



Field Guide to
**Non-chemical
Pest Management**



**in Cabbage
Production**





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Non-chemical

Pest Management

in Cabbage

Production

**for small scale farming in
the Tropics and Sub-tropics**

Pesticide Action Network (PAN).

Founded in 1982, the Pesticide Action Network is an international coalition of over 600 citizens groups in more than 60 countries, working to oppose the misuse of pesticides and to promote sustainable agriculture and ecologically sound pest management.

PAN Germany was established in 1984 as part of this global network and has continually been involved in initiatives to reduce the use of hazardous pesticides and to promote sustainable pest management systems on national, European and global levels.

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Prologue

Pesticides worth more than 30 billion US dollar are intentionally released into the global environment every year. A high proportion of these is highly toxic and has immediate adverse effects on human health, wildlife, local food sources such as cattle or fish, beneficial insects and biodiversity. Some of them have chronic effects including cancers, reproductive problems, birth defects, hormonal disruption and damage to the immune system. Impacts come from direct exposure in use, spray drift, washing work clothes used while spraying, home pesticide storage, pesticide dumps, and persistence in the environment.

Overall aim of the international *Pesticide Action Network (PAN)* is to eliminate the use of hazardous pesticides, reduce overall use, risk and dependence on pesticides, and increase support for community-based control over a sustainably produced food supply. PAN is committed, in its projects, strategies and campaigns to place pesticide concerns in the broad political and economic context in ways that will advance the fight against rural poverty and enhance pro-poor development and ethical trade. PAN aims to help local communities use the initiatives to benefit their day-to-day lives.

PAN Germany is part of the international Pesticide Action Network. It is supporting non-chemical pest management on tropical

crops that are commonly grown by small landholder farmers through the project: Online Information Service for Non-chemical Pest Management in the Tropics, OISAT (www.oisat.org). OISAT is a web-based system to distribute information on non-chemical pest management that is easy to read and easy to understand. Information provided via www.oisat.org is relevant to small-scale farmers who intend to produce crops using safer and more affordable non-chemical pest management practices. It provides varied information on how to lower the cost of production based on recommended insect/mites pests, disease, and weeds control methods.

The 'Field guide to Non-chemical Pest Management in Cabbage Production' is an excerpt taken from the PAN Germany website www.oisat.org. It enables to provide farmers with practical guides and alternatives to eliminate the use and their dependence on synthetic pesticides for the management of cabbage pests. The recommended practices are safer, more affordable, and easy to follow. Most of the farm practices, the farmers can do by themselves and the materials that are needed are found in their backyards or in their kitchens or can be purchased in the local agricultural suppliers.

Carina Weber
(Executive Director PAN Germany)

How to use this field guide

This manual is designed to let you grow cabbage as easy as possible.

It provides you the suggested appropriate management practices on how to grow cabbage. In the pest pages, each pest has a brief description of its lifecycle, damage it causes, and its control measures. It is very important to know how the insect/mite pest develops because the adult does not always

For example, you notice that the leaves have holes when you're out in the field. What would you do? First, have a closer and careful examination of your plant. If you find the pest and can't identify it, turn the following pages and look at the illustration of an insect and/or the damage or symptom in each pest entry. Once you have identified the pest, look into the corresponding control measures on how to eliminate and/or lessen its population density. You have various options like: cultural practices; physical control (e.g. handpicking); plant extract (e.g. ginger spray); other homemade solution (e.g. soap spray); other method (use of baits).

cause the damage and sometimes it is not even found where the damage occurred. Included in the control measures are cultural practices, physical control, plant extracts, other homemade solutions, and other practical methods. Also, as not to confuse you with the beneficial insects, a separate page with photos of them and their conservation and management are included.

However, with every effort made to provide you with complete information on the pest control in cabbage growing, the recommendations may vary from every location. It is highly suggested that you have to try the various control practices in small scale especially for the plant extracts and other homemade solutions, in order to make adjustments that are adaptable to your local farm conditions before going into large scale application.

Fill up the forms at the end of this manual to have a record of activities each time you grow cabbage.

Recommended practices

Throughout this field guide you will find suggestions for stopping or lessening the pests' population before they have control over your cabbage field. To make a plan for you to grow a healthy crop, the following tips are the steps you ought to take:

1. Learn to identify the insects,
2. Select the proper variety that is well adapted to your local conditions,
3. Always select good and disease-free seeds. If possible, treat seeds to kill seed borne pathogens and insect pests.
4. Have a healthy soil, and always keep in mind that over-fertilizing isn't necessarily better.
5. Practice crop rotation by planting on the next cropping season-crops of a different family group,
6. If possible practice intercropping to improve the field's bio-diversity and to encourage natural enemies.
7. Follow the recommended planting distances,
8. Prepare the soil thoroughly by appropriate tillage.
9. Always practice proper field sanitation by removing and pruning infested plant parts, keeping the area free of weeds and other plant residues, and cleaning regularly all farm tools and implements.
10. Monitor your plants regularly,
11. When in doubt, always ask for assistance from experts.

When controlling pests using the plant extracts and other homemade solutions, the following are the standard procedures for their preparation and application:

1. Select plants/plant parts that are pests-free.
2. When storing the plants/plant parts for future usage, make sure that they are properly dried and are stored in an airy container (never use plastic container), away from direct sunlight and moisture. Make sure that they are free from molds before using them.
3. Do not use cooking and drinking utensils for the extract preparation. Clean properly all the utensils every time after using them.
4. Do not have a direct contact with the crude extract while in the process of the preparation and during the application.
5. Make sure that you place the plant extract out of reach of children and house pets while leaving it overnight.
6. Always test the plant extract formulation on a few infested plants first before going into large scale spraying.
7. Wear protective clothing while applying the extract.
8. Wash your hands after handling the plant extract.

I. Introduction

About Cabbage

Scientific name: *Brassica oleracea*

Family: Crucifers (*Brassicaceae*, formerly: *Cruciferae*)

Uses

Cabbage is used as vegetables, fresh cut salads and sauerkraut. The field by-products are good source of animal feeds.

