

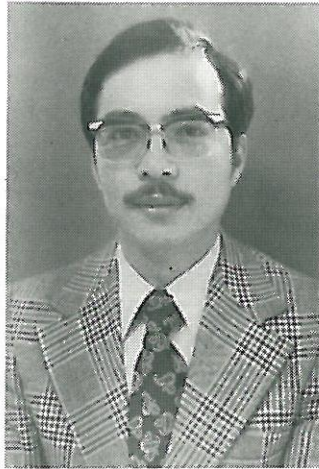
# Control of INSECTS and DISEASES on VEGETABLES



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DEPARTMENT OF AGRICULTURE AND FISHERIES

BERMUDA



#### **ABOUT THE AUTHOR**

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Dr. Wang has made many friends in Bermuda and will be greatly missed by the Staff of the Department of Agriculture and Fisheries and by the public whom he has served with such enthusiasm and skill during the past five years. The "Control of Insects and Diseases on Vegetables" is the culmination of his work in these Islands and exemplifies the thoroughness and attention to detail which Dr. Wang has applied to all of his work. This bulletin is certain to be widely used and will serve as a reminder of Dr. Wang's many contributions to Bermuda.

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### I. INTRODUCTION

All vegetables on farms and in home gardens are subject to the threat of plant diseases and insect pests. Farmers know very well what diseases and pests can do to crop yields if left unchecked and even the most careful gardener has, at some time, experienced plant damage because of diseases and pests. The key to preventing loss from plant diseases and pests is prompt and correct identification of the problem. Only at this point can proper control measures be recommended.

It is the hope of the Department of Agriculture and Fisheries that this bulletin will serve as a guide to keep local farmers and gardeners informed as to the best methods of protecting their vegetable crops from plant diseases and insect pests. Every effort has been made to list the best controls for particular diseases and pests and all control recommendations have been kept as brief as possible. It is hoped that this publication will lead to increased production of local vegetables.

## II. HOW TO USE THIS BULLETIN

No matter how little you know about plant diseases and pests it should be easily possible to find the solution to the problems of your vegetable crops in this new publication. This bulletin contains several reference sections to enable quick diagnosis of any pest or disease problem affecting vegetables.

One method of identifying the problems of diseases and pests on your vegetables is with the aid of the 150 black and white photographs, many giving close-up details of the problem, in section VII. Every common vegetable disease and insect pest is pictured in this section, many on several different hosts. An example of your own problem on at least one type of vegetable will be well illustrated, accompanied by a list of other hosts on which the problem can occur. Directions also indicate where the control measures for each particular problem are to be found in this bulletin. This method of identification will probably be of most use to the home gardener who is unfamiliar with the appearance and symptoms of plant diseases and insect pests.

If you have read sections III and IV on general descriptions of the kinds of diseases, insect pest and control measures and do not feel like leafing through the 34 pages of pictures in order to find a particular problem, an extensive host index in section X, including 31 different types of vegetables, lists all the diseases and pests by host. For each disease and pest, directions indicate where an illustration can be found and also the relevant control measures.

If the plant problem is familiar to you, the steps to control it can be quickly found in section V with recommended controls arranged alphabetically according to the host. In this section can also be found the minimum number of days one must wait after applying each pesticide before harvesting — a very useful figure for all vegetable growers.

Section V, recommending controls, has again been written for the home gardener, giving rates for pesticide application on a per gallon basis. However the bulletin can easily be used by large-scale vegetable producers as a section entitled "Mixing of Pesticides" gives the equivalent rates of application for up to 100 gallons. If you have ever been confused or just plain bewildered by the relationships between teaspoons, tablespoons, cups, fluid ounces and gallons this section will set you straight, as it gives all the necessary conversion factors.

Section IX, on pesticide safety precautions, gives general outlines on the safe handling of all pesticides, to ensure the health of both you and your plants. It should be read carefully before the application of any pesticide.

With the aid of this bulletin it should be possible for even the most novice gardener to grow and harvest prize-winning vegetables.

### III. DISEASES AND INSECT PESTS

Vegetable diseases are caused by bacteria, fungi, viruses, mycoplasmas, nematodes, or unfavourable environmental conditions.

**BACTERIA** are microscopic, single-celled organisms which depend upon green plants such as vegetables for their food. They enter the plant either through wounds or through the natural opening such as stomates and leaf scars that occur over the surface of plants. The most common diseases of vegetables caused by bacteria are **leaf spot, leaf blight, soft rot, and root rot**.

**FUNGI** are simple forms of plant life. The typical fungus body is a delicate, branched, filamentous structure known as a mycelium. Many fungi multiply by forming spores (Fig. 34) that infect the plant. Others form resting bodies known as sclerotia (Figs. 33, 61) that can endure adverse conditions in soil and cause the reinfection in the following season. Fungi affect foliar parts of the plant causing diseases known as **leaf spot, leaf blight, blossom blight, powdery mildew, rust, sclerotinia rot, stem rot, and fruit rot**. Some fungi live indefinitely in the soil and affect the crown and roots of the plant causing **damping-off** and **root rot**.

**VIRUSES** are ultramicroscopic entities, visible only through the electron microscope. A common type of virus disease on vegetables is caused by **mosaic** viruses. These viruses cause leaves to be distorted, puckered, and crinkled with variegated light and dark green areas, forming a **mosaic** pattern. Many viruses are spread by the feeding and plant-to-plant movement of certain insects. Others spread easily from diseased to healthy plants merely by contact. No chemical control of diseases caused by viruses is possible.

**MYCOPLASMAS** are a group of ultramicroscopic organisms causing yellows diseases such as **aster yellows** (Fig. 21). Insect vectors are responsible for the transmission of these diseases.

**NEMATODES** attacking vegetables are microscopic, eel-like roundworms that feed on the plant roots. The best known nematode disease on vegetables is produced by the root-knot nematode, which causes the formation of **root galls**. (Figs. 22, 61).

Diseases due to **UNFAVOURABLE ENVIRONMENTAL CONDITIONS** are sometimes called noninfectious diseases because they do not spread from one plant to another. Some of the conditions which may cause these non-parasitic injuries are too much or too little soil moisture (causing **blossom-end rot**, Fig. 54), lack or excess of nutrients (causing **mineral deficiency**, Fig. 59 or **toxicities**); temperatures above (causing **sunscauld**, Fig. 39) or below the optimum for growth of vegetable crops and injury caused by incorrect application of pesticides. Plants in poor health because of unfavourable growing conditions are most susceptible to attack by disease-causing organisms mentioned above.

Insect pests can be classified in three groups according to their feeding and living habits.

**CHEWING INSECTS** chew foliage and are usually easy to find when they injure the vegetables. Some of them can be hand picked off the plants. Many others need chemical controls. It is recommended that they be

treated in the early stage of infestation, if possible. Repeat the treatment as often as necessary. Chewing insects include **cabbage looper, cabbage worms, corn earworms, fireworms, tomato fruitworms,** and other **caterpillars**. Slugs and snails, while not insects, also chew foliage.

**SUCKING INSECTS,** sucking or rasping insects suck plant juices or scar the surface of foliage and include **aphids, leafhoppers, thrips** and **whiteflies**. Among them, aphids, leafhoppers and thrips are hard to see. By the time damage is apparent, it is often too late to do much. Always watch for scraped and rusty-looking places on foliage or twisted and deformed leaves and try to use protective sprays or dust to prevent damage by these pests. Mites, close relatives to insects, also scar plant tissue.

**UNDERGROUND INSECTS** include **cutworms** and **root maggots**. Cutworms are a most serious problem on young vegetables. They cut off the stem of young plants just at the surface of the ground. The damage they cause is great because they cut far more young plants than they are able to eat.

#### IV. GENERAL CONTROL MEASURES

There are several general practices that all vegetable growers should follow to keep losses from diseases and insect pests at a minimum.

**CROP ROTATION:** Do not grow the same vegetables in the same spot year after year. Repetition of the same crop gives disease-causing fungi and bacteria, and also insect pests, a chance to build up because most of them may multiply in the soil.

**SANITATION:** Keep your garden free of weeds since weeds often harbour disease-causing organisms and insects. Residues from diseased or insect-infested plants should be burned.

**CULTURAL PRACTICES:** Plant your vegetable in the full sun when possible. Sunlight is a great disinfectant and the energy plants draw from the sun gives them extra strength. Make sure the soil is well worked, has good drainage, and has a high content of organic matter through the inclusion of composts and manures. Space plants far enough apart to avoid crowding and to provide good air circulation. Do not work in the garden when it is wet. Rain water will promote bacterial activity and the movement of certain soil fungi and you will end up spreading these disease-causing organisms by walking through the garden.

