

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



**in Eggplant  
Production**

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**Field Guide to**

# **Non-chemical Pest Management in Eggplant 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.

## Acknowledgements

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We also wish to thank all the individuals, groups and organizations that have prepared the bases for most of the control measures presented in this field guide, may it have been by preserving traditional experience, on field trials, on field research, or in the lab.

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## Prologue

Pesticides worth more than 32 million 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 the overall use, risk and dependence on pesticides, and to 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](http://www.oisat.org)).

OISAT is a web-based information system to distribute information on non-chemical pest management in the tropics and sub-tropics that is easy to read and easy to understand. Information provided via [www.oisat.org](http://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 Eggplant Production' is an excerpt taken from the website, [www.oisat.org](http://www.oisat.org). It provides farmers with practical guidelines and alternatives to eliminate the use and their dependence on synthetic pesticides for the management of eggplant 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.

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# How to use this field guide

This field guide is designed to let you grow eggplant as easy as possible.

It provides you with the suggested appropriate management practices on how to grow eggplant. 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 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 practical methods. Also, as not to confuse you with the beneficial insects, a separate page with photos of them and their conservation and management is included.

For example, you notice that the eggplant leaves are having large 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 (e.g. removal of weeds); physical control (e.g. handpicking); plant extract (e.g. neem spray); other homemade solution (e.g. soap spray); other method (use of baits).

However, with every effort made to provide you with complete information on the pest control in eggplant growing, the recommendations may vary from location to location. It is highly recommended that you 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 in the forms at the end of this manual to have a record of activities each time you grow eggplant.



## Recommended practices

Throughout this field guide you will find suggestions for stopping or lessening the pests' population before they have control over your eggplant 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 pests and other causal agents and the natural enemies.
2. Select the proper eggplant variety that is well adapted to your local conditions.
3. Always select good and disease-free planting materials.
4. Have a healthy soil, but always keep in mind that over-fertilizing isn't necessarily better.
5. Practice crop rotation by planting in the next cropping season crops of a different family group.
6. If possible, practice intercropping to improve the field's 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 your local agriculturists.

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 pest-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. Use utensils for the extract preparation that are not used for your food preparation and for drinking and cooking water containers. Clean properly all the utensils every time after using them.
4. Do not have 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 eggplant

Scientific name: Solanum melongena

Family: Solanaceae

Other names: Aubergine, Melongene, Brinjal

### Uses

Mainly used as vegetable for various cuisines

Prior to transplanting, plow and harrow the soil to a depth which will physically support the plant and allow the use of sufficient moisture and nutrients, which is sufficient enough to control weeds and leave the soil surface level. A level field improves water use efficiency, helps control in crop weeds and allows the rapid removal of excess water.

Raising beds and mulching are recommended in eggplant growing. Mulching conserves water moisture, controls weeds, and prevents soil compaction.

## II. Climatic and soil requirement

Temperature: 24-29 °C is the optimum climatic requirement.

Soil: Well-drained sandy loam, loam or clay-loam with good supply of organic matters and with access to water source.

Soil pH: 6.0 - 6.5

## III. Selection of planting materials

Select fresh seeds for sowing. Sow seeds either in seedbeds or cell containers.

It takes 6-8 days for seedlings to emerge. Seedling production takes about 5 weeks. Seedlings needed for transplanting should be healthy (sturdy and vigorous), have 3-4 true leaves (without flower bud) and must be free from pests and diseases.

Harden the seedlings 6-9 days before transplanting by exposing them to direct sunlight and by withholding water.

## IV. Planting materials requirement

### Seedling requirement

13,500 – 16,000 seedlings are needed for transplanting for an area of 1 hectare, depending on the spacing distances

## V. Land preparation

During the land preparation, choose the tillage practices that will ensure to keep the soil in its best physical condition for a favorable crop's growth and development.

Approximately one month before planting, plow the field to turn under all plants residues. Presence of adequate soil moisture and nutrients is necessary to enhance faster the decomposition of the crop residues. Allow ample time to decompose the crop residues before planting eggplants.

## VI. Method of planting

### Transplanting

Seedlings should be watered thoroughly before transplanting. Transplanting is done in the late afternoon to avoid plant stress.

### Spacing distance

60 -75 cm within rows and 100-120 cm in between rows.

1.5 m wide (furrow-furrow) and raised beds (20-25 cm high) the seedlings are planted in a single row at a spacing distance of 50 cm apart.

