been made by Harza (3). Other reports indicate that the application of copper may be lessened and may not be needed at all, whilst manganese and zinc may best be applied as foliar sprays.

2.7. Plant Protection

Under the conditions prevailing within the project area e.g. high temperatures and humidity, pests, diseases and weeds can be expected to be a serious problem in the production of vegetables. Appendix I and II list some of the more important pests and diseases of vegetable and their control. Appendix III gives the chemical control of weeds in selected vegetables.

## 3. Programme for Adaptive Production Oriented Research (Short Term) in Vegetable Production

### 3.1. Objectives

The programme for adaptive production oriented research in vegetable production has as its overall objective the following:

3.1.1. Establishing the appropriateness of vegetables and varieties for production within the project taking into consideration, seasonality of production, cultural practices, fertilizer regimes, yields, weeds, pests and diseases associations.

3.1.2. Developing a technological package of practices for implementing on-farm vegetable cultivation under conditions which prevail in the project.

3.1.3. Accumulating data on the various aspects of vegetable production and which will provide the basis for determining those areas for future research.

3.1.4. Training of national technicians consistent with the agronomy of vegetable production.

### 3.2. Strategy

The proposed strategy is as follows:

3.2.1. In order that the programme can produce quick benefits, main emphasis will be given to the selection of suitable crops and varieties of these crops for the cultivation on the major soils of BRUMDEC. The varieties being evaluated are those which have been found to be suitable for Jamaican conditions and to conditions similar to that of the project area. Current recommendations regarding cultural practices, fertilizer applications, pests, diseases and weed control will be followed.

Since the economic viability of BRUMDEC seems to lay to some extent on the utilization of the Morass Peat Soil - 152 for the production of high-priced vegetables, major emphasis would be placed on the evaluation studies of this soil. Selected vegetables would also be tried on the Four Paths Series - Four Paths Clay - 203 and Four Paths Loam - 204, the second most widespread soils in the project after the Morass Peat.

On the Morass Peat Soil, the vegetables to be evaluated included:

> Cabbage, cauliflower, lettuce, peppers (sweet and hot), tomatoes, sweet corn, celery, string beans, egg plant, okra, onions (bulbing), onions (bunching), carrots, beets, garlic.
>
> Those to be tested on the Four Paths Series are: Melons, cucumber, onions, carrots, beets, tomatoes.

3.2.2. Field experiments will be conducted on the Morass Peat Soil - 152, Four Paths Clay - 203 and Four Paths Loam - 204 in order to establish the best N.P.K. treatments. The crops on which the studies will be done include tomatoes, carrots and cabbage which are taken as representing the fruit, root and leafy vegetables respectively. Onions will also be included.

3.2.3. Field studies will be carried out with the micro-elements Cu, Zn, Mn, Fe and Boron on the Morass Peat Soil. The objectives of these studies are to establish whether all these elements are needed, the rates to be applied and the method of application.

The crops which will be used in these studies are tomatoes, carrots, cabbages and onions.

3.2.4. Selected vegetables e.g. tomatoes, melons and onions will be sown on the Four Paths Series, and cabbage, cauliflower, onions, carrots and tomatoes on the Morass Peat Soil during the different season. The objectives of these studies are to establish the optimum period for sowing and harvesting, to determine the irrigation needs of the crops when sown during the different seasons, to observe the incidence of pests, diseases and weeds and other problems associated with growing the various crops in and out of seasons.

3.2.5. The results obtained from the variety evaluation, N.P.K., micro-elements and time of sowing experiments (3.2.1 to 3.2.4) will be used to develop a package of practices for the production of vegetables on the Morass Peat and Four Paths Series of soils of the project. These would be evaluated in large scale commercial trials of one half to one acre.

3.2.6. The national technicians assigned to the vegetable programme, will as part of their training, be fully involved in all aspects of the programme. The commercial trials will be used as the basis for holding training programmes for farmers and other interested persons. It is expected that the national technicians would be adequately trained by this time to conduct the programme for farmers.

