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U. S. DEPARTMENT OF AGRICULTURE

control of insect pests of greenhouse vegetables



AGRICULTURE HANDBOOK NO. 142
U. S. DEPARTMENT OF AGRICULTURE

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control of insect pests of greenhouse vegetables

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Approximately 2,400 acres of greenhouse vegetables are grown in the Northern United States. One-fourth of the total acreage is in Ohio. Other important areas are located in the New England States, particularly Massachusetts, and in Illinois, Indiana, Iowa, Pennsylvania, New York, and Kentucky. Some vegetables are grown commercially in small ranges or alternated with floral crops in many greenhouses throughout the Northern States. In addition, the number of small backyard greenhouses is rapidly increasing. Vegetables as well as flowers are being grown for home consumption or local markets.

The annual gross sale of commercial greenhouse vegetables amounts to approximately \$50 million. To construct 2,400 acres of new greenhouse areas at current prices would cost about \$240 million.

Tomatoes are the most important greenhouse vegetable, cucumbers are second, and lettuce is third. Watercress, endive, and radishes are also grown.

Insects and related pests have been a serious problem to producers of greenhouse vegetables. Fall crops of cucumbers and tomatoes have been an uncertainty, and spring crops have been terminated early because of thrips and two-spotted spider mites. At least 30 species or groups of closely related species of insects, mites, slugs, snails, sowbugs, and symphylids feed on the foliage or fruits or attack the stems, roots, or the seedlings.

Since the development of more effective insecticides for these pests, such as DDT, parathion, malathion, TEPP, and lindane, both fall and spring crops can be grown at will. Aerosol bombs have become standard equipment in most greenhouses and have further simplified pest control. These improvements have resulted in greater production, much higher quality crops, and considerable savings for the grower in both time and cost. However effective the new insecticides may be, good cultural practices, sanitation, and soil sterilization are essential for reducing or eliminating diseases, as well as insect pests, and for preventing their continued damage to succeeding crops.

INSECTICIDES

Precautions

Insecticides are toxic to man as well as to insects. Adequate safeguards must be used and precautions must be followed to protect the workers that apply them as well as those that work in the greenhouse after applications have been made. Also the grower must protect the consumer from harmful residues by maintaining a safe interval between the last insecticide application and harvest. Follow the directions and heed all precautions on the container label.

Parathion, TEPP, and methyl chloride, which is contained in greenhouse aerosols, are extremely poisonous. Parathion and TEPP in any form and any greenhouse aerosol regardless of the insecticidal ingredient should be applied only by a trained operator who will enforce the precautions prescribed by the manufacturer and assume full responsibility for safety. Do not use these materials in greenhouses connected to living quarters. Do not use parathion on tomatoes within 10 days, on cucumbers or radishes within 15 days, or on lettuce or endive within 21 days before harvest. Do not apply TEPP to any vegetable within 3 days before harvest.

Do not use malathion on cucumbers within 1 day, on radishes within 7 days, or on lettuce, endive, or watercress within 10 days before harvest. Do not apply to tomatoes a malathion aerosol within 15 hours or a malathion spray within 3 days before harvest.

Do not apply DDT to tomatoes or cucumbers within 5 days before harvest or to lettuce or endive after the seedling stage.

Do not apply DDT to watercress. Do not apply parathion to watercress after the foliage to be eaten appears.

Do not apply calcium arsenate or chlordane to any vegetable crop after the edible parts appear.

Do not apply metaldehyde dust to any vegetable after the foliage or fruit intended to be eaten is present. Metaldehyde baits can be used at any time.

Do not apply nicotine to tomatoes, radishes, or cucumbers within 3 days or to lettuce, endive, or watercress within 7 days before harvest.

To avoid excessive residues on greenhouse vegetables, use all insecticides at the recommended rate. To avoid plant injury, stunting, or abnormal growth, use preparations containing highly refined toxicants.

Calcium Arsenate

Calcium arsenate is not recommended against pests of greenhouse vegetables, except against slugs and snails when it is mixed with metaldehyde in commercially prepared baits. (See p. 21.)

Chlordane

Use chlordane for controlling pests outside vegetable greenhouses, for soil treatment against wireworms, and for incorporation in metaldehyde baits against slugs and snails. Apply chlordane dusts to control earwigs in areas outside the greenhouse. Do not apply chlordane dusts or baits to vegetables after parts of the plant to be eaten or marketed appear.

DDT

A 3-percent DDT dust is useful in the control of many pests. Apply the dust at 30 pounds per acre, or at 1 pound per 1,500 square feet, with a portable duster driven by hand crank or electric motor. Discharge the dust into the air above the plants so that it settles in a light uniform deposit on the foliage and leaves a minimum amount of residue. Excessive applications from uneven distribution by inferior dusters or careless workers are likely to injure the plants and leave undesirable residues. A DDT dust is safer and more economical than a DDT aerosol for the control of thrips, corn earworms, and tomato pinworms. DDT dusts are safer than DDT sprays, which are useful in small greenhouses only.

DDT aerosols available for use on ornamentals should be applied to vegetables only if directions for such use are on the

label. A 5-percent DDT aerosol containing a special solvent is available for use on vegetables, but cucumbers are sometimes susceptible to injury. Most DDT aerosols cause bleaching of cucumber foliage. However, a special DDT aerosol that is generally safe for use on this crop is available. If the label does not specify that the DDT aerosol can be used safely on cucumbers, use a 3-percent DDT dust.

Lindane

Use lindane to control garden symphylids when infestations are discovered after the crop has been planted. Apply it in wettable powders or in dusts to the soil at the rate of $3\frac{1}{2}$ pounds per acre, or 1 ounce per 780 square feet. A convenient dosage is 5 ounces of 25-percent wettable powder or 8 pounds of 1-percent dust per 1,000 square feet of surface. For newly set plants, mix 1 ounce of a 25-percent wettable powder in 10 gallons of water and pour 1 pint of the suspension around the base of each plant. If preferred, apply the insecticide dry and water it into the soil. Do not use lindane in this way, however, except in the greenhouse. When applied to the soil, lindane imparts a musty flavor to certain root vegetables. Do not apply lindane to soil that will be planted later to radishes, lettuce, endive, or watercress.

Malathion

Aerosols containing 10 percent of malathion are similar to parathion aerosols in controlling most pests, except that they have shorter residual toxicity to greenhouse whiteflies and two-spotted spider mites. Malathion residues can be removed by washing.

Malathion aerosols are safe on greenhouse vegetables when properly applied, but they may burn the foliage of tomatoes and cucumbers if temperatures are excessive, especially if the aerosols are applied on a cloudy day and the weather clears before the ventilators are opened. The bright sun quickly builds up high temperatures. Closing the ventilators for

treatment in late afternoon when the sun is shining may also result in excessive temperatures. The maximum safe temperature is not known, but it is apparently 85° F. The foliage of rapidly growing tomato plants is most frequently burned, the damage usually being confined to young almost expanded leaves near the tip. The damage may be general throughout the greenhouse or localized where temperatures increase rapidly. Older leaves are generally unaffected, and later new growth is normal except for the weakening effect of the damage on the plant. To avoid such damage, open the ventilators quickly when a sudden rise in temperature and too much sunlight occur. Treat the greenhouse again if pest control has been poor.

In greenhouses too small for application of aerosols, malathion emulsion sprays offer a practical means of controlling many pests. They leave no objectionable residue that is not easily removed by washing. Suitable respirators are available for those desiring to wear them when exposed for long periods to the spray. The usual dosage is 2 teaspoons of 50-percent emulsifiable concentrate per gallon of water, or 1 quart per 100 gallons. Follow the recommendations on the label. Malathion dusts are not recommended for use in greenhouses.

Metaldehyde

Metaldehyde dusts or readymade baits will control slugs and snails when properly used. The most effective slug baits contain metaldehyde mixed with either calcium arsenate or chlordane. Do not apply metaldehyde dust or chlordane bait to vegetables after parts of the plant to be eaten or marketed appear.

Nicotine

Apply a spray containing 40 percent of nicotine sulfate to control aphids on foliage. Use it also as a soil drench to control fungus gnat larvae. Nicotine is a violent poison. Follow the directions and heed all precautions on the container

label. Avoid spilling it on the skin or getting it into the mouth or eyes.

Parathion

A 10-percent parathion aerosol is used very extensively in vegetable greenhouses, because it is effective against most insect pests. Because of its long residual action, parathion is the most effective material against two-spotted spider mites and greenhouse whiteflies. Parathion like malathion aerosols may burn the foliage of tomato and cucumber plants. Parathion is extremely poisonous and should be applied only by a trained operator who will enforce the precautions prescribed by the manufacturer and assume full responsibility for safety.