## VII. Fertilizer and water requirements

Fertilizer application depends upon the soil nutrients and the result of a soil test.

In the absence of a soil sample, the following are the recommended fertilizer requirements. Apply 10T of compost or 3T (1 ha area) of chicken manure before transplanting.

A hectare of eggplants needs 170 kg N, 70 kg P<sub>2</sub>O<sub>5</sub>, and 180 kg/K<sub>2</sub>O.

Water is needed during the plant's early growth development, the flowering and fruiting stages. Lack of water stresses the plant, causes poor quality fruits, and reduces yield.

## VIII. Pest management

**See pests/mites, diseases, and beneficial insects information.**

## IX. Weed management

### Preventative methods

1. Thorough land preparation
2. During the seed bed preparation, make sure that the seed bed is free of weeds.

3. Place the fertilizer where the crop has access to it but the weeds do not. This allows the crop to be more competitive with weeds.
4. Keep the surroundings of your farm free of weeds, unless they are maintained and intended as habitat for natural enemies

### **Mechanical and physical practices**

Do weeding 4 - 6 weeks after transplanting. The weeds are easier to control in their earlier growing period. If possible, do not let the weeds flower

Remove them from the field before they start to flower. The seed-bearing weeds that are removed should not be placed in the 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.

Mulches prevent weeds.

The weeds can be killed through off-barring and hilling-up the furrows, hoeing, mowing, cutting with a scythe, or hand weeding.

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## **X. Harvesting**

Harvesting starts 65-85 days after transplanting.

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## **XI. Yield**

30 – 40 tons per ha

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## **XII. Postharvest handling**

After harvest, market eggplant immediately. It has a low storage life.



# Insects/Mites

Several pests will infest eggplants during its growth stages. Table 1 shows the pests that might damage the plant growth.

**Table 1. The eggplant growth stages and its pests**

Growth stages	Insects/mites
<b>0 Stage</b> - Seeds	Ants
<b>Seedling stage</b> - Leaves	Aphids Whiteflies
<b>Vegetative stage</b> - Leaves  - Stem	Aphids Colorado potato beetle Flea beetle Spider mites Stink bug Thrips Whiteflies Eggplant fruit and shoot borer
<b>Reproductive</b> - Flowers and foliage  - Stem	Aphids Colorado potato beetle Flea beetle Spider mites Stink bug Thrips Whiteflies Eggplant fruit and shoot borer
<b>Maturation</b> - Fruits and stems	Eggplant fruit and shoot borer

## 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 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 pupa is a transition 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 can 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 gardens for insect pest control.*

### Control measures

#### Cultural practices

1. Increase the seeding rate and thin the plants 3 weeks after sowing. 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 ants protect them for their food.

## Spray solution

### *Ant oil spray*

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

## 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 is 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 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 conditions.

## Control measures

### 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 60cm above the plants.

#### *Yellow basin trap*

Half-fill a yellow pan or basin with soapy water. Place the pan close to the plant but exposed enough so that aphids will see it.

### 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 and dilute the 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.)

## Colorado potato beetle



### Damage

Adults and larvae feed on leaves and often consume the entire leaves starting with the young and soft ones. Normally, black and sticky excrement is found on the stem and leaves.

### Description

Eggs are oval and bright-orange and are laid in clusters of 10-40. These are glued on the surface (usually underneath) the leaves. Eggs hatch in about 4-5 days.

The larva is sluglike, small, and reddish with shining-black head and feet. As it grows, its body color changes to yellowish-red or orange. It undergoes five molts and during each molt, it stops feeding. At the end of the larval period, the larva drops from the plant and burrows into the soil to pupate.

A pupa is like a spherical cell which is yellowish in color. Pupation lasts from 5-10 days.

An adult beetle is about 1.0 cm long and 0.9 cm wide. It is ovate, convex, and hard-bodied. It is yellowish with 10 black stripes on its wing covers. The adult hibernates during the cold weather. It falls into the ground and burrows 5-20 cm deep into the soil. Its emergence is timely when the plants start to grow.

### Control measures

#### Cultural practices

1. Practice crop rotation. Plant garlic and beans as rotation crops. Coriander, marigold, and tansy are good trap crops.
2. Remove weeds such as; horsenettle, jimsonweed, thistles, as they provide widespread sources of food.
3. Remove or plow-under crop residues after harvest, to get rid of feeding and breeding sites.

