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Protecting Soybeans and Dry Beans from Insects and Nematodes

Michigan State University

Cooperative Extension Service

Farm Science Series

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April 1979

12 pages

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Protecting Soybeans & Dry Beans From Insects & Nematodes

By Robert F. Ruppel, Thomas A. Dudek, and George W. Bird, Department of Entomology

Insects and nematodes have historically been a relatively minor problem in both dry bean and soybean production in Michigan. But a number of these pests can damage beans, and a few fields are damaged by one or more of them each year. Several species of pests may also appear in large numbers (outbreak) during some years. These pests are, thus, a constant threat to beans, even though they do not consistently cause great losses.

Pest control means the protection of both yield and quality. Control measures are necessary *before* the damage is done. You must:

- anticipate the appearance of the pests,
- detect the pests in time to prevent damage,
- make a decision if and when a control measure is needed,
- and be prepared to effect the control when it is needed.

This bulletin gives some suggestions on how to establish a sound pest control program in beans. Some effort is required to put this program into practice. This will be repaid by the savings from elimination of unneeded applications of pesticides and the protection of the yield of the crop.

Management and Pests

Most of our pests of beans also feed on other plants and may be pests of other crops. Bean insects are active in at least one of their stages and can move easily from

field-to-field. Their increase is, therefore, not dependent strictly on beans and we have no reliable management methods (or cultural controls) for these insects. On the other hand, poor management that results in wet, weedy, or trashy fields can intensify insect problems. Good management is as essential to insect control as it is to any other part of sound bean production.

Good general management of the field reduces the threat of insect damage. Good drainage, land fitting, and weed control can reduce cutworms, slugs, and two-spotted spider mites by reducing the trash, weeds, and wet places that harbor these pests. Vigorous seed, proper planting, and adequate fertilization that assure rapid germination and early growth help reduce damage from seedcorn maggot and wireworms. And always, sound management practices produce vigorous plants better able to withstand some feeding by insects without appreciable loss of yield.

Crop rotation and type of soil strongly influence the threat of soil insects. White grubs, wireworms, cutworms, slugs and seedcorn maggots are especially common following sod, old pasture, or weeds. Planting beans behind a well cultivated crop reduces insect damage. Check plow furrows for white grubs and wireworms when fitting old pastures. Apply a pest control if needed, before planting beans. Eliminate trash or weeds in such fields and check the field frequently for slugs and cutworms. Seedcorn maggot is attracted to soils containing high organic matter, including plowed-down weeds. Expect the maggot in such fields and treat the seed with an insecticide for its control.

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Some insect problems can be anticipated by checking the fields surrounding the bean fields. Both tarnished plant bug and potato leafhopper increase in alfalfa. The adults of these pests swarm from the alfalfa when it is cut and can appear suddenly in adjacent bean fields. The Mexican bean beetle adult overwinters in woodlots and fence rows. The beetle is, therefore, especially numerous in bean fields adjacent to these overwintering areas. Plant beans away from alfalfa, woodlots, and fence rows when possible. Check fields closely for the insects if they are near these areas.

Good management can reduce the damage from insects in the field. Attention to all details of bean production is needed to produce and protect high yields of quality beans. The insect suppression that comes from these good practices is a bonus for a good job.

Plant-parasitic nematodes are small, round worms that live in the soil and roots. They feed on living root tissue and reduce crop yields by altering the physiology of the bean plants, and prevent the proper uptake and use of water and nutrients. Plant-parasitic nematodes cannot be seen with the naked eye. Laboratory analysis of soil and roots is necessary to confirm that symptoms such as reduced yield, stunting, uneven stands, wilting or yellowing are caused by nematodes. Michigan State University operates a nematode diagnostic service laboratory. Samples may be submitted through the County Extension offices. The procedure is outlined in MSU Extension Bulletin E-800, "Nematode Detection." Additional basic information about plant-parasitic nematodes is available in MSU Extension Bulletin E-701, "The Hidden Enemy: Nematodes and their Control."

High population densities of root-lesion and stunt nematodes have caused significant yield reduction in Michigan soybean production. Control recommendations for these nematodes in soybean production are covered in this bulletin. These nematodes can also be a problem in Michigan dry bean production but no chemicals are currently registered for this use. Michigan growers with suspected or confirmed nematode problems in dry beans should contact their county Michigan County Extension Service for specific recommendations.

