Controlling Insects and Mites for Commercial Greenhouse Tomato Production

EXTENSION DIVISION
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INSECTS ATTACKING GREENHOUSE TOMATOES

Insects are a perpetual pest on tomatoes, whether they be in the field, home garden or greenhouse. In addition to a host of sucking and chewing insects, a large number of other arthropods feed readily on greenhouse tomatoes. Some begin feeding as soon as the seedlings emerge from the soil, and others feed on the mature plant and its fruit.

Effective control of greenhouse pests must be maintained if maximum production of quality fruit is to be realized. Effective pest control can be achieved through the use of certain cultural and chemical practices.

Frequent inspection of plants in the greenhouse is necessary to detect insect populations before they cause severe damage. Any plant or group of plants with abnormal appearance should be examined immediately for insect pests.

Light infestations of some pests may be tolerated with no economic loss. Be sure a pesticide is needed before applying one. Spot treatment may be effective when a pest is localized in one part of the greenhouse.

Soil Associated Pests

Cutworms of several species may attack greenhouse tomatoes. About 1½ to 2 inches long when full-grown, cutworms vary in colors of gray, greenish, or yellowish and usually have darker markings. They are nocturnal, hiding in the soil during the day and feeding at night. Most cutworms feed by cutting off plant stems at or slightly below the soil level. Climbing cutworms may climb the plant and feed on the fruit.

Earwigs are elongate insects with prominent forcep-like projections on their posterior end. The are from ½ to 1¼ inch in length and are brown to black in color. When disturbed or mashed, they give off a disagreeable odor. Generally, earwigs are only a nuisance, but some species may become an economic pest of greenhouse tomatoes, feeding on tender vegetation and damaging the plants.

Springtails can occur in fantastically large numbers and still go unnoticed. They are minute, dark colored insects which commonly occur in moist soils, rich in organic matter. Seldom are springtails a major pest, but they may become one when feeding on young tomato seedlings.

Fungus gnats are small flies. Their larvae often attack greenhouse plants. The adults are very small grayish to black gnats with long legs. The larvae are nearly transparent maggots with black heads and are about ¼ inch long when full-grown. They damage plants by feeding on the roots and root hairs. Their feeding causes lack of plant vigor and yellowing of the leaves.

Sowbugs and pill bugs are not insects, but are often grouped with insects in regard to their control. These are robust and distinctly segmented arthropods with seven pairs of legs. They are light gray to slate colored and often roll up into a ball. They feed on the roots and tender parts of plants. Damage is

usually observed near the soil level. The young resemble the adults and require about 1 year to reach their full growth of about ½ inch. All sized usually can be found in an infested greenhouse.

Snails and slugs can become economic pests in greenhouses. They feed on the fruit and tender parts of the plants, and often cause severe damage to seedlings. They prefer high humidity and are usually found in damper parts of the greenhouse. Both snails and slugs leave a trail of mucus where they crawl. This mucus appears as silvery trails when it dries.

Sucking Insect Pests

Aphids are small, soft-bodied insects which insert their beaks into a plant and extract the plant juices. They can build up large populations very rapidly and can cause extensive leaf curling if not controlled. They are also capable of transmitting a number of serious diseases to greenhouse tomatoes. Aphid infestations may be detected by the presence of honeydew on plants or by the black sooty mold which grows on the honeydew.

Whiteflies are common pests of greenhouse tomatoes. The adults are small white insects about 1/16 of an inch long. The larval forms suck juices from the plants. Like aphids, whiteflies produce honeydew and infestations are often located by finding honeydew or a black sooty mold on the plants. They also may be detected by shaking the plants and watching them fly from the plant.

Mealybugs often become pests on greenhouse tomatoes. The infestation can often be traced to ornamental plants brought into the greenhouse. Infestations are recognized by the cottony masses on the stems and leaves. Mealybugs cause damage b sucking juices from the plant. Control of these insects oftentimes is difficult.

