

# 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



## BROCCOLI

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exist on the various aspects of production and handling/ marketing of crops and livestock, the majority of which are outdated, not easily understood and lacking the where with all for addressing present day challenges such as good agricultural practices (GAPs) and food safety and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

## **BROCCOLI**



November 2015

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Published by

Ministry of Agriculture, St. Lucia

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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 broccoli.

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

Broccoli (*Brassica oleracea*) belongs to the cabbage family Brassicaceae. The local name in Creole is Bwòkli. It is an edible green plant whose large flower head is eaten as a vegetable. It is high in vitamin C and dietary fiber. It also contains multiple nutrients with potent anti-cancer properties and small amounts of selenium.

# Ecology and Environment

The plant requires full sun and moist, fertile soil that's slightly acidic. Broccoli can be cultivated in Caribbean temperatures which are usually above 70°F (20°C).

# Varieties/Cultivars

The popular varieties are known as Packman, Lola, Green King, Prize Head and Known You.

# Seedling Production

The production of vegetable seedlings is one of the most critical areas for the successful production of this vegetable crop. If weak seedlings are used, poor growth and crop performance will result in poor crop yields and low economic return.

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. 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 broccoli 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 expiry 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 (Plate 3)
- Expose seedlings to full days of sunlight until ready for transplanting
- Transplant seedlings when they are 3 inches (7.6 cm) tall.

## Land Preparation

The soil must be ploughed and rotavated to produce a good tilth. During land preparation incorporate organic matter into the soil. The area must be well drained.

## Spacing and Planting

Broccoli seedlings should be planted in rows 16 – 24 inches (40 – 60 cm) apart and spaced 12 - 16 inches (30 – 40 cm) in the row depending on the variety (Plate 4).



Plate 4 Broccoli seedling planted in field

# Irrigation

Irrigation water, especially from streams and ponds, should be sent for analysis to ensure that the water is not polluted or saline. It must be of good quality for irrigation. The crop should be irrigated regularly, particularly in the dry season, using over-head or drip irrigation systems. During the wet season, limit irrigation as too much water can increase the incidence of pests and diseases.

# 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 transplanting, apply 4 cwt/acre (500 kg/ha) of 12:12:12+2 fertilizer followed by two applications of 12:12:12+2 at 2 cwt/acre (250 kg/ha) at 3-weekly intervals.




# Weed Control





Weeds can be controlled using a pre-emergence herbicide e.g. Dacthal W75 after transplanting and a contact herbicide during the growth of the crop. Use a shield when applying the herbicides to avoid spray drift on the seedlings. It is advisable to hand weed during the more advanced stage of crop growth.




# Pests and Diseases



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

**Table 1** Causal agents, symptoms and control of pests and diseases of anthuriums

Pest & Diseases	Symptoms	Control/ Management
 <p>Plate 5 Slugs and Snails</p>	<p>Snails and slugs are most active at night. They chew irregular holes with smooth edges in leaves and flowers and can clip succulent plant parts and leave a silvery mucus trail.</p>	<p>Use metaldehyde baits, 4% active ingredient. Do not water heavily for at least 3 or 4 days after bait placement, watering will reduce effectiveness of the bait.</p>
 <p>Plate 6 Diamond Back Moth</p>	<p>Young larvae feed between upper and lower leaf surface and may be visible when they emerge from small holes on the underside of the leaf; older larvae leave large, irregularly shaped shot holes on leaf undersides, may leave the upper surface intact; larvae may drop from the plant on silk threads if the leaf is disturbed.</p>	<p>Larvae can be controlled organically by applications of <i>Bacillus thurengiensis</i>.  Also can use contact or systemic insecticides.</p>
 <p>Plate 7 Cabbage White Butterfly</p>	<p>Large ragged holes in leaves; green-brown frass (insect faeces) on leaves; caterpillar is green in colour and hairy, with a velvet-like appearance; may have faint yellow to orange stripes down its back; slow-moving compared with other caterpillars</p>	<p>Larvae can be controlled organically by applications of <i>Bacillus thurengiensis</i>.  Also can use contact or systemic insecticides.</p>