3.3. Methodology

3.1.1. Experimental design for varietal evaluation studies

The design of these studies will be a randomised complete block with four (4) replications. Plot size for each trial will be dependent on the crops being evaluated and the availability of planting material. On the Morass Peat soil a basal application of copper, manganese, boron and zinc will be made at 16.8 kg, 11.2 kg, 4.5 kg and 5.6 kg per hectare respectively. The fertilizer treatments for the different crops on the two (2) soil types are given below.

3.3.1.1. Morass Peat

Cabbage, cauliflower, lettuce, sweet corn, beans, celery:

$P_2O_5$ - 180 lbs/acre (202 kg/ha)

$K_2O$ - 240 lbs/acre (269 kg/ha)

Carrots, Beets:

$P_2O_5$ - 200 lbs/acre (225 kg/ha)

$K_2O$ - 300 lbs/acre (336 kg/ha)

Onions:

$P_2O_5$ - 120 lbs/acre (135 kg/ha)

$K_2O$ - 180 lbs/acre (202 kg/ha)

Tomatoes, peppers, egg plant:

$P_2O_5$ - 160 lbs/acre (180 kg/ha)

$K_2O$ - 240 lbs/acre (269 kg/ha)

Side dressing of nitrogen fertilizer will be made to the leafy vegetable if the need arises.

3.3.1.2. Four Paths Series

The recommendations of the Ministry of Agriculture which are as follows will be used:

Onions:

6 cwt. of 7-14-14 per acre plus 2 cwt of sulphate of ammonia as a side dressing.

Tomatoes, okra, beans:

5 cwt. of 7-14-14 fertilizer per acre

Carrots, beets:

4 cwt. of 6-18-27 or 12-14-12 per acre

Cabbage, lettuce, cauliflower, celery:

3 cwt. of 7-14-14 fertilizer plus 3 cwt. of sulphate of ammonia as side dressing.

Routine spraying will be carried out with the appropriate chemicals for control of pests and diseases. Weed control will be done through the use of the recommended herbicides and also manually.

### 3.3.2. Experimental design for N.P.K. fertilizer experiments

The design of these experiments will be a 3x3x3 factorial arranged in block of nine (9) treatments with two (2) replications. The N.P.K. treatment will be:

On the Morass Peat Soil

N at 0, 40 and 80 kg/ha
P at 100, 150 and 200 kg/ha
K at 150, 250 and 350 kg/ha

On the Four Paths Series

N - 40, 80 and 120 kg/ha
P - 60, 120 and 180 kg/ha
K - 60, 120 and 180 kg/ha

All of the P and half of the N and K will be applied one week prior to planting. The remaining half of N and K will be applied depending on the crop - 3 to 6 weeks after seeding. On the Morass Peat a basal application of Copper and Boran will be applied at 16.8 Kg and 4.5 kg per acre respectively. Manganese and Zinc would be applied as Foliar sprays at 0.375 Kg/ha in 30 - 40 gallons of water. Two applications of the Manganese and Zinc sprays will be made at 3 and 6 weeks.

The recommended cultural practices, pests, disease and weed control measures will be carried out.

Observations will be made on the growth of the plants and yields. Soil and plant analyses will be done at the appropriate times.

### 3.3.3 Design of micro-nutrients experiments

Two experiments are contemplated. The first experiment will be a randomised block designed and is intended to establish what micro-elements need to be applied to the Morass Peat Soil. The treatments will be as follows:

(i) No micro-elements
(ii) Complete package of micro-elements
Cu - 16.8 kg/ha (soil application)
B - 4.5 kg/ha ( " " )
Mn - 0.375 kg/ha (two foliar applications)
Zn - 0.375 kg/ha at 3 and 6 weeks
(iii) Complete package minus Cu
(iv) " " " B
(v) " " " Mn
(vi) " " " Zn

A fertilizer application of 180 kg of $P_2O_5$ and 260 kg of $K_2O$ per hectare will be made one week prior to

seeding to all the plots. Observation will be made on plant growth and yields.

Soil and plant analyses will be done at various stages before and after the application of the micro-elements. The recommended cultural practices, pest, disease and weed control measures will be adopted.