Rotenone

Rotenone sprays or dusts are useful for the control of flea beetles, cucumber beetles, midges, and several other pests. They are recommended for the control of many pests in small greenhouses where aerosols are impractical. Rotenone is the active ingredient in derris or cube. Use a spray containing 4 to 5 pounds of 4-percent rotenone wettable powder per 100 gallons of water, or 4 level tablespoons per gallon. A 1-percent rotenone dust may also be used.

Sulfur

Dusts containing 25 percent or more of sulfur are effective against susceptible species of mites, including the broad, tomato russet, and white mold mites. Although pure dusting sulfur is sometimes used, plant injury may result.

TEPP

Aerosols containing 5 percent of TEPP are useful in the control of aphids, greenhouse whiteflies, and two-spotted spider mites near harvesttime. However, 2 or 3 days should intervene between application and harvest.

TEPP aerosols are not recommended for use on tomatoes except those varieties known to tolerate them, such as Michigan State Forcing, Grothen's Globe, and June Pink, because severe burning of foliage



TC-5461

Figure 1.—Tomato leaf with small necrotic spots caused by TEPP aerosols.

may result. Injury is usually not uniform throughout the greenhouse, apparently because of local temperature variations. TEPP aerosols cause necrotic spotting of leaves on many varieties of tomatoes in the seedling stage and also on a few varieties in later stages of growth (fig. 1). Cover flats of young tomato plants of all varieties with newspaper before releasing TEPP aerosols. Do not apply TEPP aerosols to the plants before the first flower clusters form, as young plants may be injured. A partially clogged nozzle discharges large droplets, which cause necrotic spotting on the young foliage, particularly of tomato plants. Clean the nozzle promptly or replace it if it becomes clogged. TEPP is extremely poisonous and should be applied only by a trained operator who will enforce the precautions prescribed by the manufacturer and assume full responsibility for safety.

GENERAL CONTROL PROGRAM

A well-planned control program can frequently prevent the development of damaging populations of insect pests in succeeding greenhouse crops. After harvesting the crop, destroy the pests on the

old plants in the greenhouse with a heavy application of parathion. Use parathion aerosols at twice the standard rate, or 2 pounds of aerosol solution per 50,000 cubic feet of greenhouse space. (See p. 6.) For maximum benefit, close the ventilators overnight and use the aerosols before cleaning the greenhouse for the succeeding crop.

Planting the new crop in a separate plant house and using every precaution to prevent contamination from the growing house will reduce the number of pests. Keep tomato and cucumber seedlings in pots for 6 to 10 weeks in a separate plant house before transferring them to the growing house. Start lettuce and endive seedlings in flats or beds and later plant them in the growing house. Plant radish and watercress seeds directly in beds of the growing house. If the new watercress crop is started by planting sprigs from an older crop, care should be taken to prevent carrying over any pests. Rid the other growing-house crops of pests as far as possible in order to prevent infestations in the radishes and watercress.

As an added control measure, apply a parathion aerosol to the new crop at the standard rate of 1 pound of aerosol solution per 50,000 cubic feet just before removing the plants from the plant house or after transferring them to the growing house. Repeat this treatment approximately 4 weeks later and a third time 2 weeks before the first fruits ripen or before harvest, even though no insect pests are evident. These treatments may prevent pest damage to the plants until most of the crop is harvested.

Cucumbers are pollinated by hand or by honey bees to assure a good set of fruit. Greenhouse tomatoes are usually hand-pollinated, but recent experiments indicate that honey bees may also be useful in pollinating tomatoes. When colonies of honey bees are established in vegetable greenhouses, screen the entrances to the hives. Loosely cover the front of the hive with paper or cloth to protect the bees from DDT dusts or aerosols when applying them to the crops. Remove the colonies from the range for at least 1 day when

using TEPP and for 4 or 5 days when applying malathion or parathion.

Sanitation

A good sanitary program for a commercial greenhouse is important in reducing damage by disease and insect pests. Do not plant potatoes, tobacco, cucumbers, melons, spinach, celery, and dahlias close to the greenhouse, since they may harbor virus diseases and insect carriers. For the same reason, eliminate milkweed, plantain, chickweed, catnip, groundcherry, horsenettle, and jimsonweed within 150 feet of the greenhouse. Keep down all weeds. In the immediate area of the greenhouse maintain clipped lawn grass, bare soil, or ground covered with cinders.

In the greenhouse, cleanup of trash, including plant debris, eliminates breeding or hiding places of slugs and sowbugs.

Soil Sterilization

To destroy insect pests, such as garden symphylids, nematodes, and pathogenic organisms, sterilize the soil by heating it at 180° F. for 4 hours. Steam is most universally used for this purpose in vegetable greenhouses.

Before planting the greenhouse crop, bury drainage tiles in rows about 18 inches apart and connect them at each end by crossheads. Introduce steam at 15 pounds' pressure into the crossheads. Suitable covers of plastic or special paper over the soil help retain the steam, insure sterilization of the surface soil, and aid in getting penetration to the maximum depth.

Sterilize the soil in raised benches by introducing steam into the buried tiles or perforated pipes, and cover these benches with plastic covers weighted at the edges to confine the steam.

Sterilize tools, pots, flats, and small lots of soil in a tightly constructed box of wood or masonry fitted with a perforated pipe into which steam is introduced.

If the soil is kept properly moistened prior to sterilization, the symphylids tend to congregate near the surface. The heat from sterilization will then reduce the

populations to such low levels that they will cause little damage to the succeeding crop. If the soil is allowed to dry out prior to sterilization, these pests will penetrate to such depths that the steam will not reach them and they may return to cause serious damage to newly set plants. The treated greenhouse crop may also be reinfested from outside areas or adjacent untreated greenhouses through drainage tiles or gravel drainage layers.

Take every precaution to avoid reinfesting sterilized soil by means of dirty, contaminated hands, tools, and shoes and other clothing.

Insecticide Applications

Aerosols

Aerosols that are effective for use on greenhouse plants usually contain the poison gas methyl chloride. Only a trained operator should apply aerosols, regardless of the insecticidal ingredient. He should enforce the precautions prescribed by the manufacturer and assume full responsibility for safety. Wear protective clothing, rubber gloves, and a full-face gas mask with an approved canister to protect against inhalation and skin absorption. Avoid contamination of food, and do not chew or smoke tobacco during the operation. Change the clothing and wash the hands and face after completing the application. Lock or barricade the entrances and post warning signs during the treatment period. No one should enter the greenhouse without wearing a suitable mask and canister. At the end of the treatment period, ventilate the building for 1 hour before allowing anyone to work in it. Do not use aerosols in greenhouses connected to living quarters. Do not apply aerosols when an open flame is present.

Aerosol cylinders for greenhouse use contain 4 pounds of the aerosol solution, which is sufficient for treating 200,000 cubic feet of space, or approximately one-half acre, in a greenhouse. When the plants are small and the greenhouses are tightly closed, reduce the dosage to 2 pounds per 200,000 cubic feet.

Discharge the aerosol into the air above the plants. Move through the greenhouse at such a speed that the proper amount will be distributed equally throughout the area. Avoid overdosage by treating the greenhouse at the rate of 4 seconds per 1,000 cubic feet of space with the standard, or 5-gallon-per-hour oil-burner, nozzle. An area 20 feet wide can be treated by one person in one trip, but wider areas require two or more trips, which can be accomplished best by two or more operators working together. Avoid overtreatment at the ends of the greenhouse. Turn off the valve before the allotted time to allow for the discharge of the aerosol solution in the applicator. In small ranges of 15,000 or 20,000 cubic feet, leave the greenhouse at the end of the allotted time and discharge outside any solution left in the applicator.

Best results are obtained with most aerosols at greenhouse temperatures between 70° and 85° F. Higher temperatures cause plant injury and lower temperatures a poor kill of the pests. Aerosols are sometimes applied on cloudy days. If the sun appears, excessive temperatures will result, and the ventilators must be opened promptly. Most growers apply the aerosols near sunset when the ventilators can be closed without danger of a temperature buildup. The aerosol-bomb temperature should also be between 70° and 85° in order to discharge properly. Store the bomb at the desired temperature for 12 hours prior to use. Do not increase the temperature of the bomb by immersing it in hot water, as this is a dangerous practice. Close the ventilators before application and keep them closed for at least 2 hours after treatment and preferably overnight. The foliage should be dry during treatment, but the plants should be well watered.

The aerosol method of applying insecticides has largely replaced dusting and spraying in commercial greenhouses.

