

CABBAGE CULTIVATION AND POST HARVEST



INTRODUCTION

Cabbage belongs to the family Crucifereae and its scientific name is *Brassica oleracea L.* It is used as a cooked vegetable or sometimes pickled or preserved by steaming and drying. The nutritional value is relatively high, although less than that of many other crops used in tropical areas as leafy vegetables.

VARIETIES

Various types of cabbages are grown in Guyana, with the most popular ones being the compact single – leaf types. Some cultivars grown locally are Tropicana, KK Cross, Gianty, Fortuna, Salvation and Resist Crown.

CULTIVATION

Cabbage is initially grown in seed beds or seed trays and then transplanted at the four – five leaf stage (four weeks old). It can be grown on any soil type, but preferably suited to light textured soils (sandy loam, clay loam, etc.) with high organic matter content. It does not tolerate acidic conditions. If the pH is below 5.5, then limestone should be applied two - four weeks before transplanting.

Transplanting is best carried out in the afternoon to resist transplanting shock. The recommended spacing should be 60cm between rows and 45cm along rows (approximately 37,000 plants/ha).

After transplanting, plants should be irrigated continuously for three days, thereafter, two times per week until head formation, or as is necessary.

FERTILIZER

A soil test should be done to determine the fertilizer requirement. In the absence of a soil test, the following recommendation should be followed is a guide:

Urea	- 220 kg/ha	- 40% at transplanting (2.4g/plant) - 60% at head formation (3.6 g/plant)
TSP	- 90 kg/ha	-all at transplanting (2.4g/plant)
MoP	- 140 kg/ha	- 50% at transplanting (1.9g/plant) - 50% at head formation (1.9g/plant)

If organic manure is applied, then the synthetic fertilizer rate should be adjusted accordingly.

Insect Pests of Cabbage in Guyana

1. Cricket

Gryllotalpa spp. (Orthoptera: Gryllotalpidae)

Acheta spp. (Orthoptera: Gryllidae)

Cricket attacks seedlings of all vegetables. Fully grown crickets are brown in colour and are about 2.5 – 3.5 cm long (Figure 1). The various species of these insects usually live either in the soil, bushes and under decaying crop residues and vegetation.

Mole crickets, which have heavily sclerotised front legs that are adapted for digging, are usually common in sandy soils.

All crickets are nocturnal, feeding at night and secluded by day, under the soil. They feed at or slightly below the soil surface, and can cause considerable damage before being discovered. Seedlings may be denuded of leaves or cut below the soil surface without any trace of insects on them.



Fig 1. Adult cricket

Crickets spend their entire life cycle below the soil, which may go through a period of approximately 28 -35 days. They are termed soil insects.

Control

- **Good field sanitation-** rid the field of weeds and plant residues from previous crops.

Cultural control:

- The areas where vegetables are grown should receive full sunlight, kept clean of weeds and all crop residues should be removed and burnt.
- Proper land preparation serves to control weeds, diseases, and soil insects, and also helps in the destruction of large soil clods, which act as hiding places for cricket.

Chemical control:

- Any approved soil insecticide at the recommended rate may be applied, such as Basudin 60% E.C (Diazinon) or Vydate L 40% E.C at the rate of 10 mls to 4500 mls water, to seed beds and cultivated areas of cropping.

2. Cut worm

Agrotis spp. (Lepidoptera: Noctuidae)

These are the caterpillars of various species of moth (Figure 2). They have a greasy appearance, are grey to brown in colour with faint lighter-colored strips, and when fully grown are usually the colour of the soil in which they live. They can be found on the soil surface, beneath leaves and under large soil clods.

Cutworms are surface feeders, and cut seedlings at or slightly above the soil surface. Evidence of cutworm presence will be greenish-black excreta pellets below the seedling. Most of its lifecycle is spent below the soil which goes through a period of approximately. 21-28 days.

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3. Aphids

Aphis gossypii (Homoptera: Aphididae)

This pest attacks all vegetables. They are commonly known as “plant lice” or “nit” and are small, yellow, green or black pinhead-size insects (Figure 3). They are soft bodied, slow moving and multiply rapidly within a short time span.

These insects attack plants at all stages of growth and are usually found in dense clusters on the under surface of the young leaves and also on young tender stems and growing points. They suck plant sap and make the plant weak; some also act as vectors of plant diseases. Seedlings are weakened and killed when the infestation is high, and growth of older infested plants is retarded. Infested leaves curl, shrivel and may turn brown and die.