**RESISTANT VARIETIES:** Some varieties of vegetables are resistant to certain diseases and insect pests. Plant resistant varieties whenever possible.

**SEED TREATMENT:** In order to reduce losses from seed decay, soil-borne diseases (damping-off and root rot), and soil insects in the seedbed, the seed should be given a protective treatment by dusting lightly with a combination of fungicide (Captan, Zineb, or Dexon) and insecticide (Sevin or Diazinon) in the forms of wettable powder.

**SOIL TREATMENT:** The purpose of soil treatment is to kill disease-causing organisms such as bacteria, fungi, nematodes, and insects and weed seeds in the soil. This treatment can be made either by using a soil fumigant such as Vapam or by applying pesticides as a soil drench.

**CHEMICAL TREATMENT:** Agricultural chemicals are pesticides used to control pests which include insects, fungi, bacteria, nematodes, mites, and weeds. The various pesticides are subdivided accordingly into insecticides, fungicides, bactericides, nematocides, and herbicides. They are manufactured in different formulations such as wettable powders, soluble powders, emulsifiable liquids (emulsifiable concentrates), and dusts. Plant pest and disease control depends heavily upon the use of agricultural chemicals. Therefore a brief description of each pesticide recommended in this bulletin is given below:

#### **(A) FOR THE CONTROL OF PLANT DISEASES**

1. **Captan:** widely used to control leaf spots, blights or fruit rots. Captan is also used as a seed protectant and soil disinfectant to control such common seedbed diseases as damping-off and root rot.
2. **Dithane M-45 (Fore):** very effective in the control of late blight on potatoes and tomatoes as well as some rust diseases.
3. **Dexon:** used as a seed and soil fungicide to control damping-off and root rot of many vegetables.
4. **Fixed copper:** similar in action to Bordeaux mixture of olden days, except it does not require mixing with lime. Fixed copper is easy to handle and is used as a multi-purpose fungicide. It is quite effective against a wide range of bacterial diseases on vegetables.
5. **Karathane:** specific for control of powdery mildews. Karathane has replaced sulphur in many multi-purpose sprays because sulphur cannot be mixed with other pesticides.
6. **Sulphur:** is used primarily to control plant diseases known as powdery mildews and rusts. It can also be used to control mites. Never mix sulphur in multi-purpose sprays and never apply on cucumber, cantaloupe, muskmelon, pumpkin, and squash because of possible burning effect.
7. **Vapam:** a soil fumigant. Vapam is applied to the soil 3 to 4 weeks before planting. It breaks down in soil to release a toxic gas that kills nematodes. Immediately after the application to a soil depth of 6 to 8 inches seal the soil with water. Vapam is recommended as a pre-planting treatment for root-knot nematodes on tomato and other vegetables.
8. **Zineb:** an excellent, safe fungicide for vegetables. It is being widely used for the control of a variety of plant diseases.

#### **(B) FOR THE CONTROL OF INSECT PESTS**

1. **Diazinon:** used to control aphids, leafminers, and leafhoppers. Because of its long residual effect Diazinon is also recommended to control leaf chewing insects such as fireworms and caterpillars.
2. **Dipterex:** a selective insecticide for the control of chewing insects like fireworms, cutworms, corn armyworms, hornworms, and other caterpillars. It is not too effective for the control of leaf sucking insects like aphids and spider mites.

3. **Dipel:** is not a chemical insecticide but a bacterial preparation (**Bacillus thuringiensis**) composed of live spores which cause disease in certain insects thereby controlling them. It is extremely effective for the control of cabbage loopers, cabbage worms, hornworms, and other caterpillars. Dipel must be eaten by insects to become fatal to them. Do not expect the insects to die immediately. They remain on the plant but stop eating and starve to death. Dipel remains effective for several days following application. It can be applied at any time during the growing season and has no waiting period before harvesting.
4. **Kelthane:** the most effective chemical for controlling spider mites and has a long residual action, killing upon contact.
5. **Malathion:** an excellent general purpose insecticide and has the added advantage of being relatively non-poisonous to warm blooded animals. Malathion is very effective in controlling sucking insects such as aphids, harlequin bugs, and spider mites. It is not generally recommended for the control of leaf chewing insects but because of its short period of residual effectiveness is useful in some situations close to harvest.
6. **Sevin:** a very safe insecticide, expressing contact and stomach poison action with long residual effects. Sevin is used for the control of fireworms, corn earworms, and other caterpillars.



## V. RECOMMENDED CONTROLS FOR VEGETABLE DISEASES AND INSECTS

Abbreviations used in the following Tables are:

WP = Wettable Powder

SP = Soluble Powder

EC = Emulsifiable Concentrate;

Tbs. = Tablespoon measured level;

tsp. = Teaspoon measured level;

Gal. = Gallon; 1 Tbs. = 3 tsp.

MIN. DAY = Apply chemicals no closer to harvest than number of days given.

All recommendations are based on U.S. gallons.

VEGETABLE	DISEASE OF INSECT	RECOMMENDED CONTROLS	MIN. DAY TO HARVEST	REMARKS
ARTICHOKE	Bacterial soft rot (See Fig. 11)	See under CABBAGE (Fixed copper)	— —	Treat as for CABBAGE.
	Root-knot nematode (See Fig. 60)	See under TOMATO (Soil Fumigation)	— —	Treat as for TOMATO.
	Aphids (See Fig. 14)	See under MUSTARD GREENS (Malathion or Diazinon)	— —	Treat as for MUSTARD GREENS
	Leafminers (See Fig. 5)	See under BEANS (Diazinon)	— —	Treat as for BEANS
BEANS	Damping-off (Fig. 1)	<b>After planting:</b> Captan WP, 2 Tbs./gal. or Zineb WP, 2 Tbs./gal. or Dexon WP, 2 tsp./gal.	4 days	Plant in warm (65 F. or above), dry and well-drained soil. Remove and burn infected plants. Treat every 10 days after planting.
		<b>Before planting:</b> Soil drench with Captan (2 Tbs./gal.) or Dexon (2 tsp./gal.)	4 days	
			4 days	
	Powdery mildew (Fig. 2)	Karathane WP, 2 tsp./gal. or Sulphur, Dust. or Sulphur, WP, 2-4 Tbs./gal.	5 days	Apply when mildew is first seen and repeat every 7 days as needed. Remove and burn infected leaves.
			none	
		(Sulfur may injure some varieties)	none	

Rust (Fig. 3)	Sulphur Dust or Spray as for powdery mildew (as above).	none	Treat as for powdery mildew (as above).
	or Dithane M-45 WP, 1½ Tbs./gal.	4 days	
Root-knot nematode (See Fig. 60)	See under TOMATO (Soil fumigation)	— —	Treat as for TOMATO
Aphids (See Fig. 14)	See under MUSTARD GREENS (Malathion or Diazinon)	— —	Treat as for MUSTARD GREENS
Cutworms (See Fig. 15)	See under CABBAGE (Prepare a bait with Dipterex, sugar, and bran, or foliar spray with Dipterex)	— —	Treat as for CABBAGE
Fireworms and other caterpillars (Fig. 4)	Dipterex 95% SP, 1 Tbs./gal.	10 days	Apply when they appear and repeat every 7 days as needed
	or Sevin, Dust.	3 days	
	or Sevin 80% SP, 2 Tbs./gal.	3 days	
	or Diazinon 18% EC, 2 tsp./gal.	7 days	
	or Diazinon 50% WP, 1 Tbs./gal.	7 days	
Leafminers (Fig. 5)	Diazinon 18% EC, 2 tsp./1 gal.	7 days	Treat every 10 days
	or Diazinon 50% WP, 1 Tbs./gal.	7 days	
Spider mite (Fig. 6)	Kelthane 18% EC, 1 tsp./gal.	2 days	Treat every 7 days
	or Malathion 50% EC, 2 tsp./gal.	5 days	
	or Sulphur, Dust	none	
	or Sulphur, WP 2-4 Tbs./gal.	none	
Snails and slugs (Fig. 7)	Mesuroi or Snarol	— —	Apply according to the manufacturer's directions and repeat as needed.

