Fruits and Vegetables

1. Broccoli
2. Cabbage
3. Cantaloupe
4. Carrot
5. Cauliflower
6. Celery
7. Corn
8. Cucumber
9. Hot Pepper
10. Lettuce
11. Parsley
12. Passion fruit
13. Pineapple
14. Pumpkin
15. Salad Beans
16. Sweet Peppers
17. Tomato
18. Watermelon

TECHNOLOGY PACKS

HOT PEPPER

November 2015

Background

Production decisions concerning how much effort and resources to invest and which farming practices to follow, have consequences and create opportunities for the farm affecting production levels, input costs, time constraints, and the potentially size of the operation. They also may have implications for resource use and environmental quality.

Numerous information exist on the various aspects of production and handling/ marketing of crops and livestock, the majority of which are outdated, not easily understood and lacking the where with all for addressing present day challenges such as good agricultural practices (GAPs) and food safety and climate change that impact on the environment and rural livelihoods. These issues are also closely related to the importance of the role of primary producers in increasing the earnings of all actors along the value chain in supporting the development of a commercially viable and sustainable agricultural industry.

The production of high quality and easily understood information packages is critical as this forms a basis for farmers to obtain financing from lending institutions and to efficiently increase their production through the availability of modern technology. This will also result in a reduction of rural unemployment and will greatly help in alleviating poverty and other associated social ills.

TECHNOLOGY PACKS

HOT PEPPER

November 2015

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Introduction

This Technological Package (Tech Pack) deals with the production and postharvest aspects of hot pepper.

Also included in the Tech Pack are appendices:

- Template for cost of production
- List of recommended pesticides and application rates
- Good Agricultural Practices data record sheet.

Notwithstanding the identification of any specific pesticide for the control of pests and diseases, this decision is for the discretion of the Ministry of Agriculture Area Extension Officer and the farmer.

However, the mention of any pesticides and other products used in the Tech Pack should strictly comply with local regulations and all instructions provided by the manufacturer. Also, the use of trade names in the Tech Pack is for the purpose of citing examples and is not meant to either endorse or discredit any particular product.

Botanical Description

Hot pepper (*Capsicum chinense* Jacq.) belongs to the family Solanaceae. The local name in Creole is Piman Cho.

Ecology and Environment

Hot pepper plants require light, water and nutrients to live, grow and reproduce. The plant requires temperatures between 70 - 85ºF (20 - 30ºC) and relative humidity of 50 - 60% for normal growth.

Varieties/Cultivars

The main commercial varieties grown in St. Lucia are West Indies Red, CARDI Green, Scotch Bonnet and Habanero (Plates 1, 2, 3 and 4).

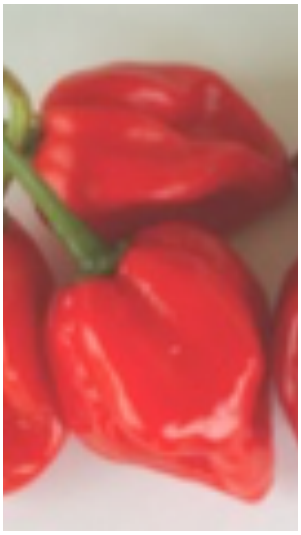

Plate 1 West Indies Red

Plate 2 CARDI Green

Plate 3 Scotch Bonnet

Plate 4 Habanero

Seedling Production

In order to produce strong and healthy seedlings, establish a seedling nursery, specifically for seedling production. The area should comprise two sections:

1. A seed germination section which is covered with solid roof to protect the germinating seeds from sun and rain
2. A hardening section with a transparent roof or netting that allows for the penetration of light for hardening the seedlings. Hardening protects seedlings from transplanting shock when planted in the field.