Aphids secrete a sweet substance known as “honey dew” while they feed.

This substance attracts ants and serves as a substrate for sooty mould (black fungus) thus impairing photosynthesis.

- Lifecycle ranges between 21-28 days.



Fig 2. Adult & Larva of cutworm



Fig 3. Adult & Nymph of aphids

Control

- **Good field sanitation-** rid the field of weeds and plant residues from previous crops.

Biological control:

- The natural predator lady bird beetles frequently feed on aphids. When aphid population is low and lady bird beetles are present, there is no need for chemical control.

Chemical control:

- This may be applied when the population is high. A contact or stomach insecticide may be used such as: Fastac, Decis or Karate at 6mls to 4500mls water, Sevin 85% W.P. (Carbaryl) at 6g to 4500 mls water or Malathion 57% E.C. at 15 mls to 4500 mls water.

N.B. Sprays should be directed to underside/surfaces of leaves when Sevin or Malathion is used. Do not harvest crops until 7 -10 days after application of chemical. In the case of Fastac, Decis or Karate, crops can be harvested within 3-5 days after chemical application.

4. White flies

Bemisia tabaci (Homoptera: Aleyrodidae)

These insects are in fact bugs. The adults are white, moth-like insects that fly upwards from the plant when disturbed. They are about 2 mm in length and their wings are covered with a white waxy powder (Figure 3). The pinhead size nymphs are oval and flattened, and are attached to the leaf surface until maturity. All stages of this pest can be found on the underside of leaves. Nymphs and adults feed by sucking plant sap, resulting in leaves becoming mottled, yellow and brown before dying. Feeding whiteflies excrete honey dew on the leaf surface which encourages the growth of sooty mould thus hampering photosynthesis. Ants are also attracted to the honey dew. This pest is also a vector of viral diseases.



Fig 3. Nymph and adult whitefly

- The life cycle may be completed in about 28-35 days.

Control**Cultural practices:**

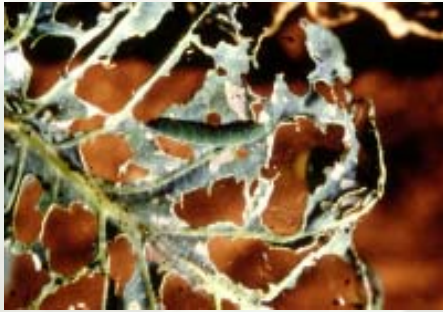
- Do not plant a new crop next to one which is mature: The common practice of having mature crops adjacent to newly planted ones makes management of the pest very difficult since the cycle of the pest is never broken.
- An integrated control strategy is necessary for the effective management of this pest.

Chemical control:

- Several new generation insecticides are now available for the effective control of white flies. Targeting both nymphs and adults with *soap based products* which should be applied very early in the morning or late in the evening is effective. Other chemicals which may be used include Admire, Pegasus and or Basudin/ Vydate L at 10 mls to 4500 mls water.

5. Diamond Back Moth

Plutella xylostella (Lepidoptera: Plutellidae)



Damage



Larva



Pupa



Adult

Fig 4. Various stages of the life cycle of the diamond back moth and damage caused

Diamond back moth is a serious pest of cabbage and other cruciferous crops. The market quality of the crops can be severely reduced by this pest.

Eggs are small and yellowish in colour. The incubation period of *P. xylostella* eggs depends upon temperature.

The larva is green in color with a black head when hatched (Figure 4).

After the first instar, the larvae are surface-feeders and eat voraciously. When fully mature the head turns to a light yellow, and the body to a light green and somewhat fatter in the middle.

It damages leaves by feeding on leaves and cabbage heads. Infested leaves are usually riddled with holes (Figure 4). Larvae also feed on the lower epidermis of leaves and the upper epidermis is left intact as a thin transparent membrane.

Fully grown caterpillars are green and 10-12 mm long (Figure 4).

The pupae are encased in loosely woven cocoons often fastened to the plant parts (mostly leaves) and frequently hidden in crevices near the bud.

