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Insect, Nematode and Disease Control in Michigan Field Crops

Michigan State University Extension Service

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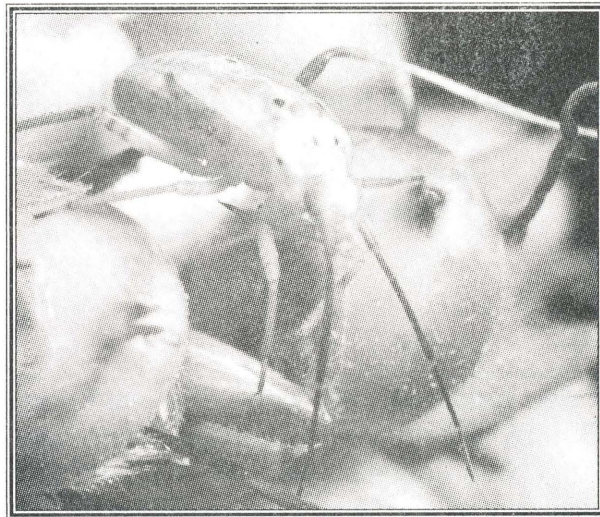
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Insect, Nematode and Disease Control in Michigan Field Crops

*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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Alton N. Sparks, Jr., University of Georgia.

Information Current as of November 21, 2008

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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/

Note: the Pesticide Certification study materials and test has changed!

To prepare for the exam, use the following bulletins:

- Private applicator certification: E-3007 = *Michigan Private Applicator Core Manual Addendum + National Pesticide Applicator Certification Core Manual*
- Commercial applicator certification: E-3008 = *Michigan Commercial Applicator Core Manual Addendum + National Pesticide Applicator Certification Core Manual*
- You can obtain these study materials from your county extension office or from the MSU bulletin office in East Lansing (517-355-0240). For more information, see 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.

TABLE of CONTENTS

How to use this bulletin 4

Before Planting: Seed Treatments & Transgenics

Seed treatments for insects

Dry beans 5
 Field Corn 6
 Transgenic Bt corn..... 7
 Refuge requirements 8
 Soybean..... 9
 Wheat 9

Seed treatments for diseases

Introduction 10
 Dry beans 11
 Field corn 12
 Small grains 13
 Soybean..... 15

Insect Control

Michigan field crops insect calendar..... 17
 Alfalfa Insects 19
 Insecticides 25
 Corn Insects 27
 Herbicide/ OP compatibility chart..... 37
 Insecticides 38
 Dry Bean Insects..... 41
 Insecticides 47
 Hay/ Pasture Insects & Insecticides 49
 Small Grain Insects 51
 Hessian Fly-free dates 53
 Insecticides 55
 Soybean Insects..... 57
 Insecticides 64
 Stored grain management..... 67
 Sugarbeet Insects 70
 Insecticides 75

Nematode Control

Introduction 76
Alfalfa, Dry beans 77
Corn 78
Hay/Pasture, Small grains 79
Soybeans 80
Sugarbeets 81
Nematicides 82

Disease Control

Fungicide Resistance Management 83
Alfalfa 85
Corn 89
Dry beans 93
Small grain 97
Soybeans 101
Sugarbeet 105

Appendices:

A. Insecticide/ Nematicide safety & environmental ratings 108
B. Fungicide safety & environmental ratings 110

Submitting samples to MSU Diagnostic Services

Diagnostic Services Submission Form

Subscription form, Field Crop Advisory Alert newsletter

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.

Bean Leaf Beetle ← pest

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)	Penncap 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)

Rate of formulated product per acre (unless specified)

* = Restricted Use (RUP)

Useful IPM info

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
--	----------------------------------	------------------------------	----------------------------	-------------------------------------

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 ^e , 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	Beetles (Bean leaf Mex bean)	Potato leafhopper	REI hrs	Notes
Attendant 600	imidacloprid		Caution	1.6 to 3.2 oz per 100 lbs seed				12	
Cruiser 5FS	thiamethoxam	no	Caution	1.28 oz per 100 lbs seed Beetle & PLH protection runs out early in season.				12	For use only by commercial seed -treaters.
Enhance AW	imidacloprid	captan vitavax	Danger	5 oz per 100 lbs seed				--	
Gaicho 480	imidacloprid	no	Caution	2 to 4 oz per 100 lbs seed			May provide early protection.	12	Provides early-season protection against injury. For use only by commercial seed-treaters.
Lorsban 30F	chlorpyrifos	no	Danger	2.75 oz per 100 lbs seed	--	--	--	--	Applied as a slurry by a commercial seed-treater
Lorsban 50W	chlorpyrifos	no	Danger	2.0 oz per 100 lbs seed	--	--	--	--	Sold in 1 lb water soluble packets. 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 a field with decaying green plant material (for ex a plowed-in 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.

Note: Seed treatments containing lindane have been cancelled.

Trade name	Insecticide common name	Contains a fungicide?	Signal word	Corn rootworm	Seedcorn maggot	White grubs	Wireworm	REI hrs
Attendant 600	imidacloprid	no	caution	--	1.34 oz per 100 lbs			12
Concur	imidacloprid	metalaxyl	caution	-	3.6 oz per 100 lbs			24
Cruiser 5FS	thiamethoxam	no	caution	5.1-9.0 oz/ 100 lbs	1.28-5.1 oz per 100 lbs			12
Cruiser Extreme	thiamethoxam	fludioxonil mefenoxam azoxystrobin	caution	1.25 mg a.i. per kernel	0.25 mg a.i. per kernel			48
Diazinon 50W CleanCrop	diazinon	no	caution	--	0.5 oz/ bushel	--	--	--
Gaucho 600	imidacloprid	no	caution	--	0.16-1.34 mg per kernel			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 50W (1 lb water soluble packets)	chlorpyrifos	no	danger	--	2 oz/ 100 lbs	--	--	--
Poncho 250 & 1250	clothianidin	no	caution	1.25 mg ai/ kernel	0.25 mg ai/ kernel			

FIELD CORN TRANSGENIC OPTIONS - TERMINOLOGY

Transgenic options are available to control European corn borer and corn rootworm. These options contain genes for selective toxins derived from *Bacillus thuringiensis* (Bt), a soil bacteria. Bt protection is available alone or stacked with genes for tolerance to Roundup (glyphosate) or Liberty herbicides. Biotech seed to control rootworm is seed treated to control soil insects at planting.

The terminology of transgenic traits is confusing and differs from company to company. When purchasing seed, make sure:

** You understand which Bt traits you are buying and the limitations of each.

** When seed is delivered, check the delivery paperwork and bag tags against your original order.

** Confirm when ordering, reconfirm at delivery, and confirm again before spraying is the seed herbicide tolerant, and if so, which herbicide? If your fields are commercially sprayed, get written confirmation of which herbicide will be sprayed, and where.

** Save seed tags for the season, to aid in tracing back problems later in the season.

Product Line	Company	Corn borer hybrid is called:	Rootworm hybrid is called	Stacked borer & rootworm hybrid is called	Notes
Agrisure	Syngenta –Garst, Golden Harvest, NK	CB	RW	CB/ RW	CB trait also controls corn earworm & suppresses fall armyworm.
Yieldgard	Monsanto – Asgrow, Dekalb	Yieldgard corn borer	Yieldgard ‘rootworm’ ‘VT’	‘plus’ ‘VT triple’	VT stands for Vector-stack Transformation. Monsanto says the VT process improves gene insertion, creating a better product. Yieldgard corn borer suppresses armyworm and earworm.
Herculex	Dow AgroSciences - Pioneer	Herculex I	Herculex RW	XTRA	Herculex I also controls western bean cutworm , armyworm, black cutworm, and suppresses corn earworm, although the control is not as complete as with corn borer.

Refuge Requirements for Bt corn

Producers using transgenic corn must follow an Insect Resistance Management (IRM) plan to delay the formation of resistance to Bt. IRM plans define the amount and placement of a non-Bt 'refuge' that produces insects which were not exposed to Bt. In theory, susceptible insects mate with the few resistant insects emerging from the Bt field, diluting resistance genes and delaying resistance.

Refuge details differ with the type of corn. Your neighbor is NEVER your refuge.

Type of Corn	Refuge Size (% of acres or area)	Can the refuge be treated for the target pest?	Location of the refuge compared to the Bt field:	Refuge placement in field				
				Block within	Head-lands	Strips in field	Block outside	Seed mixture
Bt corn for ECB	20%	Yes But cannot use a Bt spray	In field, adjacent, or within ½ mile	Yes	Yes	Yes, 4-row min. (6 preferred)	Yes	No
Bt corn for CRW	20%	Yes Soil insecticide or seed treatment	In field or adjacent - for ex, across a road or ditch	Yes	Yes	Yes, 4-row min. (6 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	White grub	REI hrs	Notes
Attendant 600	imidacloprid	no	caution	1.6-3.2 oz per 100 lbs		1.6-3.2 oz per 100 lbs			12	Use higher rate for heavier insect pressure.
Cruiser 5FS & Maxx Pak	thiamethoxam	Apron, if purchasing Maxx Pak	caution	1.28 oz per 100 lbs					12	Check label for plant back restrictions.
Enhance AW	imidacloprid	captan vitavax	danger	5 oz per 100 lbs seed						
Gaucho SB Flowable & 480 Flowable	imidacloprid	no	caution	2-4 oz/ 100 lbs	--	2-4 oz per 100 lbs of seed "reduces damage"	--		12	Check label for plant-back restrictions.
Gaucho 600	imidacloprid	no	caution	1.6-3.2 oz/ 100 lbs	--	1.6-3.2 oz/ 100 lbs seed	--		12	Provides early-season protection.

WHEAT (and barley) Seed Treatments

Trade name	Common name	Contains a fungicide?	Signal word	Aphids (fall)	Wireworm	REI hrs	Notes
Attendant 600	imidacloprid	no	caution	4 oz per 100 lbs seed		12	
Cruiser 5FS	thiamethoxam	no	caution	0.75 to 1.33 oz per 100 lbs seed	0.19 to 0.25 oz per 100 lbs seed	12	Protection in the fall (winter wheat) or early spring (barley)
Enhance AW	imidacloprid	captan vitavax	danger	0.8 – 2.4 oz per 100 lbs seed	0.13 – 0.26 oz per 100 lbs seed (suppression only)	--	

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 pumulis* 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 treatment for DRY BEAN diseases

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 FL	metalaxyl		X	X		C	0.75 fl oz	24	
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 400	captan				X	C	2-3 fl oz	96	
Dynasty	azoxystrobin	X			X	C	0.153-0.765 fl oz	4	
Kodiak HB	<i>Bacillus subtilis</i>	X				C, F	4-8 oz	24	Biological fungicide. <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
11Maxim XL	fludioxonil + mefanoxam		X	X		C	0.167 fl oz	48	See label for rates with other products
Protector-D	thiram	X			X	F	4.5 oz	24	
Rival Flowable	captan +PCNB +thiabendazole	X			X	C	4.0 fl oz	96	
Thiram 50 WP	thiram	X				C, F	2.0 oz	24	
Trilex 2000	trifloxystrobin + metalaxyl	X	X			C	1.0 fl oz	24	
Vitavax M	carboxin + thiram	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 oz	4	<i>Fusarium</i> also listed on label

Seed treatments registered for FIELD CORN diseases

Trade name	Common name	Seed rots, seedling blights	Pythium damping off	commercial or on farm use, C or F	Rate/100 lb. seed or as noted	REI hrs.	Comments
Acquire	metalaxyl		X		0.75 fl oz	24	
Allegiance FL	metalaxyl		X	C	0.75 fl oz	24	
Apron-XL-LS	mefanoxam		X	C	0.0425-0.085 fl oz	48	
Captan 400	captan	X	X	C	1.25-2.375 fl oz	96	
Captan Moly	captan	X	X	F	1.33 oz/bu	4	
Concur	imidacloprid (insecticide) +metalaxyl		X	F	1.5 oz./bu	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.
Dithane DF	mancozeb	X		C, F	2.9-5.8 oz	24	
Dithane F45	mancozeb	X		C, F	4.3-8.6	24	
Dynasty	axoxystrobin	X	X	C	0.153 fl oz	4	Mfg. recommends using only in combination with other fungicides.
Kernel Guard Supreme	carboxin + permethrin (insecticide)	X		F	1.5 oz/42 lb	12	Insecticide 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>	X		C	0.1-0.5 oz	4	Biological fungicide. <i>Fusarium</i> also listed on label.
Kodiak HB	<i>Bacillus subtilis</i>	X		F	4 oz	24	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	
System 3 Seed Treatment	Metalaxyl, PCNB + <i>B. subtilis</i>	X	X	C, F	2-3 oz/bu	12	
42-S Thiram	thiram	X		C	1.5 fl oz/bu		
Thiram 50 WP	thiram	X		C, F	3.0 oz	24	
Trilex FL	trifloxystrobin	X		C	0.32- 0.64 fl oz	12	
Trilex 2000	trifloxystrobin + metalaxyl	X	X	C	0.5 fl.oz	12	