VEGETABLE	DISEASE OR INSECT	RECOMMENDED CONTROLS	MIN. DAY TO HARVEST	REMARKS
BEET AND SWISS CHARD	Damping-off (See Fig. 1)	See under BEANS (Captan, Zineb or Dexon)		Treat as for BEANS
	Root-knot nematode (See Fig. 22)	See under TOMATO (Soil fumigation)	--	Treat as for TOMATO
	Aphids (See Fig. 14)	See under MUSTARD GREENS (Malathion or Diazinon)	--	Treat as for MUSTARD GREENS
	Cutworms (See Fig. 15)	See under CABBAGE (Prepare a bait of Dipterex, Sugar, and Bran or foliar spray with Dipterex)	--	Treat as for CABBAGE
	Fireworms and other caterpillars (See Fig. 4)	See under BEANS (Dipterex, Sevin or Diazinon)	--	Treat as for BEANS
BROCCOLI, BRUSSELS SPROUTS, CABBAGE, CAULI-FLOWER, KALE, KOHLRABI, MUSTARD GREENS, RADISH, RUTABAGA (SWEDE OR SWEDISH TURNIP) AND TURNIP	Bacterial leaf spot (Fig. 8, 9, 10)	Fixed copper 50% WP, 2 Tbs./gal. or	none	Remove and burn infected leaves. Avoid overcrowding and overfertilizing. Plant in well-drained soil. Do not work among plants while wet.
		Diazinon 18% EC, 2 tsp./gal. (Control insects that may spread the bacteria)	7 days	

Bacterial soft rot (Fig. 11)	See under leaf spot as above foul. Store only dry heads. Avoid injuries when cultivation or harvesting.	---	Slimy, soft head and root rot with odour. Often follows other diseases and insects.
Damping-off (See Fig. 1)	See under BEANS (Captan, Zineb, or Dexon)	---	Treat as for BEANS
Sooty mould (Fig. 12)	Malathion 50% EC, 2 tsp./gal. or	5 days	Sooty mould usually grows on a sweet sticky substance known as honeydew which is secreted by aphids & whiteflies. Treat as needed.
	Diazinon 18% EC, 2 tsp./gal. (To control insects responsible for the appearance of the sooty mould)	7 days	
Viruses (Fig. 13)	Control insect vectors using Diazinon 18% EC, 2 tsp./gal. Control weeds.	7 days	There is no cure for any plant virus disease. Remove infected plants and burn.
Aphids (Fig. 14)	Malathion 50% EC, 2 tsp./gal. or	5 days	Apply when they appear and repeat every 7 days
	Diazinon 18% EC, 2 tsp./gal.	7 days	
Cutworms (Fig. 15)	Prepare a bait: Dipterex 95% SP, 1 Tbs. Sugar, 4 Tbs. and Bran, 1 lb. Mix the ingredients and add water so that the bait is moist but crumbly. Foliar spray: Dipterex 95% SP, 1 Tbs/gal.	10 days	Apply the bait to soil surface in late afternoon when plants are coming up, or when worms appear. They can also be controlled without chemicals by putting a collar of a styrofoam cup with the bottom cut out. The collar should go down about 1 1/2 inches into the soil.
Cabbage looper (Fig. 16)	See under BEANS (Fireworms and other caterpillars) or Dipel, 2 tsp./gal.	---	Treat as for BEANS Dipel is a bacterial organism <b>(Bacillus thuringiensis)</b> which cause disease in loopers or caterpillars thereby controlling them.

VEGETABLE	DISEASE OR INSECT	RECOMMENDED CONTROLS	MIN. DAY TO HARVEST	REMARKS
	Cabbage worms and other caterpillars (Fig. 17)	See Cabbage looper as above	— —	Treat as for cabbage looper as above
	Harlequin bug (Fig. 18)	Malathion 50% EC, 2 tsp./gal.	5 days	Apply when they appear and repeat every 7 days. Complete coverage of both sides of leaves is essential.
		or Sevin 80% SP, 2 Tbs./gal.	3 days	
		or Sevin, Dust	3 days	
	Leafminers (Fig. 19)	See under BEANS (Diazinon)	— —	Treat as for BEANS
	Snails and slugs (See Fig. 7, 46)	See under BEANS (Snarol or Mesurool)	— —	Treat as for BEANS
	Whiteflies (See Fig. 20)	Malathion 50% EC, 2 tsp./gal.	5 days	Treat every 10 days
		or Diazinon 18% EC, 2 tsp./gal.	7 days	
BRUSSELS SPROUTS	See under BROCCOLI			
CARROT	Aster yellows (Fig. 21)	Control the insect vector: Malathion 50% EC, 2 tsp./gal.	5 days	Leafhoppers are responsible for spreading the disease. Remove and burn infected plants. Apply when they appear and repeat every 7 days.
	Sclerotinia rot (See Fig. 33, 61)	See under TOMATO (Soil drench, seed treatment and crop rotation)	— —	Treat as for TOMATO
	Root-knot nematode (Fig. 22)	See under TOMATO (Soil fumigation)	— —	Treat as for TOMATO

	Aphids (Fig. 23)	Malathion 50% EC, 2 tsp./gal. or Diazinon 18% EC, 2 tsp./gal.	5 days  7 days	Treat every 7 days and eliminate weeds.
	Cutworms (See Fig. 15)	See under CABBAGE (Prepare a bait with DiptereX, sugar, and bran, or foliar spray with DiptereX)	---	Treat as for CABBAGE
CORN	Rust (Fig. 24)	See under BEANS (Sulphur, or Dithane M-45)	---	Treat as for BEANS
	Armyworm (Fig. 25)	DiptereX 95% SP, 1 Tbs./gal. or Diazinon 18% EC, 2 tsp./gal.	10 days  7 days	Treat every 10 days and concentrate the spray on the heart leaves.
	Earworm (Fig. 26)	Sevin, Dust. or Sevin 80% SP, 2 Tbs./gal.	3 days  3 days	Treat every 5 days.
	Cutworms (See Fig. 15)	See under CABBAGE (Prepare a bait with DiptereX, sugar, and bran, or foliar spray with DiptereX)	---	Treat as for CABBAGE
	Leafhopper (See Fig. 21)	Malathion 50% EC, 2 tsp./gal.	5 days	Treat every 10 days
	Fireworms (Fig. 27)	See under BEANS (DiptereX, Diazinon, Sevin spray, or Sevin dust)	---	Treat as for BEANS
CANTALOUPE	See under CUCUMBER			
CABBAGE	See under BROCCOLI			
CAULI-FLOWER	See under BROCCOLI			
CUCUMBER, CANTALOUPE, MUSKMELON, PUMPKIN, & SQUASH	Blossom-end rot (See Fig. 5, 6)	See under TOMATO (Maintain even soil moisture supply)	---	Treat as for TOMATO

VEGETABLE	DISEASE OR INSECT	RECOMMENDED CONTROLS	MIN. DAY TO HARVEST	REMARKS
	Powdery mildew (Fig. 28, 29)	Karathane WP, 2 tsp./gal.	5 days	Treat every 7 days.
	Viruses (Fig. 30)	Control the insect vector (Aphids) & eliminate weeds that harbour aphids. Malathion 50% EC, 2 tsp./gal. or Diazinon 18% EC, 2 tsp./gal.	5 days 7 days	Rogue infected plants and burn. There is no cure for the virus disease except to control the aphids that spread the virus disease.
	Root-knot nematode (See Fig. 22, 60)	See under TOMATO (Soil Fumigation)	---	Treat as for TOMATO
	Aphids (See Fig. 14)	See under MUSTARD GREENS (Malathion or Diazinon)	---	Treat as for MUSTARD GREENS
	Cutworms (See Fig. 15)	See under CABBAGE (Prepare a bait with Dipterex, sugar, and bran, or foliar spray with Dipterex)	---	Treat as for CABBAGE
	Fireworms and other caterpillars (Fig. 31)	See under BEANS (Dipterex, Sevin, or Diazinon)	---	Treat as for BEANS
	Leafminers (See Fig. 5)	See under BEANS (Diazinon)	---	Treat as for BEANS
	Melonworm (See Fig. 67)	See under WATERMELON (Sevin, Dipterex, or Diazinon)	---	Treat as for WATERMELON
	Spider mite (See Fig. 6)	Kelthane 18% EC, 1 tsp./gal. or Malathion 50% EC, 2 tsp./gal.	2 days 5 days	Apply when spider mites are first seen and repeat every 7 days.
EGG-PLANT	Damping-off (See Fig. 1)	See under BEANS (Captan, Zineb or Dexon)	---	Treat as for BEANS
	Leaf blight (See Fig. 42)	See under late blight of POTATO (Dithane M-45)	---	Treat as for POTATO