Control

Cultural control

- Crop rotation
- Field sanitation

Chemical control

• Decis 2.5% EC-1.5 g/litre water, Ambush 5% EC-1 ml/litre water, Karate 2.5% EC-1.5 ml/litre water, Neem water extract, Dipel-3.5 g/litre water, Agree-3.5 g/litre water, Regent (Fipronil)-10ml/18 litre water are recommended for the control of the diamond back moth.

6. Budworm

Hellula phidilealis (Lepidoptera:Pyralidae)

Budworms are caterpillars (Figure 5), which feed on the young innermost leaves and then bore into the midribs or axils of leaves or into the growing point . The burrowing of the caterpillars into the growing point may result in retarded growth and frequently in the death of the plants. Cabbages often fail to produce heads when the growing point is damaged. Instead lateral buds may develop. The several “heads” formed from the lateral buds of a plant are very small and unmarketable.



Fig 5. Budworm

Control

Crop rotation

- Crop rotation usually helps in breaking the cycle of a pest’s development through the absence of host plants. The repeated planting of any one crop type ensures the availability of host material for development of the pest.

Chemical control

- Decis 2.5% EC-1.5 g/litre water, Ambush 5% EC-1 ml/litre water, Karate 2.5% EC-1.5 ml/litre water, Neem water extract, Dipel-3.5 g/litre water, Agree-3.5 g/litre water, Regent (Fipronil)-10ml/18 litre water are recommended for the control of the cabbage budworm.

7. Cabbage Butterfly

Pieris phileta (Lepidoptera: Pieridae)



Larva



Adult

Fig 6. Larva and adult cabbage butterfly

8. Armyworm

Spodoptera frugiperda (Lepidoptera: Noctuidae)



Larva



Adult

Fig 7. Larva and adult armyworm

Semi-looper*Trichoplusia sp.* (Lepidoptera: Noctuidae)**Larva****Adult****Fig 8. Larva and adult semi-looper**

There are other leaf-eating caterpillars (**cabbage butterfly, armyworm and semi-looper**) (Figure 6, 7 & 8). These are of lesser importance than the Diamond back moth and the budworm; however, they occasionally cause enormous damage to the crop. They usually make large holes on the leaves. This damage is quite different from that caused by the Diamond Back Moth. The presence of these insects is indicated by dark brown to black excreta of the larva.

Control

The similar methods applied for management of the **budworm** and **diamond back moth** may be used to control these pests.

Major Diseases of Cabbage (*Brassica oleraceae*) in Guyana and Management Strategies

1. Black Rot (*Xanthomonas campestris*)

Infection usually occurs near the margins of leaves. Yellow areas develop along the margins, progressing into the leaf. Affected areas are black (Figure 9). The bacterium may attack at all stages of growth. Cabbage is very susceptible to black rot and the interior of the stem may be destroyed by secondary soft rot organisms that attack the black rot infection. It is a seed-borne bacterium. Some wild plants may act as hosts harboring the bacterium. Under crowded conditions in the field and during periods of rain, the bacteria can spread quickly.

Control

- Crop rotation.
- Planting disease-free seed and seed that have been treated to eliminate seed-borne bacteria.

Chemical control

- Use any of the following as directed on the label: Mankocide, Rizolex and Banrot.

**Fig 9. Cabbage infected with black rot**

2. Fusarium Yellow (*Fusarium oxysporum*)

The first indication of the disease is the yellowish-green color of the foliage. Plants appear wilted and stunted (Figure 10). The fungus can live in the soil for a number of years without a host plant. It infects plants through wounds caused by transplanting or insects. The disease is checked by very cold or very hot soil temperature.

Control

- Use resistant varieties
- Crop rotation will avoid crop loss.

Chemical control

- Use any of the following as directed on the label: Carbendazine, Cuprasan, Captan, Kocide, and Mankocide.

3. Alternaria Leaf Spot (*Alternaria brassicae*)

The first symptom is a minute dark spot on seedling stems and on the leaves. These spots enlarge and are marked with concentric rings, giving a bull's eye appearance (Figure 11). Spores are disseminated by wind or water.

Control

- Use resistant varieties
- Hot water treatment, as recommended for black rot, will rid the seed of this organism.
- Fungicide application will prevent the fungus from developing in the field.

Chemical control

- Use any of the following as directed on the label: Carbendazine, Cuprasan, Captan, Kocide, and Mankocide.

