Roots and Tubers

1. Cassava
2. Dasheen
3. Sweet Potato
4. Tannia
5. Yam

TECHNOLOGY PACKS

CASSAVA

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exist on the various aspects of production and handling/ marketing of crops and livestock, the majority of which are outdated, not easily understood and lacking the where with all for addressing present day challenges such as good agricultural practices (GAPs) and food safety and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

CASSAVA

November 2015

Prepared by

Gregory Robin, CARDI (Caribbean Agricultural Research and Development Institute)

Published by

Ministry of Agriculture, St. Lucia

CARDI
P.O. Bag 212, Frederick Hardy Building
University of the West Indies
St Augustine Campus,
St. Augustine Trinidad and Tobago, W.I.

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Introduction

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

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.

Description

Cassava (*Manihot esculenta Crantz*) is said to have originated from Central America and Northeast Brazil. It belongs to the botanical family Euphorbiaceae. The plant is a bushy shrub which is commonly grown for the starchy root tubers. Plants can reach heights of 3 – 13 feet (1 - 4 m). The plant can be erect, (with or without branching) or spreading, depending on the variety. Cassava takes between 8 - 14 months to produce marketable tubers, dependent on the variety planted.It is one of the fewcrops that can produce reasonable yields under drought and pest and diseasepressures.

Cassava is commonly grown on marginal lands with few inputs (fertilisers and pesticides). In most instances the crop is not irrigated.Commercial production of cassava tubers takes place primarily in small agricultural holdings of less than 1 acre (0.5 ha).

In St. Lucia, the bitter cassava has traditionally been grown for the production of cassava bread and farine,while the sweet cassava is cooked and eaten as a staple food.

Ecology and Environmental Requirements

Cassava grows best in agro-ecological zones with the following characteristics:

- Soils: sandy or clay loam; areasthat are not prone to water logging
- Soil pH: 4.6 - 8 is the average soilrequirement, but 5.5 - 7.5 is best
- Rainfall: 39–60 inches (980–1524 mm)/year is needed for adequate growth and development
- Altitude: cassava grows best at higher altitudes.

Night temperatures between 70 - 85ºF (20 - 30ºC) favour tuberization.

Varieties

There are many varieties that have agronomic advantages, such as disease resistance, high yields, and early maturity. However, one should always select a variety with qualities that the market demands. Determinethe tuber qualities that the market prefers - sweet or bitter, flesh colour; and whether the crop is needed for food, feed, processing into flour, farine or is going to be grated for making composite bread.

Multiplication of Plant Material

The cassava plant is multiplied by three methods—use of the botanical seed, tissue culture and stem cuttings.

This guide focuses on the use of stem cuttings and suggests the following when planning to plant a new crop from freshly harvested fields.

Selection and treatment of planting material for direct field planting

- Determine quantity required
- Locate supplier of planting material
- Inspect fields where plants are being selected
- Select planting material during harvesting from 8 - 12 months old, fresh, healthy (pest and disease free) stems. Many pests and diseases of cassavacan be carried into the new crop on planting material.Therefore, trim the long sticks from healthy, disease and pest free plants and carefully remove leafy branches and tubers, as only the sticks should be taken to the new field. Some examples of pests and diseases that can be transferred are:

- For direct field planting, use only sticks from the centre part of the stem; discard the last 8 inches (20 cm) of both ends taking into consideration that the stem diameter should not be less than 0.75 inches (1.5 cm)and on average 1 inch (2 cm)
- Cut (smooth cut) the stick to a length of 8 - 12 inches (20 - 30 cm) with a minimum of 5 nodes. The length of the cuttings is very important; as it is an agro-technical factor, which influences growth and yield
- Before planting, dip the cuttings for 5 minutes in asolution of fungicide(e.g. Kocide, Manzate or Tri-Miltox Forte)/insecticide (Diazinon or Basudin)/nutrient (e.g. a foliar fertilizer Nutrex)
- Stem cuttings should be planted immediately.If the cuttings are to be stored, they should be cut about 20 - 27 inches (50 - 70 cm) long; placed under shade and covered with a plastic bag in an upright position, with the eyes facing up, as this prevents damage to the eyes and guarantees that the material does not dry out.

Plate 1 Planting sticks stored in an upright position

Do NOT use:

- Green sticks
- Young and immature sticks
- Mixed bundle.