Plowing also exposes the pupa and the hibernating adults under the soil to predators and to harsh environment.

### Physical methods

1. Crush eggs and collect adults manually. Place collected beetles in a pail of soapy water.
2. Use row covers.
3. Mulching encourages beneficial insects, by giving them a habitat.

## Cutworm



### Damage

Seedlings are often cut off at ground level. Cutworm larvae can be found in the soil (up to a depth of about 5 cm) near the plant host. 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.

Young caterpillars eat the soft leaves of the plant. The fully grown caterpillars are capable of eating the entire plant. 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.

The yellowing of the leaves is a typical symptom of Spodoptera when they cause damage to thick-leaf plants.

### Description

Eggs are tiny pearl white, round, and have a ridged surface.

The newly hatched Spodoptera 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.

## Control measures

### Cultural practices

1. Removal of weeds in and around fields will reduce egg-laying sites and will help in the prevention of cutworm infestation. Do this at least 2-3 weeks before planting to reduce the incidence of cutworm larvae transferring to newly planted crops.
2. Plow and harrow fields properly before planting. This will destroy eggs and expose larvae to chicken, ants, birds, and other predators.
3. Interplant main crops with onion, garlic, peppermint, coriander, or garlic every 10-20 rows to repel cutworms. Sunflowers and cosmos can also be planted as a trap crop in or around fields.

### Physical methods

1. Protective collars made of plastic or paper cups, plastic drink bottles with ripped-out bottom, sturdy cardboard, and milk cartons. Place the collar around the young plant and push into the soil to prevent the cutworm from attacking the stem.
2. Sticky substances such as molasses, saw dust, or crushed eggshells placed around the base of each plant. When the cutworm emerges to feed, it will come in contact with the trap, get stuck, harden, and die.

## Eggplant fruits and shoot borer



### Damage

Wilted shoots are the initial feeding damage. The damaged stem and fruit have small holes, where the larva enters and tunnels to continue its feeding activities. The tunnel contains frass and other waste materials and around this area is where it continues to feed.

### Description

The eggs are flattened, ovate, creamy-white, and are 0.5 mm in diameter. They are laid singly on the plant's foliage either at the lower surface of the young leaves, on stems, flower buds, or at the base of the fruit. The eggs hatch in about 3-6 days.

The larva is light-brown to brownish-pink in color. Immediately after hatching, it looks for food on any tender parts of the plant's foliage. As it matures, it bores into the fruit to continue its feeding activities. A full grown larva is about 1.8 -2.3 cm long. It undergoes 4-6 instars. The larval period lasts from 12-22 days, depending upon the climatic conditions.

The pupa is enclosed in a thick silken cocoon found under the soil surface (at a depth of 1-3 cm) or among the plant's debris near the base of the plant. It blends nicely with its environment and is thus difficult to find. The pupal stage lasts from 6-17 days, depending upon the temperature.

The adult is white and has brown or black spots at the back of the thorax and abdomen. Its wings are white with a pinkish or bluish tinge and the forewings have several black, pale, and light-brown spots. It measures 2.0-2.2 cm, when its wings are widely spread. Its lifespan is from 1.5-3.9 days.

## Control measures

### Cultural practices

1. Plow the field to expose larvae to predators and weather.
2. Plant resistant varieties. The eggplant accessions Pusa Purple Long, H-128, H-129, Aushey, Thorn Pandy, Black Pandy, H-165, H-407, Dorley, PPC-17-4, PVR-195, Shyamla Dhepa, and Banaras Long Purple are reported to be tolerant or resistant to the pest. Ask for assistance from your local agriculturist for the availability of such or similar varieties in your locality.
3. Raise seedlings under row covers and/or nets to prevent the moths from directly laying eggs on them.
4. Practice crop rotation. The EFSB prefers eggplant. Non-planting of eggplant for 2 cropping seasons within a community/village will reduce the pest population drastically.
5. Proper field sanitation will also reduce the pest population. Destroy or burn all plant residues as they may harbor the pupating pest.

### Physical control

1. Cut and/or prune immediately the larvae-infested shoots. Do not drop the cut shoots in the field, burn or cut them into small pieces. The signs of damaged shoots are their wilted and dried tips. Doing so will prevent the larvae's development. Continue pruning the shoots at least once a week before the final harvest. If the whole village is more or less engaged in eggplant production, all the farmers must collectively practice this method in order to suppress the migration of moths to the neighboring fields.
2. Uproot all old plants after harvest and burn them. Piling or leaving them in the field enables the larvae to pupate and continue developing.
3. Use pheromone traps. This is an effective control measure and the sex pheromone, EFSB, is commercially available in some countries. Ask for assistance from your local agriculturist office.

