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GOOD PRACTICES FOR CABBAGE CULTIVATION

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Introduction

Cabbage (*Brassica oleracea var. capitate*) is an important and popular vegetable crop in Sri Lanka. Although it can be successfully cultivated under cool climatic conditions in mid- and up-country areas, heat-tolerant varieties can be grown in dry zones in low-country areas. Cabbage is widely grown in Nuwara Eliya, Badulla, and Kandy districts.

Types of cabbage

Different types of cabbage are grown worldwide, and some of them are as follows.

1. Green cabbage
It is the most common and popular type of cabbage, and its tightly compacted leaves form a large cabbage head. The outer leaves of the head are typically light green, whereas the inner leaves are pale green or white.

Photo: Shutterstock.com

2. Red cabbage
This is similar to green cabbage except for its red color and typically shows a slow growth pattern. Although cabbage heads are comparatively smaller than green cabbage heads, they have a higher market value.

Photo: Regional Agricultural Research and Development Centre (RARDC), Bandarawela.

3. Napa cabbage or Chinese cabbage
This type of cabbage does not resemble a head cabbage; it forms an oblong shape with a loosely compact head.

Photo: Shutterstock.com

4. Savoy cabbage
Like green cabbage, its crinkled, emerald, green leaves are crunchy with a slightly elastic consistency on the palate.

Photo: RARDC, Bandarawela

Popular varieties in Sri Lanka
Green coronet; Shishiro; YR Natsubara F11.

Nutritional importance
Cabbage is an important source of protein, carbohydrates, vitamins A and C, and minerals, such as calcium and phosphorus.

Soil
Well-drained loamy soil with an adequate amount of organic matter is good for cabbage. The optimal pH range was 6-6.5. The incidence of club root disease is higher when the soil pH is low or acidic. It is recommended to add lime or dolomite to increase the pH or sulfur to lower it, depending on the soil pH.

Nursery management

Raised bed Nursery
Select suitable land and prepare 1 x 3 m size and 10 cm height raised beds. Then, add nursery media (compost: topsoil- 1:1 ratio mixture) to the nursery bed, making it 15cm in height. Drench the nursery beds with Captan 50WP or Carbendazim 50WP at 32g/16 liter of water 5 days before seed sowing. Established seeds 10 cm

apart rows to a depth of 1 cm. Cover the seed using sterilized nursery media and mulch over the bed. Remove mulch soon after seedlings are germinated. Ten beds are sufficient to raise seedlings for one ha cultivation.

Healthy seedlings using nursery trays
Nursery trays with 98 cells are ideal for cabbage seedling production. Around 600 trays are required to produce seedlings for one ha of land in a recommended spacing of 50 x 40 cm. Fill the tray with sterilized topsoil, sand, and compost with a ratio of 3:2:1. Add a single seed for the seedling hole. Cover the seeds with cocopeat and ensure sufficient moisture for germination. Keep the trays one over the other (8-10 trays in one stack) while covering them with a polythene sheet until germination starts. After germination, arrange the seedling trays on the raised beds inside the shade net. Then, the seedlings should be managed properly for up to 21-25 days for transplanting.

Seed requirement

200 – 250 g / ha.
It is always advantageous to grow seedlings under covered low tunnel structures to protect them from rain and insect pests. Such dome structures can be erected on nursery beds using bamboo, TMT steel bars, and PVC pipes, which are covered with 50% shade net.

Land preparation

Plough up to a depth of 40 cm. Add lime (1000 – 2000 kg/ha) based on soil acidity (generally upcountry soils) at land preparation or 14 days before crop establishment. If the soil pH is high (basal soil), add sulfur to lower it (generally dry zone soils). Prepare the planting beds with the appropriate width. It is advisable to make 3 or 4 planting rows per plot.

Planting

21 to 25 days old seedlings that are properly maintained in the nursery are suitable for planting. Seedlings have to be hardened about one week before planting by gradually reducing the irrigation and opening to direct sunlight. Irrigate twice a day after transplanting to ensure proper establishment.

Spacing

The recommended plant spacing is 50 x 40 cm (50,000 plant/ ha). Most cabbage varieties produce larger heads, approximately 1.5 kg to 2 kg in head weight under this spacing. Some research findings revealed that a higher yield (78.41 kg/ha) and consumer preferable size of the head (0.75 – 1 kg) could be obtained using plant spacing of 40 cm x30 cm (83333 plants/ha).