Dusts

DDT dusts are widely used in commercial vegetable greenhouses for controlling corn earworms, tomato pin-

worms, and thrips. (See p. 2.) For treating large greenhouses, portable crank dusters or small electric dusters are most generally used; for small greenhouses, small crank dusters or plunger-type dusters are useful. Discharge the DDT dust into the air above the plants so that it settles in a light uniform deposit on the foliage and does not leave excessive residues or cause plant injury.

Rotenone dusts may be used in small greenhouses for several vegetable pests. Other insecticides used in dust form include sulfur for certain mites, chlordane for earwigs outside the greenhouse, and lindane applied to the soil for garden symphylids.

Smokes

Combustible powders containing parathion may be obtained in units suitable for use in different-sized greenhouses. If the manufacturer's directions are followed, a gas mask is not necessary. Do

not use these smokes in greenhouses connected to living quarters.

The slow-burning mixture is ignited with a sparkler. The generated smoke carries the insecticide throughout the greenhouse. Since some of the insecticide is lost or decomposed by the heat, the dosage for a given space is greater than for an aerosol. Smokes have less residual toxicity than aerosols. They are especially useful for the small greenhouse of 10,000 cubic feet or less and should be used instead of aerosols, because it is difficult to apply correct dosages with the latter in small spaces. (Fig. 2.)

Sprays

When applying sprays in the greenhouse, wear a respirator that is approved for protection against the materials you are using, or wear the fullface mask and canister as for aerosol applications. If the greenhouse is attached to a dwelling or if it is too small for the efficient use of aero-



TC-5516

Figure 2.—Smoke bomb in operation.

sols or smokes, apply all insecticides, except DDT, in sprays. Sprays are recommended rather than dusts, because the insecticide can be directed better toward the plant. Also it is difficult to avoid breathing floating dust particles. Compressed-air hand sprayers or small portable power sprayers are suitable for use in these small greenhouses. In larger greenhouses and ranges, spraying is costly and not necessary, although portable power sprayers or stationary spray units have been used in most commercial greenhouses and are still available in some.

CONTROL IN SMALL GREENHOUSES

In small greenhouses of 10,000 cubic feet or less, the following treatments are recommended. Sprays containing 1½ teaspoons of 40-percent nicotine sulfate and ¼ teaspoon of a detergent, such as Dreft,¹ per gallon of water will control aphids and mealy-bugs. Sprays containing rotenone preparations are effective against greenhouse whiteflies, flea beetles, cucumber beetles, midges, and thrips and fairly effective against spider mites. Use a spray containing 4 to 5 pounds of 4-percent rotenone wettable powder per 100 gallons of water, or 4 level tablespoons per gallon. A 1-percent rotenone dust may also be used. Sprays containing 2 teaspoons of 50-percent malathion emulsifiable concentrate per gallon of water are also effective against most of these pests, as well as the tomato russet, broad, and white mold mites. Dusts containing 3-percent DDT or sprays containing 5 level tablespoons of 25-percent DDT wettable powder per gallon of water will control thrips, the greenhouse leaf tier, armyworms, the corn earworm, and the tomato pinworm. Light dusting with 25-percent sulfur will destroy the tomato russet, broad, and white mold mites.

¹The mention of a trade product does not imply its endorsement by the U. S. Department of Agriculture over a similar product not named.

INSECT PESTS

Aphids

Four species of aphids, or plant lice, are commonly found on greenhouse vegetables. They feed on many crops, weeds, and other plants outdoors. If they become established on greenhouse crops in the fall, they reproduce continuously throughout the year. They damage the plants by their feeding. The melon aphid and the green peach aphid are particularly responsible for introducing cucumber mosaic into greenhouse tomatoes and cucumbers. The green peach aphid also transmits tobacco mosaic. Control of the aphids and removal of mosaic-infected plants are important in preventing further spread by insects and by greenhouse workers.

Foxglove Aphid

The foxglove aphid is about ⅛ inch long. It is a shining pale green in the wingless stage and is recognized by the darker green area around the base of each cornicle, or honey tube. It feeds on young tomato and cucumber plants and on lettuce, radishes, and watercress at any stage, causing yellow spotting and distortion of young leaves (fig. 3).

Green Peach Aphid

This species is about 1/10 inch long, a pale waxy green in the wingless stage, and green with a black patch when winged. It is most common on lettuce, watercress, and radishes, but it may also be found on cucumbers and tomatoes. Heavy infestations cause dwarfing of the new growth.

Melon Aphid

The melon aphid (fig. 4) is from 1/20 to 1/15 inch long and varies from pale to dark green or almost black. It is found more frequently on cucumbers than on any other greenhouse vegetable. Several hundred may occur on the leaves of a single plant. They cause curling of new leaves (fig. 5), stunting of tips, and yellowing and death of older leaves. A black sooty mold develops on the honey-



TC-5505B and TC-5505C

Figure 3.—Tomato foliage injured by the fox-glove aphid: Above, curled young tip leaves; below, yellow feeding spots on older leaf.

dew excreted by the melon aphid. Sooty mold is seldom observed on plants infested by the three other aphid species.

Potato Aphid

This species is about $\frac{1}{5}$ inch long and either pink or green with a frostlike waxy surface. It feeds in colonies on the veins and stems of leaves, on tomato blossom clusters, and on lettuce, watercress, and radishes. It causes stunting and curling of new growth.

* * * * *

Control: Aphids are readily controlled with parathion or malathion aerosols or with nicotine in smokes or sprays, except



TC-7097

Figure 4.—Winged and wingless adults of the melon aphid.



TC-3098

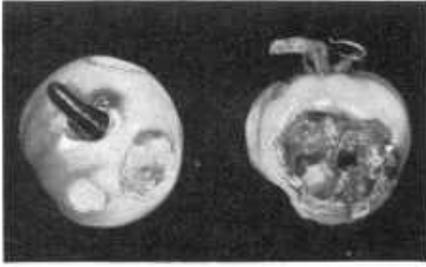
Figure 5.—Curled cucumber leaves caused by the melon aphid.

on dense foliage of lettuce or cucumbers, where TEPP aerosols are more effective. Usually one application is adequate, but reinfestations may require later applications. Maintain a safe interval between the last application and harvest to avoid excessive residues on each crop. (See p. 2.)

For control in small greenhouses, see page 8.

Armyworm

The larvae of the yellow-striped armyworm feed on the foliage of cucumbers, lettuce, and tomatoes and chew holes in the side of tomato fruits (fig. 6). The larvae are found on the underside of lower leaves, in the fruit, or in ground cracks. They develop from eggs laid by adult moths that enter the greenhouse in the fall.



TC-5454

Figure 6.—Armyworm larva and large gouged-out areas in tomato.

Control: Whenever the larvae are observed, promptly apply a malathion or parathion aerosol or a 3-percent DDT dust. Avoid undesirable residues by following the precautions on page 2 for treating each crop.

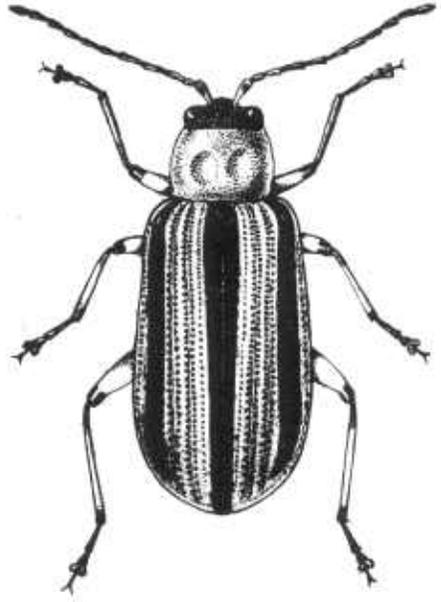
For control in small greenhouses, see page 8.

Beetles

Cucumber Beetles

The striped and spotted cucumber beetles (fig. 7) are approximately $\frac{3}{16}$ inch long and greenish yellow. The striped beetle has 3 longitudinal black stripes and the spotted beetle 12 black spots on the wings. Both species feed on many outdoor crops, but especially cucumbers, squash, and dahlias. They enter the greenhouse in the spring and fall. While feeding on the tender stems and flowers of greenhouse cucumbers, the striped cucumber beetle transmits the organism that causes bacterial wilt, which kills the plants.

Control: Because the beetles congregate on wilting cucumber vines outdoors, a great many may be destroyed before they enter the greenhouse by applying DDT dust to the piles of vine trimmings usually found near service entrances. Weekly applications of a parathion aerosol during the period of the beetles' greatest activity will destroy those in the greenhouse. In small greenhouses apply a rotenone dust or spray. (See p. 8.) Do not apply DDT to cucumbers within 5 days or parathion within 15 days before harvest.

