Hot Pepper Production and Post Harvest Handling

HOT PEPPER

Introduction

Peppers were domesticated 10,000 to 12,000 years ago by the Aztecs, Mayas and the Incas. Columbus in the fifteenth century introduced peppers to Europe and subsequently to Asia and Africa, and later to India, China and Japan through the spice trade. It is estimated that more than 3 million hectares of peppers are grown annually around the world. Asia is the largest producer, followed by Africa and Europe. Pepper production is found from the humid tropics, to the dry deserts, to the cool temperate climates. The ability of pepper to thrive under this range of climatic conditions has rendered it a common crop worldwide.

Hot pepper is cultivated in all regions of Guyana. In some cases it is done on large scale in areas such as Parika Backdam (Region #3) and on farms in the Canals Polder. In Region #4, large scale production is done in the Mahaica and Moblissa areas. The largest area under cultivation is estimated at three acres. There is tremendous scope for expansion in the production of hot peppers in Guyana. This is largely influenced by the Agricultural Diversification Strategy undertaken by the Government of Guyana through the Ministry of Agriculture and the National Agricultural Research Institute. In addition, in recent times, the export market for both fresh and processed forms of hot pepper has statistically shown a steady rate of expansion. The New Guyana Marketing Corporation which provides services to exporters has established a packhouse facility that assists in preparing high quality produce for the overseas market.

HOT PEPPER

Environmental Requirements

Peppers are considered to be warm season and day-neutral plants that require about the same growing conditions as the other members of the Solanaceae family, for example, tomato and boulanger.

Climate

Peppers can grow at wide range of altitudes with rainfall between 600-1250 mm per annum. Most cultivars cannot tolerate flooded conditions. Seeds germinate best at 25-30^{o}C. Optimal temperatures for productivity range between 18-30^{o}C. In Guyana, the climatic condition is suitable for the cultivation of this crop.

Soil

Peppers are tolerant to a wide range of soil conditions. However, fertile medium loams and well-drained soils with a pH of 5.5-6.8 are generally considered most suitable. In Guyana, they are grown on all soil types which include: sandy soils, clay soils and pegasse.

Varieties

Several cultivars are grown locally which are suitable for fresh consumption or processing. These include Wiri Wiri, Miwiri, Bird Pepper, Ball O' Fire, "Bullnose" Scotch Bonnet, Tiger Teeth, West Indian Red, Caribbean Red and Habanero. The main varieties for export however are the West Indian Red, the Caribbean Red , Habanero and the "Bullnose" Scotch Bonnet.

Crop Management

Soil Preparation

Tillage

In Guyana, land preparation is done three main ways. For new lands, the standard tillage method of preparing the soil involves ploughings twice (down and across), disc chiseling, harrowing and ridge and furrowing. Clay soils may require several ploughing before harrowing. In large-scale production (>1 acre) it is necessary to establish a drainage gradient to facilitate the drainage of excess water which in turn reduces the risk of root diseases. For small-scale production, forking and chipping is adequate and economical.

Peppers can be grown in a flat field or on raised beds. Plants grown on high ridges are less likely to have phytophtera root rot as compared to plants grown on flat grounds.

Liming

On most farms in Guyana, liming is necessary to reduce soil acidity. The acidity can be determined from a soil test. Contact your extension agent or agricultural officer for soil testing Acidity adversely affects the growth of hot peppers. Peppers require a soil with pH 5.5 – 6.8. Below pH5.5 will result in stunted growth of pepper plants and poor yields. Liming requirements of different soil types to satisfy pH preference of 5.5 – 6.8 of hot peppers are shown in Table 1.

Table 1. Liming requirements for different soil types.

pH reading	Average amount of limestone ($CaCO_3$) in tons per hectare for soils of average organic matter content				
	Sandy Soil	Sandy Loam	Loam	Silt and Clay Loam	Clay
4.0	3.0	5.5	7.0	9.5	12.0
4.5	2.5	4.5	5.8	7.8	9.8
5.0	2.0	3.5	4.5	6.0	7.5
5.5	1.5	2.5	3.3	4.3	5.8

The liming material should be incorporated into the soil during the tillage operations. Liming takes at least 4 weeks to act on the soil. To ensure that the plant benefits maximally from the liming, it is advisable that seedlings are transplanted at least two weeks after the lime has been incorporated into the soil. Once this process is properly done, it is not necessary to lime again in 3-5 years, or as determined by a soil test.