Based on the result of the first experiment, a factorial split plot experiment will be carried out. The micro-nutrients found to be necessary in the first experiments will be tested at various rates both as soil and foliar applications.

3.3.4 Time of planting experiments

The design of this experiment will be a randomised split block in which the main plots will be the variety and the sub-plots - the time of planting. The crop and varieties to be included in these experiments are:

| | | | |
|---|---|---|---|
| Tomatoes | - | Varieties: | Manalucie, Floradade Tropic |
| Onions | - | Varieties: | Texas Early Grano, Desex, El Toro |
| Cabbage | - | Varieties: | K.K. Cross, Roundup, Hybrid YR |
| Carrots | - | Varieties: | Danvers 126, Walt High-color, Chantenay |

The time of planting will be: November - December, February - March, June - July.

Other crops e.g. garlic, cauliflower, melons and lettuce will also be sown in observational plots to observe their performance during the different seasons.

The fertilizer applications will be the same as in experiment 3.3.1 as will be the cultural, pest, disease

and weed control practices. Irrigation will be provided to the crop when needed and records kept of the water requirements of the crop when sown during the different seasons. Observations will also be made of growth, yield, incidence of pests, diseases and weeds.

3.3.5 Commercial Trials

The commercial trials will be in units of one half to one acre. Records will be kept of the cost of production, yields and returns from the various crops. Based on the profitability of the different crops, recommendations will be made for large scale production at BRUMDEC and for future areas of research.

## 4. Requirements for the Programme

### 4.1 Personnel

The following personnel are required for the programme:

One (1) agronomist - as counterpart
Two (2) technicians
Ten (10) workers initially - numbers to be adjusted as the programme develops.

### 4.2 Land

Five (5) acres on the Morass Peat - 152
Two (2) acres on the Four Paths Clay - 203
Two (2) acres on the Four Paths Loam - 204

### 4.3 Planting Materials (Seeds)

Appendix V gives the requirements of planting materials (seeds) for the programme.

### 4.4 Chemicals e.g. fertilizers, insecticides etc.

The requirements of chemicals for the programme are shown in Appendix VI.

4.5 Equipment and other Items

The equipment required for land preparation, irrigation, pest control and other operations connected with the vegetable programme are listed in Appendix VII. The provision of these as well as those listed in Appendices V and VI are vital to the success of the programme.

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## SOME IMPORTANT PESTS OF VEGETABLES AND THEIR CONTROL

| CROP | PESTS | CONTROL MEASURE |
|---|---|---|
| Crucifers (Cabbage, Cauliflower etc.) | Leafminers | Dimethoate (Rogor) or Fenitrothion |
| | Cabbage Looper (*Trichoplusia ni*) | Phosvel, Diazinon or Actellic |
| | Cabbage Butterfly (*Artogeis rápae*) | Phosvel, Sevin, Atellic, Ambush or Diazinon |
| | Diamond Back Moth (*Plutella xylostella*) | Lannate, Dipterex, Phosvel, Actellic or Ambush |
| | Cabbage budworm (*Hellula, phidilealis*) | weekly application of Actellic or Gardona. |
| Tomato | Tomato fruitworm (*Heliothis armigera*) | Malathion, Sevin, Diazinon or Gelecron |
| | Tomato hornworm (*Protoparce sexta*) | Galecron, Diazinon or Fenitrothion |
| | Tomato Pinworm *Keiferia lycopersicella*) | Lannate or permethrin (Ambush) |
| | Leaf Sucking Bugs (*Nezara sp.*) (*Phthia picta*) | Malathion, Rogor 40 or Fenitrothion |
| | Thrips (*Frankliniella sp*) | Fenitrothion, Malathion or Rogor 40 |
| Curcurbits | | |
| Watermelon, | Aphids | Rogor 40, Diazinon or Malathion |
| | Banded Cucumber Beetle (*Diabrotica separata* | Dipterex, fenitrothion or Malathion |
| | Sucking Bugs - (*Anasa sp*) (*Phthia picta*) | Malathion, Dimethoate or Diazinon |
| | Melon Worm (*Margaronia* spp.) | Galecron or Diazinon |