Chewing Insect Pests

Leaf miners are the larvae of small flies which feed between the upper and lower surface of leaves. They leave narrow, winding paths through the leaves and when abundant, they can reduce yields by defoliating the plants.

Thrips of several species attack greenhouse tomatoes. They are extremely small insects which feed by rasping away plant tissue and lapping up the exuding juices. Thrips are capable of transmitting spotted wilt and cause premature blossom drop. Heavily infested plants may show a silvering on the underside of the leaves.

Hornworms are large green larvae which may reach a length of 4 inches. They are foliage feeders and are capable of destroying a large quantity of foliage. In small greenhouses, they may be controlled by hand picking them from the plants.

Cabbage loopers are pale green larvae with whitish stripes running the length of the body. They move with a looping action. These pests are foliage feeders and can cause severe damage to young plants, but large numbers on older plants will seldom reduce yields.

Tomato fruitworms are about 1½ to 2 inches long when full-grown. They range in color from green to brown, and have alternating light and dark stripes running the length of the body. This larvae feeds on the fruit, eating holes in them and causing considerable damage.

Beet armyworms are indistinctly striped, green caterpillars which are about 1¼ inches long when full-grown. They are primarily foliage feeders, but feed on fruit occasionally. At times they cause severe damage in tomato greenhouses.

Yellow-striped armyworms have three lines on the back and outer bright stripe on each side. On each side, they have a median yellowish line. They are about 1½ to 1 3/4 inches long when full-grown. They feed on foliage, but rarely do they completely defoliate the plants.

Tomato pinworms are one of the most serious pests of greenhouse tomatoes. Newly hatched larvae are orange, but they gradually darken to purplish-black color as the larvae mature. The larvae have a distinctive color pattern which resembles a pair of spectacles on each segment. The full-grown larvae are about ¼ inch long.

On young tomato plants, this insect invades the leaves as leaf miners do and sometimes the stems. On large plants, injury consists mainly of leaf mining and folding of the lower leaves. In severe infestations, all leaves are attack and the plant may be prevented from setting fruit. Fruit on heavily infested plants may be stunted or deformed. The greatest economic damage results from larvae boring into the fruit. They commonly enter where two fruits or fruit and leaf come in contact with each other.

Mites

Two-spotted spider mites are closely related to spiders and are not insects. This species is one of the most serious pests of greenhouse tomatoes. They feed on and damage tomato plants by sucking juices from the underside of the leaves. Infested leaved become stippled with gray and may be covered with a fine web. Heavy populations may cause extensive defoliation. The mites are yellowish to greenish and have a dark spot on each side. Their life cycle is completed in approximately 9 days, enabling a population to build up quite rapidly.

Tomato russet mites in heavy infestation may give the fruit a russeted appearance and sometimes cause cracks to appear in the skin. The main stem of infested plants becomes brown and much of the foliage dies and assumes a papery texture. These are small slender mites which may be much longer than wide. They can complete a life cycle in about 1 week.

CULTURAL CONTROL OF GREENHOUSE PESTS

Certain cultural practices play a significant role in reducing or eliminating many insect problems in greenhouses. The following cultural practices will aid in the control of insect pests.

1. Maintain a clean, closely mowed area adjacent to the greenhouse.
2. Dispose of any trash, boards, or old plant debris in the area.
3. Keep doors, screens, and ventilation fan screens in good repair.
4. Use clean sterile soils, tools, flats, and other equipment.
5. At the conclusion of the season remove all plants and any plant debris, clean greenhouse thoroughly and fumigate (See Insecticide Use Suggestions).

"An ounce of prevention is worth a pound of cure."

CHEMICAL SAFETY IN THE GREENHOUSE

When used as recommended on their labels, pesticides are safe and effective. However, all pesticides are poisonous and, if misused, they may be hazardous to man and animals and may also contribute to the pollution of the environment.