Seed treatments registered for SMALL GRAIN - wheat, oats, barley – diseases

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	covd. smut					
Acquire	metalaxyl						X	C	0.75 fl 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
Apron-XL-LS	mefanoxam							C	0.0425-0.085 fl oz	48	For <i>Pythium</i> - damping off. Also labeled for rye.
Captan 400	captan						X	C	1.5-4 fl oz	96	wheat
									2-3 fl. oz.		barley, rye
									2-4 fl oz		oats
Charter PB	triticonazole		X	X	X	X	X	C, F	5.5 fl oz	12	Not labeled for oats
Dithane DF	mancozeb	X		X	X	X	X	C, F	1.4-2.1 oz/bu	24	Also for rye
Dynasty	azoxystrobin			X			X	C	0.153-0.382 fl oz	4	Wheat; not labeled for oats
									0.10-3.75 fl oz		barley
Enhance	captan + carboxin	X	X	X	X	X	X	F	4 oz	12	
Grain Guard	mancozeb	X		X			X	F	2 oz./bu	12	Also seed/seedling decay on rye.
Kodiak Concentrate	<i>Bacillus subtilis</i>							C	0.05-0.1 oz wheat, barley	4	Biological fungicide. <i>Fusarium</i> , and <i>Rhizoctonia</i> .
									0.1-0.5 oz other grains		
LSP	thiabendazole			X				C	4.0 fl oz	12	

Seed treatment for SMALL GRAIN - wheat, oats, barley – diseases, continued

Trade name	Common name	Oat smuts	Wheat loose		Barley loose covered		Seed/seedling decay	commercial or on farm use, C or F	Rate /100 lb. seed or as noted	REI hrs	comments
			smut	bunt	smut	smut					
Manex	maneb	X		X	X	X	X	C, F	4.3-6.7 fl oz	24	Also for rye
Manzate	maneb + zinc +manganese	X		X	X	X	X	C	4.3-6.7 fl oz	24	barley
									5.7-11.3 fl oz		oat
									3.7-5.7 fl oz		rye
									3.5-5.2 fl oz		Wheat and triticales
Maxim 4FS	fludioxonil						X		0.08-0.16 fl oz	12	
Raxil-MD	tebuconazole + metalaxyl		X		X		X	C, F	5-6.5 fl oz	24	Labeled for seed borne scab, flag smut.
Raxil MD-W	tebuconazole + metalaxyl + imidicloprid		X		X		X	C, F	5 fl oz	24	Wheat, barley and triticales; contains insecticide
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	Metalaxyl, PCNB + <i>B. subtilis</i>		X	X	X	X	X	C, F	2-4 oz/bu	12	barley
									2-3 oz/bu		wheat
42-S Thiram	thiram	X	X	X	X	X	X	C	2 fl oz/bu	24	
Thiram 50 WP	thiram	X	X	X	X	X	X	C, F	3.3 oz.	24	
Vitavax CT	carboxin + thiram	X	X	X	X	X	X	F	9-12 fl oz	24	
Vitavax M	carboxin + thiram	X	X	X	X	X	X	C, F	9-12 fl oz	24	Contains molybdenum
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

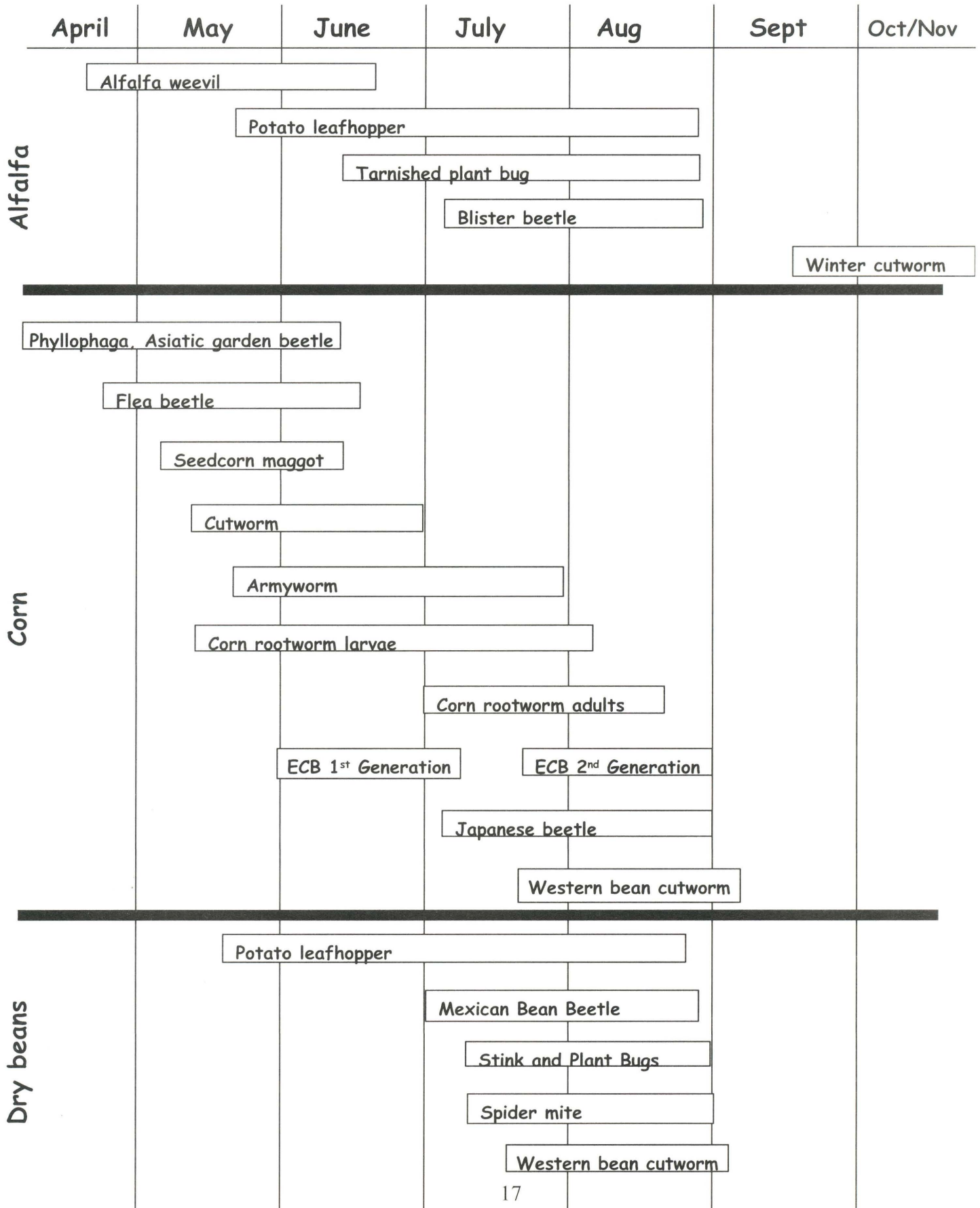
Trade name	Common name	Rhizo c	Pyth	Phyto p	Phom op	commercial or on farm use, C or F	Rate /100 lb. seed or as noted	REI hrs.
Acquire	metalaxyl		X	X		C	0.25-1.5 fl oz	24
Allegiance FL	metalaxyl		X	X		C	0.75-1.5 fl oz	24
Apron-XL-LS	mefanoxam		X	X		C	0.16-0.64 fl oz	48
ApronMaxx RFC	fludioxonil + mefanoxam	X	X	X	X	C, F	1.5 oz.	48
ApronMaxx RTA	fludioxonil + mefanoxam	X	X	X	X	F	5.0 fl oz	48
ApronMaxx RTA + Moly	fludioxonil + mefanoxam	X	X	X	X	F	5.0 fl oz	48
Bean Guard Allegiance	captan + carboxin + metalaxyl	X	X			F	2 oz./ 60 lb	24
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
Cruiser MAXX Pak	fludioxonil + mefanoxam + thiamethoxam (insecticide)	X	X	X	X		see product labels	48
Dynasty	axozystrobin	X	X				0.153-0.459 fl oz	4
Enhance	captan + carboxin	X	C			F	5 oz	12
Hi Moly Captan-D	captan	X	X		X	F	2 oz./bu	12
Kernel Guard Supreme	carboxin + permethrin (insecticide)	X	X		X	F	1.5 oz/50 lb	12
Kickstart VP	carboxin + permethrin (insecticide)	X	X		X	F	1.5 oz/50 lb	12
Kodiak Concentrate	<i>Bacillus subtilis</i>	X				C	0.125 oz	4

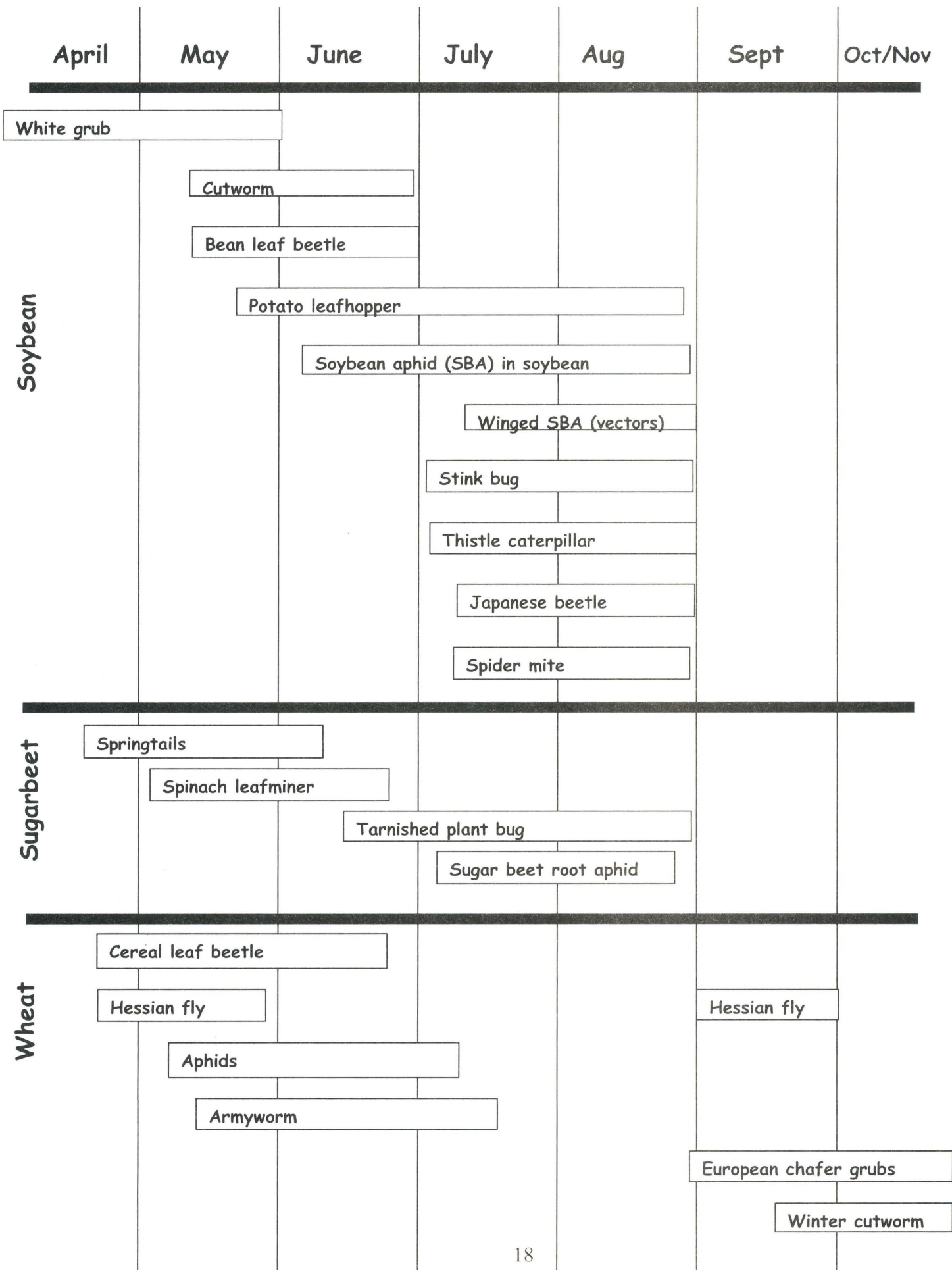
Seed treatments registered for SOYBEAN diseases, continued

Trade name	Common name	Rhizoc	Pyth	Phyto p	Phom op	commercial or on farm use= C or F	Rate /100 lb. seed or as noted	REI hrs.	Comments
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	X	X	C	0.167-0.334 fl oz	48	See label for rate in combination with other products
Protector-D	thiram	X	X		X	F	2 oz./bu	24	
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
Rival Flowable	captan +PCNB +thiabendazole	X	X		X	C	4.0 fl oz	96	
SoyGard L with Protege	azoxystrobin + metalaxyl	X	X			C	0.32-0.43 oz	24	
SoyGard with Protégé and Allegiance	azoxystrobin + metalaxyl	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>
Stiletto Pak						C	6.8 fl oz		Multipack for larger quantities
System 3 Seed Treatment	Metalaxyl, PCNB + <i>B. subtilis</i>	X	X			C, F	2-3 oz/bu	12	
42-S Thiram	thiram	X	X		X	C	2.0 fl oz	24	
Thiram 50 WP	Thiram	X	X		X	C, F	3.3 oz	24	
Trilex 2000	trifloxystrobin + metalaxyl	X	X			C	1.0 fl oz	24	
Vitavax CT	carboxin + thiram	X	X		X	F	12 fl oz	24	
Vitavax M	carboxin + thiram	X				C, F	12 oz	24	Contains molybdenum.
Vitavax M DC	carboxin +captan	X				F	2 oz/bu	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>
Warden RTA	fludioxonil + mefanoxam	X	X	X	X	C	5 fl oz	48	Labeled for seed borne <i>Sclerotinia</i> , <i>Fusarium</i>
Yield Shield	<i>Bacillus pumilus</i>	X					0.1 oz		Also labeled for <i>Fusarium</i>

Michigan Field Crops Insect Calendar

Arrows show when insects or damage are likely occur.
Insects outlined in heavy black are the most common





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)

Cobalt* (19 to 38 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, then begin larval scouting.