The entire nursery area should be weed free and preferably totally screened with polyvinyl insect netting to protect seedlings from any insect attack and/or transmitted insect diseases. Seeds are sown either in seedling trays containing peat moss as the growing medium or in peat moss blocks (Plates 1 & 2). Though seeds can be directly sown in the field, the success of germination and survivability of most seeds is not guaranteed as both soil pests and diseases can affect them. To achieve 95 - 100% seed germination and strong and healthy seedlings, seedlings produced in nurseries is the preferred option.

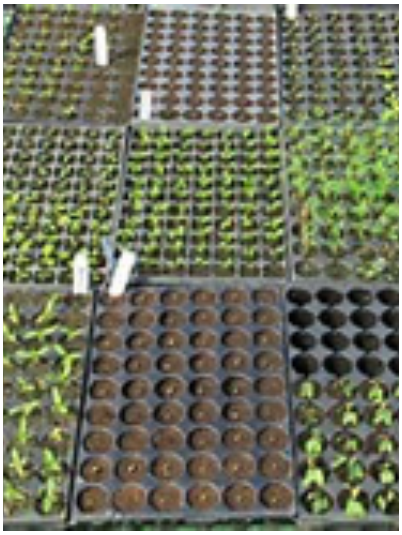

Plate 1 Seedling production in seed trays

Plate 2 Seedling production in nursery

Plate 3 Hardening seedlings

The following practices should be adopted in the production of strong healthy hot pepper seedlings:

- When purchasing seed material obtain from a reputable source
- Read the label on the seed package. Ensure that the seeds are 90 - 100% viable which must be indicated on the label and is in keeping with the expiratory date
- Use seedling trays for sowing seeds. Ensure that they are sterilized by immersing into

commercial bleach solution 1 tablespoon/gallon (5 cc/litre) of water
- Use peat moss as the planting medium
- Treat the planting medium with a broad spectrum fungicide, 6 ounces of Banrot in 15 gallons of water (170 g/68 litres), before placing in trays
- Seedling trays should be placed on raised platforms
- Make a planting hole in each cell and plant one seed per hole
- Water seeds to aid germination
- Spread peat moss lightly ensuring that the seeds are covered
- Cover trays with saran netting to hasten germination
- Place trays in the seed germination section of the nursery
- Remove the covering of saran netting at the first sign of germination
- Water seedlings at least twice per day
- Apply plant nutrient as a foliar spray once per week when seedlings are ½ inch (1.2 cm) in height
- Spray seedlings with insecticide and fungicide once per week for pest and disease control
- Apply fertilizer solution, Tropi-Gro 1 tablespoon/gallon (5 cc/litre) of water twice per week when seedlings are 1 inch (2.5 cm) in height
- Harden seedlings by placing them in the hardening section of the nursery for 3 hours during the early morning and late evening, for 2 - 3 days (Plate3).
- Expose seedlings to full days of sunlight until ready for transplanting
- Transplant seedlings when they are 3 inches (7.6 cm) tall.

Site Selection

The site selected for the cultivation of hot peppers should be flat or gently sloping. Hot peppers can be grown on a wide variety of soils. However the best soils are those that are deep and free draining, as hot peppers do not tolerate water logging.

Land Preparation

Peppers do not tolerate heavy waterlogged soils; the best soils for its cultivation are fertile well-drained friable soils. Low areas should be avoided.

The land should be first ploughed and rotavated into a fine tilth (Plate 4). Depending on the acidity of the soil, lime should be incorporated at the time of land preparation at the rate of 1 - 3 tons/acre

(2.5 to 7.5 t/ha). Prepare flat or cambered beds 5 - 20 feet (1.5 - 6 m) wide with drains 24 - 30 inches (0.6 to 0.8m) deep or form ridges 3 feet (90 cm) apart. On sloping terrain, form ridges across the slope to prevent soil erosion (Plate 5). Adopt proper soil conservation practices such as minimum tillage, contour drains and grass barriers.