Checking for Insects, Nematodes

Insects

A real problem with the sporadic appearance of the insects in bean fields is that we do not expect them and, too frequently, the insects catch us by surprise. The time of appearance of some of our bean pests can be pre-

dicted with some accuracy. Notices on when to expect them are sent to County Agricultural Extension Agents and the agents can alert growers to the pests. We cannot predict as yet the size of the population of any pest nor (with most species) what fields will have threatening numbers in any given year. The detection of threatening numbers of bean pests must be done now on a field-by-field basis by the individual grower. Table 1 gives some suggestions on when to start checking fields for pests.

Detection in time for control depends on frequent checking of the fields. Every time you enter the field, check for signs of insect problems. The most important times to check bean fields for insects are: 1) when the plants are small and highly susceptible to insect damage; and 2) again at first flower to the small pod stages when many insect pests start to increase in numbers. Make special checks for insect problems just starting at these times.

Checks for insects can be made while walking, or even driving, through the field. Look for: 1) areas of poor stand or of dead, wilted, or stunted plants; 2) plants with twisted or discolored leaves; or 3) leaves that have holes through them or have their margins chewed. These signs could be caused by any number of things (drowned-out, fertilizer deficiency, herbicide damage, or even poor seed, for example). An examination of the plant and the soil around it will disclose the insects if they are the cause. Look for other possible causes of the damage if the insect cannot be found.

Check the field for the numbers of the pest and the area of the field infested. Some insects (especially the soil insects, cutworms, and Mexican bean beetle) may threaten only a small area of the field. Control may be needed in only this small area. Most of the insects can be found in small numbers every year. The insect needs control only when its numbers threaten to reduce the yield. An index (or "economic level") of the number necessary to justify control is given in the section on "The Pests." Control measures are not needed unless the numbers of the pest meet or exceed the level noted.

Nematodes

Symptoms such as low yields, stunting, poor stands, reduced emergence, wilting, yellowing and poorly developed root systems suggest potential nematode problems. To confirm that plant-parasitic nematodes are causing a specific problem in bean production, root or soil samples (preferably both) must be analyzed by a nematode diagnostic laboratory. Detailed instructions for taking and submitting samples are presented in MSU Extension Bulletin E-800.

TABLE 1. Checking dry beans and soybeans for insect and nematode pests.

WHEN	WHERE	WHAT	WHY
BEFORE PLANTING	Field	Sod, old pasture, weeds	Expect wireworm and white grubs
		High organic matter Soil, roots	Expect seedcorn maggot Nematodes
GERMINATION	Areas of poor stand or wilting seedlings	Thick-bodied grubs in soil Slender, hard bodies worms in the soil Spindle-shaped maggots in seed or stem of seedling Soil, roots	White grubs Wireworms Seedcorn maggot Nematodes
	Areas of cut plants	Cylindrical, dark worms near bases of plants	Cutworms
SMALL PLANTS	Areas of silvery plants	Very small yellowish to black insects under leaves	Bean thrips
	Leaves	Irregular holes through leaves; brownish beetles under leaves Dark, slimy animals near bases of plants	Mexican bean beetle adults Slugs
		Margins of leaves chewed; cylindrical larvae near bases of plants	Armyworm
	Areas of stunted, wilted or off-color plants	Soil, roots	Nematodes
LARGER PLANTS	Leaves	Irregular holes; cylindrical green worms under leaves	Green cloverworm
		Leaves skeletonized, yellow spiny grubs under leaves	Mexican bean beetle larvae
		Margins of leaves chewed; large jumping insects on plants	Grasshoppers
		Leaves curled; small, sideways-running insects under leaves	Leafhopper
		Leaves bronzed; fine webbing under leaves	Twospotted spider mite
		Leaves curled; small colonies of insects on stems and leaves	Aphids
	Leaves, flowers and green pods	Oval-shaped, active running insects, 1/8 to 3/8 inches	Plant bugs
AT HARVEST	Areas of stunted and poor yielding plants	Soil, roots	Nematodes

Insect and Nematode Control

Insects

Good management that yields a clean, vigorous stand of beans is needed to assure a minimum of problems with insect control. No special equipment or operations are needed—only those normally used in producing high yields of quality beans. The application of insecticides requires a spray rig. A granular applicator will also be needed if granular insecticides are to be applied. A good discussion on the operation of application equipment is given in Extension Bulletin E-1025 "Safe, Effective Use of Pesticides. A Guide for Private Applicators" available from your County Extension Office.

