

Field Guide

Insect Pests of Selected Vegetables in Tropical and Subtropical Asia

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Abstract

This is a pictorial field guide containing information on the major insect pests causing damage to onion, garlic, shallot, chives, tomato, chili pepper, mungbean, soybean, sweet potato, and various crucifer crops in the Asian tropical and subtropical regions. It is specifically designed for farmers and extension workers to use in the diagnosis of their crop problems. Details on damage symptoms and hints on where, when, and how to look for the causal agent are provided, as well as technical facts of practical value about each insect pest species.

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FOREWORD

This field guide is a long overdue publication. Farmers and extension workers in the region have needed such a reference to help identify the economically important pests in their fields.

For the first time, vegetable producers in Asia can have access to a pocket encyclopedia that will help identify pests. This guide has been carefully planned so it will truly be useful and user-friendly. The color photos and the drawings of the pests have been carefully selected to show details and pertinent information.

In this first edition, the authors have emphasized insect pests of vegetables that AVRDC has been working on for the past several years. In future editions, the authors hope to include insects of other economically important vegetables.

We hope that this pocket guide will be worthwhile when making control decisions and managing pest problems. AVRDC has been developing alternative methods of pest management emphasizing biological control and the development of insect-resistant vegetable varieties to reduce reliance on chemicals and establish more sustainable systems.



Samson C.S. Tsou
Director General
AVRDC

INTRODUCTION

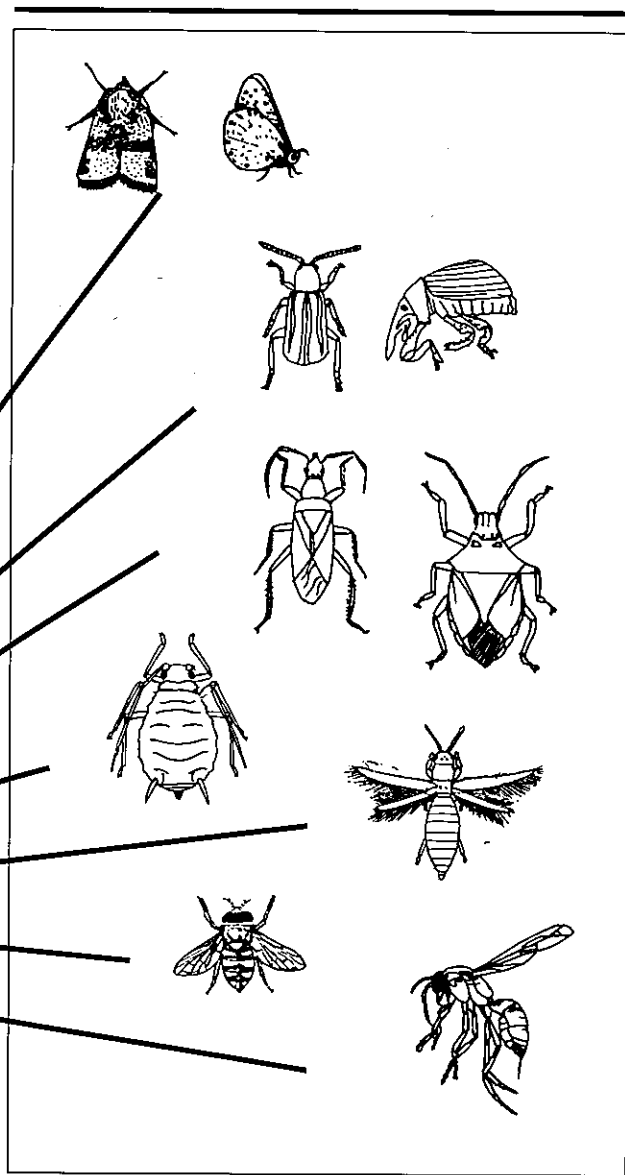
This pictorial field guide contains information on the major insect pests (and mites) causing damage to onion, garlic, shallot, chives, tomato, chili pepper, mungbean, soybean, sweet potato, and various crucifer crops in the Asian tropical and subtropical regions. It is specifically designed for use by farmers and extension workers and supplies practical facts on damage symptoms and insect diagnostic characteristics, plus hints on scouting for these pests. One should realize that there are thousands of different insect species that damage our crops. This guide includes only the most economically important ones. Care must be taken to diagnose correctly the causal agents of damage. Whenever possible, we urge farmers to seek the advice of agricultural extension personnel and/or other technical professionals when faced with serious insect problems that require management action.

A basic understanding of insect biology and morphology is an essential foundation for making accurate pest identification. This information is supplied at the beginning of this guide. Correct diagnosis of the causal agent of particular crop damage is essential to develop an effective management program. An ability to differentiate between beneficial and damaging insects is also critical to ensure survival of the beneficials when deciding upon a management action.

INSECT CLASSIFICATION

Insects have been on this Earth for about 350 million years—far longer than human beings. About 10,000 different species are pests of food and fiber throughout the world. Scientists place insects into different groups called orders based on their structure or form. This makes it easier to identify and differentiate insects. Each order is subdivided into families of closely related species. There are a few orders of insects that contain most of the serious pests of vegetables. These orders, the common names of the insects within them, and the life stage that most commonly causes the plant damage are listed below.

Insect order	Stage causing damage	Common name
Lepidoptera	Caterpillar (larva)	Butterflies & moths
Coleoptera	Larva & adult	Beetles & weevils
Hemiptera	Nymph & adult	True bugs
Homoptera	Nymph & adult	Aphids & whiteflies
Thysanoptera	Larva & adult	Thrips
Diptera	Maggot	Flies
Hymenoptera	Larva & adult	Bees, ants, & sawflies



SCIENTIFIC NAME

All insects are given a two-part scientific name which places them into separate species. The first part of this name is the genus to which it belongs. A genus is a subdivision of the insect family. The second part represents the particular species of that insect. Insects of the same species can mate and reproduce, while those of different species cannot. The species name is followed by the last name of the person who first described it. Many insects have a common name that may reflect a crop on which they often feed. An insect may have several common names but only one scientific name.

The scientific name of the cotton aphid is *Aphis gossypii* Glover. It is in the genus *Aphis*, the species *gossypii*, and it was described by Glover. At the bottom of each page in this guide we list the scientific name of the insect followed by the order and family to which it belongs.

Insect Species Classification

Aphis gossypii Glover, Homoptera: Aphididae

GENUS SPECIES PERSON
 (describer)

ORDER FAMILY



Scientific names of insects often appear incomplete:

Anoplocnemis sp., Hemiptera: Coreidae

GENUS SPECIES
 (Not specified)

ORDER FAMILY

DIAGNOSIS

A stepwise process is needed to diagnose insect problems in your fields and develop good management tactics. This requires an understanding of what insect-damaged crops look like and how the damage is done. A farmer must consider several factors, among them host plant, damage symptoms, the presence of the pest (adult or immature), and its mouthparts.



Monitoring insects with a sweep net



Monitoring insects with a pheromone trap

INSECT MOUTHPARTS

Insects have many different types of mouthparts. Some are designed to chew large holes through or into foliage, some to pierce the surface of leaves and extract plant juices, and some to suck pollen, sap or even blood of animals. Over 90% of the insect damage to our vegetable crops is done by those with chewing or piercing-sucking mouthparts. It is essential that you look at an insect and determine if that particular individual or population is capable (based on mouthpart structure) of causing the type of damage that you see in your fields. On the following page you will see insect mouthparts that are elongated and designed to pierce tissue or cells of plants to suck up internal fluids. This is the typical structure of piercing-sucking type mouthparts.

Note the other very different arrangement of mouthparts on the opposite page. These are designed to actually chew plant tissue. They are rugged and thus, it is easy to visualize how they can be used to actually consume portions of leaves or stems or even roots depending on the particular species of insect involved. The "shot-hole effect" on leaves is usually caused by insects with chewing mouthparts. Leaves with this kind of damage have many tiny holes; they appear to have been shot with many little bullets.

Piercing-sucking mouthparts



Frontal view



Side



Chewing mouthparts



Frontal view



Side



CROP DAMAGE

It is necessary to look carefully at your crops and try to assess what type of damage you see. Insects with piercing-sucking mouthparts can cause damage as seen on the following pages. Those with chewing mouthparts can cause damage shown also on the following pages. These are typical, but note that it is impossible to categorize all types of damage and exceptions do exist. In addition, damage by insects with piercing-sucking mouthparts is often confounded by the fact that they may transmit diseases to our crops. The resultant disease can be many times more devastating than the feeding damage caused initially by the insect (*see below*).



Field of pepper plants with aphid-transmitted virus

Damage caused by insects with piercing-sucking mouthparts



Distortion of leaves



Browning and drying around veins

Damage caused by insects with piercing-sucking mouthparts



Browning and drying of leaves



Yellowing and curling of leaves

Damage caused by insects with piercing-sucking mouthparts



Surface scarring



Browning and drying of leaves

Damage caused by insects with chewing mouthparts



Eating lower leaf surface

Damage caused by insects with chewing mouthparts



Shot-hole effect



Eating between veins of upper surface



Skeletonizing of leaves

Damage caused by insects with chewing mouthparts



Eating holes completely through leaves



Eating internally in fruit and stems

LIFE STAGES

An insect during its life cycle goes through several developmental stages (metamorphosis), which may each look very different. The moths have four stages: egg, larva, pupa, and adult. Some stages damage our vegetables and some don't. For example, the immature stage of the diamondback moth, called a larva or caterpillar, has chewing mouthparts and eats leaf tissue of crucifers. But the mature adult moth flies and has mouthparts that do not damage cabbage, but suck up nectar of flowers. Be careful to locate the insect stage that is causing the damage. Don't disregard a specimen merely on the basis of its mouthparts. The presence of the nondamaging adult may provide a clue to the damage that is, has been, or will be caused by the immature insect. The types of metamorphoses among vegetable insect pests, and their groups are listed below:

Gradual metamorphosis:

egg nymph adult
(Aphids, True bugs, Stink bugs, Grasshoppers)

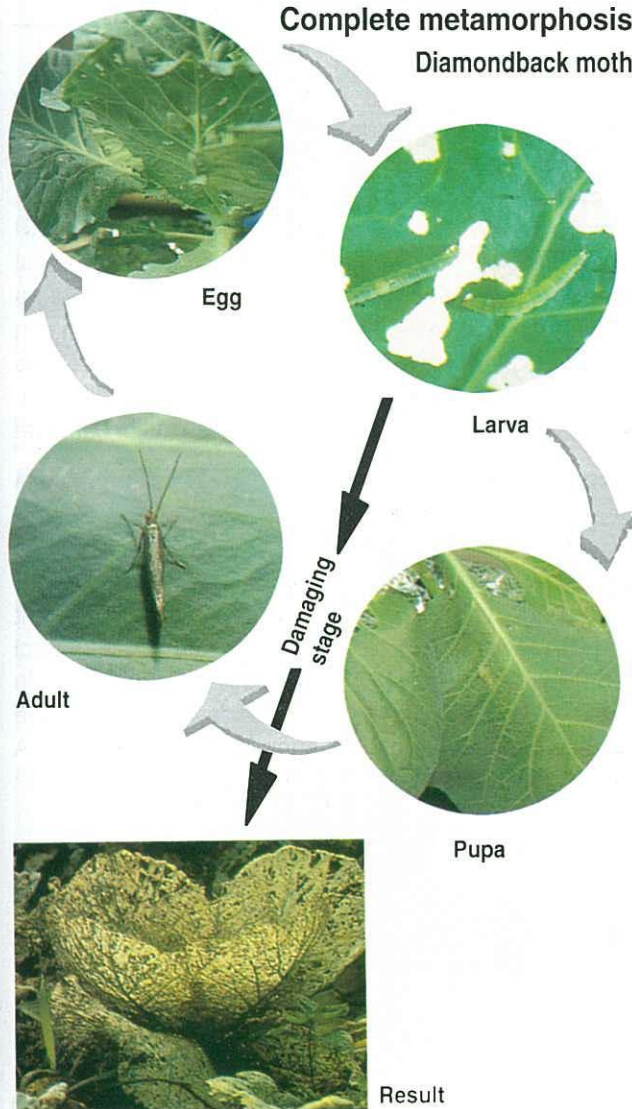
Intermediate metamorphosis:

egg larva prepupa and/or pupa adult
(Thrips, Whiteflies)

Complete metamorphosis:

egg larva (caterpillar or grub) pupa adult
(Butterflies & Moths; Beetles; Flies;
Bees, Wasps & Sawflies)

Complete metamorphosis Diamondback moth



NATURAL ENEMIES

In nature, insects are plagued by numerous living organisms that feed upon them. These are called natural enemies or beneficials and are of great value to vegetable growers. Care should be taken to allow them to thrive whenever possible. In some cases pesticide use can kill the beneficial as well as the pest species. Because natural enemy populations sometimes build up slowly, a resurgence of the pest after a pesticide application can occur. In addition, when the natural balance between the beneficial and pest complexes is disrupted, a different, previously minor, pest species can cause major damage.