Advantages of Cabbage

Cabbage contains mustard oil that give them distinctive odor and taste. It is an excellent source of vitamins A and C and calcium. Studies show that crucifers (cabbage, broccoli, cauliflower, etc) are particularly effective against colon cancer and also protect against cancers of the skin, breast, stomach, bladder, liver and lung; provided there are not much pesticide residues.

II. Climatic and soil requirement

Temperature requirement: 15 - 20° C.

Soil requirement: Loam soil with good drainage

Soil pH: 5.5 - 7.5 pH

III. Seedling production in seedbeds

Seed requirement

200 – 250 g of certified seeds needed for a hectare area.

Seedbed preparation

Seedbed is prepared approximately 5 - 15 cm high and 1.0 m wide.

Apply a thin layer of compost on the seedbed before mulching (with rice straw).

In a square meter seedbed, incorporate 40 g ammonium sulfate, 50 g super phosphate, 30 g potassium chloride, and 2 kg/ compost. Commercial inorganic fertilizer could be skipped for organic farming. Ask assistance from the local agriculturist office for advice in growing organic cabbage and in order to maintain and supply the nutrient requirement of the plant.

Protect the seedbed with a net or shed to prevent the seedlings from early pest infestation, heavy rain, and direct sunlight.

Sowing

In the seedbed, sow 15 -20 seeds per 30 cm (1 foot) at a depth of 0.5–1.0 cm.

In plug container (grown under greenhouse), sow 2–3 seeds per pot at a depth of 0.5–1.0 cm

Optimum temperature requirement for germination is 20–25°C. The seeds germinate after 3–5 days

Thinning

In plug container, leave only 1 healthy seedling (removing 1-2 unhealthy ones) during the first leaf stage

Hardening

Five (5) days before transplanting, gradually expose seedlings daily to strong sunlight and also reduce the water supply to lessen stress of the seedlings after transplanting

Transplantation

30 - 40 days after sowing (when seedlings have 5-6 leaves or when they are 3 - 5 cm tall)

Water the seedbed before uprooting the seedlings. Select only the healthy and hardened seedlings. Transplant them very early in the morning or late in the afternoon to prevent them from extreme sunlight and water stress.

The field for planting must be watered thoroughly

Distance of planting

The planting distance may vary according to variety, planting season, and soil conditions.

In between rows and in between hills

40-50 cm x 35-45 cm; 40-50 cm x 25-40 cm;

45cm X 45 cm; 60 cm X 45 cm, 60cm X 60 cm; 75cm

X 60 cm, 100-150 cm x 35-45 cm

IV. Field preparation

Plow and harrow the field until the soil is fine, level and free of weeds and plant debris. Form the bed with a plow by opening furrows to a depth of 20 cm during the dry season or at least 30 cm during the wet season.

Seed requirement for direct seeding

600g - 1.5 kg of seeds/ha are needed for direct seeding if the planting distance ranges from 100 - 150cm in between rows and 25 - 45 in between hills.

3 kg/ha if the distance of planting ranges from 40 - 50cm in between rows and 25 - 45 in between hills.

V. Fertilization

Cabbage needs plenty of nutrients. NPK is needed for head formation. However, excess nitrogen (N) may cause loose head formation and internal decay. Potassium (K) deficiency can result in marginal necrosis and lower head quality, but its excess can cause the heads to open. The plants have high Sulfur requirement; sensitive to deficiencies of Calcium, Magnesium, and Boron.

The general fertilizer recommendation: 100 - 150 kg/ha N: 50 - 65 kg/ha P: 100 - 130 kg/ha K. Split the recommended fertilizer amount into 3 and apply it as basal, 3 weeks after transplanting, and during heading.

During land preparation, incorporate 10-20 tons of manure/ha.

Remember that these are just general recommendations. Proper adjustments should be made according to your local soil conditions. To be sure, soil analysis is highly recommended to determine nitrogen, phosphorus, and potassium requirements of your soil. Commercial inorganic fertilizer could be skipped for organic farming. Ask assistance from the local agriculturist office for advice in growing organic cabbage and in order to maintain and supply the nutrient requirement of the plants.

VI. Water requirement

Cabbage needs sufficient amount of water after transplanting and during head formation. Water daily until the plants establish fully. Always water the plants when wilting happens. However, the plants are very sensitive to flooding. During rainy season, appropriate drainage canals must be in place to drain off the excess water after a heavy rain.

VII. Pests, its damage & control measures

Weeds

Weeds are the unwanted plants found in your fields and gardens. They compete with your crops for nutrients, moisture, and sunlight which can decrease the crop quality, higher the production costs due to increase cultivation and hand weeding, and considerably reduce the crop yields. They also serve as the alternate hosts of insect/mite pests and diseases.

Preventative methods

- Thorough land preparation, example: by plowing and harrowing
- During the seed bed preparation, make sure that the seed bed is free of weeds.
- Place the fertilizer where the crop has the access to it but the weeds do not. This allows the crop to be more competitive with weeds.
- Maintain cleanliness on the drainage canals
- Keep the surroundings of your farm free of weeds, unless they are maintained and intended as habitat for natural enemies
- Mulching: Use rice straw as mulch to partially control weed. Apply straw perpendicularly to the rows at a rate of 5 t/ha. Apply mulch within a few days after transplanting.
- Crop rotation. Do not continuously plant crucifers on the same area.
- Regularly monitor the status of your crops

Mechanical and physical practices

- Hand weeding. The weeds are easier to control on their earlier growing period. If possible, do not let the weeds to flower. Remove them from the field before they start to flower. The weed-bearing seeds that are removed should not be placed in compost pile for the seeds may not be killed in the process of decomposition. The compost might be the source of the reintroduction of weeds into your fields.
- Hoeing, mowing, and cutting

Insects/Mites

At the different growth stages of cabbage pests might occur. Table 1 shows the pests that can infest cabbage in its different growth stages.