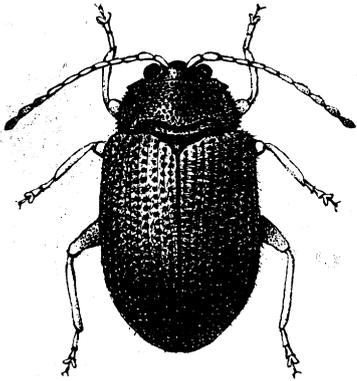


TC-3875 and TC-7111

Figure 7.—Above, striped cucumber beetle; below, spotted cucumber beetle.

Flea Beetles

Three or four species of flea beetles may attack greenhouse vegetables. The potato flea beetle (fig. 8) is the most common on tomatoes. It is a tiny black jumping insect about $\frac{1}{16}$ inch long, which may be present from May to September. The adults eat small round holes in the leaves,



TC-3176

Figure 8.—Potato flea beetle.

which if severely injured may die. Flea beetles frequently cause severe injury to newly set tomato plants in the field or garden and occasionally are found on young plants in pots or flats in the greenhouse.

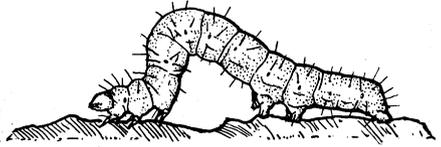
Control: To control flea beetles in greenhouses, apply a parathion aerosol or a 1-percent rotenone or 3-percent DDT dust. Do not apply parathion to tomatoes within 10 days or DDT within 5 days before harvest.

For control in small greenhouses, see page 8.

Cabbage Looper

Moths of the cabbage looper (fig. 9) enter the greenhouse in the fall. The pale-green larvae, recognized by their looping habit when they crawl, may seriously damage lettuce, cucumbers, and other greenhouse crops before they are discovered. They are usually found on the lower leaves, which become ragged from their feeding.

Control: A parathion, malathion, or DDT aerosol or a 3-percent DDT dust is toxic to cabbage loopers. On lettuce a 1-percent rotenone dust is partially effective. Apply it late in the afternoon when the larvae are active. Observe the pre-



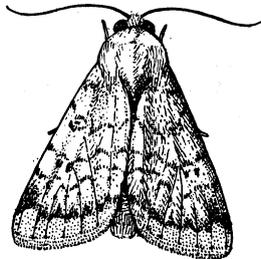
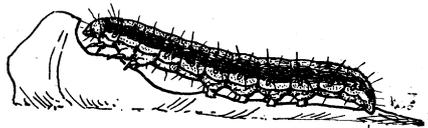
TC-3851B

Figure 9.—Larva and adult of the cabbage looper.

cautions on page 2 to avoid undesirable residues on the various crops being treated.

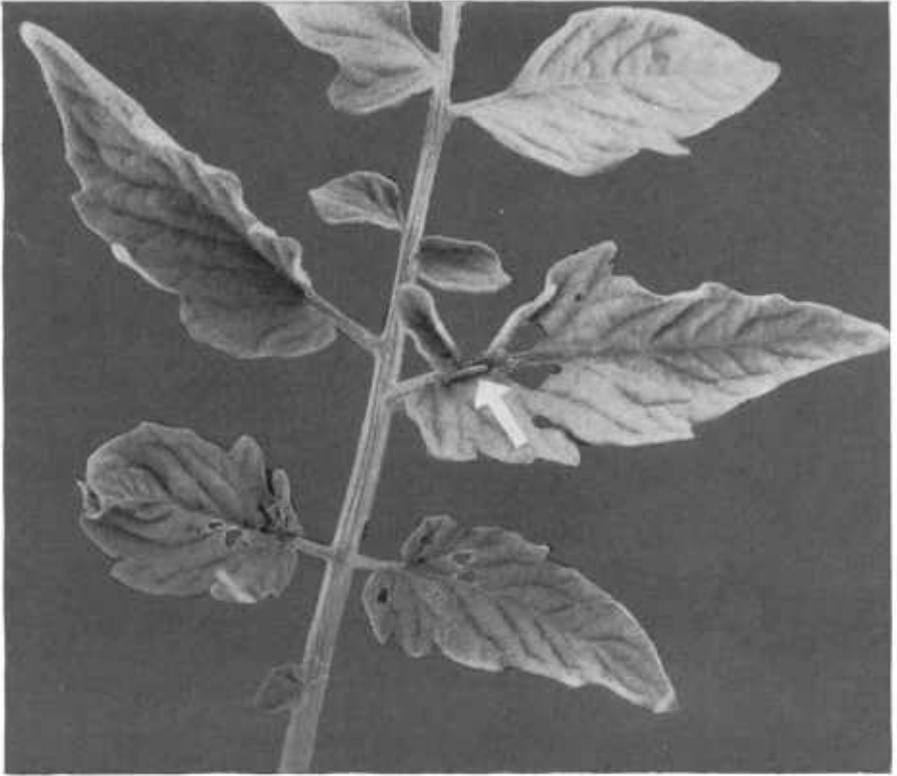
Corn Earworm

The corn earworm (fig. 10), also called the tomato fruitworm, is often confused with cutworms and armyworms. The larvae are green to brown and have alternating light and dark stripes on the sides of the body. They are less hairy than cutworms and the coloration is brighter. Young larvae feed at first on the foliage of tomatoes (fig. 11) and then enter the fruit. They damage tomatoes primarily



TC-3851D

Figure 10.—Larva and adult of the corn earworm.



TC-7183

Figure 11.—Young corn earworm larva and feeding injury on tomato leaf.

by eating round holes in the fruits and devouring the interior (fig. 12). Infestations usually occur in the fall before frost, when the moths fly into the greenhouse and lay their eggs.

Control: A parathion aerosol usually holds this pest in check if applied when the larvae are small. If the infestation is heavy, a 3-percent DDT dust will destroy both large and small larvae. Light infestations may be controlled by hand-picking and destroying the infested fruits and the larvae within. Do not apply parathion to tomatoes within 10 days or DDT within 5 days before harvest.

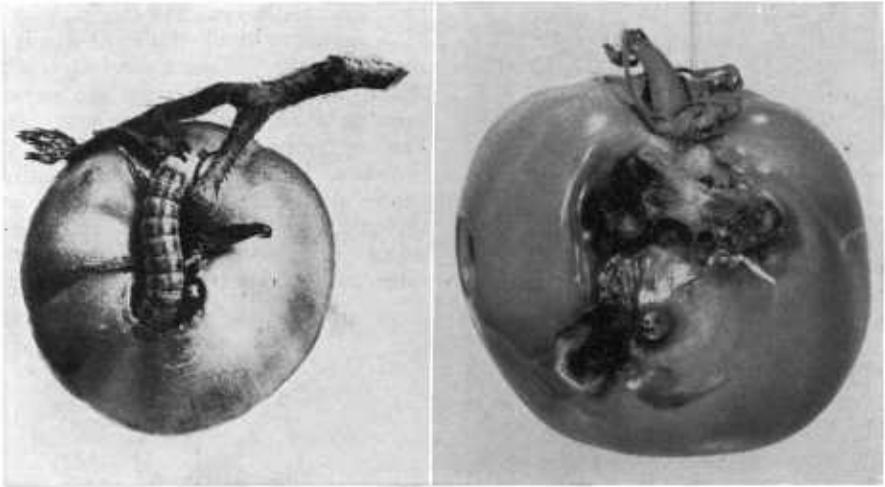
For control in small greenhouses, see page 8.

Cutworms

Many species of cutworms (fig. 13) attack a wide variety of plants, including lettuce, cucumbers, and tomatoes, espe-

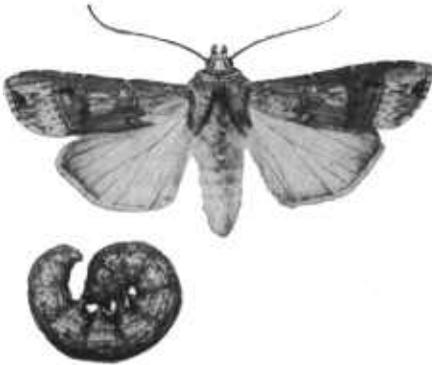
cially in the seedling stage. They cut off the plants near the soil surface. Some species, known as climbing cutworms, climb older plants and feed on leaves, buds, or fruits. The most common cutworms attacking greenhouse crops are the variegated cutworm and the dingy cutworm (fig. 14). The larvae are 1 to 2 inches long and greenish or dull gray with darker markings. They hide in the soil or mulch during the day and damage foliage or fruit at night. The larvae develop into night-flying moths. Several generations may occur in the greenhouse during a year.

Control: Parathion or malathion aerosols will control cutworms in greenhouses, particularly when the larvae are small. A 3-percent DDT dust applied to the soil surface is also effective. Follow the precautions on page 2 to avoid excessive residues on each crop.