Many of the natural enemies look very similar to vegetable insect pests and they should not be mistaken for harmful species. Among the natural enemies of insects are organisms such as bacteria, fungi, nematodes, viruses, and protozoans. Each of these is an important component of the natural biological control system. The natural enemies of insects are either predators or parasites. In any given area of your vegetable fields, about 30% of the insects present are natural enemies of other insects. A few of the common ones are shown on the next pages.



Predator: Lady beetle adult

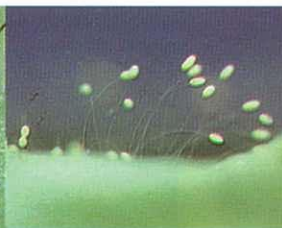


Predator: Lady beetle immature

Predator: Adult robber fly
Photo by M.P. Hoffman



Predator: Adult green lacewing
Photo by M.P. Hoffman



Lacewing eggs
Photo by M. Ibrahim Ali

Natural enemies



Predator: True bug



Predator: Spider

Photo M. Ibrahim Ali



Entomopathogen: Fungus

Photo by Tony Downer

Entomopathogen: Fungus

Photo by Tony Downer



Natural enemies



Parasite: Adult tachinid fly

Photo by M.P. Hoffman



Parasite pupae on insect body



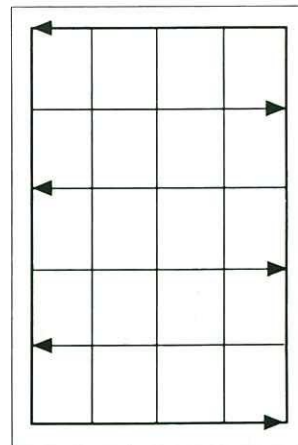
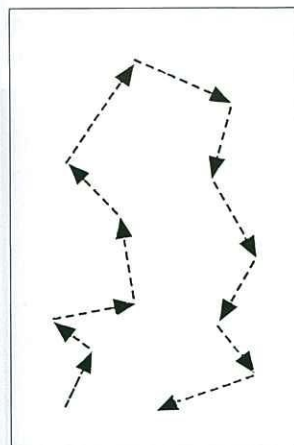
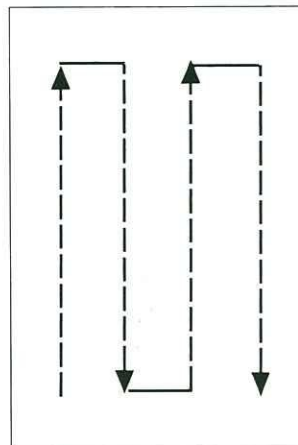
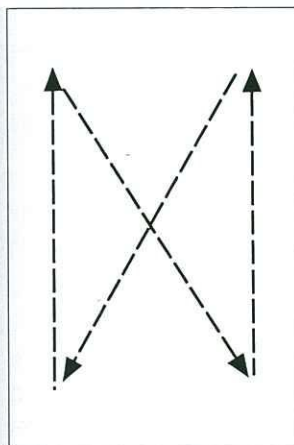
Parasitic wasps

SCOUTING PROCEDURES

Regular scouting is an excellent way to survey and monitor your crops. It serves as an insurance to prevent total destruction of your plants and allows you, the grower, to initiate pest control procedures before significant losses occur. It is essential for taking a proactive approach to insect pest management (IPM).

A periodic and systematic procedure is necessary and should be followed at regular intervals. Inspect every plant in small plantings and carefully look at all plant parts, particularly the undersides of the leaves and along the veins. You might consider using a hand lens with at least 10x magnification. In larger plantings (about 1 ha), carefully inspect at least 15 to 20 randomly selected, widely scattered plants. If damage has occurred in certain sections of the field, concentrate your efforts there and in adjacent areas. To obtain reliable results from scouting, take sample from several locations throughout the field, not only from one side or the edge of the field. Several sample scouting patterns are shown on the opposite page.

You should be aware that insect populations often differ depending on the part of the plant you are looking at. For example, some insects prefer lower leaves, while others prefer upper or younger leaves. Once the vegetable crop has germinated, inspect them at least once every 7 days. Note that insect feeding is not always confined to the aboveground portions of the plant. Damage can and does occur at the roots, tubers, and other plant structures below ground. All these should be considered and surveyed especially when you grow crops such as sweet potato.

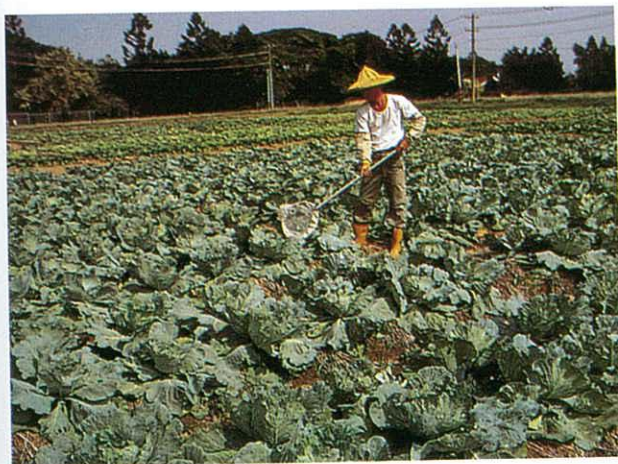


HOW TO USE THIS GUIDE

1. Inspect your crop and decide what type of damage has been done.
2. Try to locate the insect that has caused the damage. Examine it carefully. Look at several specimens to ensure a correct diagnosis.
3. Turn to the section in this Field Guide dealing with the crop you are growing. The diagnosis will be facilitated by descriptions and pictures of the insect and the damage. Once you have determined the causal agent, recommendations for management can be made available through your local or regional extension personnel or local agricultural authorities.
4. If you are still unsure of the causal agent, collect several specimens in a jar or plastic bag and bring them to your local agricultural authority for identification. Make sure you collect specimens of the pest in all its life stages.



Carefully inspect plants



Collect the pest

Onion, Garlic, Shallot, and Chive Insect Pests



Beet armyworm¹

Damage symptoms

Leaves are partially or completely consumed. Holes or crescent-shaped areas in leaves are removed.

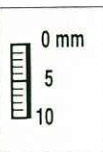
Insect characteristics

Chewing mouthparts. Armyworms, as the common name implies, feed in groups. Caterpillars are dull green with many light stripes along their backs and a broader stripe down each of their sides. Their undersides are usually yellow. Adult moths are grayish and can only be seen flying after dark.

Where to look

Feeding immatures will not be hidden, but are easily seen in groups on leaf surfaces. Sometimes, larvae bore into tubular leaves and feed concealed inside. If feeding holes are small, then look carefully at the leaves.

The insects, in their early stages of development, are small (about 5 mm long). Usually, you will find armyworms where insect frass and new feeding damage can be seen.



Technical information

Populations may develop continually throughout the year. Adult moths lay their eggs in white to dull-white hair-covered clusters on the leaves. When feeding is complete caterpillars pupate in the soil. Populations can develop on some weed species. Beet armyworm also feeds on tomato, soybean, groundnut, sugar beet, and crucifers.

¹*Spodoptera exigua* (Hübner), Lepidoptera: Noctuidae.



Larva on onion leaf



Damage

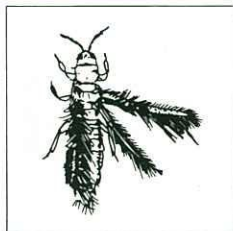


Larva on the surface of the soil
(Note pupa at the end of the pointer.)

Onion thrips²

Damage symptoms

Leaves are silvery or have tiny brownish marks or spots. They may be wilted or distorted. Outer leaves are brown at the tips. In cases of severe injury, leaves drop and bulbs are small and misshapen.



Insect characteristics

Modified piercing-sucking mouthparts. Thrips are very small and sliver-shaped, just barely visible to the naked eye. They are about the size of a flea. Immatures are either yellow or white. Older individuals are yellowish-brown and move quickly. They feed by sucking plant sap.

Where to look

Thrips are difficult to find by those not familiar with them. Look for areas on the leaves where the damage is most obvious and then carefully focus on that area and look for signs of movement. They often congregate along the leaf veins.

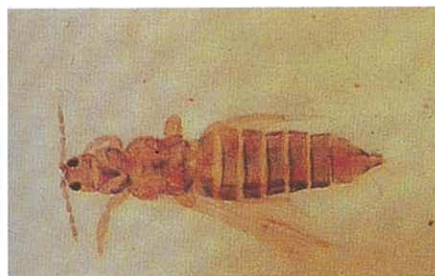
Technical information

Adults have narrow wings that are fringed with hairs, which are only visible under the microscope. They are distributed worldwide and can reproduce without males. Eggs are inserted within leaf tissues and after two larval instars, the insects drop to the soil to pupate. Definitive species identification should be made by trained taxonomists. Several generations can develop each season; hot and dry weather favors population buildup. Other hosts include tomato, pea, and beet.

²*Thrips tabaci* Lindeman, Thysanoptera: Thripidae.



Onion damaged by *Thrips tabaci*



Adult

Photo by Niann-Tai Chang



Immature on
a leaf

Photo by Niann-Tai Chang

Eriophyid mite³

Damage symptoms

Leaves are distorted and wilted. They appear to curl and have brown areas. Bulb development is slow and the bulbs are small. Plants may turn brown and die.

Mite characteristics

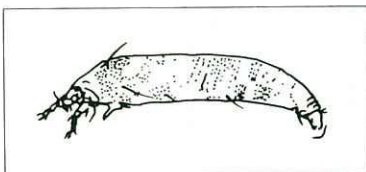
Extremely small, about the size of a particle of sand. Mites are not visible to the naked eye. They are hidden and grouped around the mid-vein.

Where to look

Obtain at least a 20x magnifying glass and inspect both sides of the leaves where you see browning of leaf tissue at the mid-vein. These tiny, rather spindle-shaped creatures appear like little white worms with two pairs of legs. Individuals of different sizes usually live together.

Technical information

Eriophyid mites have been implicated in the transmission of some mosaic viruses. Generations may be continual in favorable climates. Mortality is usually high when climatic conditions are unfavorable, i.e., extremely warm temperatures and low relative humidity.



³Probably *Eriophyes tulipae* Keifer, Eriophyoidea: Acari.
Special note: Mites are not insects but closely related.



Mite along mid-vein

(Note: The mite in the picture is about 100 times larger than its actual size.)

Photo by L.L. Black

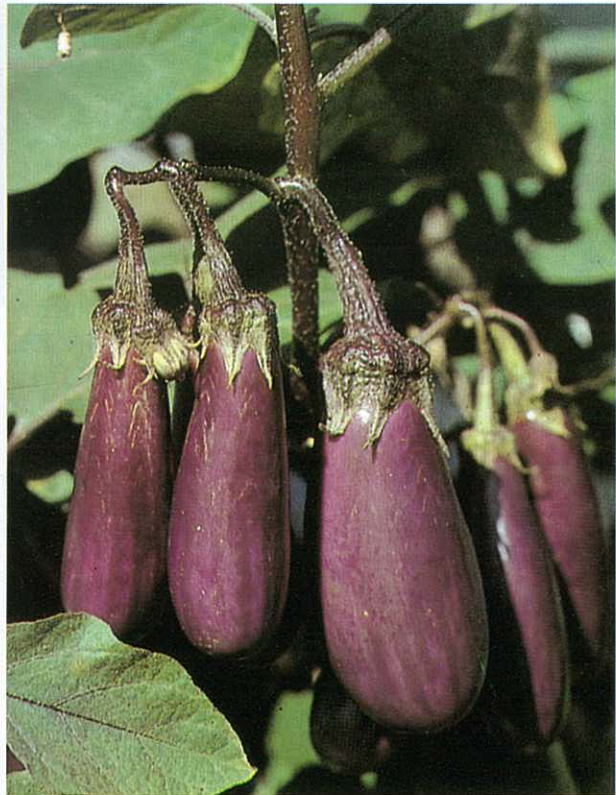


Damage to garlic

Photo by L.L. Black

Eggplant

Insect Pests



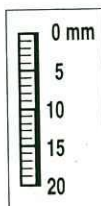
Eggplant fruit and shoot borer⁴

Damage symptoms

Wilted shoots are readily visible. There may be small darkened holes surrounded with brownish areas on fruit surface and/or fruit stalk. The inside of the fruit is hollow and filled with frass. The fruit is not marketable.

