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Insect, Nematode and Disease Control in Michigan Field Crops

Michigan State University Extension Service

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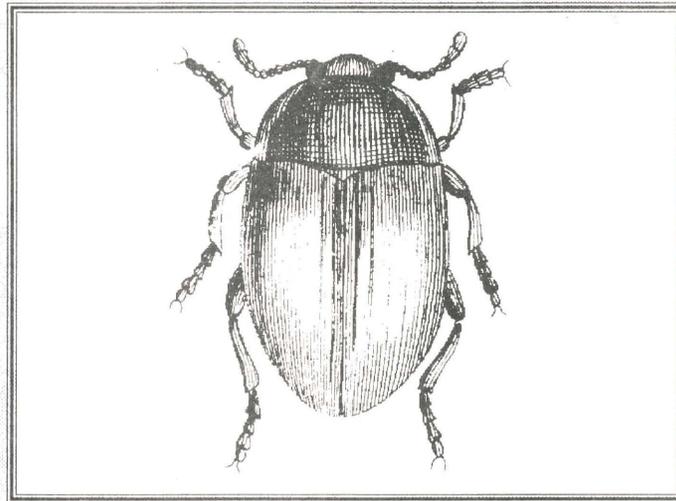
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MICHIGAN STATE
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Insect, Nematode and Disease Control in Michigan Field Crops

*With information on biology, damage, sampling, thresholds, non-chemical control options,
and pesticides registered for common field crops insects, nematodes and diseases in Michigan.*

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Information Current as of November 27, 2006

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Insect, Nematode, and Disease Control in Michigan Field Crops

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You must be certified to purchase and apply the Restricted Use Pesticides (RUP) in this guide. Certification is based on an exam given by the Michigan Department of Agriculture (MDA). Contact the MDA Pesticide Section at 517-373-1087 for information on certification procedures, exam dates and locations or visit www.michigan.gov/mda/

To prepare for the exam, use the following bulletins:

- Private applicator certification: E-2195, Pesticide Applicator Core Training Manual
- Commercial applicator certification E-2195, Pesticide Applicator Core Training Manual AND E-2034, Commercial Field Crops Pest Control. You can obtain these study materials from your county extension office, from the MSU bulletin office on the MSU campus (517-355-0240), or FREE on the MSU Pesticide Safety Education web site: www.pested.msu.edu.

This bulletin contains information on the management of field crops insects, nematodes, and diseases, including recommendations for pesticide use. Every attempt is made to verify product names, formulations, use rates, and other important information, but products and labels may change before the field season begins. Always read the label of a product to reconfirm rates, precautions, PPE, and other important information.

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INTRODUCTION

Safe Use of Pesticides

Always thoroughly read the label for all pesticides that you use. Use the pesticide only for the purposes listed, and in the manner directed, on the label. Select only pesticides labeled for your crop and the pest(s) you need to control. To do otherwise may reduce efficacy or lead to an unacceptable risk to humans, the crop, and the environment.

Handling and mixing pesticides

Always wear protective clothing and equipment when handling, mixing, and applying pesticides. Depending on the specific pesticide, protective clothing includes long pants, long-sleeved shirt, a spray suit, chemical resistant gloves and boots, eye protection, hard hat and a MSHA/NIOSH approved respirator with a chemical absorbent material. Protective clothing requirements are specified on the pesticide label.

Mix pesticides downwind and below eye level, and avoid excessive splashing. If pesticides are spilled on your body, wash immediately with water and change clothing. Resume spraying only after cleaning up any spills. Use closed handling/mixing systems when possible. Keep unauthorized people out of the area when you handle pesticides.

Cleaning pesticide application equipment

Follow all specific label directions for cleaning application equipment. If such instructions are not given on the pesticide label, then triple-rinse the inside of the tank, spraying the rinsate on a labeled site. Wash the outside of the equipment in the target area and clean the spray system with an appropriate cleaning solution. Do not spray cleaning solution onto any crop; dispose of the cleaning solution as you would any municipal waste. Follow the equipment manufacturer's guidelines for routine cleaning and maintenance.

Pesticides and the Environment

When a pesticide is applied, it moves in the application area, and starts to break down. A pesticide becomes a problem if it disperses beyond the target site, or it persists in the environment for a long period. The types of pesticide movement and break down are listed below.

Spray drift occurs at or soon after the time of application, before spray droplets have a chance to settle. Active ingredients do not differ in their potential for spray drift, but formulation does make a difference. The most important factor affecting spray drift is spray droplet size; larger droplets drift less. Apply pesticides using the largest droplet size that provides adequate coverage and control. Factors that impact droplet size are nozzle type, size, and orientation, spray pressure, and drift control additives. Other factors such as wind speed, temperature, and humidity also affect drift, but are not under the applicator's direct control.

Vapor drift (volatilization) occurs when a pesticide turns into a gas, and is carried away from the target area by air currents. While spray drift can sometimes be seen during application, vapor drift is invisible and may occur for days after application. Active ingredients differ in their potential for vapor drift; pesticide labels usually mention the potential for volatility of pesticides. Avoid applying volatile pesticides when conditions favor volatilization, such as during a temperature inversion. Volatilization can sometimes be reduced through the use of low volatile formulations or by soil-incorporating the pesticide.

Adsorption is the binding of chemicals to soil particles. Adsorption varies with pesticide properties, soil moisture, soil pH, and soil texture. Soils high in organic matter or clay are the most adsorptive; coarse, sandy soils are much less so. A soil-adsorbed pesticide is less likely to volatilize, leach or be degraded by microorganisms, and is less available for absorption by plants. Therefore, pesticides used on highly adsorptive soils may require higher rates or more frequent applications to compensate for soil adsorption.

Absorption is the uptake of pesticide by plants, animals, and microorganisms. Once absorbed, most pesticides are degraded. But residues may persist inside the plant or be released back into the environment as the plant decays.

Runoff is movement of pesticides in surface water, in the water itself or bound to soil particles carried by water. The amount of pesticide runoff depends on the slope of the field, soil type, the amount of rainfall (especially close to the time of application), and properties of the pesticide. For example, a pesticide applied to saturated clay soil is highly susceptible to runoff. No-till, reduced-till,

and soil incorporation reduces runoff. Surface grading, dikes, and the use of border vegetation can reduce pesticide movement into surface water.

Leaching is the movement of pesticide through soil into groundwater. Several factors influence leaching, including water solubility of the pesticide, soil structure/ texture, and pesticide adsorption to soil particles. If a pesticide is strongly adsorbed to soil, it is less likely to leach, regardless of its solubility (unless soil particles themselves move with the water).

Photodegradation is the breakdown of pesticides by sunlight, which commonly occurs on plant and soil surfaces. Soil incorporation reduces pesticide exposure to sunlight.

Microbial degradation occurs when microorganisms (fungi, bacteria) break down pesticides. Microbial degradation can be rapid under favorable conditions (warm temperatures, favorable pH levels, adequate soil moisture, and oxygen). Soil-applied pesticides are mainly broken down by microbes.

Chemical degradation is the breakdown of a pesticide by chemical processes, for example, hydrolysis. Soil pH, soil temperature, and moisture influence the rate of chemical degradation. Chemical degradation is the principal means of break down of pesticides in groundwater.

Keeping pesticides out of water

In rural areas, 50% of people obtain drinking water from wells, i.e., from ground water. Groundwater is stored in water-bearing geological formations called *aquifers*. It moves through aquifers and returns to the surface at springs, streams, or wells. The upper level of the saturated zone in the soil is called the *water table*. The water table depth fluctuates, depending on the amount of water removed from the ground and the amount added by recharge.

Both surface water and groundwater are subject to contamination by *point and non-point source pollution*. Point source pollution refers to movement of a pesticide into water from a specific site. Non-point source pollution results from runoff, precipitation, or percolation from a

generalized area rather than from discharge at a single location.

It is very difficult to purify contaminated ground or surface water. Management practices can be implemented to reduce pesticide runoff and leaching, and to protect ground and surface water.

- *Use integrated crop management*—Minimize pesticide use by combining chemical control with other pest management practices such as tillage, cultivation, crop rotation, and pest scouting.
- *Reduce compaction*—Surface water runoff increases when soils are compacted.
- *Rotate crops*—Crop rotations may provide more surface crop residue and reduce the need for pesticides.
- *Use conservation tillage practices*— Include no-till, reduced till, cover crops, grass waterways and buffer strips in your production system.
- *Consider geology*—When planning pesticide applications, be aware of the water table depth and the permeability of the geological layers between the surface soil and groundwater.
- *Select pesticides carefully*—Choose pesticides with the least potential for leaching into groundwater or for runoff into surface water.
- *Transport Pesticides Safely*—Have pesticides delivered directly to your pesticide storage facility to avoid accidents and spills in transit whenever possible. DOT shipping rules must be followed to transport large quantities of pesticides, including placarding of the vehicle, liability insurance, and special handling requirements.
- *Follow label directions*—Labels carry crucial information about the proper rate, timing, and placement of pesticides.
- *Calibrate and measure accurately*—Calibrate equipment carefully and often; Measure pesticides carefully before adding to the spray tank. Do not “add a little extra” to ensure the pesticide will do a better job.
- *Avoid back-siphoning*—The end of the fill hose should remain above the water level in the spray tank at all times to prevent back-siphoning of chemicals into the water supply. Use an anti-backflow device when siphoning water directly from a well, pond, or stream.
- *Consider weather and irrigation*—If you suspect heavy or sustained rain, delay pesticide application. Control irrigation to minimize the potential for pesticide leaching and runoff.
- *Avoid spray drift and volatilization*—Do not spray when weather conditions (e.g. wind, inversions)

are conducive to pesticide drift from the target area.

- *Clean up spills*—When spills do occur, contain and clean them up quickly with an absorbent material such as kitty litter. Chemicals spilled near wells can move directly and rapidly into groundwater. Chemicals spilled near ditches, streams, or lakes can move into surface water.

- *Change the location of mixing areas*—Mix and load pesticides on an impervious pad, if possible. If mixing is done in the field, change the location of the mixing area regularly. Do not mix pesticides next to a water source; do not let water run on the soil near the mixing area.

- *Dispose of wastes and containers properly*—All pesticide wastes must be disposed of in accordance with local, state, and federal laws. Pesticide containers are considered hazardous waste until they are cleaned or disposed of properly. When possible, reduce the number of pesticide containers by using bulk or returnable containers. Clean pesticide containers by triple rinsing, and add the rinsate to the spray tank. After triple rinsing, perforate the container so it cannot be reused. All metal and plastic triple-rinsed containers should be recycled, if possible. If this option is not available, dispose of them in a state-licensed sanitary landfill. Dispose of all paper bags in a sanitary landfill or a municipal waste incinerator. Do not bury or burn pesticide containers. Do not reuse empty pesticide containers for any purpose.

- *Store pesticides away from water sources*—Pesticide storage facilities should be situated away from wells and other water sources. Pesticides should be stored in a separate facility that protects them from temperature extremes, high humidity, and direct sunlight. The storage facility should be heated, dry and well ventilated. It should be designed for easy containment and cleanup of pesticide spills and made of materials that will not absorb pesticide that leaks from a container. Always store pesticides in their original containers.

Do not store protective clothing or equipment in the pesticide storage facility. Storing herbicides separately from insecticides and fungicides helps avoid contamination of one material by another and reduces accidental misuse.

Keep the facility locked when not in use. Post the facility as a *Pesticide Storage Facility* to warn others that the area is off-limits. Maintain an

accurate inventory of the pesticides stored in the facility at all times in case of emergency, such as a fire.

Michigan Groundwater Stewardship Program

The Michigan Groundwater Stewardship Program (MGSP) is a cooperative effort to reduce the risk of groundwater contamination associated with the use of pesticides and nitrogen fertilizers. The MGSP was created in 1993 by the state legislature, and is funded by assessments on the sale of nitrogen fertilizers and pesticides. The assessment generates money for educational programs, technical assistance, and cost sharing of groundwater stewardship practices. Local MGSP's - usually associated with a county MSU Extension or Conservation District office - provide farmstead pollution risk assessments (Farm*A*Syst and Field*A*Syst), develop groundwater stewardship plans, provide cost share funds used to install groundwater stewardship practices, and conduct educational workshops and on-farm demonstrations.

The MSGP also sponsors the following programs:

- Spill Response Program (1-800-405-0101) to assist individuals dealing with pesticide, fertilizer and manure spills;
- Clean Sweep to dispose of unused and unwanted pesticides safely;
- Container Recycling to assist in the safe disposal of plastic pesticide containers;
- Michigan Emergency Tube project that provides an emergency preparedness plan that meets the legal requirements of SARA Title III.

Growers that participate in some of these programs are also eligible for pesticide recertification credits. Contact your MSU Extension, Conservation District, or USDA NRCS representative to learn more about the MGSP serving your county.

Protecting non-target organisms

Bees and other pollinating insects are essential for successful production of fruits, most seed crops and certain vegetables. Many insecticides are highly toxic to pollinating honeybees and wild bees. The best way to avoid injury of bees and other beneficial insects is to minimize pesticide use. Use selective pesticides whenever possible, apply only when necessary as part of a total pest management program, and take the following precautions to reduce the chance of bee exposure:

- Do not apply pesticides that are toxic to bees if the site contains a crop or weed which is in

bloom. Mow cover crops and weeds to remove the blooms prior to spraying.

- Select pesticides and formulations less harmful to bees. Dusts are more hazardous to bees than liquids. Wettable powders and microencapsulated products are more hazardous than emulsifiable concentrates or water-soluble formulations; particulate pesticides may be carried back to the hive. Granular insecticide formulations are generally the least hazardous to bees.
- Reduce drift during application.
- Time pesticide applications carefully. Evening applications are less hazardous to bees than early morning; both are safer than midday applications.
- Do not let puddles of spray accumulate on the ground where bees might drink. Supplying fresh water near bee hives can reduce this hazard.
- Do not treat near hives. Colonies moved or covered before using insecticides are used nearby.

Pesticides can be harmful to vertebrates such as fish and wildlife. Fish kills can result from water polluted by a pesticide (usually insecticides). Pesticides enter water via drift, surface runoff, soil erosion, and leaching. Bird kills occur when birds ingest the pesticide granules, baits, treated seed, the treated crop, or contaminated water.

Pesticide Laws and Regulations

Emergency Planning and Community Right to Know Act: The Emergency Planning and Community Right to Know Law, under SARA Title III, requires farmers to notify their State Emergency Response Commission (SERC), Local Emergency Planning Committee (LEPC), and local fire department if they store large quantities (called "threshold planning quantities") of hazardous materials, including pesticides. Check with your Extension office to receive a list of EPA Extremely Hazardous Substances and threshold planning quantities. The LEPC and fire chief may request maps of your storage facility or farm, and a detailed list of materials you store. In the event of a spill, this law also requires that the SERC, LEPC and National Response Commission be notified. The reportable quantities for spills can be obtained from your Extension office. Also, see MSU bulletin E-2575, Emergency Planning for the Farm – SARA Title III.

Endangered Species Act: The Endangered Species Act minimizes the adverse impact of

pesticides on endangered species. The Michigan Department of Environmental Quality (MDEQ) administers the Michigan Endangered Species Act and maintains an endangered species list in the state. The EPA has determined threshold pesticide application rates that may affect endangered species. This information, and counties with endangered or threatened species, are identified on pesticide labels. Farmers must take the initiative to consult the MDEQ and the Fish & Wildlife Service to be sure there are no endangered species in their area.

FIFRA - Use of a Pesticide for Pests Not on Label:

The law regulating pesticide registration, distribution, sale and use in the United States is the Federal Insecticide, Fungicide and Rodenticide Act, or FIFRA. FIFRA is administered on the federal level by the EPA and in Michigan by the Michigan Department of Agriculture (MDA). FIFRA allows the use of a pesticide for a pest not on the label as long as the application is made to a crop specified on the label. This provision is referred to by its FIFRA section, "2(ee)". All rates and restrictions, including pre-harvest intervals for the labeled crop, must be followed. Please note, however, that the manufacturer will not assume responsibility for product performance, so 2(ee) applications are made at the grower's risk. For more information about 2(ee) applications, contact your local MSU Extension or MDA Agriculture office.

Record Keeping: The 1990 Farm Bill requires that all applicators applying restricted use pesticides (RUPs) keep records and maintain them for one (private applicators) or three (commercial applicators) years. You must keep a record of the following information:

- brand or product name and the EPA registration number.
- total amount of the product used.
- size of the area treated.
- crop, commodity, stored product or site to which the pesticide was applied.
- location of the application.
- month, day and year of the application.
- name and certification number of the applicator or applicator's supervisor.

Any record form is acceptable as long as the required data is included. Commercial applicators making an RUP application must furnish a copy of the required records to the customer. See MSU

bulletin E-2340, *Record-keeping System for Crop Production*.

Right-to-Farm: Farmers in Michigan are protected from nuisance lawsuits under the Right-to-Farm Act if they follow specific acceptable management practices. Generally Accepted Agricultural and Management Practices for pesticide utilization and pest control, nutrient utilization, and manure management are revised annually. Contact your Extension agent or regional office of the Michigan Department of Agriculture to obtain copies of the Acts.

Right-to-Know: Plan to conduct a farm worker Right-to-Know training program for all your employees. Use this training time to maintain and improve safety procedures for using agricultural chemicals on your farm. Contact your county Extension agent to assist you in setting up a right-to-know employee training program.

Worker Protection Standards (WPS): Federal rules for farm worker protection, issued during

1992, require farmers to provide training to workers to prevent accidental or occupational exposure to pesticides. Farmers can contact Extension agents to learn the details of this standard and availability of training materials for education of workers and handlers. Because of WPS, *Restricted Entry Intervals* (the amount of time that must pass before people can re-enter a treated area without protective clothing listed on the label) and notification requirements are given on pesticide labels. Some pesticide labels require both oral warnings and posted signs to notify workers of pesticide applications. If the label doesn't require both forms of notification, notify workers either orally or by posting warning signs at entrances to treated areas. Signs should be posted 24 hours or less before the pesticide application and removed within three days after the restricted entry interval expires. Keep workers out of the area during the entire REI, except for early-entry workers wearing the proper personal protective equipment described on the label.

Useful Conversions for application and calibration

Dry Measures

ounces (oz) = 28.35 grams

pound (lb) = 453.6 grams or 16 oz

Liquid Measures

fluid ounces (fl oz) = 29.6 milliliters (ml)

pint (pt) = 473.2 ml or 16 fl oz

quart (qt) = 946.4 ml or 32 fl oz or 2 pt

gallon (gal) = 3,785.4 ml or 128 fl oz or 8 pt or 4 qt

Area or Amount Treated

acre = 43,560 square feet

1,000 row ft = 1,000 linear feet of row, regardless of spacing

100 lb = 100 lb of seed

Standard Weights for Field Crops

field corn – 56 lb/bu

dry beans – 60 lb/bu

soybeans – 60 lb/bu

barley – 48 lb/bu

rye – 56 lb/bu

wheat – 60 lb/bu

Sample Equations for application and calibration

Use the following equations to calculate the amount of formulated pesticide or active ingredient needed, or to calibrate application equipment. These equations have been simplified so that only a single constant (or factor) is needed. The calculations can be done with a pocket calculator that can multiply (indicated by *) and divide (indicated by /) in sequence.

1) **To Determine:** pounds or gallons of pesticide needed to treat X acres

Given: the application rate per acre

Equation = $A * R / F$

A = number of acres to treat

R = application rate per acre

F = factor to transform the application rate into pounds or gallons.

The values to use for F are:

F = 1, if the rate is given in pounds or gallons per acre.

F = 4, if the rate is given in quarts per acre.

F = 8, if the rate is given in pints per acre.

F = 16, if the rate is given in dry ounces per acre.

F = 128, if the rate is given in fluid ounces per acre.

Example: How many gallons of insecticide are needed to treat 30 acres at a rate of 4 pints per acre?

A = 30 acres; R = 4 pints/acre; F = 8 (rate is in pints)

Gallons of product needed = $30 * 4 / 8$

Answer: 15 gallons of insecticide

Example: How many pounds of granular insecticide are needed to treat 30 acres at a rate of 2 ounces per acre?

A = 30 acres; R = 2 oz/ acre; F = 16 (rate is in dry ounces)

Pounds of product needed = $30 * 2 / 16$

Answer: 3.75 pounds of product

2) **To Determine:** the pounds or gallons of insecticide needed to treat X acres

Given: the application rate per 1,000 feet of row

Equation = $A * R * F / W$

A = number of acres to treat

W = row width in inches

R = application rate per 1,000 feet of row

F = factor to transform the application rate into pounds or gallons.

The values to use for F are:

F = 4.084, if the application rate is given in fluid ounces per 1,000 feet of row

F = 32.67, if the application rate is given in dry ounces per 1,000 feet of row

Example: How many pounds of insecticide are needed to treat 80 acres with 6 ounces of granular product per 1,000 feet of row? The row spacing is 30 inches.

A = 80 acres; R = 6 dry oz/ 1,000 row ft.; W = 30 inches; F = 32.67 (rate is in dry ounces);

Pounds of insecticide needed = $80 * 6 * 32.67 / 30$

Answer: 522.7 pounds of insecticide.

- 3) **To Determine:** ounces (fluid or dry) of insecticide needed to treat 1,000 feet of row
Given: the application rate per acre
Equation = $R * W * F$

R = application rate per acre
W = row width in inches
F = factor to transform the application rate to ounces or fluid ounces per 1,000 row feet.

The values to use for F are:

- F = 0.2449, if the application rate is given in gallons per acre.
F = 0.06123, if the application rate is given in quarts per acre.
F = 0.03061, if the application rate is given in pints or pounds per acre.
F = 0.001913, if the application rate is given in fluid ounces or ounces per acre.

Example: How many ounces of insecticide are needed to treat 1,000 feet of row, given a broadcast application rate of 15 gallons of spray per acre? The row width is 28 inches.

R = 15 gallons/ acre; W = 28 inches;
F = 0.2449 (rate is in gallons)
Fluid ounces needed per 1,000 row feet =
 $15 * 28 * 0.2449$

Answer: 102.8 fluid ounces

- 4) **To Determine:** Pounds of active ingredient in a recommended rate of formulated insecticide
Given: the application rate of the formulated insecticide
Equation = $F * P * R$

R = the application rate of the formulated insecticide
P = percent active ingredient in the formulated insecticide.
F = factor to transform the application rate into pounds.

The values to use for F and P depend on the type of formulation used:

Dry formulations:

P = the decimal equivalent of percent active ingredient in the formulated product
(examples: 25% SP = 0.25; 15 G = 0.15).
F = 1 if the recommendation is in pounds.
F = 0.00625 if the recommendation is in ounces.

Liquid formulations:

P = the pounds of active ingredient per gallon of formulation (example: 3 EC = 3)
F = 1 if the recommendation is in gallons
F = 0.25 if the recommendation is in quarts
F = 0.125 if the recommendation is in pints
F = 0.007813 if the recommendation is in fluid ounces.

Example: The recommended rate of a 2.4 EC insecticide (a liquid containing 2.4 pounds of active ingredient per gallon of product) is 5.333 ounces of formulated insecticide per acre. How many pounds of active ingredient are in 5.333 ounces?

R = 5.333 oz/ acre; P = 2.4 (liquid formulation, 2.4 lbs. Active/gallon); F = 0.007813
Pounds active = $0.007813 * 5.333 * 2.4$

Answer: 0.1 pounds.

5) **To Determine:** the amount (pounds or gallons) applied per acre, based on the amount of spray solution collected in a calibration test run.

Equation = $F * M / L / W$

- L = length of swath sprayed in feet (i.e. distance of the calibration run)
- W = width of swath sprayed in feet
- M = measured amount of spray solution collected over the calibration run
- F = factor to transform the amount collected into gallons/ pounds per acre.

The values to be used for F are:

- F = 43,560 if "M" is in pounds or gallons.
- F = 10,890 if "M" is in quarts.
- F = 5,445 if "M" is in pints.
- F = 2,723 if "M" is in dry ounces.
- F = 340.3 if "M" is in fluid ounces.

Example: A grower with a 20-foot boom drives a calibration test course of 200 feet, and collects a total of 5 pints of spray. How many gallons is he applying per acre?

- L = 200 feet; W = 20 feet; M = 5 pints;

F = 5,445

Gallons per acre = $5,445 * 5 / 200 / 20$.

Answer: 6.8 gallons.

6) **To Determine:** the amount (dry or fluid ounces) banded per 1,000 feet of row, based on the amount of insecticide applied in a calibration test run.

Equation: $F * M / L$

- L = length of treated swath (i.e. distance of the calibration run)
- M = measured amount of insecticide collected over the calibration run
- F = factor to transform "M"

The values to use for F are:

- F = 128,000, if "M" is in gallons.
- F = 32,000, if "M" is in quarts.
- F = 16,000, if "M" is in pints or pounds.
- F = 1,000, if "M" is in dry or fluid ounces.

Example: A grower drives a calibration test course of 200 feet, and collects 1.5 pounds of granular insecticide over the course. How many ounces is she applying per 1,000 row feet?

F = 16,000; M = 1.5 lbs; L = 200 feet

Ounces per 1,000 row = $16,000 * 1.5 / 200$

Answer: 120 ounces

How to use this bulletin:

Recommendations are organized by crop, then by pest within each crop.

In each crop section, there is a separate table for each pest species.

pest ← **Bean Leaf Beetle**

Pest status: Occasional

Description: Adult beetle has brown, greenish yellow, or red wing covers, with 4 black spots

Life cycle: Adult BLB overwinter in leaf litter and wooded field margins, becoming active in spring
Migrate into beans after first alfalfa cutting; 2 generations per year.

Type of damage: Adults chew small round holes in leaves, or feed on developing pod.

Thresholds: 50% defoliation of seedlings or 25% defoliation during pod fill

List of registered insecticides, *RUP (rate per acre):

Acephate 75SP (0.66 to 1.33 lbs)	Mustang* (3 to 4.3 oz) or Max* (2.72 to 4 oz)
Address 75S (0.66 to 1.33 lbs)	Pennacp M* (1 qt)
Asana XL* (5.8 to 9.6 oz)	Sevin 80S or 80WSP (0.62 to 1.25 lb)
Dimethoate 267 (0.75 to 1.5 pts)	Warrior* (2.56 to 3.84 oz)

Useful
IPM
info

Rate of formulated
product per acre
(unless specified)

* = Restricted Use (RUP)

Alphabetical list
of pesticides

For the insects, at the end of each section there is detailed information on each insecticide.

Insecticide trade name, formulations, RUP status	Common name of active ingredient	Pre-Harvest interval in days	Re-entry interval in hours	Precautions or notes from the label
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Trade name	Common name	Class	Recommended for:	PHI days	REI hrs	Precautions and Remarks
Acephate 75SP	acephate	OP	aphids, armyworms, bean leaf beetles, cutworms, grasshoppers, green cloverworm, leaf rollers, Mexican bean beetle, plant bugs, PLH, thrips	14	24	Max 2 lbs a.i. per acre per season
Asana XL (RUP)	esfenvalerate	Pyr	cutworm, grasshoppers, green cloverworm, Mexican bean beetle	21	12	Maximum 0.2 lb a.i. per acre per season. Do not graze or feed forage to livestock.
Deadline M-Ps 4% Bait	metaldehyde	other	slugs	--	12	For best results apply in the evening, preferably after a rain or irrigation.
Dimethoate 267,400, 4EC, 5 lb	dimethoate	OP	aphids, bean leaf beetle ^{le} , grasshoppers, Mexican bean beetle, mites, plant bugs	7	48	Do not feed treated vines to livestock. Note honeybee precautions.

Insecticide type: biological (Bio), carbamate (Carb), nicotinal (Nic), organophosphate (OP), pyrethroid (Pyr), organochlorine (OCL), or other.

Insecticide is recommended for these insects (aids in choosing a product in multiple pest situations)

SEED-BASED CONTROL of INSECTS

The following tables show seed treatments and transgenic options available for insect control. Many commercial seed treatment contain combinations of ingredients (particularly fungicides to control diseases) to provide a broader spectrum of protection. Transgenic seed also is usually treated with insecticide and/ or fungicide.

DRY BEAN Seed Treatments

Seed treatment protects seeds before germination from early season pests such as maggots and wireworm. Maggot damage can occur under cool, wet conditions that delay germination, particularly in soils with decaying green material (for example, working in a cover crop). Wireworm damage can occur when planting into fallow ground.

Trade name	Common name	Contains a fungicide?	Signal word	Seedcorn maggot	Wireworm	Mex. Bean beetle	Potato leafhopper	REI hrs	Notes
Cruiser 5FS	thiamethoxam	no	caution	1.28 oz per 100 lbs seed	1.28 oz per 100 lbs seed	1.28 oz per 100 lbs seed	1.28 oz per 100 lbs seed	12	Protects against maggots; protection against MBB and PLH runs out during the season. For use only by commercial seed treaters.
Gaucho 480	imidacloprid	no	caution	2 to 4 oz/ 100 lbs seed	2 to 4 oz/ 100 lbs seed	2 to 4 oz/ 100 lbs seed	Not on official label.	12	Provides early-season protection against injury. May also provide early season protection against potato leafhopper. For use only by commercial seed treaters.
Lorsban 30F	chlorpyrifos	no		2.75 fl oz/100 lbs seed	--	--	--	--	Applied as a slurry by a commercial seed treater
Lorsban 50SL	chlorpyrifos	no	Danger	2.0 oz per 100 lbs seed	--	--	--	--	Applied as a slurry by a commercial seed treater

FIELD CORN Seed Treatments

Seed treatment for seedcorn maggot is recommended when planting seed into cool, wet soil that delays germination and exposes the seed to extended insect damage, and also when planting into soil high in decaying green organic matter or a cover crop. Seed treatment for wireworm and grubs is recommended when planting into established fallow areas or sod, or in fields that have a history of infestation. Seed treatment for corn rootworm control is an alternative to granular insecticides at-planting. Only a limited number of seed treatments provide acceptable rootworm control, and the rate is greater than for control of other soil pests.

Trade name	Insecticide common name	Contains a fungicide?	Signal word	Corn rootworm	Seedcorn maggot	White grubs	Wireworm	REI hrs
Agrox Premiere	diazinon lindane	captan metalaxyl	danger	--	3.6 oz/ 100 lbs	--	--	96
Concur	imidacloprid	metalaxyl	caution	-	3.6 oz/ 100 lbs	3.6 oz/ 100 lbs	3.6 oz/ 100 lbs	24
Cruiser 5FS	thiamethoxam	no	caution	5.1-9.0 oz/ 100 lbs	1.28-5.1 oz/ 100 lbs	1.28-5.1 oz/ 100 lbs	1.28-5.1 oz/ 100 lbs	12
Cruiser Extreme	thiamethoxam	fludioxonil mefenoxam azoxystrobin	caution	1.25 mg a.i. per seed	0.25 mg a.i. per seed	0.25 mg a.i. per seed	0.25 mg a.i. per seed	48
Diazinon 50W CleanCrop	diazinon	no	caution	--	0.5 oz/ bushel	--	--	--
Gaucho 600	imidacloprid	no	caution	--	0.16-1.34 mg/ kernel	0.16-1.34 mg/ kernel	0.16-1.34 mg/ kernel	12
Germate Plus	diazinon, lindane	vitavax	caution	--	2 oz/ bushel	--	2 oz/ bushel	12
Kernel Guard	diazinon lindane	captan	danger	--	2 oz/ bushel	--	2 oz/ bushel	12
Kernel Guard Supreme	permethrin	vitavax	caution	--	2 oz/ bushel	--	2 oz/ bushel	12
Kickstart	diazinon, lindane	carboxin	caution	--	2 oz/ bushel	--	2 oz/ bushel	12
Kickstart VP	permethrin	carboxin	caution	--	3.6 oz/ 100 lbs	--	3.6 oz/ 100 lbs	12
Latitude	imidacloprid	carboxin metalaxyl	caution	--	3.6 oz/ 100 lbs	--	3.6 oz/ 100 lbs	24
Lorsban 50SL	chlorpyrifos	no	warning	--	2 oz/ 100 lbs	--	--	--
Poncho 250 & 1250	clothianidin	no	caution	1.25 mg ai/ kernel	0.25 mg ai/ kernel	0.25 mg ai/ kernel	0.25 mg ai/ kernel	
Seedmate Isotox F	lindane	captan	danger	--	8 oz/ 100 lbs	--	4 to 8 oz/ 100 lbs	96
Sorghum Guard	lindane	no	danger	--	--	--	8 oz/ 100 lbs	12

TRANSGENIC OPTIONS for INSECT CONTROL

Several transgenic options are now available to control European corn borer (ECB) or Corn rootworm (CRW) in corn. These options contain genes for selective toxins derived from *Bacillus thuringiensis* (Bt), a common soil bacteria. The biotech traits are available alone, double-stacked, or stacked with the gene for glyphosate tolerance ('Round-up Ready'). Biotech seed to control CRW also come treated with a product such as Poncho or Cruiser to control other soil insects.

Product	Company	Bt protein	Controls ECB?	Controls Rootworm?	Herbicide tolerant?
Agrisure CB (formerly Yieldgard)	NK Seeds/ Syngenta (licensed to many seed companies)	Cry 1Ab	Yes	No	LL
Agrisure GT/CB		Cry 1Ab	Yes	No	LL and RR
Yieldgard	Monsanto (licensed to many seed companies)	Cry 1Ab	Yes	No	Stacks w/ the RR gene are available
Yieldgard RW		Cry 3 Bb	No	Yes	
Yieldgard PLUS		Cry 1Ab Cry 3 Bb	Yes	Yes	
Herculex I	Pioneer / DowAgroSciences	Cry 1F	Yes	No	LL
Herculex RW		Cry 34Ab1/ Cry 35Ab1	No	Yes	LL

Producers using transgenic corn must follow an Insect Resistance Management (IRM) plan to delay target insect from becoming resistant to Bt. IRM plans define the amount and placement of a non-Bt corn planting called a 'refuge'. The refuge produces insects which are not exposed to Bt. In theory, these susceptible insects mate with any resistant insects produced in the Bt field, diluting resistance genes and delaying resistance. Details of the refuges differ with the type of corn.

Type of Corn	Refuge Size (% of field acreage or area)	Can the refuge be treated for the target pest?	Location of the refuge compared to the Bt field:	Refuge placement				
				Block in field	Headlands	Strips in field	Block outside field	Seed mixture
Bt corn for ECB	20%	Yes = But Do NOT use a Bt foliar spray	In field or within ½ mile	Yes	Yes	Yes, 4-row minimum (6 preferred)	Yes	No
Bt corn for CRW	20%	Yes = soil insecticide or seed treatment	In field or adjacent (for ex, across road or ditch)	Yes	Yes	Yes, 6-row minimum (12 preferred)	Yes - adjacent	No

SOYBEAN Seed Treatments

Several new seed treatments are registered for soybean to protect seeds from seedcorn maggot and wireworm. Maggot damage occurs under cool, wet conditions that delay germination, particularly in soils with decaying green material (for example, working in a cover crop). Wireworm damage may occur when planting into fallow ground. Cruiser and Gaucho are systemic, and move up into the growing plant to protect against certain foliar pests. However, the above-ground protection lasts a limited time – generally 35 to 40 days after planting – and infestation and damage can occur after the product runs out.

Trade name	Common name	Contains a fungicide?	Signal word	Seedcorn maggot	Wireworm	Soybean aphid	Bean leaf beetle	REI hrs	Notes
Cruiser 5FS	thiamethoxam	no	caution	1.28 oz per 100 lbs seed	1.28 oz per 100 lbs seed	1.28 oz per 100 lbs seed	1.28 oz per 100 lbs seed	12	Sold as Cruiser Maxx Pak when combined with ApronMaxx.
Gaucho SB Flowable & 480 Flowable	imidacloprid	no	caution	2-4 oz/ 100 wt of seed	--	2-4 oz/ 100 wt of seed	2-4 oz/ 100 wt of seed	12	Protects against maggot damage; <u>reduces</u> damage from aphids and BLB. Check label for important plant-back restriction.
Gaucho 600	imidacloprid	no	caution	1.6-3.2 oz/ 100 lbs seed	--	1.6-3.2 oz/ 100 lbs seed	1.6-3.2 oz/ 100 lbs seed	12	Provides early-season protection against injury. For use only by commercial seed treaters.

SEED TREATMENTS for DISEASE

Consult the tables for registered treatments, and diseases that can be controlled. Many commercial formulations contain combinations of ingredients in order to provide a broader spectrum of protection. Some materials are protectants, which act on the surface of the seed. Others are systemic, and spread throughout the seed. Examples of systemic fungicides include: carboxin, mefanoxam, metalaxyl, triticonazole, tebuconazole, and thiabendazole. *Bacillus subtilis* and *Bacillus pumilis* are living biocontrol bacteria that grows and colonize the seed and root surface.

When to treat seed

Corn

Seed treatment is recommended for all seed corn to prevent or reduce seed decay and seedling blights, especially in early planted corn. Corn seedling blights are more prevalent in cold, wet soil than in warmer soil (above 55 °F). Seedling blights tend to be more severe in no-till or reduced tillage fields. Corn smut, leaf blights, stalk and ear rots and viruses are not controlled by seed treatments.

Small grains

Seed treatment of small grains is recommended for reducing seed decay and seedling blights, and controlling smuts and bunts. Seed borne head scab is another common problem. If scab-infected seed is being used, the seed should be treated before planting.

Soybeans

Seed treatment for soybeans can be beneficial if seed quality is poor (germination less than 80%). It is useful to control early season damping off. Damping off can be a problem where soils are poorly- drained. *Pythium* and *Fusarium* are active when soil temperatures are less than 60°F, and soils are wet, conditions you might expect to find during early plantings. *Phytophthora* and *Rhizoctonia* are most active when soil temperatures are warmer, around 70-80° F. Seed that is infested with *Sclerotinia* (white mold) should be treated with a fungicide before it is used.

Dry beans

Seed treatments for dry beans are useful for reducing early season damping off, and seed decay and seedling diseases caused by *Rhizoctonia*, *Fusarium*, *Pythium* and *Phytophthora*. Seed that is infested with *Sclerotinia* (white mold) should be treated with a fungicide before it is used.

Seed treatment products- commercial vs. on farm treatment

When using seed treatments, it's important to get even coverage of the material on the seeds. Commercial seed treaters have specialized equipment for this purpose. There is a wider range of products available for commercial use. There are a number of seed treatments available for on-farm use, known as hopper-box or planter-box treatments. Most of these treatments call for filling the planter box half full of seed, adding half the treatment, mixing the product into the seed in the planter box with a stick, then adding the rest of the seed and product, and mixing again. You could also premix the seed and treatment together in a container first, then pour the treated seed into the planter box. Consult the label for specific directions for the product used. Some products can be applied to bulk seed on-farm. Consult your local seed dealer for more information about what is available.

Inoculants and seed treatments

Some fungicides may reduce the effectiveness of seed-applied inoculants (*Rhizobium*). The standard practice when using inoculants is to apply them as a stand-alone treatment immediately before planting. Research at Michigan State University has shown a small increase in yield when using inoculants (about 1.5 bu./A). The use of inoculants with soybeans may be helpful when land is newly planted to soybeans, or if it has been a long interval between soybean plantings.

Molybdenum and seed treatments

Several seed treatments in the tables list molybdenum as an ingredient. Molybdenum is important in the nitrogen fixation process. Michigan does not have any wide-spread problems with soils deficient in molybdenum. However, molybdenum deficiencies can occur below pH 6.0. One alternative for soils with a pH range of between 5.0 and 6.0 is to add molybdenum. Liming, however, is the best long-term solution to this problem if soybeans are to be grown regularly.

Seed treatments registered for corn

Trade name	Common name	Seed rots and seedling blights	Pythium damping off	commercial or on farm use = C or F	Rate/100 lb. seed or as noted	REI hrs.	Comments
Allegiance Dry	metalaxyl		X	F	1.5-2 oz.	24	
Allegiance FL	metalaxyl		X	C	0.75 fl. oz.	24	
Allegiance LS	metalaxyl		X	C	1.2 fl. oz.	24	
Allegiance 50 WP	metalaxyl		X	C	0.25- 0.50 oz.	24	
Apron TL	metalaxyl		X	C	0.27 fl. oz.	24	Apply in combination with captan
Apron-XL-LS	mefanoxam		X	C	0.0425-0.085 fl. oz.	48	
Captan 30-DD	captan	X	X	C	1.5 fl. oz.	96	
Captan 400	captan	X	X	C	1.25-2.375 fl. oz	96	
Captan Moly	captan	X	X	F	1.33 oz./bushel	4	
Concur	imidacloprid (insecticide) +metalaxyl		X	F	1.5 oz./bushel	24	Insecticide for wireworm, seed corn maggot, and white grubs.
Cruiser Extreme	fludioxonil +mefanoxam+ azoxystrobin + thiamethoxam (insecticide)	X		C	See label	48	Insecticide for wireworm, seed corn maggot, and white grubs.
Dynasty	axoxystrobin	X	X	C	0.153 fl. oz.	4	Mfg. recommends using only in combination with other fungicides.
Kernel Guard	captan + diazinon + lindane (insecticides)	X		F	2 oz. bushel	12	Insecticides for wireworm, seed corn maggot.
Kernel Guard Supreme	carboxin + permethrin (insecticide)	X		F	1.5 oz./42 lb.	12	Insecticide for wireworm, seed corn maggot.
Kickstart	carboxin + diazinon + lindane (insecticides)	X		F	1.5 oz./42 lb	12	Insecticides for wireworm, seed corn maggot.
Kickstart VP	carboxin + permethrin (insecticide)	X		F	1.5 oz./42 lb.	12	Insecticide for wireworm, seed corn maggot.
Kodiak Concentrate	<i>Bacillus subtilis</i>			C, F	0.1-0.5 oz.	4	Biological fungicide. <i>Fusarium</i> also listed on label.
Latitude	carboxin + metalaxyl + imidacloprid (insecticide)	X	X	F	1.5 oz/42 lb.	24	Insecticide for wireworm, seed corn maggot.
Maxim 4FS	fludioxonil	X		C	0.034-0.068 fl. oz.	12	
Maxim XL	fludioxonil + mefanoxam	X	X	C	0.167 fl. oz.	48	See label for rates in combination with other products
System 3 Seed Treatment	Pentachloronitrobenzene + metalaxyl + <i>Bacillus subtilis</i>	X	X	F	2-3 oz./bushel	12	
42-S Thiram	thiram	X		C	1.5 fl. oz./bu	24	
Trilex	trifloxystrobin	X		C	0.32- 0.64 fl. oz.	12	

Seed treatment for dry beans

Trade name	Common name	Rhizoc.	Pyth.	Phytop.	Seed/seed-ling decay, damping off	commercial or on farm use= C or F	Rate /100 lb. seed or as noted	REI hrs.	comments
Allegiance Dry	metalaxyl		X	X		F	2.0 oz.	24	
Allegiance FL	metalaxyl		X	X		C	0.75 fl. oz.	24	
Allegiance LS	metalaxyl		X	X		C, F	1.2 fl. oz.	24	
Allegiance 50 WP	metalaxyl		X	C		C	0.25-0.50 oz.	24	Use high rate for <i>Phytophthora</i>
Apron TL	metalaxyl		X	X		C	2-4 fl. oz.	24	Use high rate for <i>Phytophthora</i>
Apron-XL-LS	mefanoxam		X	X		C	0.16-0.64 fl.oz.	48	Use high rate for <i>Phytophthora</i>
ApronMaxx RFC	fludioxonil + mefanoxam	X	X	X		C,F	1.5 fl. oz.	48	<i>Fusarium</i> also listed on label
Captan 30-DD	captan				X	C	2.25 fl. oz.	96	
Captan 400	captan				X	C	2-3 fl. oz.	96	
Dynasty	azoxystrobin	X			X	C	0.153-0.765 fl. oz.	4	
Kodiak Concentrate	<i>Bacillus subtilis</i>	X				C,F	0.1-0.5 oz.	4	<i>Fusarium</i> also listed on label
Kodiak Veg. Flowable	<i>Bacillus subtilis</i>	X				C	0.25 oz.	4	<i>Fusarium</i> also listed on label
Maxim 4FS	fludioxonil	X			X	C	0.08-0.16 fl. oz.	12	
Maxim XL	fludioxonil + mefanoxam		X	X		C	0.167	48	See label for rates with other products
Protector-D	thiram	X			X	F	4.5 oz.	24	
System 3 Seed Treatment	Pentachloronitrobenzene + metalaxyl + <i>Bacillus subtilis</i>	X	X	X	X	F	2-3 oz./bushel	12	
42-S Thiram	thiram				X	C	2 fl. oz.	24	
Trilex AL	trifloxystrobin + metalaxyl	X	X			C	5.7 fl. oz.	24	
Vitavax M	carboxin + thiram	X			X	C,F	12 oz.	24	Contains molybdenum
RTU- Vitavax Thiram	carboxin + thiram	X	X		X	C, F	6.8 fl. oz.	24	Labeled for suppression of seed borne <i>Sclerotinia</i>
Yield Shield	<i>Bacillus pumilus</i>	X				C	0.1	4	<i>Fusarium</i> also listed on label

Seed treatment for small grains- wheat, oats, barley

Trade name	Common name	Oat smuts	Wheat		Barley		Seed/ seedling decay	Commercial or on farm use= C or F	Rate /100 lb. seed or as noted	REI hrs.	comments
			loose smut	bunt	loose smut	covered smut					
Allegiance Dry	metalaxyl							F	1.5-2 oz.	24	For <i>Pythium</i> - damping off. Also for rye, triticale
Allegiance FL	metalaxyl						X	C	0.75 fl. oz.	24	For <i>Pythium</i> - damping off. Also for rye, triticale
Allegiance LS	metalaxyl						X	C	1.2 fl. oz.	24	For <i>Pythium</i> - damping off. Also for rye, triticale
Allegiance 50 WP	metalaxyl						X	C	0.25-0.50 oz.	24	For <i>Pythium</i> - damping off. Also for rye, triticale
Apron TL	metalaxyl							C	2-4 fl. oz.	24	<i>Pythium</i> ; Use high rate for <i>Phytophthora</i> Also for rye, triticale
Apron-XL-LS	mefanoxam							C	0.0425-0.085 fl. oz.	48	For <i>Pythium</i> - damping off. Also labeled for rye.
Captan 30-DD	captan						X	C	1.5 fl. oz.	96	wheat
									2 fl. oz.		barley, rye
									2.33 fl. oz.		oats
Captan 400	captan						X	C	1.5-4 fl. oz	96	wheat
									2-3 fl. oz.		barley, rye
									2-4 fl. oz		oats
Charter	triticonazole		X	X	X	X	X	C, F	3.1 fl. oz.	12	Not labeled for oats
Dividend Extreme	difenoconazole + mefanoxam		X	X			X	C	1.0-4.0 fl. oz.	48	For wheat and triticale
Dividend XL	difenoconazole + mefanoxam		X	X			X	C	1.0- 2.0 fl. oz.	48	Wheat only
Dividend XL RTA	difenoconazole + mefanoxam		X	X			X	F	5- 10 fl. oz.	48	Wheat only
Dynasty	azoxystrobin			X			X	C	0.153-0.382 fl. oz.	4	Wheat; not labeled for oats
									0.10-3.75 fl. oz.		barley
Grain Guard	mancozeb	X		X			X	F	2 oz./ bushel	12	Also seed/seedling decay on rye.