Growth stages	Insect/mite Pests
0 stage - Seeds	<i>Ants</i>
Seedling stage - Leaves and leafstalks - Roots	<i>Cutworm</i> <i>Aphids</i> <i>Diamondback moth</i> <i>Flea beetles</i> <i>Whiteflies</i> <i>Cabbage root maggot</i>
Vegetative stage (true leaf development up to cupping) - Leaves and leafstalks	<i>Aphids</i> <i>Cabbagehead caterpillar</i> <i>Cabbage looper</i> <i>Cabbage webworm</i> <i>Cabbage white butterfly</i> <i>Diamondback moth</i> <i>Flea beetles</i> <i>Spider mites</i>
Maturation stage (Pre head formation up to head fill) - Developing and maturing head - Roots	<i>Aphids</i> <i>Cabbagehead caterpillar</i> <i>Cabbage looper</i> <i>Cabbage webworm</i> <i>Diamondback moth</i> <i>Cabbage root maggot</i>



growth distribution in the field, and an increased incidence of diseases caused by the mentioned insect pests.

Description

Eggs are delicate, soft, white, and are laid in clusters of 75-125 eggs.

The larva is grub-like, legless, very soft, and whitish in color. It inflicts no damage as it depends on the worker ant (older sibling) for care and food.

The pupa is whitish and develops inside the ant's nest. It has visible legs and in some cases, wings. The pupal stage is the transitional stage between the larva and the adult which emerges during the final molt.

An adult ant varies in color, from blackish to reddish-brown depending on its species. It has robust mandibles with strong teeth that could inflict painful bites. It has elbowed- antennae, a thin waist, and if it is winged, the hind wings are smaller than the front wings and have few veins.

Ants are also beneficial insects because they prey on termites, eggs, pupa, and caterpillars of other insect pests. Nevertheless, **ants should not be introduced into vegetable gardens for insect pest control.**

Suggested control practices

Cultural practices

1. Increase the seeding/seedling rate. This practice turns out cheaper than with the use of insecticide.
2. Control aphid, whitefly, and other insects that excrete honeydew. The ants are likely to be found in plants infested by these insects because they protect them for their food.

Spray solutions

Ant oil spray

Mix 2 tbsp dish washing soap, 2 tsp vegetable oil, 2 tbsp salt, and few drops of vinegar into 4 liters of water.

Ants

Damage

Ants take the sown seeds back to their colony and feed on germinating seeds and on young seedlings. They tend insect pests like aphids, scales, whiteflies, mealybugs, and other honeydew producing insects. These actions result in missing hills, thus loss of plant stand, uneven



Aphids



Damage

Both the nymphs and the adults pierce the plant tissues to feed on plant sap. The infected leaves become severely distorted when the saliva of aphids are injected into them. Heavily infested ones will turn yellow and eventually wilt because of excessive sap removal. The aphids' feeding on the plant causes crinkling and cupping of leaves, defoliation, and stunted growth.

Aphids produce large amounts of a sugary liquid waste called honeydew. A fungus, called sooty mold, grows on honeydew deposits that accumulate on leaves and branches, turning leaves and branches black. The appearance of a sooty mold on plants is an indication of an aphid infestation.

Description

The eggs are very tiny, shiny black, and are found in the crevices of bud, stems, and barks of the plant.

The nymphs look like the young adults, mature within 7-10 days, and are then ready to reproduce.

The adults are small, 3-4 mm long, soft-bodied insects with two projections on the rear end and two long antennae. Their body color varies from yellow, green, brown, to purple. Females can give birth to live nymphs as well as can lay eggs. However, the primary means of reproduction for most aphid species is asexual, with eggs hatching inside their bodies, and then giving birth to living young. Winged adults, black in color, are produced only when it is necessary for the

colony to migrate, or there is either overcrowding in colonies, or unfavorable climatic condition.

Suggested control practices

Cultural practices

1. Control and kill ants. Cultivate and flood the field. This will destroy ant colonies and expose eggs and larvae to predators and sunlight. Ants use the aphids to gain access to nutrients from the plants.
2. Avoid using heavy doses of highly soluble nitrogen fertilizers. Aphids love tender, juicy leaves. Practice split application: during seedling and flowering stage.

Traps

Sticky board traps

Place 1-4 sticky cards per 300 sq m field area. Replace traps at least once a week. To make your own sticky trap, spread petroleum jelly or used motor oil on yellow plywood, 6 cm x 15 cm in size or up. Place traps near the plants but faraway enough to prevent the leaves from sticking to the board. Traps when hung should be positioned 61 cm zone above the plants.

Yellow basin trap

Half-fill yellow pan or basin with soapy water. Place the pan close to the plant but exposed enough so that aphids will see it. This will also trap cabbage root maggot.

Botanical pesticides

Ginger rhizome extract

Grind 50 g of ginger and make into paste. Mix with 3 liters of water. Strain. Add 12 ml of soap. Mix well. Ten (10) kg of ginger is needed for 1 ha.

Custard apple leaf extract

Boil 500 g of leaves in 2 liters of water until the remaining liquid is about ½ liter. Strain. Dilute filtrate with 10 -15 liters of water.

Spray solutions

Ammonia spray

Mix 1 part ammonia with 7 parts water. This spray also controls flea beetles.

Soap spray

Mix 2½ tablespoons of liquid soap to a gallon of water.

Cabbagehead caterpillar



Damage

The cabbage plant has 'window-liked' damage on its outer leaves. Larval damage during early head formation results in an aborted head or multiple heads. The larva bores holes on developing heads. A damaged developing head contains waste matters.

Description

The eggs are laid in clusters and held together by gelatinous glue. An egg mass contains 30-40 eggs. The newly hatched egg mass is colored green and turns reddish-brown as it matures. The eggs are laid close to the midrib or on the veins at the lower surface of leaves. The egg development lasts for about 5-7 days.

The newly hatched larva is slender and greenish-yellow in color and has a dark-brown head and thorax. As the larva grows, its body becomes green and its head becomes brown with light patches, and then turns whitish with longitudinal stripes as it matures. A larva undergoes five instars.

The early larval instar feeds in group and as it grows, it disperses moving from plant to plant. A mature larva measures 1.2-1.6 cm long.

The pupa is yellowish-green and turns dark-brown as it grows. The pupa is enclosed in a silken cocoon. Pupation takes place in the soil, 2-6 cm below the soil surface.

The adult has a black thorax and a reddish-brown abdomen. The male has a thicker tuft of hairs along the costal margin near the base of the forewing than that of the female. The female has a curved ovipositor for reproduction. A female can lay 2-10 egg masses. The adult is a weak flier.