Fertilizer

Organic manure should be applied 3–5 days before planting at a rate of 10 Mt/ha and mixed well with soil. Then, follow the chemical fertilizer recommendation given below.

Time of application	Urea kg/ha	TSP kg/ha	MOP kg/ha
Basal	110	270	75
After 3 weeks	110	-	75
After 6 weeks	110	-	75

Irrigation is crucial in the head development stage, and irrigation is recommended every day during dry weather.

Weed control

Weeds are controlled by intercultural operations or by the use of suitable mulches. Weeds must be managed before applying the top dressing of fertilizer.

Pest management in cabbage

Pest damage to crops can greatly reduce the yield and quality of products. Therefore, correct identification and proper management practices are needed on time.

i. Diamondback moth – *Plutella xylostella*

Damage symptoms
The larvae feed on the lower surface of the leaves with their chewing mouthparts. It feeds voraciously on leaves, leaving the papery epidermis intact (Figure 1). Severe infestation results in the complete removal of foliar tissue, except for leaf veins, and disturbs head formation in cabbage.

Figure 1. Adult diamondback moth and damage symptoms.
Photos: Shutterstock.com and RARDC, Bandarawela.

Management of diamondback moth

- Grow mustard as an intercrop in the cabbage field (1 row of mustard after 20 rows of cabbage). Periodically spray the mustard rows with Flubendiamide 24% WG at 6g/16 litres of water, or Spinosad 25 g/l SC at 16ml/16 litres of water or Spinetoram 25% WG at 4g/16 litres of water to avoid the dispersal of the larvae. Do not repeat the same insecticide in repeated sprays.

- Intercropping cabbage with carrot, onion, and radish (two rows of cabbage and one row of intercropping).

- Install pheromone traps at 12 traps/ha to attract diamondback moth males and reduce pest breeding in the field.

- If the incidence is higher, spray any of the following insecticides and repeat at 2-week intervals if necessary.

Do not use the same insecticide as repeated sprays.
- Flubendiamide 24% WG at 6 g/16 litres of water.
- Spinosad 25 g/l SC at 16 ml/16 litres of water.
- Spinetoram 25% WG at 4 g/16 litres of water.

ii. Cabbage looper- *Chrysodexis eriosoma*

Damage symptoms
In the early stages, the larvae feed on the lower leaf surface, leaving the upper surface intact. In the next step, they make irregular holes but usually do not feed on the leaf margins (Figure 2). They may also bore into the developing cabbage heads. In severe infestation, the larvae consume the entire leaf tissue, leaving the midribs, main veins, and skeletonizing leaves. In addition, larval excretion is found at the base of the leaves.

Figure 2. Cabbage looper and infestation.
Photo: RARDC, Bandarawela.

Management of cabbage caterpillar complex
- Proper nursery management.
- Regular field monitoring.
- Crop rotation.
- Destroy crop residual after harvesting.
- Proper field sanitation.
- Use of bio pesticide *Bacillus thuringiensis*.
- Use of blacklight traps and pheromone traps.

Chemical control
Protect predators and parasitoids by avoiding unnecessary use of broad-spectrum pesticides.

- Emamectin benzoate 5%SG - rate of application 8g/16l of water.
- Etofenprox 100g/l EC - rate of application 24 ml/16l of water.
- Chlorfluazuron 50g/l EC - rate of application 16ml/16l of water.
- Bistrifluron 100g/l EC - rate of application 24 ml/16l of water.
- Tebufenozide 200g/l SC - rate of application 24 ml/16l of water.
- Chromafenozide 50g/l SC - rate of application 32 ml/16l of water.
- Chlorantraniliprole 200g/ SC - rate of application 6ml/16l of water.
- Lufenuron 50g/l EC - rate of application 16ml/16l of water.
- Spinosad 25g/l SC - rate of application 16ml/16l of water.
- Flubendiamide 24% WG - rate of application 6ml/16l of water.

iii. Black cutworm-*Agrotis* spp.

Adults are grey moths belonging to the family Noctuidae. They have a series of distinctive dark markings on their forewings and lighter-colored hind wings. The dark gray to black larvae have a greasy appearance and grainy texture. Mature larvae grow to 3–4 cm in length (Figure 3). When disturbed, the cutworms curl up into a tight C-shape.

Damage symptoms
Young seedlings are damaged close to the ground, often cutting down the entire plant at the base. Cut several plants in a single night and pull the plant stem belowground. Sometimes, entire seedlings may be eaten by larvae. Cut seedlings show wilting during the daytime.