Seed treatment for small grains- wheat, oats, barley, continued

Trade name	Common name	Oat smuts	Wheat		Barley		Seed/ seedling decay	Commercial or on farm use= C or F	Rate /100 lb. seed or as noted	REI hrs	comments
			loose smut	bunt	loose smut	covered smut					
Kodiak Concentrate	<i>Bacillus subtilis</i>							C, F	0.05-0.1 oz. wheat, barley	4	Biological fungicide. <i>Fusarium</i> , and <i>Rhizoctonia</i> .
									0.1-0.5 other grains		
LSP	thiabendazole			X				C	4.0 fl. oz.	12	
Maxim 4FS	fludioxonil						X		0.08-0.16 fl. oz.	12	
Maxim XL	fludioxonil + mefanoxam				X		X	C	0.167-0.334 fl. oz.	48	Also for rye and triticale
Raxil-MD	tebuconazole + metalaxyl		X		X		X	C	5-6.5 fl. oz.	24	Labeled for seed borne scab, flag smut.
Raxil-Thiram	tebuconazole + thiram	X	X	X	X	X	X	C	3.5-4.6 fl. oz.	24	Labeled for seed borne scab., flag smut.
Raxil XT	tebuconazole + metalaxyl	X	X		X	X	X	C	0.16-0.20 oz.	24	Also for seedborne <i>Fusarium</i>
Stiletto	carboxin + thiram + metalaxyl	X	X	X	X	X	X	F	5- 6.8 fl. oz.	24	
System 3 Seed Treatment	Pentachloronitro- benzene (PCNB) + metalaxyl + <i>Bacillus subtilis</i>		X	X		X	X	F	2-3 oz. - wheat	12	Not labeled for oats.
									2-4 oz. -barley		
42-S Thiram	thiram	X	X	X	X	X	X	C	2 fl. oz./bushel	24	
Vitavax M	carboxin + thiram	X	X	X	X	X	X	C, F	9-12 fl. oz.	24	Contains molybdenum
Vitavax TL	carboxin + thiram	X	X	X	X	X	X	F	5-6.8 fl. oz.	24	
RTU- Vitavax Thiram	carboxin + thiram	X	X	X	X	X	X	C, F	5-6.8 fl. oz.	24	

Seed treatments registered for soybean diseases

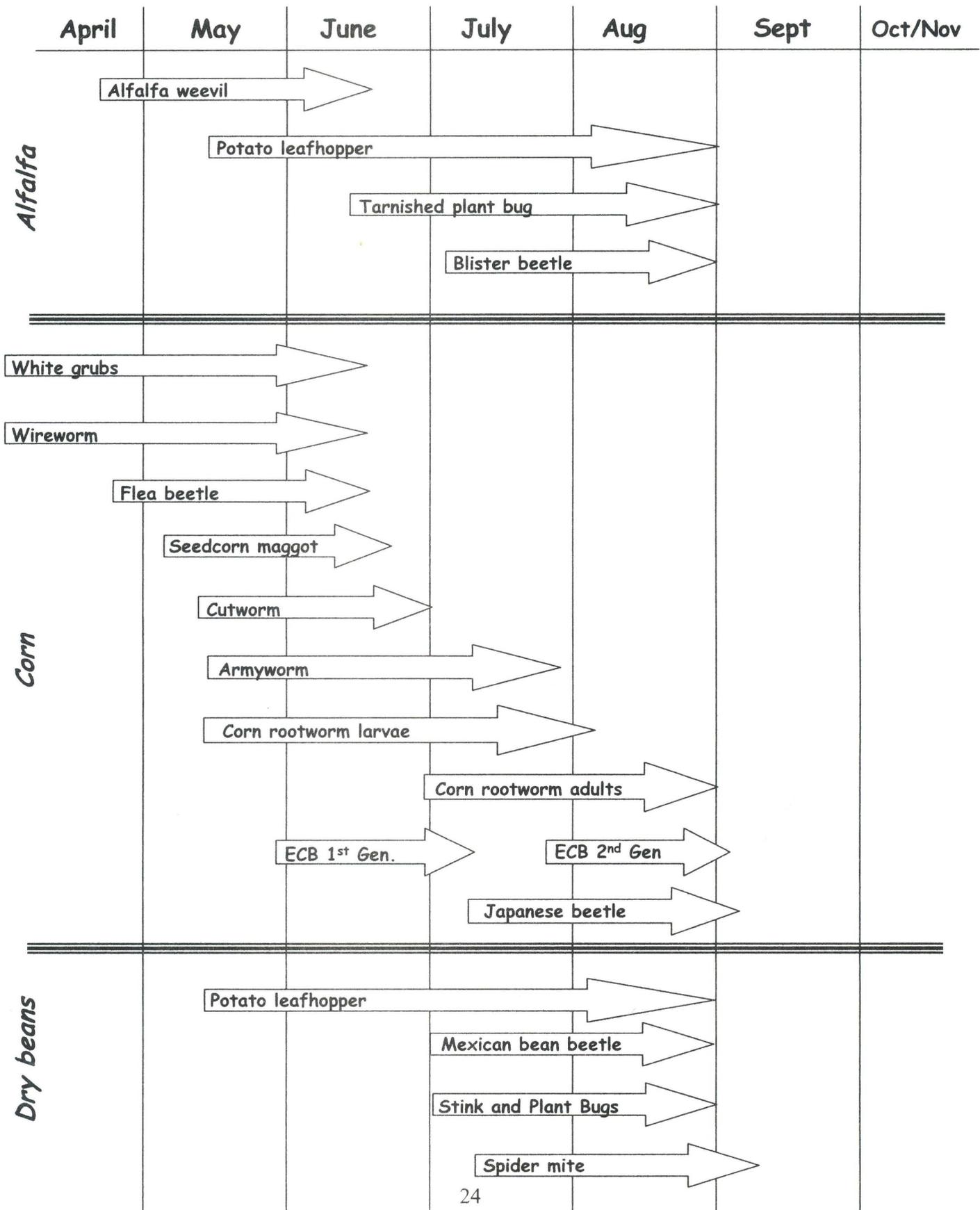
Trade name	Common name	Rhizoc.	Pyth	Phytop.	Phomop.	commercial or on farm use = C or F	Rate /100 lb. seed or as noted	REI hrs.	Comments
Allegiance Dry	metalaxyl		X	X		F	1.5 – 2.0 oz.	24	Labeled for early season <i>Phytophthora</i> control at 2.0 oz. rate
Allegiance FL	metalaxyl		X	X		C	0.75-1.5 fl oz.	24	Labeled for early season <i>Phytophthora</i> control.
Allegiance LS	metalaxyl		X	X		C, F	1.2-2.4 fl. oz	24	
Allegiance 50 WP	metalaxyl		X	X		C	0.5-1.0 oz.	24	Labeled for early season <i>Phytophthora</i> control.
Apron TL	metalaxyl		X	X		C	2.0-4.0 fl. oz.	24	Use higher rate for <i>Phytophthora</i> .
Apron-XL-LS	mefanoxam		X	X		C	0.16-0.64 fl. oz.	48	Labeled for suppression of downy mildew at higher rate
ApronMaxx RFC	fludioxonil + mefanoxam	X	X	X	X	C, F	1.5 oz.	48	Also labeled for <i>Fusarium</i> , and suppression of seed borne <i>Sclerotinia</i> .
ApronMaxx RTA	fludioxonil + mefanoxam	X	X	X	X	F	5.0 fl. oz.	48	Also labeled for <i>Fusarium</i> , and suppression of seed borne <i>Sclerotinia</i> .
ApronMaxx RTA + Moly	fludioxonil + mefanoxam	X	X	X	X	F	5.0 fl. oz.	48	Also labeled for <i>Fusarium</i> , and suppression of seed borne <i>Sclerotinia</i> . Contains molybdenum.
Bean Guard	captan + carboxin	X	X		X	F	2 oz./ 60 lb seed	12	Contains molybdenum.
Bean Guard Allegiance	captan + carboxin + metalaxyl	X	X			F	2 oz./ 60 lb seed	24	Contains molybdenum. Also labeled for <i>Fusarium</i> .
Captan 30-DD	captan	X	X		X	C	2.0 fl. oz.	96	
Captan 400	captan	X	X		X	C	1.5-2.5 fl. oz.	96	
Captan Moly	captan	X	X		X	F	3.5 oz.	4	Contains molybdenum.
Cruiser MAXX Pak	fludioxonil + mefanoxam + thiamethoxam (insecticide)	X	X	X	X		see product labels	48	Also labeled for <i>Fusarium</i> , and suppression of seed borne <i>Sclerotinia</i> ; insecticide for seed corn maggot.
Dynasty	axozystrobin	X	X				0.153-0.459 fl. oz.	4	
Hi Moly Captan-D	captan	X	X		X	F	2 oz./bushel	12	Contains molybdenum.
Kernel Guard Supreme	carboxin + permethrin (insecticide)	X	X		X	F	1.5 oz/50 lb.	12	insecticide for seed corn maggot
Kickstart VP	carboxin + permethrin (insecticide)	X	X		X	F	1.5 oz/50 lb.	12	insecticide for seed corn maggot

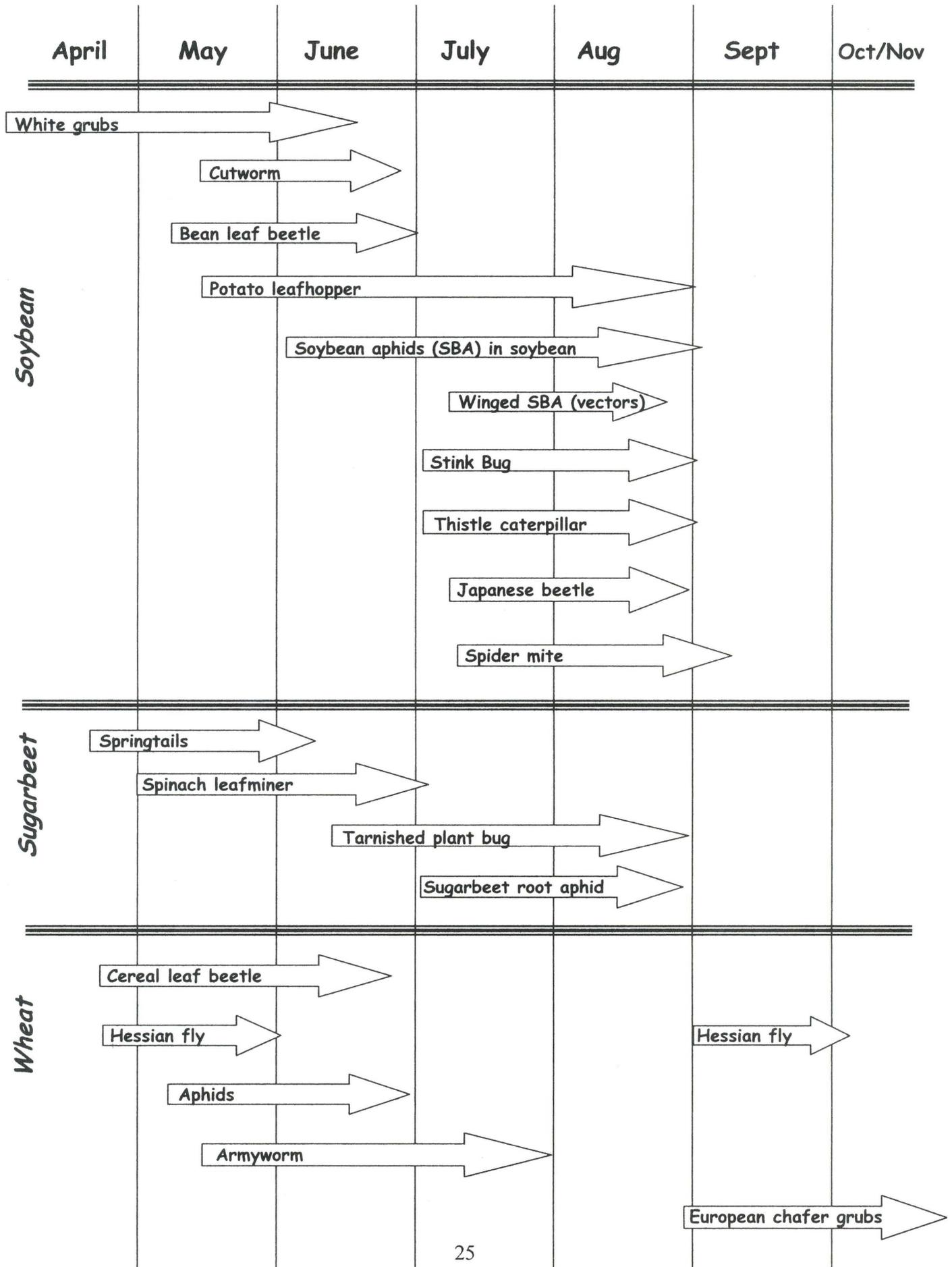
Seed treatments registered for soybean diseases, continued

Trade name	Common name	Rhizoc.	Pyth	Phytop.	Phomop.	commercial or on farm use= C or F	Rate /100 lb. seed or as noted	REI hrs.	Comments
Kodiak Concentrate	<i>Bacillus subtilis</i>	X				C, F	0.125oz.	4	Biological fungicide. <i>Fusarium</i> also listed on label.
LSP	thiabendazole				X	C	0.125-0.25 fl. oz.	12	
Maxim 4FS	fludioxonil	X			X	C	0.08-0.16 fl. oz.	12	
Maxim XL	fludioxonil + mefanoxam		X	X		C	0.167 fl. oz.	48	See label for rates in combination with other products.
Protector-D	thiram	X	X		X	F	2 oz./bushel	24	
Protector-L	thiram	X	X		X	F	6.7 fl. oz.	24	Contains molybdenum.
Protector-L-Allegiance	thiram + metalaxyl	X	X		X	F	6.7 fl. oz.	24	Contains molybdenum.
Protégé FL	azoxystrobin	X	X			C	0.20-0.27 fl. oz.	4	See label for rate in combination with other products
SoyGard, SoyGard L with Protege	azoxystrobin + metalaxyl	X	X		X	C	0.32-0.43 oz.	24	
Stiletto	carboxin + thiram + metalaxyl	X	X			F	6.7 fl. oz.	24	Also labeled for <i>Fusarium</i> Multipack for larger quantities
Stiletto Pak						C	6.8 fl. oz.		
System 3 Seed Treatment	Pentachloronitrobenzene + metalaxyl + <i>Bacillus subtilis</i>	X	X	X	X	F	4-6 oz./bushel	12	
42-S Thiram	thiram	X	X		X	C	2 fl. oz.	24	
Trilex AL	trifloxystrobin + metalaxyl	X	X			C	5.7 fl. oz.	24	
Vitavax M	carboxin + thiram	X				C, F	12 oz.	24	Contains molybdenum.
Vitavax TL	carboxin + thiram	X	X		X	F	6.8 fl. oz.	24	
RTU- Vitavax Thiram	carboxin + thiram	X	X		X	C, F	6.8 fl. oz.	24	Labeled for suppression of seed borne <i>Sclerotinia</i>
Warden RTA	fludioxonil + mefanoxam	X	X	X	X	C	5 fl. oz.	48	Labeled for seed borne <i>Sclerotinia</i> , <i>Fusarium</i>

Michigan Field Crops Insect Calendar

Arrows show when insects are likely occur.





Alfalfa Insect Pests

For more info, visit the alfalfa insects IPM web site at <http://www.ipm.uiuc.edu/fieldcrops/alfalfa/insects.html>

Honeybee Safety Statement: Honeybees often visit alfalfa fields. The insecticide listed in this section, with the exception of Bt, are HIGHLY TOXIC to honeybees. Avoid spraying when bees are present.

Alfalfa Blotch Leafminer (ABL)

For more information: Minnesota fact sheet <http://www.mda.state.mn.us/pestsurvey/factsheets/ablm.htm>

Pest status: Common in the field; rarely an economic pest

Description: Adult = gnat-like fly; larvae = small maggot within leaf tissue.

Life cycle: Overwinters as pupa in soil; adults become active in the spring at temps over 45°F. Females lay eggs on leaves; larvae feed internally between upper and lower leaf tissue. Two to five generations per year, usually one generation per cutting.

Type of damage: Females create pinholes in leaves with ovipositor (egg laying device) and drink the plant juices. Larvae create distinctive mines as they feed internally on the leaf.

Management: Biological ~ Populations in the eastern U.S. generally controlled by parasitoid wasp. Cultural ~ Cutting kills larvae. Chemical ~ Rarely justified and NOT recommended.

Sampling/scouting: Examine 20 stems in 5 different locations of the field; look for pinholes and C-shaped leafmines.

Threshold: Rough guideline - pinholes on most leaves plus small mines present and more than two weeks before next cutting.

Notes: Non-native; first detected in the U.S. in 1968 and in Michigan in 1983.

List of registered insecticides, *RUP (rate per acre):

Baythroid 2* & XL* (2.0 to 2.8 oz)

Furadan 4F* (1 to 2 pts)

Lannate LV* (1.5 to 3.0 pt) or SP* (0.5 to 1.0 lb)

Lorsban 4E* (1 to 2 pt) or Chlorpyrifos 4E* (1 to 2 pts)

Proaxis* (3.84 oz)

Warrior * (3.84 fl oz)

Alfalfa Weevil

Pest status: Common insect, occasionally an economic pest.

Description: Adult is gray-brown snout beetle, dark stripe down back; larvae is green with white stripe down back and black head.

Life cycle: Overwinters as adult in fields, fence rows, wood lots, etc. Emerges in early spring. Adults feed on new growth. Eggs laid in holes chewed on stem by females. Small larvae feed on leaf tips; larger larvae eat entire leaf. Larvae pupate in cocoons on plant. New adults emerge in mid-June/ July, feed a short time, then become inactive until following season. One generation per year.

Type of damage: Defoliation, primarily by larvae. Large larvae skeletonize leaves

Management: Biological control is highly effective. Several species of parasitoid wasp usually provide adequate control. Timely cutting kills most larvae, pupae, some adults. Consider early cutting rather than spraying to preserve natural enemies.

Sampling/ scouting: Early season, use sweep net to detect adult emergence. Before first cutting, sample 20 stems in 5 different locations of the field; look for larvae and damage. After first cutting, check stubble or regrowth for larvae. Scouting ends in July.

Threshold: Before first cutting, 40% of stems damaged, plus live larvae present; after first cutting, 25% or more of new tips damaged, or 6 to 8 larvae per square foot of regrowth.

For more information: MSU bulletin E-2271.

List of registered insecticides, *RUP (rate per acre):

Ambush 25W* (6.4 to 12.8 oz)

Arctic 3.2 EC* (4 to 8 oz)

Baythroid 2* & XL* (1.6 to 2.8 oz)

Furadan 4F* (0.5 to 2 pt for larvae, 1 to 2 pt for adults)

Imidan 70W (1.0 to 1.33 lb)

Lannate LV* (1.5 to 3.0 pt) or SP* (0.5 to 1.0 lb)

Lorsban 4E* (1 to 2 pt) or Chlorpyrifos 4E* (1 to 2 pts)

Malathion 5 EC (1.5 to 2.0 pts) or 57EC (1.5 to 2.25 pts)

Malathion 8F (1 to 2 pts) or ULV (1 pt)

Mustang* (2.4 to 4.3 oz) or Mustang Max* (2.24 to 4 oz)

Pounce 3.2 EC* (4 to 8 oz) and 25WP* (6.4 to 12.8 oz)

Proaxis* (3.84 oz)

Sevin 4F and XLR Plus (1.5 qt)

Sevin 80S and 80WSP (1.87 lb)

Warrior * (2.56 to 3.84 oz)

Aphids (pea aphid & spotted alfalfa aphid)

Pest status: Common insect, rarely an economic pest

Description: Small oval to pear shaped soft-bodied insects. Color varies from bright green to pink to brown. Pea aphids have long cornicles ("tail pipes").

Life cycle: Aphids present during the field season are all female, and do not need to mate to reproduce; females produce live young. Multiple overlapping generations.

Type of damage: Sucks plant sap from leaves, stems; heavy infestation may lead to stunting, curling of leaves, and general weakening of plants.

Conditions favoring damage: Pea aphid - cool, wet weather; spotted alfalfa aphid - hot, dry weather.

Management: Biological - natural enemies (ladybugs, lacewings, and wasps) and fungi generally keep populations in check.

Threshold: 1 or more colonies on plants less than 6 inches; 1 or more colonies per stem for larger plants (colony = 30 or more aphids)

List of registered insecticides, *RUP (rate per acre):

Ambush 25W* (3.2 to 12.8 oz)

Arctic 3.2EC* (2 to 8 oz)

Baythroid 2* & XL* (1.6 to 2.8 oz)

Dimethoate 4EC (0.5 to 1 pt) or 5lb (6.4 to 12.8 oz)

Furadan 4F* (0.5 to 2 pt)

Lannate LV* (1.5 to 3 pt) or SP* (0.5 to 1 lb)

Lorsban 4E* (1 to 2 pt)

Malathion 5EC (1.5 to 2.0 pts) or 57EC (1.5 to 2.25 pts)

Malathion 8F (1 to 2 pts) or 8 Aquamul (1.25 to 2 pts)

Mustang* (2.4 to 4.3 oz) or Mustang Max* (2.24 to 4 oz)

Pounce 3.2EC* (2 to 8 oz) or 25WP* (3.2 to 12.8 oz)

Proaxis* (2.56 to 3.84 oz)

Warrior * (2.56 to 3.84 oz)

Armyworms

Pest status: Occasional pest, depending on the season

Description: Caterpillars variable in color (black/brown/green). Narrow light stripe across back and broad stripes running down sides of body.

Life cycle: Move north into Michigan each spring. 2-3 generations per year.

Type of damage: Defoliation by larvae.

Threshold: Treat when there are four or more armyworms per foot of row.

List of registered insecticides, *RUP (rate per acre):

Agree WG (0.5 to 2 lbs)

Ambush 25W* (3.2 to 12.8 oz)

Arctic 3.2EC* (2 to 8 oz)

Baythroid 2* & XL* (1.6 to 2.8 oz)

Biobit HP (0.5 to 2.0 lbs)

Dipel DF (1 to 2 lb)

Javelin (0.25 to 1.5 lb)

Lannate LV* (1.5 to 3 pt) or SP* (0.25 to 0.5 lb)

Lorsban 4E* (1 to 2 pt) or Chlorpyrifos 4E* (1 to 2 pts)

Malathion 5EC (2 pts) or 57EC (2 to 2.25 pts)

Malathion 8 Aquamul (1.25 to 2 pts) or 8F (1 to 2 pts)

Mustang* (3.0 to 4.3 oz) or Mustang Max* (2.8 to 4 oz)

Pounce 3.2 EC (2 to 8 oz)* or 25WP* (3.2 to 12.8 oz)

Proaxis* (2.56 to 3.84 oz)

Sevin 4F and XLR Plus (1.0 to 1.5 qt)

Sevin 80S and 80WSP (1.25 to 1.875 lb)

Tracer (1 to 2 oz)

Warrior 1EC* (2.56 to 3.84 oz)

Xentari (0.5 to 2 lbs)

Clover Root Curculio

Pest status: Rare.

Description: snout beetle; black/brown, 1/8th inch long.

Life cycle: Adults overwinter. Females lay eggs in spring or fall on lower plant surface or soil; larvae enter soil and feed on roots. One generation per year.

Type of damage: Larvae feed on nodules and small rootlets, chew furrows on main root, and leave extensive scarring. Pathogens may enter these wounds. Can shorten stand life and enhance winter kill.

Conditions favoring damage: Alfalfa planted in or near an old infested field is at greater risk.

Management: Chemical ~ no insecticides available at this time.

Sampling/scouting: No set sampling method. Check roots of unhealthy plants for curculio damage.

Notes: If you have a problem with this insect, contact your local MSU extension agent.

Cutworms

Pest status: Rarely an economic pest

Description: Caterpillar is up to 2 inches long. Variable coloration (black, tan, greenish-yellow), with a row of light yellow spots down the back.

Life cycle: Adults migrate into Michigan in early spring and lay eggs on legumes. Several generations per season.

Type of damage: Larvae feed on leaves and stems. Greatest risk for damage is in new seedlings or regrowth.

Management: Cultural - if larvae are large (1.5-2 inches), delay cutting of established stand until after pupation, to avoid concentrated feeding on regrowth.

Threshold: 5% or more of plants showing cutworm damage.

List of registered insecticides, *RUP (rate per acre):

Ambush 25W* (3.2 to 12.8 oz)

Arctic 3.2EC* (2 to 8 oz)

Baythroid 2* & XL* (0.8 to 1.6 oz)

Lannate LV* (0.75 to 3 pts) or SP* (0.25 to 1 lb)

Lorsban 4E* (1 to 2 pt) or Chlorpyrifos 4E* (1 to 2 pts)

Mustang* (2.4 to 4.3 oz) or Mustang Max* (2.24 to 4 oz)

Pounce 3.2EC* (2 to 8 oz) or 25WP* (3.2 to 12.8 oz)

Proaxis* (1.92 to 3.2 oz)

Sevin 4F and XLR Plus (1.0 to 1.5 qt)

Sevin 80S and 80WSP (1.25 to 1.875 lb)

Warrior* (1.92 to 3.2 oz)

Grasshoppers

Pest status: Common insect, occasional outbreaks

Life cycle: Eggs overwinter in soil; nymphs hatch in June. As nymphs grow, feeding damage increases. Females lay eggs in soil in late summer.

Type of damage: Defoliation by nymphs and adults.

Conditions favoring damage: Unplowed or fallow areas are preferred egg-laying sites, and may contribute to populations in nearby fields. Dry, warm weather enhances nymph survival.

Management: Biological - A fungal pathogen kills many eggs and nymphs under wet spring conditions. Natural enemies (birds, rodents, amphibians) also feed on grasshoppers, but do not keep up during outbreaks.

Threshold: 8 or more per square yard for plants less than 6 inches; 16 or more per square yard for taller plants.

Notes: Usually a problem only around field edges, but during outbreak years may infest entire field.

List of registered insecticides, *RUP (rate per acre):

Baythroid 2* & XL* (2.0 to 2.8 oz)

Dimethoate 4EC (0.5 to 1 pt) or 5lb (6.4 to 12.8 oz)

Furadan 4F* (0.25 to 0.5 pts)

Imidan 70W (1 to 1.33 lbs)

Lorsban 4E* (0.5 to 1 pt) or Chlorpyrifos 4E* (0.5 to 1 pts)

Malathion 5EC (1.5 to 2.0 pt) or 57EC (1.5 to 2.25 pt)

Malathion 8 Aquamul (1.25 to 2.0 pts)

Malathion 8F (1.0 to 2.0 pts)

Malathion ULV (0.5 pts)

Mustang* (3.0 to 4.3 oz) or Mustang Max* (2.24 to 4 oz)

Proaxis* (2.56 to 3.84 oz)

Sevin 4F and XLR Plus (0.5 to 1.5 qt)

Sevin 80S and 80WSP (0.625 to 1.875 lb)

Warrior* (2.56 to 3.84 oz)

Leaf Beetles

(Japanese beetle, bean leaf beetles, corn rootworm adults, cucumber beetles, etc)

Pest status: Common insects, rarely economic pests

Description: Various, depending on species.

Life cycle: These beetles originate in other crops, i.e., bean leaf beetles from soybean, rootworm from corn, cucumber beetles from cucurbits, and Japanese beetle from many host plants. One generation per year.

Type of damage: Defoliation

Management: Typically do not cause enough damage to warrant treatment.

Threshold: Rough guideline is to treat areas where nearly all leaf tips show damage from leaf-feeding beetles.

List of registered insecticides, *RUP (rate per acre):

Ambush 25W* (6.4 to 12.8 oz)

Arctic 3.2EC* (4 to 8 oz)

Lorsban 4E* (0.5 to 1 pt) or Chlorpyrifos 4E* (0.5 to 1 pt)

Pounce 3.2EC* (4 to 8 oz) or 25WP* (6.4 to 12.8 oz)

Proaxis* (2.56 to 3.84 oz)

Pyganic EC1.4 (16 to 64 oz) or EC5.0 (4.5 to 18 oz)

Sevin 4F and XLR Plus (1.0 qt)

Sevin 80S and 80WSP (1.25 lb)

Warrior* (2.56 to 3.84 oz)

Potato leafhopper (PLH)

Pest status: Key pest; widespread and abundant

Description: Small, bright green, torpedo shaped insects. Fast moving, in a “crab-like” fashion. Nymphs resemble adults but are lime green/yellow, much smaller, lack wings.

Life cycle: Adults are carried into Michigan from the south on weather fronts in May/early June. Females lay eggs inside stems. Nymphs hatch in 7-10 days, begin feeding immediately, and reach adult stage in 2-3 weeks. Multiple overlapping generations.

Type of damage: Sucking pest. Both adults and nymphs remove plant sap and inject toxic saliva as they feed. Typical symptom is “hopperburn”. Other symptoms include stunting, curling, and slow development, especially of new seedlings.

Conditions favoring damage: Dry conditions (drought) enhance PLH damage.

Management: Biological = a naturally occurring fungal pathogen reduces PLH numbers under favorable conditions. Cultural = timely cutting kills eggs and many nymphs. Consider early cutting rather than spraying. Varietal selection = tolerant “hairy” alfalfa varieties are available, but may need to be treated under high population pressure. Chemical = Most insecticides are effective against PLH.

Sampling/scouting: Begin scouting in early June. Take 5 sets of 20 sweeps in several parts of the field. Count adults and nymphs.

Threshold: Varies with plant height in inches:

Under 3 inches = 20 adult PLH/ 100 sweeps

3 to 8 inches = 50 adult PLH/ 100 sweeps

8 to 12 inches = 100 adults and/or nymphs/ 100 sweeps

Over 12 inches = 200 adults and/or nymphs/ 100 sweeps

Note: Hopperburn may be confused with drought damage or boron deficiency.

List of registered insecticides, *RUP (rate per acre):

Ambush 25W* and 25WP* (3.2 to 12.8 oz)	Malathion 8 Aquamul (1.25 to 2 pts) or 8F (1.0 to 2.0 pts)
Arctic 3.2EC* (4 to 8 oz)	Mustang* (2.4 to 4.3 oz) or Mustang Max* (2.24 to 4 oz)
Baythroid 2* & XL* (0.8 to 1.6 oz)	Pounce 3.2EC* (4 to 8 oz) or 25WP* (6.4 to 12.8 oz)
Dimethoate 4EC (0.5 to 1 pt) or 5lb (6.4 to 12.8 oz)	Proaxis* (1.92 to 3.2 oz)
Furadan 4F* (1 to 2 pts)	Pyganic EC1.4 (16 to 64 oz) or EC5.0 (4.5 to 18 oz)
Imidan 70W (1 to 1.33 lbs)	Sevin 4 F and XLR Plus (1.0 qt)
Lorsban 4E* (0.5 to 1 pt) or Chlorpyrifos 4E* (1 to 2 pts)	Sevin 80 S and 80 WSP (1.25 lb)
Malathion 5 EC (1.5 to 2.0 pts) or 57 EC (1.5 to 2.25 pts)	Warrior* (1.92 to 3.2 fl oz)

Plant Bugs

(alfalfa and tarnished plant bug)

Pest status: Common insects, occasionally economic pests

Description: 1/8th to 1 inch long, oval “true bugs”. Alfalfa PB is greenish. Tarnished PB is dark brown with yellow V-shaped mark on back. Nymphs resemble adults, but lack wings.

Life cycle: Adults overwinter. Eggs laid into plant tissue. Multiple generations.

Type of damage: Sucking pest. Adults and nymphs remove plant sap and inject a toxic saliva during feeding, resulting in a characteristic crinkling of leaves.

Management: Cultural – cutting may reduce populations; check regrowth and treat if necessary.

Sampling/ scouting: Take 5 sets of 20 sweeps in different parts of the field.

Threshold: Rough guideline ~ plants less than 6 inches, two or more per sweep; larger plants, five or more per sweep.

List of registered insecticides, *RUP (rate per acre):

Ambush 25W* and 25WP* (6.4 to 12.8 oz)	Malathion 5 EC (1.5 to 2.0 pts) or 57 EC (1.5 to 2.25pts)
Arctic 3.2EC* (4 to 8 oz)	Malathion 8F (1.0 to 2.0 pts)
Baythroid 2* & XL* (1.6 to 2.8 oz)	Mustang* (3.0 to 4.3 oz) or Mustang Max* (2.24 to 4 oz)
Dimethoate 4EC (0.5 to 1 pt) or 5lb (6.4 to 12.8 oz)	Pounce 3.2EC* (4 to 8 oz) or 25WP* (6.4 to 12.8 oz)
Furadan 4F* (1 qt)	Proaxis* (2.56 to 3.84 oz)
Lannate LV* (1.5 to 3 pt) & SP* (0.5 to 1.0 lb)	Sevin 4F and XLR Plus (0.5 to 1.5 qt)
Lorsban 4E* (1 to 2 pts) or Chlorpyrifos 4E* (1 to 2 pts)	Sevin 80S and 80WSP (1.25 to 1.875 lb)
	Warrior* (2.56 to 3.84 fl oz)

Slugs

Pest Status: Rarely an economic pest

Type of damage: Feeding on the new plants, possibly to the point that replanting is necessary.

Conditions favoring damage: New seedlings planted into heavy sod or crop residue. Fields with a recent history of slug damage. Cool, wet conditions.

Threshold: No thresholds are established for slugs in alfalfa. Consider treatment if slug damage threatens to reduce stand density below an acceptable level.

List of registered insecticides, *RUP (rate per acre):

Deadline MPs 4% bait (10 to 40 lbs)

Snail & Slug Pellets (various manufactures and rates)

Spittlebugs

Pest status: Common insect, rarely an economic pest

Description: Small, orange/greenish insects, 3/8 inch long. Nymphs hide in frothy spittle mass.

Life cycle: Overwinter as eggs. Nymphs emerge and feed in the spring. Adults do not produce spittle. One generation per year.

Type of damage: Sucking pest. Removes plant sap.

Management: Chemical control is generally not necessary; alfalfa can support a large number of spittlebugs.

Sampling/ scouting: Examine 20 plants in 5 different locations for spittle masses.

Threshold: one or more spittlebugs (spittle mass) per stem.

List of registered insecticides, *RUP (rate per acre):

Ambush 25W* (6.4 to 12.8 oz)

Arctic 3.2EC* (4 to 8 oz)

Baythroid 2* & XL* (0.8 to 1.6 oz)

Imidan 70W (1 to 1.33 lbs)

Lorsban 4E* (1 to 2 pts) or Chlorpyrifos 4E* (1 to 2 pts)

Malathion 5EC (1.5 to 2.0 pts) or 8F (1.0 to 2.0 pts)

Mustang* (2.4 to 4.3 oz) or Mustang Max* (2.24 to 4 oz)

Pounce 3.2EC* (4 to 8 oz) or 25WP* (6.4 to 12.8 oz)

Proaxis* (2.56 to 3.84 oz)

Warrior* (2.56 to 3.84 fl oz)

Sweetclover Weevil

Threshold: Treat when one-third of plants or more show feeding of adult weevil early in the season. When used to treat other pests, malathion will provide some control.

NOTE: An insecticide may be legally applied for a pest not listed on the label as long as it is labeled for the crop (site) and for another insect target that occurs on the crop at a similar timing. Follow all rates and restrictions indicated on the label, including pre-harvest interval. The manufacturer assumes no responsibility for product performance. See page 8 for further information.

Webworms

Pest status: Occasional

Description: Larvae = slender, greenish-black or pink caterpillars, with 6 dark spots on each body segment.

Life cycle: 2-3 generations per year.

Type of damage: Ties leaves together with silk, feeds within the webbing.

Management: Cultural = cutting destroys larvae. Chemical = insecticides generally not needed; may not be effective because larvae hide in webbing.

Sampling/ scouting: Examine 20 stems in 5 locations of the field, or take 100 sweeps.

Threshold: Rough guidelines - one or more webworms per plant; 25% of tips infested; or 5-6 larvae per sweep.

List of registered insecticides, *RUP (rate per acre):

Ambush 25W* (3.2 to 12.8 oz)

Arctic 3.2EC* (2 to 8 oz)

Baythroid 2* & XL* (1.6 to 2.8 oz)

Mustang* (2.4 to 4.3 oz) or Mustang Max* (2.24 to 4 oz)

Pounce 3.2EC* (2 to 8 oz) or 25WP* (3.2 to 12.8 oz)

Proaxis* (2.56 to 3.84 oz)

Pyganic EC1.4 (16 to 64 oz) or EC5.0 (4.5 to 18 oz)

Sevin 4F and XLR Plus (0.5 to 1.5 qt)

Sevin 80S (1.25 to 1.875 lb)

Warrior* (1.92 to 3.2 fl oz)

Insecticides Registered for Alfalfa

Trade Name	Common name	Class	Recommended for:	PHI days	REI hrs	Precautions and Remarks
Ambush 25W (RUP)	permethrin	Pyr	Alfalfa weevil, aphids, armyworm, cutworm, leaf beetles, PLH, plant bug, spittlebug, webworm	0 at ≤6.4 oz 14 at >6.4 oz	12	Maximum of 12.8 oz formulated product per cutting.
Arctic 3.2 EC (RUP)	permethrin	Pyr	Alfalfa weevil, aphids, armyworm, cutworm, leaf beetles, PLH, plant bugs, spittlebug, webworm	14 at >0.1 lb	12	Max 0.2 lbs. active ingredient per cutting.
Baythroid 2 and XL (RUP)	cyfluthrin & beta-cyfluthrin	Pyr	ABL, alfalfa weevil, aphids, cutworm, grasshopper, PLH, plant bugs, spittlebug, webworm	7	12	One application per cutting.
Bt (Agree WG, Dipel, Javelin, Xentari)	<i>Bacillus thuringiensis</i>	Bio	Armyworm	0	4	Use only to control small armyworms when populations are low. Full coverage is important.
Deadline M-Ps	metaldehyde	--	Snails, slugs	--	12	Broadcast by ground or air every 3 to 4 weeks during season as needed. For best results apply in the evening, preferably after a rain or irrigation. Use caution around pets – may be fatal to dogs.
Dimethoate 4EC, 5lb	dimethoate	OP	Aphids, grasshoppers, PLH, plant bug	10	48	Maximum 1 application per cutting. Dimethoate is systemic and full coverage is not required.
Furadan 4F (RUP)	carbofuran	Carb	Alfalfa weevil, aphids, PLH, plant bug	7 at 0.5 pt 14 at 1 pt 28 at 2 pt	48	Maximum 1 application per season. Furadan is systemic and full coverage is not required.
Imidan 70W	phosmet	OP	Alfalfa weevil, grasshopper, PLH, spittlebug	7	24	Maximum of 1 application per cutting.
Lannate (RUP) LV & SP	methomyl	Carb	Alfalfa weevil, aphids, armyworm, plant bug	7	48	Maximum 3.6 lbs active ingredient per acre per season.
Lorsban 4E (RUP) (Also generics = Chlorpyrifos 4E, Govern 4E, & Nufos 4E)	chlorpyrifos	OP	ABL, alfalfa weevil, aphids, armyworm, cutworm, grasshopper, leaf beetles, PLH, plant bug, spittlebug	7 at 0.5 pt 14 at 1 pt 21 at >1 pt	24	Maximum 1 application per cutting and 4 applications per season.
Malathion 5EC, 8 Aquamul, 57EC, 8F	malathion	OP	Alfalfa weevil, aphids, armyworm, grasshopper, PLH, plant bug, spittlebug	0 for ECs 0 to 7 for Aquamul	12	
Malathion - ULV	malathion	OP	Alfalfa weevil, grasshopper	0	12	

ALFALFA

Trade Name	Common name	Class	Recommended for:	PHI days	REI hrs	Precautions and Remarks
Mustang & Mustang Max (RUP)	zeta-cypermethrin	Pyr	Alfalfa weevil, aphids, armyworm, cutworm, grasshopper, PLH, plant bug, spittlebug, webworm	3	12	Do not make applications less than 7 days apart. Maximum use: Mustang - 4.3 oz. per cutting, 12.9 oz per season; Mustang Max - 4 oz. per cutting, 12 oz per season.
Pounce (RUP) 3.2EC, 25WP	permethrin	Pyr	Alfalfa weevil, aphids, armyworm, cutworm, leaf beetles, PLH, plant bug, spittlebug, webworm	0 at 0.1 lb 14 at >0.1 lb	12	Maximum of 0.2 lb active ingredient per cutting. Several generics are available.
Proaxis (RUP)	gamma-cyhalothrin	Pyr	ABL, alfalfa weevil, aphids, armyworm, cutworm, grasshopper, leaf beetles, PLH, plant bug, spittlebug, webworm	1 forage 7 hay	24	Maximum 0.24 pints per acre per cutting, 0.96 pints per acre per season.
Pyganic EC1.4, EC5.0	pyrethrum	Bio	leaf beetles, PLH, webworm	0	12	Listed by the Organic Materials Review Institute (OMRI) for use in organic production.
Sevin 4 F, XLR Plus, 80S, 80WSP	carbaryl	Carb	Alfalfa weevil, armyworm, cutworm, grasshoppers, leaf beetles, PLH, plant bug, webworm	7	12	Do not apply to small plants if they are wet or rain is expected within 48 hrs (may bleach tender foliage). Maximum 1 application per cutting.
Snail and Slug Pellets 3.5 % bait	metaldehyde	--	Snails, slugs	--	12	May apply every 2 weeks as needed. Do not allow pellets to contact edible portion of plant. Keep children, pets, and poultry away from treated areas.
Tracer	spinosad	Bio	armyworm	0 forage 3 hay	4	Max 6 treatments per season and 6 oz per acre per season.
Warrior (RUP)	lambda-cyhalothrin	Pyreth	ABL, alfalfa weevil, aphids, armyworm, cutworm, grasshopper, leaf beetles, PLH, plant bug, spittlebug, webworm	1 forage 7 hay	24	Maximum 0.24 pints per acre per cutting, 0.96 pints per acre per season.