	Root-knot nematode (See Fig. 60)	See under TOMATO (Soil fumigation)	---	Treat as for TOMATO
	Aphid (See Fig. 14)	See under MUSTARD GREENS (Malathion or Diazinon)	---	Treat as for MUSTARD GREENS
	Cutworms (See Fig. 15)	See under BEANS (Prepare a bait with Dipterex, sugar, and bran, or foliar spray with Dipterex)	---	Treat as for BEANS
	Fireworms and other caterpillars (See Fig. 4, 27)	See under BEANS (Dipterex, Sevin or Diazinon)	---	Treat as for BEANS
	Flea beetles (See Fig. 50)	See under SWEETPOTATO (Malathion)	---	Treat as for SWEETPOTATO
	Leaf roller (See Fig. 32)	Sevin, Dust or Sevin 80% SP, 2 Tbs./gal.	3 days  3 days	Apply when they appear and repeat every 7 days as needed.
	Spider mite (See Fig. 6)	See under BEANS (Kelthane, Malathion, or Sulphur)	---	Treat as for BEANS
KALE	See under BROCCOLI			
KOHLRABI	See under BROCCOLI			
LEEK	Tip blight or blast (See Fig. 34)	See under ONION (Dithane M-45 or Zineb)	---	Treat as for ONION
	Leafminers (See Fig. 5, 35)	See under BEANS (Diazinon)	---	Treat as for BEANS
	Thrips (See Fig. 36)	See under ONION (Diazinon or Malathion)	---	Treat as for ONION
LETTUCE	Aster yellows (See Fig. 21)	See under CARROT (Rogue infected plants and control leafhoppers)	---	Treat as for CARROT



VEGETABLE	DISEASE OR INSECT	RECOMMENDED CONTROLS	MIN. DAY TO HARVEST	REMARKS
	Bacterial soft rot (See Fig. 11)	See under CABBAGE (Fixed copper)	---	Treat as for CABBAGE
	Damping-off (See Fig. 1)	See under BEANS (Captan, Zineb or Dexon)	---	Treat as for BEANS
	Root-knot nematode (See Fig. 60)	See under TOMATO (Soil fumigation)	---	Treat as for TOMATO
	Sclerotinia rot or Lettuce drop (Fig. 33)	See under TOMATO (Soil drench, seed treatment, and crop rotation)	---	Treat as for TOMATO
	Cutworms (See Fig. 15)	See under CABBAGE (Prepare a bait with Dipterex, sugar, and bran, or foliar spray with Dipterex)	---	Treat as for CABBAGE
	Caterpillars (See Fig. 31)	See under BEANS (Dipterex, Sevin or Diazinon)	---	Treat as for BEANS
	Snails and slugs (See Fig. 7, 46)	See under BEANS (Snarol or MesuroI)	---	Treat as for BEANS
MUSKMELON	See under CUCUMBER			
MUSTARD GREENS	See under BROCCOLI			
ONION	Tip blight or blast (See Fig. 34)	Zineb, WP, 2 Tbs./gal. or Dithane M-45 WP, 1½ Tbs./gal.	4 days  4 days	Apply when they appear and repeat every 7 days. Add a spreader-sticker, (or use liquid detergent for dishes ½ tsp./gal) to the spray.
	Pink root	See under damping-off of BEANS (Soil drench, seed treatment, and foliar spray)	---	Treat as for BEANS. Affected roots turn pink, shrivel, and die. Infected plants produce mere scallions or small bulbs.

	Leafminers (Fig. 35)	See under BEANS (Diazinon)	---	Treat as for BEANS. Add a spreader-sticker to the spray as for onion tip blight.
	Thrips (Fig. 36)	Diazinon 18% EC, 2 tsp./gal. or Malathion 50% EC, 2 tsp./gal.	7 days 5 days	Treat every 10 days. Add a spreader-sticker to the spray.
PEPPER	Blossom-end rot (See Fig. 54)	See under TOMATO (Maintain even soil moisture supply)	---	Treat as for TOMATO
	Damping-off (See Fig. 1)	See under BEANS (Soil drench, seed treatment, and foliar spray)	---	Treat as for BEANS
	Bacterial leaf spot (See Fig. 38)	See under leaf spot of TOMATO (Seed treatment and cultural practices)	---	Treat as for TOMATO
	Fruit rot (Fig. 37)	Dithane M-45 WP, 1½ Tbs./gal. or Zineb WP, 2 Tbs./gal.	4 days 4 days	Destroy the rotting fruit. Keep fruit off soil by staking or mulching. Treat every 10 days and add a spreader-sticker to the spray.
	Sunscald (Fig. 39)	Water and fertilize to keep plants vigorous)		Pepper are susceptible to sunscald which cause a paper-white to yellowish white, slightly sunken area.
	Viruses (Fig. 40)	See under TOMATO (Control vector insects)	---	Treat as for TOMATO
	Root-knot nematode (See Fig. 60)	See under TOMATO (Soil fumigation)	---	Treat as for TOMATO
	Aphids (See Fig. 14, 43)	See under MUSTARD GREENS (Malathion or Diazinon)	---	Treat as for MUSTARD GREENS
	Cutworms (See Fig. 15)	See under CABBAGE (Prepare a bait with Dipterex, sugar, and bran, or foliar spray with Dipterex)	---	Treat as for CABBAGE
Leafminers (See Fig. 5)	See under BEANS (Diazinon)	---	Treat as for BEANS	

VEGETABLE	DISEASE OR INSECT	RECOMMENDED CONTROLS	MIN. DAY TO HARVEST	REMARKS
	Fireworms and other caterpillars (See Fig. 31)	See under BEANS (Dipterex, Sevin or Diazinon)	---	Treat as for BEANS
POTATO	Bacterial soft rot (See Fig. 52)	Avoid injuring the tubers, when they are immature. Do not store infected tubers.	---	Harvest in dry weather and store only mature sound, dry, clean, blemish-free tubers in clean, dark, cool and well-ventilated area.
	Bacterial ring rot (See Fig. 41)	Plant certified seed. Disinfect the cutting knife with Clorox, 1 part to 4 parts of water for 15 minutes.	---	The disease is spread mainly by the knife used for cutting seed pieces.
	Late blight (See Fig. 42)	Dithane M-45, WP, 1½ Tbs./gal.	4 days	Apply when the blight appears and repeat every 7 days
	Early blight (See Fig. 56)	See under late blight of POTATO as above.	---	Treat as for late blight as above.
	Root-knot nematode (See Fig. 22)	See under TOMATO (Soil fumigation)	---	Treat as for TOMATO
	Viruses (See Fig. 40, 55)	See under TOMATO (Control vector insects)	---	Treat as for TOMATO
	Aphids (Fig. 43)	Diazinon 18% EC, 2 tsp./gal. The Aphid is also called the pink & green Aphid because of its two colour phases.	7 days	Treat every 10 days.
	Fireworms and other caterpillars (See Fig. 4, 31)	See under BEANS (Dipterex, Sevin or Diazinon)	---	Treat as for BEANS
	Leafhopper (See Fig. 21)	See under CORN (Malathion)	---	Treat as for CORN
	Leafminers (Fig. 44)	See under Bean (Diazinon)	---	Treat as for BEANS

	Potato tuberworm (Fig. 45)	Infestation in growing potatoes: Diazinon 18% EC, 2 tsp./gal. or Sevin 80% SP, 2 Tbs./gal. or Sevin, Dust.	7 days  3 days	Digged potatoes should not be left overnight in the field. They should be stored in moth-free places.
	Snails and slugs (See Fig. 46)	See under BEANS (Snarol or MesuroI)	— —	Treat as for BEANS
PUMPKIN	See under CUCUMBER			
RADISH	See under BROCCOLI			
RUTABAGA (SWEDE OR SWEDISH TURNIP)	See under BROCCOLI			
STRAW- BERRY	Leaf blight (Fig. 47)	Dithane M-45 WP, 1½ Tbs./gal. or Zineb WP, 2 Tbs./gal.	4 days  4 days	Treat every 10 days when first leaves are unfolding.
	Leaf spot (Fig. 48)	See under leaf blight as above	— —	Treat as for leaf blight as above
	Blossom blight	Zineb, WP, 2 Tbs./gal.	4 days	Apply when the blight is first seen and repeat every 7 days.
	Spider mite (See Fig. 6)	See under BEANS (Kelthane, Malathion, or Sulphur)	— —	Treat as for BEANS
	Sowbug (Pillbug) and Millipede (Fig. 49)	Malathion 50% EC, 2 tsp./gal.	5 days	Treat every 10 days after fruits are set. They are usually abundant in moist soils high in organic matter.
SQUASH	See under CUCUMBER			
SWISS CHARD	See under BEET			