4. Soft Rot (*Erwinia carotovora*)

Soft rot occurs most commonly when fields become water saturated. Stems become decayed and have a foul odor (Figure 12). During storage and transit, a slimy decay with a foul odor develops. The disease begins in areas that have been bruised, particularly during periods of high temperature and humidity prevail.

Control

- Crop rotation
- Plant on raised beds in well drained soil to prevent field infections.

Chemical control

- Use any of the following as directed on the label: Mankocide, Rizolex and Banrot.



Fig 10. Cabbage infected with fusarium wilt.



Fig 11. Symptoms of alternaria leaf spot



Fig 12. Symptoms of soft rot

5. Cabbage Mosaic Virus (CMV)

Aphids can acquire the virus by feeding on infected plants for 1-2 minutes and then thereafter transmit it within one minute to healthy plants.

Although numerous aphid species are able to transmit the virus, in many instances *Myzus persicae* and *Brevicoryne brassicae* are largely responsible for the spread. Levels of infection are closely correlated with the occurrence and size of populations of vector aphids. The major sources of infection are older infected crops grown nearby and from infected seedlings from seedbeds.

Leaves display green and yellow mottled areas. Leaf veins may be lighter in color (Figure 13).

Control

- Keeping fields and surrounding areas free of weed hosts will help reduce the disease.

Chemical control

- Decis 2.5% EC-1.5 g/litre water, Ambush 5% EC-1 ml/litre water, Karate 2.5% EC-1.5 ml/litre water, Agree-3.5 g/litre water are Regent (Fipronil)-10ml/18 litre water are recommended for the control of CMV.

Harvest Maturity Indices

Determining the optimal time to harvest cabbage is often difficult and differs between heading and non-heading types. Most heading-type cultivars are ready to harvest several months after transplanting. The principal harvest maturity index is based on size.

Heading-type cabbage may be harvested as small as 10 cm (4 in) in diameter and continued until 15 cm to 25 cm (6 in to 10 in). Harvest maturity for heading-types is also based on head compactness and firmness to the touch (Figure 14). A firm or compact head is mature. A compact head can be only slightly compressed with moderate hand pressure. A very loose head is immature and should not be harvested (Figure 15). Harvest maturity may also be based on arrangement of the wrapper leaves; when they are spread and the head is exposed it is usually mature. A mature cabbage has a well-developed head and good weight in comparison to its size. Mature cabbage has a longer postharvest life than immature cabbage.

Cabbage should be harvested promptly when the heads are firm and mature. Delaying harvest even a few days beyond maturity can result in split heads and increased incidence of field disease, particularly during wet weather. Pak choi type cabbage is usually ready for harvest within 7 weeks after transplanting, although this may vary according to cultivar and environmental conditions.



Fig 13. Symptoms of cabbage mosaic virus



Fig 14. Mature compact cabbage head ready for harvest.



Fig 15. Immature loosely compact cabbage head

Size is the principal indicator of harvest maturity and this is largely based on market demand. Pak choi should have well-formed upright petioles tightly adhering together (Figure 16). Pak choi should always be picked when leaves are fresh and crisp and before the outer leaves turn yellow.

Harvest Methods

Cabbage is harvested by hand by bending the head (or stalk in the case of pak choi) to one side and cutting it with a sharp knife or small machete. The cutting instruments should be sharpened frequently to reduce harvesting effort and lessen picker fatigue.

The head should not be removed by snapping or twisting it, as this practice damages the head and results in jagged appearing stems which extend too far out from the base of the head. Broken stems are also more susceptible to decay. The stalk should be cut flat and as close to the head as possible, yet long enough to retain two to four wrapper leaves. Extra leaves act as cushions during handling and may be desired in certain markets. Yellowed, damaged, or diseased wrapper leaves should be removed. Heads with insect damage and other defects should be discarded. In the case of pak choi types, any damaged or dead leaves should be removed and the base should be trimmed flush with the first petiole.

Cabbage should be put in baskets or well-ventilated picking containers and taken out of the field immediately after harvest. Cabbage put in non-ventilated field sacks will heat up due to tissue respiration and start to wilt. It is recommended that harvesting be conducted during the coolest time of the day, preferably in the morning when the head is most turgid. It is essential that heads not harvested be left undamaged because fields may be harvested as many as three times for maximum yield.