Plate 4 Flat lands prepared for planting

Plate 5 Land prepared across the slope

Spacing and Planting

Seedlings should be planted in rows spaced 3 feet (90 cm) apart and 2 feet (60 cm) apart along the row giving a population of 7,250 plants/acre (18,000 plants/hectare). Prior to transplanting ensure that seedlings are well watered before they are removed from the seed trays for planting. Seedlings are transplanted in the field manually (Plate 6) by placing the plug (roots with adhering peat moss) in prepared holes at a depth of 1¼ inches (3.0 cm). The soil is then pulled around the base of the plant and firmly pressed down around the roots. On sloping terrain, seedlings should be planted across the contour. Ensure that the plants are well watered for 1 week after transplanting.

Plate 6 Field planting of hot pepper seedlings

Irrigation

Irrigation water, especially from streams and ponds, should be sent for analysis to ensure that the water is not polluted or saline, and must be of good quality for irrigation. Hot pepper does not thrive under drought conditions. The crop needs adequate irrigation to produce high yields and quality fruits. The critical moisture periods are during the seedling stage, at transplanting, the week after, just before flowering and during fruit set and development. Apply irrigation water using sprinklers or drip irrigation lines (Plate 7). Where rainfall is adequate, above 50 inches (1,300 mm) annually, planting should be timed to benefit from rain-fed conditions. Highest yields are obtained under rain-fed conditions supplemented by drip irrigation. During the dry season hot pepper should be irrigated at least once every 2 days to maintain adequate soil moisture.

Plate 8 Drip irrigation in cucumbers

Fertilization

Specific kinds and rates of fertilizers must be determined from the results of soil and leaf analyses. Composted manure if available should be applied to the soil to help with the uptake of nutrients from inorganic fertilizers; it adds organic matter to the soil, enhances soil structure and growth of micro-organisms. All manure should be well composted to ensure that harmful microorganisms and weed seeds are destroyed.

At least 2 weeks before transplanting place 1 ounce (30 g) of NPK fertilizer (16:8:24+2) in the planting holes. Thereafter apply ¾ ounce (20.0 g) of NPK fertilizer (16:8:24+2) around the base of the plants every 3 weeks throughout the life of the crop (Plate 8)

Plate 8 Application of NPK fertilizer around base of plant

Weed Control

Proper weed management begins at the land clearing and land preparation stage during which time the 'stale seed bed technique' is applied. This involves clearing the land from brush, deep ploughing and rotavating and then allowing weeds to re-grow. A systemic herbicide (Round-up) is then applied 2 weeks before transplanting when weeds are actively growing and are about 3 - 4 inches (8 - 10 cm) high. The weeds are allowed to fully die covering the topsoil and acting as a mulch suppressing further growth of weeds (Plate 9). Transplanting is then carried out at a high plant population, which can also suppress future weed growth. After the crop has been established further weed control should be done manually or by applying a contact herbicide (Gramoxone) with the use of a shield to protect the plant from spray drift.

Plate 9 "Stale bed technique" as a method of weed control

Plastic Mulch

An alternative method of weed control is the use of plastic mulch (Plate 10). Plastic mulches can be used commercially for hot pepper production. Plastic mulch is used to reduce weed pressure, and conserve moisture and fertilizer. Most often drip irrigation is used in conjunction with plastic mulch.

Plate 10 Use of plastic mulch for weed control

Advantages of using plastic mulch:

- Plastic mulches will reduce light penetration to the soil. Weeds cannot survive therefore, the cost of weed control is drastically reduced
- Soil water loss is reduced under plastic mulch, and more uniform soil moisture is maintained and irrigation frequency can be reduced. The growth of plants on mulched soil can be twice that of plants that are not mulched. Because larger plants will require more water, mulching is no substitute for irrigation
- Excess water runs off the impervious mulch, and fertilizer is not lost beneath the mulch by leaching, so that fertilizers are optimally used
- The soil under plastic mulch remains loose, friable and well aerated. Roots have access to adequate oxygen, and microbial activity is enhanced
- Cultivation is eliminated, except in the area between the mulched strips, which reduces the frequency of mechanical root pruning. Weed growth in these areas can be controlled by cultivation or by use of a chemical herbicide
- Plastic mulch also keeps the fruit cleaner by reducing soil spatter. When using drip irrigation, the incidence of disease is often reduced because the foliage stays drier.
- Use of reflective mulches reduces the population of certain insect pests, which are vectors of viruses

- Water is shed from the row area by the raised tapered bed so that excess water runs off by the fields, thus reducing drowning and other excess soil water stress.