VEGETABLE	DISEASE OR INSECT	RECOMMENDED CONTROLS	MIN. DAY TO HARVEST	REMARKS
SWEET-POTATO	Root-knot nematode (See Fig. 22, 60)	See under TOMATO (Soil fumigation)	—	Treat as for TOMATO
	Caterpillars (See Fig. 4, 31)	See under BEANS (Dipterex, Sevin or Diazinon)	—	Treat as for BEANS
	Flea beetles (Fig. 50)	Malathion 50% EC, 2 tsp./gal.	5 days	Apply when the injury is first seen and repeat every 10 days.
	Leafminers (See Fig. 5)	See under BEANS (Diazinon)	—	Treat as for BEANS
	Spider mite (Fig. 51)	See under BEANS (Kelthane, Malathion, or Sulphur)	—	Treat as for BEANS
TOMATO	Bacterial soft rot (Fig. 52)	Fixed copper, 50% WP, 2 Tbs./gal. and	none	Do not work among plants while wet. Handle fruit carefully. Refrigerate promptly after harvest. The bacteria gain entrance to the fruit through the stem scar after picking, insect punctures, growth cracks, and wounds.
		Diazinon 18% EC, 2 tsp./gal. Control insects that spread bacteria in the field.	7 days	
	Bacterial spot (Fig. 53)	Dust seeds with Captan or Zineb before planting. Avoid overhead irrigation. Cultivate and handle plants only when they are dry.	—	The disease can be seed transmitted. The bacterial spot is prevalent when the weather is rainy.
	Blossom-end rot (Fig. 54)	Spray foliage with Calcium Chloride Solution, 2 Tsp./gal. Avoid excess nitrogen fertilization.	—	Secondary microorganisms always gain entrance through the blossom end and cause fruit rot.
Damping-off (See Fig. 1)	See under BEANS (Soil drench, seed treatment, and foliar spray)	—	Treat as for BEANS	

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## VII. DISEASES AND INSECT PESTS

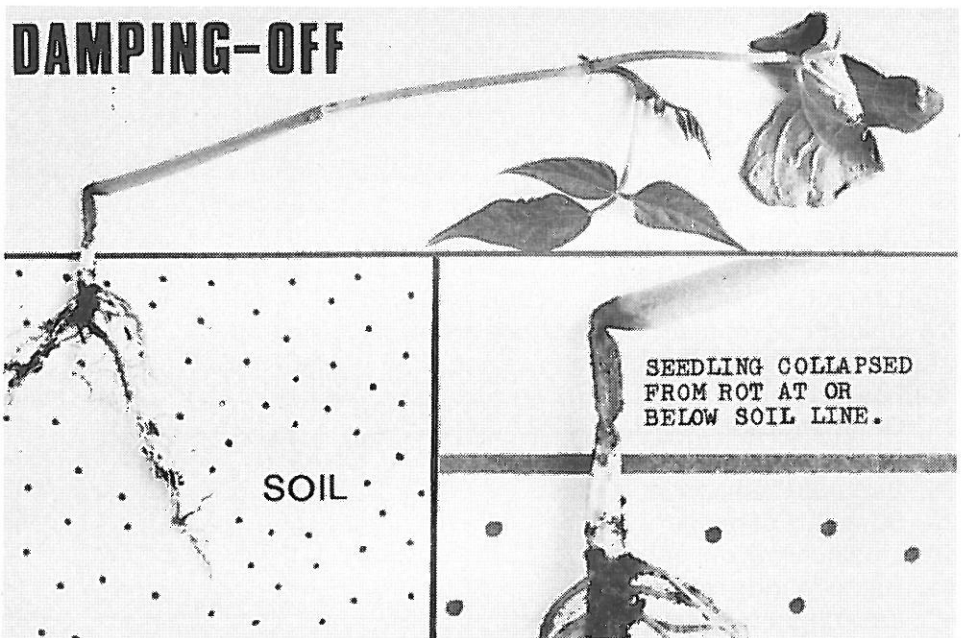


Fig. 1. Damping-off of bean.

**Other host:** Beet, broccoli, brussels sprouts, cabbage, cauliflower, cantaloupe, cucumber, egg-plant, kale, kohlrabi, lettuce, mustard greens, muskmelon, pepper, pumpkin, radish, rutabaga, squash, swiss chard, tomato, turnip, and watermelon.

**Recommended controls:** See page 8.

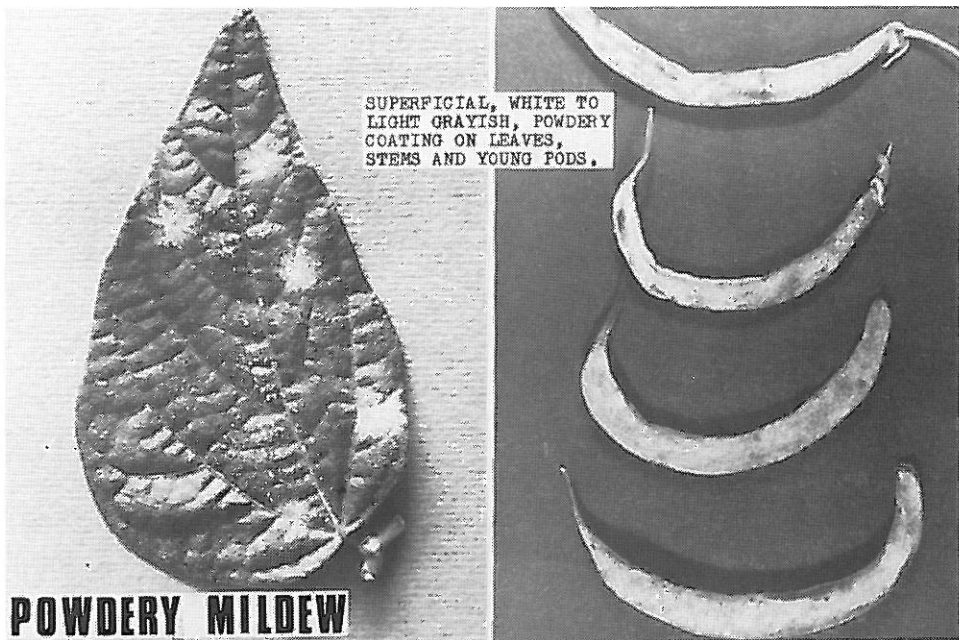


Fig. 2. Powdery mildew of bean.

**Other hosts:** Cantaloupe, cucumber, muskmelon, pumpkin, squash, and watermelon.

**Recommended controls:** See page 8.

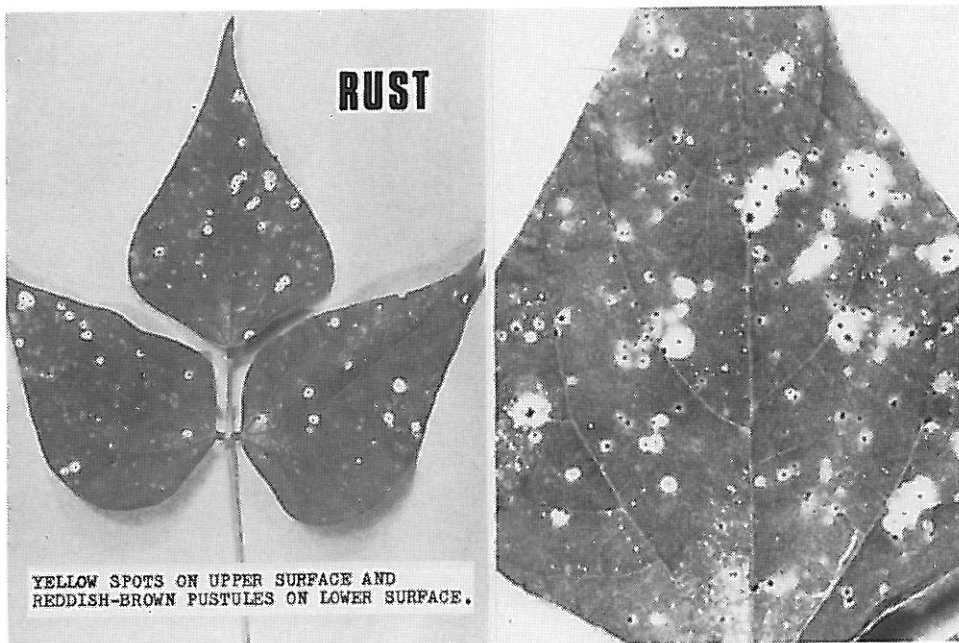


Fig. 3. Rust of bean.