Insect characteristics

Chewing mouthparts. The young caterpillar is dull white and turns light pink as it matures. It is 15-18 mm long. The adult moth is white with a pink or bluish tinge and brownish on its wings.



Where to look

Look for wilted shoots. The larva can be found feeding inside. Fruit damage will not be obvious. The first indication is a small hole in the fruit stalk or in the fruit itself. This is where the insect has entered. Cut the fruit near this entry hole and you will find areas where the larva has tunneled. The tunnels contain frass and insect remains. If you continue to cut around this area you may locate the live larva.

Technical information

Creamy-white eggs are laid singly or in groups on the undersides of the leaves, on stems, flower buds, or the base of the fruit. The newly hatched larva prefers to bore directly into the fruit. When feeding is complete pupation occurs on stems, dried shoots, or among fallen leaves. Multiple overlapping generations occur in warm climates. This pest feeds on many other solanaceous plants such as tomato and potato.

⁴*Leucinodes orbonalis* Guenée, Lepidoptera: Pyralidae.



Symptom of shoot attack



Symptom of fruit attack



Plant damage in the field

Eggplant fruit and shoot borer



Adult and eggs

Photo by M. Ibrahim Ali



Larva and internal damage



External damage

Epilachna beetles⁵

Damage symptoms

Leaf tissue is eaten between the veins. The leaves may be completely stripped to the mid-vein, and small areas eaten out and/or shallow holes may be present on the fruit surface.



Insect characteristics

Chewing mouthparts. Adults and the young are often seen living together. Adults are familiar and look like common lady beetles. They are oval-shaped, brownish with black spots on their backs. The young are pale yellow and have branched spines covering their backs and sides.

Where to look

Look at both sides of the leaves where the beetles should be evident. Adults fall to the ground or fly when you disturb them. The young normally stay in place. Due to their yellow color, they can easily be found. Their sizes vary.

Technical information

Most of the ladybird beetles feed on other insects. However, the ones described here are exceptions. The yellow eggs are commonly laid on the underside of leaves, and look like little kegs grouped together. Insects in all stages can be found on leaves. Pupae can be recognized easily because one end of their bodies is cemented in place and often, partial adult characteristics can be seen. Different species of *Epilachna* feed on tomato, potato, cucurbits, and beans.

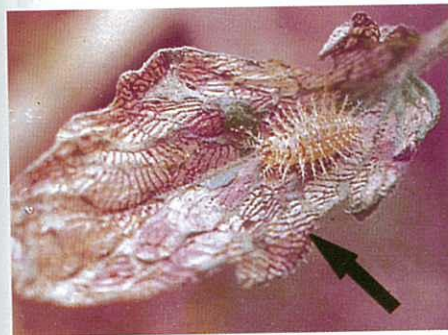
⁵*Epilachna duodecastigma* Mulsant (12-spotted),
Epilachna vigintioctopunctata F. (28-spotted).



Adult beetle on damaged leaf (12-spotted)



Adult beetle
(28-spotted)



Immature
(Note damage
between the
leaf veins.)

*Thrips palmi*⁶

Damage symptoms

Damage is most obvious on the underside of the lower leaves, where areas appear brownish and dried up. In severe cases, the entire leaf dries up. Similar damage is seen along the mid-vein on the upper leaf surface.

Insect characteristics

Modified piercing-sucking mouthparts. These insects are sliver-shaped and very small, about the size of a flea, and just visible to the naked eye. The young are either yellow or white. Adults are darker with two brownish strips down their backs.

Where to look

First look at the upper surface of the lower leaves. Along the mid-vein notice the damage on either side. This is where you should see these tiny insects. Turn the leaf over and carefully look at the sections with healthy tissue that border areas of brown or damaged tissue. If you focus well, you will notice the tiny insects moving.

Technical information

Adults lay their eggs within leaf tissues and the young hatch after several days. Adults are excitable and fly off if disturbed. Pupation occurs in the soil usually at the base of the plant. Identification of species should be made by a trained taxonomist. This pest also damages watermelon, muskmelon, bottle gourd, cucumber, chili pepper, tomato, and potato crops.

⁶*Thrips palmi* Karny, Thysanoptera: Thripidae.



Adult

Photo by Niann-Tai Chang



Damaged upper leaf surface



Damaged lower leaf surface

Photo by
Nianne-Tai Chang



Damaged surface of eggplant

Photo by
Nianne-Tai Chang

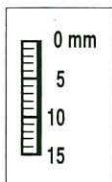
Leafhoppers⁷

Damage symptoms

Infested leaves curl upwards along the margins. Outer leaf areas appear yellowish or burned. Leaves are extremely small and show a mosaic pattern of yellowing. Fruit-set may be very low.

Insect characteristics

Piercing-sucking mouthparts. These pests infest the lower surface of the leaves. Commonly, if disturbed, they move very rapidly sideways and often hop. They are usually less than 13 mm long, with slender, tapered bodies of various colors and legs with rows of sharp spines.



Where to look

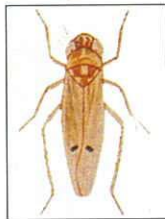
Adults and immatures are readily found on the undersides of leaves. Their nervous behavior makes them difficult to catch.

Technical information

In warm climates, multiple generations occur. Heavy infestations can cause yield reductions and total loss of crops. Some species transmit little-leaf disease and mosaic virus. Leafhoppers occur on most types of plants and different species attack a variety of vegetable crops.



Immature



Adult

⁷Also known as jassids. Several species are important: *Amrasca biguttula biguttula* (Ishida), *Amrasca devastans* (Distant), *Hishimonus phycitis* (Distant), Hemiptera: Cicadellidae.



Adults



Damage



Close-up of damage

Eggplant leaf roller⁸

Damage symptoms

Young leaves are rolled lengthwise. Rolled leaves are brown and eventually dry. In heavy infestations entire portions of plants appear brown and leaf drop occurs.

Insect characteristics

Caterpillars have chewing mouthparts and are purple-brown with many cream-colored hollow bumps and long hairs on the back and sides. The adult is an olive green moth that is active at night.

Where to look

Inspect the young leaves for signs of silken webbing and rolled leaves. Open these leaves and look for the caterpillar and signs of chewing damage on the leaf surface.

Technical information

The female lays eggs in masses on the young leaves. Each mass may have 8–22 eggs. The caterpillar feeds for about 4 weeks and then pupates inside the rolled leaf. In favorable climates there may be three to four generations each year.

⁸*Eublemma olivacea* Walker, Lepidoptera: Noctuidae.



Damage symptom



Caterpillar



Damage



Adult moths

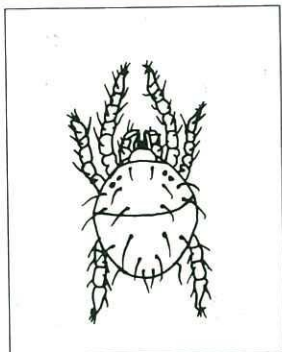
Chili Pepper Insect Pests



Broad mite⁹

Damage symptoms

Damage is usually confined to undersides of leaves, where areas between veins are brownish and dried out and brittle in severe cases. Young leaves are cupped downward and narrower than normal.



Mite characteristics

Individuals are extremely small, about the size of a grain of sand, and not clearly visible to the naked eye. They are found in groups hidden around the mid-vein on the undersides of the leaves. They appear crablike and are yellow or white.

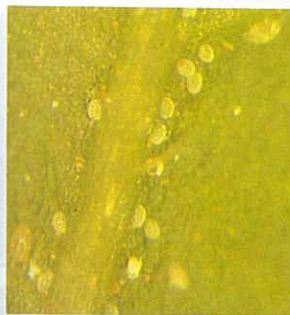
Where to look

Locate leaves with a brownish cast, preferably young leaves that are beginning to curl under. With a 10x magnifying glass, look at areas on the undersides of the leaves around the mid-vein. There you should see the crablike mites. Definitive identification of species should be reserved for an expert.

Technical information

Females lay eggs singly on the surface of the leaves. These eggs are white, oval, and extremely large compared to adults that lay them. Populations are continual but appear to be limited at high temperatures. Broad mites also feed on tomato, potato, beans, and pepper.

⁹*Polyphagotarsonemus latus* (Banks), Acarina: Tarsonemidae.
Special note: Mites are not insects but are closely related.



Mites on the underside of leaf



Symptoms of damage – curling downwards



Damage – wilting



Surface damage

Photo by L.L. Black et al.

Cotton aphid¹⁰

Damage symptoms

Leaves are distorted, stunted, and often curled under. The upper leaf surface is sticky and has a black moldy growth (sooty mold). The plants have fewer fruits than usual. Some wilting may also be evident.

Insect characteristics

Piercing-sucking mouthparts. These are small pear-shaped insects with prominent reddish eyes. They vary in color from yellow to green to black. Some have transparent wings.

Where to look

Select leaves that are beginning to curl under or have signs of black sooty mold on the upper surface. Turn them over and look for groups of variable-sized insects. You will see adults and young living and feeding together.

Technical information

The cotton aphid has continual generations and many different hosts. When populations on the host plant are high, winged forms are produced, and they fly to adjacent plants to establish new colonies. Aphid colonies are commonly visited by ants which feed on the honeydew secreted by the aphids. This honeydew also serves as the food on which the sooty mold grows. The cotton aphid is a virus vector and has a wide host range including many vegetable crops.



Aphids on leaf

Photo by L.L. Black et al.



Photo by L.L. Black et al.

Damage symptoms – distortion and curling of leaves



Close-up of aphids on leaves

Photo by L.L. Black et al.

Sooty mold

Photo by L.L. Black et al.

¹⁰ *Aphis gossypii* Glover, Homoptera: Aphididae.

Tomato fruitworm¹¹

Damage symptoms

A small darkened partially healed hole at the base of the fruit pedicel is evident. The inside of the fruit has a cavity that contains frass and decay. Damaged fruits ripen early, but these are not usually marketable.

Insect characteristics

Chewing mouthparts. The young, small caterpillars have prominent rows of dark bumps (tubercles) on their backs. The older, larger ones vary in color from dark gray to light brown and have lengthwise stripes on their bodies. Adult moths are usually active at night.

Where to look

Look at the base of the fruit pedicel. If you find a darkened hole, remove the fruit and cut it open. Inside you will see tunneling caused by the insect. This cavity may contain frass and decay. Often the caterpillar is present.

Technical information

In warm areas, several generations may occur. Caterpillars often move from one fruit to the next destroying only small portions of each fruit. Pupation occurs in soil near the base of the plant. Adults are extremely fecund; they are active during the day but more commonly at dusk. Eggs are laid on the pepper plant. These insects are pests of other crops in the solanaceous family, for example, tomato. They also commonly feed on maize.

¹¹*Helicoverpa armigera* Hübner, Lepidoptera: Noctuidae.



Caterpillar



Caterpillar on the inside of sweet pepper
(Note: The frass from the insect appears as dark brown specks stuck together.)



External damage

Thrips¹²

Damage symptoms

Areas near the mid-vein are brown and dried up. The major damage occurs on the undersides of new or old leaves. Leaves tend to curl upward like the shell of a boat. They appear distorted or misshapen.

Insect characteristics

Modified piercing-sucking mouthparts. These insects are very small, about the size of a flea. They are just visible to the naked eye. The young are yellow or white. Adults are darker and brownish with or without stripes on their backs.

Where to look

Inspect the upper surface of the leaves for brownish damaged areas on either side of the mid-vein. Insects congregate at the mid-vein or at the borders of damaged areas and feed on healthy tissue.

Technical information

Adults lay eggs within leaf tissues and the young hatch after several days. Adults are excitable and fly off if disturbed. Pupation occurs in the soil usually at the base of the plant. Definitive identification of species should be made by trained taxonomists. Thrips feed on a wide variety of vegetable crops. Some species are host-specific and some are not.

¹²Several species possible, among them *Scirtothrips dorsalis* Hood and *Thrips palmi* Karny, Thysanoptera: Thripidae.



Thrips on underside of leaf

Photo by L.L. Black et al.

Close-up

Photo by
Niann-Tai Chang



Symptom:
leaf curling

Thrips



Damaged peppers

Photo by H.C. Mellinger



Browning, narrowing, and leaf drop

Tomato Insect Pests



Tomato fruitworm¹³

Damage symptoms

A small darkened partially healed hole at the base of the fruit pedicel is evident. The inside of the fruit has a watery cavity that contains frass and decay. Tomatoes ripen early but are not usually marketable.

Insect characteristics

Chewing mouthparts. The young, small caterpillars have prominent rows of dark bumps (tubercles) on their backs. The older, larger ones vary in color from dark gray to light brown and have lengthwise stripes on their bodies. The adult form is a moth.