Before using any pesticide, read the label in its entirety. Note any special precautions, such as the necessity of wearing special protective clothing when applying the chemical. Follow all safety precautions set forth in the label. The following suggestions will aid in developing safe pesticide use practices in greenhouses.

1. Become familar with the use of a pesticide before using it. Know its toxicity and the necessary precautions for its safe use.

2. Keep all safety equipment, such as face masks, respirators, and protective clothing on hand and in good working order.

3. When mixing pesticides, use well ventilated area or mix outdoors. Avoid contact with skin and do not breathe vapors.

4. Do not save used pesticide containers. Dispose of old containers properly.

5. Store all pesticides in a secure place, away from pets, children, and unknowledgeable persons. Never store pesticides in unmarked containers.

6. Post caution signs during fumigation and after treatment of greenhouse to avoid contact with chemicals.

7. Apply correct dosage of pesticide. Using less than the correct amount may result in poor control of the pest. Using more than the correct amount may result in excessive residue or damage to plants.

8. Obey specified time intervals between treatments and cut off dates before harvest. A failure to observe these restrictions may result in excessive residue or damage to plants.

9. The use of certain chemicals may be phytotoxic to some varieties of plants. This should be checked before using a chemical.

10. Special restrictions apply to greenhouses connected to living quarters. Read label restrictions where this applies and follow all restrictions carefully.

TABLE OF MEASURES

Liquid:

1 level tablespoonful = 3 level teaspoonfuls

1 fluid ounce = 2 tablespoonfuls = 29.57 milliliters

1 cupful = 8 fluid ounces

1 pint = 2 cupfuls = 16 fluid ounces

1 quart = 2 pints = 32 fluid ounces

1 gallon = 4 quarts = 128 fluid ounces

Weight:

1 ounce = 28.3 grams

1 pound = 16 ounces = 454 grams

1 ton = 2,000 lbs.

DILUTION TABLES

Wettable Powders

Number of ounces of wettable powder to use in small sprayers when amount per 100 gallons is known.

100 gals.	10 gals.	5 gals.	2 gals.	1 gal.
0.5 lb.	0.8 oz.	0.4 oz.	0.2 oz.	0.1 oz.
1 lb.	1.6 oz.	0.8 oz.	0.3 oz.	0.2 oz.
2 lb.	3.2 oz.	1.6 oz.	0.6 oz.	0.3 oz.
3 lb.	4.8 oz.	2.4 oz.	1.0 oz.	0.5 oz.
4 lb.	6.4 oz.	3.2 oz.	1.3 oz.	0.6 oz.
5 lb.	8.0 oz.	4.0 oz.	1.6 oz.	0.8 oz.

Emulsifiable Concentrates

Number of fluid ounces of emulsifiable concentrate to use in small sprayers when amount per 100 gallons is known.

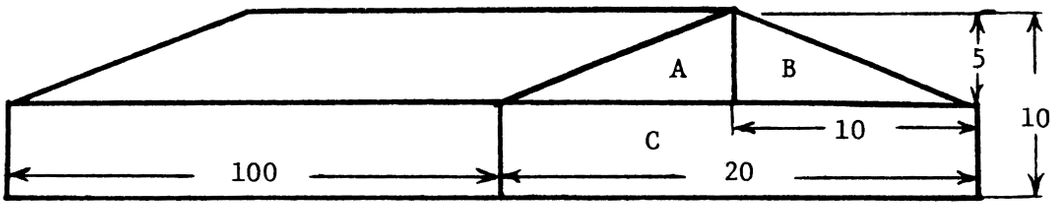
100 gals.	10 gals.	5 gals.	2 gals.	1 gal.
1 pt.	1.6 fl. oz.	0.8 fl. oz.	0.3 fl. oz.	0.2 fl. oz.
1 qt.	3.2 fl. oz.	1.6 fl. oz.	0.7 fl. oz.	0.3 fl. oz.
2 qt.	6.4 fl. oz.	3.2 fl. oz.	1.3 fl. oz.	0.6 fl. oz.
1 gal.	12.8 fl. oz.	6.4 fl. oz.	2.6 fl. oz.	1.3 fl. oz.