Suggested control practices

Cultural practices

Plant Indian mustard (*Brassica juncea*) as a trap crop between several rows of common cabbage to attract most Cabbagehead caterpillar (CHC) moths and some Diamondback moth (DBM) adults. Mustard

attracts almost the entire population of CHC and 80% DBM. **Remove the trap crops when these are heavily infested with the pests or else these pests will transfer to the main crop.**

Cabbage looper



Damage

Larvae feed primarily on leaves causing irregular, rugged holes, bore through the pods, and contaminate pods and leaves with their frass (excreta). Plants can be severely defoliated and stunted. Sometimes, they damage the seedlings, but heavy injury usually occurs during pod stage.

Description

The egg is very small and bowl-shaped with a flat side, yellowish to greenish-white in color, and found singly lying on the leaves.

The larva is light green and about 3-4 cm long when fully developed. It has 3 pairs of slender legs near the head and 3 pairs of thickened prolegs on the abdomen. It moves by arching its back to form a loop and then projecting the front section of the body forward. It usually feeds on the leaves and into the cabbage head.

The pupa is green or brown in color and is nearly 2 cm long. It is enclosed in a flimsy, silken cocoon. Pupation occurs in a folded webbed leaf or between two webbed leaves.

An adult is a grayish-brown moth and has a wingspan of about 3.3-3.8 cm. Each of the mottled and brown front wings bears a small and silvery-spot that resembles like a figure 8. The hindwings are paler-brown. Adults are strong fliers and are primarily nocturnal. During the day the adults can be found resting in foliage or in crop debris.

Moths feed on various wild and cultivated hosts where they obtain water and dissolved nutrients. A female moth can produce 300 - 1600 eggs.



Suggested control practices

Botanical pesticide

Gliricidia sepium leaf extract

Grind or pound ½ kg of *Gliricidia* leaves. Soak overnight in water. Strain. Add 20 liters of water to the filtrate.

Cabbage root maggot



Cabbage root fly

Damage

The larva eats the lateral roots, then tunnels into the taproot, and sometimes bores into the base of the stem. Attacked plants will wilt and the leaves will turn bluish. The plants become stunted or eventually die.

Description

Eggs are white, ovate-shaped, and less than 1 mm in size. These are laid on the stems or in the soil near the base of the plants.

Maggots (larvae) are soft and white; about 3-8 mm long. They have a pair of prominent forked tubercles below the hind spiracles that separate them from other *Delia* species.

Pupae are found close to the roots or sometimes within the plant where the larvae last feed. These are brown and hard and are ovate-shaped.

Adults are dark gray flies slightly smaller than the common housefly. They can fly up to 2 km to find suitable hosts to lay their eggs upon.

Suggested control practices

Cultural practices

- Planting clover (*Trifolium* spp.) as soil cover
- Mulching with dried grasses and rice straw
- Planting onions as trap crops around the borders and down the rows of cabbage protects cabbage from egg laying moths. **Pull and destroy trap crops 2 weeks after they sprout.**

- Row covers
Cover the seedbed with a screen covering or fine nylon net placed immediately after seeds are sown. The covering should extend at least 18 cm on either side of the seed row, with the edges buried in the soil.

Other substances

Powdered hot pepper or powdered ginger

Place the powdered hot pepper or powdered ginger around the base of the stems when the cabbage root maggot population is moderate

Wood ash

If population is moderate, repel moths by mounding wood ashes and diatomaceous earth (D.E.) placed around the base of the stems. Buy D. E. at your local agricultural suppliers.

Cabbage webworm



Damage

The feeding damages made by the larvae are the mined and/or bore leaves and bore stems. They feed first externally on the leaves and continue feeding into the terminal bud. Infested plants produced small heads and in severe cases, they do not form heads at all. The larvae feed beneath their protective webs made from the silken like threads that they form. The silken webs are found on the inner leaves' surfaces and stalks.

The cabbage webworm can be detected by their webs, frass, and other feeding debris produced while.

Description

Eggs are oval and creamy-white in color. These are laid in clusters from 28 to 214 eggs. The egg stage lasts from 2-5 days.

The *larva* has dark-brown or black heads. Its body is creamy-white with light pinkish-brown longitudinal stripes. It is about 1.2 to 1.5 cm when fully grown. The larval stage is about 6 to 18 days.

The *pupa* is contained inside a loose cocoon. It has a shining pale-brown color with a dark dorsal stripe. The pupal stage is about 4 to 20 days.

The *adult* is grayish-brown with pale-dusky hindwings. Each forewing has a prominent black spot and zigzagging light-brown lines. The central band between the lines is sometimes filled with darker-brown scales. The adult moth is capable of flying long distances. It occasionally migrates to areas outside its normal breeding range.

Suggested control practices

Botanical pesticide

Mammy spray

Pound 10g of ripe and dried Mammy seeds. Add to 1 liter of water. Mix in few drops of soap. Stir well. Shake from time to time while in the process of application to avoid separation. This spray material controls other worms found on crucifers.

Physical control

- Cut off webbed leaves and kill the caterpillars inside.
- Screen seedling beds when seedlings are about 15 cm high. See to it that the seedlings are growing vigorously.

Pathogens

Bacillus thuringiensis (BT)

Spray plant thoroughly with BT when larvae are less than 5 mm long. The larva is not killed instantly because it has to ingest BT before it is killed, but it cannot do more damage. It will take about 2-3 days after the pest will die. Read label thoroughly or ask assistance from local agriculturist if use for the first time.

Cabbage white butterfly

Damage

The larva chews the leaves, hearts, and curds of crucifers. The young larva is hatched on the outer leaves and feeds superficially leaving the upper leaf surface intact. As it grows older, it makes holes in the leaves and eats through small veins. It continues feeding into the center of the head damaging the edible portion of the plant.

When there is a heavy infestation, all the leaf tissues are eaten leaving the veins and large stem. The larva's waste matters contaminate and stain the produce.

Description

The eggs are pale yellow in color, about 1 mm long, and bullet-shaped. These are laid singly on the lower surface of the outer leaves of the plant.