A weed-killer type spray rig with the flat-fan nozzles generally used for applying weed killers is adequate for the control of most insects. A wide variety of such nozzles is available. Catalogs and further information on the nozzles are available from your dealer. The proper selection of nozzle size and spacing on the boom (and a little ingenuity) will adapt the weed-killer sprayer for the control of most insects.

The flat-tip nozzles are generally rated for use at a pressure of about 30 psi. A cone spray nozzle that gives a fine mist for complete coverage of the plant may be needed for control of pests such as mites. The cone spray nozzle is also needed for the application of most fungicides in beans. The cone spray nozzles require a higher pressure (usually about 75 psi) than the flat-tip spray nozzles. A pump and pressure regulator capable of delivering sprays at pressures up to 100 psi are, therefore, recommended for beans. This larger capacity pump can be used to apply herbicides or insecticides at the lower pressure with a reserve capacity to deliver insecticides or fungicides at the higher pressure when needed.

The spray of insecticide should always be limited to cover only the plant. There is no benefit in spraying the open ground between rows of plants. A single nozzle centered over the row at a height that will concentrate the spray on the plant is all that is needed for most insects. Drops (boom extensions that place the nozzle at the sides of the plants) may be needed to apply some fungicides and insecticides. A boom with nozzle spacings for both row-center and between-rows is desirable. Blank nozzle tips can be used to seal off the nozzles that are not being used.

Granular applicators are less flexible than sprayers. Granules can be applied in place of sprays for control of some insects in beans. Granules are not recommended for herbicides or fungicides, however. A sprayer rather than a granular applicator is generally recommended for use in beans. A granular applicator that can place the granules in-furrow (right into the furrow with the fertilizer) or in a four- to seven-inch band over the row

is desirable. Check with your dealer on how to set up the granular applicator to fit your specific needs.

The pesticides currently recommended for control of the bean pests are given in Table 3. We have had some problems obtaining insecticides for field crops. A check to see what your dealer has on hand could save you a problem later in the season.

The use of pesticides is under increasing regulation by government. The more hazardous pesticides (called "restricted use pesticides") are sold only to persons certified in their use by the Michigan Department of Agriculture. You must become certified to apply restricted use pesticides. Current information on certification is available from your County Agricultural Extension Agent or representative of the Michigan Department of Agriculture.

The use of pesticides (which are, after all, poisons) is inherently hazardous to man, livestock, and the environment. They must be stored, handled and applied with great care. Extension Bulletin E-1025 goes into detail on the safe, effective use of the pesticides. Further information on pesticides is included in Extension Bulletins E-751 "Pesticides Manual" and E-789 "Pesticides, How They Work, Treatments for Human Poisonings." These are available from your County Extension Office and it is strongly recommended that you study these manuals for the safe, effective use of pesticides.

Nematodes

Plant-parasitic nematodes can be managed by preventing their entrance into the field, by chemical or cultural controls or by use of resistant varieties. MSU research programs are currently designing crop rotation recommendations for control of plant-parasitic nematodes in soybean production. There are no known soybean varieties resistant to Michigan plant-parasitic nematodes.

Population reduction necessary to reduce losses caused by nematodes can be achieved through proper application of pre-plant broadcast or at-planting row applications of granular nematocides. Nematocides must be stored, handled and used in a safe and effective manner. Study Extension Bulletins E-751 and E-789 in detail.

The Pests

A key to the damage and field identification of insect and nematode pests is presented in Table 2. Damage signs can vary with the stage of a plant, the numbers of the pest, and the weather. Make a careful examination of a plant and the soil around it to be sure that the pest is properly identified. A magnifying glass of about ten power (10x) is useful for identifying the small insects. A laboratory analyses is necessary for identification of plant-parasitic nematodes.

TABLE 2. A key to the identification of insect and nematode pests of beans in Michigan.