Corn (field & seed) Insect Pests

NOTE: Check the “Herbicide/ Organophosphate Insecticide Compatibility” chart on page XX prior to choosing an organophosphate insecticide (for example, Counter, or Lorsban).

Aphids

Pest status: Common insects, rarely economic pests

Description: Small oval to pear shaped soft-bodied insects, varying shades of green. Have cornicles (“tailpipes”) at rear end.

Life cycle: During the summer, all aphids are female and do not need to mate to reproduce; females produce live young (parthenogenesis). Multiple overlapping generations.

Type of damage: Sucks plant sap from leaves, removing water and nutrients. In heavy infestations, honeydew secretions may result in sticky leaves, whorls, and tassels, inhibiting pollen shed and weakening plants.

Conditions favoring damage: Drought stress may be amplified by aphids removing plant sap.

Management: Biological = natural enemies (ladybugs, lacewings, and wasps) and diseases generally keep populations in check. Heavy rainfall may also reduce the population.

Scouting: Check twenty groups of five plant

Threshold: General guidelines - Consider control if you find 50-400 corn leaf aphids per plant on 50% of the plants, or when there is one colony (group) of aphids or more per plant large enough to make the leaves sticky, but before milk stage.

List of registered insecticides, *RUP (rate per acre):

Asana XL* (5.8 to 9.6 fl oz)

Capture 2EC* (2.1 to 6.4 oz)

Dimethoate 4EC and 400 (0.67 to 1 pt)

Dimethoate 267 (1.0 to 1.5 pt)

Lannate LV* (0.75 to 1.5 pt) or SP* (0.25 to 0.5 lb)

Lorsban 4E* (1 to 2 pt)

Malathion 5EC (1.5 pt)

Malathion 8 Aquamul (1 pt) or 8F (1 pt)

Pennacp-M* (2 to 3 pt)

Armyworm

Pest status: Occasional economic pest

Description: Caterpillars variable in color (black/brown/green), up to 1 ½ inches long. Narrow, light stripe across back and broad stripes running down sides of body.

Life cycle: Eggs are laid on the lower leaves of grasses, especially in the headlands of small grains. Larvae feed on leaves of weeds and corn, molting several times. Larvae pupate in the soil and adults emerge in about one week. There are two to three generations per year, the first in late May to early June. The first generation is most damaging.

Conditions favoring damage: Reduced tillage corn fields; corn near small grain fields.

Type of damage: Larvae feed on leaf margins, sometimes completely defoliating plants and leaving only the midrib. Corn plants usually recover if growing point is not injured, but a severe infestation can defoliate a field in two days.

Scouting: Mainly active at night and during overcast days. During the day, larvae often hide in the whorl, at the base of plants and under debris.

Management: Good weed control, especially grasses in the field and along field borders, reduces likelihood of severe infestation.

Threshold: Treat when 25% of plants have 2 or more larvae per whorl, OR 75% of plants have 1 larvae. Treat only if caterpillars are less than 1.25 inch in length. May be able to limit spray to the field edge, if armyworms invade from another field or grassy border.

List of registered insecticides, *RUP (rate per acre):

Ambush 25W* (6.4 to 12.8 oz)

Arctic 3.2EC* (4 to 8 oz)

Asana XL* (5.8 to 9.6 fl oz)

Bt - *Bacillus thuringiensis* (check specific products for rates)

[Dipel, Javelin, Lepinox, Xentari]

Baythroid 2* & XL* (1.6 to 2.8 oz, controls 1st - 2nd instar larvae)

Capture 2EC* (2.1 to 6.4 oz) or 1.15G (3.5 to 8.7 lbs into whorl)

Capture LFR (0.2 to 0.39 oz/ 1,000 row feet)

Entrust (0.5 to 2 oz/ acre)

Intrepid 2F (4 to 8 oz)

Lannate LV* (0.75 to 1.5 pt) and SP* (0.25 to 0.5 lb)

Lorsban 4E* (1 to 2 pt)

Lorsban 15G (6 to 8 oz per 1000 row ft, into whorl)

Mustang* (3.4 to 4.3 oz) or Mustang Max* (3.2 to 4.0 oz)

Pennacp-M* (2 to 3 pt)

Pounce 3.2EC* (4 to 8 fl oz)

Pounce 25WP* (6.4 to 12.8 oz)

Proaxis * (2.56 to 3.84 oz)

Sevin 4F or XLR Plus (1 to 2 qt)

Sevin 80S and 80WSP (1.25 to 2.5 lb)

Warrior* (2.56 to 3.84 fl oz)

Billbugs

Pest status: Infrequent, local

Description: Adult weevil is gray/brown/black ¼ to ½ inch long

Life cycle: One generation per year. Adults overwinter along field borders. Emergence occurs during corn planting and continues for about five weeks. Eggs are then laid in the soil or in holes eaten in the corn. After hatching, larvae feed on the root crown and go through five to six instars before pupating. Adults emerge between mid summer and fall.

Conditions favoring damage: Small, young plants much more susceptible. Non-rotated corn, reduced tillage corn, field borders, and areas with nutsedge are at greater risk for injury.

Type of damage: Adults create feeding slits on the lower stem and the leaf whorl. When leaves open may see rows of oval-shaped holes (long, oval shot-holing). Larvae feed on the root crown and may severely reduce yield.

Management: Cultural - Crop rotation is an excellent practice because adult billbugs are slow and don't move far. Control of nutsedge and alternate host is highly recommended. Early planting may get corn through susceptible early stages before billbugs emerge.

Threshold: Treat when one-third of small plants or more show feeding of billbugs. Localized treatment on field margins will reduce the amount of insecticide needed.

Special Note: Counter, Furadan, or Lorsban used pre- and at-planting for corn rootworm control will aid in billbug control.

List of registered insecticides, *RUP (rate per acre):

Counter CR* (4.5-6 oz /1,000 row ft), 15G* (8 oz /1,000 row ft) Lorsban 15G (see label for pre- and at-planting rates)

Cereal Leaf Beetle Adults (CLB)

Pest status: Infrequent pest in corn. More common with small grains nearby.

Description: Adult up to 1/4 inch long; black body, metallic blue wing covers, a red pronotum (neck), and orange-red legs with black tarsi (feet). Eggs- very tiny, oblong; yellow to brown. Larvae- Up to ¼ inch long pale yellow to black, usually covered in fecal material to camouflage themselves. First discovered in Berrien County in 1962.

Life cycle: Adults overwinter in plant stubble and in cracks and crevices such as under tree bark. Mating occurs during warm spring temperatures and eggs are laid on the upper surface of the grain leaves. Larvae feed for about two weeks and move to the soil to pupate. If soil moisture is high they may pupate on the plant. These adults emerge in late June and feed for about 3 weeks, then become sedentary. One generation per year.

Type of damage: Adults feed on the surface of leaves, between the veins, rarely causing economic damage.

Conditions favoring damage: Beetles usually abundant in the margins of corn fields adjacent to heavily infested small grain fields.

Management: Biological ~ wasp parasitoids, lady beetles and various other natural enemies.

Threshold: Treat areas where leaves of whorl stage corn are whitened ("frosted") from feeding beetles (i.e. over 50% defoliation).

List of registered insecticides, *RUP (rate per acre):

Capture 2EC* (2.1 to 6.4 oz)

Malathion ULV (4 to 8 fl oz) or 8 Aquamul (1pt)

Mustang Max* (2.72 to 4 oz)

Proaxis * (2.56 to 3.84 oz)

Warrior* (2.56 to 3.84 fl oz)

Corn Rootworm (CRW) Adults

Pest status: Occasional pest, greatest problems in seed corn

Description: Adult beetles about 1/4 inch long; color varying from yellow with spots (southern CR), yellow with black stripes (western CR), or green (northern CR).

Life cycle: Overwinter as eggs in the soil. Eggs hatch in late May to early June. Larvae feed on corn roots for about three weeks; pupation lasts for about two weeks. Adults emerge in early July and feed through the summer; emergence peaks around late July-August. Adults mate soon after emergence, females continue to lay eggs until death.

Type of damage: Adults prefer feeding on silks, but also feed on leaves, and soft kernels.

Conditions favoring damage: Planting corn after corn. Late-planted corn with fresh silks later in the season.

Threshold: Treat only when silks are clipped shorter than 0.5 inch before pollination occurs and if adults are still active.

List of registered insecticides for Corn Rootworm Adults, *RUP (rate per acre):

Ambush 25W* (6.4 to 12.8 fl oz)

Arctic 3.2EC* (4 to 8 oz)

Asana XL* (5.8 to 9.6 fl oz)

Baythroid 2* and XL* (1.6 to 2.8 oz)

Capture 2EC* (2.1 to 6.4 oz)

Dimethoate 4EC and 400 (0.67 to 1 pt), 267EC (1 to 1.5 pts)

Lannate LV* (0.75 to 1.5 pt) or SP* (0.25 to 0.5 lb)

Lorsban 4E* (1 to 2 pt)

Malathion ULV (4 fl oz) or 8 Aquamul (1pt)

Mustang* (2.9 to 4.3 oz) or Mustang Max* (2.72 to 4 oz)

PennCap-M* (1 to 2 pt)

Pounce 3.2 EC* (4 to 8 fl oz)

Pounce 25 WP* (6.4 to 12.8 oz)

Proaxis * (2.56 to 3.84 oz)

Sevin 4F and XLR Plus (1 to 2 qt)

Sevin 80S and 80WSP (1.25 to 2.5 lb)

Warrior* (2.56 to 3.84 fl oz)

Corn Rootworm (CRW) Larvae

Pest status: Important economic pest, greatest problem in corn following corn

Description: Small, white larvae with a brown head, 3 pairs of short legs.

Life cycle: Overwinter as eggs in the soil. Eggs hatch in late May to early June. Larvae feed on corn roots for about three weeks; pupation lasts for about two weeks. Adults emerge in early July and feed through the summer. Eggs laid in soil of fields.

Type of damage: Small larvae feed on root hairs, tips. Larger larvae feed inside large roots, and can severely prune entire nodes of roots. Root loss leads to plant stress from poor water and nutrient uptake. Poor root formation also leads to lodging of plants, harvest problems.

Conditions favoring damage: Planting corn after corn. Late-planted corn with fresh silks later in the season (attract females for egg laying). Damage to rotated corn occasionally occurs in fields with lush growth of alfalfa, soybeans, or weeds during August and September of the previous year, and that are immediately adjacent to heavily infested fields.

Scouting: Count adult rootworms in the current season as a way to predict the threat of the pest the following season as a way to predict the threat of the pest the following season (described in MSU bulletin E-2438). You are strongly urged to make this count if you plan to grow corn after corn and apply a soil insecticide the following year if necessary.

Management: Cultural ~ Crop rotation remains the most effective way to control CRW.

Threshold: When scouting the current-season's corn to predict need for a soil insecticide the next season, 1 beetle per plant. When scouting soybean, yellow sticky trap catches or more than 5 CRW per trap per day in late July- August suggests the need for rootworm control in next years' corn crop. In the current season, a rating scale is used to evaluate root damage after-the-fact, and assess performance of soil insecticides.

Note: Damage from rotation-resistant variant of western corn rootworm is an increasing problem in southern Berrien, Branch, Calhoun, Cass, Kalamazoo, St. Joseph, and Van Buren Counties. Treatment of such fields may be warranted. Please notify your county MSU Extension agent to report damage in rotated corn and to get current scouting/ treatment recommendations.

See the seed treatment section (pg 14-15) for additional rootworm control products applied to the seed or incorporated into transgenic hybrids.

List of registered insecticides, *RUP (rate based on a 30-inch row spacing – method of placement)

Insecticide Placement:

B = seven inch Band placed behind press wheel

BC = Broadcast and incorporated.

IF = In-Furrow

PPI= Pre-Plant Incorporate

T = Seven inch band placed in front of press wheel (T-band)

Aztec 2.1G* (6.7 oz/ 1,000 row feet - T, B, IF)

Furadan 4F* (2.5 fl oz/ 1,000 row feet - T, B, Cult. BC)

Aztec 4.67G* (3 oz / 1,000 row feet – T, B, IF)

Lorsban 15G (8 oz/1,000 row feet - T, B, IF, Cult)

Capture 2EC* (0.3 oz / 1,000 row feet - T)

Lorsban 4E* (2 pt/acre - Cult) or (6 pt/acre - PPI)

Capture 1.15 G (6.4 to 8 oz/ 1,000 row feet - T)

Lorsban 4E* (2.4 oz/ 1,000 row feet - T)

Capture LFR (0.2 to 0.39 oz/ 1,000 row feet)

Mocap 15G* (8 oz/ 1,000 row feet - B)

Counter CR* (4.5 to 6 oz/1,000 row feet - T, B, IF, Cult)

Mocap EC* (1.4 to 2.9 fl oz/ 1,000 row feet)

Counter 15G* (8 oz/ 1,000 row feet - T, B, IF, Cult)

Proaxis * (0.66 oz / 1,000 row feet – IF, T)

Empower 2* 6.4 to 8 oz/ 1,000 row feet

Regent 4SC* (0.24 oz/ 1,000 row feet – IF)

Force 3G* (4 to 5 oz/ 1,000 row feet - T, B, IF)

Warrior* (0.66 oz/ 1,000 row feet – IF, T)

Fortress 5G* (3 to 4.5 oz/ 1,000 row ft - T, IF)

Cutworms

Pest status: Sporadic pest, early season

Description: Several species, including black, dinghy, and variegated cutworms. Black cutworm is most common - larvae (caterpillar) up to 2 inches in length. Variable coloration (gray to black), 4 tubercles per body segment, inner tubercles smaller than the outer tubercles.

Life cycle: Adult moths migrate into Michigan in early spring. Females lay eggs on low-growing weeds (for example, chickweed) or crop debris. Small larvae first feed on weeds, then may move to the crop when larger, or after weed-kill. Several generations per season.

Type of damage: Small larvae create shot holes in the leaves. Older larvae feed on the leaves (variegated) or cut seedlings (black cutworms), reducing stand development. Older plants usually not as affected by cutting as small seedlings. Larvae generally feed at night, and can tunnel into the lower stalk.

Conditions favoring damage: Low, dense weeds in field (egg laying site for females), areas with high crop residue, planting into plowed sod or pasture, cover crops, wet areas, no-till, and late-planted corn after soybeans.

Sampling/ scouting: Begin scouting as soon as corn seedlings emerge. Look for wilted or cut plants; determine percent seedlings damaged. Dig around base of nearby seedlings to identify larvae.

Management: Biological - parasitoids attack older larvae, while ground beetle larvae and adults prey on cutworm larvae. Chemical - rescue (post-planting) treatment is effective and is the preferred option as populations vary from year to year and by location.

Threshold: Treat when five percent or more of crops show cutworm damage.

Special Note: Aztec, Counter, Force, Fortress, Lorsban and Mocap used for corn rootworm control will also control, or aid in control of cutworms. See product label.

List of registered insecticides, *RUP (rate per acre):

Ambush 25W* (6.4 to 12.8 fl oz)	PennCap-M* (4 pt)
Arctic 3.2EC* (4 to 8 oz)	Pounce 3.2EC* (4 to 8 fl oz)
Asana XL* (5.8 to 9.6 fl oz)	Pounce 25WP* (6.4 to 12.8 oz)
Baythroid 2* and XL* (0.8 to 1.6 oz)	Proaxis* (1.92 to 3.2 oz foliar or 0.66 oz/1,000 row ft - IF, T)
Capture 2EC* (2.1 to 6.4 oz)	Sevin 4F and XLR Plus (2 qt)
Capture LFR (0.2 to 0.39 oz/ 1,000 row feet)	Sevin 80S and 80WSP (2.5 lb)
Intrepid 2F (4 to 8 oz)	Warrior* (1.92 to 3.2 fl oz foliar)
Lorsban 4E* (1 to 2 pt)	Warrior* (0.66 oz/1,000 row ft - IF, T)
Mustang* (1.4 to 3 oz) or Mustang Max* (1.28 to 2.8 oz)	

(European corn borer is on the following page)

Flea Beetle

Pest status: Common insect, but rarely an economic pest in field corn

Description: Small, shiny black beetles, with enlarged back legs for jumping

Life cycle: Adults overwinter, emerge in the spring. Lay eggs in soil around corn plants. Larvae feed and pupate in soil. Several generations per year.

Type of damage: Beetles feed on the upper leaf surface, leaving white streaking or scratches on leaf epidermis. Beetles also carry and spread Stewarts wilt bacteria - generally not a problem in field corn, but can cause symptoms (linear yellow lesions, wilting, stunting) and yield loss in seed and sweet corn.

Conditions favoring damage: mild winters favor survival of both adults and the Stewarts wilt bacteria

Threshold: Treat when one-third of seedling plants or more show feeding of leaf beetles.

List of registered insecticides, *RUP (rate per acre):

Ambush 25 W* (6.4 to 12.8 oz)	PennCap-M* (2 to 3 pt)
Arctic 3.2EC* (4 to 8 oz)	Pounce 3.2EC* (4 to 8 fl oz)
Asana XL* (5.8 to 9.6 fl oz)	Pounce 25WP* (6.4 to 12.8 fl oz)
Baythroid 2* and XL* (1.6 to 2.8 oz)	Proaxis* (2.56 to 3.84 oz)
Capture 2EC* (2.1 to 6.4 oz)	Sevin 4F and XLR Plus (1 to 2 qt)
Lannate LV* (0.75 to 1.5 pt) or SP* (0.25 to 0.50 lb)	Sevin 80S and 80WSP (1.25 to 2.5 lb)
Lorsban 4E* (1 to 2 pt)	Warrior* (2.56 to 3.84 fl oz)
Mustang* (2.9 to 4.3 oz) or Mustang Max* (2.72 to 4 oz)	

European Corn Borer (ECB)

Pest status: Common insect. Outbreaks in some years and at some locations.

Description: Adult ~ white to brown moths with waves brown lines on wings. Eggs ~ white, pinhead sized, laid in masses, overlapping like fish scales. Larvae ~ whitish body with black heads, up to an inch when full grown.

Life cycle: Mature larvae overwinter in corn stubble, debris and soil, pupate occurs in late spring. Adult moths emerge in May. Females lay eggs of the 1st generation on the undersides of corn leaves. Eggs hatch within 5-7 days, larvae feed on the leaves or in the whorl. Mature larvae tunnel into stalk to complete development. 1st generation adults emerge, mate, and females lay 2nd generation eggs. 2nd generation larvae bore into the stalk, ear shank, and ear. In most locations of Michigan there are two generations (usually one generation in the UP). ECB have over 200 species of hosts besides corn, and they can be found in weeds, potatoes, peppers, apples, and small grains.

Type of damage: 1st Generation = Shot holing in the leaves by feeding on the whorl, then tunneling into stalk. 2nd generation = Larvae tunnel into the stalk, shank, and ear. Stalk tunneling weakens plant, disrupts water flow, and creates entry wounds for stalk rot fungus.

Conditions favoring damage: Early-planted (taller) fields at risk for 1st gen.; late-planted (shorter) fields at risk for 2nd gen.

Sampling/ scouting: 1st Generation = Mark off 5 sets of 20 consecutive plants. Count the number of plants with ECB feeding, and unroll some whorls to make sure live larvae are still present. 2nd Generation = Mark off 5 sets of 20 consecutive plants and examine each plant for ECB egg masses.

Management: Biological control - Many insect predators as well as birds, bats, and small mammals eat ECB. Parasitoids and pathogens are also common. Cultural- Stalk shredding and plowing reduce number of overwintering moths, but have little impact on subsequent generations. HPR – Resistant hybrids and early crop maturity also help suppress ECB. Transgenic - Bt hybrids effectively kill ECB; non-Bt corn refuge areas must be planted nearby to reduce the chance of resistance to Bt.

Threshold: A decision to treat for ECB depends on many factors including percent infestation, stage of plant and insect growth, and expected yield. A worksheet for calculating the economic threshold can be found in the North Central Regional Publication No. 327, *European Corn Borer: Development and Management*. Scouting and following the worksheet guidelines are strongly recommended for this pest. The following general guidelines should be used only if the more accurate worksheet method cannot be followed. *First Generation* – (last half of June) 50% or more of plants show early feeding (small, whitish marks on the leaves / shot-holing). *Second Generation* (late July) - eggs present on 50% or more of plants and early feeding is first seen.

Note: Timing is critical for ECB control. Large larvae (1/2 in long or longer) are usually deep in the whorls or leaf sheaths, and cannot be reached by insecticides. Do not try to control large larvae. Granules penetrate better into whorls or leaf sheaths than sprays, so granules should be used, when practical.

For more information: Scouting worksheet for 1st generation ECB is in MSU bulletin E-2275

List of registered insecticides, *RUP (rate per acre):

Ambush 25W* (6.4 to 12.8 fl oz)

Arctic 3.2EC* (4 to 8 oz)

Asana XL* (7.8 to 9.6 fl oz)

Bt - *Bacillus thuringiensis* (check specific products for rates)

[Dipel, Javelin, Lepinox, Xentari]

Baythroid 2* and XL* (1.6 to 2.8 oz)

Capture 2EC* (2.1 to 6.4 oz)

Capture 1.15G* (3.5 to 8.7 lbs / acre directed into whorl)

Empower 2* (3.5 to 8.7 lbs/ acre directed into whorl - 1st generation)

Entrust (0.5 to 2 oz)

Furadan 4F* (1.5 to 2 pt)

Intrepid 2F (4 to 8 oz)

Lorsban 4E* (1.5 to 2 pt)

Lorsban 15G (5 to 6.5 lb aerial, broadcast into whorl)

Lorsban 15G (3.5 to 8 oz/ 1,000 row feet, 1st gen. or 6 to 8 oz/ 1,000 row feet, 2nd gen. Directed into whorl)

Mustang* (2.9 to 4.3 oz) or Mustang Max* (2.72 to 4 oz)

PennCap-M* (2 to 4 pt)

Pounce 3.2EC* (4 to 8 fl oz)

Pounce 25WP* (6.4 to 12.8 oz)

Proaxis * (2.56 to 3.84 oz)

Regent 4SC* (0.24 oz / 1,000 feet of row)

Sevin 4F and XLR Plus (1.5 to 2 qt)

Sevin 80S and 80WSP (1.87 to 2.5 lb)

Warrior* (2.56 to 3.84 fl oz)

Grasshoppers

Pest status: Common insects, occasional outbreaks

Life cycle: Eggs overwinter in the soil, and nymphs hatch in June. Nymphs molt as they grow, and feeding increases with size. Females lay eggs in the soil in late summer.

Type of damage: Defoliation (chewing) by nymphs and adults.

Conditions favoring damage: Unplowed or fallow areas next to fields are preferred egg-laying sites, and may contribute to populations in a field. Dry, warm weather often enhances survival of nymphs.

Management: Cultural - plowing and cultivation to destroy eggs. Biological – a fungal pathogen can kill many eggs and nymphs under wet spring conditions. Natural enemies include animals (birds, rodents, amphibians), parasitic wasps, and ground beetles.

Threshold: Treat when there are five grasshoppers or more per plant. In tasseled plants, treat when large numbers of hoppers are feeding on the upper leaves.

List of registered insecticides, *RUP (rate per acre):

Asana XL* (5.8 to 9.6 fl oz)

Baythroid 2* and XL* (2.1 to 2.8 oz)

Capture 2EC* (2.1 to 6.4 oz)

Dimethoate 4EC / 400 (1 pt), 5lb (12.8 oz), or 267 (1.5 pts)

Furadan 4F* (0.25 to 0.5 pt)

Lorsban 4E* (0.5 to 1 pt)

Malathion 5EC (1.5 pt)

Malathion 8F and Aquamul (1pt)

Malathion ULV (8 fl oz)

Mustang* (2.9 to 4.3 oz) or Mustang Max* (2.72 to 4 oz)

PennCap-M* (2 to 3 pt)

Proaxis * (2.56 to 3.84 oz)

Sevin 4F or XLR Plus (0.5 to 1.5 qt)

Sevin 80S and 80WSP (0.66 to 1.875 lb)

Warrior* (2.56 to 3.84 fl oz)

Japanese beetle adults

Pest status: Common insects, rarely economic pests

Description: Various, depending on species. Japanese beetle is metallic green or bronze with reddish wing-covers and tufts of white hair down the side.

Life cycle: Japanese beetle and rose chafer have many host plants. Larvae (grubs) feed underground on roots. Adult emerge mid-summer, and feed on leaves, flowers, and pollen. One generation per year.

Type of damage: Adults clip silks. Severe clipping can reduce pollination. Adults also feed on leaves, giving them a skeletonized appearance. However, leaf feeding usually doesn't cause economic damage.

Scouting: Randomly examine plants in five areas of the field. Note length and maturity of the silks.

Management: Typically do not cause enough damage to warrant treatment.

Threshold: Treat if unpollinated silks are pruned to within one-half inch of the husk.

List of registered insecticides, *RUP (rate per acre):

Baythroid 2* and XL* (1.6 to 2.8 oz)

Capture 2EC* (2.1 to 6.4 oz)

PennCap-M* (2 to 4 pts)

Proaxis * (2.56 to 3.84 oz)

Sevin 4F and XLR Plus (1 to 2 qt)

Sevin 80S and 80WSP (1.25 to 2.5 lb)

Warrior* (2.56 to 3.84 fl oz)

Mites

Pest status: Common, but rarely an economic pest

Description: Tiny, wingless, 8-legged; two-spotted spider mite is greenish yellow to orange with 2 black spots on body.

Life cycle: Adults overwinter in field borders and sheltered areas. In spring, adults move to new growth and lay eggs on underside of leaves. Mites spread by crawling or blowing in the wind. Populations can increase quickly in hot, dry weather.

Type of damage: Sucking pest. Adults and nymphs insert mouthparts and feed in individual plant cells, resulting in small speckled yellow spots (stippling), water loss, and leaf damage.

Conditions favoring damage: Prolonged dry, hot weather

Sampling/scouting: Look for mites on undersides of leaves using hand lens, or tap leaves over a piece of paper. Webbing may be present on leaves if population is high.

Management: Biological – a natural fungal pathogen can infect and wipe out large mite populations.

Threshold: Treat when one-third of plants or more have mites and when the first yellowing of the leaves appears.

List of registered insecticides, *RUP (rate per acre):

Capture 2EC* (5.12 to 6.4 oz)

Comite (2 to 3 pt)

Dimethoate 4EC, 400 (0.67 to 1 pt) or 267EC (1 to 1.5 pt)

Dimethoate 5lb (8.4 to 12.8 oz)

Seedcorn Maggot

Pest status: Occasional, localized pest

Description: Larva is a small (1/4 inch), white maggot, with no legs or visible head; adult is a small gray fly.

Life cycle: Overwinter as pupae in soil. Adult flies emerge in early spring, laying eggs in disturbed soil with decaying organic matter. Larvae feed on decaying matter or seeds. Several generations per year.

Type of damage: Maggots feed on germinating seed; may cause variable emergence, stand loss and delayed development.

Conditions favoring damage: Cool wet soil (delays germination) or any other factor that slows germination; soils high in organic matter from cover crop or manure.

Management: Cultural – Shallow seeding in prepared, warm soil decreases potential for injury. Delay planting into cover crops until after organic matter decomposition.

Threshold: Treat where corn is planted in soils high in organic matter where manure has been applied, or fields that have a heavy growth of green plant material plowed down in the spring.

List of registered insecticides, *RUP (rate based on a 30-inch row - placement)

Insecticide Placement:

B = Seven-inch Band placed behind press wheel

BC = Broadcast and incorporated.

IF = In-Furrow

PPI = Pre-Plant Incorporate

T = Seven-inch band placed in front of press wheel (*T*-band)

See the seed treatment section (pg 14) for additional maggot control products.

Aztec 2.1G* (6.7 oz/ 1,000 row feet - T, B, IF)

Force 3G* (4 to 5 oz/ 1,000 row feet - T, B, IF)

Aztec 4.67G* (3 oz/ 1,000 row feet - T, B, IF)

Fortress 5G* (3.0/ 1,000 row feet - T, IF)

Capture 1.15G* (rate varies with application method - see label)

Lorsban 4E* (4 pt/ acre preplant, 2.6 pts/ acre – T)

Capture 2EC* (0.15 to 0.3 oz/ 1,000 row feet - T)

Lorsban 15G (8 oz/ 1,000 row feet – B, IF)

Capture LFR (0.2 to 0.39 oz/ 1,000 row feet)

Proaxis * (0.66 oz / 1,000 row ft – IF, T)

Counter CR* (4.5 to 6 oz/ 1,000 row feet - T, B, IF)

Regent 4SC* (0.24 oz/ 1,000 row feet – IF)

Counter 15G* (8 oz/ 1,000 row feet - T, B, IF)

Warrior* (0.66 oz / 1,000 row feet - T, IF)

Empower 2* (rate varies with application method - see label)

Slugs

Pest status: Common pest, but only a sporadic (though increasingly) economic pest.

Description: 1-2 inches, usually gray to brown in color.

Life cycle: Overwinter as eggs and adults. Females deposit egg masses in soil; these hatch in about one month. Multiple overlapping generations.

Type of damage: May damage seeds and seedlings by feeding on stems, cotyledons, and leaves; heavy feeding on the whorl stage corn may inhibit stand development and reduce yield. Damage often occurs at night.

Conditions favoring damage: Cool, wet conditions in the spring; planting into wheat stubble or other heavy crop residue, or into a field with recent history of slug damage.

Sampling/ scouting: No established method. Note slime trails on the foliage and soil.

Threshold: No thresholds have been established for slugs in corn. Consider treatment if slug damage threatens to reduce plant vigor or stand density below an acceptable level.

List of registered insecticides (rate per acre)

Deadline MPs 4% bait (10 to 40 lb)

Snail and Slug Pellets 3.5% bait (products and rates vary)

Stalk Borers

Pest status: Rarely an economic pest.

Description: Larvae purple to black. Front half of body is generally darker than rear-half. White stripe down back. Adult moths are dull, white.

Life cycle: Overwinter as eggs. Small larvae tunnel into grasses and other weeds, large larvae may move to corn. Larvae pupate inside tunnels, emerging as moths in August. Eggs (overwinter) deposited on weeds. Stalk borers have a wide host range, and will feed on several hundred different broadleaf and grassy weeds.

Type of damage: Stalk tunneling by larvae – kills small plant outright. Tunneling in larger plants causes “dead heart” (a dead whorl). Infestations can also cause stunting, tillering, and other development problems.

Conditions favoring damage: Corn after corn, grassy field edges, or buffer strips.

Management: Biological - Many insect predators and pathogens. Cultural – mowing field edges to remove egg-laying sites. Chemical – insecticides can sometimes be applied to field margins, rather than the entire field.

Threshold: Treat when one-third of plants or more show early damage from stalk borers.

List of registered insecticides, *RUP (rate per acre):

Ambush 25W* (6.4 to 12.8 oz)

Arctic 3.2EC* (4 to 8 oz)

Asana XL* (5.8 to 9.6 oz)

Baythroid 2* and XL* (1.6 to 2.8 oz)

Capture 2EC* (2.1 to 6.4 oz)

Capture LFR (0.2 to 0.39 oz/ 1,000 row feet)

Lorsban 4E* (2 to 3 pt)

Lorsban 15G (8 oz/1,000 row ft)

Mustang* (2.9 to 3.4 oz) or Mustang Max* (2.72 to 4 oz)

Pounce 3.2EC* (4 to 8 fl oz)

Pounce 25WP* (6.4 to 12.8 oz) or WSP* (1 to 2 sol. bags)

Proaxis* (2.56 to 3.84 oz)

Regent 4SC* (0.24 oz / 1,000 feet of row)

Warrior* (2.56 to 3.84 fl oz)

Thrips

Pest status: Common insect, rarely an economic pest

Description: Adult – small, slender, brown and white-banded abdomen, narrow fringed wings; larvae – resemble adults, but are wingless, yellow/orange

Life cycle: Adults move into corn in the spring. Females insert eggs in plant tissue. Larvae and adults both feed on corn. Multiple, overlapping generations.

Type of damage: Most obvious early in season; adult & nymph rasping/sucking mouthparts scrape cells of leaves, stalks and husks, causing silvery lesions. Severe injury may cause stunting. Injury at the base of ears may cause poor quality, under-developed ears susceptible to secondary infection.

Conditions favoring damage: Hot dry weather coupled with large thrips populations.

Management: Biological – many natural enemies (minute pirate bugs, predacious thrips and mites) attack thrips. Chemical control not usually recommended.

Threshold: None. A tremendous number of thrips would have to be present to cause damage.

List of registered insecticides, *RUP (rate per acre):

Malathion 5EC (1.5 pt), 8 aquamul (1 pt), or 8F (1 pt)

White Grubs

Pest status: Localized economic pest (especially in last few years)

Description: White, C-shaped larvae of scarab beetles (includes Japanese, May/ June, European chafer beetles). Up to one inch long in last instar. Orange to brown head.

Life cycle: JB and chafer ~ Adults emerge in mid-summer, lay eggs in fields and turf. Grubs feed until the ground freezes, reaching largest stage in late fall. Grubs resume feeding in early spring, can do considerable damage to small plants. Chafer pupates in late May, JB feeds a little longer. May/June beetle ~ remain in larval stage for several years in undisturbed grassy areas and fallow fields.

Type of damage: Prune small roots and damage larger roots. Corn can wilt, or occasionally turn purple due to inability to take up phosphorus. Severe injury lead to plant death.

Conditions favoring damage: May/June beetles ~ Fields following an established grass, planting into fallow areas.

Sampling/ scouting: Dig one-foot square samples several inches deep and check for grubs. Also watch for grubs moved to the surface when plowing in the spring.

Management: Cultural = spring and fall plowing of established sod is recommended before planting; Chemical = soil insecticide generally not required, but rescue treatments are ineffective.

Threshold: General guideline, minimum of .1 grub per square foot.

List of registered insecticides, *RUP (rate per acre):

Insecticide Placement:

*B = seven inch Band placed behind press wheel BC = Broadcast and incorporated.
IF = In-Furrow PPI= Pre-Plant Incorporate
T = seven inch band placed in front of press wheel (T-band)*

See the seed treatment section (pg 14) for additional grub control products.

Annex 2EC* (rate varies w/ application method - see label)	Force 3G* (4 to 5 oz/ 1,000 feet of row - T, B, IF)
Aztec 2.1G* (6.7 oz/ 1,000 feet of row - T, B, IF)	Fortress 5G* (3.0 to 3.75 oz/ 1,000 feet of row - T, IF)
Aztec 4.67G* (3 oz/ 1,000 feet of row - T, B, IF)	Lorsban 15G (8 oz/ 1,000 feet of row - T, IF)
Capture 2EC * (rate varies with application method -see label)	Mocap 15G* (8 oz/ 1,000 feet of row - B)
Capture 1.15G* (rate varies with application method -see label)	Proaxis* (0.66 oz / 1,000 feet of row - T, IF)
Capture LFR (0.2 to 0.39 oz/ 1,000 row feet)	Regent 4SC* (0.24 oz / 1,000 feet of row – IF)
Counter CR* (4.5 to 6 oz/ 1,000 feet of row - T, IF)	Thimet/ Phorate 20G* (6 oz/ 1,000 feet of row - T, B)
Counter 15G* (8 oz/ 1,000 feet of row - T, IF)	Warrior* (0.66 oz / 1,000 feet of row - T, IF)
Empower 2* (rate varies with application method - see label)	

Wireworms

Pest status: Common insect; economic infestations often localized within a field.

Description: Slender, shiny, yellow to brown insect with wiry, segmented, hard body; up to 1.5 inches long.

Life cycle: Wireworms are the immature form of click beetles; found in grasslands, sod, or fallow fields. Wireworms can spend several years in the immature stage. Overlapping generations.

Type of damage: Feed on newly-planted corn seeds as well as roots of established corn. May tunnel into the base of seedlings below the soil surface.

Conditions favoring damage: Porous, well drained loam soils. Corn planted into long-standing fallow fields & pasture.

Sampling/ scouting: Scout for wireworms with a bait trap (see web site below) at least one week before planting.

Management: Cultural – If practical, spring and fall plowing of established sod is recommended before crop is planted

Threshold: It using bait trap, one or more wireworm per trap. Otherwise, consider treating when wireworms are seen while plowing old pasture or fields that had grasses, or where damage has occurred previously.

For more information: http://www.ipm.msu.edu/CAT02_fld/FC5-16-02.htm

List of registered insecticides, *RUP (rate based on 30-inch row - placement)

Insecticide Placement:

*B = seven inch Band placed behind press wheel BC = Broadcast and incorporated.
IF = In-Furrow PPI= Pre-Plant Incorporate
T = seven inch band placed in front of press wheel (T-band)*

See the seed treatment section (pg 14) for additional wireworm control products.

Wireworms, Continued from previous page

Aztec 2.1G* (6.7 oz/ 1,000 feet of row - T, B, IF)	Force 3G* (4 to 5 oz/ 1,000 feet of row - T, B, IF)
Aztec 4.67G* (3 oz/ 1,000 feet of row - T, B, IF)	Fortress 5G* (3.0 to 3.75 oz/ 1,000 feet of row - T, IF)
Capture 2EC * (rate varies with application method -see label)	Lorsban 15G (8 to 12 oz/ 1,000 feet of row - T, IF, B)
Capture 1.15G* (rate varies with application method -see label)	Lorsban 15G (13.5 lb/acre - BC)
Capture LFR (0.2 to 0.39 oz/ 1,000 row feet)	Mocap 15G* (8 oz/ 1,000 feet of row - B)
Counter CR* (4.5 to 6 oz/ 1,000 feet of row - T, IF, B)	Regent 4SC* (0.24 oz / 1,000 feet of row - IF)
Counter 15G* (8 oz/ 1,000 feet of row - T, IF, B)	Thimet/ Phorate 20G* (6 oz/ 1,000 feet of row - T, B)
Empower 2* (rate varies with application method - see label)	

Herbicide / Organophosphate (OP) insecticide compatibility chart for conventional & IT corn

Herbicide	Soil-applied OP ¹						Foliar applied OP ⁴	
	Counter 15G	Counter 20 CR in-furrow	Counter 20 CR T-band	Thimet/ phorate	Lorsban 15G	Other ²	⁵ Days before herbicide	⁶ Days after herbicide
<i>Accent</i>	DNU	DNU	NR	T	T	T	7	3
<i>Accent Gold</i> <i>Accent Gold WDG</i>	DNU	DNU	DNU	DNU	NR	T	7	3
<i>Beacon</i>	DNU	DNU	NR	T	T	T	10	7
<i>Basis</i>	DNU	DNU	NR	NR	NR	T	7	3
<i>Basis Gold</i>	DNU	DNU	NR	NR	NR	T	7	3
<i>Callisto (foliar)</i>	DNU	DNU	NR	NR	T	T ³	7	7
<i>Hornet WDG (soil-applied)</i>	DNU	DNU	DNU	DNU	T ³	T ³	NA	NA
<i>Hornet WDG (foliar-applied)</i>	DNU	DNU	DNU	DNU	T ³	T ³	10	10
<i>Lightening - IT corn only</i>	DNU	DNU	T ³	T ³	T ³	T ³	--	--
<i>Option</i>	DNU	DNU	DNU	DNU	T	T	7	7
<i>Steadfast</i>	DNU	DNU	NR	NR	NR	T	7	3

¹ DNU = Do Not Use. Do not apply herbicide to corn treated with soil applied OP; severe injury may result.
 NR = Not Recommended to make an application of herbicide to corn treated with soil applied OP.
 T = Temporary injury may result from application of herbicide to corn treated with soil applied OP.
 NA = not applicable -- = no information

2 Includes *Diazinon & Mocap*. *Aztec & Fortress* do not appear to interact with herbicides, and can be used without risk of injury.
 3 OP insecticides should be banded to reduce risk of crop injury.
 4 Includes dimethoate, diazinon, Imidan, Lorsban 4F, malathion, PennCap, Basagran and Laddock
 5 Foliar-applied OP can be safety applied this many days BEFORE herbicide treatment
 6 Foliar-applied OP can be safety applied this many days AFTER herbicide treatment

Insecticides Registered for Corn (field and seed)

Trade name	Common name	Class	Recommended for:	PHI days	REI hrs	Precautions and Remarks
Ambush (RUP) 25W	permethrin	Pyr	armyworm, CRW adults, cutworm, ECB, flea beetle, stalk borers	30	12	Do not apply more than 0.6 lb a.i. per acre per season. Allow minimum of six days between treatments. PHI for forage is 0 days. Several generics available.
Arctic (RUP) 3.2 EC	permethrin	pyr	Armyworm, CRW adults, cutworm, ECB, flea beetle, stalk borer	30	12	Same precautions as Ambush (above).
Asana XL (RUP)	esfenvalerate	Pyr	aphids, armyworm, CRW adults, cutworm, ECB, flea beetle, grasshoppers, stalk borer	21	12	Maximum 48 oz per acre per season.
Aztec 2.1G (RUP)	tebupirimphos + cyfluthrin	OP Pyr	CRW larvae, seedcorn maggot, white grubs, wireworm	--	48	Maximum of 7.3 lbs per acre per season.
Aztec 4.67G (RUP)	tebupirimphos + cyfluthrin	OP Pyr	CRW larvae, seedcorn maggot, white grubs, wireworm	--	48	Maximum of 3.27 lbs per acre per season.
Bt [Dipel, Javelin, Lepinox, Xentari]	<i>Bacillus thuringensis</i>	Bio	armyworm, ECB	0	4	Use only to control small armyworm when populations are low. Full spray coverage is needed.
Baythroid 2 and XL (RUP)	cyfluthrin & beta cyfluthrin	Pyr	armyworm, CRW adults, cutworm, ECB, flea beetle, grasshopper, JB adults, stalk borer.	21	12	Maximum of 11.2 oz per acre per season.
Capture (RUP) 2EC, 1.15G	bifenthrin	Pyr	aphids, armyworm, CLB, CRW adults, CRW larvae, cutworm, ECB, flea beetle, grasshopper, JB adults, mites, seedcorn maggot, stalk borer, white grub, wireworm	30	12 -EC 24 -G	Maximum 12.8 oz a.i. of the 2EC per acre per season. Note that the REI for detasseling and roging seed corn treated with Capture 1.15G is 18 DAYS.
Capture (RUP)	bifenthrin	Pyr	armyworm, CRW larvae, cutworm, seedcorn maggot, stalk borer, white grub, wireworm	--	12	Max 0.1 lb active ingredient per acre at planting. Max 0.3 lb active per acre per season of at-plant plus foliar applications of bifenthrin.
Comite	propargite	other	mites	30	168	Max 1 application per season. Apply when corn leaves are dry to prevent crop injury. Rotation interval to small grains is 82 days. Rotation interval to other crops is 6 months, unless propargite is registered on that crop.
Counter (RUP) CR, 15G	terbufos	OP	billbugs, CRW larvae, ECB, seedcorn maggot, white grub, wireworm	30	48	Maximum 6.5 lb 20 CR per acre.
Deadline MPs 4% bait	metaldehyde	other	slugs	---	12	Broadcast by ground or air every 3 to 4 weeks during season as needed. For best results apply in the evening, preferably after a rain or irrigation.
Dimethoate 4EC, 400, 5 lb, 267 EC	dimethoate	OP	CRW adults, grasshoppers, mites	14	48	Maximum 2 applications per season. Do not apply during pollen shed if bees are actively foraging in field. Dimethoate is systemic and full coverage is not required. Several generics available.