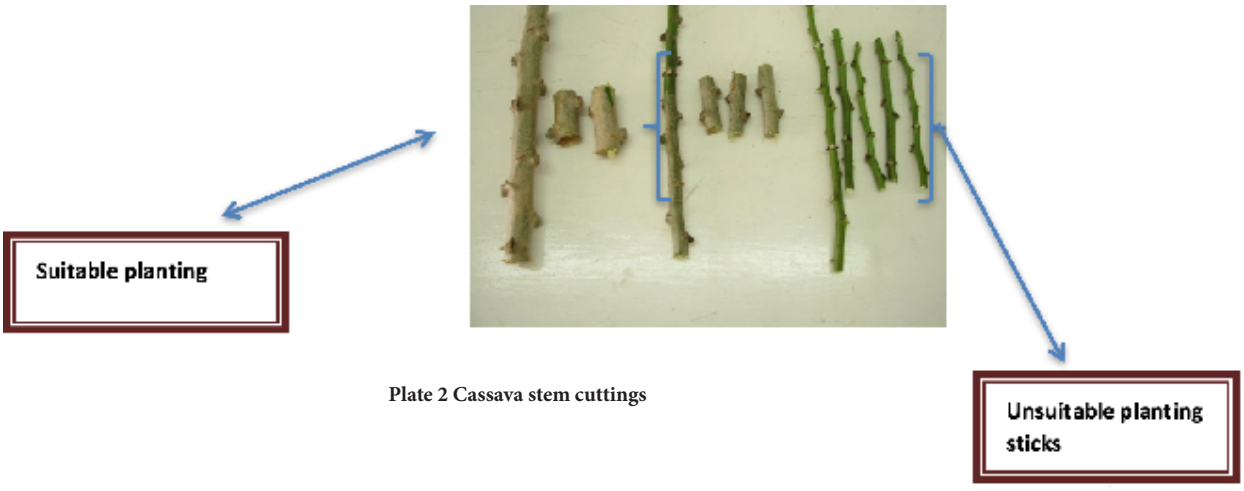


Plate 2 Cassava stem cuttings

Rapid Multiplication of Vegetative Planting Material

For farmers who intend to plant cassava year round and not wait on lengthy harvesting periods to obtain planting materials, two methods of plant propagation are suggested using two types of mini-stem cuttings from a cassava stem

1. Hardwood cuttings
2. Semi-mature cuttings.

Mini-stem cuttingsare small stem pieces, each with one or more nodes, depending on the stem portion from which the cuttings are taken:

- Cuttings from the hardwood (hardwood mini-stem cuttings) portion may have one or two nodes (Plate 3)
- Cuttings from the semi-mature (semi-mature mini-stem cuttings) portion may have four to six nodes (Plate 4).

Plate 3 Cuttings from the hardwood portion may have one or two nodes (hardwood mini-stem cuttings)

Plate 4 Cuttings from the semi-mature portion have four to six nodes (semi-mature mini-stem cuttings)

The cuttings are treated (dipped) in a fungicide/insecticide solution for 5 minutes to protect the crop from pests. A possible solution is copper hydroxide (e.g. Kocide, Manzate or Tri-Miltox Forte), with a broad spectrum insecticide (Use an insecticiderecommendedby the Ministry of Agriculture Plant Protection Unit) and a foliar fertilizer (e.g. Nutrex).

The hardwood mini-stem cuttings are then planted in beds that are free draining, at a spacing of 4 x 4 inches (10 x 10 cm)to a depth of 1.5 – 2 inches (4 - 5 cm) (Plate 5).Do not plant cuttings too shallow, otherwise they become exposed and dehydrated and avoid orientating one node on top

and one node below (Plate 6). The beds are covered with shade netting to provide protection from direct sunlight.Cuttings can also be planted in bins covered with shade netting (Plate 7).

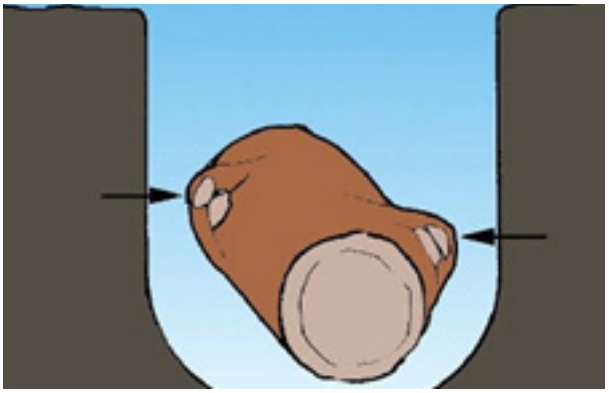


Plate 5 Place cuttings so that two adjacent nodes are on the right and left sides