A. Areas of poor stand or dead, wilted or stunted plants.

1. Seeds tunneled or roots pruned; hard, slender worms with distinct head and six small legs just behind head in soil . . . **Wireworms**
2. Seed or seedling stalk tunneled; soft, white, headless, legless maggots in seed or stalk . . . **Seedcorn maggot**
3. Roots pruned; thick, soft, C-shaped white grubs in soil with definite head and six small legs just behind head . . . **White grubs**
4. Stems cut near the crown or leaves cut from the plants; dark, cylindrical worms with a definite head, six small legs near the head and a series of soft legs near the rear; in soil or on plants . . . **Cutworms**
5. Poor yields, reduced stands, wilting, yellowing, stunting, poorly developed root systems . . . **Nematodes**

B. Plants with curled or discolored leaves.

1. Leaves silvered or with fine, white spots; small, active, reddish to black, tear-shaped insects under the leaves . . . **Bean thrips**
2. Leaves bronzed or drying; minute, whitish mites in webbing along veins on underside of leaves . . . **Twospotted spider mite**
3. New growth stunted or twisted, or stems and pods with black spots on them; active, oval bugs on the plants; bugs may be green, wingless, black-spotted nymph or the winged, tan to blackish adult with a yellow V in the center of its back . . . **Tarnished plant bug**

B. Plants with curled (cont.)

4. Leaves cupped or plants stunted; active, small, pale green insects that run sideways on underside of leaves . . . **Potato leafhopper**
5. Leaves crinkled, cupped or rolled; small, soft, inactive, round, green to blackish insects in colonies on stems or leaves . . . **Bean aphid**

C. Leaves skeletonized, or with holes through them, or with their margins chewed.

1. Slimy trails on the leaves and rounded holes through them; soft, slimy, headless, legless slugs up to 1/2 inch long on plants or in soil near plants . . . **Slugs**
2. Round to irregular shaped holes in leaves; round, 1/4 inch long, hard-shelled beetles, bronze with black spots on the underside of the leaves . . . **Mexican bean beetle adults**
3. Leaves skeletonized or with irregular holes; round, spiny, yellow larvae about 3/8 inch long with definite head and six small legs just behind the head on underside of leaves . . . **Mexican bean beetle larvae**
4. Irregular holes through leaves; slender, green larvae with definite head, six small legs just behind head and fleshy legs near rear on underside of leaves . . . **Green cloverworm**
5. Margins of leaves chewed:
 - a. large, jumping insects on plants . . . **Grasshoppers**
 - b. cylindrical larvae on plants or in soil near bases of plants . . . **Armyworm**

A description of each pest and some notes on its biology and control are included in this section. The description should be carefully checked with your field observations to be sure of the pest's identity. Insects should be placed in small bottles with rubbing alcohol and taken to your County Agricultural Extension Agent if you are uncertain of their identification. It could be a common pest doing an uncommon type of damage. It could also be a new pest; perhaps one from some foreign land. These new pests can be devastating if not detected soon after they arrive. Your alertness could be a real service to your neighbors and the whole bean industry.

Many of the pests can be found, in low numbers at least, in nearly all fields. They are especially abundant in low, weedy spots. Some time spent in searching for and identifying them will help assure their proper identification if they do appear in threatening numbers later.



White grub larva.

White Grubs

The adults of the white grubs are called May beetles or June bugs. They usually lay their eggs in grassy fields, sod, old pasture and weeds. The larvae that hatch from these eggs feed on the roots of grasses and on the roots of beans that may be planted later in these fields. The larvae can persist and cause damage for two years after the sod has been plowed down. The damage generally appears in the field as circular areas of poor stand fringed by areas of stunted or wilting plants.

White grubs have white, thick, soft, cylindrical bodies and curl into a C-shape when they are disturbed. They have a definite head, six small legs just behind the head, and range up to one and one-half inches in length. Look for white grubs in plow furrows while fitting the land, and apply an insecticide prior to planting if they are easily found. Apply the insecticide as a spray or granule to cover the entire surface of the soil (a broadcast application). Work the insecticide into the upper surface of the soil immediately after application. It is a good practice to apply the insecticide just before the final disking.

If the grubs are not detected before planting, check the roots of wilting seedling plants for feeding and the soil around each plant for the grubs. If there is still time, these affected areas and a margin around them may be disked, an insecticide applied, and the area replanted.

Wireworms

The adults of the wireworms are the hard shelled click beetles. The wireworm adults lay their eggs in the grassy fields as do the white grubs. The biology, and the damage, of the wireworms are very similar to those of



Wireworm larva.

the white grub. The wireworms will eat the germ of the seed and tunnel through the seed as well as feed on the roots of the plants. Wireworms have whitish or tan, hard, thin, cylindrical bodies. They also have a definite head and six small legs just behind the head. The wireworms are as slick and hard as their name implies.