Trade name	Common name	Class	Recommended for:	PHI days	REI hrs	Precautions and Remarks
Empower 2 (RUP)	bifenthrin	Pyr	CRW larvae, ECB, seedcorn maggot, white grub, wireworm	30	24	Note that the REI for detasseling and roguing seed corn treated with Empower is 18 DAYS.
Entrust	spinosad	Bio	Armyworm, ECB	28	4	Max 3.75 oz per acre per year.
Force 3G (RUP)	tefluthrin	Pyr	CRW larvae, seedcorn maggot, white grubs, wireworm	--	48	Use only high rate for severe infestations. Apply in-furrow for best control. Do not apply within 20 yards of water.
Fortress 5G (RUP)	chlor-ethoxyfos	OP	CRW larvae, seedcorn maggot, white grubs, wireworm	--	48	Rotation interval is 30 days. For optimal control apply IF. Fortress 5G is available in closed handling system.
Furadan 4F (RUP)	carbofuran	Carb	CRW larvae, ECB, grasshoppers	30	48	Max two applications per season.
Intrepid 2F	methoxy-fenozide	Other	armyworm, cutworm, ECB	30	24	Maximum of 8.7 lbs per acre at planting. Maximum of 26.1 lbs per acre per season.
Lannate (RUP) LV & SP	methomyl	Carb	aphids, armyworm, CRW adults, flea beetle	21	48	
Lorsban 15G	chlor-pyrifos	OP	armyworm, billbugs, CRW larvae, ECB, seedcorn maggot, stalk borers, white grubs, wireworm	35	24	Maximum 13.5 lb per acre per season. For best control, apply as an in-furrow treatment. Pre-harvest interval for grazing is 14 days, and for fodder, 35 days.
Lorsban 4E (RUP)	chlor-pyrifos	OP	aphids, armyworm, billbugs, CRW adults; CRW larvae, cutworms, ECB, flea beetle, grasshoppers, seedcorn maggot, stalk borers	35	24	Maximum 15 pts per acre per season. Pre-harvest interval for grazing is 14 days, and for fodder, 35 days. Several generics available.
Malathion 8F, 5EC, 8 aquamul, ULV	malathion	OP	aphids, CLB, CRW adults, grasshoppers, thrips	5	12	
Mocap 10G, EC (RUP), 15G (RUP)	ethoprop	OP	CRW larvae, white grubs, wireworm	--	48	For CRW, apply in a band and mix with top 2 to 4 inch of soil. See label for other band-widths and row spacing varying from 30 inches. Do not allow granules to contact seed.
Mustang and Mustang Max (RUP)	zeta-cypermethrin	Pyr	aphids, armyworm, CRW adults, cutworms, ECB, flea beetles, grasshoppers, stalk borer	30	12	Max rate varies with pest, see label. Pre-harvest interval is 30 days for fodder, 60 days for silage and forage.
PennCap-M (RUP)	methyl parathion	OP	aphids, armyworm, CRW-adults, cutworms, ECB, flea beetles, grasshoppers, Japanese beetle	12	96	Do not apply at pollen shed if bees are visiting field.
Pounce (RUP) 3.2EC, 25WP	permethrin	Pyr	armyworm, CRW adults, cutworm, ECB, flea beetle, stalk borers	30	12	Do not apply more than 0.6 lb a.i. per acre per season. Allow minimum of six days between treatments. Preharvest interval is 30 days for fodder, 0 days for forage. Several generics available.
Proaxis (RUP)	gamma cyhalothrin	Pyr	armyworm, CLB, CRW adults, CRW larvae, cutworms, ECB, flea beetle, grasshoppers, Japanese beetle, seedcorn maggot, stalk borer, white grub	21	24	

Trade name	Common name	Class	Recommended for:	PHI days	REI hrs	Precautions and Remarks
Regent (RUP) 4SC	fipronil	Other	CRW larvae, ECB, stalk borers, seedcorn maggot, white grubs, wireworms	90	24	Do not apply on row spacings LESS THAN 30 INCHES. Do not apply to sweet corn or popcorn. Do not plant small grains or other rotational crops within 12 months following application. Regent will aid in control of first-generation corn borer.
Sevin 4 F, XLR Plus 80 S, 80 WSP	carbaryl	Carb	armyworm, CRW adults, cutworms, ECB, flea beetles, grasshoppers, Japanese beetle,	48	12	Maximum 4 applications per season. . Preharvest interval is 48 days for fodder, 14 days for grazing and silage.
Snail and Slug Pellets 3.5% bait	metaldehyde	other	slugs	---	12	May apply every 2 weeks or as needed. Broadcast pellets and wet soil before or after application. Do not allow pellets to contact edible portion of plant. Keep children, pets, and poultry away from treated areas.
Thimet / Phorate 20 G (RUP)	phorate	OP	white grubs, wireworms	30	48	For suppression of wireworms only. Maximum two applications per season.
Warrior (RUP)	lambda cyhalothrin	Pyr	armyworm, CLB, CRW adults, CRW larvae, cutworms, ECB, flea beetle, grasshoppers, Japanese beetle, seedcorn maggot, stalk borer, white grub	21	24	

Dry Bean Insect Pests

Annual Grub Adults (including Japanese beetle, rose chafer)

Pest status: Common insects, rarely economic pests

Description: Color & size depend on species. Japanese beetle is metallic green/ bronze with copper wing-covers, tufts of white hair down side.

Life cycle: Japanese beetle and rose chafer have many host plants. Larvae (grubs) feed underground on roots. Adults emerge mid-summer, and feed on leaves, flowers, and pollen. One generation per year.

Type of damage: Defoliation by adult beetles

Management: Typically do not cause enough damage to warrant treatment.

Threshold: Treat areas where one-quarter of the foliage or more has been damaged by annual grub adults.

List of registered insecticides (rate per acre):

Baythroid 2* and XL* (2.4 to 3.2 oz)

Mustang Max* (2.72 to 4 oz)

Proaxis* (2.56 to 3.84 oz)

Sevin 4F & XLR Plus (0.5 to 1 qt)

Sevin 80S & 80WSP (0.62 to 1.25 lb)

Warrior* (2.56 to 3.84 oz)

Aphids

Pest status: Common insect, occasionally an economic pest

Description: Small oval to pear shaped soft-bodied insects. Color varies from green to pink to brown. Have long "tail pipes".

Life cycle: Aphids present during the field season are all female, and do not need to mate to reproduce; females produce live young. Multiple overlapping generations.

Type of damage: Sucks plant sap from leaves; heavy infestation may lead to stunting, curling of leaves, and general weakening of plants. Aphids also transmit plant viruses.

Conditions favoring damage: hot, dry weather often enhances aphid damage

Management: Biological - natural enemies (ladybugs, lacewings, and wasps) and fungi generally keep populations in check

Threshold: Treat where there is one aphid colony (a group of about 30) or more per plant.

List of registered insecticides, *RUP (rate per acre):

Acephate 75SP (0.66 to 1.33 lbs)

Admire 2F (16 to 24 oz)

Asana XL* (5.8 to 9.6 oz)

Baythroid 2* and XL* (3.2 oz)

Dibrom 8E (1 pt)

Dimethoate 4EC (0.5 to 1 pt) or 5lb (6.4 oz)

Dimethoate 267 (0.75 to 1.5 pt)

Endosulfan 3EC (2.66 pts)

Lannate LV* (1.5 to 3 pt) or SP* (0.5 to 1 lb)

Malathion 57EC (2 to 2.5 pt)

Malathion 8F (1.5 pts) or 8 aquamul (1.25 to 1.75 pts)

Mustang Max* (3.2 to 4 oz)

Orthene 75S & 75WSP (0.67 to 1.33 lb) or 97 (8 to 16 oz)

PennCap M* (1 qt.)

Proaxis* (2.56 to 3.84 oz)

Provado 1.6F (3.5 oz/ acre)

Pyganic EC1.4 (16 to 64 oz) or EC5.0 (4.5 to 18)

Thimet 20G* (4.5 to 7.0 oz/ 1,000 feet of row)

Thionex 3EC (0.67 to 1.33 qts) or 50WSB (1-2 lbs)

Warrior* (2.56 to 3.84 oz)

Armyworm

Pest status: Rarely an economic pest

Description: Caterpillars variable in color (black/brown/green). Narrow light stripe across back and broad stripes running down sides of body.

Life cycle: Migrate to Michigan each spring. 2-3 generations per year.

Type of damage: Defoliation by larvae.

Threshold: Treat when there are four armyworms or more per row foot, or when one-quarter of the foliage or more has been damaged by leaf-feeding insects, predominantly armyworms.

List of registered insecticides:

Acephate 75SP (1.0 to 1.33 lbs)

Baythroid 2* and XL* (2.4 to 3.2 oz)

Dipel DF (1 to 2 lbs) or ES (2 to 4 pts)

Endosulfan 3EC (2.66 pts)

Javelin WG (0.25 to 1.5 lb)

Mustang* (3 to 4.3 oz) or Max* (2.72 to 4 oz)

Orthene 75S and 75WSP (1.0 to 1.33 lb) or 97 (12 to 16 oz)

Proaxis* (2.56 to 3.84 oz)

Pyganic EC1.4 (16 to 64 oz) or EC5.0 (4.5 to 18)

Sevin 4F or XLR Plus (1 to 1.5 qt)

Sevin 80S or 80WSP (1.25 to 1.875 lb)

Thionex 3EC (1.33 qts) or 50WSB (2 lbs)

Warrior* (2.56 to 3.84 oz)

Xentari (0.5 to 2 lbs)

Bean Leaf Beetle

Pest status: Occasional.

Description: Adult beetle has brown, greenish-yellow, or red wing covers, with 4 black spots and black stripe along edge; wing spots may be absent, but a black triangle is always present on wings behind head.

Life cycle: Adult BLB overwinter in leaf litter and wooded field margins, becoming active in spring; move into alfalfa, then migrate into beans after first alfalfa cutting; 1-2 generations per year.

Type of damage: Chewing pest; larvae feed on root hairs and nodules; adults defoliate younger plants, leaving small round holes between major leaf veins; adult feeding on developing pods causes scarring, reducing yield and seed quality.

Thresholds: 25% or more defoliation throughout field; 50% defoliation of seedlings or 25% defoliation during pod setting/filling; or more than 10% of the pods damaged.

List of registered insecticides, *RUP (rate per acre):

Acephate 75SP (0.66 to 1.33 lbs)	Orthene 75S and 75WSP (0.67 to 1.33 lb) or 97 (8 to 16 oz)
Asana XL* (5.8 to 9.6 oz)	PennCap M* (1 qt)
Baythroid 2* and XL* (2.4 to 3.2 oz)	Proaxis* (2.56 to 3.84 oz)
Dimethoate 4EC (0.5 to 1 pt) or 5lb (6.4 oz)	Sevin 4F or XLR Plus (0.5 to 1 qt)
Dimethoate 267 (0.75 to 1.5 pts)	Sevin 80S or 80WSP (0.62 to 1.25 lb)
Endosulfan 3EC (1.32 to 2.66 pts)	Thionex 3EC (0.67 to 1.33 qts) or 50WSB (1 to 2 lbs)
Lannate LV* (0.75 to 1.5 pt) or SP* (0.25 to 0.51 lb)	Warrior* (2.56 to 3.84 oz)
Mustang* (3 to 4.3 oz) or Max* (2.72 to 4 oz)	

Black Cutworms

Pest status: Rarely an economic pest

Description: Caterpillar is up to 2 inches long. Variable coloration (gray to black), 4 tubercles per body segment, inner tubercles smaller than the outer tubercles.

Life cycle: Adult moths migrate to Michigan in early spring. Females lay eggs on low-growing weeds (for ex., chickweed) or crop debris. Small larvae first feed on weeds, then may move to the crop later after weed-kill. Several generations per season.

Type of damage: Larvae feed on leaves and stems. Plants can be cut off at the base.

Conditions favoring damage: Low, dense weeds in field (egg laying site for females), areas with high crop residue, planting into plowed sod or pasture, cover crops, wet areas, no-till.

Sampling/ scouting: Begin scouting as soon as seedlings emerge. Look for wilted or cut plants; determine percent seedlings damaged. Dig around base of nearby seedlings to verify identity of larvae.

Threshold: Treat when 5 percent of small plants or more show damage.

List of registered insecticides, *RUP (rate per acre):

Acephate 75SP (0.66 to 1.33 lbs)	Proaxis* (2.56 to 3.84 oz)
Asana XL* (5.8 to 9.6 oz)	Sevin 4F or XLR Plus (1.0 to 1.5 qt)
Baythroid 2* and XL* (1.0 to 1.6 oz)	Sevin 80S or 80WSP (1.25 to 1.875 lb)
Mustang* (1.4 to 4.3 oz) or Max* (2.72 to 4 oz)	Warrior* (1.92 to 3.2 oz)
Orthene 75S and 75WSP (0.67 to 1.33 lb) or 97 (8 to 16 oz)	

Grasshoppers

Pest status: Common insect, occasional outbreaks

Life cycle: Eggs overwinter in soil; nymphs hatch in June. As nymphs grow, feeding damage increases. Females lay eggs in soil in late summer.

Type of damage: Defoliation by nymphs and adults.

Conditions favoring damage: Unplowed or fallow areas are preferred egg-laying sites, and may contribute to populations in nearby fields. Dry, warm weather enhances nymph survival.

Management: Biological - A fungal pathogen kills many eggs and nymphs under wet spring conditions. Natural enemies (birds, rodents, amphibians) also feed on grasshoppers, but may not provide adequate control during outbreaks.

Threshold: Treat areas where one-quarter of the foliage or more has been damaged by leaf-feeding insects, predominantly grasshoppers; or where there are more than 20 grasshoppers on plants less than 6 in; over 40 per 10 row ft in taller plants.

List of registered insecticides, *RUP (rate per acre):

Acephate 75SP (0.33 to 0.66 lbs)	Mustang* (3 to 4.3 oz) or Max* (3.2 to 4 oz)
Asana XL* (5.8 to 9.6 oz)	Proaxis* (2.56 to 3.84 oz)
Baythroid 2* and XL* (2.4 to 3.2 oz)	Orthene 75S and 75WSP (0.33 to 0.67 lbs) or 97 (4 to 8 oz)
Dimethoate 4EC (0.5 to 1 pt) or 5lb (6.4 oz)	Sevin XLR Plus (0.5 to 1.5 qt) or 80WSP (0.62 to 1.875 lb)
Dimethoate 267 (0.75 to 1.5 pts)	Warrior* (2.56 to 3.84 oz)

Green Cloverworm

Pest status: Occasional outbreaks.

Description: Pale green caterpillar with 2 white stripes running along side of body; ~1 inch long.

Life cycle: In early spring, adults lay eggs singly on underside of leaves; larvae feed on foliage

Type of damage: Newly hatched larvae feed on the underside of leaves. As they grow they chew through the leaves.

Management: Biological- many natural enemies and diseases.

Threshold: Treat where one-quarter of the foliage or more has been damaged by leaf-feeding insects, predominantly green cloverworm; or where there are 15 larvae or more per row foot at green pod stage.

List of registered insecticides, *RUP (rate per acre):

Acephate 75SP (0.66 to 1.33 lbs)	PennCap M* (1 qt)
Asana XL* (5.8 to 9.6 oz)	Proaxis* (2.56 to 3.84 oz)
Baythroid 2* and XL* (2.4 to 3.2 oz)	Sevin 4F or XLR Plus (0.5 to 1 qt)
Malathion ULV (0.5 pt)	Sevin 80S or 80WSP (0.62 to 1.25 lb)
Mustang* (3 to 4.3 oz) or Max* (2.72 to 4 oz)	Warrior* (1.92 to 3.2 oz)
Orthene 75S and 75WSP (0.67 to 1.33) or 97 (8 to 16 oz)	

Mexican Bean Beetle

Pest status: Common insect, occasionally an economic pest

Description: Adult – oval beetle, ~1/2 inch long, yellow/orange with 16 small black spots on wings (ladybug-like); bright yellow larvae with dark bristly spines. Eggs bright yellow, laid in clusters of 40-60 on leaf undersides.

Life cycle: Adults overwinter in crop debris, woodlots, etc. Adults move into dry beans in early summer and lay eggs. Larvae mature in 3-4 weeks, pupate on leaf surface. Adults emerge in mid-late summer and lay eggs for second generation. Second generation larvae feed, pupate in late August, and new adults overwinter.

Type of damage: Chewing pest; larvae and adults feed on undersides of leaves and between veins, giving leaves a lacy appearance.

Sampling/scouting: Examine plants in several locations of the field.

Threshold: Treat where one-quarter of the foliage or more has been damaged by leaf-feeding insects, mostly Mexican bean beetles.

List of registered insecticides, *RUP (rate per acre):

Acephate 75SP (0.66 to 1.33 lbs)	Mustang* (3 to 4.3 oz) or Max* (2.72 to 4 oz)
Asana XL* (2.9 to 5.8 oz)	Orthene 75S and 75WSP (0.67 to 1.33 lb) or 97 (8 to 16 oz)
Baythroid 2* and XL* (2.4 to 3.2 oz)	PennCap M* (1 qt)
Dimethoate 4EC (0.5 to 1 pt) or 5lb (6.4 oz)	Proaxis* (2.56 to 3.84 oz)
Dimethoate 267 (0.75 to 1.5 pts)	Pyganic EC1.4 (16 to 64 oz) or EC5.0 (4.5 to 18)
Endosulfan 3EC (1.32 to 2.66 pts)	Sevin 4F or XLR Plus (0.5 to 1 qt)
Lannate LV* (0.75 to 3 pt) or SP* (0.25 to 1 lb)	Sevin 80S or 80WSP (0.67 to 1.25 lb)
Malathion 57EC (1.5 to 2.5 pt)	Thimet 20G* (4.9 to 9.4 oz/1,000 feet of row)
Malathion 8F (1.5 pts) or 8 aquamul (1.25 to 1.75 pts)	Thionex 3EC (0.67 to 1.33 qts) or 50WSB (1 to 2 lbs)
Malathion ULV (0.5 pt)	Warrior* (1.92 to 3.2 oz)
Malathion 5EC (1.5 to 2.0 pts)	

Mites

Pest status: Common arthropod, occasional economic pest.

Description: Very small, wingless, 8-legged invertebrate; Two-spotted spider mite is greenish yellow to orange with 1 large black spot on each side of body.

Life cycle: Adults overwinter in field borders and sheltered areas. In spring, adults move to new growth and lay eggs on underside of leaves; Mites spread by crawling or blowing on the wind; all stages feed on plants; populations can expand quickly.

Type of damage: Sucking pest. Inserts mouthparts into individual plant cells, removes contents. Resulting in small yellow spots (stippling).

Conditions favoring damage: Prolonged dry, hot weather.

Sampling/scouting: Look for mites on underside of leaves using hand lens, or tap leaves over a piece of paper; webbing may be present on leaves if population is high.

Management: Biological – a fungal pathogen kills mites under high population pressures.

Threshold: Treat when mites appear on one-quarter of the plants or more and when the first yellowing is seen. Mites are difficult to control and two applications may be needed.

List of registered insecticides, *RUP (rate per acre):

Dibrom 8E (1 pt)	Dimethoate 267 (0.75 to 1.5 pts)
Dicofol 4E (1 to 3 pts)	Kelthane MF (1 to 3 pts)
Dimethoate 4EC (0.5 to 1 pt) or 5lb (6.4 oz)	Malathion 5EC (1.5 pts) or ULV (0.5 pts)

Plant Bugs

Pest status: Common insects, occasionally economic pests

Description: 1/8th to 1 inch long, oval ‘true bugs’. Plant bugs can be greenish or brown. Tarnished PB is dark brown with yellow V-shaped mark on back. Nymphs resemble adults, but lack wings.

Life cycle: Adults overwinter. Eggs laid into plant tissue. Multiple generations.

Type of damage: Sucking pest. Adults and nymphs remove plant sap. Tarnished plant bug injects a toxic saliva during feeding; can cause beans to shrink within the pod.

Threshold: Treat when there is one bug or more per plant at first flower to green pod stage.

List of registered insecticides, *RUP (rate per acre):

Acephate 75SP (0.66 to 1.33 lbs)	Mustang* (3 to 4.3 oz) or Max* (2.72 to 4 oz)
Baythroid 2* and XL* (2.4 to 3.2 oz)	Orthene 75S and 75WSP (0.67 to 1.33 lb) or 97 (8 to 16 oz)
Dibrom 8E (1 pt)	Penncap M* (1 qt)
Dimethoate 4EC (0.5 to 1 pt) or 5lb (6.4 oz)	Proaxis* (2.56 to 3.84 oz)
Dimethoate 267 (0.75 to 1.5 pts)	Sevin 4F or XLR Plus (1 to 1.5 qt)
Lannate* LV (1.5 to 3 pt) and SP* (0.5 to 1 lb)	Sevin 80S or 80WSP (1.25 to 1.875 lb)
Malathion 5EC (2 pts) or 8 Aquamul (1.25 - 1.75 pt)	Warrior* (2.56 to 3.84 oz)
Malathion ULV (0.5 pts)	

Potato Leafhopper

Pest status: Key pest; widespread and abundant

Description: Small, bright green, torpedo shaped insects. Fast moving, in a “crab-like” fashion. Nymphs resemble adults but are lime green/yellow, much smaller, lack wings.

Life cycle: Adults are carried into Michigan from the south on weather fronts in May/early June. Females lay eggs inside stems. Nymphs hatch in 7-10 days, begin feeding immediately, and reach adult stage in 2-3 weeks. Multiple overlapping generations.

Type of damage: Sucking pest. Both adults and nymphs remove plant sap and inject toxic saliva as they feed. Typical symptom is “hopperburn”. Other symptoms include stunting and curling of leaves and poor pod fill.

Conditions favoring damage: Dry conditions (drought) enhance PLH damage.

Management: Biological - a naturally occurring fungal pathogen reduces PLH numbers under favorable conditions. Chemical - Most insecticides are effective against PLH.

Sampling/scouting: Begin scouting in early June. Examine 5 sets of 20 trifoliolate leaves from different parts of the field. Count both adults and nymphs.

Threshold: On unifoliolate stage beans (prior to presence of a fully expanded 1st trifoliolate) treat if population exceeds 0.5 leafhoppers per plant. On plants with one or more fully expanded trifoliolate, treat if population exceeds 1 leafhopper per trifoliolate leaf.

List of registered insecticides - see next page

Potato Leafhopper, continued from previous page

List of registered insecticides, *RUP (rate per acre):

Acephate 75SP (0.66 to 1.33 lbs)	Malathion 8F (1.5 pts) or 8 aquamul (1.25 to 1.75 pts)
Admire 2F (16 to 24 oz)	Mustang* (3 to 4.3 oz) or Max* (2.72 to 4 oz)
Asana XL* (5.8 to 9.6 oz)	Orthene 75S and 75WSP (0.67 to 1.33 lb) or 97 (8 to 16 oz)
Baythroid 2* and XL* (1 to 1.6 oz)	Penncap M* (1 qt)
Dibrom 8E (1 pt)	Proaxis * (2.56 to 3.84 oz)
Dimethoate 4EC (0.5 to 1 pt) or 5lb (6.4 oz)	Provado 1.6F (3.5 oz)
Dimethoate 267 (0.75 to 1.5 pts)	Pyganic EC1.4 (16 to 64 oz) or EC5.0 (4.5 to 18)
Disyston 15G* (6 oz / 1000 row ft)	Sevin 4F or XLR Plus (1 qt)
Disyston 8* (0.9 to 1.9 oz / 1000 row ft)	Sevin 80S or 80WSP (1.25 lb)
Endosulfan 3EC (1.32 to 2.66 pts)	Thimet 20G* (4.5 to 7 oz/ 1,000 feet of row at planting)
Lannate LV* (0.75 to 3 pt) or SP* (0.25 to 1 lb)	Warrior* (2.56 to 3.84 oz)
Malathion 57EC (1.5 to 2.5 pt), 5EC (2 pt), ULV (0.5 pt)	

Seedcorn Maggot

Pest status: Occasional pest.

Description: Larva- small (1/4 inch), white maggot; adult – small gray fly.

Life cycle: Overwinter as pupae in soil; adults emerge as flies in early spring, lay eggs in disturbed soil with decaying organic matter. Multiple generations.

Type of damage: Maggots feed on germinating seed; may cause variable emergence, stand loss, delayed development.

Conditions favoring damage: Cool wet soil (delays germination), soils high in organic matter from cover crop or manure.

Threshold: Seed or planter box treatment of all dry bean seed is recommended. Commercial seed treatment of a fungicide mixed with an insecticide is especially recommended because treated seed can be used in any planter. Make sure that proper amount of insecticide is applied when a mixture fungicide is used. Planter box treatments cannot be used in air planters, but are effective with conventional planters.

List of registered insecticides, *RUP (rate per acre):

Lorsban 30F (seed treatment, apply as a slurry, see label)	Thimet 20G* (4.5 to 7 oz/ 1,000 feet of row at planting)
Lorsban 50SL (seed treatment, apply as a slurry, see label)	Temik 15G* (3.5 to 5 lb)

Slugs

Pest Status: Occasionally an economic pest

Type of damage: Slugs may damage seedling dry beans by feeding on the stems, cotyledons and leaves of young plants. While substantial defoliation can be tolerated in pre-blooming dry beans, if the growing point is killed, stands can be significantly reduced.

Conditions favoring damage: Dry beans established into wheat stubble or other heavy crop residue are at greatest risk. Occasionally, fields planted following a legume plow-down have been damaged. Fields with a recent history of slug damage are also at increased risk. Cool, wet conditions favor slug survival and damage.

Threshold: No thresholds have been established for slugs in dry beans. Consider treatment if slug damage threatens to reduce stand density below an acceptable point.

List of registered insecticides:

Deadline MPs 4% Bait (10 to 20 lbs)
Snail and Slug Pellets 3.5% Bait (various products and rates)

Thrips

Pest status: Common insect, occasional pest.

Description: Adult – small, slender, brown and white-banded abdomen, narrow fringed wings; larva – wingless, yellow/orange.

Life cycle: Females insert eggs into plant tissue. Immature thrips feed on crop until mature. Multiple, overlapping generations.

Type of damage: Most obvious early in season; adult & nymph rasping/sucking mouthparts scrape cells on leaf underside, leaving silvery scratches which may turn leaves brown; young leaves may appear crinkled.

Conditions favoring damage: Hot dry weather coupled with large thrips populations.

Management: Biological – many natural enemies (minute pirate bugs, predacious thrips and mites) attack thrips.

Threshold: Treat when one-third of small plants or more show damage and when dry leaves first appear.

List of registered insecticides, *RUP (rate per acre):

Acephate 75SP (0.66 to 1.33 lbs)

Admire 2F (16 to 24 oz)

Lannate LV* (0.75 to 3 pt) and SP* (0.5 to 1.0 lb)

Orthene 75S and 75WSP (0.67 to 1.33 lb) or 97 (8 to 16 oz)

Proaxis* (2.56 to 3.84 oz)

Sevin 4F or XLR Plus (1 qt)

Sevin 80S or 80WSP (1.25 lb)

Warrior* (2.56 to 3.84 oz)

White grubs

No insecticides are currently recommended for use against white grubs in dry beans. Spring and fall plowing during a season of clean fallow before a crop is strongly recommended when a field is broken from established sod. Temik or Thimet soil insecticide used at planting against soil pests such as nematodes may reduce grub numbers.

Wireworms

Pest status: Common insect, occasional pest in localized areas.

Description: Slender, shiny, yellow-brown, with wiry segmented body, up to 1.5 inches long.

Life cycle: Immature form of click beetle; found in grasslands, sod, or fallow fields. Wireworms can spend 2 to 6 years in the larval stage, during which they feed on underground parts of plants.

Type of damage: Feeds on seeds, preventing germination. Also feeds on roots.

Sampling/ scouting: Scout for wireworms with a bait station (see web site below) at least one week before planting.

Management: Cultural – spring and fall plowing of established sod is recommended before crop is planted, where practical.

Threshold: Treat when wireworms are seen while fitting established sod, or areas where damage has occurred. Spring and fall plowing during a season of clean fallow is strongly recommended when a field is broken from established soil. If using bait traps, one or more wireworms per trap.

List of registered insecticides, *RUP (rate per acre):

No insecticides are currently recommended for use against wireworms in dry beans. Spring and fall plowing during a season of clean fallow before a crop is strongly recommended when a field is broken from established sod. Temik or Thimet soil insecticide used at planting against soil pests such as nematodes may reduce wireworm numbers.

Insecticides Registered for Dry Beans

Trade name	Common name	Class	Recommended for:	PHI days	REI hrs	Precautions and Remarks
Acephate 75SP	acephate	OP	aphids, armyworms, bean leaf beetles, cutworms, grasshoppers, green cloverworm, leaf rollers, Mexican bean beetle, plant bugs, PLH, thrips	14	24	Max 2 lbs a.i. per acre per season
Admire 2F	imidacloprid	Neo	aphids, PLH, thrips	21	12	Maximum of 0.375 lbs a.i. per acre per season.
Asana XL (RUP)	esfenvalerate	Pyr	aphids, bean leaf beetle, cutworm, grasshoppers, green cloverworm, Mexican bean beetle, potato leafhopper	21	12	Maximum 0.2 lb a.i. per acre per season. Do not graze or feed forage to livestock.
Baythroid 2 and XL* (RUP)	cyfluthrin & beta-cyfluthrin	Pyr	Annual grub adults, aphids, armyworm, BLB, cutworm, grasshoppers, green cloverworm, MBB, plant bugs, PLH	7	12	Maximum 6.4 oz per acre per season with 2 applications. Max 4 applications per season.
Bt [Dipel, Javelin, Xentari]	<i>Bacillus thuringiensis</i>	bio	armyworm	--	12	Use only to control small armyworms when populations are low. Full coverage is important.
Deadline M-Ps 4% Bait	metaldehyde	other	slugs	--	12	Broadcast by ground or air every 3 to 4 weeks during season as needed. For best results apply in the evening, preferably after a rain or irrigation.
Dibrom 8 EC	naled	OP	aphids, mites, plant bugs, PLH	1	48	Do not feed treated vines or hay to livestock.
Dicofol 4-E miticide	dicofol	Ocl	mites	21	12	Max 2 applications per season.
Dimethoate 267,400, 4EC, 5 lb	dimethoate	OP	aphids, bean leaf beetle, grasshoppers, Mexican bean beetle, mites, plant bugs, PLH	7	48	Do not feed treated vines to livestock. Note honeybee precautions.
Di-Syston (RUP) 8, 15 % Granular	disulfoton	OP	PLH	60	48	Max 1 application per season.
Endosulfan 3EC	endosulfan	Ocl	aphids, armyworm, Bean leaf beetle Mexican bean beetle, PLH	3	24	Max 3 applications per season.
Kelthane MF	dicofol	Ocl	mites	21	12	Max 2 applications per season.
Lannate (RUP) LV and SP	methomyl	Carb	aphids, bean leaf beetle, Mexican bean beetle, plant bugs, PLH, thrips	14	48	Maximum 4.5 lbs a.i. per acre per year.
Lindane	lindane	OCl	seedcorn maggot	--	12	
Lorsban 30F, 50SL	chlorpyrifos	OP	seedcorn maggot	--	--	
Malathion 5 EC, 8 Aquamul, 8 Flowable, ULV	malathion	OP	annual grub adults, aphids, green cloverworm, Mexican bean beetle, plant bugs, PLH	1	12	Do not feed treated vines to livestock

DRY BEANS

Trade name	Common name	Class	Recommended for:	PHI days	REI hrs	Precautions and Remarks
Mustang and Mustang Max (RUP)	zeta-cypermethrin	Pyr	aphids, armyworm, cutworm, green cloverworm, grasshopper, MBB, plant bugs, PLH	21	12	Apply no more than 0.3 lbs a.i. per acre per season.
Orthene 75S, 97	acephate	OP	aphids, armyworm, bean leaf beetle, cutworm, grasshoppers, green cloverworm, leafrollers, Mexican bean beetle, plant bugs, potato leafhopper, thrips	14	24	Do not feed treated vines to livestock.
PennCap-M (RUP)	methyl parathion	OP	aphids, bean leaf beetle, green cloverworm, Mexican bean beetle, plant bugs, potato leafhopper	15	96	Do not apply more than 12 pts per acre per year.
Proaxis (RUP)	gamma cyhalothrin	Pyr	annual grub adults, aphids, armyworm, bean leaf beetle, cutworm, grasshoppers, green cloverworm, Mexican bean beetle, plant bugs, PLH, thrips	21	24	Maximum of 0.06 lbs a.i. per acre per season.
Provado 1.6F	imidacloprid	Neo	aphids, PLH	7	12	See label for plant back restrictions. Maximum 0.13 lbs a.i. per acre per season.
Pyganic EC1.4 and EC 5.0	pyrethrum	Bio	armyworm, MBB, PLH	0	12	Listed by the Organic Materials Review Institute (OMRI) for use in organic production.
Sevin 4 F, XLR Plus, 80 S or 80 WSP	carbaryl	Carb	annual grub adults, armyworm, BLB, cutworm, grasshoppers, cloverworm, MBB, plant bugs, potato leafhopper, thrips	21	12	Note honeybee precautions. Application to wet plants or during periods of high humidity may cause injury to tender foliage.
Snail and Slug Pellets 3.5% Bait	metaldehyde	other	slugs	--	--	Broadcast every 2 weeks or as needed. Wet soil before or just after application. Do not allow pellets to contact edible portion of plant. Keep children, pets, and poultry away from treated areas.
Temik 15G (RUP)	aldicarb	Carb	seedcorn maggot	90	48	Apply in seed furrow and cover with soil. Do not feed forage to livestock.
Thimet 20G (RUP)	phorate	OP	potato leafhopper, seedcorn maggot	60	48	Do not let Thimet contact seed. Do not graze or feed treated hay or forage to livestock.
Thionex 3 EC, 50WSB	endosulfan	OCI	aphids, bean leaf beetle, Mexican bean beetle	3	24	Do not feed treated vines to livestock.
Warrior (RUP)	lambda cyhalothrin	Pyr	annual grub adults, aphids, armyworm, BLB, cutworm, grasshoppers, cloverworm, MBB, plant bugs, PLH, thrips	21	24	Maximum of 0.12 lbs a.i. per acre per season.

Hay and Pasture Insect Pests

Armyworm

Pest status: Rarely an economic pest in hay

Description: Caterpillars variable in color (black/brown/green). Narrow light stripe across back and broad stripes running down sides of body.

Life cycle: Probably migrate to Michigan each spring. 2-3 generations per year.

Type of damage: Defoliation by larvae.

Threshold: Treat when there are 6 or more armyworms per sq ft.

List of Registered Insecticides (rate per acre, *RUP):

Carbaryl 4L (2 to 3 pts)

Dipel DF (1 to 2 lb) or ES (2.0 to 4.0 pt)

Entrust (0.63 to 1.25 oz)

Javelin (0.25 to 1.5 lb)

Lannate LV* (0.75 to 3 pts) or SP* (0.25 to 1lb.)

Malathion 5 (2 to 2.25 pts) or 8 Aquamul (1.25 pt)

Pyganic EC 1.4 II (16 to 64 oz, **Grasses only**)

Pyganic EC 5.0 II (4.5 to 18 oz, **Grasses only**)

Sevin 4F or XLR Plus (1 to 1.5 qt)

Sevin 80S or 80WSP (1.25 to 1.875 lb)

Tracer (1 to 2 oz)

Xentari (0.5 to 1.5 lb)

European skipper

Pest status: Introduced into North America in 1910. Rarely an economic pest in hay

Description: Adult is pumpkin orange, resembles a butterfly. Larvae are small, greenish caterpillars up to ¼ inch in length.

Life cycle: Eggs hatch in late April. Larvae feed until mid-June, then pupate. Adults emerge in late June to early July. One generation per year.

Type of damage: Larvae feed on grass blades, gouging, rolling and stripping the leaves. Prefers timothy.

Sampling: Cut several square-foot samples of forage down to the ground and place in bags. Leave overnight. Larvae will crawl out of grass to be counted the following day.

Threshold: Treat when there are 6 larvae per sq ft. For best protection, treat when the larvae are small (less than about 3/8 in long). Use higher rates for larger (greater than 1/2 inch long) larvae.

List of Registered Insecticides (rate per acre):

Dipel DF (0.5 to 1.0 lb) or ES (1 to 2 pt)

Sevin 4F or XLR Plus (1 to 1.5 qt)

Sevin 80S or 80WSP (1.25 to 1.875 lb)

Xentari (0.5 to 1.5 lb)

Grasshoppers

Pest status: Common insect. Occasional outbreaks.

Life cycle: Eggs overwinter in soil; nymphs hatch in June. As nymphs grow, feeding damage increases. Females lay eggs in soil in late summer.

Type of damage: Defoliation by nymphs and adults.

Conditions favoring damage: Unplowed or fallow areas, such as hay fields and pastures, are preferred egg-laying sites. Dry, warm weather enhances nymph survival.

Management: Biological - A fungal pathogen kills many eggs and nymphs under wet spring conditions. Natural enemies (birds, rodents, amphibians) also feed on grasshoppers, but may not keep up during outbreaks.

Threshold: Treat when there are eight grasshoppers or more per sq yard in hay less than 6 in tall, or 16 or more per sq yard in taller hay.

Note: In outbreak years, grasshoppers produced in hay fields and pastures may move into neighboring crops.

List of Registered Insecticides (rate per acre):

Carbaryl 4L (1 to 3 pts)

Fyfanon (1.5 to 2 pt) or ULV (8 to 12 fl oz)

Malathion 5 (1.5 to 2 pt) or 8 Aquamul (1.25 pt) or 8F (1 to 1.25 pts)

Malathion ULV (8 to 12 fl oz)

Sevin 4F or XLR Plus (0.5 to 1.5 qt)

Sevin 80S or 80WSP (0.63 to 1.875 lb)

Insecticides Registered for Hay and Pasture

Trade name	Common name	Class	Recommended for:	PHI days	REI hrs	Precautions and Remarks
<i>Bt</i> [Dipel DF/ ES, Javelin, Xentari]	<i>Bacillus thuringiensis</i>	Bio	armyworm, skippers	0	4	Bt is a biological insecticide produced from the bacterium <i>Bacillus thuringiensis</i> . Effective only against early-stage larvae. Recommended when honeybees may be exposed.
Carbaryl 4L	carbaryl	Carb	armyworm, grasshoppers, skippers	14	12	Do not apply if honeybees are foraging in the field. Maximum 2 applications per season.
Entrust	spinosad	Bio	armyworm	0 forage 3 hay	4	Do not graze cattle until sprays dry. Max 3.75 oz per acre per season.
Fyfanon	malathion	OP	grasshoppers	0	12	
Lannate (RUP) LV & SP	methomyl	Carb	armyworm	7	48	
Malathion 5, 8 Aquamul, 8F, ULV	malathion	OP	armyworm, grasshoppers	0	12	
Pyganic EC	pyrethrum	Bio	armyworm	0	12	Use on grasses only. Listed by the Organic Materials Review Institute (OMRI) for use in organic production.
Sevin 4F, XLR Plus, 80S, 80WSP	carbaryl	Carb	armyworm, grasshoppers, Skippers	14	12	Do not apply if honeybees are foraging in the field. Maximum 2 applications per season.
Tracer	spinosad	Bio	armyworm	0 forage 3 hay	4	Do not graze cattle until sprays dry. Max 6 oz per acre per season.

Small Grain insect pests

Aphids

Pest status: Common insect, occasional economic pest

Description: Small oval to pear shaped soft-bodied insects with cornicles (“tailpipes”) at the back of the body. Color varies from bright green to pink to brown, depending on species.

Life cycle: Aphids present during the field season are all female, and do not need to mate to reproduce; females give birth to live young. Multiple overlapping generations.

Type of Damage: Sucks plant sap from leaves and stems; heavy infestation may lead to yellowing/browning, stunting, curling of new leaves, and general weakening of plants. Aphids are also virus vectors.

Scouting: See MSU Bulletin E-2549, Insect Management in Wheat and Other Small Grains, for details on the presence/absence scouting method and decision table.

Management: Biological = natural enemies (ladybugs, lacewings, and wasps) and diseases generally keep populations in check.

Threshold: General guideline is 12 – 15 aphids per tiller during seedling to boot stage.

Note: Although grain aphids can transmit barley yellow dwarf virus (= red leaf in oats), this is generally not a problem in the fall in Michigan. Also, insecticides usually do not stop transmission of the virus. Aphids should be sprayed only when they are numerous enough to directly threaten yield in the spring and summer.

List of registered insecticides, *RUP (rate per acre):

Baythroid 2* and XL* (1.8 to 2.4 oz) *Wheat only.*

Cruiser 5FS (0.75 to 1.33 oz / CWT) *Wheat & Barley only*

Dimethoate 4 EC, 400 (0.5 to 0.75 pt) *Wheat only.*

Dimethoate 5lb (6.4 to 9.6 oz) *Wheat only*

Di-Syston 8EC* (0.5 to 1 pt) *Barley only*

Disyston 8EC* (4 to 12 fl oz) *Wheat only*

Endosulfan 3EC (1.32 to 2 pts)

Lannate LV* (0.75 to 1.5 pt) or SP* (0.25 to 0.5 lb)

Malathion 5EC (1.5 pt) or 57EC (1.5 to 2 pt)

Malathion 8 Aquamul (1.25 pt) or 8F (1 to 1.25 pts)

Mustang Max* (3.2 to 4 oz)

Pennacp-M* (2 to 3 pt) *Wheat, oats, barley only*

Proaxis* (2.56 to 3.84 oz) *Wheat only*

Thionex 3EC (0.67 to 1 qt) or 50WSB (1 to 1.5 lbs)

Warrior* (2.56 to 3.84 oz) *Wheat only*

Armyworm

Pest status: Occasional, although there have been outbreaks in the last few years.

Description: Caterpillars variable in color (black/brown/green), up to 1 ½ inches long. Narrow light stripe across back and broad stripes running down sides of body.

Life cycle: Likely migrate to Michigan each spring. Eggs are laid on the surfaces of grasses, especially the headlands of small grains. Two to three generations per year, the first generation in late May to early June.