Fertiliser Application

Fertiliser needs are related directly to the type and nutrient status of the soil. It is essential therefore that a soil analysis be conducted so that a precise recommendation for fertilizer application can be provided. Contact NARI for all soil analysis and fertilizer recommendations.

In the absence of a soil analysis, the following is an approximate guide.

Urea - 66 kg/ha

- 40% of N should be applied as a basal fertiliser before transplanting
- The remaining 60% of the N should be side dressed in 3 equal amounts at 2, 4 and 6 weeks after transplanting

Triple Super Phosphate (TSP) – 75 kg/ha

- 50 % should be applied as a basal fertiliser
- 50% should be side dressed at 4 weeks after transplanting

Muriate of Potash – 80 kg/ha

- 50 % should be applied as a basal fertiliser
- 50% should be side dressed at 4 weeks after transplanting

Compost and Soil Organic Matter

Compost and/or green manure crops help increase soil organic matter content. Organic matter increases the buffering capacity of the soil and helps hot peppers maintain constant growth.

In sandy and clay soils, add organic matter (well-rotted pen manure) at 10-20 tons/ha as required at land preparation.

Propagation

Peppers may be established in the field by direct seeding, by containerised transplants grown in multicellular trays or by bare root transplants grown in seed beds or seed boxes. However, it is not economical to direct seed peppers. The propagation technique employed to raise seedlings is solely dependent on the farmer.

Preparing a seed box for pepper transplants

(a) Construction

A seed box 45x30x7.5 cm in dimension is very convenient. In commercial farms, seed beds 1m*5m are usually prepared in an area fully exposed to sunlight.

(b) *Soil*

A friable and fertile soil is the best medium for starting seedlings. One part sand, one part compost or fully rotted pen manure and one part ordinary garden soil are mixed. This potting mixture can be used for seedlings prepared in a seed bed, seed box or for containerised transplants. The sand will provide drainage and irrigation; the compost will improve the soil texture and increase its fertility. The garden soil gives better anchorage to roots and increase CEC like compost.

(c) *Soil Treatment*

As a precaution against pre and post emergence damping off, the seed box/bed should be drenched with Rizolex at a rate of 1-2 tablespoon (15-30g) per gallon or Banrot at 1-2 teaspoon (5-10 g) per gallon before planting the seeds. Irrigate immediately after applying the drench with an equal amount of water. Allow one week between treating and sowing seeds. The seeds should not be broadcasted but sown thinly in furrows.

(d) *Seed Treatment*

Mix 2-4g Rizolex to 1 kg seed before planting to prevent soil borne diseases.

(e) Seeding rate

Hot peppers are seeded 1-2 kg/ha with 1 g weighing approximately 250 seeds/g. The seeds should not be broadcasted but should be sown thinly on shallow furrows. Cover the seeds with a thin layer of compost to prevent seed exposure when watering.

(f) Shading and Hardening

Shading should be provided to prevent the exposure of seedlings to the extremes of the environment: heat stress and flooding. Shading is important during the first 20-25 days after seeding. Harden seedlings by restricting water and removing shade protection starting 4-7 days before transplanting; this is to prevent transplanting shock.

(g) Management

The seed box/bed should be watered moderately daily so as to provide sufficient moisture for the seeds to germinate within 10 days after sowing. Restrict watering to once every two days during the hardening phase.

Transplanting

Transplants are planted out in the field at 5 – 8 true leaf stage, usually 20-30 days after sowing. Transplanting should be done late in the afternoon and should be followed immediately by irrigation to reduce transplanting shock and increase field stand.

Spacing

Plant seedlings 24-30" apart within rows and 24" between rows. This planting density will accommodate 37,000 plants/ha (15,000 plants/acre). For the "Bullnose" Scotch Bonnet Variety, the recommended spacing is 1m by 1m (10,000 plants/ha).

Major Diseases

1. ***Damping Off***

Casual agents: *Rhizoctonia solani, Pythium spp., and Fusarium spp.*

Affected Plant Stages: Seeds, seedlings and transplants.