Where to look

Look at the base of the fruit stem. If you find a darkened hole, remove the fruit and cut it open. Inside you will notice tunneling caused by the insect. This cavity may contain frass and decay. Often the caterpillar is present.

Technical information

In warm areas several generations occur. Caterpillars sometimes move from one fruit to the next destroying only small portions of each fruit. Pupation occurs in the soil near the base of the plant. Adults are extremely fecund; they are active during the day but more commonly at dusk. Eggs are laid on the tomato foliage. Young caterpillars feed on the leaves. Other hosts of this pest include chili pepper and maize.

¹³*Helicoverpa armigera* Hübner, Lepidoptera: Noctuidae.



Larva feeding on tomato



Larva feeding inside the fruit

Beet armyworm¹⁴

Damage symptoms

Feeding scars on the fruit surface are shallow and dry. The inside of the fruit is often hollowed out. This cavity is usually dry and may have frass and decay (see page 70 for similar damage caused by the tomato fruitworm).

Insect characteristics

Chewing mouthparts. Caterpillars are dull green with many light stripes along their backs and a broader stripe down each side. The undersides are usually yellow. Adult moths are grayish and active at night.

Where to look

Caterpillars are commonly found in two places. Groups of newly hatched larvae can skeletonize tomato leaves and typically feed under a webbing of silk. Look for the webbing and the feeding damage. Older caterpillars become more independent and can be found gouging the surface of the green fruit.

Technical information

Populations develop continually throughout the year. Adult moths lay their eggs in off-white scale-covered clusters on the leaves. When feeding is complete caterpillars pupate in the soil. The population can develop on some weeds. This pest also commonly feeds on onion, soybean, chili pepper, and sugar beets.

¹⁴*Spodoptera exigua* (Hübner), Lepidoptera: Noctuidae.



Larva entering a stem



Damage to leaves



Pupae in soil



Close-up of caterpillar



External fruit damage

Cotton aphid¹⁵

Damage symptoms

Leaves are stunted and distorted and often curl under. The upper surface is sticky and has a black moldy growth. Plants have fewer fruits than usual. Some wilting is also evident.

Insect characteristics

Piercing-sucking mouthparts. These are small insects that are rather pear-shaped with prominent reddish eyes. They vary from yellow to green to black. Some have transparent wings.

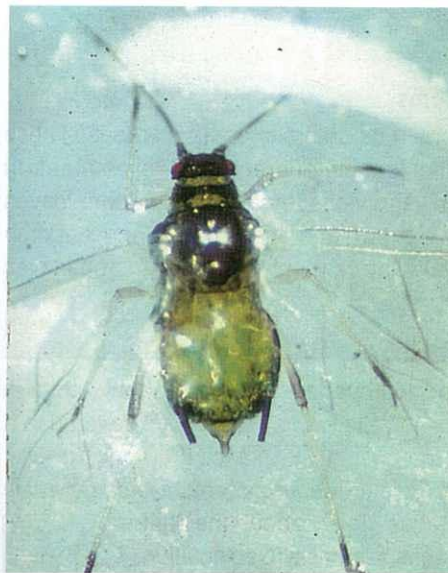
Where to look

Select leaves that are beginning to curl under or have signs of black sooty mold on the upper surface. Turn them over and look for groups of variable-sized insects. You should see adults and young living and feeding together.

Technical information

The cotton aphid has continual generations and many different hosts. When populations on the host plant are high, winged forms are produced, and these fly to adjacent plants to establish new colonies. Aphid colonies are commonly visited by ants which feed on the honeydew secreted by the aphids. This honeydew also serves as the food on which the sooty mold grows. The cotton aphid is a virus vector and has a wide host range including many vegetable crops.

¹⁵*Aphis gossypii* Glover, Homoptera: Aphididae.



Extreme close-up of cotton aphid



Close-up of aphids on leaves

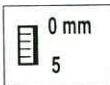
Whitefly¹⁶

Damage symptoms

Leaves have numerous chlorotic spots or areas. These spots grow together forming different sized yellow areas. In severe cases, only the veins remain green. Some leaves appear completely brown and dried. Wilting and leaf drop may occur. A sticky, black mold may be found on leaves and stems.

Insect characteristics

Piercing-sucking mouthparts. Adults are about 1 mm in size and are white to yellow. Their bodies are covered with a powdery waxy material. At first glance they look like flies. Adults readily fly if disturbed. Immatures are usually pale yellow. Early stages crawl about the leaf, whereas later stages assume a fixed position.



Where to look

The easiest way to find whiteflies is to brush or shake the leaves and look for the whitefly adults which fly off. Inspect the undersides of the leaves for the stationary immatures.

Technical information

Females lay up to 150 eggs each. Depending on weather conditions, the life cycle can be completed in about 12 days. Multiple overlapping generations occur. These pests are important vectors of diseases which are often more devastating than the injury caused by their feeding. One important disease is the leaf curl virus. Whiteflies are found on many vegetable crops and are common on sweet potato and cassava.

¹⁶Several species are possible. A common one is *Bemisia tabaci* (Gennadius), Hemiptera: Aleyrodidae.



Leaf infested with whiteflies

Photo by J.K. Brown



Adult whitefly

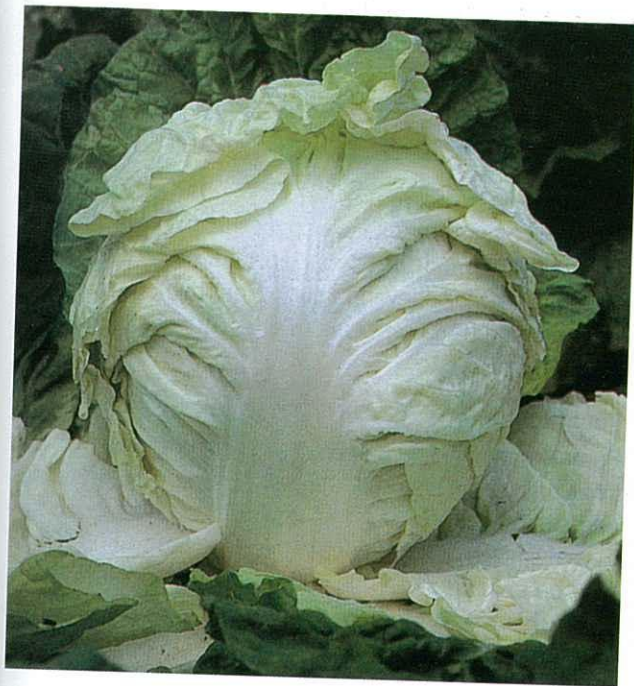
Photo by Tony Downer



Close-up of immature whitefly

Crucifer Insect Pests

**(Cabbage, Chinese cabbage,
Cauliflower, Broccoli, Radish,
and Kohlrabi)**



Diamondback moth¹⁷

Damage symptoms

Early signs are feeding damage between the leaf tissues on the undersides of the leaf. Later leaves appear with windows or holes in them. Damage is confined to areas between the veins. On young plants, the growing tips are eaten and seedlings appear stunted.

Insect characteristics

Chewing mouthparts. Caterpillars are pale green. Their bodies are wider towards the middle and they wiggle violently when disturbed. Commonly they drop off the leaf surface and, like spiders, spin down on a silken thread. Adult moths are small and gray with a diamond shape on their backs when they are at rest.

Where to look

In young plants, carefully inspect the growing tips and determine if stunting has occurred. Look at the undersides of the leaves for chewing injury. Peel back the wrapper leaves of cabbage for signs of chewing injury and frass from caterpillars.

Technical information

Female moths lay their eggs singly or in groups of two and three on crucifer leaves. Caterpillars mature in 10-30 days and pupate directly on the leaves in a silken cocoon. Female moths attract males with a sex pheromone. There may be several generations throughout the year. These pests have developed resistance to practically all insecticides used in Asia.

¹⁷*Plutella xylostella* (L.), Lepidoptera: Yponomeutidae.



Caterpillar

Pupae in cocoons on the underside of a leaf

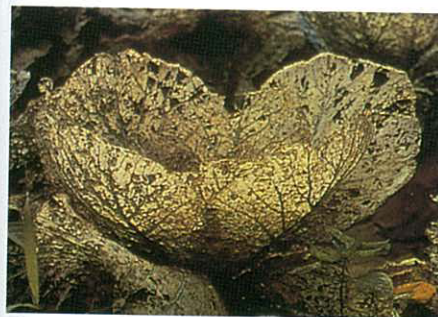


Eggs on the underside of a leaf

Diamondback moth



Adult moth
(Note diamond-shaped pattern on the back.)



Close-up of damage

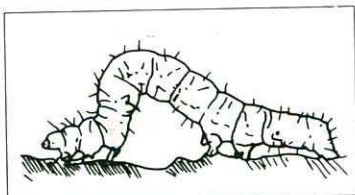


Damage in the field

Cabbage looper¹⁸

Damage symptoms

Leaves have ragged holes. The cabbage heads have internally bored holes. These areas contain frass and other insect remains. Seedlings are severely eaten and dead or stunted. The undersides of the leaves appear skeletonized between the veins.



Insect characteristics

Chewing mouthparts. The caterpillar is light green with white or pale yellow stripes along the sides. It typically moves by arching the middle part of its body. The adult moth is active at night.

Where to look

Early in the growing season, watch the growth of the seedlings. If chewing damage is evident and stunting occurs, hunt for the green caterpillars. Inspect the heads later for ragged chewing holes and internal boring damage.

Technical information

The damage caused by this insect is very similar to that caused by the imported cabbage worm (see page 86). The female lays dome-shaped pale green eggs directly on the host plant. After feeding, the caterpillar pupates on leaves in loosely constructed cocoons. There may be several generations each year depending on ambient conditions. Other hosts include lettuce, beans, tomato, spinach, pea, turnip, potato, and sweet potato.

¹⁸*Trichoplusia ni* (Hübner), Lepidoptera: Geometridae.



Caterpillar
and leaf
damage



Caterpillar
and damage



Pupa

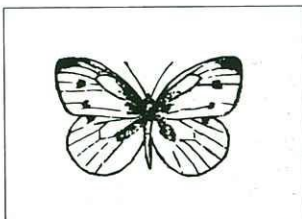
Imported cabbage worm¹⁹

Damage symptoms

The damage is similar to that caused by the cabbage looper (see page 84). Caterpillars may bore directly into the heads. The first leaves of cabbage have large irregular-shaped holes. Between the leaves, you can find pelleted frass that has a very strong smell. This may influence marketability.

Insect characteristics

Chewing mouthparts. The caterpillars are velvety green in color, are quite hairy, and have a thin orange stripe down the middle of their backs. They blend with the leaf foliage. Adult butterflies are easily recognized. They are white, yellow, or orange with black spots on their wings. They flutter about during the day.



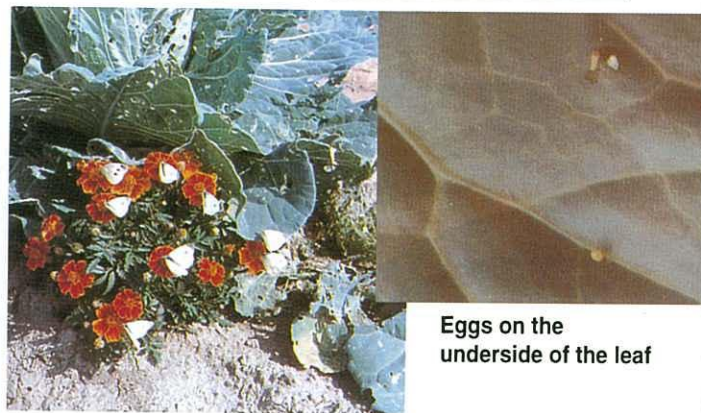
Where to look

Look at the first-formed leaves of the heads for ragged, irregular-shaped feeding holes. The insects bore into the heads. By peeling back the leaves, you will be able to detect pelleted frass and other remains. The pungent smell should be evident.

Technical information

Females lay eggs singly on the undersides of the leaves. Caterpillars are voracious eaters and reach full growth in about 14 days. They move very slowly. Pupation occurs on the plant in the form of a hanging chrysalis (pupa).

¹⁹*Pieris rapae* (L.), Lepidoptera: Pieridae.



Adults feeding on flowers

Eggs on the underside of the leaf



Caterpillar feeding on the leaf surface

Imported cabbage worm



Damage



Damage

Striped flea beetle²⁰

Damage symptoms

Young plants have small round holes in the cotyledons and leaves. This is often referred to as the "shot-hole effect". The seedlings may be killed if severe damage occurs.