Type of damage: Defoliation by larvae, first generation most damaging. Larvae eat leaves, stems, and sometimes the heads of small grains.

Scouting: Mainly active at night and during overcast days. During the day, larvae can be found at the base of plants and under debris.

Threshold: Before heading, treat when there are four or more worms per square foot.

At heading (to prevent head clipping), treat when there are two or more worms per square foot

For more information: MSU CAT Alert articles from 2004

May 13 'Watch for cutworm and armyworm' http://www.ipm.msu.edu/CAT04_fld/FC05-13-04.htm

June 17 'Armyworms abound' http://www.ipm.msu.edu/CAT04_fld/FC06-17-04.htm

List of registered insecticides, *RUP (rate per acre):

Baythroid 2* (1 to 1.8 oz) *Wheat only*

Bt products (Dipel, Javelin, Xentari)

- many products, see labels for specific rates

Endosulfan 3EC (1.32 pts)

Entrust (1 to 2 oz)

Lannate LV* (0.75 to 1.5 pt) or SP* (0.25 to 0.5 lb)

Malathion 5 and 57EC (2 pt)

Malathion 8F (1.0 to 1.25 pts)

Mustang* (1.9 to 4.3 oz) or Max* (1.76 to 4 oz)

Pennacp-M* (2 to 3 pt) *Do not apply to rye.*

Proaxis* (2.56 to 3.84 oz) *Wheat only*

Pyganic EC 1.4 II (16 to 64 oz) or 5.0 II (4.5 to 18 oz)

Sevin 4F or XLR Plus (1 to 1.5 qt) *Wheat only.*

Sevin 80S or 80WSP (1.25 to 1.875 lb) *Wheat only.*

Tracer (1.5 to 3 oz)

Warrior* (2.56 to 3.84 oz) *Wheat only*

Cereal Leaf Beetle

Pest status: Occasional economic pest

Description: Adult up to 1/4 inch long; black body, metallic blue wing covers, a red pronotum (neck), and orange-red legs with black tarsi (feet). Eggs- very tiny, oblong; yellow to brown. Larvae- Up to ¼ inch long pale yellow to black, usually covered in fecal material to camouflage themselves.

Life cycle: Adults overwinter in plant stubble and in cracks and crevices such as under tree bark. Mating occurs during warm spring temperatures and eggs are laid on the upper surface of the grain leaves. Larvae feed for about two weeks and move to the soil to pupate. These adults emerge in late June and feed for about 3 weeks, then become sedentary. One generation per year.

Type of damage: Usually begins on field borders of winter grain, then goes to the preferred spring grain. Defoliation by chewing between leaf veins. Larvae feed on the surface of leaves, while adults feed on the whole leaf. This damage gives a “frosted” appearance to a severely infested field.

Scouting: Begin when temperatures reach 60 degrees. Check 20 stems in five areas of the field.

Management: Cultural- Hairy varieties are less likely to be infested. Biological- wasp parasitoids, lady beetles and various other natural enemies.

Threshold: Treat when there is a combination of 3 or more eggs and larvae per plant and the larvae are fairly visible on small plants. For larger plants treat when there is one or more larvae per flag leaf.

Note: First discovered in the U.S. in Berrien County Michigan, 1962.

List of registered insecticides, *RUP (rate per acre):

Baythroid 2* and XL* (1 to 1.8 oz) *Wheat only*

Endosulfan 3EC (0.66 to 1.32 pts)

Entrust (0.5 to 2 oz)

Lannate LV* (0.75 to 1.5 pt) or SP* (0.25 to 0.5 lb)

Malathion 5 (1.0 to 1.5 pt) *Wheat, barley, oats and rye.*

Malathion ULV (4 to 8 fl oz) *Barley, oats, and wheat*

Mustang* (1.9 to 4.3 oz) and Max* (1.76 to 4 oz)

Proaxis* (2.56 to 3.84 oz) *Wheat only*

Sevin 4F and XLR Plus (1 qt) *Wheat only.*

Sevin 80S and 80WSP (1.25 lb) *Wheat only.*

Thionex 3EC (0.33 to 0.67 qt) or 50WSB (0.5 to 1 lbs)

Tracer (1 to 3 oz)

Warrior* (2.56 to 3.84 oz) *Wheat only*

Cutworms

Cutworm damage to small grains is rare.

Baythroid 2* and XL* (1 to 1.8 oz) and Mustang Max* (1.28 to 4 oz) *Wheat only*

Warrior* (1.92 to 3.2 oz) *Wheat only*

European Corn Borer

European corn borers are sometimes found in small grains tunneling in stems. The visible symptom of this damage is whitening (bleaching) of wheat heads. Generally this only occurs in years with heavy EBC populations, in scattered areas of the field.

Treatment is unlikely to be effective.

Grasshoppers

Pest status: Common insect, occasional outbreaks

Life cycle: Eggs overwinter in the soil, and nymphs hatch in June. Nymphs molt as they grow, and feeding increases with size. Females lay eggs in the soil in late summer.

Type of damage: Defoliation (chewing) by nymphs and adults.

Conditions favoring damage: Unplowed or fallow areas next to fields are preferred egg-laying sites, and may contribute to populations in a nearby field. Dry, warm weather often enhances survival of nymphs.

Management: Cultural- plowing and cultivation to destroy eggs. Biological – a fungal pathogen can kill many eggs and nymphs under wet spring conditions. Natural enemies include birds, rodents, amphibians, parasitic wasps, and ground beetles.

Threshold: Treat when there are eight grasshoppers or more per sq yd in small plants (less than 6 in tall), or 16 or more per sq yd in taller plants.

List of registered insecticides, *RUP (rate per acre):

Baythroid 2* and XL* (1.8 to 2.4 oz) *Wheat only*
 Dimethoate 4 EC, 400 (0.75 pt) *Wheat only*
 Dimethoate 4E (0.75 pts) or 267 (1.125 pts)
 Dimethoate 5 lb (9.6 oz) *Wheat only*
 Furadan 4F* (0.25 to 0.5 pt)
 Malathion 5 (1.5 to 2 pt)
 Malathion 8F (1 to 1.25 pts) or 8 Aquamul (1.25)

Mustang* (3.4 to 4.3 oz) and Max* (3.2 to 4 oz)
 Penncap-M* (2 to 3 pt) *Do not apply to rye.*
 Proaxis* (2.56 to 3.84 oz) *Wheat only*
 Sevin 4F or XLR Plus (0.5 to 1.5 qt) *Wheat only*
 Sevin 80W or 80WSP (0.66 to 1.87 lb) *Wheat only*
 Warrior* (2.56 to 3.84 oz) *Wheat only*

Hessian Fly

Hessian fly is controlled without insecticides by planting winter wheat after adult flies are dead late summer or early fall. The “fly-free dates” are given below for each county (all dates are in September). For additional information, see Extension Bulletin E-2549, *Insect Management in Wheat and Other Small Grains*, available at county Extension offices.

County	Earliest seeding date (Sept)	County	Earliest seeding date (Sept)	County	Earliest seeding date (Sept)
Alcona	6	Hillsdale	19	Montmorency	7
Allegan	20	Huron	13	Muskegon	18
Alpena	9	Ingham	17	Newaygo	15
Antrim	4	Ionia	16	Oakland	16
Arenac	13	Iosco	7	Oceana	16
Barry	18	Isabella	11	Ogemaw	10
Bay	14	Jackson	16	Osceola	10
Benzie	16	Kalamazoo	20	Oscoda	7
Berrien	23	Kalkaska	5	Otsego	6
Branch	19	Kent	18	Ottawa	19
Calhoun	19	Lake	13	Presque Isle	8
Cass	22	Lapeer	15	Roscommon	7
Charlevoix	3	Leelanau	8	Saginaw	16
Cheboygan	4	Lenawee	25	Sanilac	15
Claire	12	Livingston	16	St. Clair	16
Clinton	17	Macomb	18	St. Joseph	23
Crawford	6	Manistee	13	Shiawassee	16
Eaton	16	Mason	13	Tuscola	15
Emmet	4	Mecosta	12	Van Buren	22
Genesee	17	Midland	15	Washtenaw	18
Gladwin	12	Missaukee	9	Wayne	18
Grand Traverse	8	Monroe	21	Wexford	9
Grafiot	15	Montcalm	15		

Slugs

Pest status: Common, occasionally an economic pest

Type of damage: May damage seedlings by feeding on stems, cotyledons, and leaves; up to 40% defoliation can be tolerated in pre-bloom plants, but if growing point is killed, stands can be significantly reduced to the point where replanting is necessary.

Conditions favoring damage: Planting into wheat stubble or other heavy crop residue; fields with a recent history of slug damage; aerial-seeded wheat exposed on the soil surface; cool, wet conditions favor slug survival and damage.

Sampling/ scouting: Methods not established.

Threshold: No established threshold; consider treating if slug damage threatens to reduce stand density below an acceptable level

List of registered insecticides (rate per acre):

Deadline MP 4 % Bait (10 to 20 lb)

Snail and Slug Pellets 3.5% Bait (various products and rates)

Thrips

Pest status: Common insect, rarely a pest.

Description: Adult – small, slender, brown and white banded abdomen, narrow fringed wings; larva – wingless, yellow/orange

Life cycle: Adults move into fields in spring. Females insert eggs in plant tissue. Adults and larvae both feed on plants.

Type of damage: Most obvious early in season; adult & nymph rasping/sucking mouthparts scrape cells on leaf underside, leaving silvery scratches which may turn leaves brown; young leaves may appear crinkled. Young plants can generally outgrow feeding injury

Conditions favoring damage: Hot dry weather coupled with large thrips populations

Management: Biological – natural enemies (minute pirate bugs, predacious thrips and mites)

Threshold: Rough guideline – treat when 30% of plants have thrips and some drying of leaves is observed.

Notes: Damage may be confused with some types of herbicide injury

List of registered insecticides, *RUP (rate per acre):

DiSyston 8* (0.5 to 1 pt) or 15G* (6.7 lb) *Barley only*. Pyganic EC 1.4 II (16 to 64 oz) or 5.0 II (4.5 to 18 oz)

White Grubs

White grubs build up in undisturbed soil and are damaging to crops planted in fields broken from sod. European chafer, an introduced grub species, is becoming a problem in winter wheat planted after soybean. Preliminary data from MSU field trials suggest that a grub density of 4 per square foot reduces stand, tillering, and yield of winter wheat. No insecticides are labeled for white grub control in small grains. Fall and spring plowing of old pasture or other established grasses with a season of clean fallow before a crop is planted is recommended.

Wireworms

Pest status: Common insect, rare economic pest.

Description: Slender, shiny, brown caterpillar with wiry segmented body, up to 1.5 inches long.

Life cycle: Immature form of click beetle; found in grasslands, sod, or fallow fields. Wireworms can spend several years in the immature stage during which they feed on newly-planted seeds as well as roots.

Type of damage: Feeds on germinating seed.

Sampling/ scouting: Scout for wireworms with a bait trap (http://www.ipm.msu.edu/CAT02_fld/FC5-16-02.htm) at least one week before planting.

Management: Cultural – spring and fall plowing of established sod is recommended before crop planted, where practical.

Threshold: One or more wireworm per bait trap.

List of registered insecticides, *RUP (rate per acre): [insecticide should be added to seed in the seed box]

Cruiser 5FS (0.75 to 1.33 oz / 100 pounds) *Wheat, barley only*

Gaicho 480 (1 to 3 oz per 100 lb seed as slurry treatment)

Insecticides Registered for Small Grains

Trade name	Common name	Class	Recommended for:	PHI days	REI hrs	Precautions and Remarks
Baythroid 2 and XL (RUP)	cyfluthrin & beta cyfluthrin	Pyr	aphids, armyworm, CLB, cutworm, grasshoppers	30	12	
Bt [Dipel Javelin, Xentari]	<i>Bacillus thuringiensis</i>	Bio	armyworm	0	4	Do Not Apply to rye. Effective only small (1 st -2 nd stage) larvae, and with moderate populations. Full coverage is required.
Cruiser 5FS	thiamethoxam	Nic	aphids, wireworms	--	--	Seed treatment, wheat and barley
Deadline MP 4 % Bait	metaldehyde	Other	slugs, snails	--	12	Broadcast by ground or air every 3 to 4 weeks during season as needed. For best results apply in the evening, preferably after a rain or irrigation. May be fatal to dogs - use caution around pets.
Dimethoate 4EC, 267, 4E, 400, 51b	dimethoate	OP	aphids, grasshoppers	35	48	Use in wheat and sorghum only. Maximum of two applications per season. Full coverage not required.
DiSyston (RUP) 8EC, 15G	disulfoton	OP	aphids, thrips	30	48	Use only on barley and wheat. For barley, maximum of 2 pints per acre per season. For wheat, maximum of 2 fall and 2 spring applications per season. Do not graze or cut forage.
Endosulfan 3EC	endosulfan	CCD	aphids, armyworm, cereal leaf beetle	--	24	Do not feed treated forage to livestock
Entrust	spinosad	Bio	armyworm, CLB	21	4	Max 5.6 oz per acre per season. Do not allow cattle to graze unless spray is dry.
Furadan 4F (RUP)	carbofuran	carb	grasshoppers	--	48	Do not apply to rye. Apply before boot stage. Maximum of 2 applications per season. Do not feed/ graze forage.
Gaucho	imidachloprid	nic	wireworm	--	12 - 24	
Lannate (RUP) LV, SP	methomyl	carb	aphids, armyworm, Cereal leaf beetle	7	48	Maximum of 4 applications per season
Malathion 5, 57 EC, 8F,8 Aqua	malathion	OP	aphids, armyworm, cereal leaf beetle, grasshoppers	7	12	
Methyl parathion 4 EC (RUP)	methyl parathion	OP	grasshoppers, thrips	15	96	Do Not Apply to rye.
Mustang and Mustang Max (RUP)	zeta-cypermethrin	Pyr	cereal leaf beetle, grasshoppers	14	12	
PennCap-M (RUP)	methyl parathion	OP	aphids, armyworm, grasshoppers	15	96	Do Not Apply to rye.
Proaxis (RUP)	gamma cyhalothrin	Pyr	aphids, armyworm, cereal leaf beetle, grasshoppers	30	24	Do not apply more than 0.48 pints per acre per season. Use on wheat only.
Pyganic EC	pyrethrins	Bio	armyworm, thrips	0	12	Listed by the Organic Materials Review Institute (OMRI) for use in organic production.
Sevin 4F, XLR Plus, 50W, 80S, 80WSP	carbaryl	Carb	armyworm, cereal leaf beetle, grasshoppers	21	7	Use only on wheat. Maximum of 2 applications per season.

SMALL GRAINS

Trade name	Common name	Class	Recommended for:	PHI days	REI hrs	Precautions and Remarks
Snail and Slug Pellets 3.5% Bait	metaldehyde	Other	slugs, snails	--	12	Apply every 2 weeks or as needed. Broadcast pellets and wet the soil before or after application. Do not allow pellets to contact edible portion of plant. Keep children, pets and poultry away from treated area.
Thionex 3EC, 50WSB	endosulfan	OCI	aphids, cereal leaf beetle	--	24	Do not feed treated forage to livestock.
Tracer	spinosad	Other	armyworm, cereal leaf beetle	21	4	
Warrior (RUP)	lambda-cyhalothrin	Pyr	aphids, armyworm, cereal leaf beetle, grasshoppers	30	24	Do not apply more than 0.48 pints per acre per season. Use on wheat only.

Soybean Insect Pests

Armyworm

Pest status: Sporadic pest

Description: Larvae (caterpillars) variable in color, from black to brown to greenish. Narrow light stripe across back and broad stripes running down sides of body.

Life cycle: Likely migrate to Michigan each spring. 2-3 generations per year.

Type of damage: Defoliation by larvae.

Conditions favoring damage: Grassy or weedy fields; double-cropping with small grains such as wheat

Threshold: 25% defoliation

List of registered insecticides, *RUP (rate per acre):

Bacillus thuringiensis (check product labels for rates)

[Agree WG, Dipel ES / DF, Javelin WG, Xentari DF]

Baythroid 2* and XL* (1.6 to 2.8 oz)

Capture 2EC* (2.1 to 6.4 oz)

Carbaryl 4L (2 to 3 pt)

Chlorpyrifos 4E* (1 to 1.5 pt)

Entrust (1.25 to 2 oz)

Intrepid 2F (4 to 8 oz)

Larvin 3.2* (10 to 30 fl oz)

Lorsban 4E* (1 to 1.5 pt – see insecticide table for generics)

Mustang* (3 to 4.3 oz) or Max* (3.2 to 4 oz)

Nufos 4E* (1 to 1.5 pt)

Orthene 75S (1 to 1.33 lbs) or 90S (0.83 to 1.1 lbs)

Orthene 97 (0.75 to 1 lb)

Pounce 3.2EC* (4 to 8 oz)

Proaxis* (3.2 to 3.84 oz)

Sevin 4F and XLR Plus (1 to 1.5 qt)

Sevin 80S and 80WSP (1.25 to 1.875 lb)

Tracer (1.5 to 2 oz)

Warrior* (3.2 to 3.84 oz)

Bean Leaf Beetle (BLB)

Pest status: Occasional.

Description: Small beetle (1/4 inch long) with variable coloration; wings greenish-yellow or red, with 4 black spots and black stripe along edge; wing spots may be absent, but a black triangle is always present on wings behind head.

Life cycle: Adults overwinter in leaf litter and wooded field margins, become active in spring. Move into alfalfa, then migrate into soybeans after first alfalfa cutting; 1-2 generations per year.

Type of damage: Chewing pest; larvae feed on root hairs and nodules; adults defoliate younger plants, leaving small round holes between major leaf veins; adult feeding on developing pods causes scarring and reduces yield and seed quality.

Management: Young soybeans can tolerate considerable injury without loss of yield; Cultural – late planting helps avoid BLB.

Threshold: 25% or more defoliation throughout field; 50% defoliation of seedlings or 25% defoliation during pod setting/filling, or if pod damage more than 10%.

List of registered insecticides, *RUP (rate per acre):

Ambush* 25W (3.2 to 6.4 oz)

Arctic 3.2 EC* (2 to 4 oz)

Asana XL* (5.8 to 9.6 fl oz)

Baythroid 2* and XL* (1.6 to 2.8 oz)

Capture 2EC* (2.1 to 6.4 oz)

Carbaryl 4L (1 to 2 pt)

Chlorpyrifos 4E* (1 to 2 pt)

Cruiser 5FS seed treatment (1.28 oz / 100 lbs of seed)

Dimethoate 4EC (1 pt)

Dimethoate 267 (1.5 pts)

Furadan 4F* (0.25 to 0.5 pts)

Gaicho SB Flowable (2 to 4 oz/100 wt seed)

Lannate LV* (0.75 to 1.0 pt) and SP* (0.25 to 0.5 lb)

Larvin 3.2* (18 to 30 fl oz)

Lorsban 4E* (1 to 2 pt – see insecticide table for generics)

Mustang* (3 to 4.3 oz) and Max* (2.8 to 4 oz)

Nufos 4E* (1 to 2 pt)

Orthene 75S (1 to 1.33 lbs) or 90S (0.83 to 1.1 lbs)

Orthene 97 (0.75 to 1 lb)

PennCap-M* (2 to 3 pt)

Permethrin/ Perm-Up 3.2EC* (2 to 4 oz)

Pounce 3.2EC* (2 to 4 fl oz)

Pounce 25WP* (3.2 to 6.4 fl oz)

Proaxis* (1.92 to 3.2 oz)

Sevin 4F and XLR Plus (0.5 to 1 qt)

Sevin 80S and 80WSP (0.63 to 1.25 lb)

Warrior* (1.92 to 3.20 fl oz)

Cutworms

Pest status: Sporadic, early season.

Description: Larvae (caterpillar) up to 2 inches in length. Variable color (black-gray).

Life cycle: Adults migrate into Michigan in early spring and lay eggs on weeds or crop debris. Several generations per season.

Type of damage: Larvae cut seedlings, reducing stand development; older plants not as affected.

Sampling/scouting: Look for wilted or cut plants and dig around base of cut seedlings to confirm identity of larvae.

Conditions favoring damage: Weedy fields and borders (especially areas with low, prostrate weed growth); high crop residue; planting into plowed sod or pasture; cover crops; wet areas; no-till.

Management: Soybean tolerates considerable stand reduction without loss of yield; Chemical-rescue (post-plant) option preferred.

Threshold: 5% or more of small plants show cutworm damage, and larvae are less than 1.5 inches

List of registered insecticides, *RUP (rate per acre):

Ambush 25W* (3.2 to 6.4 oz)	Mustang* (1.4 to 4.3 oz) or Max* (1.28 to 4 oz)
Arctic 3.2 EC (2 to 4 oz)	Nufos 4E* (1 to 2 pt)
Asana XL* (5.8 to 9.6 fl oz)	Permethrin/ Perm-Up 3.2EC* (2 to 4 oz)
Baythroid 2* and XL* (0.8 to 1.6 oz)	Pounce 3.2EC* (2 to 4 fl oz) or 25W* (3.2 to 6.4 oz)
Capture 2EC* (2.1 to 6.4 oz)	Proaxis* (1.92 to 3.2 oz)
Carbaryl 4L (2 to 3 pt)	Sevin 4F and XLR Plus (1 to 1.5 qt)
Chlorpyrifos 4E* (1 to 2 pt)	Sevin 80S and 80WSP (1.25 to 1.875 lb)
Empower 2* (3.5 to 8.7 lbs/ acre)	Warrior* (1.92 to 3.20 fl oz)
Larvin 3.2* (20 to 30 fl oz)	
Lorsban 4E* (1 to 2 pt)	

Grasshoppers

Pest status: Common insect, occasional outbreaks.

Life cycle: Eggs overwinter in the soil, and nymphs hatch in June. Nymphs molt as they grow, and feeding increases with size. Females lay eggs in the soil in late summer.

Type of damage: Defoliation (chewing) by nymphs and adults.

Conditions favoring damage: Growing season preceded by 2 or more years of dry weather; Undisturbed grassy sites next to fields (preferred for egg laying); dry, warm weather can enhance survival of nymphs.

Management: Biological – A fungal pathogen can kill many eggs and nymphs under wet spring conditions. Many animals (birds, rodents, amphibians) eat grasshoppers.

Threshold: 25% or more defoliation throughout field.

List of registered insecticides, *RUP (rate per acre):

Asana XL* (5.8 to 9.6 fl oz)	Mustang * (3.4 to 4.3 to 4.3 oz) or Max* (3.2 to 4 oz)
Baythroid 2* and XL* (2.1 to 2.8 oz)	Nufos 4E* (0.5 to 1 pt)
Capture 2EC* (1.6 to 6.4 oz)	Orthene 75S (0.33 to 0.67 lbs) or 90S (0.28 to 0.56 lbs)
Carbaryl 4L (1 to 3 pt)	Orthene 97 (0.25 to 0.5 lb)
Chlorpyrifos 4E* (0.5 to 1 pt)	PennCap-M* (2 to 3 pt)
Dimethoate 4EC (1 pt)	Proaxis* (3.2 to 3.84 oz)
Dimethoate 267 (1.5 pts)	Sevin 4F and XLR Plus (0.5 to 1.5 qt)
Dimilin* 25W and 2L (2 oz)	Sevin 80S (0.63 to 1.875 lb)
Furadan 4F* (0.25 to 0.5 pt)	Warrior* (3.20 to 3.84 fl oz)
Lorsban 4E* (0.5 to 1 pt – see insecticide table for generics)	

Green Cloverworm and Loopers

Pest status: Occasional outbreaks.

Description: Pale green caterpillar with 2 white stripes running along side of body; ~1 inch long.

Life cycle: In early spring, adults lay eggs singly on underside of leaves; larvae feed on foliage.

Type of damage: Newly hatched larvae feed on the underside of leaves. As they grow they chew through the leaves.

Management: Biological -many natural enemies and diseases.

Threshold: Rough guideline is 25% or more defoliation throughout entire field.

For more information: <http://www.entm.purdue.edu/Entomology/ext/targets/e-series/EseriesPDF/E-78.pdf>

List of registered insecticides, *RUP (rate per acre):

Ambush 25W* (3.2 to 6.4 fl oz)

Arctic 3.2 EC (2 to 4 oz)

Asana XL* (2.9 to 5.8 fl oz)

Bt = *Bacillus thuringiensis* (check product labels for rates)

[Agree WG, Dipel ES/ DF, Javelin WG, Xentari DF]

Baythroid 2* and XL* (0.8 to 2.8 oz)

Capture 2EC* (2.1 to 6.4 oz)

Carbaryl 4L (1 to 2 pt)

Chlorpyrifos 4E* (0.5 to 1 pt)

Dimilin 25W* and 2L* (2 to 4 oz)

Entrust (1.25 to 2 oz)

Intrepid 2F (4 to 8 oz)

Lannate LV* (0.4 to 0.75 pt) or SP* (0.125 to 0.5 lb)

Larvin 3.2* (10 to 30 fl oz)

Lorsban 4E* (0.5 to 1 pt – see insecticide table for generics)

Mustang* (3 to 4.3 oz) and Max* (2.8 to 4 oz)

Nufos 4E* (0.5 to 1 pt)

Orthene 75S (1 to 1.33 lbs) or 90S (0.83 to 1.1 lbs)

Orthene 97 (0.75 to 1 lb)

PennCap-M* (2 to 3 pt)

Permethrin/ Perm-Up 3.2EC* (2 to 4 oz)

Pounce 3.2EC* (2 to 4 oz)

Pounce 25WP* (3.2 to 6.4 oz)

Proaxis* (1.92 to 3.2 oz)

Sevin 4F and XLR Plus (0.5 to 1 qt)

Sevin 80S and 80WSP (0.63 to 1.25 lb)

Tracer (1 to 2 oz)

Warrior* (1.92 to 3.20 fl oz)

Japanese Beetle

Pest status: Common insect, occasional pest

Description: Adult is metallic green or bronze with reddish wing-covers and tufts of white hair down the side; approx. ¼ inch long

Life cycle: Wide host range; one generation per year.

Type of damage: Adults feed on leaf tissue between veins, giving 'skeletonized' appearance

Sampling/scouting: Look at several areas of field to assess defoliation, rather than a single area, as feeding is not uniform throughout field; consider upper and lower leaves in your assessment

Threshold: Feeding by Japanese beetle alone usually not sufficient to warrant treatment; a general threshold is 25% defoliation due to combined feeding from Japanese beetles and other insects such as bean leaf beetles, grasshoppers, etc.

List of registered insecticides, *RUP (rate per acre):

Ambush 25W* (6.4 to 12.8 fl oz)

Arctic 3.2 EC (2 to 4 oz)

Asana XL* (5.8 to 9.6 fl oz)

Baythroid 2* and XL* (1.6 to 2.8 oz)

Capture 2EC* (2.1 to 6.4 oz)

Carbaryl 4L (1 to 2 pt)

Mustang* (3 to 4.3 oz) and Max* (2.8 to 4 oz)

PennCap-M* (3 to 4 pt)

Permethrin/ Perm-Up 3.2EC* (2 to 4 oz)

Pounce 3.2EC* (2 to 4 oz)

Pounce 25WP* (3.2 to 6.4 oz)

Proaxis* (3.2 to 3.84 oz)

Sevin 4 F and XLR Plus (0.5 to 1 qt)

Sevin 80S and 80WSP (0.63 to 1.25 lb)

Warrior* (3.20 to 3.84 fl oz)

Mexican Bean Beetle (MBB)

Pest status: Occasional pest.

Description: Adult – oval beetle, ~1/2 inch long, yellow/orange with 16 small black spots on wings; larvae – bright yellow grubs with dark bristly spines.

Life cycle: Adults overwinter in crop debris, woodlots, etc.

Type of damage: Chewing pest; larvae and adults feed on undersides of leaves and between veins, giving leaf a lacy appearance.

Management: Greatest potential for yield loss from flowering through pod fill; dry hot summers may reduce populations.

Threshold: 25% or more defoliation throughout field, or 1 or more adults per plant in established plants.

MBB Continued:

List of registered insecticides, *RUP (rate per acre):

Ambush 25W* (3.2 to 6.4 oz)	Mustang* (3 to 4.3 oz) and Max* (2.8 to 4 oz)
Arctic 3.2 EC (2 to 4 oz)	Nufos 4E* (1 to 1.5 pt)
Asana XL* (2.9 to 5.8 fl oz)	Orthene 75S (1 to 1.33 lbs) or 90S (0.83 to 1.1 lbs)
Baythroid 2* and XL* (1.6 to 2.8 oz)	Orthene 97 (0.75 to 1 lb)
Carbaryl 4L (1 to 2 pt)	PennCap-M* (2 to 3 pt)
Chlorpyrifos 4E* (1 to 1.5 pt)	Permethrin/ Perm-Up 3.2EC* (2 to 4 oz)
Dimethoate 267 (1.5 pt) or 4EC, 400 (1 pt)	Pounce 3.2 EC (2 to 4 oz)
Dimilin 25W* or 2L* (2 to 4 oz)	Pounce 25WP* (3.2 to 6.4 oz)
Lannate LV* (0.4 to 0.75 pt) or SP* (0.125 to 0.5 lb)	Proaxis* (1.92 to 3.2 oz)
Larvin 3.2* (18 to 30 fl oz)	Sevin 4F and XLR Plus (0.5 to 1 qt) or 80WSP (1.25 lb)
Lorsban 4E* (1 to 1.5 pt – see insecticide table for generics)	Warrior* (1.92 to 3.2 fl oz)

Mites

Pest status: Common arthropod, occasional economic pest.

Description: Very small, wingless, 8-legged invertebrate; Two-spotted spider mite is greenish yellow to orange with 1 large black spot on each side of body.

Life cycle: Adults overwinter in field borders and sheltered areas; in spring, move to new growth and lay eggs on underside of leaves; may spread by crawling or be blown by wind; all stages feed on plants; populations can expand quickly.

Type of damage: Sucking pest; insert mouthparts into individual plant cells, resulting in small speckled yellow spots (stippling)

Conditions favoring damage: Prolonged dry, hot weather .

Sampling/scouting: Look for mites on underside of leaves using hand lens, or tap leaves over a piece of paper; webbing may be present on leaves if population is high.

Management: Biological – a fungal pathogen kills mites under warm, humid conditions.

Threshold: If problem identified early, treatments of hot-spots may suffice; or, if mites have spread across field:

Pre-bloom – 40% damage. Bloom to podfill – 15% damage. Podfill to early maturity – 25% damage.

Notes: Mites are difficult to control, and 2 applications may be needed. Notify your county MSU extension agent if you have a mite problem, so that a pest alert can be issued. If soybean aphid populations are also heavy, dimethoate may not be the best choice to control both pests.

For more information: MSU CAT Alert article from 28 July 2005, ‘You Might Have Mites’

http://www.ipm.msu.edu/CAT05_fld/FC07-28-05.htm

List of registered insecticides, *RUP (rate per acre):

Capture 2EC* (5.12 to 6.4 oz)	Lorsban 4E* (0.5 to 1 pt – see insecticide table for generics)
Chlorpyrifos 4E* (0.5 to 1 pt)	or WG (0.67-1.33 lb)
Dimethoate 267 (1.5 pt) or 4EC, 400 (1 pt)	Nufos 4E* (0.5 to 1 pt)

Potato Leafhopper (PLH)

Pest status: Common insect, rarely a pest in soybeans.

Description: Small, bright green, torpedo shaped insects. Fast moving - often move in a “crab-like” fashion. Nymphs resemble adults but are lime green/ yellow, much smaller, lack wings.

Life cycle: Adults are carried into Michigan from the south on weather fronts in May/early June. May colonize alfalfa and other hosts prior to soybean seedling emergence. Females lay eggs in soybean leaf veins and petioles. Multiple overlapping generations.

Type of damage: Adults and nymphs suck plant sap, causing leaf edges to become yellowish and cupped (curled downward and inward); greatest injury often seen in border rows adjacent to alfalfa.

Management: Cultural – ‘hairy’ soybean cultivars interfere with PLH feeding.

Threshold: 1 or more PLH per trifoliate leaf, and leaves show first signs of cupping.

List of registered insecticides, *RUP (rate per acre):

Ambush 25W* (3.2 to 6.4 fl oz)	Orthene 75S (0.67-1.33 lbs), 90S (0.56-1.1 lbs), 97 (0.5-1.0 lb)
Arctic 3.2 EC (2 to 4 oz)	Permethrin/ Perm-Up 3.2EC* (2 to 4 oz)
Asana XL* (2.9 to 5.8 fl oz)	Pounce 3.2EC* (2 to 4 fl oz)
Baythroid 2* and XL* (0.8 to 1.6 oz)	Pounce 25WP* (3.2 to 6.4 oz)
Capture 2EC (1.6 to 6.4 oz)	Proaxis* (1.92 to 3.2 oz)
Carbaryl 4L (2 pt)	Sevin 4F and XLR Plus (1 qt)
Dimethoate 4EC and DiGon 400 (1 pt) or 267 (1.5 pt)	Sevin 80S and 80WSP (1.25 lb)
Mustang* (3 to 4.3 oz) or Max* (2.8 to 4 oz)	Warrior* (1.92 to 3.2 fl oz)

Seedcorn Maggot

Pest status: Occasional pest.

Description: Larva- small (1/4 inch), white maggot; adult – small gray fly.

Life cycle: Overwinter as pupae in soil; adults emerge as flies in early spring, lay eggs in disturbed soil with decaying organic matter. Multiple generations.

Type of damage: Maggots feed on germinating seed; may cause variable emergence, stand loss, delayed development, or plants with two main stems (Y-plants).

Conditions favoring damage: Cool wet soil (delays germination), soils high in organic matter from cover crop or manure.

Management: Cultural - decreased potential for injury in reduced tillage fields; Chemical- seed treatment before planting is the easiest control method and can be used in air blast planters. Planter box treatments are also effective in conventional planters, but can't be used with air blast planters. Seed and planter box treatments often come mixed with fungicides. Be sure that the insecticide is applied at the amount recommended when a prepared mixture is used. Soil insecticide is more expensive, but offers an alternative if seed or planter box treatments cannot be used.

Threshold: Treat soybeans planted in soils high in organic matter.

List of registered insecticides, *RUP (rate per acre):

Cruiser 5FS seed treatment (1.28 oz / 100 lbs of seed)

Phorate 20G* (6.75 oz per 1,000 feet of row)

Empower 2* (3.5 to 8.7 lbs/ acre)

Thimet 20G* (6.75 oz per 1,000 feet of row)

Gaucho SB & 480 Flowable (2 to 4 oz/ 100 wt of seed)

Slugs

Pest status: Common animal, occasional economic pest

Type of damage: May damage seedlings by feeding on stems, cotyledons, and leaves; up to 40% defoliation can be tolerated in pre-bloom plants, but if growing point is killed, stands can be significantly reduced.

Conditions favoring damage: Planting into wheat stubble or other heavy crop residue, or into a field with recent history of slug damage; cool, wet conditions

Threshold: No established threshold; consider treating if slug damage threatens to reduce stand density below an acceptable level.

List of registered insecticides, *RUP (rate per acre):

Deadline MP's 4% Bait (10 to 40 lb)

Snail and Slug Pellets 3.5% Bait (various products and rates)

(Soybean aphid – see next page)

Thrips

Pest status: Common insect, occasional pest.

Description: Adult – small, slender, brown and white banded abdomen, narrow fringed wings; larva – wingless, yellow/orange.

Life cycle: Adults move into Michigan on airstreams in the spring. Females insert eggs into plant tissue.

Type of damage: Most obvious early in season; adult & nymph rasping/sucking mouthparts scrape cells on leaf underside, leaving silvery scratches which may turn leaves brown; young leaves may appear crinkled.

Conditions favoring damage: Hot dry weather coupled with large thrips populations.

Management: Biological – natural enemies (minute pirate bugs, predacious thrips and mites).

Threshold: Rough guideline – treat when 30% of plants have thrips and some drying of leaves is seen.

Notes: Young plants can generally outgrow feeding injury; damage may be confused with some types of herbicide injury.

List of registered insecticides, *RUP (rate per acre):

Baythroid 2* and XL* (0.8 to 1.6 oz)

Orthene 97 (0.25 to 0.5 lb)

Capture 2EC* (2.1 to 6.4 oz)

PennCap-M* (2 to 3 pt)

Carbaryl 4L (2 pt)

Proaxis* (1.92 to 3.2 oz)

Lannate LV* (0.75 to 1.0 pt) or SP* (0.25 to 0.5 lbs)

Sevin 4 F and XLR Plus (1 qt)

Mustang Max* (3.2 to 4.0 oz)

Sevin 80S and 80WSP (1.25 lb)

Orthene 75S (0.33 to 0.67 lbs) or 90S (0.28 to 0.56 lbs)

Warrior* (1.92 to 3.20 fl oz)

Soybean Aphid

Pest status: The soybean aphid, a pest native to Asia, was first found in 2000. It caused yield loss in 2001, 2003, and 2005.

Type of damage: Aphids are sucking pests that remove plant sap. Soybean aphids can reproduce rapidly, resulting in hundreds of aphids per leaf; this population level appears to reduce pod number, beans per pod, and bean size. Heavily infested plants are coated with sticky honeydew and black sooty mold, and may also exhibit top-down symptoms of potassium deficiency (yellow leaf margins, leaf cupping, stunting).

Conditions favoring damage: Dry conditions increase the impact of aphid feeding. Earlier-infested (early July), late-planted (June) and potassium deficient fields are at greater risk for yield loss if aphid-infested.

Management: In some years, aphid populations are held in check by a combination of natural enemies and fungal pathogens.

Sampling: Fields should be sampled multiple times to determine if populations are increasing. Count the number of SBA per plant, or use the 'Speed Scouting' technique at http://www.soybeans.umn.edu/crop/insects/aphid/aphid_sampling.htm

Threshold: 250 aphids per plant on vegetative through R5 stage beans, with INCREASING APHID POPULATIONS. In practical terms, aphids should be common (on most or all plants) and abundant (several hundred aphids per plant). The threshold provides a ~7 day treatment window.

Timing: Timing is critical. Spraying too early (below the 250 threshold) potentially disrupts natural enemies, leading to higher aphid populations and re-application later in the season. If fields are sprayed too late (honeydew, sooty mold), yield has already been lost. Sprays in late August often do not result in yield increases compared to unsprayed trials.

Product Efficacy: It is important to get excellent coverage when treating for aphids - use the highest pressure and gal/ acre practical when spraying, and choose a nozzle type recommended for insecticide coverage. When tank-mixing insecticides with other products, be sure to maximize the application for insecticide coverage.

For more information: MSU CAT Alert article from 23 June 2005: http://www.ipm.msu.edu/CAT05_fld/FC06-23-05.htm

List of recommended insecticides, *RUP (rate per acre): PHIs are given in [square parentheses]

Asana XL* (5.8 fl. oz) [21]	Lorsban 4E* (1 pt) or WG (0.67-1.33 lb) [28]
Baythroid 2* and XL* (2 to 2.8 oz) [30]	Mustang Max* (2.8 to 4 oz) [21]
Capture 2EC (2.1 to 6.4 oz) [3]	Nufos 4E* (1 pt) [28]
Chlorpyrifos 4E* (1 pt) [28]	Orthene 75S (1-1.33 lbs), 90S (0.83-1.1 lbs), 97 (0.75-1.0 lb)
Cruiser 5FS seed treatment (1.28 oz / 100 lbs of seed)	PennCap-M* (1 to 3 pts) [20]
Furadan 4F* (0.25 to 0.5 pts) [21]	Proaxis* (1.92 to 3.2 oz) [45]
Gaucha SB & 480 Flowable (2 to 4 oz/ 100 wt of seed)	Warrior* (3.2 oz) [45]

Wireworms

Pest status: Common insect, occasional pest in localized areas.

Description: Slender, shiny, yellow-brown, with wiry segmented body, up to 1.5 inches long.

Life cycle: Immature form of click beetle; found in grasslands, sod, or fallow fields. Wireworms can spend 2 to 6 years in the larval stage, during which they feed on underground parts of plants.

Type of damage: Feeds on seeds, preventing germination. Also feeds on roots.

Sampling/ scouting: Scout for wireworms with a bait station at least one week before planting.

Management: Cultural – spring and fall plowing of established sod is recommended before crop is planted, where practical.

Threshold: One or more wireworms per bait trap.

List of registered insecticides: Cruiser 5FS seed treatment (1.28 oz/ 100 lbs of seed)

Insecticides Registered on Soybean

Trade Name	Common Name	Class	Registered for:	PHI days	REI hrs	Precautions and Remarks
Ambush (RUP)	permethrin	Pyr	BLB, cloverworm, cutworm, Japanese beetle, MBB, PLH	60	12	Maximum 24 oz per acre per season. Do not graze or feed forage.
Arctic 3.2 EC	permethrin	Pyr	BLB, cloverworm, cutworm, Japanese beetle, MBB, PLH	60	12	Maximum 0.4 lb a.i. per acre per season.
Asana XL (RUP)	esfenvalerate	Pyr	BLB, cloverworm, cutworm, grasshoppers, Japanese beetle, MBB, PLH, SBA	21	12	Do not exceed 38 oz per acre per season. Do not graze or feed forage to livestock.
Bt [Agree, Dipel, Javelin, Xentari]	<i>Bacillus thuringiensis</i>	Bio	armyworm, cloverworm	0	4	Use only to control small armyworms when populations are light. Full coverage is important.
Baythroid 2 and XL (RUP)	cyfluthrin & beta-cyfluthrin	Pyr	armyworm, BLB, cutworm, grasshopper, cloverworm, JB, MBB, PLH, SBA, thrips	45	12	Maximum 11.2 oz per acre per season. Max 4 applications per season.
Capture 2EC (RUP)	bifenthrin	Pyr	armyworm, BLB, cutworm, grasshopper, cloverworm, JB, MBB, PLH, thrips	3	12	Maximum 0.2 lbs a.i. per acre per season.
Carbaryl 4L	carbaryl	Carb	armyworm, BLB, cloverworm, cutworm, grasshopper, MBB, PLH, thrips	21	12	Similar to Sevin (below)
Chlorpyrifos 4E (RUP)	chlorpyrifos	OP	armyworm, BLB, cloverworm, cutworm, grasshoppers, MBB, mites, SBA	28	24	Similar to Lorsban 4E (below)
Cruiser 5FS	thiamethoxam	Nic	BLB, MBB, PLH, seedcorn maggot, soybean aphid, wireworm			Seed treatment. Provides early season control – lasts 35-40 days after planting.
Deadline MPs	metaldehyde	other	slugs	--	12	Broadcast by ground or air every 3 to 4 weeks during season as needed. For best results apply in the evening, preferably after a rain or irrigation. Keep children, pets, and poultry away from treated areas.
Dimethoate	dimethoate	OP	BLB, grasshoppers, MBB, mites, PLH	21	48	Full coverage is not required when using dimethoate.
Dimilin (RUP) 25W & 2L	diflufenuron	IGR	cloverworm, grasshoppers, MBB	21	12	Do not graze or feed forage to livestock. Maximum 2 applications per season. Dimilin inhibits molting of larvae. 3-7 days may be required before populations are reduced.
Empower 2 (RUP)	bifenthrin	Pyr	cutworm, seedcorn maggot, wireworm	3	24	Maximum 0.2 lbs a.i. per acre per season.
Entrust	spinosad	Bio	armyworm, cloverworm, loopers	28	4	Max 0.18 lb active per acre per year. Do not feed treated vines to livestock.
Furadan 4F (RUP)	carbofuran	Carb	BLB, grasshoppers, SBA	21	48	Maximum 2 applications per season. Do not feed treated vines to livestock.
Gaicho SB Flowable, 480 Flowable	imidacloprid	Neo	BLB, Seedcorn maggot, SBA	--	--	Seed treatment. Provides early season control – lasts 35-40 days after planting. See label for plant back restrictions.
Intrepid 2F	methoxyfenozone	other	armyworm, cloverworm, loopers	14	4	Max 64 oz per acre per season. Max 4 applications per season.
Lannate (RUP) LV & SP	methomyl	Carb	BLB, cloverworm, MBB, thrips	14	48	Maximum 3 applications per crop.