**Other host:** Corn.

**Recommended controls:** See page 9.



## FIREWORM

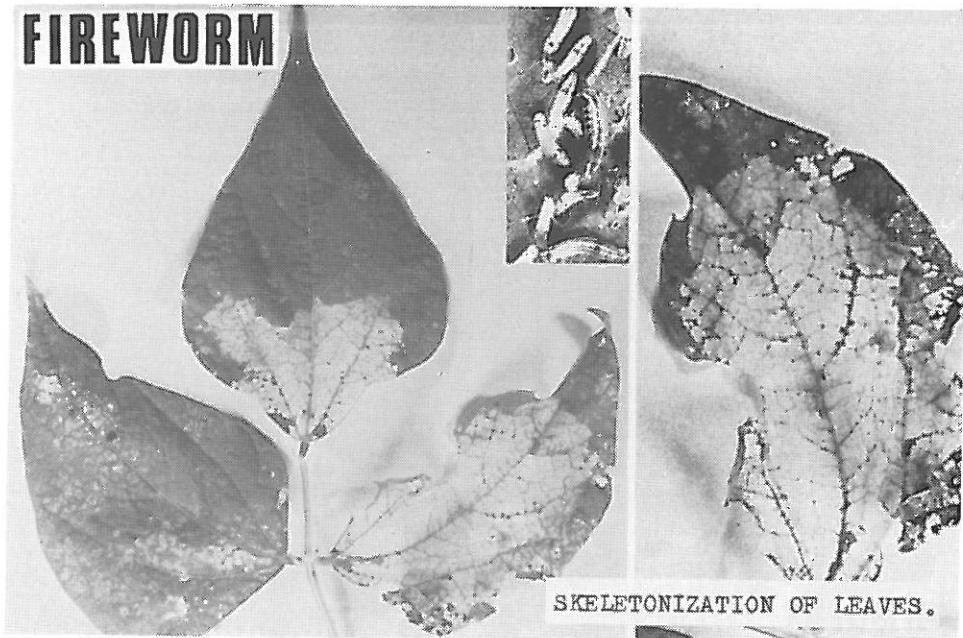


Fig. 4. Fireworm on bean.

**Other hosts:** Artichoke, beet, cantaloupe, corn, cucumber, egg-plant, lettuce, muskmelon, pepper, potato, pumpkin, squash, sweetpotato, Swiss chard, tomato, and watermelon.  
**Recommended controls:** See page 9.

## LEAFMINER

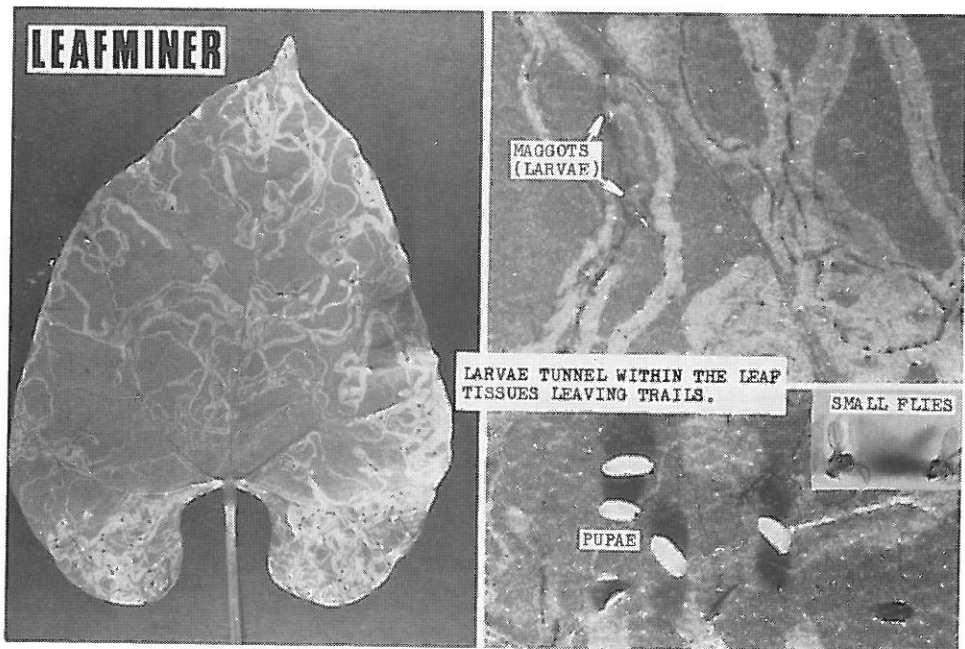
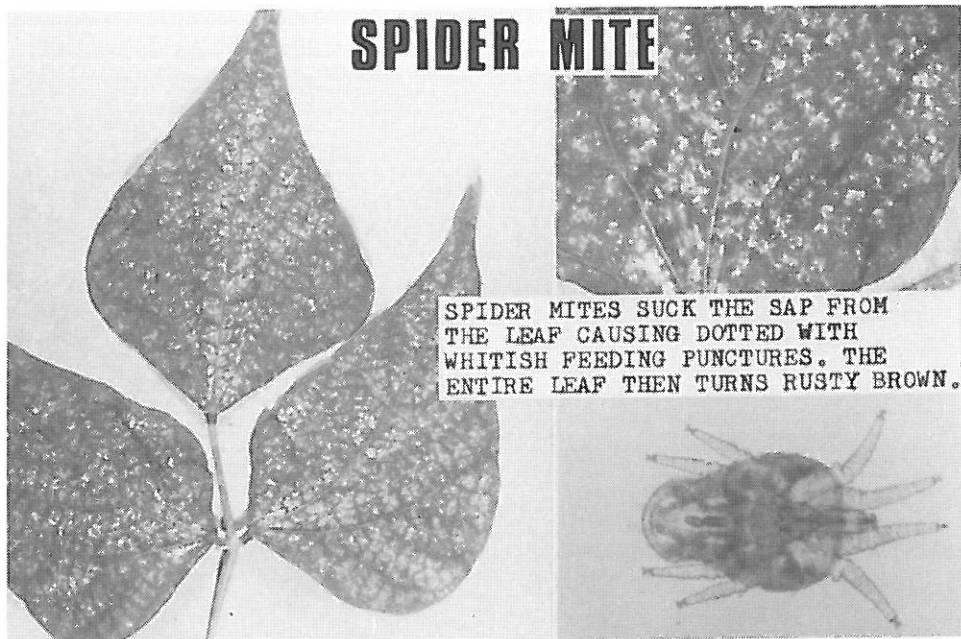


Fig. 5. Leafminer on bean.

**Other hosts:** Artichoke, broccoli, Brussels sprouts, cabbage, cauliflower, cantaloupe, cucumber, egg-plant, kale, kohlrabi, leek, mustard greens, muskmelon, onion, pepper, potato, pumpkin, radish, rutabaga, squash, sweetpotato, tomato, turnip, and watermelon.  
**Recommended controls:** See page 9.



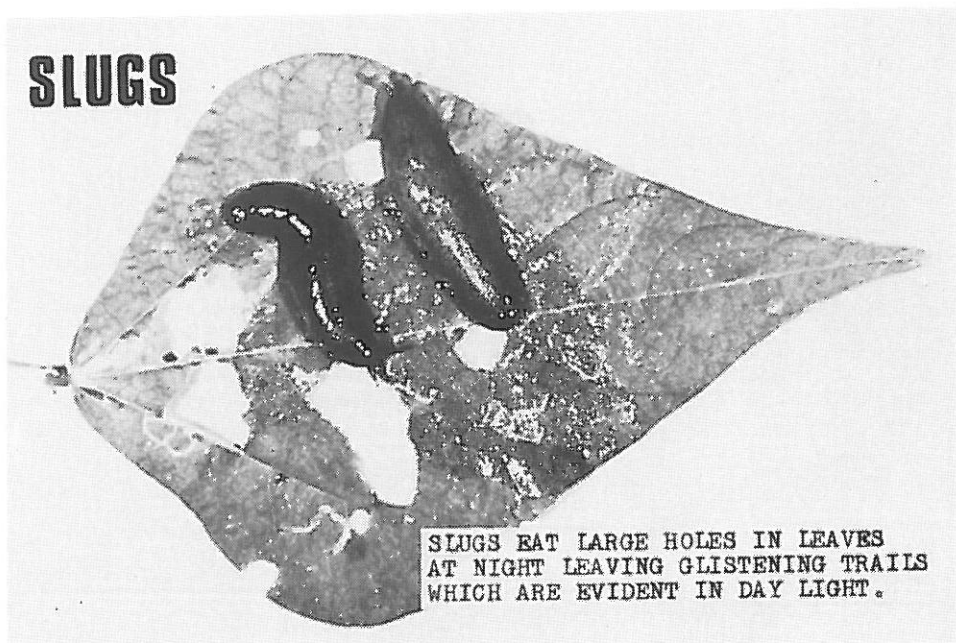
## SPIDER MITE

SPIDER MITES SUCK THE SAP FROM THE LEAF CAUSING DOTTED WITH WHITISH FEEDING PUNCTURES. THE ENTIRE LEAF THEN TURNS RUSTY BROWN.