- a. Feeding. 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. 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.
- b. Stem-and-Bucket method. Carefully pick 10 stems randomly as you walk. Place them upside down in a bucket. Shake vigorously to dislodge large larvae, then pull apart the stem tips to find any small larvae missed by shaking. Threshold: alfalfa less than 12 inches = 1 or more larvae per plant; 12-16 inch alfalfa = 2-4 larvae per plant; 16+ alfalfa = consider cutting, but check regrowth for weevil larvae.

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)

Cobalt* (19 to 38 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* (2.56 to 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* (2.8 oz)

Cobalt* (13 to 26 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)

Cobalt* (19 to 38 oz)

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)

Warrior* (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. Damage primarily occurs during the first year of the stand, with little or no damage happening in later years.

Conditions favoring damage: A new seeding planted in or near an old infested field is at greater risk. Drought stress increases stand loss from this insect.

Management: Cultural, not chemical! Isolate new seedings away from old stands. Rotate old stands of alfalfa or clover to a non-legume crop (eg not soybeans). Spring seed versus fall seed to avoid fall dispersing beetles.

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)

Cobalt* (13 to 26 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)

Cobalt* (7 to 13 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)

Cobalt* (19 to 38 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* (3.2 to 12.8 oz)

Arctic 3.2EC* (4 to 8 oz)

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

Cobalt* (7 to 13 oz)

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

Furadan 4F* (1 to 2 pts)

Imidan 70W (1 to 1.33 lbs)

Lorsban 4E* (0.5 to 1 pt) or Chlorpyrifos 4E* (1 to 2 pts)

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

Malathion 8 Aquamul (1.25 to 2 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* (1.92 to 3.2 oz)

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

Sevin 4 F and XLR Plus (1.0 qt)

Sevin 80 S and 80 WSP (1.25 lb)

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* (6.4 to 12.8 oz)

Arctic 3.2EC* (4 to 8 oz)

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

Cobalt* (19 to 38 oz)

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

Furadan 4F* (1 qt)

Lannate LV* (1.5 to 3 pt) & SP* (0.5 to 1.0 lb)

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

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

Malathion 8F (1.0 to 2.0 pts)

Mustang* (3.0 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)

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

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)

Cobalt* (19 to 38 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)

Cobalt* (19 to 38 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* (1.92 to 3.2 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)

White grubs (in newly established seedings)

Pest status: Localized and increasing pest (especially in last few years) of new seedings

Description: White, C-shaped larvae of scarab beetles (includes Japanese, June, European chafer beetles). Up to one inch long in last instar. Orange to brown head. In alfalfa, June beetle seems to be the most common problem.

Life cycle: True white grubs remain in larval stage for several years in undisturbed grassy areas and fallow fields. To attack a new alfalfa seeding, larvae must be present in the field prior to establishment.

Type of damage: Grubs feed on germinating seeds and young plants, killing plants and reducing stand.

Conditions favoring damage: Fields following an established grass stand, or planting into fallow areas.

Management: Fall or spring plowing prior to establishment may reduce grub numbers. Establishing a new seeding in the spring will avoid Japanese beetle and chafer feeding, but June beetle larvae may still be present.

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

Lorsban 15G* (6.7 lbs/ acre) Apply in-furrow or broadcast-incorporate before planting

Winter cutworm (*Noctua pronuba*)

Pest status: The first report of economic damage in the U.S. by this insect was in northern Michigan in fall 2007.

Life cycle: Adults (yellow underwing moths) begin to emerge in May, but some may emerge later in the summer. Moths fly at night through October. Caterpillars are found perhaps as early as July, but are commonly found by August and September. Winter cutworms can withstand very cold conditions, feeding in fields well into fall, when nighttime temperatures dip below freezing. Even during the winter, caterpillars emerge and feed on warm days; feeding also occur in early spring until caterpillars pupate.

Type of damage: Defoliation by caterpillars in the fall, leaving no crop residue on the field. The direct impact of defoliation damage has not been quantified. Defoliated fields in 2008 did green up in the spring. There may also be an impact of removing crop residue in the field, leading to reduced snow cover and potential winter kill of crowns.

Conditions favoring damage: In 2007, economic damage was found in fields only in the upper 1/3 of the lower peninsula.

Management: No insecticide labels specifically list winter cutworm as a target pest. Experience in 2007-08 showed that products that control other cutworm species kill *Noctua pronuba*, even when sprayed in late fall under cool conditions.

Insecticide list [may not be supported by manufacturer], *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)

Cobalt* (13 to 26 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)

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.
Cobalt (RUP)	chlorpyrifos + gamma cyhalothrin	OP Pyr	ABL, alfalfa weevil, aphids, armyworm, cutworm, grasshopper, leaf beetles, PLH, plant bug, spittlebug, web worm.	7 at < 13 oz 14 at 13-26 oz 21 at > 26 oz	24	Phytotoxicity symptoms are possible on young, tender, rapidly-growing alfalfa.
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.

Trade Name	Common name	Class	Recommended for:	PHI days	REI hrs	Precautions and Remarks
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	
Mustang & Mustang Max (RUP)	zeta- cypermethrin	Pyr	Alfalfa weevil, aphids, armyworm, cutworm, grasshopper, PLH, plant bug, spittlebug, webworm	3 cutting, grazing	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	metalde- hyde	--	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.
Warrior (RUP)	lambda- 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.

Corn (field & seed) Insect Pests

NOTE: Check the “Herbicide/ Organophosphate Insecticide Compatibility” chart on page 37 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)

Brigade 2EC* (2.1 to 6.4 oz)

Capture 2EC* (2.1 to 6.4 oz)

Cobalt* (13 to 26 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)

PennCap-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)

Brigade 2EC* (see label for rate)

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)

Cobalt* (13 to 26 oz)

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)

PennCap-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)

Radiant SC (3 to 6 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* & 15G* (see labels for specific rates)

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):

Brigade 2EC* (2.1 to 6.4 oz)

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

Capture 2EC* (2.1 to 6.4 oz)

Proaxis * (2.56 to 3.84 oz)

Cobalt* (13 to 26 oz)

Warrior* (2.56 to 3.84 fl oz)

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

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)	Malathion ULV (4 fl oz) or 8 Aquamul (1pt)
Arctic 3.2EC* (4 to 8 oz)	Mustang* (2.9 to 4.3 oz) or Mustang Max* (2.72 to 4 oz)
Asana XL* (5.8 to 9.6 fl oz)	PennCap-M* (1 to 2 pt)
Baythroid 2* and XL* (1.6 to 2.8 oz)	Pounce 3.2 EC* (4 to 8 fl oz)
Brigade 2EC* (2.1 to 6.4 oz)	Pounce 25 WP* (6.4 to 12.8 oz)
Capture 2EC* (2.1 to 6.4 oz)	Proaxis * (2.56 to 3.84 oz)
Cobalt* (13 to 26 oz)	Sevin 4F and XLR Plus (1 to 2 qt)
Dimethoate 4EC and 400 (0.67 to 1 pt), 267EC (1 to 1.5 pts)	Sevin 80S and 80WSP (1.25 to 2.5 lb)
Lannate LV* (0.75 to 1.5 pt) or SP* (0.25 to 0.5 lb)	Warrior* (2.56 to 3.84 fl oz)
Lorsban 4E* (1 to 2 pt)	

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 6) 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)

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

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

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

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

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 (0.39 to 0.49 oz/ 1,000 row feet T, IF)

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

Cobalt* (38 to 42 oz/ 1,000 row feet Cult)

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

Counter CR* (see label for methods and rates)

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

Counter 15G* (see label for methods and rates)

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

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

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

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

Arctic 3.2EC* (4 to 8 oz)

Asana XL* (5.8 to 9.6 fl oz)

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

Brigade 2EC* (rate varies by application method))

Capture 2EC* (2.1 to 6.4 oz)

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

Cobalt* (13 to 26 oz foliar)

Cobalt* (at planting, see label for specific rates)

Intrepid 2F (4 to 8 oz)

Lorsban 4E* (1 to 2 pt)

Mustang* (1.4 to 3 oz) or Mustang Max* (1.28 to 2.8 oz)

Pennncap-M* (4 pt)

Pounce 3.2EC* (4 to 8 fl oz)

Pounce 25WP* (6.4 to 12.8 oz)

Proaxis* (1.92 to 3.2 oz foliar or 0.66 oz/1,000 row ft – IF, T)

Radiant SC (3 to 6 oz)

Sevin 4F and XLR Plus (2 qt)

Sevin 80S and 80WSP (2.5 lb)

Warrior* (1.92 to 3.2 fl oz foliar)

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

(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, sweet, and Indian corn.

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

Threshold: Treat when half of seedling plants or more show feeding and there are 5 or more beetles per plant

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

Ambush 25 W* (6.4 to 12.8 oz)

Arctic 3.2EC* (4 to 8 oz)

Asana XL* (5.8 to 9.6 fl oz)

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

Brigade 2EC* (2.1 to 6.4 oz)

Capture 2EC* (2.1 to 6.4 oz)

Cobalt* (13 to 26 oz)

Lannate LV* (0.75 to 1.5 pt) or SP* (0.25 to 0.50 lb)

Lorsban 4E* (1 to 2 pt)

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

Pennncap-M* (2 to 3 pt)

Pounce 3.2EC* (4 to 8 fl oz)

Pounce 25WP* (6.4 to 12.8 fl 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)

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.

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

Ambush 25W* (6.4 to 12.8 fl oz)	Lorsban 4E* (1.5 to 2 pt)
Arctic 3.2EC* (4 to 8 oz)	Lorsban 15G (5 to 6.5 lb aerial, broadcast into whorl)
Asana XL* (7.8 to 9.6 fl oz)	Lorsban 15G (3.5 to 8 oz/ 1,000 row feet, 1 st gen. or 6 to 8 oz/ 1,000 row feet, 2 nd gen. Directed into whorl)
Bt - <i>Bacillus thuringiensis</i> (check specific products for rates) [Dipel, Javelin, Lepinox, Xentari]	Mustang* (2.9 to 4.3 oz) or Mustang Max* (2.72 to 4 oz)
Baythroid 2* and XL* (1.6 to 2.8 oz)	PennCap-M* (2 to 4 pt)
Brigade 2EC* (2.1 to 6.4 oz)	Pounce 3.2EC* (4 to 8 fl oz)
Capture 2EC* (2.1 to 6.4 oz)	Pounce 25WP* (6.4 to 12.8 oz)
Capture 1.15G* (3.5 to 8.7 lbs / acre directed into whorl)	Proaxis * (2.56 to 3.84 oz)
Cobalt* (26 to 38 oz)	Radiant SC (3 to 6 oz)
Empower 2* (3.5 to 8.7 lbs/ acre directed into whorl - 1 st generation)	Regent 4SC* (0.24 oz / 1,000 feet of row)
Entrust (0.5 to 2 oz)	Sevin 4F and XLR Plus (1.5 to 2 qt)
Furadan 4F* (1.5 to 2 pt)	Sevin 80S and 80WSP (1.87 to 2.5 lb)
Intrepid 2F (4 to 8 oz)	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)	Malathion 5EC (1.5 pt), 8F and Aquamul (1pt)
Baythroid 2* and XL* (2.1 to 2.8 oz)	Malathion ULV (8 fl oz)
Brigade 2EC* (2.1 to 6.4 oz)	Mustang* (2.9 to 4.3 oz) or Mustang Max* (2.72 to 4 oz)
Capture 2EC* (2.1 to 6.4 oz)	Pennacp-M* (2 to 3 pt)
Cobalt* (13 to 26 oz)	Proaxis * (2.56 to 3.84 oz)
Dimethoate 4EC / 400 (1 pt), 5lb (12.8 oz), or 267 (1.5 pts)	Sevin 4F or XLR Plus (0.5 to 1.5 qt)
Furadan 4F* (0.25 to 0.5 pt)	Sevin 80S and 80WSP (0.66 to 1.875 lb)
Lorsban 4E* (0.5 to 1 pt)	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)	Proaxis * (2.56 to 3.84 oz)
Brigade 2EC* (2.1 to 6.4 oz)	Sevin 4F and XLR Plus (1 to 2 qt)
Capture 2EC* (2.1 to 6.4 oz)	Sevin 80S and 80WSP (1.25 to 2.5 lb)
Cobalt* (38 to 42 oz)	Warrior* (2.56 to 3.84 fl oz)
Pennacp-M* (2 to 4 pts)	

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):

Brigade 2EC* (5.12 to 6.4 oz)	Dimethoate 4EC, 400 (0.67 to 1 pt) or 267EC (1 to 1.5 pt)
Capture 2EC* (5.12 to 6.4 oz)	Dimethoate 5lb (8.4 to 12.8 oz)
Comite (2 to 3 pt)	

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 6) for additional maggot control products.