| | | |
|---|---|---|
| | Leafminers | Dimenthoate, Fenitrothion or Malathion |
| **Onions** | Leafminers (*Liriomyza* spp) | Dimethoate or Fenitrothion |
| | Thrips (*Thrips tabaci*) | Malathion, Fenitrothion or Dimethoate |
| | Caterpillars | Malathion, Dipterex or Fenitrothion |
| **Peppers** | Whiteflies | Malathion or Dimethoate (Rogor 40) |
| **Lettuce** | Leafminers | Dimethoate or Fenitrothion |
| | Aphids | Malathion or Rogor 40 |
| **Carrots** | Leafhoppers | Malathion, Sevin or Rogor 40 |
| | Aphids | Malathion or Rogor 40 |
| | Leafminers | Diazinon or Rogor 40 |
| | Caterpillars | Diazinon, Phosvel or Dipterex |
| **Beans** | Leafminers (*Liriomyza* sp.) | Rogor 40, Diazinon, Fenitrothion |
| | Mites (*Tetranychus* spp.) | Kelthane, Fenitrothion or Rogor 40 |
| | Caterpillars (*Spodoptera* sp.) (*Pseudoplusia* sp.) (*Anomis* sp.) | Fenitrothion, Diazinon, Dipterex, Phosvel |
| **Corn** (Sweet) | Armyworm (*Spodoptera frugiperda*) | Dipterex, Fenitrothion or Furadan applied to leaves and whorls of plant |
| | Aphids (*Rhopalosiphum msidis*) | Malathion, Fenitrothion or Rogor 40 |

| | | | |
|---|---|---|---|
| General Pests | Cutworms | (Xylomiges sunia) (Anicta infecta) (Prodenia ornithogalli) | Application of Diazinon, Phosvel or Sevin to the soil. Poison bait containing Dipterex Diazinon or any suitable insecticide |
| | Nematodes | (Heloidogyne spp.) Rotylenchulus reniformis) | Because of the wide host ranges of these two species of nematode, crop rotation as a control measure is not generally successful. Soil fumigation with DECP, DD, Vydate or Furadan. |
| | Slugs and Snails | | Poison bait containing metaldehyde. |

## SOME IMPORTANT DISEASES OF VEGETABLES AND THEIR CONTROL

| CROP | DISEASES | CONTROL MEASURE |
|---|---|---|
| Beans | White mold (*Sclerotina sclerotiorum*) | Cultural. Chemical - some control is obtained with Benlate 50% wp at 1½ lbs per acre applied just prior to flowering and again 5-7 days later. Some control is also obtained with Difolaton at 3 pints per acre. |
| | Web blight (*Rhizoctonia solani*) | Good drainage. Controlled by spraying with Benlate, Daconil, Difolaton and Dithane-45 at the recommended rates at weekly intervals just prior or immediately after heavy rains. |
| | Powdery Mildew (*Erysiphe polygoni*) | Controlled by the application of Karathane or Benlate. |
| | Seed borne diseases - Anthracnose, Common blight, Mosaic | Use seed free of these diseases for sowing. |
| Carrots | Leaf and Stem Blight (*Alternaria dauci*) | Seed treatment with hot water at 50°C for 30 minutes or with a chemical seed dressing. Controlled by the application of Dithane-45 or Daconil. Spraying should commence with the first sign of disease or after plants are six weeks old. Use of resistant or tolerant varieties e.g. Waltham Hi-color. |
| Crucifers (Cabbage, cauliflower etc.) | Downy mildew (*Peronospora parasitica*) | Controlled by application of Zineb, Dithane M45, Manzate D or Daconil |
| | Downy mildew (Rhizoctonia) | Control with Benlate 50% WP. |
| | Bacterial Leaf Spot | Seed treatment with Thiram Spray with Maneb, Zineb, Antracol, Cupromaneb |

APPENDIX II

(cont.)