Affected plant parts: Roots

Symptoms:

The symptoms vary with the age and stage of development of the plant affected. Seeds may fail to germinate, become soft and mushy, then turn brown, shrink and finally disintegrate. Small seedlings suddenly collapse by toppling over or are stunted when infected.

Control: The control measures recommended are:

1. Seeds should be treated with a recommended fungicide;
2. Nursery beds should be located on well-drained sites and treated prior to seeding with insecticide;
3. Covered beds should be well ventilated to prevent high humidity. Allow at least 0.76 m (2.5') between seedlings and shading material;
4. Improve heavy soils by adding organic matter;
5. Avoid applying excessive amounts of nitrate forms of nitrogen fertilisers; or/and
6. Apply Banrot or Rizolex 2-3 days after transplanting to the soil at 1-2 tsp/3.78 l (5-10 g/ 3.78 l) and 1-2 tbsp/3.78 l (15-30 g/ 3.78 l) respectively.

2. ***Bacterial Spot***

Causal agent: *Xanthomonas campestris pv. vesicatoria*

Affected Plant Stages: Vegetative growing stage, flowering stage, fruiting stage, and post- harvest.

Affected plant parts: Leaves, stems, fruits, seeds and inflorescence.

Fig 1. Typical symptom of bacterial spot disease.

Symptoms

On young leaves, lesions begin as circular, water-soaked spots that become necrotic with brown centres and chlorotic borders. The spots have dead, straw coloured centres with a dark margin. The spots are angular because the bacteria spread along the veins. The presence of numerous spots results in leaf yellowing and abscission or a scorched or blighted appearance. Narrow or elongated raised cankers may appear on stems which eventually become rough and light brown. Fruit spots are initially circular and green turning brown, but become raised with a cracked, scabby surface (Figure 1).

Control: The control measures recommended are:

1. Practice crop rotation;
2. Use disease-free seeds and transplants;
3. Seed treatment by soaking seeds in 1.3 % sodium hypochlorite (one part bleach solution (5.25%) to four parts water) for 40 minutes with agitation. One litre of solution treats 0.5 kg of seed. Rinse thoroughly and dry seed immediately. Or soak in water at exactly 50 ^{o}C for 25 minutes, then cooled and dried; or/and
4. Twice weekly applications of a copper-mancozeb mixture, such as Mankocide 2-4 tbsp / 3.8 l of water every 5-7 days. Spray preventatively especially during the rainy season, alternating a combination of Kocide 101 or Kocide DF and Manzate with Mankocide every 5-7 days.

   Rates: Kocide 2-3 tbsp/3.8 l
   Manzate 1 tbsp/3.8 l
   Mankocide 2-4 tbsp/3.8 l

The disease spreads rapidly during warm, rainy weather and persists in crop debris.

3. ***Bacterial Soft Rot***

Causal agent: *Erwinia carotovora* pv. *carotovora*

Affected Plant Stages: Pre-emergence, seedling stage, vegetative growing stage, flowering stage, fruiting stage and post-harvest.

Affected plant parts: Whole plant, leaves, stems, roots, growing points and vegetative organs.

Symptoms:

Bacterial soft rot of pepper causes a soft rot of the fruit (Figure 2). At first, a small water-soaked lesion appears on the tissue which rapidly enlarges in diameter and depth. The area then becomes soft, watery and slimy grey or brown. The epidermis usually remains intact, while the interior has changed to a watery mass usually possessing a foul odour.

Fig 2. Bacterial soft rot on fruit.

The disease is most frequent when the weather is hot and humid.

Control: The control measures recommended are:

1. Planting in well-drained soils at adequate planting density;
2. Minimising physical damage to fruits during harvesting and handling;
3. Use chlorinated water (50 ppm) to wash fruits;
4. Good storage conditions, 21°C. Control and monitor the temperature and relative humidity during storage;
5. Apply copper sprays prior to harvest during hot wet weather will reduce disease losses; or
6. Rotate with non-hosts for at least 2-3 years.

4. ***Bacterial Wilt***

Causal agent: *Pseudomonas solanacearum*

Affected Plant Stages: Vegetative growing stage

Affected plant parts: Fruits, leaves, roots, seeds, stems, vegetative organs and whole plant.