Wireworms are often associated with white grubs and the check for wireworms is done the same as for white grubs. The broadcast applications recommended for white grub control will also control wireworm. A band application (insecticides applied in a seven-inch band centered over the row at planting time) can also be used where only wireworms are a problem. Cover the insecticide with some soil immediately after application.

Seedcorn Maggot

The seedcorn maggot is a whitish, spindle-shaped larva that lacks both a definite head and legs. The maggot tunnels into the seed and stems of the seedlings. The adults of the maggots are small flies. They lay their eggs in soil high in organic matter (muck soils or fields that have had a lot of weeds, stubble or manure plowed



Seedcorn maggot.

down). The maggots hatch from these eggs and cause the damage.

Start looking for areas of poor stand or wilting plants as soon as the beans start to germinate. Check the seed and the stems of the seedlings for the maggots. If there is still time, the areas affected by seedcorn maggot may be disked and replanted with insecticide-treated seed.

Seed treatment with an insecticide is the recommended control for seedcorn maggot. Seed treatment is best done by the seed dealer at the same time he treats the seed with fungicides. Seed treatment formulations of the insecticides are available for use in a planter-box application. If treated seed is not available, follow the instructions on the label of the planter-box seed treatment to be sure to obtain an even coating of the seed. Broadcast or band applications of insecticides for control of white grubs or wireworms will also control the seedcorn maggot. All bean seeds should be treated with an insecticide if they are planted in fields that have not received these other treatments.

Cutworms

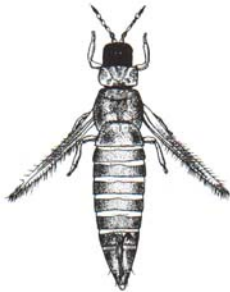
Cutworms cut the stems of small plants and eat the plant. They can be expected in fields that are weedy or poorly drained, but they can appear in any field. The cutworms, the larvae of the miller moths, have a round, dark head; six small legs just behind the head; and ten fleshy legs at the back end of their bodies. Their bodies are dark colored, soft, and cylindrical. They curl their bodies tightly when disturbed and may try to bite when handled; their bite is painless and harmless.

Cutworms cut the plants at night and hide in the soil surface near the plants during the day. Check fields every few days following germination for plants that are cut at their bases. Search the soil around the cut plants for the cutworms and apply an insecticide if about 5% or more of the plants show signs of cutworm



Cutworm larva. There are several species of cutworms that are variously colored.

feeding. If not controlled, the large cutworms can destroy a stand very quickly. Do not delay applying an insecticide if it is needed. Apply insecticides either as sprays or granules in a band just wide enough to cover the plants.



Bean Thrips adult. The nymphs lack wings.

Bean Thrips

Bean thrips are very small, oval-shaped insects that rasp the surface of the bean leaves and suck up the plant juices. The damage appears as silvery areas on the undersides of the leaves and severely attacked plants will wilt quickly in dry weather. Bean thrips have been especially damaging during cool, dry spells early in the season. Young thrips (nymphs) are yellow-to-reddish and wingless. Adult thrips are dark gray-to-black and have two pair of feathery wings. Both nymphs and adults are active and, while small, can be seen running on the underside of the bean leaves.

Check young bean plants for thrips every time you look for cutworms or seedcorn maggot. Look for leaves that appear silvered or stippled and for the small active thrips under the leaves. Apply a spray of insecticides to thoroughly cover the undersides of the leaves if the thrips are common.

Mexican Bean Beetle

The adult Mexican bean beetle is a hard-shelled beetle about $\frac{1}{4}$ inch long, round, and copper-tan with prominent black spots on its wings. Adults overwinter in



Mexican bean beetle adult.



Mexican bean beetle larva.

sheltered places and move into the beans in early spring. Adults feed by eating irregular holes through the leaf from the lower surface. They lay groups of orangish eggs in clusters of up to 50 on the undersides of the leaves. The larvae that hatch from these eggs are oval, yellowish, have prominent spines on their back, and are up to $\frac{3}{8}$ inch long. The larvae feed on the tissues between the veins of the leaves. Their feeding gives the leaves a skeletonized appearance.

Check seedling beans for the adults early in the season, especially if they are close to woodlots or fence rows that can harbor the overwintered adults. Spray the field with an insecticide if the adults are common. Check fields for the larvae and their damage, and apply a spray when the damage is easily seen. The larvae are more damaging and harder to control than the adult. An early spray to control the adult may save extra sprays needed for later larval control.