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

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

Brigade 2EC* (may be applied PPI with herbicides – see label)

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

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

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

Cobalt* (2.87 oz/ 1,000 row ft - T)

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

Counter 15G* (6 to 8 oz/ 1,000 row feet - T, B, IF)

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

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

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

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

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

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

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

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

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)

Cobalt* (38 to 42 oz)

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)

Western Bean Cutworm (WBC)

Pest status: WBC was first detected in Michigan in 2006. In 2008, economic damage to corn was found in the NW quadrant of the lower peninsula (roughly west of I127 and north of I-96). Damage was not reported east of I127/ I75, however adult moths were trapped as far east as Sanilac County and into Ontario.

Description: Adults (moths) fly at night and have a distinctive pattern of a dot, crescent, and white bar on the front wing. Eggs are laid on corn plants. Larvae are tan or pinkish, and at first glance appear to be a huge corn borer.

Life cycle: Larvae feed in the later part of the season, attacking the ear in August and September. Larval feeding ends in mid-September, and caterpillars drop to overwinter in the soil. There is one generation per year.

Type of damage: Young larvae feed on tassels and silks. Larval survival is much greater if egg hatch corresponds to presence of tassels and silks. Older larvae feed in the ear. Damage is distinctive – larvae often tunnel in the side of the ear, directly tunneling through kernels. There may be multiple caterpillars per ear. Feeding damage allows other insects and fungi to attack. Damaged ears have an increased risk of quality reduction from mycotoxins.

Sampling/ scouting: Adults should be surveyed using a milk jug trap with a pheromone lure (purchase from Great Lakes IPM, Vestaburg MI). When moths are first collected, scout fields for egg masses and young larvae in the tassel.

Management: Herculex-type Bt corn for European corn borer provides good control of WBC, although some caterpillars may survive and feeding damage may occur to kernels.

Threshold: 5% of plants with an egg mass or young larva in the tassel. If tassels have not yet emerged, wait to spray until most tassels have emerged. After tasselling, time application for when 70-90% of eggs have hatched. Note - the lower threshold of 5% (versus 8% used in western states) is based on potentially greater survival of WBC in the Great Lakes region.

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

Ambush 25W* (6.4 to 12.8 oz)

Asana XL* (2.9 to 5.8 oz)

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

Capture 2EC* (2.1 to 6.4 oz)

Cobalt* (13 to 26 oz)

Lorsban 4E* (1 to 2 pt)

Mustang Max* (2.72 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)

Warrior* (1.92 to 3.20 fl oz)

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.

White grubs, continued:

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

Insecticide Placement:

B = seven inch Band placed behind press wheel

BC = Broadcast and incorporated. T = seven inch band in front of press wheel (T-band)

IF = In-Furrow

PPI= Pre-Plant Incorporate

See the seed treatment section (pg 6) for additional grub control products.

Annex 2EC* (rate varies w/ application method - see label)	Empower 2* (rate varies with application method - see label)
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 oz/ 1,000 feet of row - T, IF)
Capture 1.15G* (rate varies with application method -see label)	Mocap 15G* (8 oz/ 1,000 feet of row - B)
Capture LFR (0.2 to 0.39 oz/ 1,000 row feet - T, I, F)	Proaxis* (0.66 oz / 1,000 feet of row - T, IF)
Cobalt* (2.87 oz/ 1,000 row ft - T)	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* (4.5 to 6 oz/ 1,000 feet of row - T, B)
Counter 15G* (6 to 8 oz/ 1,000 feet of row - T, IF)	Warrior* (0.66 oz / 1,000 feet of row - T, IF)

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 6) for additional wireworm control products.

Aztec 2.1G* (6.7 oz/ 1,000 feet of row - T, B, IF)	Empower 2* (rate varies with application method - see label)
Aztec 4.67G* (3 oz/ 1,000 feet of row - T, B, IF)	Force 3G* (4 to 5 oz/ 1,000 feet of row - T, B, IF)
Capture 2EC * (rate varies with application method -see label)	Fortress 5G* (3.0 to 3.75 oz/ 1,000 feet of row - T, IF)
Capture 1.15G* (rate varies with application method -see label)	Lorsban 15G (8 oz/ 1,000 feet of row - T, IF, B)
Capture LFR (0.2 to 0.39 oz/ 1,000 row feet - T, I, F)	Mocap 15G* (8 oz/ 1,000 feet of row - B)
Cobalt* (2.87 oz/ 1,000 row ft - T)	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, B)	Thimet/ Phorate 20G* (6 oz/ 1,000 feet of row - T, B)
Counter 15G* (8 oz/ 1,000 feet of row - T, IF, B)	

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

Herbicide	Soil-applied OP ¹					Foliar-applied OP ⁴	
	Counter 15G	Counter CR in-furrow	Counter CR T-band	Lorsban 15G ⁵	Other ²	⁶ Days before herbicide	⁷ Days after herbicide
<i>Accent</i>	DNU	DNU	NR	T	T	7	3
<i>Accent Gold</i> <i>Accent Gold WDG</i>	DNU	DNU	DNU	NR	T	7	3
<i>Beacon</i>	DNU	DNU	NR	T	T	10	7
<i>Basis</i>	DNU	DNU	NR	NR	T	7	3
<i>Basis Gold</i>	DNU	DNU	NR	NR	T	7	3
<i>Callisto (foliar)</i>	DNU	DNU	NR	T	T ³	7	7
<i>Hornet WDG</i> (soil-applied)	DNU	DNU	DNU	T ³	T ³	NA	NA
<i>Hornet WDG</i> (foliar-applied)	DNU	DNU	DNU	T ³	T ³	10	10
<i>Lightening</i> - IT corn only	DNU	DNU	T ³	T ³	T ³	--	--
<i>Option</i>	DNU	DNU	DNU	T	T	7	7
<i>Steadfast</i>	DNU	DNU	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 & Force* 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 DO NOT use Lorsban 15G prior to use of Lumax or Camix on SEED CORN.
 6 Foliar-applied OP can be safety applied this many days BEFORE herbicide treatment
 7 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, WBC	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.
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, WBC	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, WBC	21	12	Maximum of 11.2 oz per acre per season.
Brigade 2EC and 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, WBC	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 roguing seed corn treated with Capture 1.15G is 18 DAYS.
Cobalt (RUP)	chlorpyrifos + gamma cyhalothrin		aphids, armyworm, billbug, CLB, CRW, cutworm, ECB, flea beetle, grasshopper, JB adults, seedcorn maggot, stalk borer, WBC, white grub, wireworm			
Comite	propargite	other	mites	30	168 = 7 days	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	--	0	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, WBC	35	24	Maximum 3 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, WBC	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, WBC	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, hoppers, Japanese beetle, seedcorn maggot, stalk borer, white grub, WBC	21	24	

Trade name	Common name	Class	Recommended for:	PHI days	REI hrs	Precautions and Remarks
Radiant SC	spinetoram	Bio	Armyworm, cutworm, ECB	28	4	PHI for forage is only 3 days. Maximum 0.125 lb active per acre per year.
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, hoppers, Japanese beetle, seedcorn maggot, stalk borer, white grub, WBC	21	24	Limit 126 oz per acre per season. Do not make more than 3 applications of products containing chlorpyrifos per season.

Dry Bean Insect Pests

Annual Grub Adults (including Japanese beetle, rose chafer)

Pest status: Common insects, rarely economic pests

Description: 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)	Sevin 4F & XLR Plus (0.5 to 1 qt)
Brigade 2EC* (2.1 to 6.4 oz)	Sevin 80S & 80WSP (0.62 to 1.25 lb)
Mustang* (3.0 to 4.3 oz) or Max* (2.72 to 4 oz)	Warrior* (2.56 to 3.84 oz)
Proaxis* (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)	Malathion 8F (1.5 pts) or 8 aquamul (1.25 to 1.75 pts)
Admire 2F (16 to 24 oz)	Mustang* (3.0 to 4.3 oz) or Max* (2.72 to 4 oz)
Asana XL* (5.8 to 9.6 oz)	Orthene 75S & 75WSP (0.67 to 1.33 lb) or 97 (8 to 16 oz)
Baythroid 2* and XL* (3.2 oz)	PennCap M* (1 qt.)
Brigade 2EC* (2.1 to 6.4 oz)	Proaxis* (2.56 to 3.84 oz)
Dibrom 8E* (1 pt)	Provado 1.6F (3.5 oz/ acre)
Dimethoate 4EC (0.5 to 1 pt) or 5lb (6.4 oz)	Pyganic EC1.4 (16 to 64 oz) or EC5.0 (4.5 to 18)
Dimethoate 267 (0.75 to 1.5 pt)	Thimet 20G* (9 oz/ 1,000 feet of row)
Endosulfan 3EC* (2.66 pts)	Thionex 3EC* (0.67 to 1.33 qts) or 50WSB (1-2 lbs)
Lannate LV* (1.5 to 3 pt) or SP* (0.5 to 1 lb)	Warrior* (2.56 to 3.84 oz)
Malathion 57EC (2 to 2.5 pt)	

Armyworm

Pest status: Rarely an economic pest

Description: Caterpillars variable in color (black/brown/green). Narrow light stripe across back, broad stripes 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)	Proaxis* (2.56 to 3.2 oz)
Baythroid 2* and XL* (2.4 to 3.2 oz)	Pyganic EC1.4 (16 to 64 oz) or EC5.0 (4.5 to 18)
Brigade 2EC* (2.1 to 6.4 oz)	Radiant SC (4 to 8 oz)
Dipel DF (1 to 2 lbs) or ES (2 to 4 pts)	Sevin 4F or XLR Plus (1 to 1.5 qt)
Endosulfan 3EC* (2.66 pts)	Sevin 80S or 80WSP (1.25 to 1.875 lb)
Javelin WG (0.25 to 1.5 lb)	Thionex 3EC* (1.33 qts) or 50WSB* (2 lbs)
Mustang* (3 to 4.3 oz) or Max* (2.72 to 4 oz)	Warrior* (2.56 to 3.84 oz)
Orthene 75S and 75WSP (1.0 to 1.33 lb) or 97 (12 to 16 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)	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* (2.4 to 3.2 oz)	Penncap M* (1 qt)
Brigade 2EC* (2.1 to 6.4 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)

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)	Orthene 75S and 75WSP (0.67 to 1.33 lb) or 97 (8 to 16 oz)
Asana XL* (5.8 to 9.6 oz)	Proaxis* (1.92 to 3.2 oz)
Baythroid 2* and XL* (0.8 to 1.6 oz)	Sevin 4F or XLR Plus (1.0 to 1.5 qt)
Brigade 2EC* (2.1 to 6.4 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)

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)
Brigade 2EC* (2.1 to 6.4 oz)	Sevin XLR Plus (0.5 to 1.5 qt) or 80WSP (0.62 to 1.875 lb)
Dimethoate 4EC (0.5 to 1 pt) or 5lb (6.4 oz)	Warrior* (2.56 to 3.84 oz)
Dimethoate 267 (0.75 to 1.5 pts)	

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-quart 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* (1.92 to 3.2 oz)
Baythroid 2* and XL* (2.4 to 3.2 oz)	Sevin 4F or XLR Plus (0.5 to 1 qt)
Brigade 2EC* (2.1 to 6.4 oz)	Sevin 80S or 80WSP (0.62 to 1.25 lb)
Malathion ULV (0.5 pt)	Warrior* (1.92 to 3.2 oz)
Mustang* (3 to 4.3 oz) or Max* (2.72 to 4 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):