The newly hatched larva has a pale-yellow head and body with fine clear hairs arising from the small white spots. As it matures, its head and body are velvety-green with short hairs. The body has a broken yellow line or series of yellow spots which are found on both sides. The larva has five pairs of prolegs. A matured larva fastens itself to the lower leaf surface by silk bands. It can reach up to a length of 3 cm long.

The pupa is attached to some parts of the plant or other nearby objects. It is 1.8 to 2.0 cm long with a pointed anterior spine. Its color varies depending on where the pupa is situated because it camouflages with its environment.

The adult butterfly is white. Its body is covered with dense white hair which is more prominent on the male butterfly. The butterfly's wings are white with a black area near the tip of each forewing and have a small black spot on the front edge. The back wings are dull-yellow, dusted with black. It has a wingspan of 4 to 6 cm. The adult is active during the day and is often seen flying on crucifers and on flowering weeds to feed.



Suggested control practices

Botanical pesticide

Garlic oil spray

Chop finely 100 g of garlic. Soak garlic in 2 tbsp of mineral oil for a day. Add ½ liter of water and 10 ml of soap. Blend well by stirring thoroughly. Strain. Dilute the filtrate with 10 liters of water. Shake sprayer from time to time to avoid oil from floating.

Physical control

- Handpick the larvae. Put collected larvae in a bucket with soapy water to drown.
- Scatter large pieces of eggshells amongst the cabbages to confuse the Cabbage white butterfly. The eggshells are mistaken for as other butterflies which make them leave the area to look for a less populated one.





Damage caused by larvae of Cabbage white butterfly

- Catch butterflies with sweep nets. Their presence suggests a future problem.
- Cover plants with very fine nets to prevent female butterflies from laying eggs on the plants.

grown caterpillars are capable of eating the entire plant.

Description

The eggs are tiny pearl white, round, and have a ridged surface. The newly hatched larvae are greenish and about 1 mm long. The full-grown larva has a cylindrical body, brown or brownish-black with a tinge of orange. The thoracic segments have one to two dark spots near the base of the legs. The abdominal segments generally have two light brownish lateral lines on each side, one above and one below the **spiracles**. Above the top lines are broken lines composed of velvet semi-crescent patches that vary in color among cutworms.

The pupa is black or brown in color and measures about 22.5 mm long and 9.2 mm wide.

The adult has dark brown forewings with distinctive black spots and white and yellow wavy stripes. The hind wings are whitish with grayish margins. The total developmental period from egg to adult is about 35-40 days.

Pathogens

Bacillus thuringiensis (BT)

Spray plant thoroughly with BT when larvae are less than 5 mm long. The larva is not killed instantly because it has to ingest BT before it is killed, but it cannot do more damage. It will take about 2-3 days after the pest will die. Read label thoroughly or ask assistance from local agriculturist if use for the first time.

Suggested control practices

Cultural practices

Interplant onion, garlic, peppermint, coriander, or garlic every 10-20 rows to repel cutworms and attract natural enemies. Sunflowers and cosmos can also be planted as a trap crop in or around fields.

Botanical pesticides

Finger euphorbia plant extract

Cut a branch and collect the oozing sap. Add 1 liter of water to every 10 drops of the sap. Another method is to cut a mature branch and pound it finely to make it into a paste. Add this to 10 liters of water. Leave it for sometime then strain.

Basil plant extract

Pound or grind of 50 g of basil leaves. Soak it overnight in 2-3 liters of water. Add 8 - 12 ml of soap. Stir well.

Bait

Bacillus thuringiensis (BT)/bran bait

Moisten bran with a diluted solution of BT. Sprinkle the moist bran on the planting plots' surfaces 2 weeks before planting. Buy BT at your local agricultural suppliers.

Cutworm



Damage

Cutworms feed on seedlings. The seedlings are often cut off at ground level. The larvae can be found in the soil (up to a depth of about 5 cm) near the plant. They always curl-up when disturbed. Cutworms feed only at night. Generally, they are not found on plants or on the soil surface during the day. The newly hatched larvae feed from the base towards the tip of the leaf. At this stage, they first feed on the epidermis and may discolor the entire leaf surface. Young caterpillars eat the soft leaves of the plant. The full

Diamondback moth



Damage caused by larvae of Diamondback moth

Damage

Newly hatched larvae mine tunnels in the leaves. As they grow older, the larvae feed on the undersides of leaves but do not eat the veins, leaving the surfaces untouched, resulting in the 'window effect'. Larvae make irregular holes, tunnel into the cabbage heads preventing further development. In broccoli and cauliflower, Diamondback moths (DBM) feed on the leaves and not on the flower heads.

Description

Eggs are tiny, ovate-shaped, and yellowish-white in color. These are laid singly or in groups of 2-3 along the veins in the upper and lower leaf surfaces. The eggs hatch in about 5-6 days.

Larvae are pale yellowish-green to green covered with fine, scattered, erect hairs and with a forked posterior end. Mature larvae are cigar-shaped and about 12 mm long. The larval period lasts for about 10-21 days. DBM larva is easily identified because it can wriggle violently backwards when disturbed then drops from the plant suspended by a silken thread and finally climbs its way back up and continues feeding.

Pupae are delicate, white open-mesh cocoons that are attached to the leaves, stems or seedpods of the host plant. Pupae are light green but become brown as the adult moth becomes visible through the cocoon. The pupal stage lasts from 5-15 days depending on the environmental conditions.

The adult moth is approximately 8-9 mm long with a wing span of 12-15 mm. The moth folds its wings over the abdomen in a tent-like manner when immobile.

The wing tips are fringed with long hairs. Adult females can lay an average of 160 eggs during their life span of about 16 days. Egg laying occurs at night. The greatest number of eggs is laid the first night after emergence and egg laying continues for about 10 days. In the field, moths will fly up out of the plant canopy when disturbed.

Suggested control practices

Cultural practices

Planting mustard as trap crops every 15 rows of crucifers reduces attack. Bold seeded Indian mustard could also be sown densely all around the area 10 days before cabbage are planted. The plants attract up to 80% DBM. However, monitor trap crops frequently so as to control DBM before it can transfer to the main crop. Unattended trap crops can generate large populations of DBM. Care is needed to manage intercrops in order to use them as part of a control practice.