Trade Name	Common Name	Class	Registered for:	PHI days	REI hrs	Precautions and Remarks
Larvin 3.2 (RUP)	thiodicarb	Carb	armyworm, BLB, MBB, cloverworm, cutworm,	28	12	Do not exceed 120 pints per acre per season. Do not feed treated forage to livestock.
Lorsban 4E (RUP) (also Govern 4E and Nufos 4E)	chlorpyrifos	OP	armyworm, BLB, cloverworm, cutworm, grasshoppers, MBB, mites, SBA	28	24	Maximum 6 pt per acre per season. Do not graze or feed forage to livestock.
Lorsban WG	chlorpyrifos	OP	mites, SBA	28	24	
Mustang and Mustang Max (RUP)	zeta cypermethrin	Pyr	armyworm, BLB, cloverworm, cutworm, grasshoppers, MBB, PLH, SBA	21	12	Maximum 25.8 oz. per acre per season. Do not graze treated areas or feed forage. Addition of crop oil to spray may improve coverage and control.
Nufos 4E (RUP)	chlorpyrifos	OP	armyworm, BLB, cutworm, cloverworm, grasshopper, MBB, mites, SBA	28	24	Maximum 6 pints per acre per season.
Orthene 75S, 90S, 97	acephate	OP	Armyworm, BLB, grasshopper, MBB, PLH, SBA	14	24	Do not graze or cut vines for hay or forage. Maximum 4 lbs a.i. per acre per season.
PennCap-M (RUP)	methyl parathion	OP	BLB, cloverworm, grasshoppers, Japanese beetle, MBB, SBA, thrips	20	96	Maximum 2 applications per season.
Permethrin 3.2AG Perm-up 3.2EC (RUP)	permethrin	Pyr	BLB, cloverworm, cutworm, Japanese beetle, MBB, PLH	60	12	Maximum 16 oz. per acre per season. Do not graze treated areas or feed forage.
Phorate 20G (RUP)	phorate	OP	seedcorn maggot	--	48	Apply at planting as a band centered over the row and cover with soil. Same restrictions as Thimet 20G (below)
Pounce (RUP)	permethrin	Pyr	armyworm, BLB, cloverworm, cutworm, Japanese beetle, MBB, PLH	60	12	Maximum 24 oz per acre per season. Do not graze or feed forage.
Proaxis (RUP)	gamma cyhalothrin	Pyr	armyworm, BLB, cloverworm, cutworm, grasshoppers, Japanese beetle, MBB, PLH, SBA, thrips	45	24	Maximum 0.03 lb a.i. per acre per season. Do not graze or feed forage.
Sevin	carbaryl	Carb	armyworm, BLB, cloverworm, cutworm, grasshoppers, Japanese beetle, MBB, PLH, thrips	21	12	Do not mix with 2,4-DB herbicides.
Snail and Slug Pellets	metaldehyde	other	slugs	--	12	May apply every 2 weeks or as needed. Do not allow pellets to contact edible portion of plant. Keep children, pets, and poultry away from treated areas.
Thimet 20G (RUP)	phorate	OP	seedcorn maggot	--	48	Apply at planting as a band centered over row & cover with soil. Do not allow Thimet to contact seed. Do not feed foliage. Do not apply if metribuzin herbicides (Lexone, Sencor) have been applied.
Tracer	spinosad	other	armyworm, cloverworm	28	4	Maximum 6 oz per acre per season. Do not feed treated forage.
Warrior (RUP)	lambda-cyhalothrin	Pyr	armyworm, BLB, cloverworm, cutworm, grasshopper, Japanese beetle, MBB, PLH, SBA, thrips	30	24	Do not apply more than 7.7 oz per acre per season. Do not graze or feed forage.

Stored Grain Management

Insect Management in Stored Grain

Insect feeding creates fine matter, shed skins, dead insects, and webbing that reduce airflow through the bin. Insect feeding also produces “hot spots”. Reduced airflow and hot spots, combined with moisture, lead to growth of fungi, some of which produce toxins. The best way to manage an insect infestation in grain is to prevent one in the first place. Sanitation should be part of your routine prior to storing grain at your facility or farmstead.

- Clean grain-handling equipment = augers, combines, wagons, scoops, trucks, rail cars.
- Clean the bin, especially beneath floors. Seal all cracks and crevices.
- Clean up spilled grain (food for both insects and rodents) and debris around the bin. Remove weeds from a six to ten foot border.
- Cover fans when not in use.
- Treat with a registered sanitary (bin) spray

Sanitary (Bin) Sprays

Sanitary sprays are used in and around structures after cleaning, but before adding grain to the bin. A sanitary spray kills insects still in the area and creates a barrier to infestation. Treat floors, walls up to six feet, the foundation, and the ground directly around the bin. The following is a list of products registered as bin sprays. Application rates for individual products are not included because of the wide variation in use directions. Please read the product label to determine the correct rate for your particular crop or purpose.

Insecticide	Registered for use in:	Precautions and Remarks
Tempo 20WP Tempo Ultra WP Tempo SC Ultra	all indoor warehouses, bins, and surrounding areas, grain-handling equipment, trucks, rail cars	NOT registered for direct application to grain, food, or feed. For general surface, spot, crack, and crevice treatments. Mix in sufficient water to cover area being treated without runoff.
Storcide II	Bins, trucks, and wagons that carry or store barley, oats, sorghum, or wheat	Bins should be thoroughly cleaned and insect-free before application.
Reldan 4E	bins, trucks, and wagons that will carry or store barley, oats, rice, sorghum, or wheat	Do NOT use in bins that will contain corn, rye, or soybean.
diatomaceous earth (DE) (for example, Insecto, Protect-It)	bins that will contain barley, birdseed, corn, dry beans, oats, peas, popcorn, rye, sorghum, soybean, sunflower, wheat	Apply 2 weeks before filling bins. May be applied dry (using blowers or fans) or wet as a spray. See label for specific directions.
Malathion 5, 8 Aquamul, 8F	bins, trucks, railcars, etc. that will carry or store barley, corn, oats, rye, and wheat	Do NOT use in structures that will contain soybeans. Do NOT apply directly to grain. Note – due to concerns about pesticide residue, some millers will not accept grain treated with malathion. Check before making an application.

Grain Treatments - Protectants

If a bin is well cleaned, sealed, and sprayed with a sanitary treatment and the commodity will be used or sold within 6 months (by spring), a grain treatment is usually NOT needed. However, if the grain or bin is not clean, or the commodity will be stored for a longer period, insecticides should be applied directly to the grain mass as a protectant or surface treatment. Protectants are applied directly on the grain stream entering the bin, and control infestations throughout the grain mass

Insecticide	Registered for use on:	Precautions and Remarks
Reldan 4E and 3% dust	barley, oats, rice, sorghum, and wheat	For control of weevils, Indianmeal and angoumois grain moths, mealworms, confused flour beetle, saw-toothed grain beetle, etc.
Actellic 5E	corn and sorghum	For control of weevils, Indianmeal and angoumois grain moths, confused flour beetle, saw-toothed grain beetle, numerous other beetles.
Storcide II	Barley, oats, sorghum, wheat	For control of weevils, Indianmeal moth, angoumois grain moth, mealworm, confused flour beetle, sawtoothed grain beetle
diatomaceous earth (DE) Insecto, Protect-It	barley, birdseed, corn, dry bean, oats, peas, popcorn, rye, sorghum, soybean, sunflower, wheat	DE is a chemically inert dust that abrades the insect outer shell. Treat the bottom 5 ft and top 5 ft of grain mass, or entire grain mass. See label for specific directions.

Grain Treatments - Surface Treatments

If the grain entering the bin is clean, and is not being stored over older grain, a “top dress” or **surface treatment** is usually sufficient. A surface treatment is applied directly on the surface of the grain immediately after the bin is filled; once in place, the grain mass must not be disturbed, as this ruins the barrier. Surface treatments protect against insects entering from the top of the bin, but will not control insects present lower down in the grain mass (for example, insects moving into new grain from older infested grain). Do not apply a surface treatment to grain that was treated with a protectant at bin-fill.

Insecticide	Registered for use on:	Precautions and Remarks
Reldan 3%	barley, oats, rice, sorghum, or wheat	Apply to the surface of clean or infested grain to control Indianmeal moth and protect against other insects. See label for specific directions.
Actellic 5E	corn and sorghum	Apply to the surface of clean or infested grain to control Indianmeal moth and protect against other insects. See label for specific directions.
diatomaceous earth (DE)	barley, birdseed, corn, dry bean, oats, peas, rye popcorn, sorghum, soybean, sunflower, wheat	Apply to the top layer of grain to control Indianmeal moth.
<i>Bacillus thuringiensis</i> (Bt) Biobit, Dipel, Javelin	grains, soybeans, sunflower, birdseed	Controls Indianmeal moth larvae. Will NOT control weevils and other beetles. Mix into top 4 inches of grain. See label for specific directions.
pyrethrins + PBO	barley, beans, birdseed, corn, oats, rye, sorghum, and wheat	Apply to surface of grain to control Indianmeal moth.
Malathion 6% dust	corn, oats, and wheat	Apply to the top layer of grain to control Indianmeal moth and protect against other insects. Note – due to concerns about pesticide residue, some millers will not accept grain treated with malathion. Check before making an application.

Infestation during storage

The key to grain management is prevention. But if infestation occurs several months into storage, you must consider the following:

- ◆ *Type of insect:* Some insects are primary pests, i.e., they attack undamaged grain and develop inside kernels. This includes several weevils (rice, maize, granary) and the lesser grain borer. Primary feeders cause direct damage and provide holes into kernels and fine material so that secondary pests can infest the grain. Most other stored grain pests are secondary pests. Thus, the presence of weevils in your grain is of extra concern.
- ◆ *Location and density of insects:* Where is the infestation - in the top layer of the grain mass, or throughout the bin? How many insects are there? Answering these questions requires you to sample with a grain trier or a set of probe traps. An infestation that is throughout the mass requires a different management strategy than an infestation in the top layer of the grain.
- ◆ *Environmental conditions:* Some infestations can be managed with temperature, by pulling cool air through the grain mass. At temperatures of 60 degrees or less, reproduction of grain insects drops off. Moving air through the grain also removes moisture pockets and hot spots that favor insect and fungal growth. However, care must be taken not to reduce grain moisture too much
- ◆ *Plans for the grain:* Grain destined for livestock feed can contain more insects and damaged kernels than grain destined for human consumption

When a bin is infested, one option is to move the grain into a clean, empty bin if one is available, applying a protectant during the transfer. The other option is to fumigate the bin. Unfortunately, there are no easy rules to decide when to fumigate because there are few good thresholds. Federal guidelines say that wheat is “infested” if two or more live stored grain pests are found in a sample. Barley, corn, oats, and sorghum are “infested” if two live weevils, or one live weevil plus five secondary pests, or ten secondary pests are found in a sample. Another suggestion is that if one live primary pest is found per trier sample or if several insects are collected within 24 hours in a probe trap, then fumigation is justified.

Some additional notes about fumigation - Fumigation penetrates the grain and kills even primary feeders inside kernels. But fumigants dissipate quickly, and thus reinfestation of the grain can occur if the bin is not well sealed to prevent insects from getting inside. Fumigation can be dangerous. Aluminum phosphide, still a common grain fumigant, is very toxic and requires special handling, protective equipment, and application procedures. In Michigan, a fumigation ‘standard’ is required in addition to your private or commercial applicator license to do fumigation. If you don’t have the training, don’t do the fumigation.

Sugar Beet Insect Pests

NOTE: *At the time this bulletin was printed (January 2007), Mustang Max was not registered for use on sugarbeets in Michigan.*

Aphids – foliar

Pest status: Common insects, occasionally an economic pest

Description: Small oval to pear shaped soft-bodied insects. Color varies from bright green to pink to brown. Have conspicuous tail-pipe like structures called cornicles.

Life cycle: Aphids present during the field season are all female, and give live birth without mating with males. Multiple overlapping generations each season.

Type of damage: Sucking pest. Removes plant sap from leaves and stems; heavy infestation may lead to stunting, curling of new leaves, and general weakening of plants.

Conditions favoring damage: Hot, dry weather enhances aphid damage.

Sampling/ scouting: Check 5 groups of 20 plants per field.

Management: Biological – natural enemies (ladybugs, lacewings, wasps) and diseases generally keep aphids in check.

Threshold: 1 colony (30 or more aphids) per plant.

List of registered insecticides, *RUP (rate per acre):

Diazinon 50W* (0.75 to 1 lb) or AG500* (0.75 to 1 pt)

Lannate LV* (0.75 to 3 pt) or SP* (0.25 to 1 lb)

Aphids - Sugar Beet Root Aphid

Pest status: Fairly common, localized economic populations

Description: Small, oval to pear shaped, pale yellow soft-bodied insects.

Life cycle: Females overwinter in soil or on roots of lambsquarter, and move to beets later in the season. During the field season, aphids are all female, and give birth to live offspring without mating. Multiple generations.

Type of damage: Sucking pest; secretes a distinctive white, waxy substance which inhibits water and nutrient uptake by beets.

Conditions favoring damage: Dry weather.

Sampling/ scouting: Scout fields for aphids or wax on roots, particularly in areas with wilted beets.

Notes: Application of Counter to control another pest may aid in control of SRA. However, application of Counter specifically to control SRA is not recommended. Check with your company representative for more detailed information on Counter.

List of registered insecticides, *RUP (rate per acre):

Counter 20CR* (3 to 6 oz per 1,000 feet of row, suppression only)

Armyworm (true armyworm, beet armyworm, fall armyworm)

Pest status: Occasional economic pests

Life cycle: depends on species

Type of damage: Defoliation (chewing). Larvae often feed at night.

Conditions favoring damage: Female moths are attracted to grassy or weedy fields early in the season for egg laying; in midsummer, true armyworms may move from surrounding fields (small grain, pasture, sod) into beets.

Sampling/ scouting: Check several areas of the field for larvae. For true armyworm, edges of fields are at greater risk.

Management: Biological - insects, rodents, and birds feed on armyworms. Cultural – good weed control can reduce infestation from true armyworm

Threshold: 25% or more of foliage damaged by armyworms.

List of registered insecticides, *RUP (rate per acre):

Agree WG (0.5 to 2lb)

Chlorpyrifos 4E* (1.5 to 2 pt broadcast)

Dipel ES (2 to 4 pt), DF (1.0 to 2.0 lb)

Javelin WG (0.25 to 1.5 lb)

Lannate LV* (0.75 to 3 pt) or SP* (0.25 to 1 lb)

Lorsban 4E* (1 to 2 pt broadcast or 0.66 -1.33 pt banded)

Pyganic EC 1.4 II (16 to 64 oz) or 5.0 II (4.5 to 18 oz)

Sevin 4F or XLR Plus (1 to 1.5 qt)

Sevin 80S or 80WSP (1.25 to 1.875 lb)

Spintor 2SC (4 to 8 oz)

Xentari (0.5 to 2 lb)

Beet Webworm (beet and alfalfa webworms)

Pest status: Rarely an economic pest

Description: Larvae are slender, greenish-black or pink. Alfalfa WW - 6 dark spots on each body segment; beet WW - black stripe down back bordered by a white line on each side.

Type of damage: Spin webs and feed on beet leaves, usually near the leaf base.

Conditions favoring damage: Weedy fields, because females deposit eggs on some weed species.

Management: Biological - many parasites and predators. Insecticides - generally not needed.

Threshold: Rough guideline - 25% or more of leaves with feeding + larvae present OR small larvae present on 50-75% of leaves

List of registered insecticides, *RUP (rate per acre):

Asana XL* (5.8 to 9.6 oz)	Pyganic EC 1.4 II (16 to 64 oz)
Dipel DF (0.5 to 1lb)	Pyganic EC 5.0 II (4.5 to 18 oz)
Lannate* LV (0.75 to 3 pt) or SP (0.25 to 1 lb)	Sevin 4F or XLR Plus (1 to 1.5 qt)
Lorsban 4E* (1 - 2 pt broadcast or 0.66 -1.33 pt banded)	Sevin 80S or 80WSP (1.25 to 1.875 lb)

Cutworm

Pest status: Occasional economic pest (depends on year); problems often localized

Description: Light gray / black caterpillar with 4 bumps on the top of each segment, and a narrow light stripe down the back.

Life cycle: Adult moths migrate to Michigan from southern states. Females lay eggs primarily on weeds. Young larvae feed above ground on weeds and beets, larger larvae feed below the surface on the stem.

Type of damage: Young larvae feed on leaves. Extensive damage by older larvae cutting plants at or below soil surface, leading to wilting and death of plants.

Conditions favoring damage: Weeds - favor egg laying; dry conditions - drive larvae down into the soil, increasing cutting damage.

Sampling/scouting: After beet emergence, check 5 groups of 20 plants, particularly in low areas of the field. Look for cut or wilted plants. Dig around base of cut plants to find larvae.

Management: Biological - ground-dwelling predators (beetles); Cultural - good weed control.

Threshold: 5% of plants cut.

For more information: MSU bulletin E-2274.

List of registered insecticides, *RUP (rate per acre):

Asana XL* (5.8 to 9.6 oz)	Lorsban 15G (6.6 to 9 oz per 1,000 row ft)
Chlorpyrifos 4E* (2 pt foliar, 1 pt banded at planting)	Sevin 4 F or XLR Plus (1.5 qt)
Dipel DF (0.5 to 1lb) and ES (1 to 2 pts)	Sevin 80 S or 80 WSP (1.875 lb)
Lorsban 4E* (2 pt broadcast or 1.33 pt banded)	Xentari (0.5 to 2 lb)

Flea Beetles (includes potato, corn, red-headed, and striped FB)

Pest status: Common insect, occasionally an economic pest

Description: All species have large hind legs and jump when disturbed. Potato and corn FB - small, shiny, round, black. Striped FB - dark, elongate, with 2 pale stripes running lengthwise down back.

Life cycle: Adults overwinter in crop residue or field borders, emerge in spring and begin feeding.

Type of damage: Small holes chewed in leaves by adults (shot-holing).

Conditions favoring damage: Weedy fields and borders

Management: Cultural - good weed control.

Sampling/scouting: Check 5 groups of 20 seedlings for feeding damage; newly emerged plants are most vulnerable, generally not a problem in mature beets.

Threshold: 25% of seedlings with feeding damage.

List of registered insecticides, *RUP (rate per acre):

Asana XL* (5.8 to 9.6 oz)	Pyganic EC 1.4 II (16 to 64 oz) or 5.0 II (4.5 to 18 oz)
Lannate LV* (0.75 to 3 pt) or SP* (0.25 to 1 lb)	Sevin 4F or XLR Plus (1 to 1.5 qt)
Lorsban 4E* (2 pt broadcast or 1.33 pt banded)	Sevin 80S or 80WSP (1.25 to 1.875 lb)

Grasshoppers

Pest status: Common insect, occasional outbreaks.

Life cycle: Eggs overwinter in the soil, and nymphs hatch in June. Nymphs molt as they grow, and feeding increases with size. Females lay eggs in the soil in late summer.

Type of damage: Defoliation (chewing) by nymphs and adults.

Conditions favoring damage: Unplowed or fallow areas next to fields are preferred egg-laying sites, and may contribute to populations in a field. Dry, warm weather often enhances survival of nymphs. Damage to sugarbeets can occur late in season when other crops are scarce.

Sampling/scouting: Check 5 groups of 20 plants for damage.

Management: Cultural- plowing and cultivation to destroy eggs. Biological – a fungal pathogen can kill many eggs and nymphs under wet spring conditions. Natural enemies include animals (birds, rodents, amphibians), parasitic wasps, and ground beetles.

Threshold: 25% or more leaves damaged.

List of registered insecticides, *RUP (rate per acre):

Asana XL* (5.8 to 9.6 oz)

Chlorpyrifos 4E* (0.5 to 1 pt)

Diazinon 50W* (1 lb) or AG500* (1 pt)

Lorsban 4E* (0.5 to 1 pt)

Sevin 4F or XLR Plus (0.5 to 1.5 qt)

Sevin 80S or 80WSP (0.62 to 1.875 lb)

Leafhoppers

Pest status: Common insects, rarely economic pests

Description: Small, fast moving, torpedo-shaped insects. Nymphs resemble adults but are much smaller and lack wings.

Life cycle: Several species occur in beets. Multiple generations.

Type of damage: Sucking pest. Both adults and nymphs remove plant sap as they feed. Symptoms include leaf curling and yellowing.

Threshold: Leafhoppers are not usually a problem in beets. A rough guideline is to treat when large numbers of leafhoppers are seen and leaf curling is present.

List of registered insecticides, *RUP (rate per acre):

Asana XL* (5.8 to 9.6 oz)

Diazinon 50W* (0.75 to 1 lb) or AG500* (0.75 to 1 pt)

Dibrom 8E (1 pt)

Pyganic EC 1.4 II (16 to 64 oz) or 5.0 II (4.5 to 18 oz)

Sevin 4F or XLR Plus (1 to 1.5 qt)

Sevin 80S or 80WSP (1.25 to 1.875 lb)

Thimet / Phorate 20G* (4.5 oz per 1,000 row ft)

Plant Bugs (includes Tarnished Plant Bug)

Pest status: Common insects, economic populations in some years.

Description: Oval “true bugs”; Tarnished plant bug is dark brown with a yellow V-shaped mark on the back. Other plant bugs are green. Both have a large piercing sucking mouthpart. Nymphs resemble adults, but lack wings.

Life cycle: Adults overwinter in weeds or crop debris. Eggs are laid into plant tissue. Multiple generations, wide host range.

Type of damage: Sucking pest. Adults and nymphs remove plant sap and inject toxic saliva. Affected leaves turn yellow to brown at tips and edges. Injured plants wilt more easily.

Conditions favoring damage: Adult movement into beet fields may coincide with cutting of alfalfa.

Sampling/ scouting: Check 5 sets of 20 plants for yellowing leaves and TPB

Threshold: Rough guideline is to treat when significant yellowing from feeding occurs and new leaves are being affected

List of registered insecticides, *RUP (rate per acre): Asana XL* (5.8 to 9.6 oz)

Spinach Leafminer

Pest status: Occasionally an economic pest.

Description: Adult is a slender gray fly with white area between eyes. The larvae feed inside leaf mines.

Life cycle: Females lay white, oval eggs in groups of 3 to 8 on undersides of beet leaves. Larvae (maggots) move inside the leaf and feed on tissue between the upper and lower surface. Larvae drop out of the leaf, pupate in the soil. Multiple generations, but only the first attacks beets.

Type of damage: Larvae create distinctive, winding mines as they feed internally on the leaf.

Conditions favoring damage: Seedling beets are more susceptible to damage than older beets.

Sampling/ scouting: Check 5 sets of 20 plants for egg masses or small mines.

Management: Scouting is crucial - insecticides are most effective if applied just before or at egg hatch.

Threshold: Treat if 50% or more of plants have egg masses and small mines are present.

List of registered insecticides, *RUP (rate per acre):

Diazinon 50WP* (0.75 to 1 lb) AG 500 (0.75 to 1 pt)

Temik 15G* (14 to 20 lb per acre or 9.5 to 13.5 oz per 1,000 row ft)

Lorsban 4E* (1 pt broadcast or 0.66 pt banded ~ MICHIGAN only)

Thimet / Phorate 20 G* (4.5 oz per 1,000 row ft)

Springtail

Springtails are tiny soil insects that spring when disturbed. They are common in soil and normally are beneficial. They eat decaying plant material, fungi or bacteria, breaking down residue and improving soil structure. On newly emerging beets, springtail damage is rare unless populations are very high (thousands per square foot). This happens most often in fields with moist soil and high residue or in early-planted fields under cool, wet conditions. Fields that had damage in a given season are at greater risk for damage in future years. Springtails feed on root tissue leaving scars. They also feed aboveground on foliage, leaving a scraped or scarred appearance, and even reducing stand in severe cases. There is no threshold for this pest in beets, and no insecticides list springtails on the label. However, if damage is severe, the following insecticides are registered on beets, and may provide some springtails control. Note that the manufacturer is not responsible for poor performance.

For more information: MSU CAT Alert article, May 19, 2005 http://www.ipm.msu.edu/CAT05_fld/FC05-19-05.htm

Asana XL* (5.8 to 9.6 oz/acre)

Lannate 90SP* (0.25 to 1 lb/acre)

Lannate 2.4LV* (0.75 to 3 pints/acre)

Variegated Cutworm

Pest status: rarely an economic pest

Description: larvae vary in color, have band of yellow diamond-shaped spots on back

Life cycle: Adult moths migrate to MI from southern states. Females lay eggs primarily on weeds. Larvae feed above ground.

Type of damage: Larvae feed on leaves, defoliating young plants

Conditions favoring damage: Weedy fields and borders

Management: Biological ~ ground-dwelling predators eat cutworms; Cultural ~ good weed control reduces egg-laying sites.

Sampling/scouting: After beet emergence, check 5 groups of 20 plants for feeding damage. Look around plant base for larvae.

Threshold: 25% or more of leaves with feeding damage.

List of registered insecticides, *RUP (rate per acre):

Asana XL* (5.8 to 9.6 oz)

Lannate LV* (1.5 pt) or SP* (0.5 lb)

Dipel DF (0.5 to 1lb) or ES (1 to 2 pts)

Lorsban 4E* (2 pt broadcast or 1.33 pt banded)

White Grubs

Pest status: Common insect, localized problems.

Description: White, C-shaped larvae of May and June beetles.

Life cycle: Grubs can live for several years in undisturbed grassy areas.

Type of damage: Larvae prune small roots, damage larger roots and may sever taproots.

Conditions favoring damage: Beets following an established grass sod or fallow.

Management: Spring and fall plowing of established sod is recommended before crop is planted; Soil insecticide generally not required.

List of registered insecticides, *RUP (rate per acre):

Counter 20 CR* (3 to 6 oz per 1,000 row ft, in furrow or banded)

Wireworms

Pest status: Common insect, localized problems

Description: Slender, shiny, brown larvae with wiry segmented body, up to 1.5 inches long.

Life cycle: Immature form of the click beetle; found in grasslands, sod, or fallow fields. Wireworms can spend several years in the immature stage during which they feed on newly-planted seeds as well as developing beets.

Type of damage: Feeds on germinating seed, seedlings, and larger roots.

Conditions favoring damage: Cool, wet weather. Beets following an established grass sod

Sampling/ scouting: Scout for wireworms with a bait trap (see web site below) at least one week before planting.

Management: Cultural – spring and fall plowing of established sod and a season of clean fallow before a crop is planted is recommended, where practical.

Threshold: One or more wireworms per bait trap.

For more information: http://www.ipm.msu.edu/CAT02_fld/FC5-16-02.htm [explains trap design and use]

List of registered insecticides, *RUP (rate per acre):

Counter 20CR* (3 to 6 oz per 1,000 row ft)

Diazinon 14 G* (21 to 28 lb), 50 W (6 to 8 lb)

Lorsban 15G (6.5 to 9 oz banded per 1,000 row ft. Suppression only)

Insecticides registered for Sugar Beets

Trade name	Common name	Class	Recommended for:	PHI days	REI hrs	Precautions and Remarks
Asana XL (RUP)	esfenvalerate	Pyr	Beet webworm, cutworms, flea beetles, grasshoppers, leaf hoppers	21	12	Maximum 29 oz per acre.
Bt [Agree, Dipel, Javelin, Xentari]	<i>Bacillus thuringiensis</i>	Biol	armyworm, beet webworm, cutworms	0	4	Use only to control small armyworms when populations are light. Full spray coverage is important.
Counter 20 CR (RUP)	terbufos	OP	wireworms, grubs, root aphid suppression	110	48	Maximum 5 applications per season. Do not place granules in direct contact with the seed as crop injury may occur. Maximum 1 application per season.
Diazinon (RUP) 50W, AG500	diazinon	OP	aphids (foliar), grasshoppers, leaf hoppers, spinach leaf miner, wireworms	14	24	Maximum 5 applications per season.
Dibrom 8E	naled	OP	leaf hoppers	2	48	
Lannate LV, SP (RUP)	methomyl	Carb	aphids (foliar), armyworm, beet webworm, flea beetles, variegated cutworm	7	48	
Lorsban 4E (RUP) & Chlorpyrifos 4E (RUP)	chlorpyrifos	OP	armyworm, beet webworm, cutworms, flea beetles, grasshoppers, spinach leafminer	30	24	Do not exceed 8 pt per acre per season.
Lorsban 15G	chlorpyrifos	OP	Cutworms, wireworms	--	24	At planting, banded before or after the press wheel (T-band or band). Maximum 1 application per year. Do not allow granules to contact seed.
Pyganic EC	pyrethrin	Bio	aphids (foliar), armyworm, beet webworm, flea beetles, leaf hoppers	0	12	Listed by the Organic Materials Review Institute (OMRI) for use in organic production.
Sevin 4F, XLR, 80S, 80WSP	carbaryl	Carb	armyworm, beet webworm, cutworms, flea beetles, grasshoppers, leafhoppers	28	12	Maximum 4 lb active per season. Not recommended for tank mixing with herbicide due to potential for crop injury.
Spintor 2SC	spinosad	other	armyworm	3	4	Max 4 applications per season.
Temik 15G (RUP)	aldicarb	Carb	spinach leafminer	90	48	At planting, drill granules 1-3 inches below seed line. Post-emergence, apply granules on both sides of row and work into soil.
Thimet/ Phorate 20G (RUP)	phorate	OP	leafhoppers, spinach leafminer	30	48	Do not place banded application in direct contact with seed. Do not broadcast if leaves are wet. Maximum 7.4 lb/acre. Do not feed tops.

NEMATODES

Introduction

Plant-parasitic nematodes are microscopic roundworms that must have living host tissue to feed upon in order to grow and reproduce. Every cultivated plant species has at least one nematode reported to parasitize it. In turn, most agricultural sites are infested with at least one species of plant-parasitic nematode.

About 95% of plant-parasitic nematodes live in the soil and feed in or on roots. Some invade leaf and stem tissue. Plant-parasitic nematodes feed by inserting a needlelike structure, the stylet, into plant cells. This feeding interferes with a plant's ability to function properly. In the case of root-feeding nematodes, infected plants often wilt and appear to suffer from a lack of water or nutrients because their roots are damaged and don't function properly. These symptoms are often mistaken as damage caused by other factors. High nematode population densities can result in plant stunting, yellowing, poor plant health and yield loss. In the presence of other organisms, plant death can occur because nematode feeding sites often act as points of entry for invasion by other plant pathogens such as bacteria and fungi. Some nematodes even carry plant viruses.

Plant-parasitic nematodes typically complete their life cycles in 30-60 days. However, some adults may survive for a year or two. The life cycle of a plant-feeding nematode generally consists of an egg, four juvenile stages and an adult. Female nematodes produce eggs that hatch into young nematodes called juveniles. The juveniles often resemble small adults. First and second-stage juveniles are usually found within eggs. In the case of most plant-parasitic nematodes, the second-stage juvenile (designated J₂) hatches from the egg. A typical nematode molts four times before becoming an adult (similar to insects, nematodes must shed their skin to grow). If females and males are both present, they mate and produce eggs. Females can produce from as many as a few to 500 or more eggs depending on the species.

Because plant-parasitic nematodes are microscopic, samples must be collected and submitted to a Diagnostic Lab for analyses. To avoid or remedy nematode problems, this should be done on a regular basis. To best assess population densities of nematodes, plant tissues and soil should be collected. For more information on the collection and handling of nematode samples consult MSU Extension Bulletin E-2199, "Detecting and Avoiding Nematode Problems."

Additional information on nematodes can be found by obtaining other MSU Extension Bulletins especially those on Soil Ecology. For specific questions, contact Diagnostic Services at MSU.

ALFALFA NEMATODES

Lesion nematodes (*Pratylenchus sp.*)

Status: Very common (found in >75% of samples)

Parasitic habit: Found within plant roots and in soil. Migrate throughout roots while feeding.

Symptoms: Reductions in root volumes and weights. Stunting and reduced yields. Poor cold hardiness.

Management: Use of lesion nematode-resistant alfalfa varieties.

Threshold: Unknown for MI, but population densities > 500 per sample warrant action.

Sampling information: Can be detected year round.

Northern root-knot nematodes (*Meloidogyne hapla*)

Status: Common (found in 25-75% of samples)

Parasitic habit: Found within root tissue and in soil. Remain sedentary in roots while feeding.

Symptoms: Galls on roots. Small tap roots with excessive lateral branching. Slow seedling growth. Reduced yields.

Management: Use of root-knot nematode-resistant alfalfa varieties. Rotation of one to three years with monocots.

Threshold: Unknown for MI, not believed to be a serious problem in areas with temperate climates.

Sampling information: Difficult to diagnose in the soil from Nov. through March.

Stem nematodes (*Ditylenchus dipsaci*)

Status: Rare (found in <5% of samples)

Parasitic habit: Found within buds and leaves. They migrate throughout tissues as they feed.

Symptoms: Patches of poorly growing, stunted plants. Internodes are often very short. Leaves may curl and turn white. Stem blackening may occur during periods of moderate temperatures and high humidity. Reduced yields

Management: Use of stem nematode-resistant varieties. Rotation of 2-4 years with non- or poor hosts such as bean or corn. Small grains are hosts for some populations of stem nematodes but not for others. Good weed control is critical.

Threshold: Unknown for MI. A very serious pathogen of alfalfa.

Sampling information: Very difficult to detect in soil. Leaf and stem tissue must be collected during the growing season.

DRY BEAN NEMATODES

Lesion nematodes (*Pratylenchus sp.*)

Status: Common (found in 25-75% of samples)

Parasitic habit: Found within plant roots and in soil. Migrate throughout roots when feeding.

Symptoms: Reductions in root volumes and weights. Stunting and reduced yields.

Management: Use of a non-fumigant nematicide.

Threshold: 250 per root and soil sample.

Sampling information: Can be detected year round.

Northern root-knot nematodes (*Meloidogyne hapla*)

Status: Infrequent (found in <25% of samples)

Parasitic habit: Found within root tissue and in soil. Remain sedentary within roots while feeding.

Symptoms: Galls on roots. Reduced yields.

Management: Use of a non-fumigant nematicide. Rotation of one to three years with monocots.

Threshold: Unknown for MI. Not considered as destructive as lesion nematode on dry beans.

Sampling information: Difficult to diagnose in the soil from Nov. through March.

Soybean cyst nematodes (*Heterodera glycines*)

Status: Infrequent (found in <25% of samples)

Parasitic habit: Found within roots and in soil. Remain sedentary within roots while feeding.

Symptoms: Patches of yellow, stunted plants. Reduced yields (4-6 cwt/A yield losses on navy beans have been documented in MI). Reduced root nodulation.

Management: Use of a non-fumigant nematicide. However, cyst nematodes are difficult to control with non-fumigant nematicides. Rotation to non-host crops (corn, potato, small grains and sugarbeets).

Threshold: Unknown for MI but population densities > 1000 eggs per 100 cm³ soil warrant action. Colored beans are extremely good hosts for this nematode.

Sampling information: Can be detected year round. Females are visible to the naked eye on roots from July-Sept.

DRY BEAN NEMATOCIDES

NAME	RATE/ACRE	APPLICATION
Temik 15G (RUP)	7.0-14.0 lbs.	Banded

CORN NEMATODES

Corn needle nematodes (*Longidorus breviannulatus*)

Status: Infrequent (found in <25% of samples).

Parasitic habit: Ectoparasite. Not found in roots, remains in soil as it feeds.

Symptoms: Root tip swelling. Patches of stunted plants often observed very early in the growing season. Severely reduced yields (50 bu/A yield losses have been documented).

Management: Rotation to non-host crops (alfalfa, potato, soybean and sugarbeets).

Threshold: 5 per 100 cm³ soil.

Sampling information: These nematodes are extremely difficult to detect in July and August. Sampling should be done in the spring or fall. They are generally confined to sandy fields (>75% sand) where corn has been produced continuously.

Dagger nematodes (*Xiphinema americanum*)

Status: Infrequent (found in <25% of samples).

Parasitic habit: Ectoparasite. Not found in roots, remains in soil as it feeds.

Symptoms: Root tip swelling. Stunting. Reduced yields.

Management: Use of a non-fumigant insecticide/nematicide. Rotation to non- or poor hosts (many annual dicots).

Threshold: Unknown for MI but this nematode is not considered very destructive on corn. Damage has been observed at population densities of 250 or more dagger nematodes.

Sampling information: This nematode also can be difficult to detect during the summer.

Lance nematodes (*Hoplolaimus galeatus*)

Status: Infrequent (found in <25% of samples).

Parasitic habit: Found within plant roots and soil. Migrate through roots while feeding.

Symptoms: Reduced root volumes and weights. Stunting and reduced yields.

Management: Use of a non-fumigant insecticide/nematicide. Rotation to non- or poor hosts (alfalfa, potato, sugarbeets).

Threshold: 100 per root and soil sample.

Sampling information: Can be detected year round.

Lesion nematodes (*Pratylenchus sp.*)

Status: Very common (found in >75% of samples).

Parasitic habit: Found within plant roots and soil. Migrate throughout roots while feeding.

Symptoms: Reductions in root volumes and weights. Stunting and reduced yields although yield losses are not usually significant.

Management: Use of a non-fumigant insecticide/nematicide.

Threshold: 250 per root and soil sample. It is not usually recommended soil insecticides be utilized solely for nematode control. However, if corn rootworm is an issue, insecticide use will provide some nematode control.

Sampling information: Can be detected year round.

Stunt nematodes (*Tylenchorrhynchus sp.*)

Status: Common (found in 25-75% of samples).

Parasitic habit: Ectoparasite. Not found in roots, remains in soil as it feeds.

Symptoms: Stunting and reduced yields.

Management: Use of a non-fumigant insecticide/nematicide. Rotation to non- or poor hosts (alfalfa, potato, soybeans, sugarbeets).

Threshold: Estimated at 500 per 100 cm³ soil.

Sampling information: Can be detected year round.

CORN NEMATICIDES/INSECTICIDES

NAME	OZ/1000 FT ²	APPLICATION
Counter 15G (RUP)	6.0	In-furrow
Counter 15G (RUP)	8.0	Banded
Mocap 6EC (RUP)	2.4-2.9 fl oz.	Banded
Mocap 15G	8.0	Banded

HAY/ PASTURE NEMATODES

Lesion nematodes (*Pratylenchus sp.*)

Status: Very common (found in >75% of samples).

Parasitic habit: Found within plant roots and soil. Migrate throughout roots when feeding.

Symptoms: Reductions in root volumes and weights. Stunting.

Management: Use of lesion nematode-resistant or tolerant varieties.

Threshold: Unknown for MI. Very little information is available regarding the impact of these nematodes on grasses used in pastures. However, pastures are vulnerable at establishment especially if nematode population densities are very high.

Sampling information: Can be detected year round.

SMALL GRAINS

Cereal cyst nematodes (*Heterodera avenae*)

Status: Rare (found in <5% of samples).

Parasitic habit: Found within plant roots and soil. Remain sedentary within roots while feeding.

Symptoms: In wheat, additional roots are produced at invasion sites resulting in bushy root systems. Oat roots are shortened and thickened. Patches of stunted plants with fewer tillers. Reduced yields.

Management: Rotation for 2-4 years to non-host crops (dicots).

Threshold: Unknown for MI. Although this nematode is the most serious pathogen of wheat in some parts of the world, it is very limited in its distribution in MI.

Sampling information: Can be detected year round.

Lesion nematodes (*Pratylenchus sp.*)

Status: Very common (found in >75% of samples).

Parasitic habit: Found within plant roots and soil. Migrate throughout roots while feeding.

Symptoms: Reduced root volumes and weights. Stunting, yellowing and reduced yields.

Management: Use of tolerant varieties. Use of nematicides on crops where economics are justified.

Threshold: Unknown for MI. However, small grains are excellent hosts for many species of lesion nematodes. Population densities of >500 per root and soil sample should cause injury.

Sampling information: Can be detected year round.

SOYBEAN NEMATODES

Lance nematodes (*Hoplolaimus galeatus*)

Status: Infrequent (found in <25% of samples).

Parasitic habit: Found within plant roots and soil. Migrate through roots while feeding.

Symptoms: Reduced root volumes and weights. Stunting and reduced yields.

Management: Use of a non-fumigant nematicide. Rotation to non- or poor hosts (alfalfa, potato, sugarbeets).

Threshold: Unknown for MI. Reported to be 4-100 per 100 cm³ soil for *H. columbus*. Estimated at 125 per roots and soil sample for *H. galeatus* in MI.

Sampling information: Can be detected year round.

Lesion nematodes (*Pratylenchus sp.*)

Status: Common (found in 25-75% of samples).

Parasitic habit: Found within plant roots and soil. Migrate through roots while feeding.

Symptoms: Reduced root volumes and weights. Stunting and reduced yields.

Management: Use of a non-fumigant nematicide.

Threshold: Unknown for MI. Reported to be 22-100 per 100 cm³ soil in the Southern U.S. Estimated at 300 per root and soil sample in MI.

Sampling information: Can be detected year round.

Northern root-knot nematodes (*Meloidogyne hapla*)

Status: Infrequent (found in <25% of samples).

Parasitic habit: Found within plant roots and soil. Remain sedentary in roots while feeding.

Symptoms: Galls on roots although they are often very small. Patches of stunted, yellow plants. Reduced yields.

Management: Use of a non-fumigant nematicide. Rotation of one to three years with monocots.

Threshold: Unknown for MI. Estimated at 500 per root and soil sample.

Sampling information: Difficult to diagnose in the soil from Nov. through March.

Soybean cyst nematodes (*Heterodera glycines*)

Status: Common (found in 25-75% of samples).

Parasitic habit: Found within plant roots and soil. Remain sedentary in roots while feeding.

Symptoms: Reduced root volumes and weights. Reduced root nodulation. Patches of stunted (often severe), yellow plants. Young plants may die. Reduced yields (80% or higher yield losses have been documented but losses are often 10-50%).

Management: Use of soybean cyst nematode resistant-soybean varieties. Use of an at-plant nematicide. However, SCN is difficult to control with non-fumigant nematicides. Rotation for 1-3 years with non- or poor hosts crops (alfalfa, corn, potato, red clover, small grains, sugarbeets).

Threshold: 100 eggs per 100 cm³ soil with an SCN-susceptible soybean variety. Soys grown on coarse-textured soils are more susceptible. SCN-resistant varieties should not be grown if SCN population densities exceed 10,000 eggs per 100 cm³ soil in any soils as significant yield losses (10-25%) may occur especially on sands.

Sampling information: Can be detected year round. Females are visible to the naked eye on roots from July-Sept.

SOYBEAN NEMATOCIDES

NAME	RATE/ACRE	APPLICATION
Temik 15G (RUP)	10.0-20.0 lbs.	Banded

SUGARBEET NEMATODES

Lesion nematodes (*Pratylenchus sp.*)

Status: Common (found in 25-75% of samples).

Parasitic habit: Found within plant roots and soil. Migrate throughout roots while feeding.

Symptoms: Reductions in root volumes and weights. Stunting and reduced yields.

Management: Use of a non-fumigant nematicide.

Threshold: Unknown for MI. These nematodes probably do not cause significant yield losses of sugarbeets in MI grown in fine-textured soils. If beets are grown in sand, population densities of >500 per root and soil sample are a concern.

Sampling information: Can be detected year round.

Northern root-knot nematodes (*Meloidogyne hapla*)

Status: Infrequent (found in <25% of samples).