<p>Acephate 75SP (0.66 to 1.33 lbs) Asana XL* (2.9 to 5.8 oz) Baythroid 2* and XL* (2.4 to 3.2 oz) Brigade 2EC* (2.1 to 6.4 oz) Dimethoate 4EC (0.5 to 1 pt) or 5lb (6.4 oz) Dimethoate 267 (0.75 to 1.5 pts) Endosulfan 3EC* (1.32 to 2.66 pts) Lannate LV* (0.75 to 3 pt) or SP* (0.25 to 1 lb) Malathion 57EC (1.5 to 2.5 pt) Malathion 8F (1.5 pts) or 8 aquamul (1.25 to 1.75 pts) Malathion ULV (0.5 pt)</p>	<p>Malathion 5EC (1.5 to 2.0 pts) Mustang* (3 to 4.3 oz) or Max* (2.72 to 4 oz) Orthene 75S and 75WSP (0.67 to 1.33 lb) or 97 (8 to 16 oz) Penncap M* (1 qt) Proaxis* (1.92 to 3.2 oz) Pyganic EC1.4 (16 to 64 oz) or EC5.0 (4.5 to 18) Sevin 4F or XLR Plus (0.5 to 1 qt) Sevin 80S or 80WSP (0.67 to 1.25 lb) Thimet 20G* (4.9 to 9.4 oz/1,000 feet of row) Thionex 3EC* (0.67 to 1.33 qts) or 50WSB* (1 to 2 lbs) Warrior* (1.92 to 3.2 oz)</p>
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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):

<p>Brigade 2EC* (5.12 to 6.4 oz) Dibrom 8E* (1 pt) Dicofol 4E (1 to 3 pts) Dimethoate 4EC (0.5 to 1 pt) or 5lb (6.4 oz)</p>	<p>Dimethoate 267 (0.75 to 1.5 pts) Kelthane MF (1 to 3 pts) Malathion 5EC (1.5 pts) or ULV (0.5 pts)</p>
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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):

<p>Acephate 75SP (0.66 to 1.33 lbs) Baythroid 2* and XL* (1.60 to 3.2 oz) Brigade 2EC* (2.1 to 6.4 oz) Dibrom 8E* (1 pt) Dimethoate 4EC (0.5 to 1 pt) or 5lb (6.4 oz) Dimethoate 267 (0.75 to 1.5 pts) Lannate* LV (1.5 to 3 pt) and SP* (0.5 to 1 lb) Malathion 5EC (2 pts) or 8 Aquamul (1.25 - 1.75 pt)</p>	<p>Malathion ULV (0.5 pts) Mustang* (3 to 4.3 oz) or Max* (2.72 to 4 oz) Orthene 75S and 75WSP (0.67 to 1.33 lb) or 97 (8 to 16 oz) Penncap M* (1 qt) Proaxis* (2.56 to 3.84 oz) Sevin 4F or XLR Plus (1 to 1.5 qt) Sevin 80S or 80WSP (1.25 to 1.875 lb) Warrior* (2.56 to 3.84 oz)</p>
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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

Acephate 75SP (0.66 to 1.33 lbs)	Malathion 57EC (1.5 to 2.5 pt), 5EC (2 pt), ULV (0.5 pt)
Admire 2F (16 to 24 oz)	Malathion 8F (1.5 pts) or 8 aquamul (1.25 to 1.75 pts)
Asana XL* (5.8 to 9.6 oz)	Mustang* (3 to 4.3 oz) or Max* (2.72 to 4 oz)
Baythroid 2* and XL* (0.8 to 1.6 oz)	Orthene 75S and 75WSP (0.67 to 1.33 lb) or 97 (8 to 16 oz)
Brigade 2EC* (1.6 to 6.4 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)

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.

See page 5 in the seed treatment section for a list of products to control seedcorn maggot.

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)

Brigade 2EC* (2.1 to 6.4 oz)

Lannate LV* (1.5 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)

Radiant SC (5 to 8 oz)

Sevin 4F or XLR Plus (1 qt)

Sevin 80S or 80WSP (1.25 lb)

Warrior* (2.56 to 3.84 oz)

Western bean cutworm

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

Description: Moth is 1.5 – 2 times the size of a European corn borer, with a white bar along the front margin of the wing, as well as a distinctive white spot and crescent. Larvae are brown, lacking stout spines or colorful stripes. As WBC grow larger, they resemble ‘enormous corn borers’, reaching 1.5 inches in length.

Life cycle: WBC moths emerge in early July and begin to lay eggs on corn. In areas where corn and dry beans overlap, moths will switch to dry beans for egg-laying if the surrounding corn is not attractive (past the tasseling stage). Eggs are laid on the undersides of leaves. Small larvae initially feed on leaves, then switch to pods as beans develop. By late August or early September, larvae leave the plant, drop to the ground and prepare to overwinter in a cell under the soil.

Type of damage: Larvae chew into pods and consume the beans, often working their way up or down from seed to seed.

Sampling/ scouting: Sampling beans for WBC is difficult. Instead, trap adult moths using a milk-jug pheromone trap starting in early July [directions for the trap are available at <http://www.ent.iastate.edu/trap/westernbeancutworm/>]. A cumulative trap catch of 700-1000 moths has a moderate risk of dry bean damaged, while trap catches over 1000 moths suggest a high risk of damage and the need for spraying.

Management: No insecticides currently list WBC on dry beans on the label. However, insecticides targeted for black cutworm (see page 42) will kill WBC larvae if timed properly. Also, Asana, Baythroid, Mustang, Proaxis, and Warrior are labeled for WBC control in field corn. NOTE: Companies may not fully guarantee the effectiveness of their products against WBC on dry beans.

** Be aware of pre-harvest intervals, as spraying for WBC may occur late in the season.

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: 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.

Threshold: None available. 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.

See page 5 in the seed treatment section for a list of products to control wireworm

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.
Brigade 2EC (RUP)	bifenthrin	Pyr	Aphids, armyworm, BLB, cutworm, hoppers, cloverworm, MBB, mites, plant bugs, PLH, thrips	14	12	Maximum 0.3 lb active per acre per year.
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 (RUP)	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 267,4EC, 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 (RUP)	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.
Lorsban 30F	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

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, hopper, 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, hoppers, 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, hoppers, 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.
Radiant SC	spinetoram	Bio	Armyworm, thrips	3	4	Maximum 6 applications and 0.219 lb active per acre per year.
Sevin 4 F, XLR Plus, 80 S or 80 WSP	carbaryl	Carb	annual grub adults, armyworm, BLB, cutworm, hoppers, 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 (RUP)	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, hoppers, 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)

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)

Warrior* (2.56 to 3.84 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, 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)

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

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

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

Warrior* (1.92 to 3.2 oz)

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)

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

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

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

Warrior* (2.56 to 3.84 oz)

Winter cutworm (*Noctua pronuba*)

Pest status: The first report of economic damage in the U.S. by this insect was in northern Michigan, in fall 2007.

Life cycle: Adults (yellow underwing moths) begin to emerge in May, but some may emerge later in the summer. Moths fly at night into October. Caterpillars are found perhaps as early as July, but are commonly found by August and September. Winter cutworms can withstand very cold conditions, feeding in fields well into fall, when night time temperatures dip below freezing. Even during the winter, caterpillars emerge and feed on warm days.

Type of damage: Defoliation by caterpillars in the fall, leaving no crop residue on the field. Stands damaged in the fall appear to suffer severe loss in the spring (the grass portion is killed).

Conditions favoring damage: Thus far, economic damage is found in fields only in the upper 1/3 of the lower peninsula.

Management: No insecticide labels specifically list winter cutworm as a target in hay/pasture. I suggest using guidelines and insecticide listed for armyworm control as a baseline. Based on experience from 2007-08, insecticides sprays, even those applied late in the fall under cool temperatures, did a good job of killing winter cutworm larvae.

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	<i>Bt</i> 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	
Malathion 5, 8 Aquamul, 8F, ULV	malathion	OP	armyworm, grasshoppers	0	12	
Mustang and Mustang Max (RUP)	zeta-cypermethrin	Pyr	armyworm, grasshoppers	0 forage 7 straw	12	Maximum 0.025 lbs active per acre per cutting; 0.075 lbs active total per acre per year.
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.
Warrior (RUP)	lambda cyhalothrin	Pyr	armyworm, grasshoppers, skippers	0 forage 7 hay	24	Maximum 0.03 lbs active per acre per cutting; 0.09 lbs active total per acre per year

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.*

Cobalt* (7 to 13 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*

Di-Syston 8EC* (4 to 12 fl oz) *Wheat only*

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 (3.4 to 4.3 oz) or Max* (3.2 to 4 oz) *Wheat only*

PennCap-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)

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

Cobalt* (13 to 25 oz) *Wheat only*

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) *Wheat only*

PennCap-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)

Radiant SC (3 to 6 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)

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* (1.0 to 1.8 oz) *Wheat only*

Cobalt* (13 to 25 oz) *Wheat only*

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) *Wheat only*

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

Radiant SC (2 to 6 oz)

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)

Cutworms

Cutworm damage to small grains is rare.

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

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

Cobalt* (13 to 25 oz) *Wheat only*

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):

SMALL GRAINS

Baythroid 2* and XL* (1.8 to 2.4 oz) *Wheat only*
 Cobalt* (7 to 13 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) *Wheat only*
 Penncap-M* (2 to 3 pt) *Do not apply to rye.*
 Proaxis* (2.56 to 3.84 oz) *Wheat only*
 Radiant SC (3 to 6 oz) *Suppression*
 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)

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
Gratiot	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):

Di-Syston 8EC* (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.

Winter cutworm (*Noctua pronuba*)

Pest status: The first report of economic damage in the U.S. by this insect was in northern Michigan, in fall 2007.

Life cycle: Adults (yellow underwing moths) begin to emerge in May, but some may emerge later in the summer. Moths fly at night well into October. Caterpillars are found perhaps as early as July, but are commonly found by August and September. Winter cutworms can withstand very cold conditions, feeding in fields well into fall, when nighttime temperatures dip below freezing. Even during the winter, caterpillars emerge and feed on warm days.

Type of damage: Defoliation by caterpillars in the fall, leaving no crop residue on the field. The impact of the damage is not yet known. Defoliation late in the season itself may not reduce yield, but we speculate that lack of crop residue (and thus reduced snow cover) could result in winter kill of wheat.

Conditions favoring damage: In 2007, economic damage was found in fields only in the upper 1/3 of the lower peninsula.

Management: No insecticide labels specifically list winter cutworm as a target. I suggest using guidelines and insecticide listed in this section for cutworm control as a baseline.

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*

Gaucho 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 on small (1 st -2 nd stage) larvae, and with moderate populations. Full coverage is required.
Cobalt (RUP)	chlorpyrifos + gamma cyhalothrin	OP Pyr	aphids, armyworm, CLB, cutworm, grasshoppers	28	24	Maximum of 2 applications of products containing chlorpyrifos per year.
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.
Di-Syston (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.
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	
Mustang and Mustang Max (RUP)	zeta-cypermethrin	Pyr	cereal leaf beetle, grasshoppers, thrips	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 OMRI for use in organic production.

SMALL GRAINS

Trade name	Common name	Class	Recommended for:	PHI days	REI hrs	Precautions and Remarks
Radiant SC	spinetoram	Bio	Armyworm, CLB, hoppers	21 grain	4	Maximum 18 oz per acre per year. Maximum 3 applications per year.
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.
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	OCl	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):

<i>Bacillus thuringiensis</i> (check product labels for rates) [Agree WG, Dipel ES / DF, Javelin WG, Xentari DF]	Lorsban 4E* (1 to 1.5 pt – see insecticide table for generics)
Baythroid 2* and XL* (1.6 to 2.8 oz)	Mustang* (3 to 4.3 oz) or Max* (3.2 to 4 oz)
Brigade 2EC* (2.1 to 6.4 oz)	Nufos 4E* (1 to 1.5 pt)
Capture 2EC* (2.1 to 6.4 oz)	Orthene 75S (1 to 1.33 lbs) or 90S (0.83 to 1.1 lbs)
Carbaryl 4L (2 to 3 pt)	Orthene 97 (0.75 to 1 lb)
Chlorpyrifos 4E* (1 to 1.5 pt)	Pounce 3.2EC* (4 to 8 oz)
Cobalt* (13 to 26 oz)	Proaxis* (3.2 to 3.84 oz)
Entrust (1.25 to 2 oz)	Radiant SC (2 to 4 oz)
Intrepid 2F (4 to 8 oz)	Sevin 4F and XLR Plus (1 to 1.5 qt)
Larvin 3.2* (10 to 30 fl oz)	Sevin 80S and 80WSP (1.25 to 1.875 lb)
Lannate LV* (0.75 to 1.0 pt) and SP* (0.25 to 0.375 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)	Larvin 3.2* (18 to 30 fl oz)
Arctic 3.2 EC* (2 to 4 oz)	Leverage 2.7* (3.8 oz)
Asana XL* (5.8 to 9.6 fl oz)	Lorsban 4E* (1 to 2 pt – see insecticide table for generics)
Baythroid 2* and XL* (1.6 to 2.8 oz)	Mustang* (3 to 4.3 oz) and Max* (2.8 to 4 oz)
Brigade 2EC* (2.1 to 6.4 oz)	Nufos 4E* (1 to 2 pt)
Capture 2EC* (2.1 to 6.4 oz)	Orthene 75S (1 to 1.33 lbs) or 90S (0.83 to 1.1 lbs)
Carbaryl 4L (1 to 2 pt)	Orthene 97 (0.75 to 1 lb)
Chlorpyrifos 4E* (1 to 2 pt)	PennCap-M* (2 to 3 pt)
Cobalt* (19 to 38 oz)	Permethrin/ Perm-Up 3.2EC* (2 to 4 oz)
Cruiser 5FS seed treatment (1.28 oz / 100 lbs of seed)	Pounce 3.2EC* (2 to 4 fl oz)
Dimethoate 4EC (1 pt)	Pounce 25WP* (3.2 to 6.4 fl oz)
Dimethoate 267 (1.5 pts)	Proaxis* (1.92 to 3.2 oz)
Furadan 4F* (0.25 to 0.5 pts)	Sevin 4F and XLR Plus (0.5 to 1 qt)
Gaucho SB Flowable (2 to 4 oz/100 wt seed)	Sevin 80S and 80WSP (0.63 to 1.25 lb)
Lannate LV* (0.75 to 1.0 pt) and SP* (0.25 to 0.5 lb)	Warrior* (1.92 to 3.20 fl oz)