Botanical pesticides

Chili and neem seeds extract

Grind 200 grams of fully dried and shelled neem seeds. Soak overnight in 4 liters of water. Add 12 pieces chopped hot chilies. Strain. This spray material also controls aphids and other sucking and chewing insects.

Tomato leaf spray

Pound 500g of tomato leaves. Add to 8.5 liters of water. Strain. Stir in few drops of liquid soap.

Vitex negundo leaf extract

Soak 2 kg of leaves overnight in 5 liters of water. The next day, boil the mixture for 30 minutes. Cool then strain. Add 10 liters of water and 10 ml soap to the filtrate. Stir well.

Pathogens

Bacillus thuringiensis (BT)

Spray plant thoroughly with BT when larvae are less than 5 mm long. The larva is not killed instantly because it has to ingest BT before it is killed, but it cannot do more damage. It will take about 2-3 days after the pest will die. Read label thoroughly or ask assistance from local agriculturist if use for the first time.



Flea beetles



Damage

Flea beetles feed on seedlings. They usually feed on the undersides of leaves leaving numerous small round or irregularly shaped holes, although not generally all the way through the leaf. Because the beetle is small and active, it usually does not feed much in one spot. The larvae are root feeders. They trim the root hairs and make circular pits in taproots. The adults feed on the leaves and stems of emerging seedlings. They chew small holes or pits, usually less than 3 mm in diameter giving the leaves a characteristic 'shot hole' appearance.

Description

The eggs are tiny white when freshly laid and gradually become yellowish-gray in color.

The larva is white with a brown head and three pairs of brown legs near its head.

The pupa is white, shaped roughly like adult and pupates in the soil. It is found in the soil near the base of the plant on which it has been previously feeding.

The adult is small, hard, elongated, oval-shaped, with enlarged black hind legs and slightly hairy wing covers. It is about 2 mm in size. It is bronze, dark-metallic bronze or black in color. It has enlarged hind legs. They all jump vigorously like fleas when disturbed, hence the name.

Suggested control practices

Cultural practices

Plant the barrier crop along the edges of the field ahead of the main crop. Radish and Chinese mustard are good trap crops. Adult flea beetles are attracted to the tallest and earliest crop available. Another method is; Chinese mustard (*Brassica juncea* var. *crispifolia*) planted every 100 m between rows of crucifers. Remove or treat trap crops when these are infested by pests or else the pests will transfer to the protected crops.

Row covers

Keep flea beetles away by putting row cover on seed boxes and/or seed beds immediately after sowing.

Mulching

Place 2-3 inches of cut grasses or 2-4 inches of bark mulch and wood chips or 3-4 inches of compost as your mulching materials to interfere the larvae's root feeding activities.

Botanical pesticides

Neem oil extract

Add 30 ml of neem oil into 1 liter of soapy water. Constantly shake the container or stir the extract while in the process of application to prevent oil from separating.

Neem kernel extract

Add 30 grams of powdered kernel in 1 liter of water. Let it stand for 6 hours but not more than 16 hours. Add soap and stir. Constantly shake the container or stir the extract while in the process of application.

Spider mites



Damage

Generally, mites feed on the undersides of leaves. They use their sucking mouthparts to remove plant saps. The upper leaf surface has a speckled or mottled appearance while the underneath appears tan or yellow and has a crusty texture. Infested leaves may turn yellow, dry up, and drop in a few weeks. Mites produce large amount of webbing. Heavy infestation will result in a fine cobwebby appearance on the leaves. Plants die when infestation is severe.

Description

The eggs are tiny, spherical, pale-white, and are laid on the undersides of leaves often under the webbings. Eggs hatch in 4 or 5 days.

Nymph looks similar to the adult but is only the size of an egg. It has only 6 legs. It molts 3 times before becoming an adult.

The *adult* is also very tiny, maybe yellowish, greenish, pinkish, or reddish depending on the species. It looks like a tiny moving dot. It has an oval body with 8 legs and with 2 red eyespots near the head of the body.

The male is smaller than the female with a more pointed abdomen. A female usually has a large, dark blotch on each side with numerous bristles covering her legs and body. Spider mite is not an insect.

Suggested control practices

Cultural practices

Provide plants with adequate water. Water-stressed plants are prone to damage by mites. Avoid the use of broad spectrum insecticide for this may cause a mites' outbreak. This practice kills the natural enemies of mites and stimulates mites' reproduction.

Botanical pesticides

Coriander seed extract

Pound or crush 200 grams of coriander seeds. Boil in 1 liter of water for 10 minutes. Cool and strain. Dilute extract with 2 liters of water. This extract also prevents fungal diseases.

Basil leaf extract

Pound or grind of 50 g of basil leaves. Soak it overnight in 2-3 liters of water. Add 8 - 12 ml of soap. Stir well. Spray on infected plants.

Other solution

Horticultural oil

Spray 2% solution against mites. To make a 2% solution, pour 1/3 cup oil into a 1 gallon container, and then fill with water to make a 1 gallon solution. For a 3% solution, start with 1/2 cup of oil. Apply successive sprays at least 6 weeks apart. You can apply 1% oil solution by mixing 2.5 tbsp of oil in 1 gallon of water. Horticultural oil is concentrated and must be mixed with water.

Whiteflies



Damage

Both the larvae and adults pierce and suck the sap of the leaves. This causes the weakening and early wilting of the plant resulting in reduced plant growth. Their feeding may also cause yellowing, drying, premature dropping of leaves that result in

plant death. Whiteflies produce honeydews that serve as the substrates for the growth of black sooty molds on leaves and fruit. The mold reduces photosynthesis causing the poor plant growth of the plant. They are the most important carriers of plant viruses that cause diseases of fiber crops, vegetables, fruit trees, and ornamentals.

Description

The eggs are tiny, oval-shaped, about 0.25 mm in diameter, and stand vertically on the leaf surface. Newly laid eggs are white then turn brownish. They are deposited on the underside of leaves, sometimes in a circle or oval-shaped patterns.

The larvae are transparent, ovate, and about 0.3-0.7 mm in size and they move around on the plants looking for a feeding site upon hatching.

The pupae are dirty-white and surrounded by wax and honeydews. During this stage, the red eyes of the emerging adults are visible.