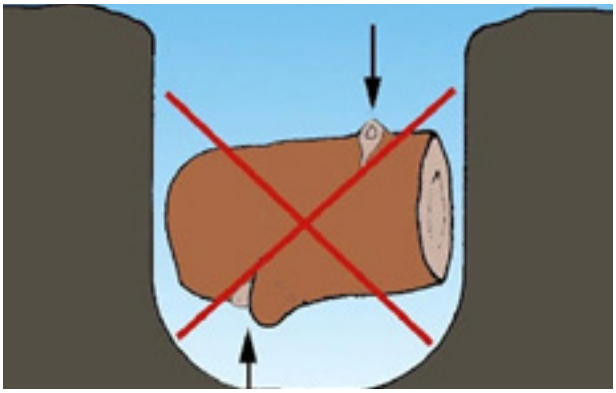


Plate 6Avoid orientating one node on top and one node below

Plate 7 Bins covered with shade netting

Plate 8 Semi-mature mini-stem cuttings planted upright

Semi-mature mini-stem cuttings are plantedvertically at a spacing of 4 x 4 inches (10 x 10 cm)with two-thirds of the cuttings and the old ends buried in the soil (Plate 8).

Nursery maintenance. Apply the following steps for nursery maintenance:

- Water the cuttings immediately after planting
- Water twice a day, once in the morning and once in the evening. After rain, it may not be necessary to apply water as too much water causes rotting
- Label the beds, indicating the variety and planting date
- Weed regularly and keep the nursery clean
- Cover cuttings that become exposed during watering with soil.
- After4 - 6 weeks in the nursery, mini-stem cuttings can be transplanted onto the open field.

Sprouting in Polythene Bags

This method is quick, inexpensive and convenient and is used for both hardwood and semi mature mini-stem cuttings.

Dip mini-stem cuttings into a fungicide/insecticide solution for 5 minutes to protect the crop from pests (Plate 9). A possible solution is copper hydroxide (e.g. Kocide, Manzate or Tri-Miltox Forte); and a broad spectrum insecticide (e.g.Diazinon or Basudin). Place mini-stems directly into perforated polythene bags (Plate 10). Tie bags with pieces of string, leaving about one-third of the total space empty for aeration (Plate 11). You can use various sizes of bags as long as there is space for aeration. Keep the bags in a shaded area or under a roof (Plate 12). High humidity and temperature in the polythene bags promote rapid and uniform sprouting. Cuttings sprout in 3–days (Plate 13). Some varieties may require a few more days. Sprouted mini-stem cuttings establish well in the field.

Plate 9 Dip mini-stem cuttings into a fungicide suspension

Plate 10 Place mini-stem cuttings directly into perforated polythene bags

Plate 11Tie bags with pieces of string, leaving about one-third of the total space empty for aeration

Plate 12 Keep bags in a shaded area or under a roof.

Plate 13 Cuttings sprout in 3 - 5 days.

Sprouting in bags without soil has additional advantages:

- Cuttings can be stored for a few days before planting
- Bags can easily be carried by hand. Little space is required to transport large quantities over long distances.

Mini-stem cuttings sprouted in bags without soil can be planted directly into the field after 7 - 10 days.

Harvesting of stems. The objective of rapid multiplication of cassava is to produce planting materials (stems). If the field is properly maintained, stems can be cut and supplied to farmers 6 - 7 months after transplanting. Do not uproot plants to harvest storage roots (Plate 14). Cut stems at a height of 8 - 10 inches (20 - 25 cm) above the ground, after ensuring that stems are physiologically mature and free of diseases and pests. The practice of leaving stumps standing after cutting the stems is known as 'ratooning'. Several shoots sprout from each stump, but leave only two or three (Plate 15). Apply herbicide and fertilizer to the ratooned fields. Cut another set of stems 6 months later.

Plate 14 Do not uproot plants to harvest storage roots

Plate 15 Several shoots sprout from each stump, but leave only 2 or 3 which will mature into stems

Land Preparation

Make ridges about 17 inches (45 cm) high and space them at 3 - 4.5 feet (1 - 1.5 m). Ridges can be prepared manually or by tractor. In hilly areas, plough along the contour.

Planting

Ways of planting

Horizontal: at depths of 2 - 4 inches (5 - 10 cm) below the soil surface. This method is used in dry conditions, particularly when operations are mechanized, since tubers will be at a shallow depth and easier to harvest. More tuberous roots are produced but they tend to be smaller

Vertical: buds facing up with two-thirds of the stake in the soil, preferably for wet conditions and sandy soils to prevent lodging

Inclined at 45°: buds facing up with two-thirds of the stake in the soil at an angle of 45°. This method is best for shallow and clayey soils and wet conditions.