Cutworm

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)	Larvin 3.2* (20 to 30 fl oz)
Arctic 3.2 EC (2 to 4 oz)	Lorsban 4E* (1 to 2 pt)
Asana XL* (5.8 to 9.6 fl oz)	Mustang* (1.4 to 4.3 oz) or Max* (1.28 to 4 oz)
Baythroid 2* and XL* (0.8 to 1.6 oz)	Nufos 4E* (1 to 2 pt)
Brigade 2EC* (2.1 to 6.4 oz)	Permethrin/ Perm-Up 3.2EC* (2 to 4 oz)
Capture 2EC* (2.1 to 6.4 oz)	Pounce 3.2EC* (2 to 4 fl oz) or 25W* (3.2 to 6.4 oz)
Carbaryl 4L (2 to 3 pt)	Proaxis* (1.92 to 3.2 oz)
Chlorpyrifos 4E* (1 to 2 pt)	Sevin 4F and XLR Plus (1 to 1.5 qt)
Chlorpyrifos 4E* (1 to 1.5 pt)	Sevin 80S and 80WSP (1.25 to 1.875 lb)
Cobalt* (13 to 26 oz)	Warrior* (1.92 to 3.20 fl oz)
Empower 2* (3.5 to 8.7 lbs/ acre)	

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)	Leverage 2.7* (3.8 oz)
Baythroid 2* and XL* (2.0 to 2.8 oz)	Lorsban 4E* (0.5 to 1 pt – see insecticide table for generics)
Brigade 2EC* (2.1 to 6.4 oz)	Mustang* (3.4 to 4.3 oz) or Max* (3.2 to 4 oz)
Capture 2EC* (1.6 to 6.4 oz)	Nufos 4E* (0.5 to 1 pt)
Carbaryl 4L (1 to 3 pt)	Orthene 75S (0.33 to 0.67 lbs) or 90S (0.28 to 0.56 lbs)
Chlorpyrifos 4E* (0.5 to 1 pt)	Orthene 97 (0.25 to 0.5 lb)
Chlorpyrifos 4E* (1 to 1.5 pt)	PennCap-M* (2 to 3 pt)
Cobalt* (7 to 13 oz)	Proaxis* (3.2 to 3.84 oz)
Dimethoate 4EC (1 pt)	Sevin 4F and XLR Plus (0.5 to 1.5 qt)
Dimethoate 267 (1.5 pts)	Sevin 80S (0.63 to 1.875 lb)
Dimilin* 25W and 2L (2 oz)	Warrior* (3.20 to 3.84 fl oz)
Furadan 4F* (0.25 to 0.5 pt)	

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)	Leverage 2.7* (3.8 oz)
Arctic 3.2 EC (2 to 4 oz)	Lorsban 4E* (0.5 to 1 pt – see insecticide table for generics)
Asana XL* (2.9 to 5.8 fl oz)	Mustang* (3 to 4.3 oz) and Max* (2.8 to 4 oz)
<i>Bt</i> = <i>Bacillus thuringiensis</i> (check product labels for rates)	Nufos 4E* (0.5 to 1 pt)
[Agree WG, Dipel ES/ DF, Javelin WG, Xentari DF]	Orthene 75S (1 to 1.33 lbs) or 90S (0.83 to 1.1 lbs)
Baythroid 2* and XL* (0.8 to 1.6 oz)	Orthene 97 (0.75 to 1 lb)
Brigade 2EC* (2.1 to 6.4 oz)	PennCap-M* (2 to 3 pt)
Capture 2EC* (2.1 to 6.4 oz)	Permethrin/ Perm-Up 3.2EC* (2 to 4 oz)
Carbaryl 4L (1 to 2 pt)	Pounce 3.2EC* (2 to 4 oz)
Chlorpyrifos 4E* (0.5 to 1 pt)	Pounce 25WP* (3.2 to 6.4 oz)
Cobalt* (7 to 13 oz)	Proaxis* (1.92 to 3.2 oz)
Dimilin 25W* and 2L* (2 to 4 oz)	Radiant SC (2 to 4 oz)
Entrust (1.25 to 2 oz)	Sevin 4F and XLR Plus (0.5 to 1 qt)
Intrepid 2F (4 to 8 oz)	Sevin 80S and 80WSP (0.63 to 1.25 lb)
Lannate LV* (0.4 to 0.75 pt) or SP* (0.125 to 0.5 lb)	Tracer (1 to 2 oz)
Larvin 3.2* (10 to 30 fl 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)	Mustang* (3 to 4.3 oz) and Max* (2.8 to 4 oz)
Arctic 3.2 EC (2 to 4 oz)	PennCap-M* (3 to 4 pt)
Asana XL* (5.8 to 9.6 fl oz)	Permethrin/ Perm-Up 3.2EC* (2 to 4 oz)
Baythroid 2* and XL* (1.6 to 2.8 oz)	Pounce 3.2EC* (2 to 4 oz)
Brigade 2EC* (2.1 to 6.4 oz)	Pounce 25WP* (3.2 to 6.4 oz)
Capture 2EC* (2.1 to 6.4 oz)	Proaxis* (3.2 to 3.84 oz)
Carbaryl 4L (1 to 2 pt)	Sevin 4 F and XLR Plus (0.5 to 1 qt)
Cobalt* (19 to 38 oz)	Sevin 80S and 80WSP (0.63 to 1.25 lb)
Leverage 2.7* (3.8 oz)	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)	Lorsban 4E* (1 to 1.5 pt – see insecticide table for generics)
Arctic 3.2 EC (2 to 4 oz)	Mustang* (3 to 4.3 oz) and Max* (2.8 to 4 oz)
Asana XL* (2.9 to 5.8 fl oz)	Nufos 4E* (1 to 2 pt)
Baythroid 2* and XL* (1.6 to 2.8 oz)	Orthene 75S (1 to 1.33 lbs) or 90S (0.83 to 1.1 lbs)
Carbaryl 4L (1 to 2 pt)	Orthene 97 (0.5 to 1 lb)
Chlorpyrifos 4E* (1 to 1.5 pt)	PennCap-M* (2 to 3 pt)
Cobalt* (19 to 38 oz)	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)
Leverage 2.7* (3.8 oz)	Warrior* (1.92 to 3.2 fl oz)

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 trifoliolate 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)	Mustang* (3 to 4.3 oz) or Max* (2.8 to 4 oz)
Arctic 3.2 EC (2 to 4 oz)	Orthene 75S (0.67-1.33 lbs), 90S (0.56-1.1 lbs), 97 (0.5-1.0 lb)
Asana XL* (2.9 to 5.8 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)
Brigade 2EC* (2.1 to 6.4 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)
Cobalt* (19 to 38 oz)	Sevin 80S and 80WSP (1.25 lb)
Dimethoate 4EC and DiGon 400 (1 pt) or 267 (1.5 pt)	Warrior* (1.92 to 3.2 fl oz)
Leverage 2.7* (3 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 insecticides (Phorate, Thimet or Temik) applied for nematode control will also control seedcorn maggot.

Threshold: None. Treat soybeans planted into soils high in organic matter.

See Soybean seed treatment table on page 9 for a list of products to control seedcorn maggot.

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

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. Proper fertility, esp. potassium levels, may delay aphid increase or reduce aphid damage.

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]

(Seed treatments are listed on page 9)

Asana XL* (5.8 fl. oz) [21]

Baythroid 2* and XL* (2 to 2.8 oz) [30]

Brigade 2EC* (2.1 to 6.4 oz)

Capture 2EC (2.1 to 6.4 oz) [3]

Chlorpyrifos 4E* (1 pt) [28]

Cobalt* (13 to 26 oz) [30]

Furadan 4F* (0.25 to 0.5 pts) [21]

Gaucho SB & 480 Flowable (2 to 4 oz/ 100 wt of seed)

Leverage 2.7* (3.8 oz)

Lorsban 4E* (1 pt) [28]

Mustang* (3.0 to 4.3 oz) or Max* (3.2 to 4.0 oz)

Mustang Max* (2.8 to 4 oz) [21]

Nufos 4E* (1 pt) [28]

Orthene 75S (1-1.33 lbs), 90S (0.83-1.1 lbs), 97 (0.5-1.0 lb)

PennCap-M* (1 to 3 pts) [20]

Proaxis* (1.92 to 3.2 oz) [30]

Warrior* (3.2 oz) [30]

Spider 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 natural fungal pathogen may infect and kill mites under warm, humid conditions.

Threshold: Based on damage levels.

Level 1: Mites barely detected, found only on undersides of leaves in dry locations or on edges of fields.

Assessment: Non-economic.

Level 2 = Mites easily found on undersides of leaves, still only in dry locations or on field edges. Leaves are still green, but stippling injury is detectable on undersides of leaves of infested plants.

Assessment: Non-economic, but keep monitoring.

Level 3 = All plants infested when examined closely, exhibiting varying levels of stippling, even on healthy leaves. Some speckling and discoloration of lower leaves. Field margins and dry areas exhibit severe damage.

Assessment: Rescue treatment is warranted, especially if many immature mites and eggs are present.

Level 4 = All plants heavily infested when examined closely. Discolored and wilted leaves easily found throughout the field. Severe damage evident.

Assessment: Effective rescue treatment will save field.

Level 5 = Extremely high numbers. Field discolored, leaves drying down. Significant foliage and stand loss.

Assessment: Rescue treatment may not save field. However, new growth may resume if treated.

Notes: Mites are difficult to control chemically. Most insecticides kill mites, but not eggs; newly hatched nymphs can thus repopulate after treatment. Insecticides do kill natural mite predators, leading to ‘flaring’ of mite populations after a spray. Repeated spraying can lead to resistance. If soybean aphid populations are also heavy, dimethoate is not the recommended choice to control both pests.

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

Brigade 2EC* (5.12 to 6.4 oz)

Capture 2EC* (5.12 to 6.4 oz)

Chlorpyrifos 4E* (0.5 to 1 pt)

Cobalt* (13 to 26 oz – see supplemental label)

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

Lorsban 4E* (0.5 to 1 pt – see insecticide table for generics)

Nufos 4E* (0.5 to 1 pt)

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 75S (0.33 to 0.67 lbs) or 90S (0.28 to 0.56 lbs)
Brigade 2EC* (2.1 to 6.4 oz)	Orthene 97 (0.5 to 1.0 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)
Cobalt* (19 to 38 oz)	Sevin 4 F and XLR Plus (1 qt)
Lannate LV* (0.75 to 1.0 pt) or SP* (0.25 to 0.5 lbs)	Sevin 80S and 80WSP (1.25 lb)
Leverage 2.7* (3.8 oz)	Warrior* (1.92 to 3.20 fl oz)
Mustang* (3.4 to 4.3 oz) or Max* (3.2 to 4.0 oz)	

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.

See Soybean seed treatment table on page 9 for a list of products to control wireworm.

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.
Brigade 2EC Capture 2EC (RUP)	bifenthrin	Pyr	armyworm, BLB, cutworm, grasshopper, cloverworm, JB, MBB, mites, 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)
Cobalt (RUP)	chlorpyrifos + gamma cyhalothrin	OP Pyr	armyworm, BLB, cloverworm, cutworm, grasshoppers, JB, MBB, PLH, SBA, spider mite	30	24	Maximum 85 oz per acre per season.
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	difluzuron	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.
Gaucho SB Flowable, 480 Flowable	imidacloprid	Neo	BLB, Seedcorn maggot, SBA	--	--	Seed treatment. Provides early season control – lasts 35-40 days after planting.