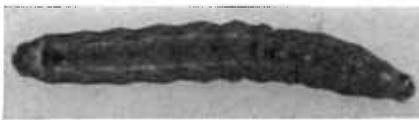
TC-7174 and TC-5456

Figure 12.—Left, corn earworm larva feeding in tomato; right, fruit breaking down from secondary rot in damaged area.



TC-7191

Figure 13.—Larva and adult of the black cutworm.



TC-3708

Figure 14.—Dinky cutworm larva.

Earwig

The ring-legged earwig, a reddish-brown insect about $\frac{3}{4}$ inch long with prominent forceps at the tip of the abdomen, is widely distributed and occasionally damages greenhouse crops. It feeds on the tender roots of radishes and

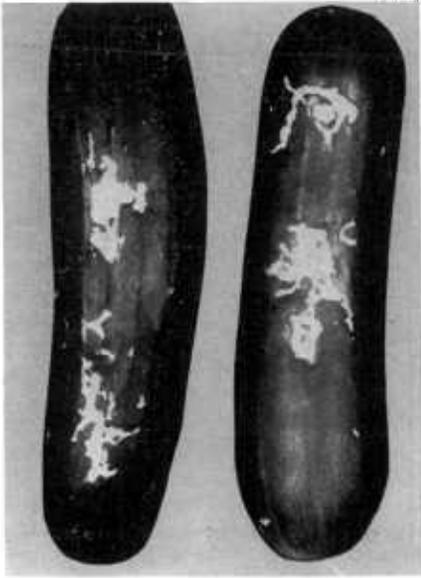
on the surface of tender young cucumber fruits. The latter are deformed as they expand and are made unattractive by the scarified areas (fig. 15). The insects hide by day in the soil, mulch, or dense foliage of cucumbers and are active by night.

Control: Dust with 5-percent chlordane to destroy earwigs near the outside of the greenhouse, but do not apply this material to food crops. Parathion or malathion aerosols will destroy earwigs in the greenhouse. To avoid excessive residues, follow the precautions on page 2 for treating each crop.

Fungus Gnats

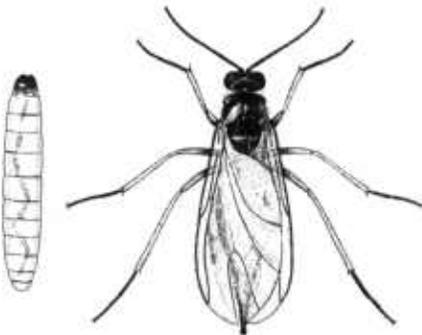
Larvae of several species of fungus gnats (fig. 16) feed on decaying organic matter in greenhouse soils. They may injure tomato seedlings growing in flats. The tiny white larvae, less than $\frac{1}{4}$ inch long and with black heads, may feed on roots or bore into the base of the stem. The dusky black 2-winged adults, about $\frac{1}{8}$ inch long, are observed in flight or resting on the plants. They do not feed; only the larvae injure the plants.

Control: Light applications of a 3-percent DDT dust on the plants will control the adults. To kill the larvae, drench the soil with 1 pint per square foot of a solu-



TC-5457

Figure 15.—Cucumbers injured by the ring-legged earwig.



TC-4951 and TC-4953

Figure 16.—Larva and adult of the fungus gnat.

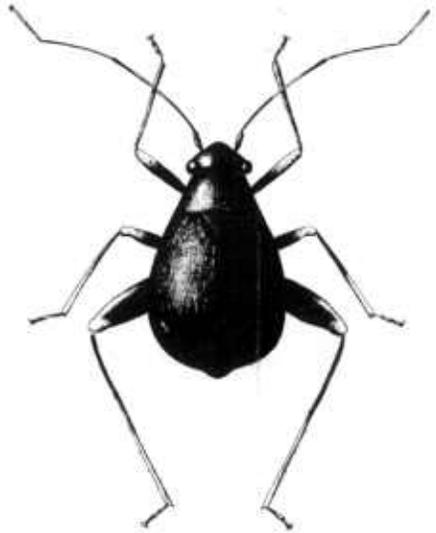
tion containing 1 teaspoon of nicotine sulfate per gallon of water. Do not apply DDT to tomatoes within 5 days or nicotine within 3 days before harvest.

Garden Fleahopper

The garden fleahopper (fig. 17) sometimes attacks the foliage of greenhouse tomatoes. This black insect, which is about $\frac{1}{12}$ inch long, jumps or quickly moves to the underside of the leaf when disturbed. It sucks the sap and chloro-

phyll from the leaves. The feeding punctures appear as small whitish or stippled areas (fig. 18). When these insects are abundant, the feeding areas are rather continuous and the leaves appear gray. Feeding injury may stunt the growth.

Control: Parathion aerosols control garden fleahoppers. Nicotine sulfate at the rate of 1 teaspoon per gallon of water, rotenone sprays, or 1-percent rotenone dusts are effective. Do not ap-



TC-7300

Figure 17.—Garden fleahopper adult.



TC-6552

Figure 18.—Typical injury by the garden fleahopper on clover leaf.

ply parathion to tomatoes within 10 days or nicotine within 3 days before harvest.

Garden Symphylid

The garden symphylid is slender, soft bodied, and white. It is about $\frac{1}{4}$ inch long and has 12 pairs of legs and prominent antennae (fig. 19). Although very frail, it lives for 2 years or more. From 2 to 3 months is required to develop from egg to adult. The population varies considerably with the season and with the temperature and moisture of the soil. When the soil temperature is low, this pest is less abundant. When the soil is moist, it is found near the surface, but when it is dry, it descends to lower levels, often below the zone of effective soil sterilization. It quickly disappears after exposure when the soil is turned.

The garden symphylid is present in the loose soil, high in organic matter, that is found in most greenhouses. When numerous enough, it seriously damages

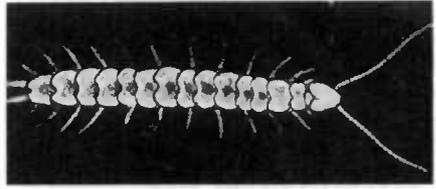


Figure 19.—Garden symphylid adult. (Courtesy of Pennsylvania Agricultural Experiment Station.)

both vegetables and flowers, feeding on the roots. The damage is most serious on newly set plants, which seldom die but fail to grow (fig. 20). Roots of established older plants are also attacked, but the stunting effect on the later plant growth is less evident.

Control: To obtain good control in the greenhouse, water the soil so that the symphylids come to the surface. Soil sterilization by the buried-tile method is the most effective treatment. (See p. 5.) Survivors below the zone of sterilization or symphylids coming from outdoors may



TC-3741

Figure 20.—Left, normal lettuce plant; right, injury caused by the garden symphylid.

injure the plants after they are set. Lindane can then be used by treating individual plants if only a few are affected or the entire greenhouse if the infestation is general. Follow the instructions under Lindane on page 3.

Greenhouse Leaf Tier

The greenhouse leaf tier larva is pale green and about $\frac{3}{4}$ inch long. The adult is a light-brown moth about the same length and has wedge-shaped flat wings when at rest. It lays its eggs on foliage at night. It may be flushed from dense foliage during the day. This insect is an occasional pest on tomato plants, where each larva ties several leaves together. Infestations may originate on nearby chrysanthemums, snapdragons, and related plants. In the South this insect is a pest of outdoor crops, but in the North it survives the winter only in the greenhouse. It has become rare in northern

greenhouses where parathion or DDT is used regularly.

Control: Destroy leaf tier larvae and adults with two applications of a parathion aerosol or a DDT aerosol or dust. Do not apply parathion to tomatoes within 10 days or DDT within 5 days before harvest.

For control in small greenhouses, see page 8.

Greenhouse Whitefly

The triangular adults of the greenhouse whitefly (fig. 21) are about $\frac{1}{16}$ inch long and have powdery white wings. They appear as snowflakes when flushed from infested plants. Their cone-shaped eggs hatch in 5 to 6 days, and the stationary yellowish-green young feed for about 5 weeks before becoming adults. The adults begin laying eggs about 5 days after emergence. Their life history must be considered in carrying out a successful control program.



Greenson-70,126

Figure 21.—Nymphs and adults of the greenhouse whitefly. (Enlarged.)

The greenhouse whitefly is a common pest on greenhouse cucumbers and tomatoes and is less common on lettuce. It also infests many ornamental plants throughout the country, both in the greenhouse and outdoors. The insect breeds on vegetables in the field, including

squash, potatoes, and tomatoes, during the summer and often reinfests greenhouse crops in the fall. It does not survive the winter outdoors in cold climates.