Fig. 6. Spider mite on bean.

**Other hosts:** Cantaloupe, cucumber, egg-plant, muskmelon, pumpkin, squash, strawberry, and sweetpotato.

**Recommended controls:** See page 9.



## SLUGS

SLUGS EAT LARGE HOLES IN LEAVES AT NIGHT LEAVING GLISTENING TRAILS WHICH ARE EVIDENT IN DAY LIGHT.

Fig. 7. Slugs on bean.

**Other hosts:** Broccoli, Brussels sprouts, cabbage, cauliflower, kale, kohlrabi, lettuce, mustard greens, potato, radish, rutabaga, tomato, turnip, and other vegetables.

**Recommended controls:** See page 9.



Fig. 8. Bacterial leaf spot of cabbage.

**Other hosts:** Broccoli, Brussels sprouts, cauliflower, kale, kohlrabi, mustard greens, radish, rutabaga and turnip.

**Recommended controls:** See page 10.

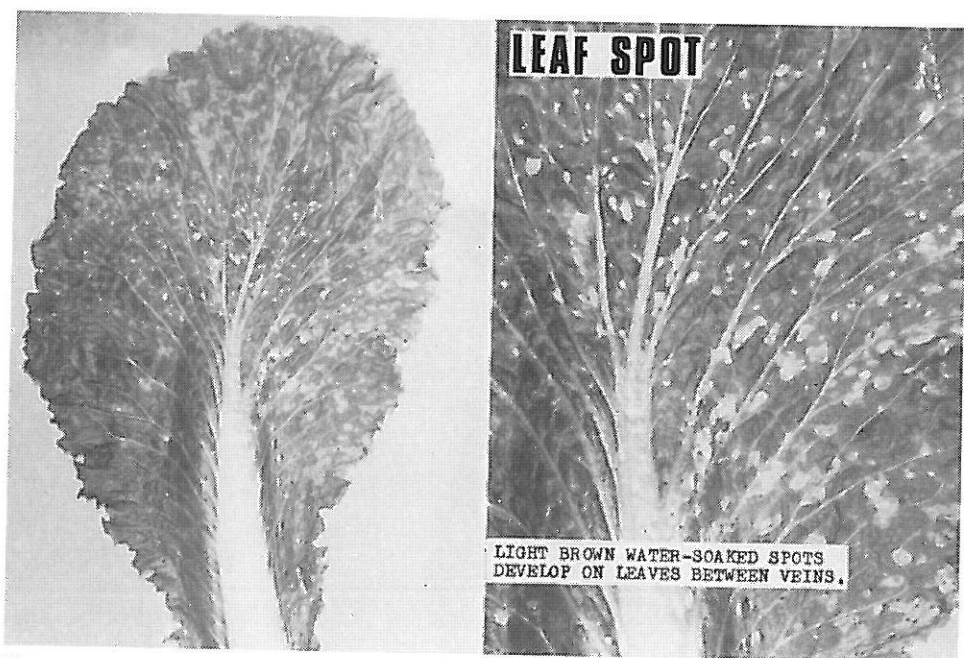


Fig. 9. Bacterial leaf spot of mustard greens.

**Other hosts:** Broccoli, Brussels sprouts, cabbage, cauliflower, kale, kohlrabi, radish, rutabaga, and turnip.

**Recommended controls:** See page 10.

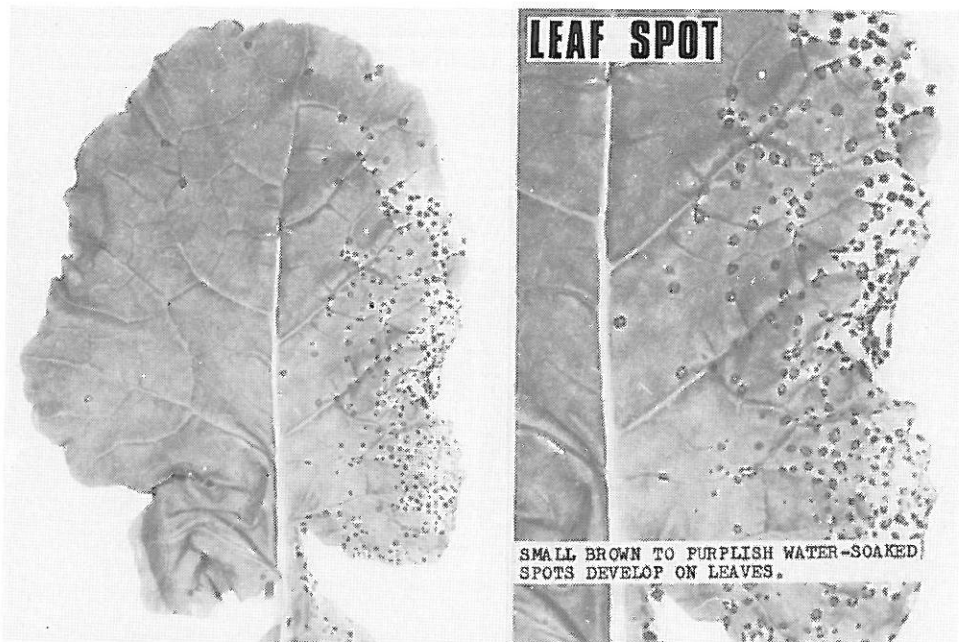


Fig. 10. Bacterial leaf spot of rutabaga (Swede or Swedish turnip).  
**Other hosts:** Broccoli, brussels sprouts, cabbage, cauliflower, kale, kohlrabi, mustard greens, radish, and turnip.  
**Recommended controls:** See page 10.

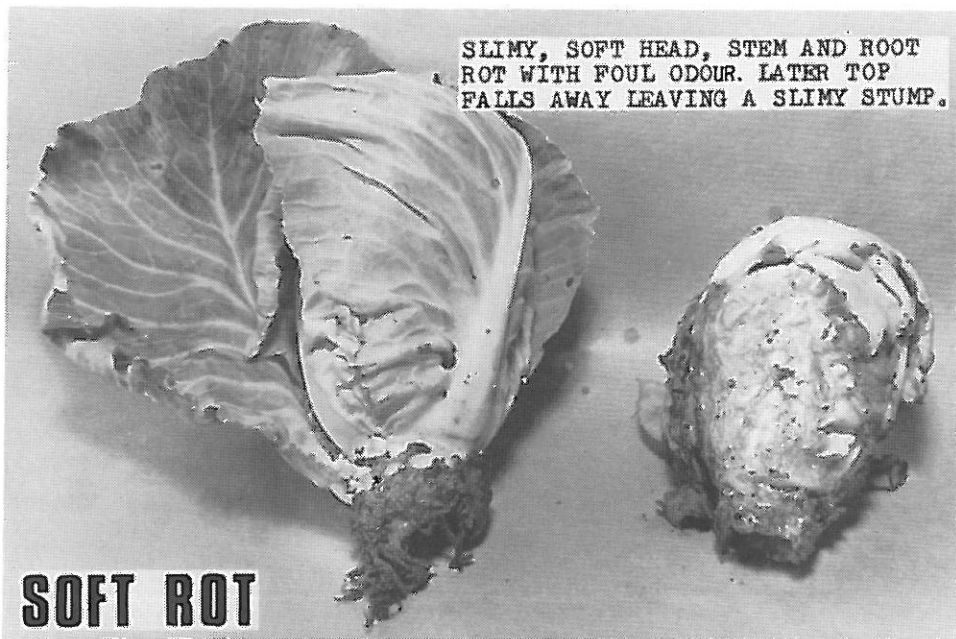


Fig. 11. Bacterial soft rot of cabbage.  
**Other hosts:** Broccoli, brussels sprouts, cauliflower, kale, kohlrabi, lettuce, mustard greens, potato, radish, rutabaga, tomato, and turnip.  
**Recommended controls:** See page 10.