| | | |
|---|---|---|
| | Bacterial Black Rot (Xanthomonas campestris) | Treat seed in hotwater at 50°C for 25 minutes. After this treatment dust seed with fungicide e.g. Thiram or Ceresan. Crop rotation and strict field sanitation. Grow resistant or tolerant varieties e.g. K.K. Cross, YR 50. Application of Agrimycin 200 ppm, Kocide or Cupravit |
| Cucurbits (cucumber, melons, etc.) | Downy mildew (Pseudoperonospora cubensis) | Use of resistant or tolerant varieties. Spray with Daconil plus Benlate combination, Antracol, Kocide, Cupravit, Dithane M 45 or Manzate |
| | Target Spot (Corynespora cassilicola) | Use of tolerant or resistant varieties. Spray with Manzate D + Benlate or Benlate alone or Zineb |
| | Powdery mildew (Oidium Spp.) | Protective spray of Captan or Dithane - 45 |
| | Mosaic Virus | Use of disease free seeds. Roguing of infected plants at an early stage. Control of aphid vector in the field with appropriate insecticides |
| Lettuce | Brown Leaf Spot (Cerospora Longissima) | Control by the application of Benlate, Difolatan, Daconil or Dithane M45 |
| Tomato | Light Blight (Phytopthora infestans) | Use of resistant and tolerant varieties e.g. Manalucie. Preventative spray prior to flowering, bi-weekly application of Cupravit Blue, Kocide, Dithane M45, Maneb or Daconil. Sanitation - use disease free transplants, destroy all infected plants. |

| | |
|---|---|
| Early Blight (Alternari solani) | Sanitation - Seed treatment e.g. Thiram. Application of chemical sprays e.g. Kocide, Dithane, Maneb, Daconil at weekly intervals. Crop rotation. |
| Leaf Mould (Cladisporium sp.). Gray Leaf Spot (Stemphylium sp), Septoria leaf spot (Septoria sp.) | Application of Difolaton, Maneb, Cupromaneb, Cupravit, Kocide, Perenox or Daconil |
| Bacterial Spot (Xanthomonas Vesicatoria) | Combination spray of Kocide 404 plus Nufilm or Citcop plus Dithane M-45 or Agrimycin |
| Fusarium Wilt (Fusarium oxysporum) (Flycopersici) | No chemical control. |
| Southern Bacterial Wilt (Pseudomonas solanacearum) | The control measures recommended for these two wilt diseases include strict field sanitation, crop rotation, the planting of resistant or tolerant varieties e.g. Manalucie, Walter etc. tolerant to Fusarium Wilt. Good drainage. |
| Collar Rot (Sclerotium rolfsii) | Controlled by improving the nutritional status of the soil and by controlling nematodes |
| Tobacco/Tomato Mosaic Virus | Disease free seeds. Sanitation-avoid infested soil. Care should always be exercised to prevent contamination of hands with virus from tobacco products e.g. cigarettes. Roguing of fields. |

| | | |
|---|---|---|
| Onion | Damping off and Root R e.g. (Pythium Spp.) (Rhizoctonia solani) | Treatment of soil in the nursery with a fungicide drench e.g. Thiram |
| | Onion Blast (Botrytis ) | Use of tolerant varieties e.g. red varieties are tolerant to disease but brown and white varieties are generally susceptible. Proper drying and storage, cultural practices e.g. allow tops to dry properly before harvesting. |
| Garlic | Purple blotch (Alternaria porri) | Soil application of suitable fungicide e.g. Cupravit Blue prior to planting. |
| Pepper | Fusarium Wilt (Fusarium solani) | Control measures as for tomatoes |
| | Bacterial Wilt (Pseudomonas solanacearum) | Good drainage. Roguing of fields. Avoid transplanting in the wet. |
| | Anthracnose (Collectotrichum sp.) (Gloersporium sp.) | Seeds from unhealthy plants should not be used for planting. Use of tolerant varieties. Chemical sprays e.g. Kocide at weekly intervals. |
| | Bacterial Leaf Spot (Xanthomonas vesicatoria) | Use disease free seeds. Crop rotation. Application of Kocide once every two weeks can reduce infection. |