Fig 3. Affected vascular tissue due to bacterial wilt.

Symptoms:

Soil-borne bacteria which infect through the roots and invade vascular tissue affect the plant water supply (Figure 3). Symtoms begin with wilting of the leaves and after a few days, a permanent wilt results, with no leaf yellowing.

A simple test for this bacterium is to suspend cut roots and lower stems in water and look for exudates of milking streams of bacteria. This pathogen can result in plant death when the plant is in full production, after 2-3 months of growth in the field.

Control: The control measures recommended are:

1. Follow a crop rotation regime;
2. Plant only bacteria-free seeds and transplants; or/and
3. Rogue diseased plants and burn.

5. ***Anthracnose or Ripe Rot***

Causal agent: *Colletotrichum capsici*

Affected Plant Stages: Pre-emergence, seedling stage, vegetative growing stage, flowering stage, fruiting stage and post-harvest.

Affected plant parts: Leaves and fruits

Symptoms:

Anthracnose may develop as post-harvest decay of fruits (Figure 4). Is appears on mature pods as small, water-soaked shrunken lesions that expand rapidly, to 3-4 cm in diameter. Fully expanded lesions are sunken and range from dark red to light tan.

The lesions have dark fungal spores in them, with a characteristic concentric ring appearance. On leaves, large grey areas bordered with black and dotted with black spores are present.

Fig 4. Pepper showing symptoms of anthracnose.

Control: The control measures recommended are:

1. Use only clean seed;
2. Practise crop rotation; or
3. Spray with Benlate alternately with Control and Saprol.

Begin spray at flowering and continue with harvesting at weekly intervals.

Benlate – systemic foliar, seed and post-harvest treatments
1-2 tsp/3.8 l (5-10 g/3.8 l)

Control – contact, foliar applied
1-2 tbsp/3.8 l (15-30g/3.8 l)

Saprol – systemic, foliar applied
1-2 tsp/3.8 l (5-10 ml/3.8 l)

6. ***Early Blight***

Causal agent: *Alternaria solani*

Affected Plant Stages: Fruiting stage and post-harvest

Affected plant parts: Leaves, stems and fruits

Symptoms:

Fig 5. Typical leaf symptoms of Early Blight.

The disease appears as small, irregular brown dead spots on older leaves up to 16 mm in diameter with concentric black rings, with spots surrounded by a yellow area. With many lesions the whole plant turns yellow. On the stems, lesions are brown. Fruit infections occur while the fruit is green. Spots are dark, leathery and sunken with a ridged appearance. Infection occurs during warm, rainy and humid weather.

Control: The control measures recommended are:

1. Use clean seed;
2. Destroy crop debris;
3. Crop rotation;
4. Seed treatment (0.2% a.i. thiram at 30°C for 24 hours);
5. Wet seed treatments most effective e.g. Ceresan 0.1% for 15 minutes; or
6. Alternate Manzate, Control and Benlate with Mankocide to prevent the spread of the disease at the above rates.

7. ***Rhizoctonia Root Rot***

Causal agent: *Rhizoctonia solani*

Affected Plant Stages: Pre-emergence, seedling stage, vegetative growing stage, flowering stage, fruiting stage and post-harvest.

Affected plant parts: Whole plant, leaves, stems, roots inflorescence, fruits, seeds and growing points.

Fig 6. Top roots affected by Root Rot disease.

Symptoms:

Early infection gives rise to seed decay and pre- and post-emergence damping-off. Later infection causes stem canker, eyespot and other diseases which results from the decay of the stem cortex and may be accompanied by stunting, yellowing and leaf-roll symptoms. A cool and damp environment is optimal for infection. Symptoms appear when the plant is under heat and water stress, and include wilting and death of the plants. The taproot will have reddish brown lesions which are a diagnostic characteristic for this disease (Figure 6).

Control: The control measures recommended are:

1. Seed treatment with a recommended fungicide; or
2. Crop Rotation

8. ***Powdery Mildew***

Causal agent: *Leveillula taurica – Oidiopsis taurica* (asexual stage)

Affected Plant Stages: Post-harvest Affected plant parts: Leaves, stems and growing points

Fig 7. Powdery Mildew on pepper leaf surface.