Preparation for Market

Harvested cabbage is particularly susceptible to wilting and should be removed from the field and direct sunlight as soon as possible. The cabbage should be taken to a wellventilated shaded area for packing and transport to market (Figure 17). When there is a delay of more than an hour or two between harvest and packing, a spray of clean water to the leaves can help prevent dehydration.

A simple field packing station can be constructed from wooden poles and a sheet of polyethylene. Thatch over the roof will provide shade and keep the station cool. The structure should be oriented so that the roof overhang keeps out the majority of the sun's rays.



Fig 16. Ideal harvest stage for pak choi.



Fig 17. Harvested cabbage should be taken to a shaded, wellventilated packing area.

Cleaning

The first step in preparing cabbage for market is to remove the torn and loose outer wrapper leaves so the head has a clean, compact, and fresh appearance (Figure 18).

Only 3 to 6 tight wrapper leaves should be left on the head. Loose leaves interfere with ventilation between heads, which is important whether the cabbage is packed for market or put into storage.

The stem end should be trimmed close to the base of the head so it does not protrude more than 2 cm (.75 in). A fresh cut of the stem end will be necessary if it is discoloured. However, it is very important not to cut the stem end too short so part of the base of the head is cut. This will cause a loss of wrapper leaves and head integrity (Figure 19).



Fig 18. Trimmed and cleaned cabbage heads ready for sorting and packing.



Fig 19. Trimming the stem end too short (center and left heads) destroys head integrity.

Pak choi will also benefit from re-cutting the base if it is discoloured or damaged (Figure 20).



Fig 20. Well-trimmed stem end of pak choi ready for packing.

Sorting

Cabbage should be sorted according to size, shape, and compactness of the head. There are 3 established size categories (small, medium, large) for domestic marketing of cabbage, based on the weight of the head. Small sized heads weigh 0.8 kg (1.7 lb) or less, medium sized heads weigh between 0.9 kg and 1.4 kg (1.7 lb and 3 lb), and large sized cabbage heads weigh 1.5 kg (3 lb) or more. Only the cabbage with crisp and turgid leaves should be packed for market. The heads should be a colour typical of the cultivar (i.e. green, red, or pale yellow-green), firm, heavy for the size and free of insect, decay, seed stalk development and other defects.

Packing

Heading-type cabbages are generally packed in fiberboard cartons, wooden or wire-bound crates, or mesh bags holding about 23 kg (50 lb). Uniformity of head size and the proper count per carton are important. Normally 18 to 22 heads are packed in a 23 kg (50 lb) container. Cartons and crates are easier to stack and load and provide considerably more protection to the cabbage than mesh bags (Figure 21).

Pak choi cabbage should be packed in fiberboard cartons usually holding between 10 kg to 18 kg (22 lb to 40 lb), depending upon market preference. Pak choi may be bunched into groups of 3 to 5 plants using a string or rubber band. Care must be taken as plants bruise easily.



Fig 21. Uniform sized cabbage packed in strong well-ventilated wooden crates.

Temperature Control

The optimal storage temperature for all cabbage types is 0°C (32°F). This maintains a very low respiratory activity in the cabbage and greatly inhibits decay. Chinese cabbage is much more perishable than heading types and should be cooled within several hours after harvest and held as close to the ideal postharvest temperature of 0°C (32°F) as possible. The maximum market life of pak choi under ideal conditions is 2 weeks. At ambient temperatures the pak choi leaves will rapidly wilt and become unmarketable after only 1 to 2 days. The need for immediate cooling after harvest is not as necessary for heading types of cabbage. However, for maximum storage life, heading types should be cooled within a day after harvest. Market life at 0°C will be 4 to 6 weeks.

Deterioration of cabbage is accelerated under non-refrigerated temperatures and is associated with discolouration of the stem end, leaf wilting, loss of fresh green colour, and postharvest decay. Storing cabbage at ambient temperature will require extensive trimming of the leaves to maintain a marketable head.

Relative Humidity Control

Cabbage is a leafy vegetable susceptible to significant moisture loss and wilting after harvest. The high surface area and numerous openings in the leaf surface (stomates) make an easy route for tissue water loss. In order to minimize the loss of crispness and wilting of the leaves it is very important to maintain a high relative humidity (RH) in the storage atmosphere. The optimal RH for cabbage is 95%. Pak choi can be stored at 0° C (32°F) for several weeks, as long as the relative humidity is greater than 85%.