Insect characteristics

Chewing mouthparts. The adult beetle is the important damaging stage. It is shiny black with a greenish tinge and two crooked yellow stripes down its back. Typically, it jumps like a flea when it is disturbed.

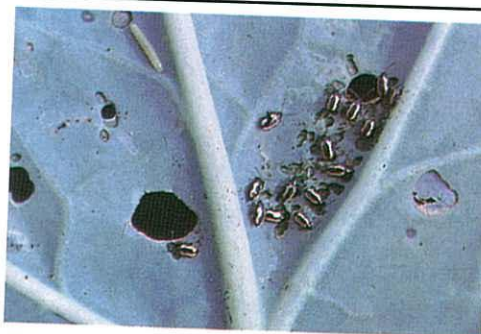
Where to look

When the seedlings first emerge, look at the cotyledons for small round holes. As plants grow, check the new leaves for the typical shot-hole effect caused by the chewing damage.

Technical information

The adult has very powerful hind legs that enable it to jump effectively. The adult lays her eggs in the soil close to the host plant. The larva lives in the soil and feeds on plant roots. Usually, the larva is not a significant pest. Generations can be continual in warmer climates.

²⁰*Phyllotreta striolata* (F.), Coleoptera: Chrysomelidae.



Adults



Close-up
of a larva



Damage

Black cutworm²¹

Damage symptoms

Plant stem is clipped very near or just below the soil surface. It is common to see several plants in a row either cut off or wilting from damage at their base.

Insect characteristics

Chewing mouthparts. The bodies of young caterpillars have an oily texture and are gray to brown to black. They have faint light-colored stripes along their bodies and several black bumps (tubercles) on each segment. Adult moths are gray or brown with irregular spots or bands on their wings. They are active only at night.



Where to look

Locate plants that have been recently (the night before) clipped at their bases. At the base of these plants dig around in the soil or plant debris with your fingers to find the black cutworm larvae. They hide there during the day and come out to feed only at night.

Technical information

Female moths have the potential to lay hundreds of eggs which they deposit on leaves or stems that are close to the soil surface. On some occasions, caterpillars bore directly into the heads of cabbage. They have a habit of curling into a C shape when they are disturbed. This pest attacks seedlings of most crops including bean, pea, tomato, onion, beet, potato, and sweet potato.

²¹ *Agrotis ipsilon* (Rottemburg), Lepidoptera: Noctuidae.



Close-up: Cutworms



Cutworms in the soil

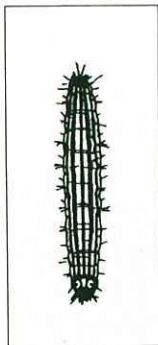


Damage

Cabbage webworm²²

Damage symptoms

Silken webbing on the surface of the inner leaves and stalks is evident. The surrounding regions have obvious feeding holes. The area beneath the webbing contains frass and other insect remains. The growing point of seedlings may be severely defoliated. If the plant survives, several small heads may form.



Insect characteristics

Chewing mouthparts. Caterpillars are pretty to look at. They are dusty yellow with broad purple stripes along the length of their bodies. Adult moths are rather nondescript and gray with small brown spots or specks.

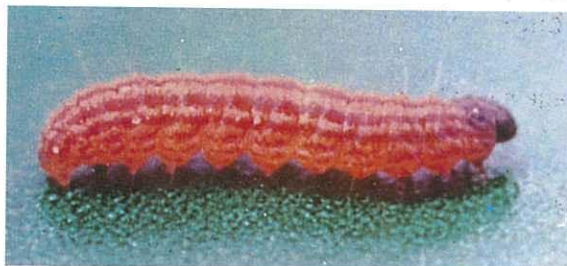
Where to look

Inspect the young growing points, inner leaves, and stalks for chewing damage. If webbing is found, look underneath it for the webworm. Positive identification can only be made if the insect is found, but if webbing with dirty frass underneath is found, it is likely the damage is caused by this species.

Technical information

Female moths lay eggs on foliage near young growing points. After hatching, larvae bore into the growing point and cover themselves with a silken web, which has an exit hole in it. Larvae are voracious feeders. They pupate on shed leaves or other debris on the ground.

²²*Hellula undalis* (E.), Lepidoptera: Pyralidae.



Caterpillar



Caterpillar
inside
webbing
surrounded
by frass



Damage



Damage

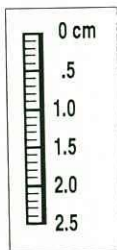
Cabbage head caterpillar²³

Damage symptoms

The leaves are tied together by webbing. Leaf damage occurs on the lower surface. Young foliage may be completely consumed. In cases of severe defoliation, the leaf surface is chewed extensively leaving only the major veins.

Insect characteristics

Chewing mouthparts. Caterpillars are light to yellowish green with distinctive red heads. They often measure 2 cm long and have three white parallel lines along their backs and two others along each side. Some have black pigmentations on their bodies forming dots triangularly arranged on the sides. Adult moths fly at night.



Where to look

Caterpillars generally feed on the undersides of leaves. When young, they feed in large groups. Look for plants with damage on the young leaves and extensive webbing.

Technical information

Eggs are laid in masses on the undersides of leaves. Larval feeding may last 4 weeks. Pupation occurs in a cocoon which is formed in the soil at the base of the plant. Although their life cycle may take 40–60 days for completion, multiple generations may occur annually. They are common during hot-wet seasons.

²³*Crociodolomia binotalis* Zeller, Lepidoptera: Pyralidae.



Damage



Close-up of damage



Caterpillars and damage

Aphids²⁴

Damage symptoms

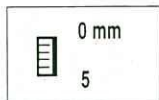
Leaves are curled, wrinkled, or cup-shaped. Plants in all growth stages can be damaged. With severe infestations the leaves wilt and the entire plant dies.

Insect characteristics

Piercing-sucking mouthparts. They are small, soft-bodied, and pear-shaped. They vary from yellow to green to black. Some have transparent wings and prominent eyes. Note the small tubes arising from either side of the back of their bodies (tail region).

Where to look

Select leaves that are beginning to curl, show signs of wilting, or are partially dried up. Look within the cupped leaf for colonies of the pear-shaped insects. They vary in size from 2 to 4 mm in length.



Technical information

Aphids have continual generations and many hosts. When populations on one plant are high, winged forms are produced that fly to adjacent plants to establish new colonies. Aphid colonies are commonly visited by ants which feed on the honeydew secreted by the aphids. This honeydew also serves as food on which mold grows. Some aphid species are virus vectors. Many different vegetables serve as hosts for aphids.

²⁴Positive identification of aphid species should be made by an expert. Several species are common on crucifers, including *Myzus persicae* (Sulzer), *Hyadaphis erysimi* (Kaltenback), and *Brevicoryne brassicae* (L.), Homoptera: Aphididae.



Aphids on the stem and flower buds



Close-up:
Female with young



Typical population on underside of a leaf

Aphids



Susceptible
variety in
the field



Close-up of severe damage

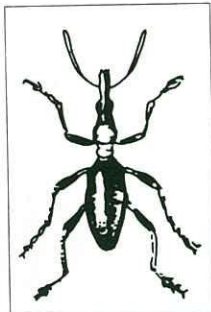
Sweet Potato Insect Pests



Sweetpotato weevils²⁵

Damage symptoms

Small and scattered feeding holes are occasionally present on the leaves. The surface of the storage roots are scarred or chewed. Internal portions of the roots are tunneled out and some areas may be soft. Rotting may occur and a strong terpene smell may be evident.



Insect characteristics

Chewing mouthparts. Adults are brown to black with heads elongated into a snout. They appear to have typical piercing-sucking mouthparts but they don't. Larvae are white with brown heads. They are fat, grublike, and legless.

Where to look

Adults are commonly found on the foliage, but they quickly drop to the ground if disturbed. Select storage roots that appear soft, smell, or have external scarring or small darkened holes. Cut these open and look for tunneling and grublike larvae.

Technical information

Continual generations can occur even in temporary storage conditions. Female weevils lay eggs singly in the stem or storage root. These insects pupate in the stem or root. Infested sweet potato develops a bitter taste and is not marketable. No alternative hosts outside the morning glory family have been reported for this pest.

²⁵Identification of species should be made by a trained individual. Three species commonly cause similar damage: *Cylas formicarius* (F.), *Cylas puncticollis* (Bohemann), and *Cylas brunneus* (F.), Coleoptera: Apionidae. The latter two species occur only in Africa.



Close-up of adult



Larva feeding inside stem



Surface damage



Internal damage

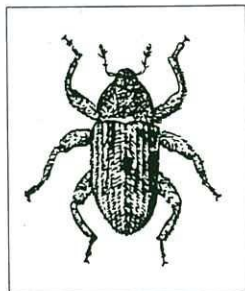
West Indian sweetpotato weevil²⁶

Damage symptoms

There is internal tunneling in the root or stems. Root discoloration and a foul, terpene smell may be evident. A bitter taste may also be imparted.

Insect characteristics

Chewing mouthparts. Adults are reddish brown to grayish black with stifferect hairs on their bodies. Their heads are elongated into a snout which at a glance, look like they have piercing-sucking mouthparts. Larvae are white, legless, and grublike with brown heads.



Where to look

The surface of the storage root may appear unblemished except for tiny sealed holes. Cut the roots open and look for the damage and the immature weevil. Adults are extremely difficult to find because of their secretive habits; they look like soil particles.

Technical information

Adults lay eggs singly and directly into the stem or root. The hole they make for insertion of the egg is plugged with fecal matter. Hatching larvae bore deeper and deeper into the root. When feeding is complete, the larvae pupate inside the root or stem and emergent adults tunnel out to complete their life cycle.

²⁶ *Euscepes postfasciatus* (Fairmaire), Coleoptera: Curculionidae.



Adults

Photo by K.V. Raman, CIP



Larvae in stem

Photo by K.V. Raman, CIP



External (surface damage)

Photo by K.V. Raman, CIP



Internal damage

Photo by K.V. Raman, CIP

Sweetpotato vine borer²⁷

Damage symptoms

The plant has poor overall growth. There is no full flush of foliage and some plants appear yellow and wilted. The distal portions of some vines dry up and die. Storage root formation is poor and yield is low.

Insect characteristics

Chewing mouthparts. The larvae are cream to light purple. The heads are brown and the undersides of their bodies white. Brown spots form stripes along their sides. Adult moths are white with brown yellow patterns on their wings.

Where to look

Borers are difficult to detect. The major signs of an infestation are the presence of insect frass in the crown of the plant and adult exit holes in the stem. If you see the former, carefully cut the stem lengthwise to expose the larval tunnel. Follow the tunnel to its end and locate the borer.

Technical information

Adult moths are only active at night when they lay their greenish eggs singly on the leaves and petioles. The hatching larvae bore into the stems and feed internally. Before pupating the larvae bore exit holes in the stem for adults to escape.

²⁷ *Omphisa anastomasalis* (Guenée), Lepidoptera: Pyralidae.



Exit holes in the stem



Egg on the leaf petiole



Borer feeding inside the stem

Sweetpotato vine borer



Exit holes
in crown
and some
vines
killed by
feeding



Internal damage to sweet potato
(Note the light brown pupa.)

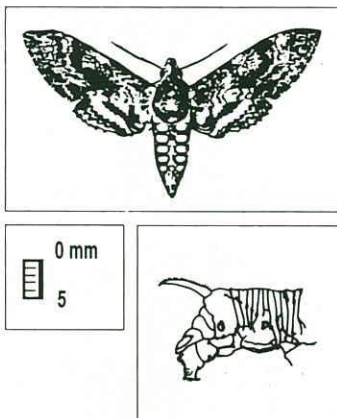
Hawk moth²⁸

Damage symptoms

Leaves have large holes. Extensive defoliation generally occurs in the plant. In severe cases, the plant is completely devoid of leaves and dies.

Insect characteristics

Chewing mouthparts. The caterpillar is large, often with a diameter the size of your thumb. Its color varies from green to brown. It has a horn arising from the upper end of its body. The sleek adult moth has a streamlined spindle-shaped body built for rapid, strong flying.



Where to look

Because of the large size of the caterpillar and its prominent horn, you should have little difficulty finding it on the leaves. However, its color may blend with the foliage so inspect the entire plant carefully.

Technical information

The full grown larva pupates in the soil. After several weeks, the adult surfaces and lays eggs singly on the foliage. The eggs are about 1 mm in diameter. Adult activities only occur at night. The adult is often attracted to lights. This insect is also occasionally found on beans.

²⁸*Agrius convolvuli* (L.), Lepidoptera: Sphingidae.



Caterpillar and damage



Severe damage

Sweetpotato leaf roller²⁹

Damage symptoms

Leaflets may be twisted upwards or downwards to form a sheath or leaf roll. Unrolled leaves have chewed surfaces with extensive frass. In severe cases, rolled leaves are brownish and dried.