## CHEMICAL WEED CONTROL IN SELECTED VEGETABLES

| CROPS | HERBICIDE | METHOD OF APPLICATION |
|---|---|---|
| Cabbage | TOK 50% EP | Applied post emergence when cabbage plants are in 2-3 true leaf stages and weeds quite young. |
| | Dacthal 75 W | Applied at 10 lbs/acre pre-emergence after seeding or transplanting. Soil must be moist. |
| | Diphenamid (Dymid) | Applied at 4 to 6 lbs/acre after seeding. |
| Celery | Kerosene oil or Stoddard solvent | Applied at 30-40 gallons/acre not later than one month after seeding or transplanting. |
| Carrots | Prometryn 50 WP (Gesagard) | Applied at 2-3 lbs/acre as a pre-emergence spray. |
| | Stoddard Solvent or Kerosene | Applied as a post emergence spray at the rate of 30-50 gallons per acre when the first true leaf has developed but before the carrots have reached the size of a lead pencil. Application should be made in the late afternoon when temperatures are below 85°F. |
| | Linuron 60% (Lorox, Afalon) | Applied at the rate of 2-3 lbs per acre when the crop has 2 or more true leaves. At the time of application, the temperature must be below 85°F. |
| Beans | Dacthal 75% W | Applied as a pre-emergence at 10 lbs/acre plus paraquat at 1 pt/acre if weeds are present. |
| Beets | Pyrazon (Pyramin 80) | Pre- or post-emergence application at 5 lbs/acre supplied when soil is moist or incorporated in |

| | | |
|---|---|---|
| Cucurbits (Melon,. cucumbers) | Alanap 2E | 1½ - 2 gallons per acre immediately after seeding. |
| Corn | Atrazine (Gesaprim 80) | Pre-emergence at 1¼-1½ lbs/acre |
| | Bladex 80 WP plus Lasso 4E | Bladex at 2-2½ lbs plus Lasso at 4-5 pints per acre in 20-30 gallons of water after. |
| Onions | Eptam plus Gramoxone | Eptam at 1/3 gallon plus Gramoxone at 1½ pint/acre applied as pre-plant application. Allow at least three weeks before seeding. |
| | Dacthal 75W | Applied at 10-12 lbs in 40-100 gallons of water per acre immediately after seeding. |
| | TOK 50 WP | Applied at 6-8 lbs/acre in 40-80 gallons of water per acre when the onions are at least in the 2-3 true leaf stage. |
| Tomato | Dymid 80 W | 5-7 lbs (4 to 6 lbs active) per acre after direct seeding or transplanting or within one month of transplanting or seeding. |
| | Dacthal 75 W | 10 lbs per acre, 4 to 6 weeks after transplanting or on direct seeded plants at 4" to 6" in height. |

## LIST OF VARIETIES OF VEGETABLES RECOMMENDED FOR JAMAICA

| CROP | VARIETIES | REMARKS |
|---|---|---|
| Tomatoes | Tamaulipas<br>Floradel<br>Florida MH-1<br>Homestead<br>Tropics<br>Walter<br>Roma<br>Floradade | |
| Onions | Texas Early Grano<br>Granex Fi | Recommended for sowing in fall season (October end of November) |
| | New Mexican White<br>" " Yellow<br>El Toro<br>Granex Fi<br>Dessex | Recommended for spring season March - April |
| Carrots | Danvers Half Long<br>" 126<br>Sparton Bonus | |
| Beets | Detroit Dark RED | |
| Cucumbers | Ashley<br>Poinsetta<br>Straight Eight<br>Explorer<br>Spartan Dawn<br>Pickie<br>Wisconsin Sn Ri | Slicing cucumbers<br>" "<br>" "<br>Pickling cucumbers<br>" "<br>" "<br>" " |
| Watermelon | Charleston Grey | |
| Muskmelon | Swiss Perfect | |
| Sweet Peppers | California Wonder<br>New Improved California Wonder<br>Yolo Wonder | |
| Egg Plant | Black Beauty<br>Long Purple | |

APPENDIX IV

(cont.)

| | | |
|---|---|---|
| Cauliflower | Early Patna | Fall planting |
| | Snow Peak | " |
| | Snow Crown | " " |
| | Monarch | " " |
| | Tropical Sureheart | " " |
| Lettuce | Mignonette | Leaf Variety |
| | Minetto | Head |
| | Great Lakes | " " |
| Cabbage | K.K. Cross | |
| | K.Y. Cross | |
| | Y.R. Cross | |
| | Roundup | |
| | King Cole | |
| | Superette | |
| | Early Cross | |