Figure 3. Adult moths and larvae of the black cutworm.
Photo: RARDC, Bandarawela.

Management
- Plough the soil deeply to bring the larvae and pupae to the surface of the soil.
- Regular monitoring of the field.
- Hand collecting and destroying the caterpillar.
- Proper field sanitation.
- Encourage predatory birds to preying the worms during the tillage operation.

Chemical control
One of the following insecticides should be applied in the collar region of the plant during the evening hours once cutworm damage is observed.
- Profenophos 500 g/l EC at the rate of 32 ml per 16 l of water.
- Etofenprox 100g/l EC at the rate of 24 ml per 16 l of water.

iv. Aphids

Cabbage aphids are green in color and commonly occur in dense colonies. Adults can either be winged or wingless (Figure 4).

Figure 4. Aphid colonies in cabbage leaves.
Photo: RARDC, Bandarawela.

Damage symptom
Cabbage aphids prefer young leaves. Feeding injuries include wrinkled and downward-curled leaves, yellow leaves, and reduced growth. Contamination of the marketable parts of plants with aphids is frequently the biggest problem, as is contamination with aphid honeydew and growing sooty molds.

Management
- Monitoring aphid populations visually or placing yellow sticky traps at a rate of 15-20 traps/ha.
- Weed control in crop fields reduces the availability of alternative host plants.
- Overhead irrigation.
- Protect predators and parasitoids by avoiding unnecessary use of broad-spectrum pesticides.

Chemical control
Apply any of the following insecticides and repeat in 2-3 weeks intervals, if necessary, but do not repeat the same insecticide.

- Thiamethoxam 25% WG - rate of application 5g /16 l of water.
- Imidacloprid 70%WG - rate of application 2g /16 l of water.
- Chlorantraniliprole 20% + Thiamethoxam 20% WG - rate of application 5g /16 l of water.
- Buprofezin 25% SC - rate of application 45ml per 16 l of water.
- Azadirachtine 5%EC - rate of application 16ml per 16 l of water.

Diseases management in cabbage

i. Cabbage club root disease

The causal agent is a soil-borne fungus named *Plasmodiophora brassicae.* The features of club root disease infected cabbage plants are shown in Figure 5.

Symptoms
- Wilted plant in the daytime and recovering in the evening.
- Stunting and yellowing of plants.
- Club like swelling of the root system.

Figure 5. Club root infected cabbage plants.
Photo: RARDC, Bandarawela.

Management
- Use of disease-free planting materials.
- Increase soil pH by adding lime (2 t/ha), two weeks before planting.
- Crop rotation with non-cruciferous crops.
- Treat seeds with *Pseudomonas fluorescens* at 10 g/kg of seeds before planting, followed by seedling dip in *Pseudomonas fluorescens* 5 g/litre before transplanting.
- Remove weed host plants such as wild mustard.
- Use clean equipment at the land preparation and intercultural practices.

ii. Black rot

Cabbage black rot is a bacterial disease. The pathogen is *Xanthomonas cammpestris*.

Symptoms
First, angular-shaped chlorotic or yellow areas appear near the leaf margins. These areas slowly extend to veins and midribs, forming characteristic "v"-shaped chlorotic spots. Finally, these patches, veins, and veinlets turn black. The vascular blackening extends to the stem through the midrib and petiole (Figure 6).

Figure 6. Black rot disease in cabbage.
Photo: RARDC, Bandarawela.

Management
- Use of healthy seeds.
- Field sanitation.
- Maintain proper drainage.
- Crop rotation with non-cruciferous crops.
- Follow proper pest management practices since pests can act as vectors.
- Continuous field monitoring to remove and destroy infected plants.

iii. White mold disease

White mold disease is caused by the fungus *Sclerotinia sclerotiorum*.

Symptoms
Water-soaked lesions on the leaves or crown of the plant are the major symptoms of the disease. Later, a fluffy mass of white mycelia can be seen on the infected area (Figure 7).

Figure 7. White mold disease symptoms in cabbage.
Photo: RARDC, Bandarawela.

Management
- Select a non-infected field for cultivation.
- Remove and destroy crop residues before land preparation.
- Plough the field deeply and expose it to sunlight for two weeks.
- Maintain proper planting space.
- Field sanitation: remove infected plants with the soil surrounding the plant.

Chemical control
- Carbendazim 50g/l WG – rate of application -7g/10l of water.
- Carbendazim 500 g/l SC – rate of application -7ml/10l of water.

iv. Cabbage ring spot

Cabbage ring spot is a major disease of brassicas caused by a fungus, *Mycosphaerella brassicola*.