The adults are about 1mm long with two pairs of white wings and light yellow bodies. Their bodies are covered with waxy powdery materials. They are found feeding on top of the plants. A female can produce as many as 200 eggs in her lifetime and mating is not necessary. It takes about 40 days to develop from egg to adult.

Suggested control practices

Botanical pesticides

Garlic oil spray

Chop finely 100 g of garlic. Soak the chopped garlic in mineral oil for a day. Add 1/2 liter and 10 ml of soap. Dilute filtrate with 10 liters of water. Constantly shake the container or stir the extract while in the process of the application to prevent oil from separating.

Madre de cacao & neem

Shred 1 kg of Madre de cacao leaves and 1 kg of neem leaves. Soak leaves in 5 liters of water for 3 days. Strain. Add water to make up 20 liters of filtrate. Spraying interval is 4-5 days.

Neem oil extract

Add 15 ml of neem oil into 1 liter of soapy water. Constantly shake the container or stir the extract while in the process of application to prevent oil from separating.

Spray solution

Soap spray

Mix 2 1/2 tablespoons of liquid soap to a gallon of water.

Potato starch spray

Mix 2-4 tbsp potato flour to 1 liter of water and add 2-3 drops of liquid soap. Shake the mixture and spray thoroughly before spraying.

Common garden snails



Damage

Snails feed on the seedlings and the growing plants. Their feeding damage on the leaves is irregular large holes but they can consume the young seedlings completely.

Suggested control practices

Cultural practices

- Limit the addition of organic matters into the area when the infestation is causing economic loss because organic matters are very attractive to slugs. Slugs eat on organic matters found in the soil.
- Screen the seedbed or seedling plot using a fine mesh screen of about 7.5 cm high that surrounds the plot and securely fix about 2.5 cm of it into the ground.

Traps

- Trap the snails using 30 cm x 30 cm white painted-surface wooden boards. Place them securely along the plant's rows. At daytime, snails take shelter underneath the cooler places. Be sure to check the wooden traps before sunset and

collect the snails. Crush or place them in a bucket of soapy water. Potato or cabbage, cereal bran or chicken food can be placed under the board as an attractant.

- Over-turned earthen flower pots, placed under the shady part of the plant, is another way of trapping them. Make sure to make an opening to let them crawl underneath and to collect them before sunset. Crushing them in the pots also make the pots more attractive to other snails.

Plant ash, saw dusts, sand, or eggshells

Sprinkle enough ash, sand, or crushed eggshells at the base of the plants. The snails are sensitive to harsh objects which prevent them from crawling into the plants. Remember to keep these substances dry to be effective. But make sure that your control method is not a waste of time because snails are problematic only when the soil is moist.

Baits

Grapefruit and melon peel baits

After eating grapefruit and/or melon, invert the peel as food and as a cool shelter for the pests. Be sure to collect peels and kill the trapped pests.

Yeast and water solution

Dissolve 1 tbsp of yeast in 100 ml of water. Fill any shallow container with the solution. Bury up to the rim near the plant. Make some modifications to cover your trap to avoid non-target pests from entering. The snails drink, get drunk and drown in the pan. Monitor the pans and the trapped snails. Change the solution when necessary, especially after rain.

Spray solution

A 2% caffeine solution in water

Spray directly on the trapped pests. Test solution on a few plants first as it can cause yellowing to some leaves.

Beneficial Insects

The following are some beneficial insects that are indigenous on your fields and gardens or can be introduced for the control of pests.



Braconid



Damsel bugs



Diadegma



Ground beetles



Hoverflies



Lacewings



Ladybird beetles



Rove beetles



Spiders



Tachinid flies



Trichogramma

Conservation of the beneficial insects

1. Provide hiding sites and alternative habitats such as mulches and other ground covers.
2. Plant small flowering plants on borders, hedges, and other perennial habitats as source of food and shelter
3. No indiscriminate use of synthetic pesticides.

Diseases

Bacterial soft rot



An initial infection occurs on the outer petiole (leafstalk) which is in contact with the soil, and then progresses to its head. An infected head is watery and often has a complete head rot. The affected area becomes soft and mushy and generally turns dark in color. Soft rot infection on crucifers almost always emits a foul odor when other secondary organisms invade the infected tissues.

Suggested control practices

- Control nematodes and other insect pests that serve as vectors (carriers) of the bacteria to invade the plant tissues
- If possible, avoid plant injury during weeding especially when the disease symptoms are observed
- Remove infected plants immediately

Clubroot



The plant is stunted with the leaves wilting and becoming yellow particularly on hot and sunny days and club-like galls are formed on roots.

Suggested control practices

- Use disease free transplants, do not use any clubrooted seedlings as transplants
- Avoid moving infected transplants and/or infested soil on farm equipment to clean fields.
- Maintain soil pH at 7 – 7.3 with hydrated lime.
- Provide and maintain well drained soil.
- To reduce the risk of clubroot occurrence in fields that have not had the disease, grow crucifers on the same soil no more than once every 3-4 years.
- In fields where the disease has occurred, rotate cruciferous crops with unrelated crops for a period of 7-10 years. Each time cabbage is planted in the rotation, hydrated lime should be applied.

Downy mildew



The disease initially appears as irregular yellow patches on the leaves. These lesions later turn tan to light-brown. During cool and humid weather condition, the fungus develops white fungal growths on the undersides of leaves. Heavily infested leaves will have a blighted appearance as a result of numerous infection sites. Early symptoms on transplants may resemble bacterial leaf spot. Severely diseased seedlings are stunted that will die eventually.

Suggested control practices

Compost tea

Put a gallon of well-matured compost into a 5 gallon (20 liters) container. Add water until the container is full. Stir well. Place in warm place for 3 days to ferment. Strain.

Baking soda

Dissolve 1 tbsp of baking soda in 4 cups of warm water. Add 1 tsp of liquid soap.

Mix well.

VIII. Harvesting

The harvesting starts when 75% of the fruit capsules are ripened. The crop dries above where it will be cut, stems tend to change from green to yellow to red in color and the leaves will begin to fall off. Physiological maturity normally occurs 90 - 110 days after planting and normally dries down in 130 to 160 days, depending on variety and climatic condition.

