



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



**in String bean
Production**



Pesticide Action Network (PAN) Germany



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Non-chemical

Pest Management

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Pesticide Action Network (PAN) Germany
Hamburg, 2005

This publication is prepared by PAN Germany
for PAN UK.

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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© Pesticide Action Network (PAN) Germany
Nernstweg 32, 22765 Hamburg, Germany
Phone: +49 (0) 40 – 399 19 10-0
Fax: + 49 (0) 40 – 390 75 20
Email: info@pan-germany.org
Internet: www.pan-germany.org
www.oisat.org

Prepared by: Dr. Jewel Bissdorf
Editor: Carina Weber
Layout: Reginald Bruhn

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How to use this field guide

This field guide is designed to make the control of pests as easy as possible. Each pest included has a brief description of its lifecycle, damage it causes, and the 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. Also, as not to confuse you with the beneficial ones, a separate description of the natural enemies and their conservation and management are discussed at the last part. Included in the control measures are cultural practices, physical control, plant extracts, other homemade solutions, and other practical methods.

For example, you notice that the leaves are having brownish spots 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 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 natural pest control in string bean production, the recommendations may vary from every location. It is highly recommended 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. And best of all, always keep farm records to have a list of successes and failures in each time you grow a crop!

General recommendations

Throughout this field guide you will find suggestions for lessening the pests' population before they have control over your plants. 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 variety that is well adapted to your local conditions
3. Always select good and diseased-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 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 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. 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 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.

Insects/Mites

Ants

Damage

Ants take the sown seeds back to their colony, 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 abovementioned insects.



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.

Control measures

Cultural practices

1. Increase the seeding/seedling rate. This practice turns out cheaper than with the use of insecticide.
2. Control mealybug, 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.

Other 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

Soap spray

Neem leaf extract

Method of preparation

Pound gently 1-2 kg of neem leaves. Place in a pot. Add 2-4 liters of water. Cover the mouth of the pot securely with the cloth and leave it as such for 3 days. Strain to get clear extract. Dilute 1 liter of neem leaf extract with 9 liters of water. Add 100 ml of soap. Stir well.

Pests controlled

Aphids
Colorado potato beetles
Grasshoppers
Grubs
Japanese beetles
Leafhoppers
Locusts
Plant hoppers
Scales
Snails
Thrips
Weevils
Whiteflies

Soap spray

Method of preparation

Mix 2½ tbsp of liquid soap to a gallon of water. Stir well.

Another method is to mix 1 tbsp of dishwashing detergent with 1 cup of cooking oil, to make a stock solution. For a gallon of spray, add 5-8 tbsp of stock solution to a gallon of water.

Pests controlled

Ants
Leafhoppers
Mealybugs
Psyllids
Scales
Spider mites
Thrips
Whiteflies and
Plant diseases

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 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. Instead apply fertilizer into 3 phases: during seedling, vegetative, and reproductive stages of plant growth.

Physical control

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.

Yellow sticky board traps (refer to p. 19)

Plant extracts

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 in needed for 1 ha.

This spray also controls plant hoppers and thrips.

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. This spray also controls other caterpillars.

Neem leaf extract (refer to p. 10)

Neem seed extract (refer to p. 12)

Other solutions

Ammonia spray

Mix 1 part ammonia with 7 parts water. This spray also controls flea beetles, scales, thrips, and whiteflies.

Flour spray (refer to p. 20)

Soap spray (refer to p. 10)

Bean flies

Damage

Larva feeds on leaves, stems, and taproots that lead to wilting and sometimes death of affected parts. There may be wilted or dead seedlings, and the leaves of older plants may become yellow and stunted. In case of heavy infestation, many plants will die in the scattered areas of the field.

Insect damage on young plants is confined mostly on the main stem of the young plant just above the soil line. Plants will wilt or will eventually die if damage is severe.

The larval feeding on leaves causes holes with corresponding light-yellow spots and larval mines with silvery curved stripes. At the later stage, the damage is clearly visible as the holes and the larval mines turned dark-brown. In cases of severe attack, infested leaves become blotchy and later hang down. Infested leaves may dry-out and may eventually shed.

Insect damage on mature plants is confined to the leaf petioles which become swollen and at times the leaves may wilt.



When larva is about to pupate, it feeds downward into the taproot and pupates inside the stem close to the soil surface. The damaged stems are thicker than normal and they cracked lengthwise just above the soil.

Description

The eggs are oval, clear, and milky-white in color. These are laid in holes of leaves near the petiole.

The maggot is small and white in color with brown head.

The pupa is barrel-shaped, yellow with a brownish-tinge and distinctly darker ends. It has

well-defined segments with black anterior and posterior breathing organs. It becomes dark-brown before the adult emergence.