Whiteflies suck the juices from the underside of the leaf (fig. 22). Foliage of infested plants becomes yellowish

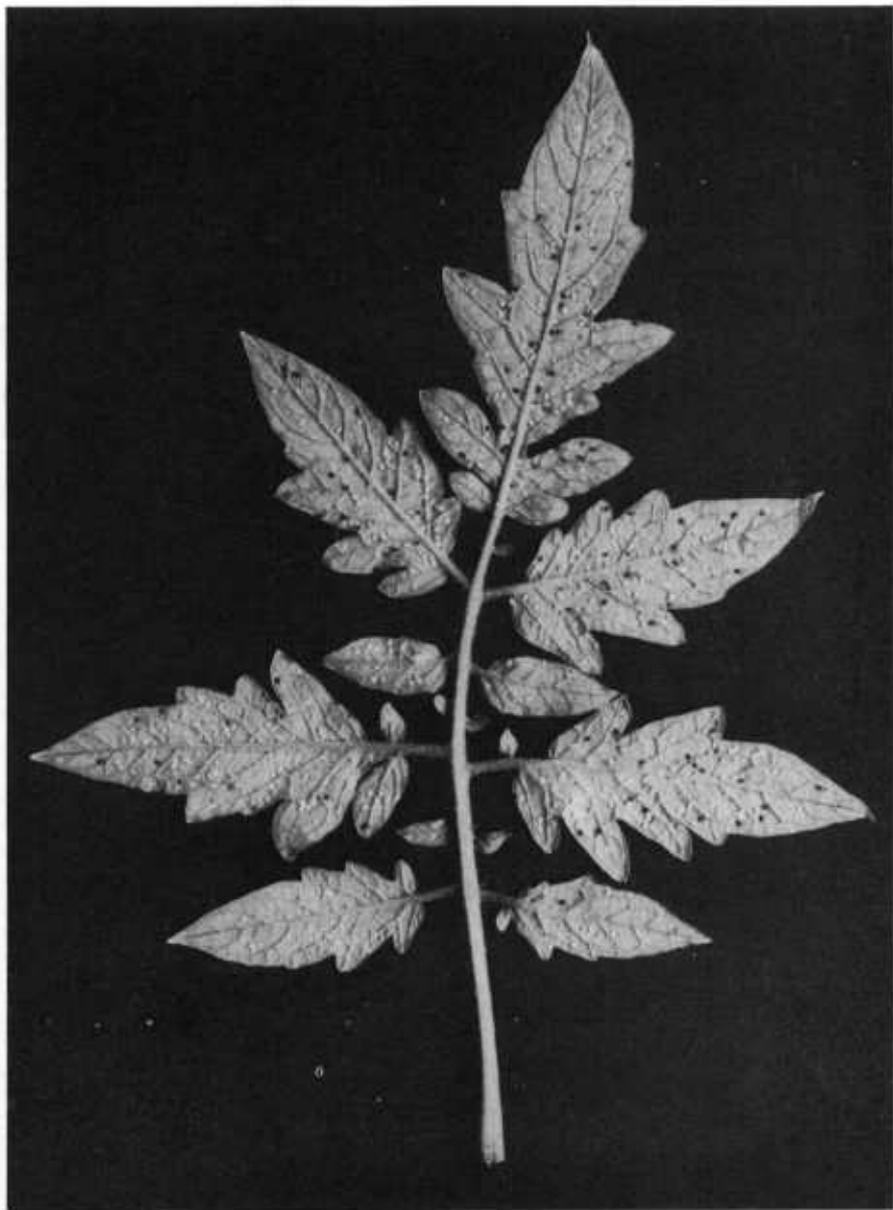


Figure 22.—Greenhouse whiteflies and black parasites on tomato leaf.

TC-6449

green, and the plants are stunted. Foliage and fruits are often blackened by the sooty fungus that grows on the honeydew excreted by the insects. Whiteflies are reduced but usually not satisfactorily controlled by parasites.

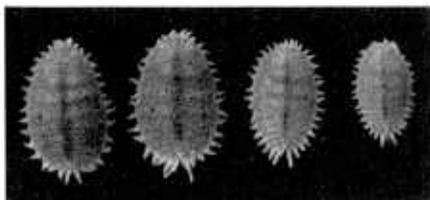
Control: Use an aerosol containing parathion, TEPP, or malathion. Apply the parathion aerosol 2 or 3 times at intervals of 2 weeks until the infestation is destroyed. Use the TEPP aerosol every 5 days for 4 to 5 weeks to destroy the newly emerged adults before they start laying eggs. Eggs and nymphs are not affected by TEPP. Use 4 weekly applications of the malathion aerosol to destroy the adults. It will kill some of the larvae, but it is most effective against the adults. Follow the precautions on page 2 when using these insecticides.

For control in small greenhouses, see page 8.

Mealybugs

Localized infestations of the citrus (fig. 23) or grape mealybug on cucumbers and tomatoes become serious late in the season. They can usually be traced to infested ornamental plants brought into the greenhouse as boarders. Grape mealybugs are found on roots of shrubs and trees. They may crawl into the greenhouse or may be brought in by ants. Mealybug infestations are recognized by the cottony masses on the stems and leaves and by the black sooty mold that grows on the honeydew excreted by these pests (fig. 24).

Control: When the infestation is confined to a few plants, remove and destroy the affected plants. When the infestation is more general, apply a parathion, malathion, or TEPP aerosol three or more



TC-5647

Figure 23.—Citrus mealybugs.



TC-4827

Figure 24.—Cucumber fruit and stem infested with the citrus mealybug.

times at 10- to 14-day intervals. To avoid excessive residues on each crop, follow the precautions on page 2.

For control in small greenhouses, see page 8.

Mites

Broad Mite

The broad mite, seen only with a microscope, is an outdoor pest of many plants in the warmer areas of the United States. It is brought into northern greenhouses on ornamental plants from the South, where it breeds throughout the year and damages many kinds of ornamentals and vegetables, including tomatoes and cucumbers. The tiny caramel-colored mites feed on the lower surface of young leaves. Injured leaves become stiff and brittle, are cupped downward, and develop a mottled and glazed appearance that resembles a virus disease.

Control: To destroy broad mites, use a parathion aerosol or two light applications, a week apart, of a dust containing 25 percent or more of sulfur. Do not apply parathion to tomatoes within 10 days or to cucumbers within 15 days before harvest.

For control in small greenhouses, see page 8.

Mushroom Mite

The mushroom mite is a slow-moving species about $\frac{1}{50}$ inch long and has a white rounded body and long bristles. It is frequently found on rotting compost and may be brought into the greenhouse with the manure mulch. As the mulch dries, these mites move to nearby plants and gouge out small pits in the stems and leaves of cucumbers. Tender young plants are more susceptible to attack than older plants. The period of damage is usually short, because the mites do not normally subsist on living plant tissue.

Control: When damage is observed, promptly apply a parathion or TEPP aerosol. Do not apply parathion to cucumbers within 15 days or TEPP within 3 days before harvest.

Tomato Russet Mite

This slow-moving mite, visible only under high magnification, is milky white, cylindrical, and wedge shaped, tapering toward the posterior end. It is an outdoor pest of tomatoes in warmer sections of the country and is sometimes brought to northern areas on young plants. Once established in a greenhouse this mite may be taken to the field with infested plants, where it damages the crop, and it may reenter the greenhouse on the fall crop. This microscopic mite may complete a generation within a week, and consequently its damage increases rapidly. In feeding, it causes the main stem to become rusty brown, and the foliage becomes papery and dies. Infested fruits also are russeted and sometimes cracked.

Control: A parathion aerosol or a 25-percent sulfur dust applied at 2-week intervals is effective in controlling the tomato russet mite. Do not apply parathion to tomatoes within 10 days before harvest.

For control in small greenhouses, see page 8.

Two-Spotted Spider Mite

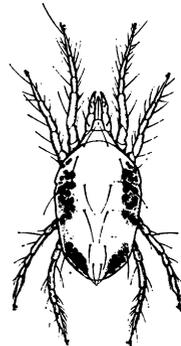
The two-spotted spider mite (fig. 25) is the most troublesome pest of greenhouse tomatoes and cucumbers. It may

also attack radishes, lettuce, and other crops.

These mites are found on outdoor weeds or other plants. They crawl or are carried by the wind or by workers on their clothing or tools to the indoor crops. Outdoors the adults hibernate on low-growing vegetation, but in the greenhouse they reproduce continuously. Under a hand lens the adults appear green or reddish with a dark spot on each side and are about $\frac{1}{50}$ inch in length. They deposit shining globular eggs on the underside of the leaf, and the young hatch in a few days. Since a generation may develop in 9 days in a warm greenhouse, a mite population builds up rapidly. At lower temperatures the development is much slower.