Parasitic habit: Found within root tissue and soil. Remain sedentary within roots while feeding.

Symptoms: Galls on roots. Patches of yellow, stunted plants that may wilt in dry conditions. Reduced yields.

Management: Use of a non-fumigant nematicide. Rotation of one to three years with monocots.

Threshold: Unknown for MI. Population densities of >250 per root and soil sample are estimated to cause yield loss especially if beets are grown on sand. In a trial conducted in the Pacific Northwest, the northern root-knot nematode reduced the fresh root weight of sugarbeet 65%.

Sampling information: Difficult to diagnose in the soil from Nov. through March.

Pin nematodes (*Paratylenchus sp.*)

Status: Common (found in 25-75% of samples).

Parasitic habit: Ectoparasite. Not found in roots, remains in the soil as it feeds.

Symptoms: Stunted plants and reduced yields.

Management: Use of a non-fumigant nematicide. Rotation to non- or poor host crops (alfalfa, dry beans, potato, soybeans).

Threshold: Unknown for MI. Not believed to be a serious pathogen but poor growth of sugarbeets has been associated with high pin nematode population densities (>1,000 per 100 cm³ soil).

Sampling information: Can be detected year round.

Sugarbeet cyst nematodes (*Heterodera schachtii*)

Status: Common (found in 25-75% of samples).

Parasitic habit: Found within roots and soil. Remain sedentary within roots while feeding.

Symptoms: Forked or stubby taproots. Roots often have a bearded appearance due to stimulation of lateral roots. Patches of stunted plants that often wilt. Reduced yields.

Management: Use of a non-fumigant nematicide. Use of resistant varieties if available. Rotation for 3-5 years to non-host crops (alfalfa, corn, potato, small grains, soybeans). Use of trap crop (oil seed radish). Proper disposal of tare soil.

Threshold: 100 eggs per 100 cm³ soil. In areas where sugarbeet cysts nematodes exist, initial population densities of 1000 eggs and J_{2s} reduced yields 1-65% depending upon soil texture and location.

Sampling information: Can be detected year round. Females are visible to the naked eye during the growing season usually beginning in June or July.

SUGARBEET NEMATOCIDES/INSECTICIDES

NAME	RATE/ACRE	APPLICATION
Telone II (RUP)	18.0 gal	Broadcast
Telone C-17 (RUP)	21.6 gal.	Broadcast
Telone C-35 (RUP)	26.0 gal.	Broadcast
Temik 15G (RUP)	27.0-33.0 lbs.	Banded
Counter 15G (RUP)	13.1 lbs.	Knifed-in

FUMIGANT NEMATOCIDES/INSECTICIDES

Trade Name	Common Name	Class	Application	PHI (days)	Remarks
Telone II (RUP)	1,3-dichloropropene	Chlorinated Hydrocarbon	Broadcast or in-row	120	Inject 12 inches deep in well-prepared soil. Soil temp. should be 50-80°F. Apply in the fall or at least two weeks before planting in the spring. REI=5 days.
Telone C-17 (RUP)	1,3-dichloropropene + chloropicrin	Chlorinated Hydrocarbon	Broadcast or in-row	120	See remarks for Telone II.
Telone C-35 (RUP)	1,3-dichloropropene + chloropicrin	Chlorinated Hydrocarbon	Broadcast or in-row	120	See remarks for Telone II.

NON-FUMIGANT NEMATOCIDES/INSECTICIDES

Trade Name	Common Name	Class	Application	PHI (days)	Remarks
Counter 15G (RUP)	terbufos	Organo-Phosphate	Banded, in-furrow or knifed-in		If banded on corn, apply in a 7-inch band over the row in front or behind the press wheel, incorporate lightly. In furrow, place granules in the furrow behind the planter shoe. If knifed-in, drill granules 2 inches to the side of the seed and 2-4 inches below the seed. REI=2 days
Mocap 6EC (RUP)	ethoprop	Organo-phosphate	Banded	90	Apply in a 12-15 inch band on the row at planting. Mix with the top 2-4 inches of soil after application. REI=2 days.
Mocap 15G (RUP)	ethoprop	Organo-phosphate	Banded	90	Apply in a 6-7 inch band on the row over a closed seed furrow at planting. Mix the granules with the top ½ inch of soil with drag chains, spring-tooth incorporators, or similar equipment. REI=2 days
Temik 15G (RUP)	aldicarb	Carbamate	Banded	90	Apply granules in a band (band width depends on crop, read label) and work into the soil to a depth of 2-4 inches. Plant in treated zone. On sugarbeets, an at-plant plus post-emergence application can be made. REI=2 days

DISEASE MANAGEMENT IN FIELD CROPS

The disease management section of the Michigan field crops bulletin includes sections on management for some of the most important diseases of corn, small grains, dry beans, soybeans, and sugar beets. Several diseases have been added this year. In some cases, there are not any fungicides labeled for control of a particular disease. We have provided information on the cause of the disease, symptoms, disease cycle, conditions favoring development of the disease, and management techniques, including fungicides registered for use in Michigan. There are tables for seed treatments registered for soybeans, corn, small grains, and dry beans. We hope you find this information helpful and easy to use. We welcome your comments and suggestions for improvements and additions.

FUNGICIDE RESISTANCE MANAGEMENT

WHAT IS FUNGICIDE RESISTANCE?

- Resistance is an inherited change in a plant pathogen's susceptibility to a fungicide.
- Resistance usually develops due to a change by the fungal pathogen at the site where the fungicide is active (mode of action).
- Strains of pathogens develop reduced sensitivity to fungicides causing complete or partial loss of fungicide efficacy.
- Intensive use, overuse or misuse of certain fungicides can result in the development of resistance.

RECOGNIZING RESISTANCE

- Resistance may gradually increase over time resulting in partial loss of control.
- Resistance may appear suddenly with significant loss of control.

STRATEGIES FOR MANAGING RESISTANCE

The risk of resistance varies within chemical classes. Pathogens may become cross resistant to fungicides with the same mode of action even though they are in different chemical classes. It is important to rotate fungicides based on different modes of action, instead of rotating based on chemical classes. An international organization, the Fungicide Resistance Action Committee (FRAC), has grouped fungicides by mode of action and given each mode of action a code number. You can select fungicides for rotation by looking at the group code and choosing a registered fungicide with a different code than the one used previously. The fungicide group code will soon be added to all fungicide labels.

Avoid resistance:

- Use disease predictive models for effective timing of fungicide applications.
- Scout fields frequently for the appearance of disease symptoms.
- Increase crop rotation intervals to avoid the buildup of soil-borne pathogens.
- Use varieties that are less susceptible to disease.
- Use formulated mixtures or tank-mixes of effective fungicides having different modes of action. For effective resistance management, both mixing partners must be active against the target pathogen.
- Use effective multi-site fungicides, less prone to fungicide resistance, as mixing partners (group code begins with M).
- Watch for and report control failures and difficulties so that the possibility of resistance can be monitored and evaluated.
- Read fungicide labels carefully for additional resistance management recommendations.

Group code (mode of action)	Common name	Trade names	Field crops on label Foliar or soil application only (no seed treatments)	Resistance risk L, M, H
1	thiophanate, thiophanate methyl	Topsin, Topsin-M	Dry beans, soybeans, sugar beets, wheat	H
2	iprodione	Rovral	Dry beans	M-H
3	propiconazole	Tilt, Bumper, Propimax	Corn, small grains, soybeans*	M
3	tebuconazole myclobutanil	Folicur Laredo	Soybeans,* wheat (head scab) Soybeans *	M
3	tetraconazole	Domark	Soybeans*	M
4	metalaxyl, mefenoxam	Ridomil Gold	Dry beans, soybeans, sugar beets	H
7	boscalid	Endura	Dry beans	M
11	azoxystrobin	Amistar	Dry beans, sugar beets	H
11	azoxystrobin	Quadris	Barley, corn, dry beans, soybeans, sugar beets, wheat	H
11	pyraclostrobin	Headline	Barley, oats, rye, wheat, sugar beets, soybeans *	H
11	trifloxystrobin	Gem	Sugar beets	H
11/3	pyraclostrobin + tebuconazole	Headline SBR	Soybeans*	
11/3	azoxystrobin + propiconazole	Quilt	Barley, wheat, corn, soybeans*	
11/3	trifloxystrobin + propiconazole	Stratego	Corn, wheat, soybeans*	
14	quintozene (PCNB)	Blocker	Dry beans	L-M
30	triphenyltin hydroxide	Super Tin	Sugar beets	L-M
M1	copper hydroxide	Kocide	Barley, oats, wheat, dry beans, sugar beets	L
M1/M3	copper hydroxide + mancozeb	ManKocide	Barley, oats, wheat, sugar beets	L
M3	ethylene bisdithiocarbamates (EBDC)	Penncozeb	Barley, oats, rye, wheat, sugar beets	L
		Dithane	Corn, barley oats, rye, wheat, sugar beets	
		Manzate	Barley, oat, wheat, rye, sugar beets	
		Maneb	Dry beans, sugar beets	
M 5	chlorothalonil	Bravo, Echo	Soybeans	L

* soybean rust only

SEED CORN DISEASES

Control of foliar diseases on field corn is rarely needed. However, control of some foliar disease may be needed for the highly inbred lines used for production of hybrid seed corn. Many of the fungicide recommendations listed below are specifically for seed corn. If using these products for disease control on field corn or popcorn, make sure that they are listed on the label.

Crop rotation is one of the most important means of managing disease in corn. Rotate corn with a broadleaf crop such as dry beans, soybeans, sugar beets or potatoes. Crop rotation to broadleaf crops reduces the potential for corn leaf diseases that survive in corn debris. Small grains such as wheat, barley and oats share several serious diseases with corn. The fungus that causes Gibberella (*Fusarium graminearum*) stalk rot of corn is the same fungus that produces head scab in wheat and barley. This fungus overwinters in corn residue, and can produce high numbers of spores to infect wheat and barley. Avoid planting wheat or barley back into fields previously planted to corn. Wheat, barley and oats also share several root disease fungi in common with corn.

Northern corn leaf spot, Carbonum leaf spot

Cause: *Bipolaris zeicola* (fungus)

Symptoms: Narrow linear lesions 1/8 to 1/4 inch wide and 1/2 to 3/4 inch long appear on leaves. Lesions are grayish-tan and usually surrounded by a purplish border. The lesions usually develop between the veins of the leaf. The shape and color of the lesions may vary depending on the hybrid or variety. The leaf, leaf sheath, husks, and ears may become infected.

Disease cycle: The fungus overwinters on corn residue and kernels. It forms thick-walled resting spores (chlamydospores). Young plants become infected as they grow up through residues of the previous corn crop. During prolonged damp weather, infected leaves produce more spores which may be wind blown over long distances to other cornfields to spread the disease.

Conditions favoring the disease: The disease is favored by moderate temperatures (65°-80°F) and high relative humidity during the growing season. Dry weather slows spread of the disease. Using minimum tillage and growing continuous corn also favor the disease.

Management: Many hybrids are resistant. There are five distinct races of this fungus; race 3 causes northern corn leaf spot. Disease is primarily a problem in seed production fields planted with highly susceptible inbreds. Rotate away from corn for 1-2 years; till fields deeply in fall to bury infected crop residue. Foliar fungicides may be useful in seed production fields.

Check the label for additional information including re-entry intervals (REI) pre-harvest intervals (PHI), and plant-back restrictions.

List of registered fungicides (rate per acre or as noted):

Bumper 41.8 EC 2 - 4 fl. oz.

Dithane F45 1.2 quarts

Dithane M45 1.5 lbs.

Echo 720 1.5 - 2 pints

Echo 90 DF 1.25- 1.63 lb.

Echo Zn 1.13- 2.75 pints

Equus 500 Zn 1.1 - 2.8 pints

Equus 720 SST 0.75 - 2 pints

Propimax EC 2-4 fl. oz.

Quadris Flowable 9 - 15.5 fl. oz.

Quilt 7 - 14 fl. oz.

Tilt EC 2 - 4 fl. oz.

Common corn rust

Cause: *Puccinia sorghi* (fungus)

Symptoms: The first symptoms appear as chlorotic flecks on the upper and lower surfaces of the leaves. The flecks become oval to elongate reddish-brown pustules containing reddish-orange spores. Severely infected corn leaves and leaf sheaths turn chlorotic and die. As the pustules mature, they become brownish black, and produce a different type of spore (teliospores) that only infects oxalis. However, in cooler areas of the country like Michigan, oxalis does not become infected.

Disease cycle: The fungus spreads by airborne spores traveling up on wind currents and storms from the South. This fungus does not survive winter in Michigan. Symptoms usually appear soon after silking. Once the pustules begin to produce the reddish-orange spores (called uredospores), repeating cycles of infection can take place, spreading the disease. New infections can occur about every 7-14 days.

Conditions favoring the disease: Cool temperatures (61 to 77°F) and high humidity (greater than 95%), especially for extended periods of time.

Management: Rust is usually not a serious disease in hybrids. Monitor fields weekly for signs of disease. For susceptible inbreds, apply a registered fungicide soon after symptoms appear. Check the label for additional information including re-entry intervals (REI) pre-harvest intervals (PHI), and plant-back restrictions.

List of registered fungicides (rate per acre or as noted):

Bravo Ultrex 0.7 - 1.8 lbs.

Bravo Weatherstik 0.75 - 2 pints

Bumper 41.8 EC 4 fl. oz.

Chlorothalonil 720 0.75 - 2.0 pints

Dithane DF Rainshield 1.5 lb.

Dithane F45 1.2 quarts

Dithane F45 Rainshield 1.2 quarts

Dithane M45 1.5 lbs.

Echo 720 1.5 - 2 pints

Echo 90 DF 1.25 - 1.63 lb.

Echo Zn 1.13 - 2.75 pints

Equus 500 Zn 1.1 - 2.8 pints

Equus 720 SST 0.75 - 2 pints

Headline 6 - 9 fl. oz.

Manzate 75DF 1.5 lb

Manzate Flowable 1.2 quarts

Manzate Pro-stick 1.5 lbs.

Penncozeb 75 DF 1.0 - 1.5 lb.

Penncozeb 4FL 0.8 - 1.2 quarts

Penncozeb 80 WP 1 - 1.5 lb

Propimax EC 4 fl. oz.

Quadris Flowable 6 - 9 fl. oz.

Quilt 10.5 - 14 fl. oz.

Serenade WP 1 - 3 lb. (biofungicide)

Sonata 2 - 4 quarts (biofungicide)

Stratego EC 7 - 10 fl. oz.

Tilt EC4 fl. oz.

Gray leaf spot

Cause: *Cercospora zeae-maydis* (fungus)

Symptoms: Early foliar symptoms are yellow to tan lesions with a faint watery halo which can be seen when held up to the light. Older lesions are tan to brown in color and bordered by the veins of the leaf; several lesions may run together. Individual lesions are about 3" to 4" long and 1/16" to 1/8" inch wide. Lesions which are orange to yellow in color (instead of tan) are produced on some hybrids. Lesions may occur on the leaf sheath and stalk of some hybrids.

Disease cycle: The fungus overwinters in and on corn debris in the field and on the soil surface. In late spring when weather is warm and humid, spores develop on the corn residue, and are spread by wind to the lower leaves of the current season's corn crop. Infections may begin to develop in early summer, and spread rapidly with favorable weather conditions in mid to late summer.

Conditions favoring the disease: High humidity, and poor air circulation create favorable conditions for infection, which requires leaf surfaces to be wet for 11 to 13 hours and relative humidity at or above 90% for 12 to 13 hours. Continuous corn and reduced tillage allow the fungus to build up in the field.

Management: Use resistant hybrids. Rotate away from corn for two years with reduced tillage or one year with conventional tillage. In fields with a history of this disease, begin scouting for the disease at the V10-V14 growth stage. Fungicides need to be applied before significant injury has taken place if they are to be effective.

List of registered fungicides (rate per acre or as noted):

Bumper 41.8 EC 4 fl. oz.

Headline 6 - 9 fl. oz.

Manzate 75DF 1.5

Manzate Flowable 1.2 quarts

Manzate Pro-stick 1.5 lbs.

Penncozeb 75 DF 1.0 - 1.5 lb.

Penncozeb 4FL 0.8 - 1.2 quarts

Penncozeb 80 WP 1 - 1.5 lb

Propimax EC 4 fl. oz.

Quadris Flowable 9 - 15.5 fl. oz.

Quilt 10.5 - 14 fl. oz.

Stratego EC 10 - 12 fl. oz.

Tilt EC 4 fl. oz.

Northern corn leaf blight

Cause: *Exserohilium turcicum*, (formerly *Helminthosporium turcicum*) (fungus)

Symptoms: Cigar-shaped, gray-green to tan lesions (1"-6" long) develop first on older lower leaves. Symptoms progress up the plant and resemble frost or drought injury. Lesions form on husks but ears are not infected.

Disease cycle: The fungus overwinters on leaves, husks, and other crop debris as thick walled resting spores (chlamydospores). In early summer during wet weather, spores are produced on the corn residue and travel in wind and rain to infect the lower leaves of young plants. Lesions develop within 7-12 days. Spores produced on infected leaves can be wind-blown long distances. Secondary spread can occur within and between fields.

Conditions favoring the disease: Infection occurs when free water is present on the leaf surface for 6-18 hours with temperatures between 66 and 80°F Moderate temperatures, heavy dews, and frequent showers are favorable. High losses can occur if infection takes place before tasselling.

Management: Use resistant hybrids. When growing susceptible hybrids, use a one- to two-year rotation away from corn. Destroy old corn residues by tilling. If applying fungicides, begin applications when lesions first appear on the leaf below the ear.

Check the label for additional information including re-entry intervals (REI) pre-harvest intervals (PHI), and plant-back restrictions.

List of registered fungicides (rate per acre or as noted):

Bravo Ultrex 0.7-1.8 lbs.

Bravo Weatherstik .75-2 pints

Bumper 41.8 EC 2-4 fl. oz.

Chlorothalonil 720 0.75-2.0 pints

Dithane DF Rainshield 1.5 lb

Dithane F45 1.2 quarts

Dithane F45 Rainshield 1.2 quarts

Dithane M45 1.5 lbs.

Echo 720 1.5 - 2 pints

Echo 90 DF 1.25 - 1.63 lb.

Echo Zn 1.13 - 2.75 pints

Equus 500 Zn 1.1 - 2.8 pints

Equus 720 SST 0.75 - 2 pints

Headline 9 - 12 fl. oz.

Manzate 75DF 1.5

Manzate Pro-stick 1.5 lbs

Manzate Flowable 1.2 quarts

Penncozeb 75 DF 1.0 - 1.5 lb.

Penncozeb 4FL 0.8 - 1.2 quarts

Penncozeb 80 WP 1 - 1.5 lb.

Propimax EC 2 - 4 fl. oz.

Quadris Flowable 9 - 15.5 fl. oz.

Quilt 7 - 14 fl. oz.

Stratego 10-12 fl oz

Tilt EC 2 - 4 fl. oz

Stewart's disease (Stewart's wilt)

Cause: *Pantoea (Erwinia) stewartii* (bacterium)

Symptoms: Stewart's wilt is most serious when it infects corn seedlings, but can infect corn plants at any stage of development. In the seedling stages, the bacteria produce (systemic) infections that spread through the whole plant, causing stunting, wilting or death. Leaf blights occur more commonly on adult plants later in the season, usually after pollination. Leaf lesions appear as long, thin, tan to brown stripes running lengthwise on the leaf. Severe case of leaf blight can reduce yields and increase susceptibility to other diseases, such as stalk and root rots.

Disease cycle: During mild winters, the bacterium survives over winter in the gut of infected corn flea beetles, living in the upper layers of soil and plant debris. As infected beetles emerge in spring, they feed on weeds and grasses until corn seedlings emerge. Once the seedlings emerge, the beetles move to begin feeding on corn foliage, and deposit bacteria (in feces) in the feeding wounds. Repeated feeding re-infects the corn plant at additional sites, worsening the infection. Beetles that feed on infected plant tissue become carriers for the bacterium, spreading the disease even further.

Conditions favoring the disease: Mild winter conditions that allow for survival of infected beetles.

Management: This disease is managed by controlling the corn flea beetles that carry the disease (see information pg 36). Seed treatments with systemic insecticides may be of benefit to reduce early season-feeding by CFB, but will not last the entire season. Seed corn varieties tend to be the most susceptible to this disease. There is little university-based research available about field corn hybrids tolerant to Stewart's wilt. Field corn hybrids haven't necessarily been selected for resistance to Stewart's wilt, as it hasn't been considered a problem in northern-grown hybrids. Check with seed corn dealers for more specific information about field corn hybrids with tolerance to Stewart's wilt. There are no known cultural practices to reduce the disease. Several predictive models based on average air temperatures during December, January and February have been developed to help determine the risk of Stewart's wilt, but these models haven't always proved reliable.

Dry Bean Diseases

Anthracnose

Cause: *Colletotrichum lindemuthianum* (fungus)

Symptoms: Symptoms can appear on any above ground part of the plant, including cotyledons, leaves, petioles, stems, and pods. The first symptoms are dark, water soaked lesions. Lesions are commonly found on the petioles and on lower surfaces of leaves and leaf veins as elongate, angular, brick red to purple spots, turning dark brown to black. They may also be found on the upper leaf surface. Pod infections are tan to rust- in color, becoming sunken cankers surrounded by a slightly raised black ring with a reddish brown border. Tan to salmon colored spores may form in the lesions.

Disease cycle: Between crops, the fungus survives in crop debris and can be spread in seed, air and water. Initial infection can take place anytime during the growing season during cool, wet weather; secondary infections can occur from spores forming on infected plants and spreading in wind and splashing rain, or being transported on equipment.

Conditions favoring the disease: The disease is favored by temperatures of 55–70 degrees F with an optimum of 63 degrees F and High humidity (more than 92%) or free moisture during all stages of disease development. The disease is most severe when there is frequent rainfall accompanied by wind and splashing rain. Seed treatment and certain copper fungicides are available for use. Look for resistant varieties and rotate every three years to reduce the buildup of disease inoculum.

Management: For the names of some cultivars with resistance to anthracnose, Visit MSU's dry bean breeding website at: <http://www.css.msu.edu/bean/Variety.cfm>. Avoid introducing anthracnose into the fields by using certified anthracnose-free seeds. Avoid cultivating when the plant canopy is still wet. Work infected fields last and clean your equipment thoroughly before entering other fields. Plow under infected bean refuse, and clean your equipment afterwards. Use a three year crop rotation with corn and small grains. Several fungicides are registered for use on dry beans. **See labels for specifics, including pre-harvest intervals, REIs and plant-back restrictions.**

List of registered fungicides, rate per acre:

Amistar 2.5 oz.	Maneb 75 DF 1.5 - 2.0 lb
Armcarb 100 2.5 - 5.0 lb.	Maneb 80 WP 1.5 - 2.0 lb
Bravo Ultrex 1.25 - 1.8 lb.	Manex 1.2 - 1.6 quarts
Bravo Weatherstik 1.38 - 2 pints	Quadris F 6 - 15.5 fl. oz.
Chlorothalonil 720 F 1.37 - 2 pints	Quadris Opti 1.6 - 2.4 pints
Echo 90 DF 1.13 - 1.63lb.	Thiophanate methyl 4.5F 30 - 40 fl. oz.
Echo 720 1.38 - 2 pints	Thiophanate methyl 85 WDG 0.8 - 1.6 lb.
Echo Zn 2 - 3 pints	T-methyl 70 W 1 - 1.5 lb
Eco-Mate Armcarb 2.5 - 5.0 lb.	Topsin M 70 WP 1 - 1.5 lb
Equus 500 Zn 2 - 2.8 pints	Topsin M 70 WDG 1 - 1.5 lb
Equus 720 SST 1.37 - 2 pints	Topsin 4.5F 20 - 30 fl. oz.
Headline 6 - 9 fl. oz.	

Fusarium Root Rot

Cause: *Fusarium solani* f.s. *phaseoli*(fungus)

Symptoms: The first symptoms are usually red to brown streaks or lesions on the roots and the portion of the stem below ground. These symptoms appear several weeks after seedlings emerge. Symptoms are rarely visible above ground. The primary root may be killed, and the lower stem may become pithy or hollow as the disease progresses. Infected plants can develop roots above the stem lesion, but may be stunted, exhibit yellowing leaves or leaf drop, and have poor pod fill. Later in the season, severely infected plants may show internal browning of the pith below the first node. The disease is distributed in circular to irregular patches in the field.

Disease cycle: The fungus survives in the soil as thick-walled resting spores (chlamydospores). The fungus is able to live indefinitely in infested fields by germinating and reproducing on organic matter, and roots and seeds of other plants in the soil until susceptible hosts become available. The spores germinate in response to nutrients exuded by germinating seeds and roots. Hyphae produced by the fungus penetrate the bean plant through wounds and natural openings.

Conditions favoring the disease: Low fertility, high plant density, hardpan, poor drainage or soil compaction; High amounts of decomposing organic matter at planting time.

Management: Use high-quality seed; selecting varieties with tolerance to *Fusarium*. Plant beans in warm, moist soil to encourage rapid germination and emergence. Cultivate soil to hill up around the stems to encourage the development of lateral roots. Avoid close cultivation that may trim lateral roots. Seed treatments must be systemic to be effective. Rotate to non-susceptible crops such as small grains or corn, with beans planted every third or fourth year.

Rhizoctonia Root Rot

Cause: *Rhizoctonia solani* (fungus)

Symptoms: The first symptoms are small, sunken reddish brown lesions on the roots and portion of the stem above the roots. These expand into cankers, become more sunken, and may girdle the stem. Small brown-black specks (sclerotia) may appear on the surface of cankers. Seedlings and young plants are most susceptible to infection. Seedlings may die. Older plants may appear stunted or die.

Disease cycle: The fungus survives as mycelium or sclerotia in the soil or on infested crop debris. It can survive in or on bean seed. Soil temperatures around 59 to 64°F are optimum for the fungus.

Conditions favoring the disease: Poor drainage, high levels of organic matter, high plant density, wounds on roots and stems caused by cultivation

Management: Use high-quality certified seed. Plant beans in warm, moist soil to encourage rapid germination and emergence. Cultivate soil to hill up around the stems to encourage the development of lateral roots. Avoid close cultivation that may trim lateral roots. Seed treatments must be systemic to be effective. Rotate to non-susceptible crops such as small grains or corn, with beans planted every third or fourth year. Rotations with sugar beets, soybeans or potatoes are not recommended, as they are susceptible hosts for *Rhizoctonia*.

See labels for PHI, REI and plantback restrictions.

List of registered fungicides (rate per acre):

Quadris F 0.40 - 0.80 fl. oz/ 100 0 ft. row as in furrow treatment	Ridomil Gold PC GR 12 oz./1000 linear ft. (banded)
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White Mold, Sclerotinia Stem Rot

Cause: *Sclerotinia sclerotiorum* (fungus)

Symptoms: Infected flowers look white and cottony. Lesions start as small water-soaked dark spots on pods, leaves, stems and petioles. Spots enlarge, and become slimy. Cottony patches of white mycelium appear on stems and other infected parts. Late season symptoms- bleached, papery and/or shredded lower stem; hard, black, irregularly-shaped pieces of dormant mycelium (sclerotia) develop on stems, in stem pith and (sometimes) in pods.

Disease cycle: Survives as sclerotia in crop residue, or combined with the seed. Burying sclerotia in soil increases their ability to survive. Sclerotia germinate in the spring and summer by forming mushroom-like fruiting bodies called apothecia. Apothecia produce large numbers of spores, which spread by wind and splashing rain. The spores germinate using dead and dying bean flowers as a food source to grow mycelium. The mycelium infects the stem near the node and spreads to other plant parts.

Conditions favoring the disease: Cool temperatures and high humidity in the crop canopy, particularly as plants are flowering. Cropping practices such as narrow rows, high planting rates irrigation, high soil fertility, and early planting increase risk.

Management: Use clean seed, free of sclerotia. There are several seed treatments that can be used to eradicate the fungus from seed to be planted (See section on dry bean seed treatments, page 19).

Avoid rotation to susceptible crops-sunflower, dry beans or snap beans. Rotate with non-host crops such as sugar beets, corn, alfalfa, or small grains to reduce the number of sclerotia in fields. The fungus can survive for years in the absence of a susceptible host. Control broadleaf weeds during the non-host crop rotation- many broadleaf weeds are hosts for this disease. Plant partially resistant varieties. See MSU dry bean variety trials website: <http://www.css.msu.edu/varietytrials/soybean/whitemold.htm> Use planting rates and row widths that promote air circulation and rapid drying of plants and soil surface. Irrigate only as required for optimum plant growth.

See labels for PHI, REI and plant-back restrictions.

List of registered fungicides (rate per acre):

Contans WG 1 - 2 lbs. (biological, to reduce inoculum in soil)

Endura 8 - 11 oz.

Iprodione 4L 1.5 - 2.0 pints

Rovral 4F 1.5 - 2 pints

Rovral 75 WG 1.0 - 1.33 lb.

Serenade 1 - 3 lb (biofungicide)

Sonata 2 - 4 quarts (biofungicide)

Thiophanate methyl 4.5F 30 - 40 fl. oz.

Thiophanate methyl 85 WDG. 12.8 - 25.6 oz.

T methyl 70 W 1.5 - 2 lb.

Topsin 4.5 FL 30 - 40 fl. oz. for single application;

20 - 30 fl. oz. for multiple applications

Topsin M 70 WP- 1.5 - 2 lb.

Topsin M 70WDG- 1.5 - 2 lb.

Pythium root rot

Cause: *Pythium* spp. (Oomycete; “fungus-like” pathogen)

Symptoms: Seedlings die rapidly, leaving gaps in rows. Young plants turn yellow, collapse, and die, leaving gaps in row plantings. Infected seedlings develop a water-soaked lesion on the stem above the root (hypocotyl). Root systems are stunted and/or rotted. Mild infections stunt plant growth, but don’t kill the plant. During prolonged period of cool, wet weather, pods in contact with the soil may become infected- they can look water-soaked, and develop a fluffy white mold.

Disease cycle: Overwinters as resting spores (oospores). During periods of adequate soil moisture and temperature, oospores germinate to form structures called sporangia. In saturated soils, small swimming spores (called zoospores) are released. They swim to dry bean roots, where they attach, germinate, invade the root and grow.

Conditions favoring the disease: Wet soils favor damping off. Disease is more severe in poorly-drained or saturated soils, and where there is soil compaction. High amounts of organic matter, and high planting densities can contribute to more severe disease.

Management: Rotate with a non-legume crop for at least three years. Improve soil drainage. Manage irrigation runoff to restrict spread of root rots within and between fields. Avoid working or driving on wet soil; avoid tillage practices that contribute to soil compaction. Use systemic seed treatments or soil treatments. Apply fungicides to soil as broadcast, band, or in furrow treatment, depending on methods listed on label.

See labels for PHI, REI and plant-back restrictions.

List of registered fungicides (rate per acre or as noted):

Ridomil Gold EC 1/2 -1 pint as preplant incorporated

Ridomil Gold EC 1/2 -1 pint as banded surface application

Ridomil Gold PC GR 12 oz./1000 linear ft. at planting

Common Blight, Halo Blight

Cause: Common blight- *Xanthomonas phaseoli* (bacterium)

Halo blight- *Pseudomonas syringae* pv. *phaseolicola* (bacterium)

Symptoms: Common blight first appears as water-soaked spots on leaves. Spots are greasy, and green, with a small border of lemon yellow. Veins near the spots may turn dark. As the spots enlarge, the leaves take on a burned appearance. Dead leaves may remain attached to the plant. Lesions on pods are dark green with brick red margins, and may develop a yellow bacterial ooze in wet weather. Seeds may have areas discolored yellow or brown.. **Halo blight** appears first as small, greasy green spots on leaves. These spots turn into small dead areas (about ½ “), with light green halos. Veins near spots may turn dark. Pod lesions are similar to those on common blight but develop a white ooze instead of yellow ooze. Plants may be stunted.

Disease cycle: Both of these blights are seedborne, and planting contaminated seed is a major source of infection. Bacteria survive on crop residue at or near the soil surface.

Conditions favoring the disease: Splashing rain and humid weather, temperatures around 82 to 90 are favorable conditions for the pathogen. It can also spread on windblown soil, and can be spread from infected foliage to healthy plants by people and farm equipment.

Management: Plant high quality seed. Bactericides such as streptomycin can be applied to seed. Avoid working in wet fields. Plow down and bury bean refuse. Rotate crops with at least two years between bean crops. Copper compounds are registered for treating bacterial blights, but have had limited effectiveness at suppressing the disease in the field.

List of registered bactericides (rate per acre or as noted):

Champ Dry Prill 0.67 - 2 lb.

Champ Formula 2 Flowable- 0.67 - 2 pints

Champ WP 1 - 3 lb.

Kocide 101 1 - 3 lb.

Kocide 2000 0.75 - 2.25 lb.

Kocide 4.5 LF 0.67 - 2 pints

Kocide DF 1 - 3 lb

DISEASES OF SMALL GRAINS

Crop rotation is one of the most important means of managing disease in small grains. Rotate small grains with a broadleaf crop such as dry beans, soybeans, sugar beets or potatoes. Small grains such as wheat, barley and oats share several serious diseases with corn. The fungus that causes Gibberella (*Fusarium graminearum*) stalk rot of corn is the same fungus that produces head scab in wheat and barley. This fungus overwinters in corn residue, and can produce high numbers of spores to infect wheat and barley. Avoid planting wheat, barley or oats back into fields previously planted to corn. Wheat, barley and oats also share several root disease fungi in common with corn. Smuts and bunts can be controlled with seed treatments; see seed treatments section, page 20.

***Fusarium* head blight of wheat and barley (Head scab)**

Cause: *Fusarium graminearum* (fungus)

Symptoms: After flowering, spikelets appear bleached or blighted. An orange or pink color may appear at the base of the diseased spikelets. Diseased spikelets may be sterile or contain shriveled seed. Infected grains are lightweight, and may be pinkish to chalky white in color.

Disease cycle: The fungus overwinters on corn residue, grass residue and wheat or barley stubble on the soil. The fungus can also survive on seed. Infection is most common and serious at flowering. Wind-blown spores are carried to flower parts, glumes and other portions of the spike where they germinate during warm, moist weather. Symptoms are visible within three days where temperatures are favorable (77-86°F) and there is continuous moisture from rain, heavy dew or irrigation.

Conditions favoring the disease: Epidemics of wheat scab occur when rain periods coincide with flowering and grain fill. Sprinkler irrigation may predispose plants to infection or create conditions that may make it more severe.

Management: Plant certified seed. Avoid planting wheat or barley after corn or grasses. Rotate away from corn or grasses for at least one year. Deep plowing to bury corn debris or grass debris should help reduce the inoculum on the soil surface if you must plant barley or wheat following a susceptible crop. Several fungicides are labeled for suppression of head scab on wheat in Michigan.

Other concerns: The fungus that causes head scab also produces mycotoxins. When harvesting, increase airflow in the combine to remove as many as possible of the shriveled, scabby kernels.

Check the label for additional information including re-entry intervals (REI) pre-harvest intervals (PHI), and plant-back restrictions.

List of registered fungicides (rate per acre or as noted): Section 18 registration* Section 24(c) registration** These registrations are only for wheat (not barley).

*Folicur 3.6 F 4 fl. oz.

**Tilt EC 2-4 fl. oz.

Powdery mildew

Cause: On wheat- *Erysiphe graminis* f.s. *tritici* (fungus) On barley- *Erysiphe graminis* f.s. *hordei* (fungus) These fungi are host specific.

Symptoms: Powdery, white to light gray patches may appear on leaves and stems (especially upper leaf surfaces) any time after seedlings emerge. Black specks containing spores may form in the patches of mildew as the season progresses.

Disease cycle: The pathogen overwinters as resting spores on straw, stubble, volunteer or overwintering wheat.

Conditions favoring the disease: Cool temperatures (59 to 72°F) and high humidity (greater than 85%) are optimal for the development of the disease. Heavy nitrogen fertilization also enhances disease development.

Management: Select resistant varieties of small grains. Avoid heavy amounts of nitrogen, which can stimulate rapid growth. Determine the need for fungicide treatment by scouting for powdery mildew at flag leaf emergence and the boot stage. Select 50 individual tillers at random throughout the field and count the number of powdery mildew spots on the leaf just below the flag leaf. Take the average number of spots over 50 leaves. The threshold for treatment with a fungicide is an average 2-3 spots/leaf.

Check the label for additional information including re-entry intervals (REI) pre-harvest intervals (PHI), and plant-back restrictions.

List of registered fungicides (rate per acre or as noted):

Armcarb 100 2.5-5 lb.

Bumper 41.8 EC 4 fl. oz

Eco-Mate Armcarb 2.5-5 lb.

Headline 6-9 fl. oz.

Propimax EC 4 fl. oz.

Quadris Flowable 12 fl. oz. (barley)

Quadris Flowable 7-11 fl. oz. (wheat and triticale)

Quilt 7-14 fl. oz. (barley, wheat and triticale)

Sonata 2-4 quarts (biofungicide)

Stratego 7 fl. oz. (barley and oats)

Stratego 10 fl. oz. (wheat)

Tilt EC 2-4 fl. oz.

Septoria leaf blotch, Stagnospora leaf and glume blotch

Causes: *Septoria tritici* and *Stagnospora (Septoria) nodorum*. (fungi)

Symptoms: The first symptoms are tiny chlorotic flecks on the lower leaves. Depending on the species of fungus, the flecks can expand to long, straight-sided lesions, or more lens-shaped lesions. Lesions can be found on leaves or leaf sheaths.

Lesions initially have a watersoaked appearance, turning dry, yellow and eventually reddish-brown. Older lesions turn ash brown and may develop black specks in the center.

Disease cycle: Both of these fungi overwinter on straw, and can also overwinter on living plants or survive on seed. Spores are present in late summer and fall, and can germinate over a wide temperature range. Spores are produced during periods of wet weather and can cause infections throughout the growing season.

Conditions favoring the disease: Barley is generally less susceptible to leaf and glume blotch than wheat. Weather that is wet and windy favors the development of the disease. Planting small grains as successive crops allows inoculum to build up in the field, especially under no till or minimum tillage.

Management: Select varieties with resistance. Use certified seed. Seed treatment may help limit seed-borne disease. Rotate out of small grains for two years. If planting wheat in fields planted to wheat the previous year, incorporate crop residues with deep plowing. Monitor for disease in the field. Cool, wet weather during flag leaf emergence provides favorable conditions for severe outbreaks of this disease. Determine the need for fungicide treatment by scouting at boot stage and full head emergence. Select 50 individual tillers at random throughout the field and count the number of lesions on the leaf just below the flag leaf. Take the average number of lesions over 50 leaves. The threshold for treatment with a fungicide is an average 1-2 lesions/leaf.

Check the label for additional information including re-entry intervals (REI) pre-harvest intervals (PHI), and plant-back restrictions.

List of registered fungicides (rate per acre or as noted):

Armcarb 100 2.5-5 lb.

Eco-Mate Armcarb 2.5-5 lb.

Bumper 41.8 EC 4 fl. oz

Champ Formula 2 Flowable 1-1.33 pints

Champion WP 1.5-2 lb.

Dithane DF Rainshield 2.1 lb.

Dithane F45 1.6 quarts

Dithane F45 Rainshield 1.6 quarts

Dithane M45 2 lbs.

Headline 6-9 fl. oz.

Kocide 101 1.5-2 lb.

Kocide 2000 1-1.5 lb.

Kocide 4.5 LF 1-1 .33 pints

Kocide DF 1.5-2.0 lb.

ManKocide 2-2.5 lb.

Manzate Flowable 1.6 quarts

Manzate 75DF 2 lb

Manzate Pro-stick 2 lbs.

Penncozeb 4FL 0.8-1.6 quarts

Penncozeb 75 DF 1- 2 lb.

Penncozeb 80 WP 1-2 lb.

Propimax EC 4 fl. oz.

Quilt 7-14 fl. oz. (barley, wheat and triticale)

Quadris Flowable 12 fl. oz. (barley)

Quadris Flowable 4-12 fl. oz. (wheat and triticale)

Stratego 7 fl. oz. (barley and oats)

Stratego 10 fl. oz. (Wheat)

Tilt EC 2-4 fl. oz.

Leaf rust

Causes: Wheat leaf rust, *Puccinia triticina* (fungus)

Symptoms: Infections first appear on the lower leaves. Reddish-orange spore masses of the fungus break through the leaf surface leaving an orange powder that rubs off the leaf. As the crop develops and matures, leaf rust generally appears on upper leaves of plants and severity increases.

Disease cycle: The fungus can survive overwinter on wheat during a mild winter or when covered by deep snow, or carried in on wind currents from more southern areas as the wheat crop develops in spring.

Conditions favoring the disease: Temperatures of 60-80 °F, and conditions that promote leaf wetness in the canopy for extended periods of time, such as rain, ground fog, and dew increases the severity of the disease.

Management: use varieties resistant to leaf rust. To determine the need for fungicide treatment, scout for leaf rust at the boot stage and at full head emergence by checking the flag leaf of 50 individual tillers at random in the field for rust pustules. Determine the average number over 50 leaves. The threshold for treatment is an average 5-10 pustules/leaf. Avoid spreading the disease on clothing or farm equipment. Clothing or boots contaminated with rust spores should be cleaned before being worn to walk through healthy fields. Likewise, rust can spread from contaminated farm equipment. Clean contaminated equipment before using it in a healthy field.

Check the label for additional information including re-entry intervals (REI) pre-harvest intervals (PHI), and plant-back restrictions.

List of registered fungicides (rate per acre or as noted):

Bumper 41.8 EC 4 fl. oz.
Dithane DF Rainshield 2.1 lb.
Dithane F45 1.6 quarts
Dithane F45 Rainshield 1.6 quarts
Dithane M45 2 lbs.
Headline 6-9 fl. oz.
Manzate 75DF 2 lb
Manzate Flowable 1.6 quarts
Manzate Pro-stick 2 lbs.
Penncozeb 4FL 0.8-1.6 quarts

Penncozeb 75 DF 1- 2 lb.
Penncozeb 80 WP 1-2 lb.
Propimax EC 4 fl. oz.
Quilt 7-14 fl. oz. (barley, wheat and triticale)
Quadris Flowable 6-12 fl. oz. (barley)
Quadris Flowable 4-12 fl. oz. (wheat and triticale)
Sonata 2-4 quarts (biofungicide)
Stratego 7 fl. oz. (barley and oats)
Stratego 10 fl. oz. (Wheat)
Tilt EC 4 fl. oz.

Stripe rust

Causes: Stripe rust, *Puccinia striiformis*. (fungus)

Symptoms: Stripe rust appears as long stripes of small yellowish orange pustules on the leaves. The pustules are masses of rust spores. It can be confused with leaf rust, but the stripe rust pustules are arranged in rows, or stripes, while the leaf rust pustules are scattered on the leaf. Wheat is the only host for stripe rust.

Disease cycle: Stripe rust usually arrives in the north on wind currents from more southern wheat growing areas. It survives down south on volunteer wheat until it can infect newly planted wheat in fall and winter.

Conditions favoring the disease: Stripe rust is favored by cool, humid weather. Disease development is most rapid between 50 and 60 F. The disease is inhibited when night time temperatures reach 65 F or temperatures for several days in a row reach the mid 80's.

Management: The primary means of controlling stripe rust by using resistant varieties. Several foliar fungicides are labeled for control of stripe rusts, but fungicides aren't commonly used, unless the disease occurs early in the season. Check the label for application timing if a fungicide is used. Avoid spreading the disease on clothing or farm equipment. Clothing or boots contaminated with rust spores should be cleaned before being worn to walk through healthy fields. Likewise, rust can spread from contaminated farm equipment. Clean contaminated equipment before using it in a healthy field.