## Flea beetles



### Damage

The Flea beetle feeds 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 tap roots. Its feeding damage is external on the root which can reduce the marketability of radish and turnips. The adults feed on the leaves and stems of emerging seedlings, on green pods, and heads. 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 ovate, 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. 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.

### Control measures

1. Row covers keep flea beetles away. Put row cover immediately after sowing.
2. White or yellow sticky traps placed every 5-10 m on the rows.
3. Thick mulch in isolated planting interferes with the larva's feeding activities.

## Spider mite



### 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 amounts 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.

### Control measures

#### 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 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.

## Stink bug



### Damage

Adults and nymphs suck plant sap from leaves, flowers, bolls, buds, fruits, and from the seeds of a wide array of crops. Feeding on fruits causes scarring and dimpling known as cat-facing. Feeding on the developing grains of rice at the milking stage causes shriveling and empty seeds with brown spots. Feeding on cotton bolls prevents bolls to open or stains the lint or causes bolls to drop.

### Description

The eggs are yellow and barrel-shaped. These are laid on the lower surface of the leaves in clusters of 20-130 in 5-8 parallel rows.

The nymph has heterogeneous colors (green, tan, brown or gray). It is oval-shaped, wingless but looks similar to an adult counterpart. The first nymphal instars do not feed. The nymphs form clusters at the natal site. The second and third instars are also found in clusters but they disperse when disturbed. The fifth nymphal instars are sensitive to day length, which also causes the adults to begin diapauses. The nymphal development lasts for about 8 weeks.

The adult is shield-shaped and green, tan, brown or gray in color. Most of the adults are shiny, but some species are spiny and rough-textured. The female starts mating one week after emergence and lives for about 30 days.

Stinkbug emits a foul odor when disturbed, hence the name.

### Control measures

1. Remove and control weeds from fields and also in the adjacent fields. Weeds serve as the pests' alternate hosts.
2. Plant small flowering plants to attract native parasitic wasps and flies.
3. Plow-under all plant debris after the harvest to destroy all possible breeding sites.

### Parasitoids

#### *Native parasitic wasps*

*Trichopoda pennipes* is a Tachinid fly species that is as big as the housefly. The adult fly is brightly colored with a gold and black thorax and an orange abdomen. It has a fringe of feather-like black hairs on the outer side of the hind legs. The fly develops in the nymph and adult stink bug or squash bug. The female tachinid fly lays its eggs on the body of the bug, completes its cycle inside the bug's body, and the bug dies upon the fly's emergence.

### Thrips



### Damage

Thrips have rasping-sucking mouthparts and feed by rasping the surface of the rapidly growing tissues of the leaves and sucking up the released plant fluid. Thrips cause tiny scars on leaves and fruit, called stippling, which can cause stunted growth. Damaged leaves may become papery and distorted. Infested terminals lose their color, rolled, and drop leaves prematurely.

### Description

The egg is very tiny and is impossible to see. A single egg is 0.25 mm long and 0.1 mm wide. It is white

when freshly laid and turns pale yellow toward maturation.

The nymph is elongated, elliptical, slender, and is pale yellow in color. It is very small from 0.5-1.2 mm in size. Its eyes have darker coloration and are easy to see. Immature thrips do not have wings.

The pupa appears as an intermediate form between the nymph and the adult. It has short wing buds that are not functional. At this stage, they do not do any damage to the plant.

The adult has a slender small body, yellowish to dark brown in color, and is cigar-shaped. It is 1-2 mm long with a well-pronounced 5-8 segmented antennae. It can exist in two forms, winged or wingless. The winged form has two pairs of elongated narrow wings which are fringed with long hairs. Female thrips can reproduce both sexually and asexually.

### Control measures

### Botanical pesticides

#### *Garlic bulb spray*

Finely chop 85 g of garlic. Soak chopped garlic in 50 ml of mineral oil for 1 day. Add 10 ml of soap to the soaked garlic. Dilute with water to make a liter of spray material. Stir well. This spray also controls bacterial and fungal diseases.