Symptoms:

This disease is favoured by warm temperatures (20-35°C). Chlorotic blotches or spots appear on the upper leaf surface which may become necrotic. When numerous, they may fuse resulting in a general chlorosis of the leaves (Figure 7). On the lower leaf surface, the lesions develop a necrotic flaking and are often covered with a white to grey powdery growth.

Premature leaf abscission is a prominent symptom of powdery mildew exposing fruits to direct sun irradiation.

Control: The control measures recommended are:

1. Fungicides have been effective in controlling this disease;
   Tri-Miltox Forte 410 WP applied at 1.9 to 3.8 kg per hectare at 7-14 days interval
2. Sulphur dust and spray is effective;
3. Neem treatments and bicarbonate were found to be effective. Apply all chemicals to the lower leaf surface; or
4. Proper irrigation to prevent drought stress of aging plants.

Fig 8. Stunting and curling of leaves due to Gemini virus.

9. ***Geminivirus***

Causal agent: *Geminivirus*

Affected Plant Stages: All stages of plant growth

Affected plant parts: Leaves and fruits

Symptoms:

The common symptoms are stunting, curling or twisting of leaves, bright yellow mosaic, distorting of leaves and fruits and reduced yield (Figure 8).

Control: The control measures recommended are:

1. Control is difficult once plants become infected;
2. The virus is spread by whiteflies (*Bemisia tabaci)*, hence this vector should be controlled using recommended insecticides;
2. Destroy all perennial weeds which harbour the whiteflies; or
3. Crop rotation.

10. ***Pepper Mottle Virus***

Causal agent: *Pepper Mottle Virus*

Affected Plant Stages: Vegetative and reproductive stages

Affected plant parts: Leaves and fruits

Symptoms:

Mild chlorosis and stunting especially if plants are young. Fruits are small, malformed, mottled and may have necrotic depressions (Figure 9).

Fig 9. Stunting of fruits due to pepper mottle virus.

Control: The control measures recommended are:

1. The virus is mechanically transmitted by aphids; hence aphid control should be effected by recommended insecticides.

Insect Pest Management

Cutworms

Agrostis spp.

Affected Plant Stages: Seedling stage

Affected plant parts: Leaves and young stems

Symptoms:

Cutworms are dull grey, brown or black, and may be striped or spotted, up to 50 mm in length, soft bodied and smooth. They curl tightly when disturbed. Cutworms cut leaves and young stems damaging seedlings and transplants above, at or just below the soil surface.

Control: The control measures recommended are:

1. Plant seedlings that have been hardened or at least 4-5 weeks; or
2. Place a plastic collar or aluminium foil around the seedling stem.
   Use recommended insecticides.

Leaf miner

Agromyza spp.

Affected Plant Stages: Vegetative growing stage, flowering stage and fruiting stage.

Affected plant parts: Leaves

Fig 10. Damage due to leaf miner.

Symptoms:

The larva is yellow about 3 mm long and lives inside the leaves. Adult flies are less than 3 mm in length. Damage is done by the feeding habits of the larvae that leave irregular trails on the leaves (Figure 10). Infected leaves are blotchy. Heavy infestations can result in yellowing and premature leaf abscission and consequent loss in yield. The larvae make long, slender, winding mines under the epidermis of the leaves.

Control: The control measures recommended are:

1. Remove infested leaves and burn.
2. Use of recommended insecticides such as Triazophous and Triggard.

Thrips

Affected Plant Stages: Vegetative and reproductive stages

Affected plant parts: Leaves and fruits

Symptoms:

Thrips are yellow, elongated insects less than 1 mm in length found in the upper and lower leaf surfaces (Figure 11). Nymphs and adult flies feed on leaves causing discoloration. Fruits are also discoloured, distorted and hardened. Leaves are distorted and curl upwards. The lower surface of the leaves develops a silvery sheen that later turn bronze. Some species are known vectors for viruses.

Fig 11. Thrips infestation on pepper leaf.

Control: The control measures recommended are:

1.Adequate and timely irrigation regimes,
2. Crop rotation with cabbage, or
3. Use of recommended insecticides such as Vydate L. (2.5 ml/L) and Admiral (1 ml/L).