The adult has metallic-black color about ¼ in size than that of a common housefly.

Control measures

Cultural practices

Mulch plants with rice straw and cut grasses

Neem seeds extract

Method of preparation

Pound gently 3-5 kg of de-shelled neem seeds. Place pounded seeds in a clay pot. Add 10 liters of water.

Cover the mouth of the pot securely with the cloth and leave it as such for 3 days.

Strain to get clear extract.

Dilute 1 liter of neem seed extract with 9 liters of water.

Add 100 ml of soap. Stir well.

Pests controlled

Most agricultural pests

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 greyish-brown moth and has a wingspan of about 3.3-3.8 cm. Each of the mottled and brown front wings which bears a small and silvery-spot that resembles like a figure 8. The hind wings 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.

Control measures

Plant extracts

Gliricidia (Madre de cacao) leaf extract

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

Corn earworm

Damage

Larvae feed on leaves, flowers, and pods. The pods are the preferred sites for attack. The damage is characterized by extensive excrement. They remain feeding inside the pods until they leave to pupate in the soil.

Description

Eggs are pinhead-sized and yellow-green in color. These are found singly laid on the silk and occasionally on the husks of the corn ear. Hatching occurs within about 2-5 days.

Larvae vary in color from bright green, pink, brown, to black, with lighter undersides. Alternating light and dark bands run lengthwise along their bodies, the heads are yellow and the legs are almost black. Mature larvae vary in length about 3-5 cm. They drop to the ground to burrow into the soil



to pupate. The larval stage lasts from 12-24 days. Pupae are yellowish green and turn brown as they mature. Pupation takes place under the soil. Pupal period is 12-24 days.

An adult male is yellow-brown while a female is orange-brown in color. It has a wingspread size of about 3.8cm. Each female may deposit 200 - 2,000 eggs in her entire lifetime. Total development period from egg to adult is 34-45.

Control measures

Plant extracts

Ginger, garlic, and chilli extract

Tomato leaf spray

Finely chop 1-2 cups of tomato leaves. Soak overnight in 2 cups of water. Strain and add 2 more cups of water. This spray controls also aphids.

Physical methods

Light traps

Install the light trap near or within the field where you want to trap the flying insects. Secure the poles firmly on the ground. Mount the lamp or the bulb on the frame, five meters from the ground. When using electric bulb, make sure that the bulb and wiring are not in contact with water to avoid electrocution. Place the shallow basin with soapy water or the jute sack underneath the light. Put the light trap from early evening until early morning. Collect the trapped insects daily and dispose them properly.

Pheromone traps

Place pheromone traps at a distance of 3 meters. If use to monitor the pest, place 2-3 traps in a hectare field area. Buy the pheromone that

attracts the pests you want to control. Read the label and follow the instructions properly.

To make your own traps, make 10-12 holes into an old plastic bottle or 3 holes on each side of a used 1 liter ice cream container to allow moths to enter. Place a wire to suspend the bait. Half-fill the container with soapy water.

Hang the pheromone capsule using a string or wire. Attach the trap to a stake or hang it on branch of a tree.

Ginger, garlic, and chilli extract

Method of preparation

Soak 50 g of peeled garlic overnight in 10 ml mineral oil.
Combine garlic, 25 g of green chillies, and 25 g of ginger.
Add 50 ml of water to the mixture.
Grind them.
Add 3 liters of water.

Pests controlled

Aphids
Armyworm
Cotton bollworm
Caterpillars
Corn earworm
Fruit borers
Leafminers
Shoot borers
Thrips
Tomato fruitworm
Whiteflies

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 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.

Control measures

Cultural practices

Interplant tomato with 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.

Plant extracts

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.

Other method

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.

Leafminers

Damage

The larvae make long, slender, winding, white tunnels in leaves. Severely mined leaves may turn yellow, disfigured, and drop. Severely mined seedlings are stunted and eventual death occurs.

Description

The eggs are laid under the surface of leaf epidermis, are ovate, creamy-white in color, and tiny- about 0.10-0.15 mm in diameter. The eggs hatch after 2-5 days.

The larva is legless, whitish to yellow green with a darker head. It has a mouth hook structure that is retractable into the body. A newly hatched larva tunnels through the mid-leaf tissues leaving its characteristic wavy lines that are visible on top of the leaf. It undergoes 3 larval stages that last for 4-7



days. When the larva is ready to pupate, it cuts a hole where it stays and feeds and usually drops to the soil to pupate.

The pupa varies in color, from yellowish-brown to almost black, and distinctly segmented. It is oval-shaped, becoming narrow at the end. The pupal stage lasts for 10-12 days.