### 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



# Diseases

## Bacterial wilt

The initial symptom is a wilting of the terminal leaves, which after 2 - 3 days becomes permanent when the whole plant wilts due to the active development of the disease. Then the whole plants wilt and die suddenly. In the case of a slow development of the disease, the plant stunts and produces large numbers of adventitious roots on the stem.

Bacterial wilt diagnosis in the field can be done easily. Cut a piece of the stem 2-3 cm long from the base. Suspend the cut stem in clear water in a glass container. Hold the stem with an improvised tong to maintain it in a vertical position. Within a few minutes, smoke-like milky threads are discharged from the cut stem.

### Preventive control

1. Remove and destroy all infected plants immediately
2. Rotate crops other than solanaceous crops. Rice, corn, beans, cabbage, and sugarcane are found to be resistant to bacterial wilt.
3. Since the bacteria can be transmitted through farm tools, wash or expose them to heat before using in another field

### Conditions that favor development

1. Crop residues left in the field that were infected by *Ralstonia solanacearum*
2. Injured roots caused by farm tools or by soil pests
3. Warm temperature and high moisture
4. High soil pH
5. Poor and unfertile soil
6. Nematodes present in the soil

## Damping-off on seedlings

There are 3 causal agents of damping-off, namely: *Pythium* spp., *Rhizoctonia solani*, *Fusarium*

*Pythium* spp.

The symptoms include dark-brown to black water-soaked lesions that rapidly spread over the entire seedling causing the seedling to wilt and die.

*Rhizoctonia solani*

The symptoms include reddish-brown lesions on stem and death of growing tips. The lesions are also found on roots and stem near the soil line that cause the seedlings to wilt and eventually die. □

*Fusarium* species

The symptoms include dark-brown lesions on the stem and dark-brown lesions on roots and stems at or near the crown, killing the seedlings. The root lesion is soft and water-soaked.

### Conditions that favor development

1. High soil moisture and/or compaction
2. Overcrowding
3. Poor ventilation
4. Cool, damp, cloudy weather.
5. Water-splashing moves infested soil from diseased to healthy plants.

### Preventive control

1. Improve the drainage and regulate soil moisture to prevent soil saturation.
2. Seed treatment.
3. Rotation to cereal crops .
4. Soil fumigation or solarization may reduce damping-off in the field.
5. Use pasteurized soil mixes in nurseries.

## Verticillium wilt

The symptoms are stunted and wilted plants.

The initial symptom is yellowing of the leaf margins which later turn brown and cause the plant to wilt. A lengthwise cut of the infected stem shows dark-brown discoloration in the vascular tissue.

### Preventive control

1. Use pasteurized soil mixes in nurseries.
2. Seed treatment
3. Soil sterilization, soil fumigation.
4. Crop rotation with non-Solanaceous crops are recommended.
5. Grafting eggplants on suitable rootstocks also minimizes the disease infestation.
6. Use of verticillium wilt resistant varieties.

# 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.



Damsel bug



Diadegma



Lacewings



Spider



Hoverfly



Ground beetle



Ladybird beetles



Tachinid fly



Rove beetles



Trichogramma



Braconid

## Conservation of the beneficial insects

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

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| 1  | Eggplants by Jewel Bissdorf                                                                                                                                                          |
| 11 | Ants by Takumasa Kondo                                                                                                                                                               |
| 12 | Aphids by AVDRC                                                                                                                                                                      |
| 13 | Colorado potato beetle by Clemson University                                                                                                                                         |
| 13 | Cutworm by Clemson University<br><a href="http://entweb.clemson.edu/cuentres/eiis/factshot/pages/Cutworm.htm">http://entweb.clemson.edu/cuentres/eiis/factshot/pages/Cutworm.htm</a> |
| 14 | Eggplant fruit and shoot borer by AVCRD                                                                                                                                              |
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| 17 | Thrips by Canola Council of Canada<br><a href="http://www.canola-council.org/slides/pests/insects/insects.html">http://www.canola-council.org/slides/pests/insects/insects.html</a>  |
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| 20 | Rove beetles by Jim Kalisch & Barry Pawson                                                                                                                                           |
| 20 | Trichogramma by Sylvie Chenus                                                                                                                                                        |

# Tables

**Table 2. Monthly cropping calendar of activities**

<b>Management practices</b>	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Seed procurement												
Land preparation												
Seedling preparation												
Fertilization												
Irrigation												
Pests monitoring												
Pests control												
Harvesting												
Post harvest												







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

**[www.oisat.org](http://www.oisat.org)**

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