Green Cloverworm

The green cloverworm is a cylindrical larva with a definite head, six small legs just behind the head, and fleshy legs near the tail end of its body. The worm is



Green Cloverworm larva.

light green, and has faint, narrow, white lines running the length of its body. They range in size to nearly $1\frac{1}{2}$ inches long when fully grown. They wriggle rapidly and drop to the ground when disturbed. They feed by eating irregular holes through the leaf from the lower surface of the leaf.

The worms are hard to spot on the leaves, but their damage is easily seen. Check fields for damage by looking for holes in the leaves, shaking the plant, and counting the worms found. A spray of insecticides is needed when there are 15 or more worms per row-foot during pod fill or when about 25% or more of the leaves have been damaged.

Bean Aphid

Aphids are small, round, soft-bodied insects that are found in colonies on the stems and leaves. There are several species that damage beans. These range in color from pale green to almost black. The most common species is the bean aphid, which is black. Aphids suck plant juices and inject a toxic saliva into the plant. This causes a general weakening of the plant and a curling of the leaves. Aphids are especially threatening to beans as carriers (vectors) of virus diseases. Aphids excrete a



An aphid adult. There are several species of aphids in bean that are variously colored. The young (nymphs) lack wings and some adults are also wingless.

sticky "honey dew" that often becomes covered with a sooty fungus.

Check for aphids by looking for curled leaves and honey dew. Examine the plants when these are seen, and apply an insecticide when nearly all plants have aphids on them. Use a row-crop sprayer or a weed-type sprayer that is carefully adjusted to completely cover the plant with spray.

Leafhoppers

Leafhoppers are small, spindle-shaped-to-oval, active insects. They range in color from pale green to dark gray. The potato leafhopper is the most common species



Potato leafhopper adult. The young (nymphs) lack wings.

and is about 1/8 inch long and pale green. Potato leafhoppers have the peculiar habit of running sideways when disturbed. They suck sap from the potato and generally weaken the plant when they are abundant. The potato leafhopper injects a toxic saliva into the plants that causes the leaves to curl tightly. High populations of potato leafhoppers can stunt the plants to the point that they are unproductive.

Check fields for leafhoppers by looking at the undersides of leaves for the sideways-running small insects. Apply a spray of insecticide when about five or more leafhoppers are found per plant.

Plant Bugs

Plant bugs are active insects, oval to elongate in form, and range from small to 3/8 inches in length. The most common species is the tarnished plant bug. This insect is oval, about 1/4 of an inch long, light gray to dark brown, and usually has a V-shaped yellow mark on the center of its back. It sucks plant juices and injects a very toxic saliva into the plant. This saliva can blast flowers and young pods and leave stings ("dimple blemish"; hard, darkened spots) on the beans. Recent research has shown that the most damage from the tarnished plant bug is the blasting of flowers and pods. The number of stings that you see on the harvested beans, therefore, is only a small portion of the damage done by the bug.

The tarnished plant bug can be found at almost any time in bean fields, but is most damaging to the flowers



Tarnished plant bug adult. The young (nymphs) are green, spotted, and lack wings.

and pods. Check the field for the bug at blossoming and again at the small pod stage and apply an insecticide if the bugs can be easily seen in the field.

Twospotted Spider Mite

The twospotted spider mite is a relative of the spiders and only distantly related to the insects. It is a minute,



Twospotted spider mite.

rounded, eight-legged animal that feeds by sucking sap from the lower surfaces of the leaf. Affected leaves turn yellow or bronze and dry and fall off when severely attacked. Look for a fine webbing with the small whitish to reddish mites under the leaves. The mites are most abundant during dry years, and are most commonly found in weedy areas of the field.

Check the field, especially during dry weather, for yellowing leaves. Apply a spray of insecticide to thoroughly cover the leaves when the mites are found. Mites are difficult to control, and two or more sprays may be needed.

Slugs

Slugs are not insects. They are mollusks related to the clam, snail and octopus. They feed at night by chewing irregular holes through the leaves of beans and hide during the day in the soil near the bases of the plants. The holes in the leaves and the slimy trails that they make on the leaves are easily seen during the day. A search of the soil and debris near the plants will reveal a soft, dark, slimy, rounded to elongate animal that ranges from 1/2 to 1 1/2 inches long. Slugs can severely damage small plants when they are abundant.