Trade Name	Common Name	Class	Registered for:	PHI days	REI hrs	Precautions and Remarks
Intrepid 2F	methoxy-fenozide	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.
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.
Leverage	imidacloprid + cyfluthrin	Nic Pyr	BLB, cloverworm, grasshoppers, JB, MBB, SBA	45	12	Maximum 1.4 oz per acre per season
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.
Mustang and Mustang Max (RUP)	zeta cypermethrin	Pyr	armyworm, BLB, cloverworm, cutworm, grasshoppers, MBB, PLH, SBA, thrips	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, hoppers, Japanese beetle, MBB, PLH, SBA, thrips	30	24	Maximum 0.03 lb a.i. per acre per season. Do not graze or feed forage.
Radiant SC	spinetoram	Bio	Armyworm, cloverworm	28	4	Do not apply more than 0.109 lb active ingredient per acre per year
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 to contact seed. Do not feed foliage. Do not apply if metribuzin herbicides have been applied.

Trade Name	Common Name	Class	Registered for:	PHI days	REI hrs	Precautions and Remarks
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 (beta-cyfluthrin)	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 (chlorpyrifos methyl + deltamethrin)	Bins, trucks, and wagons that carry or store barley, oats, sorghum, or wheat	Bins should be thoroughly cleaned and insect-free before application.
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 – May not provide adequate control of certain insects, such as meal moth. Note - Due to concerns about pesticide residue, some millers may 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
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
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!* Chloropicrin and aluminum phosphide are very toxic and require special handling, protective equipment, and application procedures.
- In Michigan, an additional fumigation ‘standard’ is required in addition to your private or commercial applicator license use fumigants.
- If you don’t have specialized training, don’t do the fumigation.

Sugar Beet Insect Pests

NOTE: At the time this bulletin was printed (December 2008), Mustang is registered for use on sugar beets in Michigan. Mustang Max IS NOT.

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 CR* (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)

Mustang* (2.4 to 4.3 oz)

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)
Mustang* (2.4 to 4.3 oz)	

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)	Mustang* (2.4 to 4.3 oz)
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)
Lorsban 15G (6.6 to 9 oz per 1,000 row ft)	

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)
Mustang* (2.4 to 4.3 oz)	

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)

Lorsban 4E* (0.5 to 1 pt)

Mustang* (2.4 to 4.3 oz)

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)

Dibrom 8E* (1 pt)

Lorsban 4E* (0.5 to 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)

Mustang* (2.4 to 4.3 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)

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)

Mustang* (2.4 to 4.3 oz)

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)

Lorsban 4E* (2 pt broadcast or 1.33 pt banded)

Dipel DF (0.5 to 1lb) or ES (1 to 2 pts)

Mustang* (4.3 oz banded or broadcast in 3-5 gals/ acre water)

Lannate LV* (1.5 pt) or SP* (0.5 lb)

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 CR* (3 to 6 oz per 1,000 row ft, in furrow or banded)

Mustang* (4.3 oz in-furrow or t-band over open furrow in minimum 3-5 gal/ acre water)

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 CR* (3 to 6 oz per 1,000 row ft)

Diazinon 50 W (6 to 8 lb)

Lorsban 15G (6.5 to 9 oz banded per 1,000 row ft. Suppression only)

Mustang* (4.3 oz in-furrow or t-band over open furrow in minimum 3-5 gal/ acre water)

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 thuringien-sis</i>	Biol	armyworm, beet webworm, cutworms	0	4	Use only to control small armyworms when populations are light. Full spray coverage is important.
Counter 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	diazinon	OP	aphids (foliar), grasshoppers, leaf hoppers, spinach leaf miner, wireworms	14	24	Maximum 5 applications per season.
Dibrom 8E (RUP)	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.
Mustang (RUP)	zeta cypermethrin	Pyr	Armyworm, webworm, cutworm, flea beetle, hoppers, leafhopper, plant bugs, leafminer, grubs, wireworm	50	12	Do not apply more than 0.15 lb active per acre per season
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

Updated by Fred Warner, Nematologist, MSU Diagnostic Services

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 yield & root nodulation (4-6 cwt/A yield loss on navy beans documented in MI).

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.

NEMATICIDES

NAME	RATE/ACRE	APPLICATION
Temik 15G (RUP)	7.0-14.0 lbs.	Banded

FIELD 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.

NEMATOCIDES/INSECTICIDES

NAME	OZ/1000 FT ²	APPLICATION
Counter 15G (RUP)	6.0	In-furrow
Counter 15G (RUP)	8.0	Banded
Mocap 15G (RUP)	8.0	Banded

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 root 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. May predispose SCN-resistant varieties to injury by SCN.

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 November 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 host 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.

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 fumigant or non-fumigant nematicide. Use of resistant varieties. 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} may reduce 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.

NEMATICIDES/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-dichloro-propene	Chlorinated Hydrocarbon	Broadcast or in-row	120	Inject 12 inches deep in well-prepared soil. Soil temp. should be 50-80 ⁰ F. Apply in the fall or at least two weeks before planting in the spring. REI=5 days.
Telone C-17 (RUP)	1,3-dichloro-propene + chloropicrin	Chlorinated Hydrocarbon	Broadcast or in-row	120	See remarks for Telone II.
Telone C-35 (RUP)	1,3-dichloro-propene + 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	Organophosphate	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 15G (RUP)	ethoprop	Organophosphate	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 alfalfa, corn, small grains, dry beans, soybeans, and sugar beets. 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, included 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	Folicur	Soybeans, wheat (head scab)	M
3	myclobutanil	Laredo	Soybean rust	M
3	tetraconazole	Domark	Soybeans	M
3	cyproconazole	Alto	Soybeans	M
3	prothioconazole	Proline	Small grains, dry beans, soybeans, sugar beets	M
3	prothioconazole + tebuconazole	Prosaro	Small grains	M
3	metconazole	Caramba	Small grains	M
3	flusilazole	Punch	Soybean rust	M
3	flutriafol	Topguard	Soybean rust	M
4	metalaxyl, mefenoxam	Ridomil Gold	Dry beans, soybeans, sugar beets	H
7	boscalid	Endura	Dry beans, soybeans	M
11	azoxystrobin	Amistar	Corn, dry beans, sugar beets	H
11	azoxystrobin	Quadris	Barley, corn, dry beans, soybeans, sugar beets, wheat	H
11	pyraclostrobin	Headline	Corn, small grains, sugar beets, soybeans	H
11	trifloxystrobin	Gem	Sugar beets	H
11/3	triflozystrobin + propiconazole	Stratego	Corn, small grains, soybeans	
11/3	azoxystrobin + cyproconazole	Quadris Xtra	Soybeans	
11/3	azoxystrobin + propiconazole	Quilt	Barley, wheat, corn, soybeans	
11/3	Pyraclostrobin + metconazole	TwinLine	Small grains	
11/M5	azoxystrobin + chlorothalonil	Quadris Opti	Dry beans	
14	quintozene (PCNB)	Blocker, Terraclor	Dry beans	L-M
30	triphenyltin hydroxide	Super Tin	Sugar beets	L-M
M1	copper hydroxide	Champ, 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, Equus,	Soybeans	L

Important Alfalfa Diseases in Michigan

Anthracnose (AN)

Cause: *Colletotrichum trifolii*, (fungus)

Incidence: This fungal disease is most common in the southern third of lower Michigan and is increasing in severity every year.

Symptoms: Infected stems develop diamond-shaped lesions with straw-colored centers and dark brown borders. Black specks with the lesions are fruiting bodies of the fungus. The portion of the stem above the lesion wilts and becomes straw-colored and bends in a “shepherd’s crook”.

Disease cycle: Hot, moist weather favors the disease which infects stems and crowns and may kill some plants.

Management: Only anthracnose resistant varieties should be planted in Michigan. Avoid spreading the disease to clean fields by harvesting infested fields last, and disinfecting cutter bars with 10% chlorine bleach after harvesting.

Aphanomyces root rot (APH)

Cause: *Aphanomyces euteiches* (oomycete)

Incidence: Aphanomyces root rot is a soil-borne disease that occurs on poorly-drained soils.

Symptoms: Seedlings infected with aphanomyces will have chlorotic leaves and gray roots and stems. Seedlings remain yellowed and stunted as they mature. In established plants it causes a chronic root disease with symptoms that may be confused with nitrogen deficiency. Symptoms of this disease may also be confused with phytophthora or pythium root rot.

Disease cycle: Aphanomyces is a soil-borne fungus that thrives in cool-moist conditions.

Management: Avoid planting alfalfa in poorly drained fields; improve drainage if possible. Planting resistant varieties is recommended. There are two races of aphanomyces. Alfalfa resistant to race 2 is also resistant to race 1; however, resistance to race 1 does not infer resistance to race 2. Although aphanomyces is also an oomycete, seed treatments labeled for phytophthora and pythium are not effective against this disease.

Bacterial wilt (BW)

Cause: *Clavibacter michiganense* subsp *insidiosus* (bacterium)

Incidence: Bacterial wilt is present in all areas of Michigan.

Symptoms: Symptoms of bacterial wilt include chlorotic, sometimes cupped or mottled foliage and stunted growth. Affected plants may have spindly stems. Wilted or dead plants may be scattered throughout the field, especially when plants are stressed by heat or drought. Cutting into infected taproots will reveal a yellowish tan color in the water conducting tissues. Infected plants are more prone to winter kill.

Disease cycle: The bacterium can survive in the soil in diseased alfalfa roots and plant debris for extended periods of time. Infection takes place through wounds to the roots, crowns, or stems, which is why disease symptoms are most evident during regrowth after clipping.

Management: Use resistant varieties. All of the named varieties are adequately resistant to BW. “Common” alfalfa varieties sold by some seed companies should be avoided since the seed may be from susceptible plants. The disease tends to increase with the age of the stand. Cut infected fields last, to avoid spreading the bacterium to younger stands. Avoid mowing fields when they are wet.

Phytophthora root rot (PRR)

Cause: *Phytophthora megasperma*, (oomycete)

Incidence: Phytophthora root rot is one of the most important diseases of alfalfa in the state.

Symptoms: Infected seedlings are stunted with reduced root systems, and may wilt and die. The tap roots of older plants develop reddish-brown water soaked lesions, which turn black and rot. Lower leaves turn yellow, then reddish brown, due to lack of water and nutrients. Disease tends to appear in patches, particularly when water collects. Root rots and damping off caused by *Pythium* spp. (also oomycetes) produce similar symptoms, and most often occur as seed rots or damping off early in the season.

Disease cycle: New seedlings are most susceptible to infection, which occurs as plants emerge. Phytophthora root rot occurs on heavy or poorly drained soils but can develop in any soil which becomes saturated during extended rainy periods. Infection may result in high levels of disease that can severely injure young alfalfa seedlings.

Management: Use varieties that are resistant to phytophthora. Seed treatment with a fungicide labeled for controlling phytophthora may improve stands of resistant varieties, but will be of limited benefit for susceptible varieties, such as Vernal. There are no pythium resistant varieties, but seed treatments labeled for phytophthora will also control pythium.

List of registered fungicides (rate per acre or as noted)

Ridomil Gold SL applied as broadcast soil surface spray at planting.0.25-0.50 pt./A use the lower rate of seed was treated with metalaxyl or mefanoxam.

Seed treatments (commercial use only):

Acquire -0.75- 1.5 fl oz /100 lb seed

Alligiance FL-0.75- 1.5 fl oz /100 lb seed

Apron XL LS -of 0.64 fl. oz./100 lbs. of seed

Verticillium Wilt (VW)

Cause: *Verticillium albo-atrum* (fungus)

Incidence: First detected in Michigan in 1982, verticillium wilt has not increased in severity as expected. It is generally introduced with infested seed. It usually is not a problem until the third year, and then primarily in the first cutting.

Symptoms: Leaflets of infected plants wilt, curl and turn pink, or tan. Leaflets near the top of the stem look abnormally small and twisted. The fungus colonizes water conducting tissues, producing a brown-colored ring in the taproot that is visible when the root is sliced crosswise.

Disease cycle: Verticillium can enter roots directly or through wounds, and is commonly spread from plant to plant during cutting operations. The fungus survives on seed, in plant debris and in animal manure, and broadleaf weed hosts.

Management: Choosing a variety with resistance to verticillium is recommended. Growing alfalfa for three to four years in rotation with corn or small grains will help break the disease cycle. Control broadleaf weed hosts during the rotation period. Avoid spreading the disease to clean fields by harvesting youngest, non-infested first, and oldest fields last, and disinfecting cutter bars with 10% chlorine bleach after harvesting.

Alfalfa Disease Resistance Ratings

An alfalfa variety consists of a population of plants which are genetically different from each other. Varieties are described according to the mean response of all plants, such as average yield, and as a frequency of certain types, such as the percentage of plants resistant to some pest or disease. Even in a "resistant" variety, only a portion of the plants will be resistant. For example, a moderate rating means 15 to 30% of the plants are resistant but 70 to 85% are susceptible. Even resistant varieties may suffer damage from a disease, and resistant varieties are susceptible to PRR or Pythium diseases in the seedling stage . Choose varieties with high resistance if possible to insure longer stands and persistence. A list of disease resistance for varieties evaluated for yield at MSU follows.