Whiteflies

Affected Plant Stages: Vegetative and reproductive stages

Affected plant parts: Leaves

Symptoms:

Whiteflies are minute insects (2 mm) with broad wings that are covered with a fine, white, waxy powder. First instar nymphs are crawlers. Later instars are light green, oval, flattened and are attached to the leaf surface (Figure 12).Both the immature and adult stages suck plant sap from the leaves causing the leaves

Fig 12. Whiteflies infestation on pepper leaf.

to appear mottled, chlorotic and eventually drop. Honey dew is excreted and glazes over leaves, allowing the development of sooty mold. Whiteflies are known to transmit viruses to pepper plants.

Control: The control measures recommended are;

1. Control weeds which may act as alternate hosts;
2. Remove infected plants; or
3. Use recommended insecticides.

Physiological Disorder

Blossom End Rot

This disorder first appears as a water soaked area on the fruit. The tissue near the blossom end of the pods has a brown discolouration. Spots elongate and become brown to black, dry and leathery. Discoloured tissue shrinks until the affected areas are flat or concave. Fungi and bacteria may later invade the affected area, creating further rot. Pods with blossom end rot usually ripen prematurely. This disorder is caused by a calcium deficiency. It is also associated with low soil moisture, high temperature and excessive nitrogen fertilisation and root pruning during cultivation.

Fig 13. Fruits exhibiting blossom end rot

Control: The control measures recommended are:

1. If the soil is deficient in calcium, apply limestone to low pH soils or gypsum (calcium sulphate) to high pH soils. Refer to the section on liming for rates.
2. Maintain a uniform supply of soil moisture.
3. Avoid large amounts of nitrogen fertilisers.
4. Irrigate when necessary during rapid pod development.

Avoid cultivating near the plant since this can cause root development.

Weed Control

If nut sedge or nutgrass (*Cyperus rotundus*) is present at land preparation, spray Roundup (Glyphosate) 7-14 days before starting land preparation at 3 quarts per acre or use a 1 to 2 % solution from a CP3 Sprayer using 3-4 tbsp per gallon.

Weeds compete with peppers for nutrients, light, space and water. The presence of weeds may reduce crop yields and increase the cost of insect and disease control. Direct seeded peppers are more susceptible to being smothered by weeds than transplants because of slow emergence of seeds. Weed control is critical at planting and up to flowering

Weed control is generally done by using recommended herbicides when acreages are under cultivation. For small plot cultivation and homesteads mechanical control by hoeing and hand weeding is generally practised. Mulching at transplanting with dried grass, crop residue or rice straw which is layered over the soil reduces weed growth by its smothering effect on emerging weeds. The application of post emergence herbicides such as Herbadox or Lasso (3 tbsp per gallon or 21/2 – 3 pints per acre) between rows is recommended.

Harvest Maturity Indices

Usually the first peppers are ready for harvest about 2 months after transplanting, depending on the cultivar and season of the year. Several different indices are commonly used in determining harvest maturity. Size of the fruit is the most widely used index of maturity. The fruit should be fully developed and at full size for the particular cultivar, with a firm thick wall and waxy (shiny) skin. The calyx and stem should be fresh and green. Peppers having a soft, thin flesh and pale green colour (for certain varieties) are immature and not ready for harvest.

External colour is another widely used index of harvest maturity. Most pepper cultivars change skin colour as they become fully mature. However, it is not always desirable to wait for the fully mature colour before -harvesting. For example, the principal demand for sweet bell peppers is for uniformly green coloured fruit. If the fruit is allowed to remain on the plant after reaching full size, it will eventually change in colour, typically to red. Hot peppers may change from green to yellow, orange, or red colour. Therefore, the specific colour demanded in the market will dictate when to harvest the fruit. In most cases, it is recommended to wait and harvest the fruit until after it has completely changed colour . However, some hot pepper cultivars can be marketed with a mixed skin colour.

Fig 14. Avoid harvesting mixed-coloured bell pepper fruit

Pimiento pepper fruit should generally not be harvested until they are dark red. However, since fruits will sometimes crack in wet weather during the rainy season, they can be harvested at a light red stage and set in a dry place to redden.