Mist Blower

Quantity of emulsifiable concentrate (EC) needed to make a 25X Concentrate.

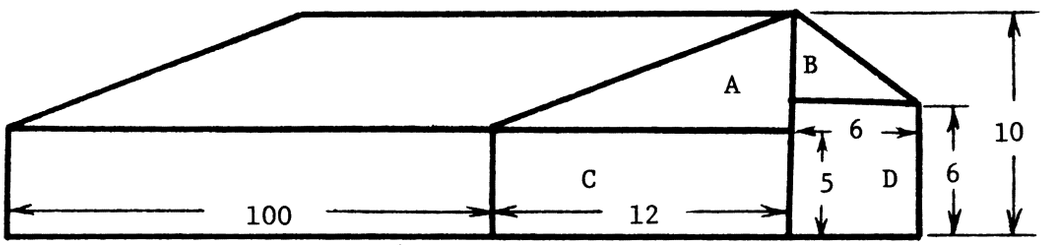
If amount per 100 gal. for a high volume spray is:	Use This Amount in a Mist Blower:			
	25 gal.	10 gal.	2 gal.	1 gal.
1 pt.	6.25 pt.	2.50 pt.	8 fl. oz.	4 fl. oz.
1 qt.	6.25 qt.	5.00 pt.	1 pt.	8 fl. oz.
2 qt.	3.13 gal.	5.00 qt.	1 qt.	1 pt.
1 gal.	6.25 gal.	2.50 gal.	2 qt.	1 qt.

CALCULATION OF GREENHOUSE VOLUME



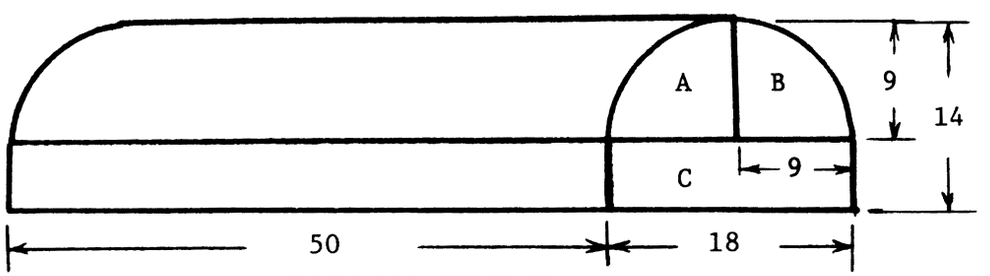
EVEN SPAN STRUCTURE

Area A and B = .5(5 x 10) = 25
Area C = 20 x 5 = 100
Total Area = A + B + C = 100 + 25 + 25 = 150
Volume = Length x Total Area = 100 x 150 = 15,000 cu. ft.



3/4 SPAN HOUSE

Area A = .5(12 x 5) = 30
Area B = .5(4 x 6) = 12
Area C = 12 x 5 = 60
Area D = 6 x 6 = 36
Total Area = A + B + C + D = 30 + 12 + 60 + 36 = 138 sq. ft.
Volume = Length x Total Area = 100 x 138 = 13,800 cu. ft.



ROUNDTOP STRUCTURE

Area A + B = $.5(\pi r^2)$ = 127
Area C = 5 x 18 = 90 sq. ft.
Total Area = A + B + C = 127 + 90 = 217
Volume = Length x Total Area = 50 x 217 = 10,850 cu. ft.