Adult is a small fly, about 2.5 mm long. It is grayish to black with yellow markings. Female flies are slightly larger than males.

Control measures

Cultural practices

Conservation of the natural enemies is an important aspect of leafminer management. Maintain flowering grasses around field margins to provide habitat and food for natural enemies.

Physical methods

Kitchen funnel

Inverted kitchen funnel capped with a plastic vial to monitor adults' emergence from the seedbeds.

Plastic trays

Place the trays under the plants to monitor and catch pupating larvae as they leave the plants to pupate in the soil.

Yellow plastic gallon containers

Mount containers upside down on sticks coated with transparent automobile grease or used motor oil. These should be placed in and around the field at about 10 cm above the foliage. Clean and re-oil when traps are covered with flies.

Yellow plastic drinking cups

Coat cups with adhesive (used motor oil) and stapled on stakes above plant canopies to trap flies.

Yellow plastic trapping sheets

A 2 m long x 75 cm wide yellow plastic sheet coated with motor oil, both ends attached to bamboo or wooden poles and carried by 2 persons through the field to mass capture adult flies.

Plant extracts

Ginger, garlic, and chili extract (refer to p. 14)

Neem powdered seed extract

Neem powdered seed extract

Method of preparation

Add 50 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 on the process of application.

Pests controlled

Aphids
 American bollworms
 Cotton leaf rollers
 Diamondback moths
 Grasshoppers
 Leafhoppers
 Leafminers
 Red locusts
 Mexican bean beetles
 Whiteflies

Seedcorn maggots

Damage

The maggot burrows into the seeds and the seedlings, proceeds into the lateral roots, then tunnels into the taproot, and sometimes bores into the base of the stem. Damaged plants will wilt, stunt, and/or eventually die. The damaged seedlings do not have primary leaves and/or severely damaged primary leaves.



Description

Eggs are elongate and pearly white with a diagonal pattern. They are deposited near the seeds or seedlings, especially those grown in soil with abundant organic matter.

Larvae are small maggots, yellowish white to dirty yellow, and legless. They undergo three larval stages. Larval development lasts for about 12-16 days.

Pupae are tan to brown in color. They are situated near the host plant. The pupal stage is about 7-20 days.

The adult flies are grayish brown and look like small houseflies. The female adults prefer to lay their eggs in newly harrowed fields. They can lay about 100 eggs over a 3-4 week period. Life span is about 1-2 ½ months.

Control measures

Cultural practices

3. Sowing shallow in a well prepared soil to ensure quick germination of seeds.
4. Allow plant residues to decompose properly for a moist heavy-textured soil is very attractive to the pests.

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.

Control measures

Cultural practices

1. Provide plants with adequate water. Water-stressed plants are prone to damage by mites.
2. 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.

Physical control

1. Hosing with a strong jet of water knocks off mites and destroys their webs. Be sure to include the underneath of the leaves.
2. Apply water to pathways and other dusty areas at regular intervals.

Plant extracts

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.

Other solutions

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.

Other methods

Basil leaf extract (refer to p. 21)

Milk spray

Milk spray

Method of preparation

Mix 1/2 liter of milk to 4.5 liters of water (Milk and water ratio is 1 part milk to 9 parts water). Spray at weekly interval as a preventive control measure.

Pests controlled

Spider mites
Mildews
Mosaic virus
Leaf blights
Fungal diseases

Stink bugs

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 other 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

Plant extract

Yam bean seed extract

Grind ½ kg of yam seeds. Soak in 20 liters of water for 1-2 days. Strain.

Sticky board trap

To use, 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 painted plywood of desired color, 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.

Pests monitored/controlled

Blue sticky cards
Thrips

White sticky cards
Flea beetles, tarnished plant bugs

Yellow sticky cards
Aphids, cabbage root maggots, carrot rust flies, cabbage white butterflies, gnats, whiteflies

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 1 mm 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.

Control measures

Cultural practices

1. Do not plant near crops that have whitefly infestation. This would lead to early infestation of your crop and could ruin the whole field crop.
2. Plant *Nicotiana* as a trap crop. Whiteflies are attracted to *Nicotiana*, a flowering tobacco plant variety.

This spray also controls aphids, armyworm, termites, and white grubs.

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.

Plant extract

Garlic oil spray

Chop finely 100 g of garlic. Soak the chopped garlic in mineral oil for a day. Add ½ 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.

Other methods

Ammonia spray
(refer to p. 11)

Flour spray

Soap spray
(refer to p. 10)

Sticky board trap
(refer to p. 19)

Flour spray

Method of preparation

Add 2-4 tbsp of wheat or potato or any baking flour into 4 cups of warm water. Add 1 tsp of soap as sticker. Stir the filtrate prior to application.