Disadvantages of using plastic mulch:

- Yellow and purple nut sedges are not controlled by black plastic mulch, and suitable fumigants/herbicides must be applied if nut sedge is a potential problem
- The use of plastic mulch will increase the cost of production for a given crop. These costs should be offset by reduced weed control expense and increased income due to better quality fruit and higher yields.

Mulch film is nearly impervious to carbon dioxide, which is necessary for photosynthesis. Research has shown that high levels of carbon dioxide may build up under the plastic mulch. Because the film does not allow the gas to penetrate, it has to escape through the holes punched for the plants and a 'chimney effect' is created, resulting in carbon dioxide for the actively growing leaves.

Pests and Diseases

The major pests and diseases, symptoms and control/management affecting hot pepper are indicated in Table 1.

Table 1 Causal agents, symptoms and control of pests and diseases of hot pepper

Pest & Diseases	Symptoms	Control/ Management
 Plate 11 Whiteflies	The symptoms are chlorotic spots on the leaves, wilting of leaves, retarded plant growth and the shedding of leaves. Whiteflies also transmit viruses that lead to viral diseases which cause the leaves to crinkle and curl, become chlorotic and leathery. Fruits may become striped and malformed. The disease may kill young plants .	White flies have developed resistance to many synthetic pesticides making chemical control difficult. Insecticidal soap, neem oil and botanical insecticides can be used to "knock down" heavily infested areas.

Pest & Diseases	Symptoms	Control/ Management
 Plate 12 Aphids	Symptoms are stunting, deformation, gall formation, withering and dying of plants. Leaves may become curled, wrinkled or cup-shaped. The symptoms may be due to the feeding or viral diseases spread by the aphids. Honeydew secreted by the aphids encourages the growth of sooty mold (black in colour) on the leaves.	Aphids can be controlled using contact or systemic insecticides.
 Plate 13 Mites	Mites can cause any of the following symptoms in pepper plants. Distortion, curling, shedding or discolouration of leaves; russeting or bronzing of leaves and stems; in severe cases the plant becomes stunted, the flowers drop and any fruit already formed will fail to develop properly.	Mites can be controlled using contact or systemic insecticides.
 Plate 14 Thrips	Bronze dry areas along the midrib on both surfaces of the leaf, which become deformed resulting in high yield losses.	Thrips can be controlled using contact or systemic insecticides.

Pest & Diseases	Symptoms	Control/ Management
 Plate 15 Wilts, Blights and Foot/Collar Rot caused by *Phytophthora* spp, *Sclerotium* spp, *Pithium* spp and *Rhizoctonia* spp	These soil fungi cause root rot and collar rot and the blockage of vessels that take water and plant food from the roots up to the leaves and other parts of the plants. As a result the leaves wilt and droop.	These diseases can be controlled by rapid drainage, drying of the field by sunshine and spraying fungicides into the root zone of the plant. The best control is to plant tolerant varieties.

Pest & Diseases	Symptoms	Control/ Management
 Plate 16 Viral diseases Tobacco Mosaic Virus (TMV), Cucumber Mosaic Virus (CMV), Potato Y Virus (PYV), Tobacco Etch Virus (TEV) and the Gemini viruses.	These diseases can occur together as a complex. The symptoms are mosaic on leaves, deformation of leaves, cupping and crinkling of leaves, retarded and stunted plants. Viral diseases can drastically reduce yields and kill plants.	There are no cures for the viral diseases. However, the following measures should be adopted to contain these diseases: • Planting tolerant/ resistant varieties • Management of insect vectors (whiteflies, aphids, etc.) from the seedling nursery and field • Use of seeds that have been specially grown, selected and treated to wash off viral particles • Rogueing of all seedlings and plants showing symptoms of viral diseases and burning them. Washing of hands thoroughly before handling other healthy plants • Practice of field and crop rotation (with corn, cassava and sweet potato) and the use of higher planting densities.