Pest & Diseases	Symptoms	Control/ Management
 <p>Plate 8 Cabbage Looper</p>	<p>Young larvae scarify the leaves and older larvae eat irregular shaped holes of various sizes. Loopers can kill young plants if they destroy the growing point, or they can cause branching in brassicas by early feeding on the growing point.</p>	<p>Larvae can be controlled organically by applications of <i>Bacillus thuringiensis</i>.</p> <p>Also can use contact or systemic insecticides.</p>
 <p>Plate 9 Bud Worms</p>	<p>Larvae feed on all plant parts, but prefer to feed around the bud of young plants.</p>	<p>Larvae can be controlled organically by applications of <i>Bacillus thuringiensis</i>.</p> <p>Also can use contact or systemic insecticides.</p>
 <p>Plate 10 Cabbage Aphids</p>	<p>Aphids cause damage by sucking plant sap, which causes heavily infested leaves to curl and stunts plants.</p>	<p>Aphids can be controlled using contact or systemic insecticides.</p>
 <p>Plate 11 White Flies</p>	<p>Common noticeable symptoms are an abundance of white, waxy material covering leaves and fronds, a sugary substance called “honeydew” produced by the leaf-sucking insects, and excessive dark sooty mold on leaves or fronds that grows on the honeydew.</p>	<p>White flies have developed resistance to many synthetic pesticides making chemical control difficult.</p> <p>Insecticidal soap, neem oil and botanical insecticides can be used to “knock down” heavily infested areas.</p>

Pest & Diseases	Symptoms	Control/ Management
 <p><b>Plate 12</b> Black Rot caused by <i>Xanthomonas campestris</i> pv. <i>Campestris</i></p>	<p>The infected tissue is wilted and pale green initially becomes yellow then turns brown and dies. Affected areas are usually wedged or V-shaped. Bacteria are spread within a crop primarily by wind-blown and splashing water and by workers, machinery, and occasionally insects.</p>	<p>Diseases affecting broccoli can be controlled with hot water treatment of seeds, crop rotation, the removal of crop residues in the field, the use of resistant varieties and a number of fungicides available on the market.</p>
 <p><b>Plate 13</b> Bacterial Soft Rot caused by <i>Erwinia carotovora</i> var. <i>carotovora</i></p>	<p>Prolonged moisture from rain or irrigation and mild temperatures encourage disease development. Bacteria survive in soil and plant debris.</p> <p>Early symptoms first appear as water-soaked areas on the heads of broccoli, which rapidly break down into a soft, mushy rot.</p>	<p>Soft Rot often follows insect damage to the leaves as well as Black Rot attack. It is advisable to control insects for the control of Soft Rot.</p>
 <p><b>Plate 14</b> Phytophthora Stem and Root Rot caused by the spores of <i>Phytophthora</i></p>	<p>The disease thrives in wet soil. Root Rot may infect and kill broccoli by destroying the root and stem.</p>	<p>Phytophthora Stem and Root Rot often follows insect damage. It is advisable to control insects for the control of <i>Phytophthora</i> Stem and Root Rot. Prevention also includes monitoring water levels in the soil or improving drainage.</p>

Pest & Diseases	Symptoms	Control/ Management
 <p data-bbox="201 577 591 630"><b>Plate 15</b> Alternaria Leaf Spot caused by <i>Alternaria brassicicola</i></p>	<p data-bbox="613 310 1016 850">Symptoms of Alternaria Leaf Spot on broccoli may first develop on young plants in seedbeds, where leaf spots, stunting, or damping off may occur. Dark brown to black leaf spots may appear on tissues of any age and vary in size from pinpoint to 2 inches (5 cm) in diameter. The leaf spots enlarge in concentric circles and mature lesions have a bull's eye type appearance.</p>	<p data-bbox="1036 310 1421 598">Alternaria Leaf Spot often follows insect damage. It is advisable to control insects for the control of Alternaria Leaf Spot. Prevention also includes monitoring water levels in the soil or improving drainage.</p>
 <p data-bbox="201 1197 591 1249"><b>Plate 16</b> Peppery Leaf Spot caused by <i>Pseudomonas syringa</i> pv. <i>maculicola</i></p>	<p data-bbox="613 909 1016 1575">Symptoms consist of leaf spots that first begin as small water-soaked points. After some time these points develop into dark brown or purple spots surrounded by translucent haloes. Individual spots are generally slightly sunken and up to 1/8 inch (3mm) in size. Often spots will join together forming an irregular angular lesion and giving a puckered, ragged appearance to the leaf. On severely affected plants the leaves may turn yellow and drop off.</p>	<p data-bbox="1036 909 1421 1197">Peppery Leaf Spot often follows insect damage. It is advisable to control insects for the control of Peppery Leaf Spot. Prevention also includes monitoring water levels in the soil or improving drainage.</p>

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/Maturity

The crop reaches maturity in 60 -70 days after transplanting. Maturity of broccoli can also be determined by head diameter and compactness with all florets (beads) closed. Harvest when the individual flower buds of the main head are apparent and tight and before any apparent yellowing. Before harvesting ensure that the harvest interval for any pesticides applied has been strictly adhered to. To harvest, cut the main stem of the broccoli about 6 - 8 inches (15 – 20 cm) below the head with 2 – 3 leaves attached to the head (Plate 17). Depending on the variety there may be some secondary smaller heads after the main head of broccoli is harvested.