Check the label for additional information including re-entry intervals (REI) pre-harvest intervals (PHI), and plant-back restrictions.

List of registered fungicides (rate per acre or as noted):

Bumper 41.8 EC 4 fl. oz.
Headline 6-9 fl. oz.
Propimax EC 4 fl. oz.
Quilt 7-14 fl. oz.
Quadris Flowable 4-12 fl. oz.

Sonata 2-4 quarts (biofungicide)
Stratego 10 fl. oz.
Tilt EC 4 fl. oz.

Soybean Diseases

Asian Soybean Rust

Cause: *Phakopsora pachyrhizi* (fungus)

Symptoms: First symptoms appear on the lower leaves (occasionally on petioles or stems) as tiny, water-soaked spots that turn chlorotic. Spots expand into angular lesions, (about 1/20 inch) bounded by the leaf veins. The lesions range in color from grayish brown to tan to reddish brown. Pustules with raised centers develop in lesions, mainly on undersides of leaves. Pustules rupture, become covered with masses of tan spores. Once pod set begins on soybean, infection can spread rapidly to the middle and upper leaves of the plant.

Disease cycle: The fungus can not overwinter in Michigan. It could potentially travel to Michigan as spores on wind currents and in rain. The fungus requires a living host to survive, except as short lived spores. It overwinters in susceptible hosts (such as kudzu) in southern areas without killing frosts. Under favorable environmental conditions, pustules form in 5–10 days, spores within 10–21 days.

Conditions favoring the disease: Levels of soybean rust in the Gulf Coast States during spring and early summer determines how many spores will be available to travel northward. Incidence and severity of soybean rust depends on favorable environmental conditions. Spore germination and infection requires prolonged leaf wetness with temperatures between 59 and 86°F and humidity of 75–80%.

Management: The period from the start of flowering (R1) to full seed (R6) is the most critical for soybean rust management. Again, in 2007, sentinel plots will be monitored for soybean rust in Michigan. Fungicide applications may reduce yield loss, depending on the plant developmental stage, time when soybean rust is detected, and fungicide application method. Watch the Field CAT Alerts for information about the movement of rust northward.

In general, 10% incidence of rust in the lower canopy should be the maximum action threshold for an initial fungicide application. **Consult the label for additional specific information, including plant-back restrictions.**

List of registered fungicides, (*Section 18, emergency labeling) rate per acre:

Bravo Weatherstik 16 -3 6 fl. oz.	Laredo 25EW 4.8 - 9.6 fl. oz.*
Bumper 41.8EC 4 - 8 fl. oz.*	Orius 3.6 F 3 - 4 fl. oz.*
Domark 125SL 4 - 6 fl. oz.*	Propimax 3.6 EC 4 - 8 fl. oz. *
Echo 720 16 - 40 fl. oz.	Quadris F 6 - 15.5 fl. oz.
Echo 90 DF 24 - 48 oz.	Quilt 14 - 20 fl. oz. *
Folicur 3.6F 3 - 4 fl. oz. *	Stratego 5.5 – 10 fl oz
Headline 6 - 12 fl. oz	Thiophanate methyl 4.5 F 20 fl. oz.
Headline SBR- 7.8 fl. oz.*	Tilt 3.6EC 4 - 8 fl. oz. *
Laredo 25EC, 4 - 8 fl. oz. *	

Brown Stem Rot

Cause: *Phialophora gregata* (fungus)

Symptoms: There are two pathotypes of this fungus; pathotype 1= foliar symptoms, greater yield losses than pathotype 2. Pathotype 2 = causes internal browning in the pith.

Foliar symptoms appear around R4-R5. Leaves wilt, become chlorotic, and turn brown between the veins. Later in the season, the leaves turn dull brown, dry, and drop prematurely. Foliar symptoms, if present, are similar to those of soybean sudden death syndrome (SDS). They are less likely to develop if rainfall for the season is below normal. Stem pith turns brown to reddish-brown. Depending on severity, symptoms range from discoloration within sections of the stem, to discoloration from the base of the stem upwards, with a greasy appearance to the outside stem base.

Disease cycle: Survives mainly on crop residue left on the soil surface. Conidia (spores) are produced in late spring; the fungus invades roots and the vascular system. After pod formation, symptoms of brown stem rot can be found in affected plants.

Conditions favoring the disease: Cool, wet weather during midsummer. When rain or irrigation follows flowering, foliar symptoms tend to be more severe in infected plants. Cool temperatures during pod fill followed by hot, dry weather increases losses. Low soil moisture reduces the severity of stem and foliage symptoms produced by pathotype 1.

Management: Partial resistance to brown stem rot has been developed. Select soybean varieties with resistance to brown stem rot (BSR) and use them in combination with good management practices to reduce damage caused by this disease. Avoid continuous planting of soybeans or short rotations. Use longer rotations with non-host plants like corn and small grains.

Brown stem rot is more severe in no-till or minimum till than in conventionally-tilled fields. Where this disease has been a problem, deep plowing of infested crop debris in combination with a minimum of rotation out of soybeans is recommended.

Soybean sudden death syndrome (SDS)

Cause: *Fusarium solani* f.sp. *glycines* (fungus)

Symptoms: In the northern part its range, disease symptoms appear around R4 to R6. Early symptoms-small, round, light green to yellow spots on leaves between the veins. Later symptoms- brown to tan areas surrounded by chlorotic tissue between the veins. Stem pith remains white (compared with brown pith in brown stem rot). Smaller root systems; some degree of decay to the roots; discoloration on lower part of the taproot first. Dark blue to blue-green areas may be visible on the root surface where the pathogen has produced spores, but are not always present

Disease cycle: Produces a thick-walled survival structure, (chylamydospore) within soybean root tissue. Overwinters as resting spore; can survive for several years in the soil. Yield reductions due to SDS are dependent on when infections begin. Typically infections that occur after flowering will not have a significant impact on yield. Infections that occur early will result in pod abortion, reduced seed number and size.

Conditions favoring the disease: Severity of SDS tends to be greater under no-till than conventional tillage systems. Research on the relationship between SDS and soybean cyst nematode (SCN) suggests that SCN increases the severity of SDS but isn't required for the development of the disease.

Management: Use resistant cultivars. Cultivars resistant to SCN tend to show fewer symptoms of SDS than susceptible cultivars. Avoid early planting. SDS is often less severe in delayed plantings and in early maturing cultivars, as the onset of the disease doesn't occur until later reproductive stages. Several seed treatments are labeled for *Fusarium*.

White Mold, Sclerotinia Stem Rot

Cause: *Sclerotinia sclerotiorum* (fungus)

Symptoms: Early symptoms- wilting and dying upper leaves. Leaves remain attached to the stems. Infections develop at the stem nodes as water-soaked lesions. As lesions spread, stem girdling and dieback above the lesions occurs. Cottony patches of white mycelium appear on stems and other infected parts. Late season symptoms- bleached, papery and/or shredded lower stem; hard, black, irregularly-shaped pieces of dormant mycelium (sclerotia) on stems, in stem pith and (sometimes) in pods.

Disease cycle: Survives as sclerotia in crop residue, or combined with the seed. Burying sclerotia in soil increases their ability to survive. Sclerotia germinate in the spring and summer by forming mushroom-like fruiting bodies called apothecia. Apothecia produce large numbers of spores, which spread by wind and splashing rain. The spores germinate using dead and dying soybean flowers as a food source to grow mycelium. The mycelium infects the stem near the node and spreads to other plant parts.

Conditions favoring the disease: Cool temperatures and high humidity in the crop canopy, particularly as plants are flowering. Cropping practices such as narrow rows, high planting rates (more than 200,000 plants/acre), irrigation, high soil fertility, and early planting increase risk.

Management: Use clean seed, free of sclerotia. There are several seed treatments that can be used to eradicate the fungus from seed to be planted (See section on soybean seed treatments, page 22).

Avoid rotation to susceptible crops-sunflower, dry beans or snap beans. Rotate with non-host crops such as sugar beets, corn, alfalfa, or small grains to reduce the number of sclerotia in fields. The fungus can survive for years in the absence of a susceptible host. Control broadleaf weeds during the non-host crop rotation- many broadleaf weeds are hosts for this disease. Plant partially resistant varieties. See MSU soybean variety trials website: <http://www.css.msu.edu/varietytrials/soybean/whitemold.htm> Use planting rates and row widths that promote air circulation and rapid drying of plants and soil surface. Irrigate only as required for optimum plant growth.

Apply recommended fungicides when flowers are present on the lower half of the stem, or as directed on the label.

Consult the label for additional specific information, including plant-back restrictions.

List of registered fungicides (rate per acre):

Cobra- (while mold suppression) 6.8 fl. oz-*

*Use with crop oil concentrate and non-ionic surfactant; at or just before first bloom. Do not apply after white mold infection has occurred

Contans WG 1 - 2 lbs. (biological, to reduce inoculum in soil)

Thiophanate methyl 4.5F 15 - 20 fl. oz

Farmsaver Thiophanate methyl 85 WDG 9.6 - 12.8 oz

Topsin 4.5 FL 15 - 20 fl. oz. Topsin M 70 WP .12 - 16 oz

Topsin M 70 WDG 12 - 16 oz

T-methyl 12 - 16 oz

Phytophthora root rot

Cause: *Phytophthora sojae* (Oomycete; “fungus-like” pathogen)

Symptoms: Seedlings die rapidly, leaving gaps in rows. Young plants turn yellow, collapse, and die, leaving gaps in row plantings. Foliage of older plants wilts and turns yellow starting at the bottom of the plant and moving up. Dead leaves may remain attached. Lower stem discoloration starts near the soil line, and spreads upward. Root systems are rotted.

Disease cycle: Overwinters as resting spores (oospores) During periods of adequate soil moisture and temperature, oospores germinate to form structures called sporangia. In saturated soils, small swimming spores (called zoospores) are released. They swim to soybean roots, where they attach, germinate, invade the root and grow.

Conditions favoring the disease: poorly-drained or saturated soils, soil compaction, optimum soil temperatures above 60°F.

Management: Plant soybean varieties that are tolerant to *Phytophthora*. Rotate with a non- legume crop for at least two years. Improve soil drainage. Avoid working or driving on wet soil; avoid tillage practices that contribute to soil compaction. Apply fungicides to soil as broadcast, band, or in furrow treatment, depending on methods listed on label.

Consult the label for additional specific information, including plant-back restrictions.

List of registered fungicides (rate per acre or as noted):

Ridomil Gold EC

surface application: 0.38 - 1.25pt/A

in furrow: 0.08 - 0.28 fl. oz/1000 linear ft. of row

Ridomil Gold GR 6 oz./1000 linear ft. in a 7-inch band

Ridomil Gold GR 1.5 - 3 oz./1000 linear ft. in furrow

Frogeye leaf spot

Cause: *Cercospora sojina* (fungus)

Symptoms: Stunted seedlings may develop from infected seed. The upper leaves develop small, gray spots with reddish-brown borders in mid to late August. The disease can cause leaves to fall prematurely and can spread to stems and pods. The fungus infects seed, causing the seed coat of infected seeds to turn gray.

Disease cycle: The fungus survives over winter in infested soybean residue and in infected seed. Infection can begin early in the season on young leaves and continue as new leaves develop.

Conditions favoring the disease: Warm, humid weather favors the development of spores that travel by wind and splashing rain to spread infection. Multiple cycles of spore development and re-infection can continue when weather conditions are favorable.

Management: Use tillage and crop rotation help to reduce the population of fungal spores. Use resistant varieties in fields where frogeye has been a problem. Some soybean varieties are less susceptible to frogeye leaf spot than others. Avoid saving seed from infected fields. If foliar fungicides are used they should be applied from R2-R5.

Consult the label for additional specific information, including plant-back restrictions.

List of registered fungicides (rate per acre or as noted):

Bravo Weatherstik 1.5 - 2.25 pints

Chloronil 720 1.5 - 2.25 pints (2 applications)

1 - 2 pints (3 applications.)

Chlorothalonil 720F 1.5 - 2.25 pints (2 applications)

1 - 2 pints (3 applications.)

Equus 720 SST 1.5 - 2.4 pints 2 application program

1 - 2 pints 3application program

Headline 6 - 12 fl. oz

Quadris F 6 - 15.5 fl. oz.

Thiophanate methyl 4.5F 10 - 20 fl oz

Farmsaver Thiophanate methyl 85WDG 6.4 - 12.8 oz

T-methyl 70WP 8 - 16 oz

Topsin 4.5FL 20 fl. oz

Topsin M 70 WP 8 - 16 oz

Topsin M 70 WDG 8 - 16 oz

Sugarbeet Diseases

Rhizoctonia crown and root rot

Cause: *Rhizoctonia solani* (fungus). Anastemoses Group ((AG) 2-2.

Symptoms: First symptoms appear on the petioles of the lower leaves and within the crown as extensive elongated black lesions. Lesions spread to all the leaves and the upper portion of the crown and spread into the root. As the disease progresses in the root the entire plant becomes blackened and loses adhesion with the soil. The disease often occurs along rows affecting adjacent plants.

Disease cycle: The fungus over-winters in Michigan although the sexual stage of the fungus is relatively rare the pathogen survives as fragments of hyphae (threadlike vegetative cells) in plant debris and also as small sclerotia (melanized, bundles of hyphae) in the soil which can survive extreme environmental conditions.

Conditions favoring the disease: Under favorable environmental conditions, sclerotia can germinate in the soil at temperatures from about 50°F. Plants are infected early in the season often after cultivation and also after heavy rain which can both deposit propagules of the pathogen in the crown. The disease is further favored by wet conditions during the growing and tends to spread along rows. Levels of crown and root rot vary drastically among different growing regions of Michigan but seem to be more prevalent in heavier clay soils.

Management: Rotations greater than three years tend to reduce the impact of crown and root rot. Also, check with your seed supplier for more resistant cultivars which can be immune to crown and root rot. In susceptible cultivars, applications of the strobilurin fungicide azoxystrobin (Amistar, Quadris) either as an in-furrow application at planting or foliar banded applications up to the 4-6 leaf stage has proved effective in suppressing crown and root rot.

List of registered fungicides, rate per acre or 1000 row feet:

Amistar 80WG in-furrow at planting 0.125 – 0.25 oz/1000 row feet Quadris F 0.40-0.80 fl. oz./1000 row feet at planting

Amistar 80WG foliar 3.0 - 5.0 oz

Cercospora Leaf Spot

Cause: *Cercospora beticola* (fungus)

Symptoms: Individual leaf spots are roughly circular and can measure from 1/8 to 1/4 inch diameter. The lesions are tan to light brown with red to purple borders. As the disease progresses the lesions can join to form irregularly shaped lesions. Small black dots are often visible within the lesions. In severe cases the leaves turn become chlorotic, and turn brown.

Disease cycle: Survives mainly on crop residue left on the soil surface as conidia (spores) and stromata (fragments of hyphae). Under humid conditions conidia are dispersed by wind and splashing rain to leaves where germination occurs and new lesions are formed. Weed hosts can also serve as sources of inoculum, e.g. Lambsquarters and other Chenopodia.

Conditions favoring the disease: High temperature (~75 - 90°F) and protracted periods of high humidity (>90%RH) favor all aspects of disease development including expansion of lesions and production of conidia. Little infection occurs below 60°F.

Management: Partial resistance to *Cercospora* leaf spot has been developed. Select sugarbeet varieties with resistance to *Cercospora* leaf spot and use them in combination with good management practices to reduce damage caused by this disease. Avoid continuous planting or short rotations. Use longer rotations with non-host plants like vegetables, corn and small grains and attempt to plant new fields at least 300 feet from previous season's fields. There are several fungicides registered for management of *Cercospora* leaf spot however, because fungicide resistant strains of *Cercospora beticola* are known to occur in Michigan, exclusive use of e.g. Topsin should be avoided and should only be used in tank mixture with a mancozeb-containing compound. Rotations of fungicides with different modes of action should be alternated during season where more than one application of fungicide is necessary.

The list of registered fungicides, rate per acre, follows on page 101:

Cercospora leaf spot, continued

Agri Tin 80WP 2.5 – 5 oz- RUP	Maneb 80WP 1.5 - 2 lb
Amistar 80WG 3 - 5 oz	Manex 1.2-1.6 quarts
Champ Formula 2 Flowable 1.33 – 3.33 pint	ManKocide 2.5 – 6.5 lb
Champ Dry Prill 1.33 – 3.33 lb	Manzate 75DF 1.5 – 2 lb
Champion Wettable Powder 2 – 5 lb	Manzate F 1.2 – 1.6 quarts
Dithane Rainshield DF 1.5 - 2.0 lb	Manzate Pro-Stick 1.5 - 2.0 lb
Dithane F45 1.2 – 1.6 quarts	Penncozeb 75DF 1.5 - 2 lb
Dithane M45 1.5 – 2lb	Penncozeb 4FL 1.2 - 1.6 quarts
Eminent 125SL 13 fl oz	Penncozeb 80WP 1.5 - 2 lb
Farmsaver Thiophanate-methyl 85WDG 6.4 – 12.8 oz	Quadris F 9-15.5 fl. oz.
Gem 6 – 7 oz	Super Tin4L 4-8 fl oz RUP
Gem 50 SC 2.9 - 3.6 fl. oz	Super Tin 80WP 2.5 – 5 oz- RUP
Headline 2.09SC 9 – 12 fl oz	Thiophanate methyl 4.5F 10-20 fl oz
Kocide 101 2 - 5 lb	T-methyl 70W WSB 6 – 8 oz
Kocide 2000 1.5-3.75 lb	Topsin 4.5FL 10 – 20 fl oz
Kocide DF 2-5 lb	Topsin M 70WP 8-16 oz
Kocide 4.5LF 1.33 – 3.33 pint	Topsin M 70 WDG 8-16 oz
Maneb 75DF 1.5 - 2 lb	RUP = restricted use product

Appendix A: Safety and environmental information for insecticides and nematicides used in field and forage crops.

Trade Name	Common Name	Runoff Potential	Leaching Potential	LD ₅₀ mg/kg Oral**	LD ₅₀ mg/kg dermal	Bee Toxicity
Acephate	acephate	3	3	846-1,447	2000-10,000	HT
Actellic	pirimiphos-methyl	2	3	2050	2128	MT
Address	acephate	3	3	846-1,447	2000-10,000	HT
Admire	imidacloprid	2	1	609-4350	>2000	MT
Ambush	permethrin	2	3	1030 - 2305	>2000	HT
Arctic	permethrin	2	3	1030 - 2305	>2000	HT
Asana	esfenvalerate	2	3	458	>2000	HT
Aztec	tebupirimphos + cyfluthrin	na	na	122-246	>2000	na
Baythroid	cyfluthrin	2	3	647-1,015	>2,000	MT
Bt	<i>Bacillus thuringiensis</i>	na	na	>3,000	>2,500	PNT
Capture	bifenthrin	2	3	262	>2,000	HT
Carbaryl	carbaryl	3	3	280-649	>2,000	HT
Comite	propargite	1	3	960	4500	PNT
Counter	terbufos	3	3	11-29	10-182	na
Cruiser	thiamethoxam	2	1	> 5000	> 2000	na
Deadline MP	metaldehyde	3	3	220-690	2200-5000	PNT
Declare	methyl parathion	2	3	1237	>1250	HT
Diatomaceous earth	diatomaceous earth	na	na	--	--	na
Diazinon	diazinon	1	3	500-2000	1000-5800	HT
Dibrom	naled	3	3	92-191	360-390	HT
Dicofol	dicofol	1	3	575	100	na
Digon	dimethoate	3	2	215-750	650-2020	HT
Dimate	dimethoate	3	2	215-750	650-2020	HT
Dimethoate	dimethoate	3	2	215-750	650-2020	HT
Dimilin	diflubenzuron	2	3	> 4000	> 2000	PNT
Di-Syston	disulfoton	3	2	3-52	9-1000	MT
Empower	bifenthrin	2	3	262	>2,000	HT
Endosulfan	endosulfan	1	3	24-312	200-5000	MT
Force	tefluthrin	2	3	969-1213	>2000	na
Fortress	chlorethoxyfos	2	3	44-229	>2,000	na
Furadan	carbofuran	2	1	7.34	6,789	HT
Fyfanon	malathion	3	3	480-10700	2000	HT
Gaucho	imidacloprid	2	1	609-4350	>2000	MT
Imidan	phosmet	3	3	126-681	>2000	HT
Intrepid	methoxyfenozide	na	na	>5000	>2000	PNT
Kelthane	dicofol	1	3	575	100	na
Lannate	methomyl	3	1	30-160	>2000	HT
Larvin	thiodicarb	3	3	166	>2000	MT
Lorsban	chlorpyrifos	2	3	300-2,250	5,000	HT
Malathion	malathion	3	3	480-10700	2000	HT
Metasystox-R	oxydemeton-methyl	3	1	125-138	253-359	HT
Mocap	ethoprop	3	1	15-425	18-271	MT
Mustang/ Mustang Max	zeta-cypermethrin	na	na	191	> 2000	HT
Nufos	chlorpyrifos	2	3	300-2,2250	5,000	HT
Orthene	acephate	3	3	846-1,447	2000-10,000	HT

Trade Name	Common Name	Runoff Potential	Leaching Potential	LD ₅₀ mg/kg Oral**	LD ₅₀ mg/kg dermal	Bee Toxicity
Phaser	endosulfan	1	3	24-312	200-5000	MT
Penncap-M	methyl parathion	2	3	1237	>1250	HT
Phorate	phorate	1	3	5-13	86-113	MT
Poncho	clothianidin	na	na	na	na	na
Pounce	permethrin	2	3	1030 - 2305	>2000	HT
Proaxis	gamma cyfluthrin					HT
Pyganic	pyrethrum	2	3	200-2600	> 1500	MT
Regent	fipronil	2	2	296-336	374-382	MT
Reldan	chlorpyrifos methyl	2	3	> 3,000	> 3,700	HT
Seedmate	lindane	1	2	88-270	1000	HT
Sevin	carbaryl	3	3	280-649	>2,000	HT
Snail/ Slug bait	metaldehyde	3	3	220-690	2200-5000	PNT
Spintor	spinosad	2	3	> 5000	> 5000	HT
Telone	dichloropropene	3	2	200-300	300-500	NA
Temik	aldicarb	3	1	5	283	PNT
Tempo	cyfluthrin	2	3	647-1,015	>2,000	MT
Thimet	phorate	1	3	5-13	86-113	MT
Thionex	endosulfan	1	3	24-312	200-5000	MT
Tracer	spinosad	2	3	> 5000	> 5000	HT
Warrior	lambda-cyhalothrin	2	3	110	2,000	HT

*Potential: 1=high, 2=medium, 3=low, na = not available.
Ratings are from the ARS/NRCS pesticide properties database.

**The LD₅₀ is a relative measure of acute toxicity, indicating the number of milligrams (mg) of pesticide per kilogram (kg) body weight to kill 50 percent of a test animal population. A low LD₅₀ (especially less than 10) indicates high toxicity to mammals; a high LD₅₀ indicates lower mammalian toxicity. Values reported are sometimes for technical grade material. Formulated products are usually less toxic than technical material.

Relative rating of insecticide toxicity to honeybees: HT = Highly Toxic, kills bees on contact during application and for one or more days after treatment. Bees should be moved from the area. MT = Moderately Toxic, can be used with limited danger if not applied directly over bees in fields or hives. PNT = Practically Non-Toxic, can be used with few precautions, minimum injury to bees. na = not applicable or not known.

Appendix B: Fungicide safety and environmental ratings

Trade Name	Common Name	Runoff potential	Leaching potential	LD ₅₀ mg/kg oral	LD ₅₀ mg/kg dermal
Agri Tin	triphenyltin hydroxide	1	3	160	500
Allegiance	metalaxyl	2	1	>2900	>2000
Amistar	axozystrobin	1	3	>2000	>5000
Apron TL	metalaxyl	2	1	1750-4250	6000
ApronMaxx	fludioxonil +mefanoxim	1	3	5050	5000
Apron-XL-LS	mefanoxam	3	3	862	>2020
Armicarb	potassium bicarbonate	NA	NA	2700	>5000
Bean Guard	captan + carboxin	3	3	5000	5000
Bean Guard Allegiance	captan + carboxin + metalaxyl	2	1	5000	5000
Blocker	pentachloronitrobenzene (PCNB)	2	3	>5050	>2020
Bravo	chlorothalonil	2	3	>5020 - 9000	2000 - >2010
Bumper	propiconazole	1	2	972-2000	>5000
Captan	captan	3	3	>5000	>5000
Captan Moly	captan	3	3	9000	5000
Champion	cupric hydroxide	1	3	846-943	>2000
Charter	triticonazole	3	3	>2000	>2000
Chlorothalonil	chlorothalonil	2	3	>5020 - 9000	2000 - >2010
Cobra	lactofen	2	3	2400-2600	2000
Concur	imidacloprid +metalaxyl	2	1	500-5000	>5000
Contans	<i>Coniothyrium minitans</i>	NA	NA	NE	NE
Cruiser Extreme	fludioxonil +mefanoxam+ azoxystrobin + thiamethoxam	1	1	>5000	>5050
Dithane	ethylene bisdithiocarbamate (EBDC)	1	3	5000	5000
Dividend Extreme, Div. XL	difenoconazole +mefanoxim	1	3	>5050	.2020->5050
Domark	tetraconazole	NA	NA	2000	5000
Dynasty	axozystrobin	1	3	2000	2000
Echo	chlorothalonil	2	3	3260	>2020
Eminent 125 SL	tetraconazole	NA	NA	4090->5000	>2000
Endura	boscalid	1	2	>2000	>2000
Folicur	tebuconazole	1	2	3776	3710
Gem	trifloxystrobin	2	3	5050	2000
Grain Guard	mancozeb	1	3	7500	NE
Headline	pyraclostrobin	1	3	200->500	>4000
Hi Moly Captan-D	captan	3	3	5050	5050
Iprodione	iprodione	3	3	>2000	>1000
Kernel Guard	captan + diazinon + lindane	1	2	829	>2000
Kernel Guard Supreme	carboxin + permethrin	2	3	3302-5050	>5050
Kickstart	carboxin + diazinon + lindane	1	2	829	>2000
Kickstart VP	carboxin + permethrin (insecticide)	2	3	3302-5050	>5050

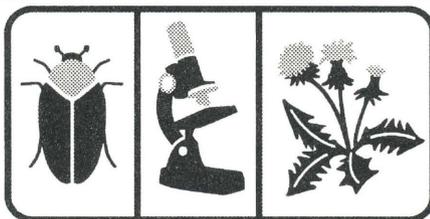
Trade Name	Common Name	Runoff potential	Leaching potential	LD ₅₀ mg/kg oral	LD ₅₀ mg/kg dermal
Kocide	copper hydroxide	1	3	646	>5000
Kodiak	<i>Bacillus subtilis</i>	NA	NA	NE	NE
Manzate	ethylene bisdithiocarbamate	1	3	>5000	>2000
Maxim 4FS	fludioxonil	1	3	5050	2020
Maxim XL	fludioxonil + mefanoxam	1	3	2830	2020
Orius	tebuconazole	1	2	3710-3776	2011
Penncozeb	dithiocarbamate	1	3	>5000	>2000
Propimax	propiconazole	1	2	972-2000	>5000
Protector-D	thiram	3	3	290	2000
Protector-L	thiram	3	3	5050	5050
Protector-L/ Allegiance	thiram + metalaxyl	2	1	5050	5050
Protégé	azoxystrobin	1	3	>2000	>2000
Quadris	azoxystrobin	1	3	5000	4000
Quilt	azoxystrobin + propiconazole	1	2	1750	5000
Raxil MD	tebuconazole + metalaxyl	1	1	5050	5050
Raxil Thiram	tebuconazole + thiram	1	2	3910	2020
Raxil XT	tebuconazole + metalaxyl	1	1	2065	5050
Ridomil Gold	mefanoxam	3	3	1172-5000	2000-2020
Rovral	iprodione	3	3	1170	>2000
RTU- Vitavax Thiram	carboxin + thiram	3	3	10,000	21,500
Sonata	<i>Bacillus pumilus</i>	NA	NA	>5000	>5000
SoyGard	azoxystrobin + metalaxyl	1	1	1428-5000	>5000
Stiletto	carboxin + thiram + metalaxyl	2	1	5050	5050
Super Tin	triphenyltin hydroxide	1	3	160	500
Switch	cyprodonil + fludioxonil	1	3	5000	2000
System 3 Seed Treatment	pentachloronitrobenzene(PCNB) + metalaxyl + <i>Bacillus subtilis</i>	2	1	5000	2000
Terraclor	pentachloronitrobenzene(PCNB)	2	3	>5000	2000->5000
Thiophanate -methyl	thiophanate-methyl	2	3	5000	2000
Thiram 42-S	thiram	3	3	2950-4430	>4000
Tilt	propiconazole	1	2	1310	5000
Topsin	thiophanate-methyl	2	3	>5000	>2000
Tri'lex	trifloxystrobin	2	3	5000	5000
Tri'lex AL	trifloxystrobin + metalaxyl	2	1	5000	5000
Vitavax	carboxin + thiram	3	3	1300	1050
Warden	fludioxonil + mefanoxam	1	3	5000	2000
Yield Shield	<i>Bacillus pumilus</i>	NA	NA	>5000	NE

Potential: 1=high, 2=medium, 3=low, NA= not available

Ratings are from the ARS/NRCS pesticide properties database.

The LD₅₀ is a relative measure of acute toxicity, indicating the number of milligrams (mg) of pesticide per kilogram (kg) of body weight to kill 50 percent of a test animal population. A low LD₅₀ (especially less than 10) indicates high toxicity to mammals; a high LD₅₀ indicates lower mammalian toxicity. *Oral LD50 ratings:* up to 50mg/kg= Category I, **Danger**; ratings from 50-500mg/kg= Category II, **Warning**; ratings from 500-5,000 mg/kg= Category III, **Caution**; ratings >5,000 mg/kg= Category IV, **Caution**. *dermal LD50 ratings:* up to 2000mg/kg= Category I, **Danger**; ratings from 2000-2,000mg/kg= Category II, **Warning**; ratings from 2,000-20,000 mg/kg= Category III, **Caution**; ratings >20,000 mg/kg= Category IV, **Caution**. *Some fungicides can also be corrosive or irritating to the eyes. Be sure to check the label for all precautions.*

How to submit a sample to MSU Diagnostic Services



Diagnostic Services

Sample Submission

Accurate diagnosis depends on the rapid receipt of fresh and representative samples along with pertinent information relating to the problem. A completed submittal form should accompany all samples. Submittal forms are available at MSU Diagnostic Services or your local Extension office. Submittal forms can also be downloaded from www.pestid.msu.edu. Samples can be dropped off at our reception area between 8 a.m. and 5 p.m. or shipped overnight delivery by U.S. mail, FedEx, or UPS. To preserve the quality of the sample, do not package samples in envelopes. Also avoid mailing samples on Friday.

Submit samples to:

Michigan State University
Diagnostic Services
101 Center for Integrated Plant Systems
East Lansing, MI 48824-1311
Phone: (517) 355-4536 Fax: (517) 432-0899

Plant Health Analysis Samples:

Herbaceous Plants: Send whole plants, including roots and soil. Roots and soil should be in a plastic bag tied off at the soil line to prevent soil from touching foliage.

Tree Decline/Wilt: Send 6 to 12 branch sections .5 inch to 1 inch diameter and ~ 8 inches long. Samples should be taken from live areas of tree with symptoms, not from completely dead branches. Seal branches in plastic to retain moisture.

Seedlings: Leave plants in plug sheets or trays if possible. Send a minimum of 12 seedlings.

Turf: Include a 6" square of turf from the margin of the diseased area so that both healthy and diseased turf is included. An intact layer of soil should be included. Wrap sample in newspaper and pack in a box for shipment. Include a detailed description of cultural practices. Do not add moisture to the turf prior to shipment.

Leaf spot and Fruit Rot: Send several affected samples representing the early and moderate stages of the symptom progression.

Herbicide Injury: Submit both injured and apparently healthy crop plants. Plants should be dug carefully from the soil so roots, if injured, will remain intact. Roots and soil should be placed in a plastic bag, pot, or small bucket to prevent soil from touching the foliage. A pint of soil from both "good" and "bad" area should also be submitted. Any patterns in the field should be noted on the submittal form, along with past crop and pesticide history.

Weed/Plant Samples:

Herbaceous Plant Identification: Submit whole plants, including roots, vegetative structures, and flowers. Plants may be pressed flat between paper or cardboard to prevent leaf crinkling. For best results, plants should be submitted immediately after digging. Roots and soil should be in a plastic bag to prevent soil from touching the foliage.

Woody Plant Identification: Submit a large section of the terminal end of the stem or branch. Where possible, include any flower or fruiting structures, roots, and leaves. Leaves may be pressed flat between paper or cardboard to prevent crinkling. Woody plants may be wrapped in plastic to retain moisture.

Herbicide Resistance: Weeds will be screened for herbicide resistance using one of several techniques. Typically, a whole plant pot assay established from seed will be our standard test for resistance confirmation. Mature, high quality seed or seedheads should be collected from suspicious plants in late summer or fall and submitted in a paper bag. Do not seal in plastic. Screens will be designed by herbicide site of action (ie: ACCase inhibitors, ALS inhibitors, Photosynthesis inhibitors). Other resistance confirmation tests may be utilized but will depend upon weed species, herbicide, and mechanism of resistance. Extensive tests include but are not limited to: petri-dish germination, chlorophyll fluorescence, leaf disc flotation, and enzyme sensitivity assays, as well as molecular diagnostic testing.

How to submit a sample to MSU Diagnostic Services (continued)

Nematode Samples:

Refer to MSU Extension Bulletin E-2199, "Detecting and Avoiding Nematode Problems."

Always store nematode samples in plastic bags or other containers that retain moisture. Submit a pint to a quart of soil.

Problem Diagnosis: Collect soil & roots (or foliage) from the margins of diseased areas. Submit samples of diseased plants and apparently healthy ones.

Problem Avoidance: Collect soil & roots (if available) by walking a zigzag or w-shaped pattern. The more sub-samples (soil, cores, probes, etc.) collected the "better" the sample.

Insect/Arthropod Samples:

Precise identification of insects or other arthropods requires specimens to be undamaged upon arrival. It is very important to kill and ship the specimens in a manner that will not damage the delicate structures that facilitate their identification. Dried and unprotected insects crumble easily during mail processing. Kill and ship specimens in a small, leak proof vial filled with rubbing alcohol.

Moths/Butterflies: Place specimens in the freezer for half an hour to kill them and gently pack in a small box or vial with tissue paper.

Ants/Other Adult Arthropods: Ant specimens should only include worker ants (i.e. those without wings). Submit all specimens in alcohol. Other adult and hard-bodied specimens: Submit in alcohol.

Larvae (Caterpillar, grub, maggot, etc.): Whenever possible, soft-bodied larvae should be lightly boiled for a few minutes before placing them in alcohol. This prevents the specimens from shriveling and becoming discolored, however it only works if the larvae are alive when dropped in the boiling water.

Pesticide Analysis Samples:

Soil, water, and plant vegetation can be tested for the presence of pesticides using appropriate analytical instruments and techniques. Pesticides will be tested on an individual basis or, if available, in multi-pesticide screens. Samples should be submitted in leak-proof, glass containers and kept cold or frozen until arrival.

Services and Fees for MSU Diagnostic Services

Note: Fees for out-of-state samples are higher. Contact laboratory for pricing.

Plant Health Analysis

- Visual inspection for infectious and non-infectious diseases, insect injury and herbicide injury; pathogen culturing; pH and soluble salts: \$20.00
- INSV / TSWW ELISA tests: \$20.00
- Bacterial ID (BIOLOG™): \$25.00
- Special laboratory analysis: *

Weeds/Plants

- Common plant ID: N/C
- Keyout plant ID: \$10.00
- Herbicide resistance in weeds
Standard test:
- Single site of action \$50.00
- Each additional site of action \$20.00
Extensive test: *
- Special identification/diagnosis *

Nematodes

- Basic nematode analysis: \$20.00
- Total nematode community analysis: \$50.00
- HG Type testing \$50.00
- *Verticillium* analysis
Wet sieving: \$20.00
Dilution plating: \$15.00

Insects/Arthropods

- Common insect ID: N/C
- Keyout insect ID: \$10.00
- Special identification/diagnosis *

Pesticide Analysis

- Individual pesticide tests/
multi-pesticide tests
Water: \$90.00 / \$125.00
Vegetation: \$100.00 / \$150.00
Soil: \$125.00 / \$175.00

* Variable costs requiring client approval. Contact laboratory for pricing.

DIAGNOSTIC SERVICES
 101 Center for Integrated Plant Systems
 East Lansing, MI 48824-1311
 Office: 517-355-4536 FAX: 517-432-0899
 www.pestid.msu.edu



Case No.: _____
 Date Received: _____
 Amount Paid: _____
 Check/Receipt No.: _____
 MSU Account #: _____
 Diagnostic Fee: _____

Name: _____
 Business Name: _____
 Address: _____
 City/State/Zip: _____
 Work: () FAX: () Home: ()
 Email: _____ Cell: ()
 Sample Reference: _____

Plant Disease Diagnosis Fees
 Plant health analysis: \$20
 INSV / TSWV ELISA tests: \$20
 Bacterial ID (BIOLOG™): \$25
Insect / Plant Identification Fees
 Common ID: N/C
 Key ID: \$10
 Special ID / diagnosis (Per hour charge): contact lab
 Herbicide Resistance / Pesticide Analysis: contact lab
 Nematode Sample Fees (see below)
 Out of State Fees Double
 Fees subject to change

SEND RESULTS TO: CLIENT COUNTY AGENT KEEP RESULTS CONFIDENTIAL Fax: ()
 MSU Extension Agent: _____ County: _____ Email: _____

SAMPLE (ex. Tomato, Insect, Pine, etc.): _____

GENERAL INFORMATION (indicate all that apply)

PLANT PARTS AFFECTED		TYPE OF PLANTING		PROBLEM DISTRIBUTION		HERBICIDE HISTORY
Entire Plant	Stems	Field	Garden	Upland	Near Drive/Road	This year: _____
Leaves/Needles	Twigs/Limbs	Nursery	House Plant	Slopes	Edge of Field	_____
Roots	Trunk	Greenhouse	Pasture	Low Areas	Near a Residence	_____
Fruit	Flowers	Orchard	Natural Area			Last year: _____
		Turf/Lawn	City/Recreation			_____
NATURE OF THE INJURY		PREVALENCE		OTHER BACKGROUND		INSECTICIDE HISTORY
Poor or Abnormal Growth		Entire Planting		How long at site?		This year: _____
Spots		Single Localized Area		Height of plant?		_____
Wilting	Yellowing	Several Localized Areas		How many plants affected?		FUNGICIDE HISTORY
Plant Death	Boring	Few Scattered Plants		How often watered?		This year: _____
Leaf/Needle Drop	Cupping			How fertilized?		CROP HISTORY
Chewing	Dieback	EXTENT OF THE DAMAGE		Sunny or Shaded?		Last year: _____
Rot	Galls/Cankers	Light	Moderate	Severe		This year: _____
SOIL TYPE		DRAINAGE				Next year: _____
Sandy	Clay	Good	Fair	Poor		
Muck	Silt Loam					

INSECT / ARTHROPOD ID SAMPLES ONLY (indicate all that apply)

Where was the insect found? _____ What was the insect doing there? _____
 How many insects are there? One Few Several Hundreds Do you have small children living with you? _____

PLANT / WEED ID SAMPLES ONLY (indicate all that apply)

PLANT TYPE		PLANT SIZE		GROWTH HABIT	FLOWERS	PLANT AGE
Tree	Groundcover	Height: _____		Upright/Erect	Color: _____	Annual: _____
Shrub	Herbaceous	Width: _____		Prostrate/Low-Growing	Size: _____	Perennial: _____
Vine	Aquatic	Few Leaves	Many Leaves	Climbing	List any unique features: _____	

NEMATODE SAMPLES ONLY (indicate type of analysis requested)

Soil and root analysis (\$20/sample) Foliar nematode analysis (\$20/sample) No. of samples: _____
 Total nematode community structure analysis (\$50/sample) Sample/Field ID: _____
 Hg Type test (\$50/sample)
Verticillium dahliae analysis (potato soil / stem only) Dilution (\$15/sample) Wet-sieving (\$20/sample) Both (\$35/sample)

The Field Crop Advisory Team Alert newsletter



Dependable pest management information
from MSU Extension

The CAT Alert is MSU Extension's targeted advice for growing field crops under Michigan conditions

Our newsletters are written, formatted, printed and mailed within 48 hours. With Internet access, you can view the newsletter even faster, typically within eight hours from the start of our production. We look at conditions in surrounding states, data on trends from past years, insect trap catches, disease forecasting tools, and the reports of our agricultural meteorologist to predict what your pest management needs will be.



Students count soybean aphids.

The *Field Crop CAT Alert* stays on top of pest situations that could have impact on Michigan crops. In 2006, articles were published that kept growers informed of soybean rust movement throughout the United States, as well as how to handle their farms should rust arrive. MSU specialists also wrote about updated strategies for managing soybean aphid.



Visit us on the Internet

See issues and archives of the *CAT Alert* at the IPM resources website:

<http://www.ipm.msu.edu/field-cat.htm>

Also try our new IPM weather resources at: <http://www.enviroweather.msu.edu>

Subscribe for the 2007 growing season

Our season begins March 2007. Send your subscription in any time during the year, and we'll send back issues from the current publishing year. Editions of the *CAT Alert* are also available for vegetables, landscape and fruit.

Name _____ County _____

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Zip Code (9-digit if available) _____ Enclose \$35 for each edition.
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Make your check payable to: **Michigan State University**. Send your check and this form to: CAT Alerts, 243 Natural Science Building, Michigan State University, East Lansing, MI 48824 (Phone: 517-353-4703)

The CAT Alert program is coordinated by the MSU IPM Program. With grant funding from the Michigan Department of Agriculture, we are able to offer free Internet service and keep subscription costs down for our mail recipients.





PESTICIDE EMERGENCY INFORMATION



For any type of an emergency involving a pesticide, immediately contact the following emergency information centers for assistance.

Current as of November 2006

Human Pesticide Poisoning

POISON CONTROL

From anywhere in the United States, call

1 - 8 0 0 - 2 2 2 - 1 2 2 2

Special Pesticide Emergencies

Animal Poisoning

.....
Your veterinarian:

Phone No.

or

Animal Poison Control Center (\$55 consultation fee per case)

***1-888-426-4435**

www.aspca.org

*** Telephone Number Operated 24 Hours**

Pesticide Fire

.....
Local fire department:

Phone No.

and

***911**

Traffic Accident

.....
Local police department or sheriff's department:

Phone No.

and

Operations Division, Michigan State Police:

***(517) 336-6605**

Environmental Pollution

.....
District Michigan Department of Environmental Quality (MDEQ) Office Phone No.

Phone No.

and

MDEQ Pollution Emergency Alerting System (PEAS):

***1-800-292-4706**

also

***1-800-405-0101**

Michigan Department of Agriculture Spill Response (for fertilizer, pesticide, and manure spills)

Pesticide Disposal Information

.....
Michigan Clean Sweep, Michigan Department of Agriculture Environmental Stewardship Division.

Monday - Friday: 8 a.m. - 5 p.m.

(517) 335-2874

National Pesticide Information Center

Provides advice on recognizing and managing pesticide poisoning, toxicology, general pesticide information and emergency response assistance. Funded by EPA, based at Oregon State University

7 days a week; excluding holidays
6:30 a.m. - 4:30 p.m. Pacific Time Zone

1-800-858-7378

FAX: 1-541-737-0761

Web: npic.orst.edu

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