Insect characteristics

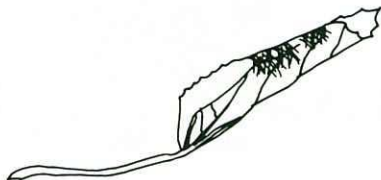
Chewing mouthparts. Caterpillars are black with distinct white markings. A well-defined white stripe runs down their backs. They are very active, jumping and squirming at the slightest touch. Adult moths are active at night. They are dark gray or black. Their wings have two light gray patches.

Where to look

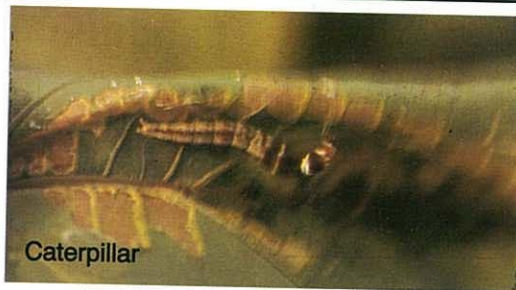
Look for rolled leaves, especially ones with obvious chewing damage, and open them. Both the larva and the reddish-brown pupa can often be found inside.

Technical information

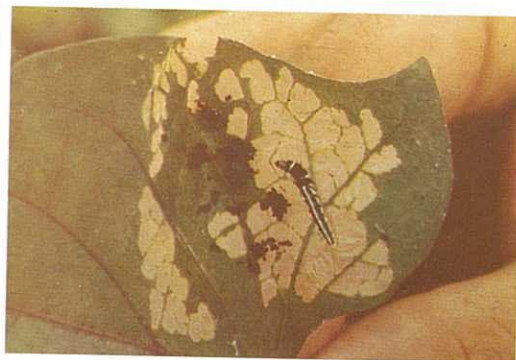
These insects attack only sweet potato. Greenish-yellow oval eggs are flattened at each end and are laid on the undersides of leaves. The egg, larval, and pupal stages last 4, 14, and 6 days, respectively.



²⁹*Brachmia convolvuli* Wals, Lepidoptera: Gelechiidae.



Caterpillar



Damage



Rolled leaf



Unrolled leaf showing damage

(Note: Black remains are insect frass.)

Mungbean Insect Pests



Beanflies³⁰

Damage symptoms

There may be wilted or dead seedlings, and leaves of older plants may be yellow and stunted. Stems are thicker than normal and cracked lengthwise just above the soil. In cases of heavy infestation in scattered areas in the field, many plants die.

Insect characteristics

Chewing mouthparts. The immatures are small white maggots with brown heads. Adults are tiny black flies with transparent wings, about 1/4 the size of a common housefly.

Where to look

Larval feeding occurs mostly in the main stem just above the soil line. Since feeding is internal, the main stem must be cut open to find tunneling and the small white maggots.

Technical information

These pests are important only during the seedling stage (up to 4 weeks after germination). The life cycle may be completed rapidly, often in less than 2 weeks. Generations are continual in tropical areas. Pupation occurs inside the stem and eggs are laid in punctures of leaves near the petiole. Maggot feeding facilitates the invasion of plant pathogens.

³⁰Several species cause similar damage. Identification should be made by technical personnel. The following species are commonly present: *Ophiomyia phaseoli* (Tryon), *Ophiomyia centrosematis* (de Meijere), and *Melanagromyza sojae* (Zehntner), Diptera: Agromyzidae.



Maggot feeding inside the stem



Maggot and severe damage to the stem

Bean thrips³¹

Damage symptoms

Flowers and flower parts are brown, dried, or completely destroyed. The flowers drop early. The petioles and leaves have tiny holes surrounded by discolored areas. Pod production is low and pods are deformed.

Insect characteristics

Modified piercing-sucking mouthparts. These insects are very small and sliver-shaped, about the size of a flea. They are just barely visible to the naked eye. The young are white, whereas adults are dark brown with a reddish tinge.

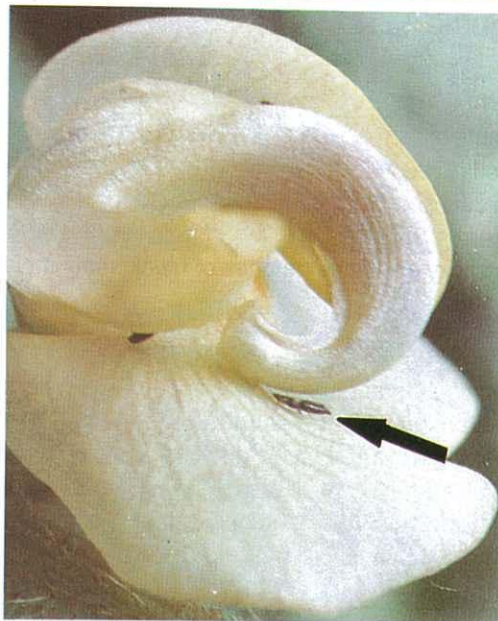
Where to look

Bean thrips prefer to feed on the flower. Inspect the flower, especially around its reproductive parts. These insects remove plant cell contents and also feed on pollen. Inspect the undersides of leaves that appear brown or dry. The areas around the mid-vein are likely to harbor thrips.

Technical information

Adults lay their eggs inside the leaf tissue. After the immatures have completed feeding, they drop from the plant and pupate in the soil. Generations are continual and populations are highest during warm and dry weather. Temperatures of around 20°C favor reproduction and survival.

³¹ *Megalurothrips usitatus* (Bagnall), Thysanoptera: Thripidae.



Adult feeding in the flower



Damage to developing buds



Overall plant damage

Black legume aphid³²

Damage symptoms

Growing points of the plant are withered, brown, or dead. Pod and seed production is extremely low. Plants become stunted and deformed when populations are high. Leaves crinkle or exhibit a yellowish, mottled, or mosaic coloration. Leaves are sticky and have patches of black sooty mold growing on them.

Insect characteristics

Piercing-sucking mouthparts. Both winged and wingless forms may be present, living and feeding together. The soft-bodied, rather pear-shaped adults are shiny black and the young appear lightly dusted with wax. Two distinct tubes arise from the sides of the end of their bodies.

Where to look

Select yellowish plants with wilted growing tips. Inspect areas of new growth for the presence of aphid colonies, or where they seem to concentrate. Look for ants on the plants.

Technical information

The colonies are often attended by ants that feed on aphid secretions. Continual generations occur and populations increase very rapidly under ideal conditions. In some locales, these insects are more prevalent in cool weather. They are vectors of about 30 plant viruses, especially leaf crinkle virus and cucumber mosaic virus. Other plant hosts include sweet potato, pea, cucurbits, and groundnuts.

³²*Aphis craccivora* Koch, Homoptera: Aphididae.



Close-up of
A. craccivora



Heavily infested stem



Infested stem
(Note the two tubes at the end
of the body.)



Damage

Asiatic corn borer³³

Damage symptoms

Small, dark colored entry holes can be found on the stem or pods. An accumulation of frass around these holes is common. The stem and leaves above the entry holes are wilted.

Insect characteristics

Chewing mouthparts. The larva is cream-colored and marked with brown spots on its back. There are two spots per segment of the body. The adult female moth is pale yellow brown with irregular bands across its wings. The male is marked in the same but much darker color. Both are strong fliers and active only at night.

Where to look

Inspect the plants for indications of wilting. Look for small piles of frass on the stems or pods. If there are entry holes, open the pods or stem and look for the caterpillar.

Technical information

One female lays 500-1500 eggs in groups mainly on the undersides of leaves. Hatching occurs within 3 days. When feeding is completed, pupation occurs within the stem or mungbean pod. Depending on temperature, multiple generations may occur in one season. Maize is also a common host for this pest.

³³*Ostrinia furnacalis* (Hübner), Lepidoptera: Pyralidae.



Caterpillar



Close-up of larva feeding inside the pod



Symptom of internal damage to the stem



Close-up of stem damage

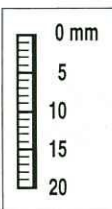
Bean pod borer³⁴

Damage symptoms

Flowers may be damaged and discolored. The reproductive parts of the flower are damaged and/or missing. There is flower bud shedding and pod production is reduced. Pods have small darkened entry holes on the surface and borers inside. Leaves and pods are stuck together by webbing and show signs of surface feeding.

Insect characteristics

The immature is dull- to yellow-white and often reaches a length of 18 mm. Each segment has dark spots which form a distinct series along the length of the body. This is especially obvious on the upper surface. The head is dark brown to black.



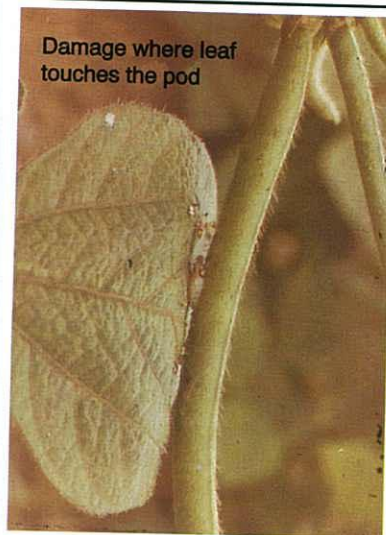
Where to look

Inspect the flowers and the developing mungbean pods. If the pods look malformed or you see entry holes on the surface, cut them open. Look for feeding damage, frass, other insect debris, and the borer itself. The larva is often found among the external webbing of pods and leaves. If two or more pods or leaves and pods are touching, a borer is often found at the juncture or inside the pod.

Technical information

Eggs are laid on the sepals or petals of the flower. The larva feeds for about 3 weeks. At night, it emerges from the pods and crawls about. It then descends to the soil and pupates beneath leaf debris. Cowpea is also a common host of this pest.

³⁴*Maruca testulalis* Geyer, Lepidoptera: Pyralidae.



Caterpillar



Damage

Close-up of damage

Bruchids (pea and bean weevils)³⁵

Damage symptoms

There are holes bored into bean pods. These symptoms are visible in dry pods at harvest, especially if harvest is delayed. The beans in storage are completely hollow and are unmarketable.

Insect characteristics

Chewing mouthparts. Adults are small brown beetles with light bands and markings on their backs. The larvae, which are responsible for the major damage, are small, white, C-shaped worms with darker heads.

Where to look

To locate them, split open the dried bean pods. Then, select beans with minute holes that appear drilled to the inside. Cut these open to expose larvae feeding internally. In dried stored beans, large holes through which adults have escaped are easily visible.

Technical information

Female beetles lay eggs on the bean pod, or in storage on the seed coat. The hatching larvae immediately bore inside and spend their entire life feeding within the seed. The life cycle can be completed in about 1 month or less and continual generations are possible until the food source is exhausted. The infestation may originate in the field and continue in storage. These insects are considered primarily destructive storage pests.

³⁵Several closely related species including the following: *Callosobruchus chinensis* (L.), *C. maculatus* (F.), *C. analis* (F.), Coleoptera: Bruchidae. Technical assistance is necessary to identify these species.



Eggs on bean pod



Larvae inside bean



Eggs and damage



Close-up of adults and damage

Soybean Insect Pests



Beanflies³⁶

Damage symptoms

Plants are yellow and stunted. Stems are often thicker than normal and cracked lengthwise just above the soil line. In cases of heavy infestation, many plants die.

Insect characteristics

The larva is a small white maggot with a brown head. The adult is a tiny black fly with transparent wings, about 1/4 the size of a common housefly.

Where to look

Larval feeding mostly occurs in the main stem just above the soil line. Since feeding is internal, cut the main stem open and look for mining and the small white maggot.

Technical information

All beanflies prefer to feed on young plants. The life cycle of beanflies is completed very rapidly often in less than 2 weeks. Generations are continual in tropical areas. Pupation occurs inside the stem and adult egg-laying activity occurs mainly in the leaves near the petiole.

³⁶Several species are responsible for the damage; among them are the following: *Ophiomyia phaseoli* (Tryon), *Ophiomyia centrosematis* (de Meijere), *Melanagromyza sojae* (Zehntner), Diptera: Agromyzidae.



Adult fly



Maggot inside the stem



Pupa inside the stem



Severe damage

Girdle beetle³⁷

Damage symptoms

Early symptoms include the drying of the edges of trifoliate leaves. Seedlings and young plants are wilted or dead. On older plants, all or part of the leaves are wilted and brown. Plants may fall over (lodge). Petioles or the main stem have two parallel girdles.

Insect characteristics

Chewing mouthparts. The adult beetle has a hard shell-like exterior and rather long antennae. The larva is a white, soft-bodied worm with a dark head.