Symptoms
The fungus causes light brown to grey spots surrounded by a yellow halo. The spots are limited to veins and are angular. Black spores develop in concentric circles at the center of the spot (Figure 8).

Figure 8. Cabbage ring spot.
Photo: RARDC, Bandarawela.

Management
- Use of healthy planting materials.
- Field sanitation.
- Remove alternate host weeds.
- Avoid overlapping of plants by keeping proper spacing.

Chemical control
On the appearance of disease, spray the crop with Hexaconazole 50 g/l EC at 6 ml/16 liters of water or Tebuconazole 250 g/l EW at 6 ml/16 liters of water.

v. Downy mildew

Caused by the parasitic fungal pathogen *Peronospora parasitica.*

Symptoms

Infected cabbage plants develop yellowish lesions on the upper surface of the leaves (Figure 9). When closer inspection, a greyish-purple fungal growth, known as the downy mildew sporulation, can be observed on the lower surface of the infected leaves.

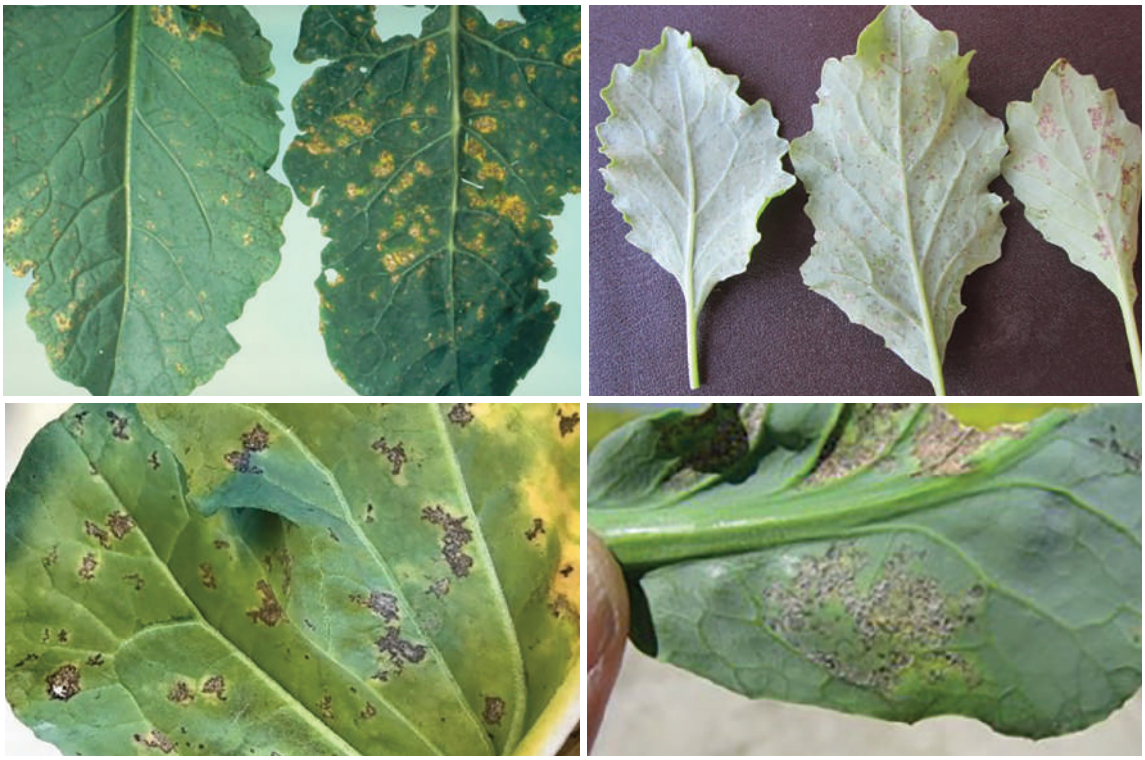

Figure 9. Downy mildew symptoms.
Photo: RARDC, Bandarawela.

Management

- Field sanitation.
- Weed control.

Chemical control
After symptoms appear, spray the crop with Captan 50% WP at 32 g/16 liters of water, Maneb 80% WP at 32 g/16 liters of water or Mancozeb 80% WP at 32 g/16 liters of water.

Harvesting

Cabbage can be harvested 90-110 days after planting. The potential yield is 40-45 t/ha, and may depend on the variety, management practices, and climatic conditions.

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