Chili peppers for processing are usually harvested when red. For the fresh market, they are usually harvested green because of better quality maintenance during shipping. Chili peppers are usually green when immature and turn red with maturity, so harvest time depends on product usage and market destination

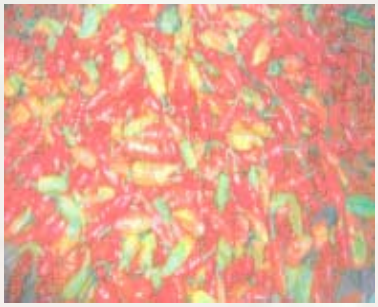

Fig 15. Harvest of mixed-coloured hot pepper fruit may be acceptable.

Harvest Methods

Peppers should be harvested by grasping the fruit in the hand with the thumb and forefinger and pressing against the stem, followed by snapping the fruit off the plant. Care should be taken not to sever or damage the fruiting branches while attempting to remove the fruit. Pepper plants have brittle branches that may break during harvest. Most sweet bell pepper cultivars lack a defined abscission zone in the stem, while pungent cultivars do possess a clearly defined abscission layer, allowing for a cleaner separation of the fruit from the mother plant.

Peppers are typically harvested once per week. They should be picked in the cool hours of the day and placed directly into a field basket, plastic container, or field crate. Never drop or throw pepper fruit into the picking container. Peppers should not be harvested when wet because surface moisture increases decay.

Fruit which have injuries that penetrate the skin are likely to rot and should be eliminated. Unmarketable quality or diseased fruit should also be removed from the plant and not mixed in the same field container as the marketable fruit. The discarded peppers should be removed from the field to avoid the spread and buildup of diseases and insect pests.

Peppers should be handled carefully when picking and transferring to field containers to avoid bruising and punctures. Picking containers which have rough inner surfaces may cause skin damage or fruit punctures and should be avoided. The picking containers should be wide, shallow, and stackable to avoid excessive weight and bruising of the fruit at the bottom of the container. Sturdy, well-ventilated plastic containers and/or plastic buckets make ideal harvest containers. They have smooth inner walls, which eliminate abrasion damage to the delicate skin of the pepper fruit. In addition, they can easily be cleaned and last for many years. The plastic field containers should be cleaned and sanitized before each days harvest to prevent accumulated disease organisms from infecting healthy peppers. The plastic containers should be rinsed with water to remove debris then submerged for 2 minutes in a sanitising solution consisting of 200 ppm sodium hypochlorite (household bleach) at a water pH of 6.5.

If wooden crates or straw baskets are used as field containers, they should be lined with newspaper to minimize fruit abrasion during transport. Large canvas or nylon sacks are not suitable field containers because they are usually stuffed with too many fruit and provide little protection. The fruit may also heat up and deteriorate more rapidly due to restricted ventilation. Harvested peppers should be placed in the shade immediately after harvest and cooled as soon as possible.

Fruit should never be packed tightly into the harvest container or allowed to remain in the sun. It is not unusual for the pulp temperature of harvested peppers to be more than 32°c (90°F). In addition, peppers left in the sun for an hour on a hot, sunny day can be 100°c (50°F) hotter than fruit held in the shade. If peppers are allowed to remain at these high temperatures for more than several hours, they will begin to soften and show signs of shrinkage. Shelf life can be reduced by one-half if peppers are left in full sunlight for two hours after harvest.

During all operations, from harvesting through packing, peppers should be handled carefully to avoid bruising, cuts and punctures. Physical injury not only detracts from the visual quality of the fruit, but also causes increased weight loss and decay.

Preparation for Market

Cleaning

Peppers should be cleaned by dipping into a tank of water or wiping with a soft cloth to remove dirt, sand, and surface stains. If peppers are washed, chlorine should be added to the water at a concentration of 150 ppm (2.4 pints of 5.25 percent chlorine bleach to 100 gallons of water). This will significantly reduce the amount of postharvest decay. The chlorine level and pH of the wash water should be checked at least hourly during the day with test papers or a meter. A water pH of 6.5 is desirable. The fruit must be air dried before packaging in order to reduce storage rot.