Source of information. Miss J. Brand, Ministry of Agriculture, Kingston

APPENDIX V

## SEEDS MATERIAL (SEEDS)

| CROP | VARIETIES | QUANTITY (LBS) |
|---|---|---|
| Cabbage | King Cole | 1 |
| | Rio Verde | 1 |
| | Roundup | 1 |
| | K.K. Cross (summer stride) | 1 |
| | Hybrid YR Cross 20 | 1 |
| | Bonanza | 1 |
| | Shamrock | 1 |
| | Hybrid YR (summer 50) | 1 |
| | Danish Bald Head | 1 |
| Lettuce | Great Lakes | ½ |
| | Mignonette | ½ |
| | Mesa | ½ |
| | Minetto | ½ |
| | Fulton | ½ |
| | Bibb | ½ |
| | Prizehead | ½ |
| | Black-seed Simpson | ½ |
| Cauliflower | Fangshan Extra Early | ½ |
| | Farmers Early #3 | ½ |
| | Snow Queen | ½ |
| | Early Patna | ½ |
| Peppers (hot) | Long Cayenne | ½ |
| | Scotch Bonnet | ½ |
| Peppers (sweet) | Early Calwonder | ½ |
| | Yolo Wonder | ½ |
| | Resistant Giant | ½ |
| | California Wonder | ½ |
| | Wonder Giant | ½ |
| Tomatoes | Walter | 1 |
| | Floradel | 1 |
| | Tropic | 1 |
| | Madhead or Quickie (local variety from St. Elizabeth) | 1 |
| | Manapal | 1 |
| | H 118 | 1 |
| | Manalucie | 1 |
| | Calypso | 1 |
| | Castlex 1025 | 1 |
| | Ox-heart | 1 |
| | Floradade | 1 |
| | Roma | 1 |

APPENDIX V

(cont.)

| | | |
|---|---|---|
| Sweet Corn | Sweet Tennessee | 5 |
| | Sunshine State | 5 |
| | USA-34 | 5 |
| | Iobelle | 5 |
| | Golden Cup | 5 |
| | Florigold | 5 |
| Watermelon | Fengshan #1 Seedless | 1 |
| | Sweet Baby | 1 |
| | Sugar Baby | 1 |
| | Charleston Grey | 1 |
| | Jubilee | 1 |
| Celery | Golden Self Blanching Dwarf | ¼ |
| | Waltham Strain Summer Pascal | ¼ |
| | Golden Plume | ¼ |
| String Beans | Provider | 1 |
| | Harvester | 1 |
| | Sprite | 1 |
| | Extender | 1 |
| | Contender | 1 |
| | Eagle | 1 |
| | Tender Best | 1 |
| | Prince | 1 |
| | Top Crop | 1 |
| Egg Plant | Florida Market | ¼ |
| | Pompano Market | ¼ |
| | Black Beauty | ¼ |
| | Early Prolific (Hybrid) | ¼ |
| | Black Bell | ¼ |
| | Royado | ¼ |
| | Florida Beauty | ¼ |
| | Long Purple | ¼ |
| Cucumbers | Poinsett | ½ |
| | Cheroke | ½ |
| | Ashley | ½ |
| | Green Prolific | ½ |
| Okra | Clemson Spineless | ¼ |
| | Louisiana Green Velvet | ¼ |
| | Emerald | ¼ |

APPENDIX V

(cont.)

| | | |
|---|---|---|
| Onions (bulbing) | Texas Grano 1015 | 1 |
| | Tropicana Red | 1 |
| | New Mexican | 1 |
| | Granex Hybrid | 1 |
| | Yellow Creole | 1 |
| | Red Creole | 1 |
| | Dessex | 1 |
| | Tropi Brown | 1 |
| | Hybrid Rio | 1 |
| | El Toro | 1 |
| Onions (bunching) | Ebenezer | 1 |
| | White Portugal | 1 |
| | Silverskin | 1 |
| | Green Bunching | 1 |
| Carrots | Waltham Highcolor | 1 |
| | Danvers 126 | 1 |
| | Chantenay Royal | 1 |
| | Chantenay Red Core | 1 |
| | Nantes Cross Fi Hybrid | 1 |
| Beets | Detroit Dark Red | 1 |
| | Early Wonder | 1 |
| | Top Market | 1 |
| | King Red | 1 |
| | Early Wonder Crossby Improved | 1 |