Pests controlled

Aphids
Spider mites
Thrips
Whiteflies

Nematodes

Root knot nematodes

Symptoms

Infected plants have swollen, impaired roots. Nematode's feeding stimulates the production of galls (root knots). Galls are found on the root system both on the primary and secondary roots. Their sizes vary from .02 to 20 cm in diameter.

The gall is characterized by smaller swellings and more uniformly distributed infection on the lateral feeding roots. Inside the gall are shiny white bodies of the female nematodes (about the size of a pinhead). At the root surface, shiny white to yellow

egg masses are found. A closer look with a magnifier may show the adults, but mostly they are not seen with the naked eye.

Severe infestation results in stunted growth, yellowing of leaves, wilting, and poor yield because the galls disturb the roots ability to absorb water and nutrients. They also serve as openings for pathogens, such as fungi and bacteria, which cause plant diseases.

Prevention and control

Basil leaf extract

Fermented marigold extract

<p>Fermented marigold extract</p> <p>Method of preparation</p> <p>Fill-in container with ½ - ¾ of flowering plants Leave to stand for 5-10 days. Stir occasionally Strain Dilute filtrate with water at a ratio of 1:2</p> <p>Diseases controlled</p> <p>Tomato blights Rice blast Coffee berry disease</p>	<p>Basil leaf extract</p> <p>Method of preparation</p> <p>Grind leaves 50 g of basil leaves Soak overnight in 2-3 liters of water Strain Add 8-12 ml soap Stir well</p> <p>Pests controlled</p> <p>Caterpillars Fruit flies Red spider mites Red scales Spotted leaf beetles Fungal diseases Nematodes</p>
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Diseases

Anthracnose

Symptoms

Anthracnose on beans appears on leaves at all the growth stages of a plant but often appears in the early reproductive stages on stems, petioles, and pods. It generally appears first as small and irregular yellow, brown, dark-brown, or black spots. The spots can expand and merge to cover the

whole affected area. The color of the infected part darkens as it ages. The disease can also produce cankers on petioles and on stems, causing severe defoliation.



Prevention and control

1. *Baking soda*
2. *Basil leaf extract* (refer to p. 21)
3. *Compost tea spray* (refer to p. 23)
4. *Seed treatment* (refer to p. 23)
5. *Onion bulb extract*.
Finely chop 50 g bulb onion. Add to 1 liter of rain water. Strain.

6. *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 corn earworm / cotton bollworm / tomato fruitworm and bacterial and fungal diseases.

<p>Baking soda</p> <p>Method 1 Mix 1 tbsp of baking soda and 1 tbsp of dormant oil or vegetable oil Add 4 liters of water Stir well Add ½ tbsp of dish washing liquid soap Stir it again</p> <p>Method 2 Dissolve 1 tbsp of baking soda in 4 cups of warm water Add 1 tsp of liquid soap Stir well</p> <p>Method 3 Mix 1 tbsp of baking soda and 2 ½ tbsp of vegetable oil Add 4 liters of water Stir well</p> <p>Diseases controlled Powdery mildew, black spot, and other fungal diseases.</p>	<p>Copper spray (Bordeaux mix)</p> <p>Method of preparation Mix 3 ½ tbsp of copper sulphate, 10 tbsp of hydrated lime and 1 gallon of water (4 liters of water) in a plastic bucket Stir using wooden stick</p> <p>Pests controlled Flea beetles Anthracnose Bacterial blight Bacterial wilt Black spot Downy mildew Late blight Powdery mildew Rust and many other disease causing pathogens</p> <p>Cautions Use only plastic or any non-corrosive containers Shake or stir to prevent extract from clogging Spray only on dry and sunny day, preferably early morning.</p>
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Bacterial leaf blight

Symptoms

Infected tomato leaf has dark watersoaked circular spots which are about 3 mm in sizes but may become larger when the temperature is right. The spots become angular and turn brown-black. Eventually, the centre of the spots may dry and leaf

may drop prematurely. Infected young fruit has small black spots. As the bacteria further develop, the spots turn brown, slightly sunken, scabby, and sometimes surrounded by rings. Severe infestation gives the plant the appearance of blight.

Prevention

1. *Compost tea*
2. *Copper spray / Bordeaux mix* (refer to p. 24)
3. *Garlic bulb extract*
Grind 2 garlic bulbs. Add to 4 cups of water and stir in few drops of soap. Dilute 1 part of this filtrate with 9 parts of water.
4. *Lemongrass extract*
Soak 50 g of ground lemongrass in 2 liters of water for a few hours. Strain.
5. *Mint leaf extract*
Grind 250 g of mint leaves. Make into a paste. Add 2 liters of water. Stir well and ready for use or strain it to have a clear extract.