POLICY STATEMENT FOR MAKING CHEMICAL CONTROL SUGGESTIONS

Suggestions on use of pesticides made by the Virginia Agricultural Extension Service and the Virginia Agricultural Experiment Stations are based upon:

- Effectiveness under Virginia conditions
- Avoidance of residues in excess of allowable tolerances
- Avoidance of toxicity to desirable vegetation, animals and humans
- Avoidance of adverse side effects upon beneficial predators, parasites, honey bees, fish and other wildlife, plants, animals and humans

Suggested pesticides must be registered and labeled for use by the Environmental Protection Agency and the Virginia Department of Agriculture and Commerce. The status of pesticide label clearances is subject to change, and may have changed since this publication was printed. County Extension Agents and appropriate specialists are advised of changes as they occur.

The USER always is responsible for the effects of pesticide residues on his livestock and crops, as well as problems that could arise from drift or movement of the pesticide from his property to that of others. Always read and follow carefully the instructions on the container label.

For further information, contact your County Extension Agent or:

Dr. Norman E. Lau, Extension Coordinator, Chemicals, Drugs, and Pesticides, 202 Price Hall, VPI & SU, Blacksburg, Virginia 24061, (703/951-6543)

INSECTICIDE USE SUGGESTIONS

I N S E C T S C O N T R O L L E D

P E S T I C I D E S	Cutworms (Soil)	Cutworms (Climbing)	Earwigs	Springtails	Fungus gnats	Sowbugs and Pillbugs	Snails and Slugs	Aphids	Whiteflies	Mealybugs	Leaf Miners	Thrips	Hornworms	Cabbage Loopers	Tomato Fruitworm	Beet Armyworm	Yellow Striped Armyworm	Tomato Pinworm	Two-spotted Spider Mites	Tomato Russet Mite
Calcium cyanide			X						X										X	X
Dibrom (Naled)								X	X										X	X
Malathion (Aerosol) 1/		X		X	X			X	X	X	X	X		X						
Malathion (EC) 2/		X		X	X			X	X	X		X		X						
Malathion (WP) 3/		X		X	X			X				X		X						
Metaldehyde (Dust)							X													
Metaldehyde (Bait)							X													
Methyl bromide			X	X																
Nicotine sulfate								X	X	X	X	X							X	X
Parathion						X	X	X	X	X		X							X	
Phosdrin								X	X					X					X	
Thiodan (Aerosol)								X	X					X						
Vapona				X	X			X	X	X	X	X						X	X	X

1/ For best results with aerosol, apply when air temperature in greenhouse is between 70° and 80°F. Keep vents closed and fan off during treatment. Ventilate before reentering; follow label directions.

2/ WP = Wettable Powder

3/ EC = Emulsifiable Concentrate

GREENHOUSE TOMATO PESTICIDE RESTRICTIONS

PESTICIDE	FORMULATION	DOSAGE	WAITING PERIOD FROM APPLICATION TO HARVEST	RESIDUE TOLERANCE IN PPM	REMARKS
Calcium cyanide	Dust, granules, or flakes	0.5 oz./1,000 cu. ft.	6 hours	5	Apply on paper, walks, etc. Exposed to fumigation for 2 hr. in tightly closed greenhouse. Overdosage may cause foliage burn. Air for 1 hr. before entering. USE WITH GREAT CAUTION.
Calcium cyanide	Dust, granules, or flakes	4 oz.-2 lb./ 1,000 cu. ft.		5	For general cleaning of empty greenhouse. Exposure to fumigation for 24 hr. Use high dosage when mites are present. Air thoroughly before entering. USE WITH GREAT CAUTION.
Dibrom (Naled)	4 or 8 lb. EC	1.0 oz./10,000 cu. ft.	1 day	0.5	Greenhouse fumigation. Make treatment when plants are dry. Apply undiluted to cold or hot heating pipes, or place in open pans on hot plates. Applications to cold pipes should be followed immediately by heating pipes to 160°F. In steam-heated greenhouses, vents should be closed for at least one hour after pipes are hot. For hot water systems, greenhouse vents should be closed for at least three hours. Greenhouses may be left closed overnight. If application is made to hot pipes, protective equipment must be used. Ventilate greenhouse thoroughly before re-entering. For aphids, repeat as needed. For spider mites, make 3 or 4 treatments at 3- or 4-day intervals. For whiteflies, make 2 treatments 7 days apart.