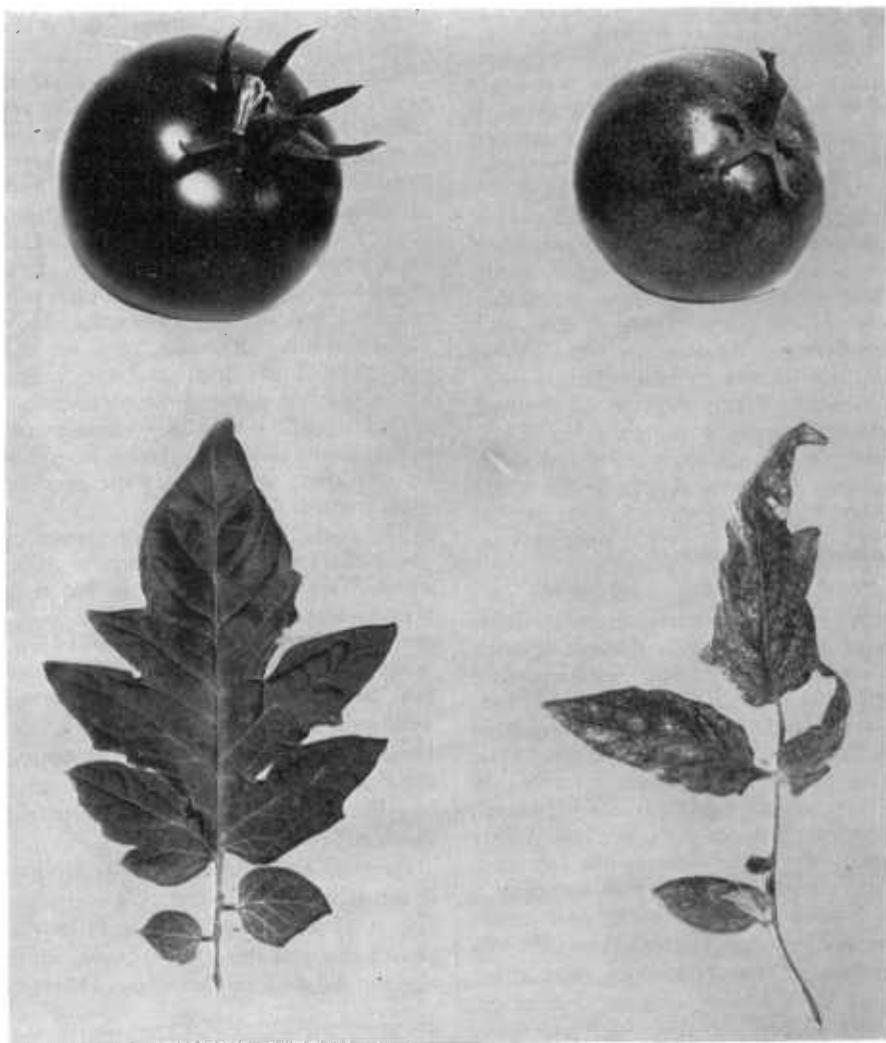
The mites feed on the undersurface of the leaf. Injured leaves have a white stippled appearance, which is due to a loss of chlorophyll. More serious injury results in a yellowed or bronzed appearance, and the leaves tend to curl and dry out. Such infested plants become covered with webs and are stunted or even killed. Usually the injury is most severe during the fruiting period, when the fruits may be reduced in size and the harvest period shortened considerably (fig. 26).

Control: A parathion aerosol is effective in controlling the two-spotted spider mite. Use it as a preventive measure in the plant house and also apply it two or more times in the growing house before harvest.



TC-7278

Figure 25.—Adult female of the two-spotted spider mite.



TC-5462A and TC-5452B

Figure 26.—Left, normal tomato fruit and leaf; right, injury caused by the two-spotted spider mite.

Control an established infestation with 2 or 3 applications at 7- to 10-day intervals. During the fruiting period when a parathion aerosol might leave an undesirable residue, apply a TEPP aerosol at 5-day intervals until the mites are controlled, but do not apply it within 3 days before harvest. A malathion aerosol may also be used at 5- to 10-day intervals on tomatoes. Do not apply it to tomatoes within 15 hours, to cucumbers within 1

day, or to leafy vegetables within 10 days before harvest.

Parathion-resistant strains of spider mites have not appeared in vegetable greenhouses as they have on greenhouse roses, chrysanthemums, and other ornamental crops. To prevent their development on vegetable crops, clean out the greenhouse and destroy all plant materials remaining after harvest, especially ornamentals. Destroy all outdoor crops or

weeds that might serve as reservoirs of mite infestations for the succeeding greenhouse crop.

For control in small greenhouses, see page 8.

White Mold Mite

The white mold mite is similar in structure and size to the tomato russet mite, but it causes an abnormally heavy growth of white hairs on the stems and leaves of tomato plants. It has been found occasionally in northern greenhouses and was doubtlessly introduced from the warmer regions of the country.

Control: A thorough cleanup of crop remnants and applications of a 25-percent sulfur dust or a parathion aerosol will control the white mold mite. Do not apply parathion to tomatoes within 10 days before harvest.

For control in small greenhouses, see page 8.

Slugs and Snails

The presence of slugs (fig. 27) and snails is revealed by their track of slime as well as their feeding injury. The foliage of lettuce and watercress is damaged at any stage of growth. The tomato fruit (fig. 28) is most likely to be injured when the plants are lowered on the supporting strings and a cluster of fruit touches the mulch. These pests hide by day in damp places beneath the rim of pots, in bench or wall cracks, benchboards, or flats beneath the bench. They tend to come out when the humidity is high. Slugs may not feed every night but may hide for several nights between feedings. For this reason a single application of bait may be ineffective.

Control: Slugs and snails enter the greenhouse through cracks in the walls and through the side ventilators that remain open. Much can be done to eliminate outdoor sources. Reduce the dampness near the greenhouse as much as possible. Keep the grass and weeds cut to reduce the hiding places of these pests. Do not leave piles of manure, soil, or compost near the greenhouse. Do not store pots, flats, pipe, or other equipment



Figure 27.—Spotted garden slug.



Figure 28.—Tomato injured by slugs.

in damp places near the greenhouse or under the benches. Sterilize the soil and potting mixtures before they are brought into the greenhouse. Where conditions favoring the existence of the slugs and snails cannot be eliminated, use baits periodically.

Effective granulated and pelleted metaldehyde baits are available commercially. Sometimes they contain 2 percent of calcium arsenate or 5 percent of chlordane. Sprinkle the bait between the plants or place about a teaspoonful in a pile at intervals of 3 or 4 feet.

A 10- to 15-percent metaldehyde dust is generally effective, but it is more costly than baits. Apply it to the soil at the rate of 1 pound per 1,000 square feet. A dust may also be spread in a band over which slugs must cross to reach their feeding area; thereby less material is required than when the entire area is treated.

The effectiveness of metaldehyde baits and dusts varies under different conditions. Metaldehyde causes temporary paralysis of slugs and snails. Under warm, dry conditions these affected in-

dividuals rapidly dehydrate and die. Under cool, moist conditions they may recover from the paralyzing effect, especially if they have eaten too little to be killed, and continue the infestation. The calcium arsenate increases the effectiveness of the bait against paralyzed slugs, particularly under unfavorable conditions. Follow a regular schedule of bait applications until the pests are eradicated.

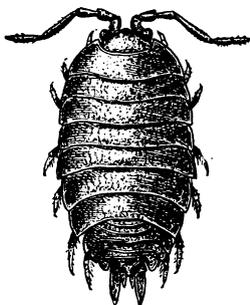
Avoid getting the bait on the foliage. Do not apply metaldehyde dusts to vegetables after the parts of the plant to be eaten or marketed appear.

Sowbugs

Two species of sowbugs are commonly found in greenhouses. They usually feed on decaying organic matter, but they may also attack seedling plants and damage the main stem of tomato plants at the soil surface.

Sowbugs (fig. 29) are about $\frac{1}{2}$ inch long and gray and have transverse overlapping plates covering their backs. When disturbed, one species rolls into a ball with the plates outside. It is sometimes called a pillbug. Sowbugs and pillbugs feed at night or on cloudy days and hide during the day in damp places under pots, boards, or trash.

Control: A 3-percent DDT dust or a parathion aerosol is effective in controlling sowbugs. Make two applications of a parathion aerosol at 10-day intervals, or use it until the pest is eradicated. Avoid excessive residues by following the precautions on page 2.