Pest & Diseases	Symptoms	Control/ Management
 Plate 17 Anthracnose caused by a fungus *Colletotrichum gloeosporioides*	The disease causes small, sunken water soaked circular lesions on fruits.	The disease can be managed by removal of infected fruits, improved drainage, wider spacing in the wet season and the use of fungicidal sprays. Other control methods are the use of clean seeds, crop rotation and the burning of crop residues from infected fields.
 Plate 18 Bacterial spots caused by a bacterium *Xanthomonas campestris*	The disease is expressed as numerous spots (brown and black) on the infected leaves. The spots have a central depression on the upper leaf surface and slightly raised brown areas centrally on the lower surface. The spots on the fruits are raised and have distinct holes.	Control measures are through draining soils well, controlling weeds, crop rotation, keeping fruits from soil contact, burning residues from infected fields and spraying with suitable fungicides.

Good Agricultural Practice (GAP) related to the use of pesticides, requires farmers to maintain up to date records on the application of pesticides to the crop. These records should include trade names, application rates and dates of application. During the harvesting period use pesticides with a very short harvest interval.

Fruit Maturity

Harvesting for the fresh fruit export market must be undertaken differently from that done for local processors. Fruits for the export market should be harvested when mature or have developed full colour and while fruits are fresh, firm with a glossy appearance. Export market preferences in most cases specify the fruit colour required i.e. fully red/yellow, turning or mature green. Fruits harvested for processing must develop their full colour. For West Indies Red and CARDI Green varieties fruits must be harvested when they are fully mature and red in colour and for Scotch Bonnet when they are fully mature and yellow in colour.

Harvesting

Before of harvesting ensure that the harvest interval for any pesticides applied has been strictly adhered to. The harvesting operation is best carried out during the early part of the day when temperatures are much cooler and fruits are more turgid. Harvesting for the export market during rainy weather should be avoided, as high levels of post-harvest losses (over 50%) occur when moisture causes microbial infection resulting in fruit rot.

Fruits for export should be harvested by detaching from the branch with the stem intact and attached to the fruit. This is done by grasping the stalk at the base, between the thumb and forefinger and pulling it gently upwards. The stalk will break off at its base if the pepper is mature and this will avoid stalk damage. For processing intact stems is not required.

Field Handling

Harvested fruits should be placed in field crates not in bags and stored temporarily in the shade, giving protection from the sun and rain during the harvesting period. On completion of harvesting, fruits should be transported from the field to a designated area/pack house in preparation for export or processing.

Preparation for Market

On arrival at the pack-house fruits intended for the export market are properly selected, sorted and size graded. Washing is not recommended. Any soiling should be removed by gently rubbing. Fruits are sorted mainly for maturity and or colour. Ripe peppers are more prone to diseases and hence are sometimes separated from the green or turning peppers. This selection is dependent on the market, as some importers require an assortment of colours.

Mechanically damaged, diseased undersized, fruits without intact stems, shriveled and black-stemmed fruits are rejected. Special care must be taken to ensure rejection of fruit contaminated with scale, stem borer larvae and other insects when shipping to export markets as inevitable delays will be incurred at the ports of entry.

Peppers should be selected based on the degree of ripening and size. Size grading can be carried out during harvesting or at the pack-house with the use of a size grader designed specifically for this purpose. An example of a suitable grader for West Indian Red hot peppers is shown in Figure 1. If the pepper goes through the hole check its length against the end of the grader. Fruits can also be graded according to weight. Select fruits that weigh over 0.5 ounces (12 g). An average of 30 - 40 fruits should weigh 1 lb (500 g). Rejected fruits from which diseased fruits are selected out can be used for processing.