GREENHOUSE TOMATO PESTICIDE RESTRICTIONS (continued)

PESTICIDE	FORMULATION	DOSAGE	WAITING PERIOD FROM APPLICATION TO HARVEST	RESIDUE TOLERANCE IN PPM	REMARKS
Malathion	10% aerosol	1 lb./50,000 cu. ft.	15 hours	8.0	
Malathion	57% EC	1 qt./100 gal. water	1 day	8.0	
Malathion	25% WP	4 lb./100 gal. water	1 day	8.0	
Metaldehyde	5.5% dust	----------	---	NF	Apply to soil around plants. Do not apply to foliage.
Metaldehyde	Bait formulation	0.5 lb. actual/ 1,000 sq. ft.	---	NF	Apply to soil around plants. Do not contaminate edible parts.
Methyl bromide	Liquid or pressurized container	3 lb. /1,000 cu. ft.	---	NF	Space fumigation for empty greenhouses. Expose for 48 hr. FOLLOW DIRECTIONS WITH EXTREME CAUTION.
Methyl bromide	Liquid or Pressurized container	11 lb./1,000 cu. ft.		NF	Empty crates or boxes for harvesting or storing fumigation. Expose for 24 hr. FOLLOW DIRECTIONS ON LABEL.
Methyl bromide	Liquid or pressurized container	3 lb./1,000 cu. ft.		20.0	Plant fumigation in greenhouse. Exposure 4 hr. Do not fumigate if temperature is above 90°F.
Parathion	10% aerosol	1.0 lb./50,000 cu. ft.	10 days	1.0	Use extreme caution when using Parathion. May impart an offtaste. For commercial greenhouse use only. Be sure foliage is dry. Adjust inside temperature 70-80°F. Keep humidity as low as possible. Never apply directly to foliage. Direct aerosol 2-3 ft. above tops of plants. Keep greenhouse closed tightly for at least 2 hr. following application. Close vents 2 hr. daily for a week following treatment.

GREENHOUSE TOMATO PESTICIDE RESTRICTIONS (continued)

PESTICIDE	FORMULATION	DOSAGE	WAITING PERIOD FROM APPLICATION TO HARVEST	RESIDUE TOLERANCE IN PPM	REMARKS
Phosdrin	10% aerosol	1.0 lb./50,000 cu. ft.	1 day	0.25	Use extreme caution when using Phosdrin. For commercial greenhouse use only. Be sure foliage is dry. Adjust inside temperature to 70-85°F. Direct aerosol 2 or 3 ft. above tops of plants. Keep greenhouse tightly closed for at least 2 hr. following treatment. Ventilate thoroughly for at least 1 hr. before entering. Repeat at weekly intervals as needed.
Thiodan	10% aerosol	1 lb./50,000 cu. ft.	15 hours	2.0	Keep greenhouse tightly closed for 2 hr. after application.
Vapona	10% aerosol	0.32 oz./1,000 cu. ft.	1 day	0.5	

KEYS TO PROPER USE OF PESTICIDES

1. **Read the label on each pesticide container before each use. Follow instructions to the letter; heed all cautions and warnings, and note precautions about residues.**
2. **Keep pesticides in the containers in which you bought them. Put them where children or animals cannot get to them, preferably under lock and away from food, feed, seed, or other material that may become harmful if contaminated.**
3. **Dispose of empty containers in the manner specified on the label.**

SEE YOUR DOCTOR IF SYMPTOMS OF ILLNESS OCCUR DURING OR AFTER USE OF PESTICIDES.