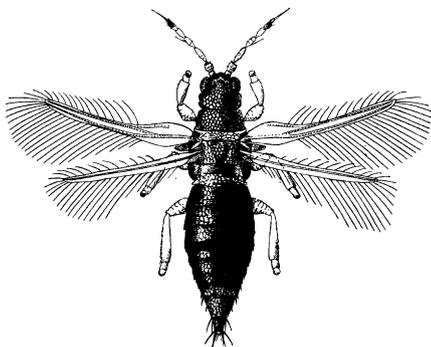
TC-3606

Figure 29.—Sowbug adult.

Thrips

Greenhouse Thrips

The adults of this species are about $\frac{1}{20}$ inch long and dark brown and have a lighter median band (fig. 30). The larvae are milky white and carry an accumulation of dark excrement on their backs. Both the adults and larvae cause a coarse stippling of the foliage. This species is usually brought into vegetable greenhouses on house plants or other ornamentals. It does not survive outdoors in the Northern States.



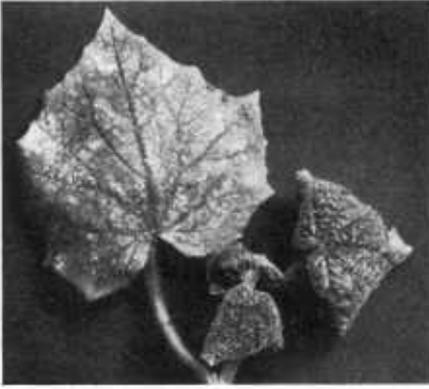
TC-3659

Figure 30.—Greenhouse thrips adult.

Onion Thrips

A common pest of greenhouse cucumbers and tomatoes is the onion thrips. The highest populations occur on cucumbers; as many as 300 larvae and adults have been collected from one plant. This insect is slender, light brown, and about $\frac{1}{25}$ inch long. The larvae are milky white when young but pale green to lemon yellow when nearly mature. Both larvae and adults feed by rasping the leaf surface and lapping up the exuding juices. White stippled areas appear on the upper leaf surface (fig. 31), and the lower surface becomes shiny. When the injury is severe, the leaves turn brown and die and the plants become dwarfed or die.

The onion thrips transmits the virus that causes spotted wilt to greenhouse tomatoes from outdoor dahlias and other infected host plants. In the fall the in-



TC-3097

Figure 31.—Feeding injury by the onion thrips on cucumber foliage.

sects move into the greenhouse bringing with them the virus, which, if uncontrolled, may infect a large percentage of the plants.

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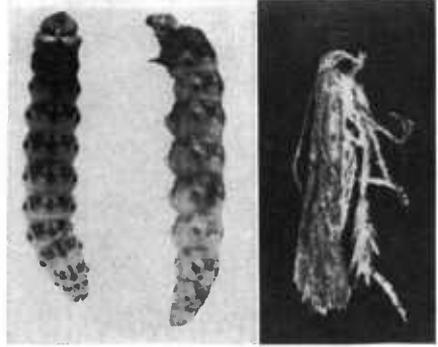
Control: A parathion, malathion, or DDT aerosol or a 3-percent DDT dust will control these two species of thrips. Make 2 or 3 applications at 10-day intervals to destroy an infestation. After onion thrips are controlled with DDT, spotted wilt stops spreading. Prevent excessive residues by following the precautions on page 2.

For control in small greenhouses, see page 8.

Tomato Pinworm

The grayish-purple larvae of the tomato pinworm (fig. 32) are about $\frac{1}{4}$ inch long. They bore into the stems, mine the leaves (fig. 33), and tunnel in the fruits near the stems (fig. 34). Pinworms originating from greenhouse infestations may persist during the summer on tomatoes, potatoes, eggplants, and horse-nettle in the field and return to the fall crop of tomatoes in the greenhouse. Although this insect does not survive outdoors in the North, occasionally it becomes established on tomatoes in northern greenhouses. It is common in California.

Control: Omitting the fall crop of greenhouse tomatoes will eliminate the



TC-3958

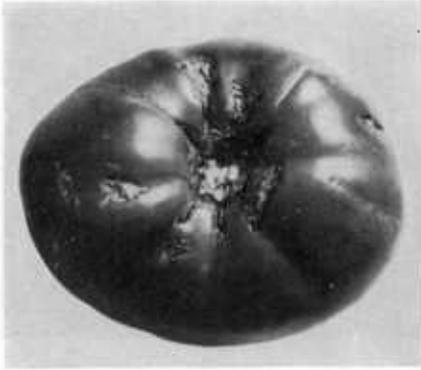
Figure 32.—Larvae and adult of the tomato pinworm.



TC-2929

Figure 33.—Leaf-mining injury by the tomato pinworm.

infestation. A parathion aerosol or a 3-percent DDT dust applied at 2-week intervals has eliminated serious infestations in northern greenhouses. Do not



TC-3953

Figure 34.—Tomato damaged by the tomato pinworm.

apply parathion to tomatoes within 10 days or DDT within 5 days before harvest.

For control in small greenhouses, see page 8.

Wireworms

Wireworms are the larvae of several species of click beetles. They are shiny, slender, and cylindrical. Their yellowish-brown hard bodies are $\frac{1}{2}$ to $1\frac{1}{4}$ inches long. Wireworms feed on the underground parts of many crops. They devour seeds in the soil, cut off small roots, and bore into larger roots and stems (fig. 35), causing severe crop losses. Wireworms may damage greenhouse vegetables when they are grown in in-

festated soil that is brought in from the field and not sterilized.

Control: Steam sterilization of soil before planting will destroy any wireworms present. If the soil is not sterilized, mix 8 ounces of 50-percent chlordane wettable powder in 50 gallons of water and apply $\frac{1}{2}$ pint in the holes when the plants are set, or apply the mixture to the entire area to be planted at the rate of 300 gallons per acre and work into the soil. Do not apply chlordane to plants after the edible parts appear.



TC-4711

Figure 35.—Left, lettuce stems and roots injured by the wireworm; right, wireworm larva.

COMMON AND SCIENTIFIC NAMES OF INSECT PESTS OF GREENHOUSE VEGETABLES

<i>Common name</i>	<i>Scientific name</i>
→ Armyworm	<i>Pseudaletia unipuncta</i> (Haw.)
→ Black cutworm	<i>Agrotis ypsilon</i> (Rott.)
→ Broad mite	<i>Hemitarsonemus latus</i> (Banks)
→ Cabbage looper	<i>Trichoplusia ni</i> (Hbn.)
→ Citrus mealybug	<i>Pseudococcus citri</i> (Risso)
→ Corn earworm	<i>Heliothis zea</i> (Boddie)
→ Dingy cutworm	<i>Feltia subgothica</i> (Haw.)
→ Foxglove aphid	<i>Myzus solani</i> (Kltb.)
× → Fungus gnat	<i>Lycoria inconstans</i> (Fitch)
→ Garden flea hopper	<i>Halticus bracteatus</i> (Say)
→ Garden symphylid	<i>Scutigera immaculata</i> (Newp.)
→ Grape mealybug	<i>Pseudococcus maritimus</i> (Ehrh.)
→ Green peach aphid	<i>Myzus persicae</i> (Sulz.)
→ Greenhouse leaf tier	<i>Udea rubigalis</i> (Guen.)
→ Greenhouse thrips	<i>Heliothrips haemorrhoidalis</i> (Bouché)
→ Greenhouse whitefly	<i>Trialeurodes vaporariorum</i> (Westw.)
→ Melon aphid	<i>Aphis gossypii</i> Glov.
→ Mushroom mite	<i>Tyrophagus lintneri</i> (Osb.)
→ Onion thrips	<i>Thrips tabaci</i> Lind.
→ Potato aphid	<i>Macrosiphum solanifolii</i> (Ashm.)
→ Potato flea beetle	<i>Epitrix cucumeris</i> (Harr.)
→ Ring-legged earwig	<i>Euborellia annulipes</i> (Lucas)
× → Sowbug or pillbug	<i>Armadillidium vulgare</i> (Latr.)
→ Spotted cucumber beetle	<i>Diabrotica undecimpunctata howardi</i> Barber
→ Spotted garden slug	<i>Limax maximus</i> L.
→ Striped cucumber beetle	<i>Acalymma vittata</i> (F.)
→ Tomato pinworm	<i>Keiferia lycopersicella</i> (Busck)
→ Tomato russet mite	<i>Vasates lycopersici</i> (Massee)
→ Two-spotted spider mite	<i>Tetranychus telarius</i> (L.)
→ Variegated cutworm	<i>Peridroma margaritosa</i> (Haw.)
→ White mold mite	<i>Eriophyes cladophthirus</i> Nalepa
× → Wireworms	<i>Melanotus</i> spp.
→ Yellow-striped armyworm	<i>Prodenia ornithogalli</i> Guen.