Bacterial leaf spot

Symptoms

Infected leaf has ovate-shaped spots of dead tissues surrounded with yellow-green to lemon-yellow margins. As the spots enlarge, they may join together often having torn out dead tissues, developing a shot-hole appearance. An infected pod has initially tiny water-soaked spots that later enlarge and join together, become sticky, and develop tiny crusty area on its center during rainy

days. Later, the infected area turns brown and dies causing the pod to twist or bend.

Prevention and control

1. Make sure to select and sow only good seeds
2. Treat seeds with *sweetflag* (*Acorus calamus*) *rhizome extract*
3. *Mint leaves extract*
Grind 250 g of mint leaves. Make into a paste. Add 2 liters of water. Stir well and ready for use or strain it to have a clear extract.

For seed treatments

Sweetflag rhizome
Pound or grind dried sweetflag rhizome. Take 10 g sweetflag rhizome powder and add 60 ml of water. Soak seeds for 30 minutes. Sow treated seeds immediately.

Vinegar solution
Mix 1 tbsp of vinegar and 4 cups of water. Place the seeds on a small cotton bag. Dip the bag into the vinegar and water solution. Dry dipped seeds on old newspapers before sowing and make sure that seeds are completely dry before storing.

Pests controlled
Seed borne pathogens

Compost tea spray

Method of preparation

Put a gallon (4 liters) 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.

Diseases controlled
Fungal diseases

Bean rust

Symptoms

The initial symptom is a yellow mosaic discoloration on the undersides of the lower leaves on the onset or during the flowering stage. The small lesions gradually increase in size and become tan or brown in color. The lesions are slightly raised and consist of small pustules, with a small hole on top where the spores emerge. The pustules become plentiful and eventually coalesce to form larger pustules that break open, releasing masses of spores. During pod formation, the disease spreads rapidly to the middle and upper parts of the plant. Lesions are found on petioles, pods, and stems but are most abundant on leaves.



Prevention and control

1. *Baking soda* (refer to p. 22)
2. *Compost tea spray* (refer to p. 23)
3. *Copper spray / Bordeaux Mix* (refer to p. 22)
4. *Papaya leaf extract*
Soak 50 g of finely shredded leaves in 1 liter of water. Let it stand for 1 night. Squeeze the extract and strain. Add 2-3 liters and 10 ml soap as adhesive.

Mosaic virus

Symptoms

The common symptom of an infected plant is alternating spots of yellowish and light or dark green (mottle) leaves. The mottled areas often appear thicker and somewhat elevated giving the leaves a

blister-like appearance. Other symptoms include curling and yellowing of the leaves, stunted growth, and malformed fruits.

Prevention

1. Control aphids and other sucking insects as they carry the virus.
2. *Milk spray* (refer to p. 18)

Powdery mildew

Symptoms

Powdery mildew is characterized by a dusty-white to gray coating and talcum powder-like growth commonly infecting plant's leaves. It begins as circular, powdery-white spots that turn yellow-brown and finally black. In most cases, the fungal growth can be partially removed by rubbing the leaves.

Powdery mildew is commonly found on the upper side of the leaf. It also infects the underneath

surface of the leaf, young stem, bud, flower, and young fruit. The infected leaf becomes distorted, turns yellow with small patches of green, and falls off prematurely. Infected buds fail to open. Other injuries include stunting and distortion of leaves, buds, growing tips, and fruits. Infected seedlings will eventually die.

Prevention

1. *Baking soda* (refer to p. 22)
2. *Basil leaf extract* (refer to p. 21)
3. *Copper Spray / Bordeaux mix* (refer to p. 22)
4. *Compost tea spray* (refer to p. 23)
5. *Ginger powder extract*.
Add 20 g of ginger powder to 1 liter of water.
Mix thoroughly.
6. *Milk spray* (refer to p. 18)
7. *Papaya extract*.
Soak 50 g of finely shredded leaves in 1 liter of water. Let it stand for 1 night. Squeeze the extract and strain. Add 2-3 liters and 10 ml soap as adhesive.

Natural enemies

Braconids

Hosts

Ants, aphids, armyworms, beetle's larvae, bollworms, cabbageworms, caterpillars, codling moths, corn borers, cutworms, imported tent caterpillars, leafhoppers, leafminers, maggots, midges, plant bugs, scales, tomato hornworms, weevils, and many more.

Description

Eggs and larvae of Bracons are found inside the hosts' bodies.