Grading

The initial grading of the fruit should take place in the field at the time of harvest. Pickers should separate the unmarketable or damaged peppers from the marketable ones. At the packinghouse, the pepper fruit should be graded according to size, shape, colour, appearance, and amount of surface defects. The fruit intended for market should be fresh in appearance, uniform in shape, and free from decay and physical injury. An irregular shape does not affect edible quality, but reduces eye appeal and may lower market acceptability. Peppers should be separated into different size classes. For example, bell peppers intended for export should not be less than 7.5cm (3 inches) in diameter and not less than 9 cm (3.5 inches) long.

export destined fruit should be firm, well-shaped, and free from damage caused by scars, sunburn, disease, insects, or mechanical injury. Peppers that are misshapen, cracked, damaged, decayed, or wilted should be discarded. The fruit should also have a uniform colour typical of the cultivar with a shiny skin. Pepper fruit of different colours should not be packed in the same carton. For example, red or partially red bell peppers should not be mixed with green-co loured fruit .
All fruit packed in the same carton should be similar in appearance.

Fig16. Fruit of different colours should not be mixed in the same market container.

Waxing

A light supplementary wax coating applied to the surface of pepper fruit can increase market life, reduce fruit shriveling, and diminish the amount of vibration damage incurred during transit. Fruit appearance may also be enhanced by making the fruit more glossy. Pepper waxes must be food-grade and are often made from plant extracts.

Fig17. Waxed peppers exhibit a noticeable surface shine.

Packing

Only the highest quality peppers should be packed for export. They should be selected for uniform maturity of colour, shape, and size and be free from defects. Any pepper showing signs of sunscald, mechanical or insect damage or disease should be discarded.
Peppers should be sent to the market as soon as possible after packing.

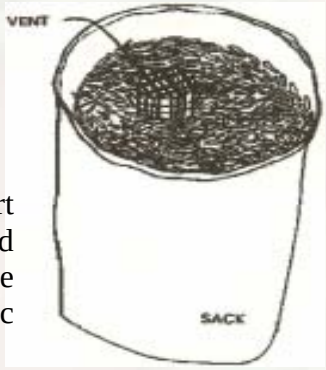

Fig 18. Inner tube of woven bamboo used to vent a large sack of hot peppers.

Fiberboard cartons are the most common type of package used for export markets. The cartons should be well ventilated and strong. The carton should have a minimum 275 psi bursting strength in order to avoid collapse while stacked on a pallet. One-piece self-locking cartons or two-piece telescopic cartons are the most widely used package designs.

Hot peppers destined for export are typically packed in shallow perforated fiberboard cartons containing 4.5 kg (10 lb) of fruit. Bell peppers destined for the North American export market are often packed in fiberboard cartons that hold 14 kg (30 lb) of fruit. They may also be packed in smaller 40 x 60 cm (16 x 24 in) cartons holding two layers of fruit. This size carton is also very popular in Europe.

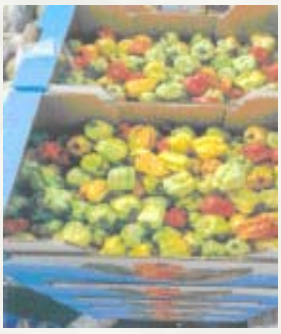

Fig 19. Scotch Bonnet peppers packed loose in 4.5 kg (10 Ib) cartons.

Postharvest Temperature

The optimum temperature for storage and transport of peppers is 7°C (45°F). At this temperature, the market life of peppers will be about 3 weeks. Peppers held at higher temperatures suffer more water loss and shrivel. Peppers are susceptible to chilling injury at temperatures below 7°C.

Cooling of the pepper fruit immediately after harvest is necessary for maintaining quality and maximizing postharvest life. It is not unusual for the pulp temperature of harvested peppers to be 32°C (90°F) or more if harvested in the heat of the afternoon or if they are exposed to full sun. If they are allowed to remain at high temperatures for more than a few hours, they will begin to show signs of shrinkage and softening. In addition, temperatures greater than 21°C (70°F) greatly accelerate fruit colour changes.

Containers of peppers should be loosely stacked in a cool room with space between the containers to allow for sufficient air circulation.

Fig 20. Two layers of red bell peppers packed in a 40 x 60 cm carton for export.