Slugs are most abundant during cool, moist springs and are often damaging only in the wetter areas of the field. They are especially abundant in weedy or trashy areas of the fields. Check the leaves for the holes and slimy trails made by the slugs and for the slugs them-



A slug.

selves around the bases of the plants. Apply a spray to the affected area of the field if their damage is seen on most plants in that area.

Grasshoppers

Grasshoppers are usually present in low numbers in our bean fields. They are abundant during some years and become a threat to beans. The most common grasshopper in beans is the redlegged grasshopper. This species is about 1 inch long when fully grown, dull brown in color, with reddish hind legs. The young (or nymphs) are wingless but are active jumpers and are easy to see in the field. The adults are winged and can both jump and fly. They breed in unplowed weedy area (rights-of-way, roadsides, fence rows, old pastures, and the like) and can move into bean fields when their numbers are high. They feed by chewing the margins of the leaves.

Check the field, especially the margins adjacent to large areas of weeds, when the grasshoppers are known to be abundant. Look for them jumping in the plants and for their chewing on the leaves. Apply an insecticide for their control if there is about 1 grasshopper or



A grasshopper adult. The young (nymphs) lack wings.

more per row-foot. Grasshoppers are often abundant only in margins and headlands of a field. Only the infested area and a 20-40 foot area around it need be treated.

Armyworm

Armyworms have a cylindrical body, definite head, six small legs behind the head and fleshy legs near the rear like the cutworms. The armyworm varies in color from a light green to nearly black. It can be distinguished by the light line that extends along each side of its body. The armyworms are active at night and usually hide in the soil near the base of the plants during the day. They feed by chewing from the margins of the leaves. Their green, rounded dropping (called frass) is usually easily seen under the plants. They feed on grasses and small grains most frequently, and damage beans in areas of grass weeds in the bean field or in margins and headlands adjacent to grassy fields or small grain fields. They "march" out of the grasses when abundant and feed on beans, or almost any other plant, during their march.

Check regularly for armyworms in bean fields, especially areas of weed grasses and adjacent fields of grasses or small grains. Look for the chewed leaves, the frass, and the worms themselves near the bases of the plants. Apply an insecticide when armyworm damage



Armyworm larva.

appears on about 1/4 of the leaves. Large armyworms, like cutworms, are difficult to control. Do not delay in applying the insecticide when needed. Armyworms are often present in only certain areas of a field. The infested area and a 20 to 40 foot border around it only need to be treated.

Nematodes

Plant-parasitic nematodes are microscopic roundworms and not insects. Two types of nematodes, root-lesion and stunt, are associated with yield losses in Michigan bean production. The root-lesion nematode is an endoparasite and migrates throughout the cortex of roots. Stunt nematodes usually feed on roots as ectoparasites. Five species of root-lesion nematodes (*Pratylenchus penetrans*, *P. neglectus*, *P. cranatus*, *P. vulnus* and *P. scribneri*) and two species of stunt nematodes (*Tylenchorhynchus dubius* and *T. nudus*) have been associated with bean yield reduction in Michigan.



A nematode.

TABLE 3. Insecticides recommended for control of insects in dry beans and soybeans.

The insecticides can be used on dry beans and soybeans unless noted under "limits".

Pest	Insecticide	Pounds of active insecticide per acre	Limits*
Seedcorn Maggot	diazinon	2 oz./bu. seed	Do not use seed for food or feed.
White Grubs	parathion	4.0	Apply prior to planting; do not contaminate ponds or streams.
	diazinon	4.0	Apply prior to planting; do not contaminate ponds or streams.
Wireworms	parathion	4.0	Apply prior to planting; do not contaminate ponds or streams.
	diazinon	4.0	Apply prior to planting; do not contaminate ponds or streams.
	fonofos (Dyfonate)	4.0	Apply prior to planting; do not contaminate ponds or streams. <i>Dry beans only.</i>
Green Cloverworm	malathion	1.5	1 day dry beans; 7 days soybeans.
	carbaryl (Sevin)	1.0	0 days.
	azinphosmethyl (Guthion)	0.5	30 days dry beans; 45 days soybeans.
	methomyl (Lannate or Nudrin)	0.5	<i>Soybeans only</i> ; 14 days.
	Bacillus thuringiensis (Dipel, Thuricide)	0.5	0 days.

of formulation

TABLE 3 (Continued). Insecticides recommended for control of insects in dry beans and soybeans.