The larvae are tiny, cream-colored grubs that feed in or on other insects. Larvae molt five times and undergo 5 instars.

Pupae of some species live and pupate within the host until they mature; others pupate in silken cocoons on the outside of the body of the host, while others spin silken cocoons away from the host.

Adult wasps are tiny, about 2.5 mm in size, slender black or brown with threadlike waists.



Female wasps lay eggs into the eggs of hosts' pests but prefer caterpillars' bodies.

In cases where aphids are the host pests, aphids are not killed instantly. Aphids continue to feed on plants tissues until the Braconid larvae inside their bodies completely consume them. The fully-grown Braconid larvae cement the dead aphids to the leaf surface making aphids' shells black and mummified. About a week later, the adult Bracon wasps cut round holes in the mummies and emerge. The empty mummies remain on the leaf. The presence of mummies in a colony of aphids is a sign that Bracons are present.

Conservation

Adult Bracons feed on nectar, honeydew, or pollen before laying eggs. Dill, parsley, yarrow, zinnia, clover, alfalfa, parsley, cosmos, sunflower,

and marigold are flowering crops that attract the native braconid populations and provide good habitats for them.

Damsel bugs

Hosts

Aphids, armyworms, asparagus beetle, Colorado potato beetle eggs and nymphs, corn earworm, corn borer, imported cabbageworm, leafhoppers, mites, moth eggs, sawfly larvae, and tarnished plant bug nymphs. Although they can survive for about two weeks without food, they will eat each other if no other prey is available.



Description

Eggs are deposited in soft plant tissues where they are so difficult to find.

Nymphs resemble adults and develop through 5 nymphal stages in about 50 days.

Adults are tiny, about 2-4 mm long, with slender bodies and are yellowish or gray or reddish-brown in color. They have piercing-sucking mouthparts, a 4-

segmented beak, elongated heads, and 4 long segmented antennae. They are fast runners with long slender back legs and enlarged forelegs for grasping prey. They are commonly found in most agricultural crops, especially legumes, throughout the year. Adults begin laying eggs soon after emergence.

Conservation

They prefer to live in soybeans, grassy fields, and alfalfa. You can collect damsel bugs in alfalfa fields and release them around your garden.

Ground beetle

Hosts

Slugs, snails, cutworms, cabbage root maggots, grubs and insect pupae, and small caterpillars

Description

Eggs are normally laid singly in the soil.

Larva is elongated and tapered toward the end, worm-like in appearance and have a large head directed forward.

Pupa is brownish black, small and found in the soil.

Adult ground beetles or Carabids are about 2-6cm long, dark shiny brown to metallic black, blue, green, purple, or multi-colored. They vary in shapes, - from elongated to heavy-bodied, - tapered head end with threadlike antennae, and have a ringed wing cover. Their heads are usually smaller than their thorax. Both adults and larvae have strong pincher-like mandibles. They have prominent long legs, which make them fast moving insects. Most species are nocturnal and they hide during the

day in soil crevices, under rocks and stones, decaying logs, leaf litter, or composting materials.

When disturbed or when other vertebrates prey upon them, they emit an odor or gas, as a type of defense mechanism, preventing them from being eaten by other predators. Ground beetles live on or below the ground, hence the name. Development from the egg to the adult stage takes about a year, although adults may live 2 to 3 years or longer.



Conservation

1. Practice mulching in some sections of your field to provide a habitat for the ground beetles.
2. Provide permanent beds and perennial plantings to protect population.
3. Plant white clover and/or amaranth as ground covers.

Hoverfly

Hosts

Aphids, thrips, psyllids, scale insects, small caterpillars, and larvae of Heliothis

Description

Eggs are tiny, about 1mm in size, ovate-shaped, and glistening white. These are found laid singly and close to the developing aphid colony in the leaves, shoots, or stems of the plants. They hatch within 2-3 days.

The larvae, known as Syrphids, are legless slug like maggots, about 1-13mm in length depending on their larval stages. They usually have a mottled gray, beige, or light green color. They lift their pointed heads to look for preys. Once preys are located, their mouthparts suck out the contents of the preys. Larvae are frequently found feeding on aphids in the sheltered and curled portion of leaves. They blend well with their habitat and therefore they must be looked for closely to locate them.



Pupae

are teardrop shaped and are found in the soil surface or in the plant's foliage.

Adult hoverflies are true flies with only two wings instead of four which most insects have. Adults are large and beautiful insects about 13 mm long. They have a dark head, a dark thorax, and a banded yellow and black abdomen. They closely resemble bees or wasps rather than flies. Their habit of hovering like humming birds gave them the names hoverflies or flower flies. They feed on pollen, nectar, and honeydew. They are good pollinators.