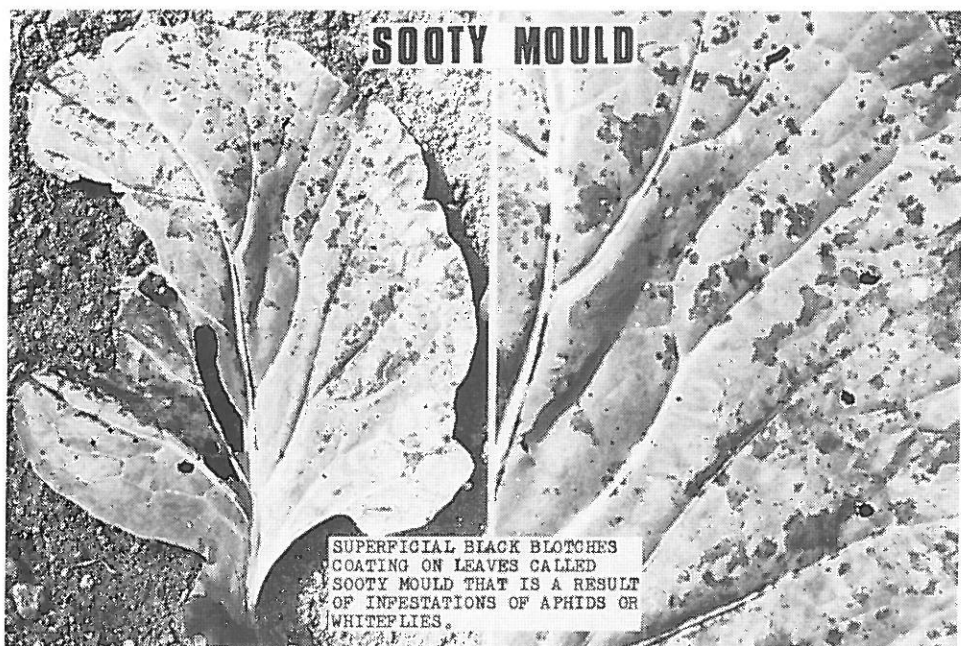


Fig. 12. Sooty mould of cauliflower.

**Other hosts:** Broccoli, brussels sprouts, cabbage, kale, kohlrabi, mustard greens, radish, rutabaga, and turnip.

**Recommended controls:** See page 11.

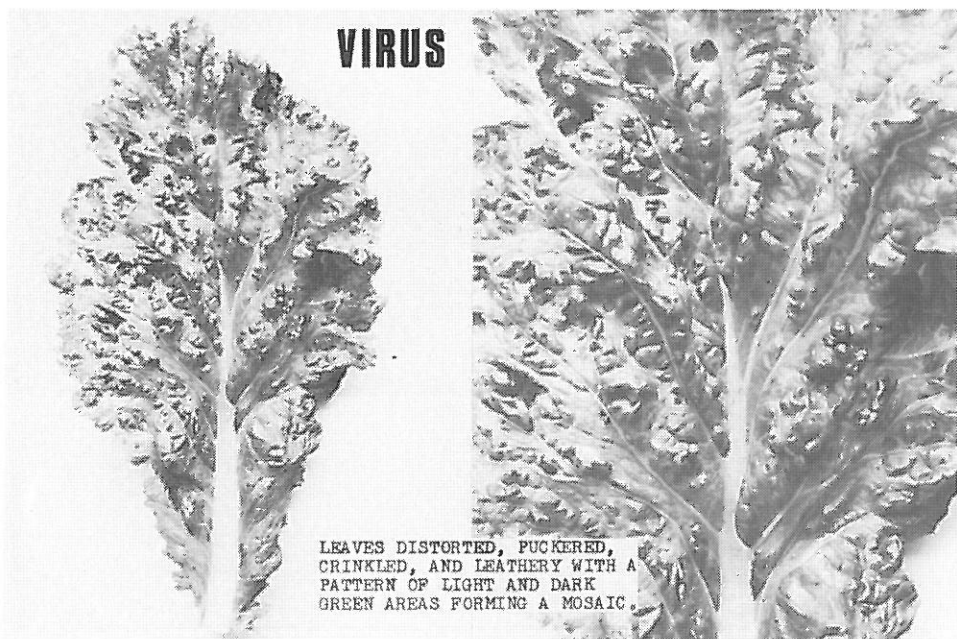
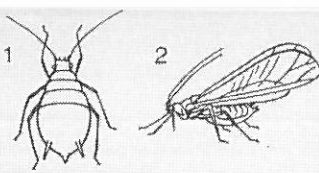


Fig. 13. Mosaic virus of mustard greens.

**Other hosts:** Broccoli, brussels sprouts, cabbage, cauliflower, kale, kohlrabi, radish, rutabaga, and turnip.

**Recommended controls:** See page 11.

## APHID



WINGLESS (1) & WINGED (2) APHIDS



ADULT APHIDS MAY BE WINGED OR WINGLESS. THEY ARE GREEN IN COLOUR. INFESTATIONS PRODUCE YELLOWING OR BROWNING OF LEAVES.

Fig. 14. Aphid on mustard greens.

**Other hosts:** Artichoke, beans, beet, broccoli, brussels sprouts, cabbage, cantaloupe, carrot, cauliflower, cucumber, egg-plant, kale, kohlrabi, mustard greens, muskmelon, pepper, potato, pumpkin, radish, rutabaga, squash, swiss chard, tomato, turnip, and watermelon.

**Recommended controls:** See page 11.

## CUTWORM



CUTWORMS ARE NIGHT FEEDERS WHICH HAVE THE HABIT OF CUTTING OF THE STEM OF YOUNG PLANTS JUST AT THE SURFACE OF THE GROUND.

Fig. 15. Cutworm on cabbage.

**Other hosts:** Beans, beet, broccoli, brussels sprouts, cantaloupe, cauliflower, carrot, corn, cucumber, egg-plant, kale, kohlrabi, lettuce, mustard greens, muskmelon, onion, pumpkin, pepper, radish, rutabaga, squash, swiss chard, tomato, and turnip.

**Recommended controls:** See page 11.

## CABBAGE LOOPER

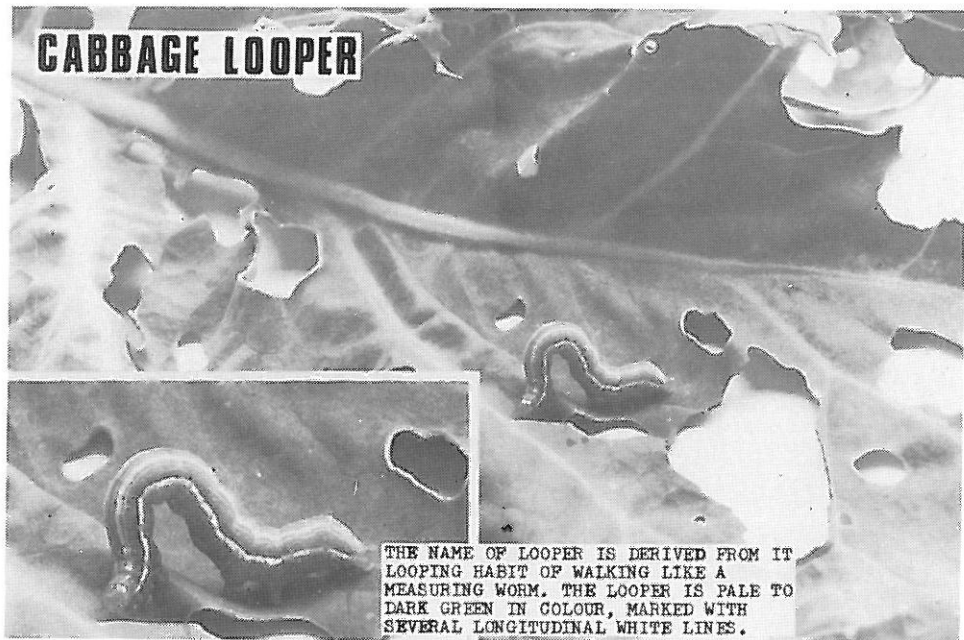


Fig. 16. Cabbage looper on broccoli.

**Other hosts:** Brussels sprouts, cabbage, cauliflower, kale, kohlrabi, mustard greens, radish, rutabaga, and turnip.

**Recommended controls:** See page 11.

## CABBAGE WORMS



SEVERAL SPECIES OF CATERpillARS, GENERALLY GREEN BROWN OR BLACK IN COLOUR, WHICH EAT THE LEAVES OF CABBAGE AND OTHER CRUCIFERS.



Fig. 17. Cabbage worm on cabbage.

**Other hosts:** Broccoli, brussels sprouts, cauliflower, kale, kohlrabi, mustard greens, radish, rutabaga, and turnip.

**Recommended controls:** See page 12.



Fig. 18. Harlequin bug on broccoli.

**Other hosts:** Brussels sprouts, cabbage, cauliflower, kale, kohlrabi, mustard greens, radish, rutabaga, and turnip.

**Recommended controls:** See page 12.



Fig. 19. Leafminer on cabbage.

**Other hosts:** Artichoke, beans, broccoli, brussels sprouts, cauliflower, cantaloupe, cucumber, egg-plant, kale, kohlrabi, leek, mustard greens, muskmelon, onion, pepper, potato, pumpkin, radish, rutabaga, squash, sweetpotato, tomato, turnip, and watermelon.

**Recommended controls:** See page 12.