Population density

In common with many plants, the planting density of cassava has a positive influence on vegetative growth and root tuber production. The optimum plant spacing is dependent on the **cultivar** and **soil fertility**. If the soil is fertile, closer spacings can be used. Plant spacing can range from about 2 feet (50 cm) for varieties with a compact architecture to 2.5 feet (75 cm) for plants with spreading characteristics.

The planting distance recommended by experts in cassava production is 3 x 3 feet (1 x 1 m) giving vital area of 9 square feet (1 m2) per plant and a production base of 4840 plants/acre (10,000 plants/ha).

Fertilization

In collaboration with an Extension Officer, have the soil tested before the application of any type of fertilizers or lime. Leaf analysis should be done if possible. The results of the test will provide the guidance for fertilizer application. Cassava can do well on soils with a pH as low as 4.6 as high as 7.8. If the soil pH is too low, dolomitic lime should be applied when preparing the land. A soil pH of 5.5 - 6.5 is the ideal level for plant growth.

Weed Control

Weeds may be a problem early in crop growth and before the canopy covers the ridges. It is recommended that after land preparation, a broad spectrum systemic pre-emergent herbicide (as recommended by the Ministry of Agriculture Plant Protection Unit) be applied to control weeds. Allow the weeds to die and act as a mulch. Plant the cassava sticks or mini-stem plantlets setts at least 2 weeks after spraying the herbicide. From then on shielded spraying with Paraquat and hand weeding, when needed, can be practiced. Sometimes it is required that the plants be molded. This is done generally after weeding and fertilizing.

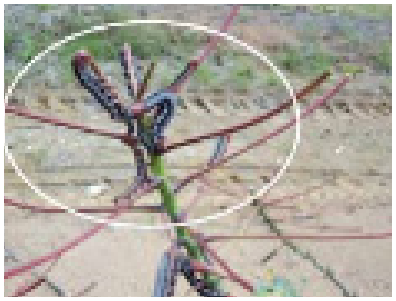
Pests and Diseases

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

Table 1 Symptoms and control of pests and diseases of cassava

Pest & Diseases	Symptoms	Control/ Management
Plate 2 Anthracnose (olletotrichum gloeosporioides  Source: http://entnemdept.ufl.edu/creatures/orn/mealybug/coconut_mealybug01.jpg	Shoot Flies damage the tips (growing area) of the young plant causing growth to be stunted. Plate 16 shows plant tips damaged by Shoot Fly.	Typically, Shoot Fly is managed by natural enemies present in the field. As such, management practices should seek to preserve these agents through the careful selection and application of pesticides and enhancing the area with flowering crops that are necessary for the survival of the natural enemy. Roguing of plants that are infested with the fly is also recommended.
Plate 17 Cinch Bug 	Cinch Bugs suck juices from the root area and wound the roots of the plant with their mouthparts. Soil micro-organisms can penetrate through these wounds and cause rots. The symptoms may not be seen until the cassava tuber is cut.	The best control method is crop rotation, which breaks the life cycle of the pest.

Pest & Diseases	Symptoms	Control/ Management
Plate 18 Cassava Mite 	These are tiny insects that suck the juices from the leaves of the plant and the tips of the shoots. Leaf fall can result. Cassava Mite is found on the lower surface of the first 5 - 10 upper leaves, green stems and buds. The infected leaves develop small yellow to reddish spots depending on the type of mites. Leaves are also deformed. There may also be fine webs. Mites are transmitted from plant to plant by the wind as well as on clothing and tools as the farmer walks through the field. Cassava Mites are major pests in the dry season and severe attacks often result in 20 - 80% losses.	Cassava Mites can be managed with a combination of cultural practices, chemical applications and biological control. Cultural practices that can help reduce the infestation include crop rotation to break the life cycle of the pest, the use of clean planting material, the removal of infected plants once detected (roguing) and spraying the cassava plants with water during the dry season. Insecticidal soaps and oils, as well as environmentally friendly chemicals can be applied to manage mites. However, care should be taken to rotate the pesticides used to prevent resistance from developing. Other mites and insects that occur naturally in the field will feed upon this pest and reduce their levels. Harsh chemicals will kill these natural predators; therefore, care should be taken to select environmentally friendly pesticides.