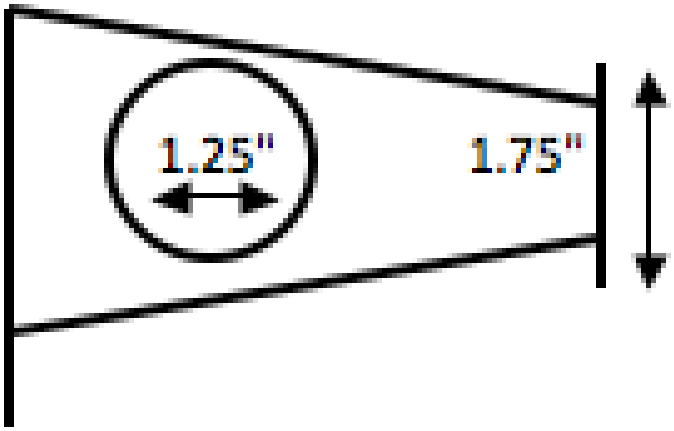

Figure 1 Size grader for sizing West Indian Red hot pepper

Select fruits for processing that have attained full colour (red or yellow). Reject immature, green coloured, diseased or damaged fruit. The stems/stalks should be detached from the harvested fruit without damaging the fruit, placed in field crates and taken to the processors on the same day.

Yields

Yields vary 15,000 - 25,000 lb/acre (17,000 - 28,000 kg/ha) depending on the variety and level of management.

Storage

Peppers should be exported by air within 24 hours of harvesting. If there are delays in shipment peppers should be stored at a temperature of 55ºF (13ºC). Before shipping peppers stored at low temperatures it is advisable to allow fruits 4 - 5 hours to dry out before loading, as moisture will condense on the fruit surface when removing from a lower temperature to a higher temperature.

Fruits for processing can be stored overnight under ambient conditions but must be disposed of the following day, as fully mature fruits particularly with their stalks removed do not store well. Shelf life can be extended to 10 days if stored at 55ºF (13ºC) and 90 - 95% relative humidity.

APPENDICES

APPENDIX I: TEMPLATE FOR COST OF PRODUCTION ANALYSIS: HOT PEPPER

	Input	Quantity	Units	Unit Cost	Total Cost
1.	**Seedling production**				
	Seed material				
	Seedling trays				
	Peat moss				
	Saran netting				
	Fungicide, plant nutrient, insecticide, fungicide, fertilizer (specify names used)				
	Total cost for seedling production				
2.	**Land preparation**				
	Lime				
	Peat moss				
	Plastic mulch				
	Other land preparation costs (e.g. equipment rental)				
	Total cost for land preparation				
3.	**Crop maintenance**				
	Water/irrigation				
	Fertilizer (specify types used)				
	Weed control (specify chemicals etc used)				
	Pest and disease control (specify chemicals etc. used)				
	Total cost for crop maintenance				
4.	**Harvest/storage**				
	Crates				
	Size grader manufacture (if applicable)				
	Estimate any utility costs				
	Transport to market				
	Total cost for harvest/storage				
5.	**Labour**				
	Seedling production				

APPENDIX I: TEMPLATE FOR COST OF PRODUCTION ANALYSIS: HOT PEPPER

	Input	Quantity	Units	Unit Cost	Total Cost
	Land preparation				
	Crop maintenance				
	Harvest/storage				
	Total cost for labour				
6.	**Rent/insurance**				
7.	**Miscellaneous costs**				
	Total cost of production				

Notes

1. It is recommended that the above data be completed on a per crop basis.

2. The cost of any fixed structures should be considered. For example if a seedling nursery is solely used for to produce hot pepper seedlings in the year and is expected to last for 10 years, then one tenth of the cost of construction (plus any annual maintenance) should be added at item 7. If, however seedlings for other crops are also produced then these also need to be considered. If hot pepper seedlings account for half the seedlings in a year, then the annual cost calculated as above needs to be divided by 2. Similar considerations should be given to the cost of any refrigerator if the crop is stored at a low temperature and to an irrigation system.