Conservation

Hoverflies are attracted to all flowering plants but even more so to small-flowered herbs like wild mustard, coriander, dill, lupines, sunflower, and fennel. It is advisable to have multiple crops as adults basically feed on pollen and nectar and it is

advisable to allow flowering weeds such as wild carrot and yarrow to grow between crop plants. Hoverflies' larvae are most noticeable in the latter half of the growing season when aphids are established.

Lacewing

Hosts

Aphids, leafminer, mealybugs, thrips, whitefly, armyworms, bollworms, cabbage worm, codling moths, corn borer, cutworm, DBM, fruitworm, leafhopper nymphs and eggs, potato beetle, scale insects, spider mites, and caterpillars of most pest moths. If given the chance, they can also prey on adult pests.

Description

Eggs are found on slender stalks or on the underside of leaves. Each egg is attached to the top of a hair-like filament. Eggs are pale green in color.

Larvae are known as aphid lions. Newly hatched, they are grayish-brown in color. Upon



emerging, larvae immediately look for food. They grow to about 1 cm in length. They attack their prey by taking them with their large sucking jaws and injecting paralyzing poison, and then sucking out the body fluids of the pest. A larva can eat 200 or more

pests or pest eggs a week. An older larva can consume 30-50 aphids per day. It can consume more than 400 aphids during its development. The larvae resemble alligators with pincers like jaw. However, they become cannibalistic if no other prey is available. They feed for 3 to 4 weeks and molt three times before pupation. They cover their bodies with prey debris.

Pupae are cocoons with silken threads. These are found in cracks and crevices. The pupal stage lasts for approximately 5 days.

Conservation

Flowering plants such as dill, cosmos, sunflower, carrots, and dandelions are good source

Adults are green to yellowish-green with four, delicate transparent wings that have many veins and cross veins. Adults are about 18 mm long, with long hair-like antennae and red-gold eyes. Each adult female may deposit more than 100 eggs. Many species of adult lacewings do not prey on pests. They feed on nectar, pollen, and honeydew. An adult will live for about four to six weeks depending on the climatic conditions.

of pollen and nectar for adults. Provide source of water during dry season.

Ladybird beetles

Hosts

Aphids, mealybugs, scale insects, spider mites, whiteflies



Description

Eggs are yellow to orange in color, football-shaped, and are laid in circular clusters of 10 -50 eggs on the underside of leaves or near the aphid colony.

Newly hatched larvae are gray or black and less than 4 mm long. They emerge as dark alligator-like flightless creatures with orange spots. Adult larvae can be gray, black, or blue with bright yellow or orange markings on the body. The larvae are elongate and slightly oblong in shape. They undergo four instars before pupating.

The pupae are usually brightly patterned and can be found attached to the leaves and stems of plants where larvae have fed and developed.

Adults are oval to hemispherical and strongly convex with short legs and antennae. Most species are brightly colored. Body length ranges from 0.8-16 mm. Their colors tell other predators that they are tasteless and toxic. When disturbed, some of them emit a strong smelling yellow liquid as a protection against other predators. Their colors vary from red, orange, steel blue, yellow-brown, or yellow elytra, frequently spotted or striped with black. They feed on pollen, nectar, water, and honeydew but aphids or other prey are necessary for egg production. They are the best-known predators of aphids and are capable of eating up to 50-60 per day and about 5000 aphids in their lifetime.

Conservation

Lady bird beetles are found in most agricultural and garden habitats. Their presence indicates that natural biological control is occurring. It is important to maintain habitats planted with several flowering crops. These give the ladybird beetles varied food

sources. When food is not available, they tend to eat each other. Their beneficial predatory behavior and activities are continuous when there is no indiscriminate use of synthetic pesticides.

Rove beetles

Hosts

Both adults and larvae are predators of root maggots' eggs and larvae, mites, worms, nematodes, and other small insects. Adults tend to be cannibalistic, eating their own eggs and attacking other adults when food supply is low.

Description

Eggs are tiny, about 0.5 mm long and 0.4 mm wide, pear-shaped, pale green in color, and are covered with a gelatin-like material. These are laid by female adults in the soil among the roots of the root-maggot infested plants. The eggs hatch 5-10 days later.

The first instar larvae are pale brown, about 1.5 mm long, slender, segmented, and tapered toward the anterior. They have large heads. The parasitic second and third instar larvae are white, have rudimentary legs, and are found within the host puparium. Before pupating, a larva will actively search for a host (pupa of maggot) in the surrounding soil. It will pupate in the pupa of the maggot by entering into its cocoon and feeding its contents, and then pupate itself inside for about 3-4



weeks before emerging as an adult. It is possible that two or more larvae enter into one maggot pupa but only one will survive and mature.