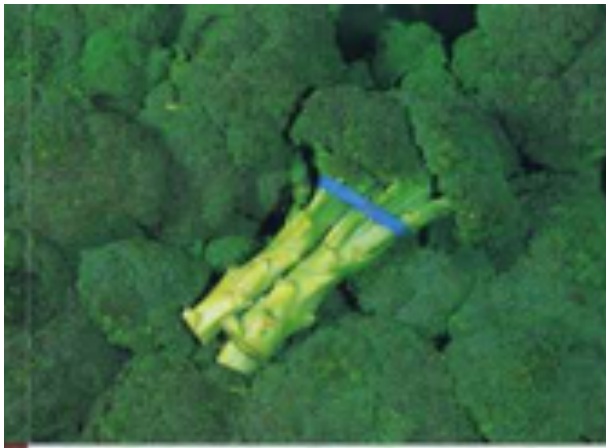
Plate 17 Harvesting broccoli

# Field Handling

In the field, heads are packed in crates or baskets and taken immediately to a cool area away from the sun as broccoli deteriorates quickly at high temperatures. Care must be taken to avoid damaging the heads during harvesting and field handling

# Preparation for Market

The stems are usually cut from 6 - 8 inches (15 – 20 cm) in length and the leaves are removed. The heads should be bunched together tightly with twist tie or rubber bands, then placed in cartons (Plates 18 and 19).



**Plate 18** Broccoli heads tied in bunches



**Plate 19** Broccoli heads in cartons

# Yields

Yield is dependent on the time of planting. Better yields are obtained during the cooler months of the year and can vary from 10,000 - 12,000 lb/acre (11,000 – 13,000 kg/ha).



# Storage

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Broccoli does not store well under ambient conditions. The flower buds open and the heads become yellow. The heads should be marketed soon after harvesting. Low temperature storage is extremely important to achieve adequate shelf life in broccoli. A temperature of 32°F (0°C) with over 95% relative humidity is required to optimize broccoli storage life. Broccoli is extremely sensitive to exposure to ethylene. Floret yellowing is the most common symptom and broccoli should not be stored with ethylene producing commodities.

# APPENDICES



## APPENDIX I: TEMPLATE FOR COST OF PRODUCTION ANALYSIS: BROCCOLI

	Input	Quantity	Units	Unit Cost	Total Cost
<b>1.</b>	<b>Seedling production</b>				
	Seed material				
	Seedling trays				
	Peat moss				
	Saran netting				
	Fungicide, plant nutrient, insecticide, fungicide, fertilizer (specify names used)				
	<b>Total cost for seedling production</b>				
<b>2.</b>	<b>Land preparation</b>				
	Organic manure				
	Other land preparation costs (e.g. equipment rental)				
	<b>Total cost for land preparation</b>				
<b>3.</b>	<b>Crop maintenance</b>				
	Water/irrigation				
	Fertilizer (specify types used)				
	Weed control (specify chemicals etc used)				
	Pest and disease control (specify chemicals etc. used)				
	<b>Total cost for crop maintenance</b>				
<b>4.</b>	<b>Harvest/storage</b>				
	Crates/baskets				
	Other materials (e.g. twist ties, rubber bands etc)				
	Estimate any utility costs				
	Transport to market				
	<b>Total cost for harvest/storage</b>				
<b>5.</b>	<b>Labour</b>				
	Seedling production				
	Land preparation				

**APPENDIX I: TEMPLATE FOR COST OF PRODUCTION ANALYSIS: BROCCOLI**

	<b>Input</b>	<b>Quantity</b>	<b>Units</b>	<b>Unit Cost</b>	<b>Total Cost</b>
	Crop maintenance				
	Harvest/storage				
	<b>Total cost for labour</b>				
<b>6.</b>	<b>Rent/insurance</b>				
<b>7.</b>	<b>Miscellaneous costs</b>				
	<b>Total cost of production</b>				

**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 broccilli 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 broccilli seedlings account for half the seedlings in a year, then the annual cost calculated as above needs to be divided by 2. Similar consideration 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**

<b>INSECTICIDES</b>	<b>APPLICATION RATE</b>
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 (Perfection, 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 ( <i>Bacillus thuringiensis</i> )	Label rates
Rotenone	1 - 2 teaspoons/gallon of water
Neem X.	8 - 10 oz/gallon of water
<b>FUNGICIDES</b>	<b>APPLICATION RATE</b>
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-Milttox-Forte	3 teaspoons/gallon of water
Botrilex	5 - 200 lbs/acre
Kocide 101	2 - 4 teaspoons/gallon of water
Cupravit	2½ lb/acre

**APPENDIX II: LIST OF RECOMMENDED PESTICIDES AND APPLICATION RATES**

<b>WEEDICIDES</b>	<b>APPLICATION RATE</b>
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.