3. The revenue obtained from sale of the crop should be compared with the cost of production to determine the profit/loss on the operation.

APPENDIX II: LIST OF RECOMMENDED PESTICIDES AND APPLICATION RATES

INSECTICIDES	APPLICATION RATE
Pronto 35 SC	3 - 5 teaspoons/gallon of water
Target	1 - 2 teaspoons/gallon of water
Pirate	½ - 1 teaspoons/gallon of water
Fastac	1 - 2 teaspoons/gallon of water
Caprid	½ - 1 teaspoon/gallon of water
Diazinon (Basudin)	¾ - 1½ pints/acre
Admiral	¼ teaspoon/gallon of water
Dipel	1½ - 2 teaspoons/gallon of water
Aza-direct	1 - 2 teaspoons/gallon of water
Cure	½ - 1 teaspoon/gallon of water
Danitol	1 - 2 teaspoons/gallon of water
Cypro	½ tablespoon/gallon of water
Dimethoate (Perfecthion, Rogor 40)	1 pint/acre
Phosvel	1¼ - 2 pints/acre
Orthene	3.2 ounces/acre
Permethrin (Ambush)	½ teaspoon/gallon of water
Padan 50 WSP	2 - 3 teaspoons/gallon of water
Lannate	1 teaspoon/gallon of water
Decis	½ teaspoon/gallon of water
Kelthane 42%	1¼ lb/acre
Orthene 75S	1 lb/acre
Malathion	½ - 1 pint/acre
Sevin	1½ lb/acre
BT (*Bacillus thruingiensis*)	Label rates
Rotenone	1 - 2 teaspoons/gallon of water
Neem X.	8 - 10 oz/gallon of water
FUNGICIDES	**APPLICATION RATE**
Bellis	2 teaspoon/gallon of water
Acrobat	2 - 4 teaspoon/gallon of water
Mancozeb (Dithane M45)	1.5 lb/acre
Cabendazim	2 teaspoon/gallon of water
Daconil	1½ - 2 pints/acre
Benomyl (Benlate)	6 oz/acre
Captan	2 - 3 teaspoons/gallon of water
Peltar	3 teaspoons/gallon of water
Manzate DF	2 - 4 teaspoons/gallon of water
Bravo	1½ - 2 pints/acre
Tri-Miltox-Forte	3 teaspoons/gallon of water
Botrilex	5 - 200 lb/acre
Kocide 101	2 - 4 teaspoons/gallon of water
Cupravit	2½ lb/acre

APPENDIX II: LIST OF RECOMMENDED PESTICIDES AND APPLICATION RATES

WEEDICIDES	APPLICATION RATE
DCPA (Dacthal W-75)	10 lb/acre
Diphenamide	4 - 10 lb/acre
Paraquat (Gramoxone)	1 - 2 pints/acre
Dymid 80W	5 lb/acre
Atrazine 80 (Gesaprim).	1¼ - 1½ lb/acre
Linuron (Lorox)	1 pint/acre
Prometryn (Caparol)	0.8 - 1.6 lb/acre
Sethoxydim (Poast)	1¼ - 3½ lb/acre
Clethodim (Select)	0.094 - 0.25 lb/acre
Prometryn 50WP (Geagard)	2 - 3 lb/acre
Herbicidal Oil (Stoddard Solvent, Kerosene oil)	40 - 80 gallons/acre

APPENDIX III: GOOD AGRICULTURAL PRACTICES DATA RECORD SHEET

Grower name:							
***Name of applicator**	**Date**	**Brand and product name**	**Rate**	**Size of area/no. of plants treated**	**Total application (amount of the product used)**	**Notes/target pest**	**Start/finish time**

*The applicator should be trained or, if not, supervised by a trained or certified person. Proof of training required.