Pest & Diseases	Symptoms	Control/ Management
late 5 Termites (Neotermes spp.)  **http://coralspringstree.com/wp-content/uploads/2012/05/tree-termite-adult-soldier-broward.bmp**	Defoliates the plant	A combination of physical and cultural practices, biological control and chemical applications are recommended to reduce infestations of the Cassava Hornworm. Early detection is critical for the management of this pest. As such, fields should be scouted regularly for the presence of eggs and young larvae. Cultural and physical practices include hand picking worms when their numbers are low and proper field sanitation. Natural agents also regulate populations; therefore, efforts should be made to encourage these beneficial organisms. The commercially available natural insecticide Bt (*Bacillus* sp) can be used but this is most effective when the hornworms are very small. If there is an extremely high population, chemicals can be used (e.g. Ethrine plus, Agaclin). These can give a fast knockdown within 3 - 4 hours.

Pest & Diseases	Symptoms	Control/ Management
Plate 20 Thrips 	Thrips are tiny, yellow insects found mainly on the growing points of the plant. The baby thrips (nymphs) feed on the leaf veins and stems resulting in chlorotic (yellow) spots. The space between leaves may become shorter with the plant becoming bushy in that area ('Witches broom' appearance). Most of the damage is done in the dry season.	Cultural practices include crop rotation to break the life cycle of the pest, the use of clean planting material and removal of infected plants once detected (roguing). Insecticidal soaps and oils, as well as environmentally friendly chemicals can be used to manage thrips. However, care should be taken to rotate the pesticides used to prevent resistance from developing.
Plate 21 Cassava Bacterial Blight 	The disease is characterized by spots on the underside of the leaves that appear as angular wet areas. As the disease progresses, leaf shed can occur with root rot occurring in susceptible varieties.	The management of Cassava Bacterial Blight is mainly through cultural practices such as crop rotation. This is especially important since the bacterial spores can remain in the ground for 2 years. It is also necessary to use clean planting material, remove plants that are infected and use resistant varieties where they are available.

Pest & Diseases	Symptoms	Control/ Management
Fungi **Super-elongation** 	Internode elongation along the stems resulting in tall plants with weak stems. The leaves sometimes curl causing the lower surface to face upwards. This disease can cause severe defoliation. Super-elongation is most prevalent during the rainy season.	Ensure that the planting material used to establish the crop is clean. Farmers must therefore inspect fields from which they obtain planting material before the leaves fall. The planting material should be treated with a pesticide dip.

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.

Harvesting

Generally, the cassava crop can be harvested after 6 - 12 months. However, each cassava variety has a specific maturity period. A good practice is to cut back the plants 2 weeks before harvesting, leaving only 8 - 10 inches (20 – 25 cm) of the stem protruding from the ground. This allows the sugars in the tubers to be converted to starches, resulting in a cassava that will not deteriorate or rot as easily.

When the plant has completed 8 - 12 months, it demonstrates a series of characteristics which indicates that it is ready for harvesting. These are as follows:

- Yellowing of leaves
- Dropping of leaves
- An increase in size of tubers, which cracks the top of the soil
- Decrease in size of stem and increase in size of root tubers.

Cassava is harvested manually. A garden fork can be used to loosen the soil around the tubers before they are pulled by hand. If the soil is hard, some water can be applied to loosen it.

Storage

The cassava tuber does not store for a long time. It deteriorates rapidly after harvest. This generally starts after 48 hours after harvest. Burying the root under the soil in humid conditions can control this to a limited extent. Cassava can be stored also at a temperature ranging between 40 - 45ºF (5 - 7ºC) with a relative humidity of 85 - 90%.

APPENDICES

APPENDIX I: TEMPLATE FOR COST OF PRODUCTION ANALYSIS: CASSAVA

	Input	Quantity	Units	Unit Cost	Total Cost
1.	**Planting material**				
	Cassava sticks (if purchased)				
	Fungicide, nutrient, insecticide, fertilizer (specify names used)				
	Shade netting				
	Polythene bags				
	Total cost for planting material				
2.	**Land preparation**				
	Pre planting herbicide, fertilizer (specify names used)				
	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**				
	Materials (e.g. storage containers etc.)				
	Estimate any utility costs				
	Transport to market				
	Total cost for harvest/storage				
5.	**Labour**				
	Planting material				
	Land preparation				
	Crop maintenance				

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

Notes

3. It is recommended that the above data be completed on a per crop basis.
4. The cost of any fixed structures should be considered. For example if a seedling nursery is solely used for to produce cassava planting material 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 planting material for other crops are also produced then these also need to be considered. If cassava planting material accounts for half the production 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.
5. The revenue obtained from sale of the crop should be compared with the cost of production to determine the profit/loss on the operation.

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 lbs/acre
Kocide 101	2 - 4 teaspoons/gallon of water
Cupravit	2½ lb/acre
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 II: LIST OF RECOMMENDED PESTICIDES AND APPLICATION RATES

APPENDIX III: GOOD AGRICULTURAL PRACTICES DATA RECORD SHEET

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