The insecticides can be used on dry beans and soybeans unless noted under "limits".

Pest	Insecticide	Pounds of active insecticide per acre	Limits*
Cutworms	carbaryl (Sevin)	1.5	0 days; <i>dry beans only</i> .
	trichlorfon (Dylox or Proxol)	1.0	14 days; <i>dry beans only</i> .
Mexican Bean Beetle	carbaryl (Sevin)	1.0	0 days.
	azinphosmethyl (Guthion)	0.5	30 days dry beans; 45 days soybeans.
	malathion	1.25	1 day dry beans; 7 days soybeans.
	methomyl (Lannate or Nudrin)	0.5	25 days dry beans; 14 days soybeans.
Bean Thrips	carbaryl (Sevin)	1.0	0 days; <i>dry beans only</i> .
	carbaryl (Sevin)	1.0	0 days.
Leafhoppers	dimethoate (Cygon or DeFend)	0.5	0 days; <i>dry beans only</i> .
	azinphosmethyl (Guthion)	0.5	30 days dry beans; 45 days soybeans.
	carbophenothion (Trithion)	0.5	7 days soybeans; 21 days dry beans.
	dimethoate (Cygon or DeFend)	0.5	0 days; <i>dry beans only</i> .
Plantbugs	azinphosmethyl (Guthion)	0.5	30 days; <i>dry beans only</i> .
	carbaryl (Sevin)	1.0	0 days; <i>dry beans only</i> .
	malathion	1.25	1 day; <i>dry beans only</i> .
	dimethoate (Cygon or DeFend)	0.5	0 days; <i>dry beans only</i> .
Aphids	azinphosmethyl (Guthion)	0.5	30 days dry beans; 45 days soybeans.
	carbaryl (Sevin)	1.0	0 days; <i>dry beans only</i> .
	malathion	1.25	1 day; <i>dry beans only</i> .
	dimethoate (Cygon or DeFend)	0.5	0 days; <i>dry beans only</i> .
	malathion	1.25	1 day; <i>dry beans only</i> .
	demeton (Systox)	0.5	21 days; <i>dry beans only</i> .
Mites	naled (Dibrom)	1.0	4 days; <i>dry beans only</i> .
	carbophenothion (Trithion)	0.5	Dry beans—2 applications per season; 21 days; soybeans—7 days, do not use forage.
	carbophenothion (Trithion)	0.5	Dry beans—2 applications per season; 21 days; soybeans—7 days, do not use forage.
	demeton (Systox)	0.5	21 days; <i>dry beans only</i> .
	naled (Dibrom)	1.0	4 days; <i>dry beans only</i> .
	dimethoate (Cygon or DeFend)	0.33	0 days; <i>dry beans only</i> .
Slugs	dicofol (Kelthane)	0.75	45 days; <i>dry beans only</i> .
	carbaryl (Sevin)	1.50	0 days.
Armyworm	carbaryl (Sevin)	1.50	0 days.
	trichlorfon (Dylox or DeFend)	1.50	14 days; <i>dry beans only</i> .
Grasshoppers	carbaryl (Sevin)	1.50	0 days.

*The number of days refers to the time between application and harvest.

TABLE 4. Nematocide recommendations for nematode control in soybean production.

Pest	Nematocide	Rate	Application
Root-lesion and stunt nematodes	Nemacur 15G	26.7—40 lb/acre	Broadcast (preplant) and incorporate to 2-6 inch depth.
	Nemacur 15G	6.7—20 oz/1,000 ft row	Band (at planting), 12-18 inch band incorporated to a 2-6 inch depth.
	Nemacur 3	1.3—2 gal/acre	Broadcast (preplant) in 20-50 gal. of water per acre and incorporate to a 2-6 inch soil depth.
	Nemacur 3	5.3—10.7 oz/1,000 ft	Band (at planting) or a water emulsion spray in a 12-18 inch band in front of the planter shoe.
	Temik 15C	10-14 lb/acre	Drill granules 2-3 inches below seed line, or 2-3 inches to side of seed row 2-3 inches deep, or apply in an 8-12 inch band and work into soil or cover with soil to a depth of 2-4 inches. Plant seed in treated zone.

*The number of days given refers to the time between application and harvest.