Where to look

Adult feeding can be seen most easily by looking at the main stem and petioles. You will notice the two parallel girdles. To locate the larva, cut open the stems and petioles where girdling has occurred.

Technical information

The female beetle lays up to 75 eggs very close to the lower girdle. The larva feeds and hollows out the inside of the stem. This weakens the basic structure of the plant and causes the plant to lodge. Seed yield may be significantly reduced. This insect is confined to the Indian subcontinent.



Adult



Larva in stem



Wilting symptom of damage



Girdling and death of terminal

³⁷*Oberia brevis* Swed., Coleoptera: Lamiidae.

Armyworm³⁸

Damage symptoms

Chewed holes are present on the leaves. Leaves are damaged to the point that they are not recognizable as those of soybean. In severe infestations, leaves are completely gone causing the plant to die. Occasionally this insect also cuts plant stems at the soil line and feeds directly on the pods.

Insect characteristics

Chewing mouthparts. Very young caterpillars are blackish-green and have a distinct black band across the back of their heads. Older ones are slightly darker with yellow bands along their backs and sides of their bodies. Their heads are prominent and black and along their backs are rows of crescent-shaped black spots. Adult moths are active only at night.

Where to look

They are easy to detect. The young larvae feed together on the surface of the leaves. Larger caterpillars tend to feed alone. Search the entire plant to locate them. Look carefully at the upper and lower surfaces of the leaves.

Technical information

The behavior of this species is variable. (*Note above paragraph*). Females lay their eggs in hair-covered clusters. Mature caterpillars pupate in earthen cells in the soil. Generations may be continual in warm climates. This insect attacks many species of crops. Among them are tomato, cauliflower, potato, onion, eggplant, chili pepper, lettuce, pea, and maize.

³⁸*Spodoptera litura* (F.), Lepidoptera: Noctuidae.



Older caterpillar

Young caterpillars



Pupae in the soil



Field defoliation

Taiwan tussock moth³⁹

Damage symptoms

Leaves are damaged either at the center or towards the edges (or both areas). Often flowers show signs of feeding damage. There may be a resultant decrease in yield.

Insect characteristics

Larvae are attractive and easily seen. Their heads are brown and their bodies are yellow with distinct black bumps. There is a broad yellow stripe with a thin red line in the center that runs down the middle of their backs. Tufts of long hair arise from their bodies. Avoid handling these insects. The hairs have glands which produce an extremely irritating chemical.

Where to look

Inspect the leaves and look for signs of chewing damage. If the leaves or flowers appear defoliated, caterpillars may be in the vicinity. Pupae may also be in cocoons on the leaf or stem section of the plant.

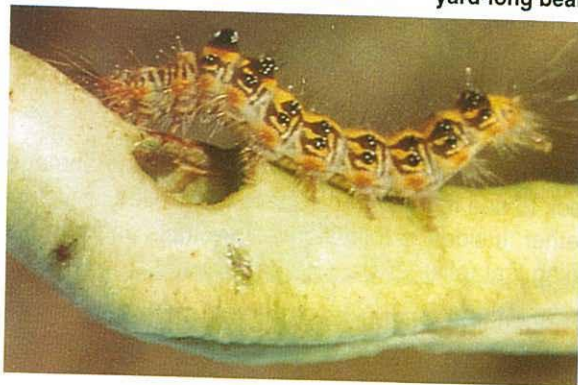
Technical information

These pests feed on a wide variety of plants including fruits and vegetables. In tropical regions, there may be eight to nine generations per year. During warm seasons, the life cycle is completed in about a month. Young caterpillars prefer to feed on the center of the leaf. Later they feed on the edges. Adult moths, which are active at night, lay between 20-80 eggs each.

³⁹*Porthesia taiwana* (Shiraki), Lepidoptera: Liparidae.



Caterpillar on mungbean



Damage on
yard-long bean



Leaf damage
on soybean

Soybean leaf roller⁴⁰

Damage symptoms

Single leaves are rolled lengthwise. These leaves turn yellow and are skeletonized to the point where only a very thin leaf membrane remains. From a distance, parts of a field with heavy damage appear to have many silvery-yellow masses of leaves. Yield may be significantly reduced.

Insect characteristics

Chewing mouthparts. Larvae are light to dark green on top and yellowish green underneath. Their heads are light brown. There is a single thin greenish stripe running lengthwise down the middle of their backs.

Where to look

Inspect individual plants with signs of feeding damage. Check to see if some of the leaves are rolled and stuck together. Inside the rolled leaves are frass and perhaps feeding leaf roller larvae.

Technical information

Female moths, which are active at night, lay their eggs either singly or in groups on the upper leaf surface. Some lay approximately 450 eggs. In warm climates, the active feeding stage of the larvae is completed in about 2 weeks. Pupation occurs inside the rolled leaf. Multiple generations are possible in the tropics.

⁴⁰*Hedylepta indicata* (F.), Lepidoptera: Pyralidae.



Caterpillar



Damage



Severe damage



Field damage

Soybean aphid⁴¹

Damage symptoms

Plants are stunted with very poor development at the growing tips. In severe infestations, the entire stem dries up and dies. Entire plants may die.

Insect characteristics

These pear-shaped insects are yellow with a black tube coming out from each side of the rear end of their bodies. Some of them have clear wings. All stages and sizes of the insect may be living together.

Where to look

Commonly this species is found colonizing the new, young leaves forming at the ends of the stems. Be sure to inspect the undersides of young and slightly older leaves.

Technical information

This species can transmit several kinds of plant diseases. Among them are abaca mosaic, beet mosaic, and millet red leaf viruses; also bean yellow mosaic and mungbean mosaic viruses. It is also common to find this aphid living on several species of weeds.



Aphids on stem, pods, and leaves



Close-up of aphid colony on the stem

⁴¹*Aphis glycines* Matsumura, Homoptera: Aphididae.

Beet armyworm⁴²

Damage symptoms

There are chewed holes on the leaves. Leaves are damaged to the point that they are not recognizable as those of soybean. In severe infestations, leaves are completely gone causing the plant to die.

Insect characteristics

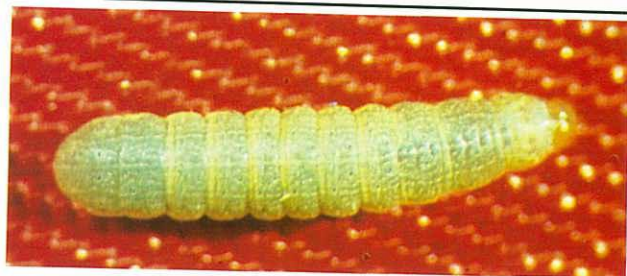
Chewing mouthparts. Caterpillars are dull green with many light stripes along their backs and a broader stripe down each side. The undersides are usually yellow. Adult moths are grayish and active at night.

Where to look

You should have little difficulty locating the caterpillars. Many of them feed together on the surface of the leaves.

Technical information

Populations develop continually throughout the year. The adult moth lays eggs in hair-covered clusters on the leaves. Hatching caterpillars are gregarious and feed as armies consuming large quantities of foliage. When feeding is complete caterpillars pupate in the soil. The population can develop on some weeds. This insect also feeds on onion, rice, tomato, and sugar beets.



Close-up of a larva



Pupae in soil



Damage —
underside
of leaf



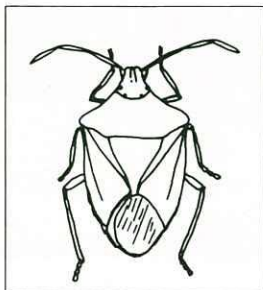
Damage
and
larvae
feeding

⁴²*Spodoptera exigua* (Hübner), Lepidoptera: Noctuidae.

Stink bugs⁴³

Damage symptoms

Pods have puncture marks surrounded by a darkened area of dead tissue. Beans are malformed or absent. In heavy infestations, pod development is reduced.



Insect characteristics

Piercing-sucking mouthparts. These insects are flattish and shield-shaped. They vary from a bright green to a dark drab brown. When you crush them with your finger, a sweetish, sickening smell is noticeable. The young look much like the adults except that their wings are not fully developed.

Where to look

These insects move about quickly from the upper to the lower plant surfaces and are secretive. They are most likely found feeding where soybean pods are developing. All species prefer to feed on developing seeds in green pods.

Technical information

Stink bugs secrete a defense chemical to ward off enemies and warn others in their population of danger. Adults lay barrel-shaped eggs in groups on the undersides of leaves. Many generations occur and overlap in warm climates. Some species are vectors of plant diseases. Stink bugs feed on a wide range of crops.

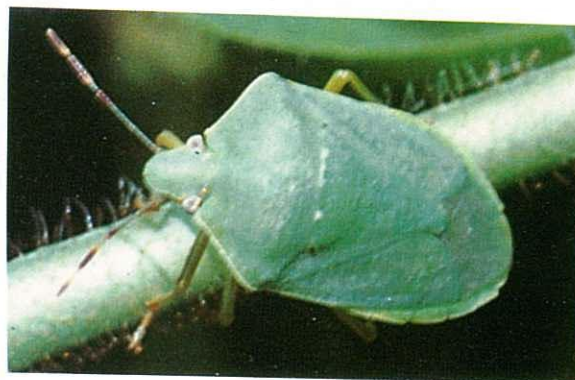
⁴³Several species attack soybean. Among them are: *Nezara viridula* (L.), *Piezodorus hybneri* (Gmelin), Hemiptera: Pentatomidae; *Riptortus linearis* (F.), *Riptortus clavatus* (Thunberg), Hemiptera: Coreidae.



Stink bug eggs



Stink bug immatures on pods



Stink bug adult

Coreid bugs



Coreid eggs on a leaf



Coreid immature

Coreid bugs



Coreid adult damaging pod



Damage caused by coreids

Limabean pod borer⁴⁴

Damage symptoms

Seed pods are poorly developed. Individual soybean seeds have holes and internal portions are gutted out. The insides of the pods are partially or completely consumed. Externally, pods appear to be abnormal, i.e., not full but shrunken in appearance. Small surface punctures are evident.

Insect characteristics

The caterpillar is rather pretty, blue with a yellow head. It wiggles violently when disturbed. The adult moth is small, brown, and active only at night.

Where to look

Remove soybean pods that are shrunken. You might also notice small punctures on the surface of the pods. Open these pods and inspect them for the larva. Check areas around the developing beans and internal portions of the beans themselves.

Technical information

Often the developing caterpillar transfers from one soybean pod to another to feed. The adult moth lays her eggs on inflorescences and young pods and the hatching larva immediately bores through the surface to feed internally. Pupation normally takes place in the soil but sometimes on pods.

Larva



Adult



Pupa



Symptom of borer attack

⁴⁴*Etiella zinckenella* Treitschke, Lepidoptera: Pyralidae.

Limabean pod borer



Damage



Damage

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GLOSSARY

Borer An immature insect in the order Lepidoptera that feeds by excavating a tunnel through plant tissue, i.e., a stem or root.

Brittle In reference to the condition of plant leaf tissue following insect feeding. It shatters, breaks, or falls apart.

Butterfly Adult stage of insects belonging to the order Lepidoptera. It has sucking mouthparts and does not cause feeding damage to vegetable crops. It is active during the day.

Caterpillar Immature stage of insects in the order Lepidoptera. It has chewing mouthparts and is often the cause of damage of vegetable crops.

Chlorotic An unusual or abnormal yellow color of green leaves or other parts of plants.

Cotyledons First pair of leaves developed by the embryo of a seed plant or some lower plants.

Crucifer Member of the plant family Cruciferae including cabbage, broccoli, Chinese cabbage, cauliflower, brussels sprouts, radish, and kohlrabi.

Defoliator Insect that feeds on leaves and removes either portions of or the entire leaf from the plant leaving the plant partially or completely defoliated.

Fecund In reference to an insect that will produce a large number of eggs or young.

Flea An insect in the order Siphonaptera. It is a small compressed (from one side to the other) pest that is found on the skin of cats, dogs, and other mammals. It jumps rather long distances when disturbed.

Frass Solid waste excreted by the insect through the anus. It often makes vegetables dirty and lowers their value. Also referred to as fecal matter.

Generation In reference to insects, it is a group of individuals born, living, and feeding during the same period of time.

Germinate In reference to plants, it means to begin to grow as a seed sprouts.

Girdle To cut away the outer surfaces of a stem or a petiole in a ring around a plant.

Gregarious In reference to insects that characteristically live and feed together as a group or an army.

Half-moon Something shaped like a crescent or one half of a circle.

Honeydew A secretion of the insect which comes out from the posterior end of its body. It is rich in some sugars and is an excellent medium for the growth of some fungi. It is also the favored food of some ants.