Make bundles and stalked upright for drying. One week after harvesting, thrash and winnow the seeds. The seeds for storage must have 10% moisture content. The harvesting starts when 75% of the fruit capsules are ripened. The crop dries above where it will be cut, stems tend to change from green to yellow to red in color and the leaves will begin to fall off. Physiological maturity normally occurs 90 - 110 days after planting and normally dries down in 130 to 160 days, depending on variety and climatic condition.

Make bundles and stalked upright for drying. One week after harvesting, thrash and winnow the seeds. The seeds for storage must have 10% moisture content.



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- 01 Head of cabbage. G.Schoenemann. www.pixelio.de
- 11 Ants. Takumasa Kondo
- 12 Aphids. AVRDC, <http://www.avrdc.org/pdf/heading.pdf>
- 13 Cabbagehead caterpillar. AVRDC, <http://www.avrdc.org/pdf/heading.pdf>
- 13 Cabbage looper. Ric Bissen
- 14 Cabbage root fly. Photo courtesy of R. Coutin, OPIE
- 14 Cabbage webworm
- 15 Cabbage white butterfly, larva, damage. www.inra.fr/.../HYPPZ/IMAGES/7032723.jpg
- 16 Cutworm. Clemson University. <http://entweb.clemson.edu/cuentres/eiis/factshot/pages/Cutworm.htm>
- 17 Diamondback moth. http://www.ipmthailand.org/en/Natural_enemies/Parasitoids/DBM/DBM_parasitoids.htm
- 18 Flea beetles. Texas A&M University
- 18 Spider mites. University of Nebraska
- 19 Whiteflies. University of California, <http://www.uckac.edu/whitefly/newhomepage.htm>
- 20 Snail. Jewel Bissdorf
- 21 Damsel bug. University of Georgia, <http://www.cpes.peachnet.edu/lewis/1nabid.jpg>
- 21 Diadegma. http://www.ipmthailand.org/en/Natural_enemies/Parasitoids/DBM/DBM_parasitoids.htm
- 21 Ground beetle, Spider & Tachinid fly. IRRI & Queensland University. IRRI, Los Banos, Philippines.
- 21 Hoverfly. <http://www.canola-council.org/slides/pests/insects/insects.html>
- 21 Lacewing. Photo courtesy of Clemson University - Department of Entomology
- 21 Ladybird beetles. Kok, L., Kok, V. http://www.ento.vt.edu/~kok/Biological_Control/Main_body.htm
- 21 Rover beetles. Jim Kalisch & Barry Pawson
- 21 Spider. IRRI & Queensland University. IRRI, Los Banos, Philippines.
- 21 Tachinid fly. IRRI & Queensland University. IRRI, Los Banos, Philippines.
- 21 Trichogramma. Cornell University http://www.nysaes.cornell.edu/ent/biocontrol/parasitoids/trichogramma_ostriniae.html
- 22 Bacterial soft rot, damaged Chinese cabbage. AVRDC, <http://www.avrdc.org/pdf/heading.pdf>
- 22 Clubroot. www.ext.vt.edu/.../450-705/fig2.jpg
- 23 Downy mildew. <http://www.omafra.gov.on.ca/english/crops/hort/news/hortmatt/2005/08hrt05a6f3.jpg>

References

- www.oisat.org and its suggested web links are relevant to growing of cruciferous crops
- CABI. (2004): *Crop protection compendium*. 2004 Edition. CAB International Publishing. Wallingford, UK.
- Card, A.; Whiting, D.; Wilson, C. (2002): *Organic fertilizers. Colorado Master Gardener Training*. Colorado State University. CMG Fact Sheet #S-34.
- Ellis, B.; Bradley, F. (1996): *The organic gardener's handbook of natural insect and disease control*. Rodale Press. Emmaus, Pennsylvania.
- Facknath, S. (2000): *Application of neem extract and intercropping for the control of some cabbage pests in Mauritius*. Proc. International Neem Conference, Queensland, Australia, Feb. 1996 In Press.
- Facknath, S. (2000): *Integrated pest management of Plutella xylostella*. University of Mauritius.
- Makumbi, H. (1996): *Ifoam '96 Book of Abstracts*. 11th IFOAM Scientific Conference, 11-15 August 1996, Copenhagen, Denmark.
- Muniappan, R.; Lali, T. (2000): *Management of cabbage pests of the Asia Pacific lowland tropics*. College of Agriculture and Life Sciences, University of Guam, Guam.
- Siemonsma, J.; Piluek, K. (2000): *Vegetables*. Plant resource of Southeast Asia (PROSEA).
- Talekar, N.; et. al. (2000): *Intercropping and modification of irrigation method for the control of diamondback moth*. Asian Vegetable Research and Development Center (AVRDC), Shanhua, Tainan, Taiwan, ROC



Tables

Table 2. Monthly cropping calendar of activities

Management practices	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
I. Seed preparation 1. Seed selection 2. Seed treatment												
II. Seedling production 1. Seedbed preparation 2. Sowing 3. Fertilization 4. Mulching 5. Hardening												
III. Land preparation 1. Seedbed preparation 2. Sowing 3. Fertilization 4. Mulching 5. Hardening	-											
IV. Fertilization 1. organic (<i>chicken dung; compost</i>) 2. inorganic (<i>commercial; NPK</i>)												
V. Irrigation												
VI. Pests 1. Weeds 2. Insect pests 3. Diseases 4. Slugs and snails <i>Innumerate the name of the pests</i>												
VII. Pest control 1. Herbicides (<i>organic, inorganic</i>) 2. Insecticide (<i>organic, inorganic</i>) 3. Fungicide (<i>organic, inorganic</i>) 4. Natural enemies 5. Traps and baits												
VIII. Harvesting												
IX. Post harvest												

Table 3. Weekly activities

Field activities	-4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Care of seedlings																				
Transplanting																				
Fertilizer application																				
Irrigation																				
Weeding																				
Control of insect pests and diseases																				
Harvesting																				

Table 4. Crop lifecycle

Growth stages	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Seedling												
Vegetative <i>(true leaf development until cupping)</i>												
Maturation <i>(early head formation until head fill)</i>												





**For more information
on non-chemical pest management see:**

www.oisat.org

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