Adult rove beetles are brown, reddish-brown, or black or have gray markings on the wings and abdomen, with slender elongate bodies. Their wing covers are shorter than the abdomen where most part of the abdomen is exposed. Both adults and larvae have well-developed 'jaws' cross in front of the head. They live mostly in decaying organic matter but are also found in moist agricultural soils or in habitats where large numbers of fly larvae live. When disturbed, they run very fast, with their abdomen lifted upward, like that of scorpions. Adults are good fliers as well.

Conservation

Provide ground covers or mulches within and around fields for rove beetles love to stay in moist decaying organic matter; provide hiding sites and alternative habitats and plant flowering borders,

hedges, and other perennial habitats as a source of food and shelter; and provide protection by not spraying broad spectrum pesticides.

Spider

Hosts

Moths and caterpillars

Description

Some spiders' eggs are laid in a cluster in silken sacs, while some species lay their egg masses covered with silks within folded leaves. Some of these sacs are attached to the mother spiders or mothers stay nearby to guard their egg sacs. Eggs usually hatch into spiderlings within three weeks. The spiderlings may remain attached to the mother for several days on some species, but for some



species they are left on their own.

Spiders are not insects. They have 8 legs while insects have 6. They do not have wings whereas insects do. They have two body sections; a united

head and thorax and abdomen, while insects have three; head, thorax, and abdomen.

A female can produce 200-400 eggs but only 60-80 spiderlings can hatch from these. Females

can survive 2-3 months. In some species, females die after laying eggs.

All spiders are poisonous to insects but only a few species are poisonous to humans, like the Black widow and the Brown recluse.

Conservation and management

Mulching along some sections in dikes of rice paddies, in field corners, or a portion of the fields can increase the number of spiders. They can hide in the layer of mulch that serves as their alternate habitat. They can also prey on other small insects inside the mulch.

Remember, that the more food the spiders can eat, the faster their population build-up will become.

Cover crops are also important to provide over-wintering sites of spiders' sacs.

A spider population depends on the availability of food, the habitat, and the environmental conditions. Avoid use of pesticides as much as possible, for broad-spectrum insecticides can easily kill them.

Tachinid fly

Hosts

Aphids, armyworm, beetles, bollworm, bugs, cabbage looper, cotton stainer, cutworm, grasshoppers, hornworm, leafhoppers, mole crickets, moths, sawflies, scale insects, stem borers, stick insects.



Description

Eggs are ovate-shaped and white in color. They are found in the skin of the host insect or in leaves near the host and are hatched when the host ingests them.

The larvae or maggots are worm-like and lack appendages like all other fly larvae. They are greenish-white in color. They have three larval instars and then leave the hosts to pupate in the soil. Before pupation, some mature maggots produce hard cocoons. The larval stage takes about 4 days to 2 weeks depending on the climatic conditions. The newly hatched larvae enter into its host and feed on the content before pupating into the soil. Some tachinid species are hosts' specific, for example for a certain species; it is parasitic only on leaf rolling caterpillars, or only on sugarcane stem borer.

Pupae are oblong, yellowish and turn dark-reddish as they mature.

Adults measure between 3 and 10 mm and have very stout bristles at the tips of their abdomens. They look very similar to the common housefly but are larger with stocky and soft bodies. They vary in appearance from gray black to brightly colored, or sometimes looking like bees. Adult Tachinid flies have only 1 pair of wings. They feed on honeydews and flower pollen. Different species have varied modified sucking type mouthparts: the cutting sponging, the piercing-sucking, and lapping-sponging. Adult flies are found in almost all crop habitats, either resting on foliage or feeding on nectars and pollen. Additionally for females, they search for hosts to lay their eggs. The female adult lays her eggs near or into the larvae, or on another insect. She can lay as many as 1000-2000 eggs in her lifetime. Adults can live from 3 days to 2 months depending on the species.

Conservation

Providing sources of food like dills, parsley, clover and other herbs are the most efficient ways to

conserve Trachinid flies in the agricultural ecosystems.

Photo credits

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- 30 Rove beetles. Jim Kalisch & Barry Pawson
- 30 Spider. IRRI & Queensland University. IRRI, Los Banos, Philippines
- 31 Tachinid fly. IRRI & Queensland University. IRRI, Los Banos, Philippines

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www.oisat.org

Pesticide Action Network (PAN) Germany

Nernstweg 32 • 22765 Hamburg • Germany

Phone: +49 (0)40 - 399 19 10-0 • Email: info@pan-germany.org

Internet: www.pan-germany.org • www.oisat.org