APPENDIX VI

[illegible] FERTILIZERS, INSECTICIDES AND FUNGICIDES

| Fertilizers | Type | Amount |
|---|---|---|
| | 4-18-2 [illegible] 12-14-12 fertilizer | 6 cwt. |
| | Urea (4[illegible]) | 1,800 lbs |
| | Triple Superphosphate (45-50% $P_2O_5$) | 2,600 lbs |
| | Muriate of Potash (60% K) | 3,200 lbs |
| | 7.14 14 fertilizer | 6 cwt. |
| | Manganese sulphate | 200 lbs |
| | Copper sulphate | 200 lbs |
| | Iron chelate | 10 lbs |
| | Zinc sulphate | 30 lbs |
| | Borax | 50 lbs |
| Insecticides and Fungicides | Metaldehyde Bait | 50 lbs |
| | Dipterex 80-90% SP | 50 lbs |
| | Actellic | 1 gallon |
| | Dimethoate (Rogor 40, Perfekthion) | 1 gallon |
| | Fernasan 75-W | 10 lbs |
| | Benlate 50 W | 20 lbs |
| | Ambush | 1 gallon |
| | Kocide 101 or Cupravit Blue | 50 lbs |
| | Dithane M 45 | 50 lbs |
| | Furadan 10G | 100 lbs |

APPENDIX VI

(cont.)

| | | |
|---|---|---|
| Herbicide | Premaxone | 1 gallon |
| | Kerosene Oil | 5 gallons |
| | Dacthal 75 WP | 10 lbs |
| | Bladex 50 WP | 10 lbs |
| | Lasso 4E | 2 gallons |
| | Tok 50 WP | 10 lbs |
| | Dymid 80 WP | 10 lbs |

[illegible]

| Spraying Equipment | Type | Amount |
|---|---|---|
| | Knapsack Sprayers (4 gls) | 2 |
| | Constant Pressure Knapsack Sprayers (4 gls) | 2 |
| | Motorized Mistblowers (Model Solo 418) | 1 |
| Field Equipment | Irrigation Pump 2"-3" with hose | 2 |
| | Garden Tractor (15-25 HP) with ploughs, harrows, rotovators etc. | 1 |
| | Portable Irrigation Unit | 1 |
| Laboratory and Field Items | Torsion Balance Scale (model DBM 2-1) | 1 |
| | Gram Scale (Capacity 550 g 16 ozs) | 1 |
| | Graduated cylinder (100 cc) | 4 |
| | Graduated cylinder (500 cc) | 4 |
| | Soil Thermometer | 2 |
| | Plastic Bags (2" x 6") | 500 |
| | Soil Auger | 1 |
| | Tensionmeters ("Quick Draw" Model 2900) | 2 |
| | Measuring Tape (100 ft.) | 2 |
| | Tally Meters | 2 |
| | Plastic Buckets (20 L) | 5 |
| | Respirators (Seedburo No. 413) | 6 |
| | Refrigerator (for storing seeds) | 1 |

APPENDIX VII

(cont.)

| | | |
|---|---|---|
| Tools | Poker | 10 |
| | Hoes | 10 |
| | Shovels | 10 |
| | Pachetes | 10 |
| | Hammer | 4 |
| Miscellaneous Items | Stakes | 500 |
| | Paint (white) | 1 gallon |
| | Paint (black) | 1 gallon |
| | Brush (Marking) | 10 |
| | Cord polythene | 400 meters |

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Vegetable production (Brumdec) review & proposed short-term adaptive production oriented research programme.

Autor

Título

| Fecha Devolución | Nombre del solicitante |
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| 2 MAR 1994 | George Buchanan |