Immature In reference to the development of an insect, it is an individual that is not mature or not fully developed. Often it is the particular stage that causes damage to vegetable crops.

Insect A member of the class Hexapoda having three pairs of legs, a hardened shell-like body that has three divisions, none, one, or two pairs of wings, and various types of mouthparts.

Larva The immature stage of an insect. It is wormlike in appearance and may or may not have legs. It has chewing mouthparts and can cause damage to vegetable crops.

Life cycle The series of stages in form and activity that an insect passes through from life to death.

Lodge To beat a plant or an entire crop to the ground. If a plant is lodged it is not erect but lying flat.

Maggot The immature stage of insects belonging to the order Diptera, the flies. Typically it is white, broad at one end and tapering to the other. Some species damage vegetable crops.

Mid-vein The middle vein that runs along the length of the leaf. It arises in the vicinity of the leaf stem or petiole.

Mold A fungus of the order Mucorales. A woolly growth that often forms on damp or decaying surfaces. Certain molds can grow in and on some excretions of insects.

Mosaic A virus disease of plants which characteristically causes a yellow and green mottling of the foliage.

Moth The adult stage of insects belonging to the order Lepidoptera. It has sucking mouthparts and does not cause feeding damage to vegetable crops. Normally it is active only at night.

Naked eye In reference to one's ability to see tiny insects damaging vegetable crops without a magnifying glass or other means of enlarging the specimen for viewing.

Pedice A small stalk or stem bearing a fruit, flower, or leaf.

Petiole The slender stem that supports the leaf of a plant.

Pupation The process the insect goes through when it pupates or becomes a pupa. The pupa is the immature stage of the insect just prior to becoming an adult. It is a stage where many body changes occur. The pupa does not damage vegetable crops.

Sepal One of the small modified leaves comprising the calyx and found at the base of the flower.

Sex pheromone A chemical substance produced by an individual insect to obtain a response from another insect of the same species.

Skeletonizing A type of leaf damage caused by insects with chewing mouthparts. They actually consume leaf tissue in a manner which leaves a basic skeleton or framework of the leaf intact.

Snout A prolongation of the head. This is a common characteristic of weevils. At a glance the insects look as though they have piercing-sucking mouthparts. Actually they have chewing mouthparts located at the end of the snout.

Spine An erect, usually sharp-pointed projection from the body of an insect. It is slightly thicker than a normal insect hair.

Taxonomy The study of the general principles of scientific classification.

Terpene A chemical compound. Any of various isomeric hydrocarbons found present in essential oils. An example is turpentine.

Thrips The common name of tiny insects belonging to the order Thysanoptera. Some species damage vegetable crops.

Trifoliate Having three leaflets.

Vector An organism like an insect or mite that transmits a pathogen to a plant.

Virus The causative agent of an infectious disease.

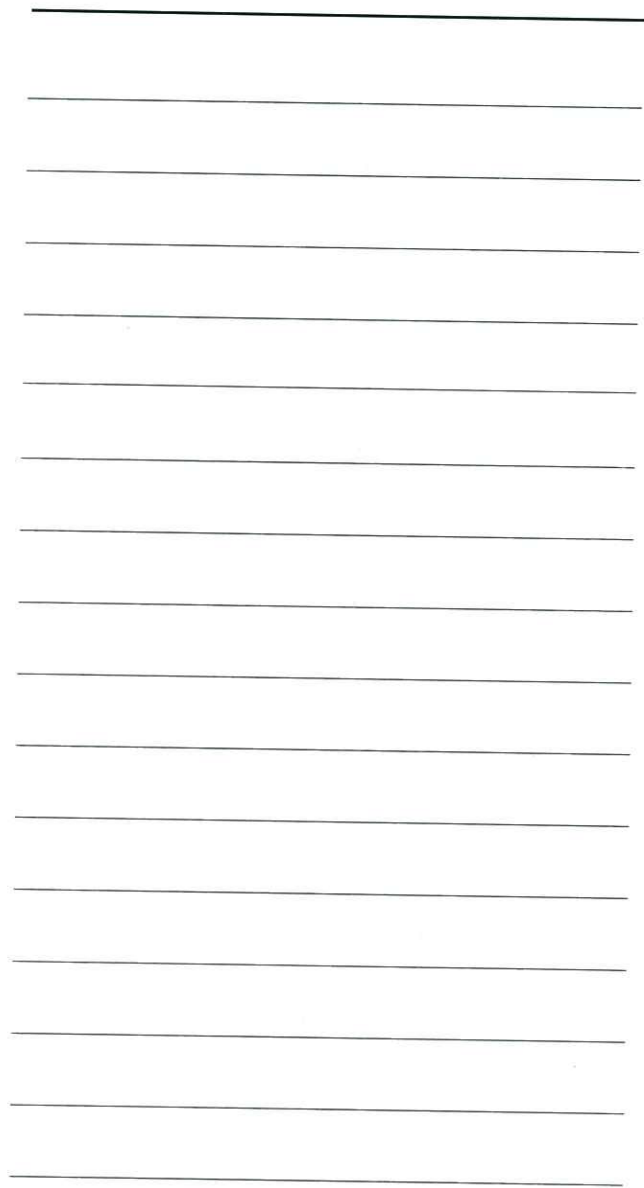
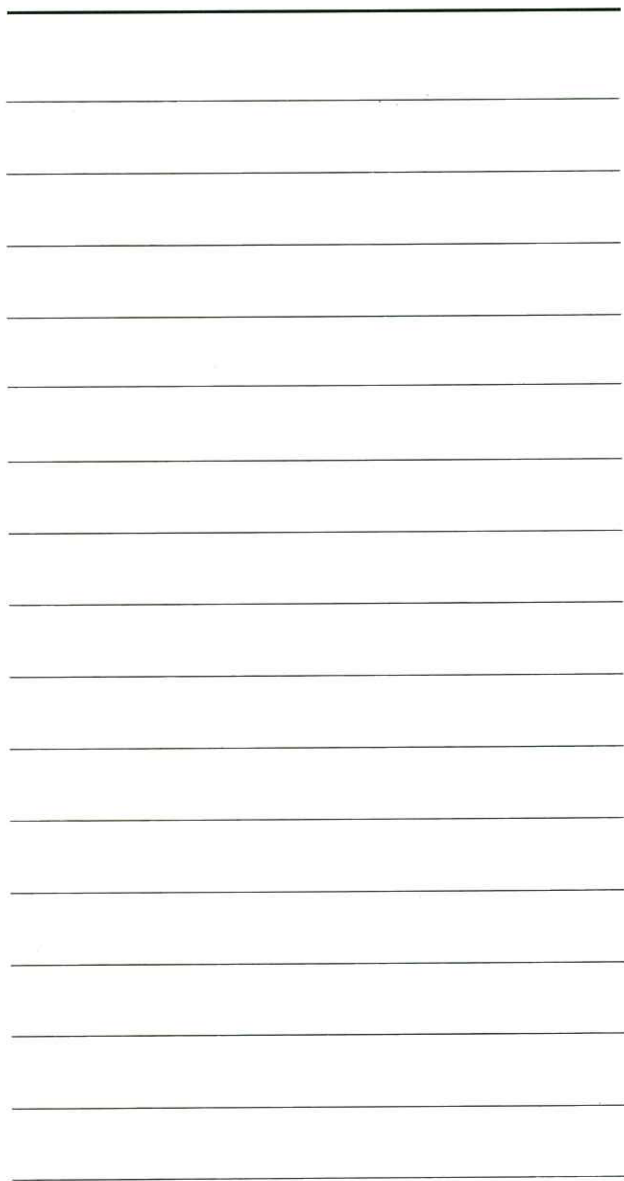
Wilt In reference to the condition of plant leaves that become weak and droop. They lose their freshness due to lack of water.

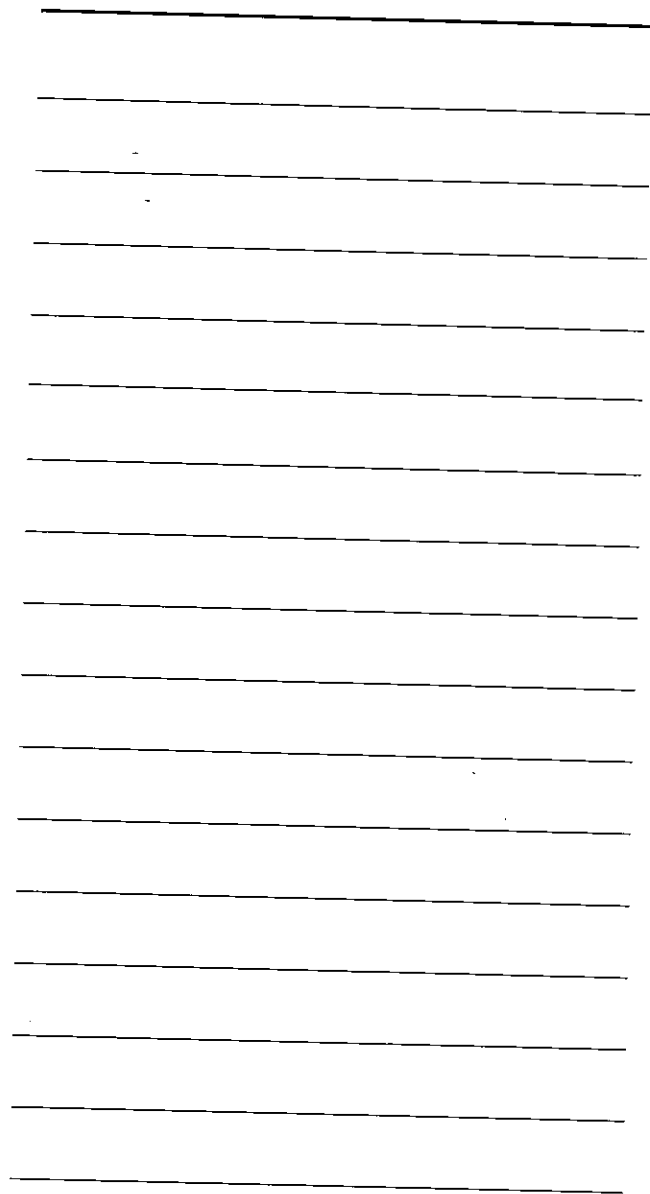
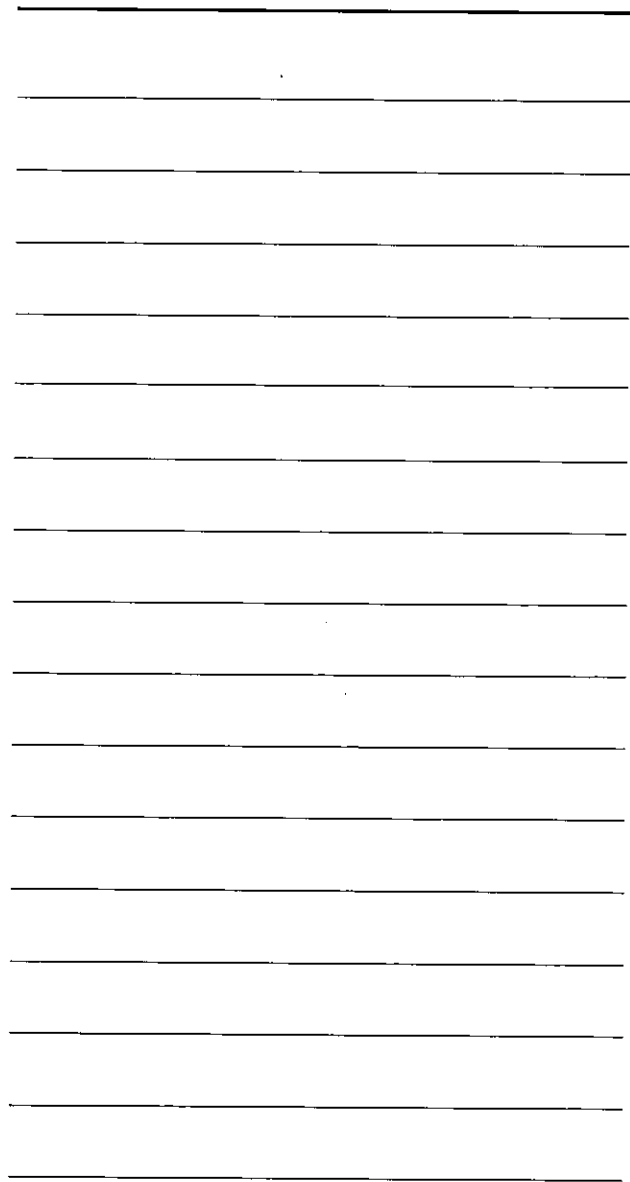
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