<u>% Resistant Plants</u>	<u>Resistance Class</u>	<u>Class Abbreviation</u>
0-5%	Susceptible	S
6-14%	Low Resistance	LR
15-30%	Moderate Resistance	MR
31-50%	Resistant	R
>50%	High Resistance	HR

Alfalfa Disease Resistance Table

Variety	BW	PRR	AN	VW	FW	APH
4A421	HR	HR	HR	HR	HR	HR
4P424	HR	HR	HR	HR	HR	-
4R429	HR	HR	HR	HR	HR	HR
4S419	HR	HR	HR	HR	HR	R
Alfatar II	HR	HR	HR	R	HR	HR
Ameristand 40	HR	HR	HR	HR	HR	HR
Ameristand 40	HR	HR	HR	HR	HR	HR
Ascend	HR	HR	-	HR	-	-
Attention	HR	R	R	R	HR	R
Baralfa 32IQ	HR	HR	HR	R	HR	-
Baralfa 42	HR	HR	HR	HR	HR	HR
Cimarron VL4	HR	HR	HR	R	HR	HR
Dakota	R	HR	MR	MR	R	-
DKA33-16	HR	HR	HR	HR	HR	HR
DKA37-20	HR	HR	HR	HR	HR	R
DKA42-15	HR	HR	HR	HR	HR	HR
DKA50-18	HR	HR	HR	HR	HR	HR
Duragreen	HR	HR	HR	HR	HR	HR
Dynamic	HR	HR	HR	HR	HR	HR
Evergreen 2	HR	HR	HR	HR	HR	HR
Everlast	HR	HR	HR	R	HR	R
Extend	HR	HR	HR	HR	HR	HR
Extreme	HR	HR	HR	HR	HR	HR
FSG 351	HR	HR	R	HR	HR	R
FSG 400 LH	HR	HR	HR	HR	HR	HR
FSG 406	HR	HR	HR	HR	HR	R
FSG 408DP	HR	HR	HR	R	HR	R
FSG 505	HR	HR	HR	HR	HR	HR
Garst 620	HR	HR	HR	R	R	R
Garst 6200HT	HR	HR	HR	HR	HR	HR
Garst 631	HR	HR	R	R	R	MR
Garst 6310	HR	HR	HR	HR	HR	HR
Garst 6325	HR	HR	HR	HR	HR	R
Garst 6400HT	HR	HR	HR	HR	HR	HR
Garst 6415	HR	HR	HR	HR	HR	HR
Garst 6420	HR	HR	HR	HR	HR	R
Genoa	HR	HR	HR	HR	HR	-
GH 717	HR	HR	R	MR	HR	MR
GH 727	HR	HR	HR	HR	HR	HR
GH 744	HR	HR	HR	HR	HR	HR
HayGrazer	HR	R	R	R	HR	MR
HybriForce 40	HR	HR	R	HR	HR	-
HybriForce 42	HR	HR	R	R	HR	R
Integrity	HR	HR	HR	HR	HR	HR
Labrador	HR	HR	HR	-	HR	R

Variety	BW	PRR	AN	VW	FW	APH
LegendDairy 5	HR	HR	HR	HR	HR	R
LegenDairy YP	HR	HR	HR	HR	HR	MR
LHR100	HR	HR	HR	HR	HR	-
Magnum V W	HR	HR	R	R	HR	R
Magnum VI	HR	HR	HR	HR	HR	HR
Mountaineer 2	HR	HR	HR	R	-	-
Nova	HR	HR	R	R	HR	R
Phabulous II	HR	HR	HR	HR	HR	HR
Phirst	HR	HR	HR	R	HR	R
Pioneer var. 53	HR	HR	HR	HR	HR	-
Pioneer var. 53	HR	HR	HR	HR	HR	HR
Pioneer var. 54	HR	HR	HR	HR	R	LR
Pioneer var. 54	HR	HR	HR	HR	HR	R
Pioneer var. 54	R	HR	HR	HR	HR	HR
Pioneer var. 54	HR	HR	HR	HR	HR	MR
Power 4.2	HR	HR	R	R	HR	HR
Prolific	HR	HR	HR	HR	HR	R
Radiant	HR	HR	HR	HR	HR	HR
Radiant AM	HR	HR	HR	HR	HR	HR
Rebel	HR	HR	HR	HR	HR	HR
Rebound 5.0	HR	HR	HR	HR	HR	HR
Rugged	HR	HR	HR	HR	HR	HR
Saranac	R	S	S	S	S	S
Shepard	HR	HR	HR	HR	HR	HR
Somerset	HR	HR	HR	HR	HR	HR
Starbuck	HR	HR	HR	R	HR	HR
SummerGold	HR	HR	HR	HR	HR	HR
Vernal	R	S	S	S	MR	S
WinterGold	HR	R	HR	HR	HR	HR
WL 319 HQ	HR	HR	HR	HR	HR	HR
WL 335HQ	HR	HR	HR	HR	HR	HR
WL 342	HR	HR	HR	HR	HR	HR
WL 343HQ	HR	HR	HR	HR	HR	HR
WL 346 LH	HR	HR	HR	HR	HR	MR
WL 347 LH	HR	HR	HR	HR	HR	HR
WL 348 AP	HR	HR	HR	HR	HR	HR
WL 357 HQ	HR	HR	HR	HR	HR	HR

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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.

Carbonum leaf spot, Northern corn 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) preharvest intervals (PHI), and plantback restrictions.

List of registered fungicides (rate per acre or as noted):

Amistar 80 WG 3-5 oz.	Folicur 3.6 F 4-6 fl. oz.
Bumper 41.8 EC 2 - 4 fl. oz.	Headline 9-12 fl. oz.
Dithane F45 1.2 quarts	Propimax EC 2-4 fl. oz.
Echo 720 1.5 - 2 pints	Quadris Flowable 6- 15.5 fl. oz.
Echo 90 DF 1.25- 1.63 lb.	Quilt 7 - 14 fl. oz.
Echo Zn 1.13- 2.75 pints	Stratego 10-12 fl. oz.
Equus 500 Zn 1.1 - 2.8 pints	Tilt EC 2 - 4 fl. oz.
Equus 720 SST 0.75 - 2 pints	

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 preads 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. See labels for additional information including plantback restrictions.

List of registered fungicides (rate per acre or as noted):

Amistar 80 WG 3-5 oz.	Headline 6 – 9 fl. oz.
Bravo Ultrex 0.7 - 1.8 lbs.	Manzate Flowable 1.2 quarts
Bravo Weatherstik 0.75 - 2 pints	Manzate Pro-stick 1.5 lbs.
Bumper 41.8 EC 4 fl. oz.	Penncozeb 75 DF 1.0 - 1.5 lb.
Chlorothalonil 720 0.75 - 2.0 pints	Penncozeb 4FL 0.8 - 1.2 quarts
Dithane DF Rainshield 1.5 lb.	Penncozeb 80 WP 1 - 1.5 lb
Dithane F45 Rainshield 1.2 quarts	Propimax EC 4 fl. oz.
Echo 720 1.5 – 2 pints	Quadris Flowable 6 - 15.5 fl. oz.
Echo 90 DF 1.25 – 1.63 lb.	Quilt 10.5 - 14 fl. oz.
Echo Zn 1.13 – 2.75 pints	Serenade AS 2-6 qts.. (biofungicide)
Equus 500 Zn 1.1 - 2.8 pints	Stratego EC 7 - 10 fl. oz.
Equus 720 SST 0.75 - 2 pints	Tilt EC 4 fl. oz.
Folicur 3.6 F 4-6 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. **See labels for additional information including plantback restrictions.**

List of registered fungicides (rate per acre or as noted):

Amistar 80 WG 3-5 oz.	Penncozeb 4FL 0.8 – 1.2 quarts
Bumper 41.8 EC 4 fl. oz.	Penncozeb 80 WP 1 - 1.5 lb
Folicur 3.6 F 4-6 fl. oz.	Propimax EC 4 fl. oz.
Headline 6 – 9 fl. oz.	Quadris Flowable 6- 15.5 fl. oz.
Manzate 75DF 1.5	Quilt 10.5 - 14 fl. oz.
Manzate Pro-stick 1.5 lbs.	Stratego EC 10 -12 fl. oz.
Penncozeb 75 DF 1.0 - 1.5 lb.	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: Moderate temperatures, heavy dews, and frequent showers are favorable conditions for infection. Infection occurs when free water is present on the leaf surface for 6-18 hours with temperatures between 66 and 80°F. 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. See labels for additional information including plantback restrictions.

List of registered fungicides (rate per acre or as noted):

Amistar 80 WG 3-5 oz.	Folicur 3.6 F 4-6 fl. oz.
Bravo Ultrex 0.7-1.8 lbs.	Headline 9 - 12 fl. oz.
Bravo Weatherstik .75-2 pints	Manzate Pro-stick 1.5 lbs
Bumper 41.8 EC 2-4 fl. oz.	Manzate Flowable 1.2 quarts
Chlorothalonil 720 0.75-2.0 pints	Penncozeb 75 DF 1.0 - 1.5 lb.
Dithane DF Rainshield 1.5 lb	Penncozeb 4FL 0.8 - 1.2 quarts
Dithane F45 Rainshield 1.2 quarts	Penncozeb 80 WP 1 - 1.5 lb.
Echo 720 1.5 - 2 pints	Propimax EC 2 - 4 fl. oz.
Echo 90 DF 1.25 - 1.63 lb.	Quadris Flowable 6 - 15.5 fl. oz.
Echo Zn 1.13 - 2.75 pints	Quilt 7 - 14 fl. oz.
Equus 500 Zn 1.1 - 2.8 pints	Stratego 10-12 fl oz.
Equus 720 SST 0.75 - 2 pints	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 on page 12).

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.

Fungicides Registered for Corn in Michigan

Trade Name	Common Name	Recommended for:	PHI days	REI hrs	Precautions and remarks
Amistar 80 WG	azoxystrobin	Anthracnose, gray leaf spot, Northern corn leaf blight, Northern corn leaf spot, rust	7	4	Maximum of 2 lb a.i./A/season no more than 2 applications per season.
*Bumper 41.8 EC PropiMax EC	propiconazole	Gray leaf spot, Northern corn leaf blight, rust, Northern corn leaf spot	30	24	Maximum 16 fl oz/A per season, 8 fl oz if used for forage. *Do not apply after silking.
Bravo Weatherstik, Chloronil 720 Chlorothalonil 720 F, 720 SC , Equus 500 ZN Echo 720, Initiate 720	chlorothalonil	Northern corn leaf blight, Northern corn leaf spot, rust	14	12	Corn grown for seed only. Maximum 12 pt/A/year. Do not ensile treated corn or use as livestock forage.
Dithane DF	mancozeb	Rust, Northern corn leaf blight	40	24	No more than 16 lb/A/ season
Bravo Ultrex Echo, 90 DF, Ultimate Equus 90 DF Farmsaver Equus 90 DF	chlorothalonil	Northern corn leaf blight, Northern corn leaf spot, rust	14	12	Seed corn only. Maximum of 10.9 lb/A/year. Do not graze livestock in treated fields. Do not ensile treated corn or use as livestock forage.
Echo Zn Equus 500 Zn	chlorothalonil	Northern corn leaf blight, Northern corn leaf spot, rust	14	12	Seed corn only. Maximum of 17.2 pt/A/year. Do not graze livestock in treated fields. Do not ensile treated corn or use as livestock forage.
Folicur 3.6 F	tebuconazole	Northern corn leaf blight, gray leaf spot, rust	36*	12	Maximum 24 fl oz/ A per season *PHI for grain or fodder, for forage, PHI is 21 days
Headline 2.09 EC	pyraclostrobin	Anthracnose, gray leaf spot, Northern corn leaf blight, Northern corn leaf spot, rust	7	12	Maximum 2 sequential foliar applications/season; maximum of 72 fl oz/A per season
Quadris	azoxystrobin	Anthracnose, gray leaf spot Northern corn leaf blight, Northern corn leaf spot	7	4	Maximum of 2 lb. a.i./A/season no more than 2 applications per season.
Ridomil Gold PC GR, SL	PCNB + metalaxyl	Phytophthora and pythium root rots	*	48	*Apply at planting time as in-furrow or banded application
Stratego 250 EC	propiconazole+ trifloxystrobin	Anthracnose, gray leaf spot, Northern corn leaf blight, Northern corn leaf spot, rust	*	24	Maximum 24 fl oz/A per season *Do not apply after silking. No more than 2 sequential applications.

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: Avoid introducing anthracnose into the fields by using certified anthracnose-free seeds. 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 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 additional information including plantback 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 Ultimate 825 1.25-1.82 lb.	T-methyl 70 W 1 - 1.5 lb.
Echo Zn 2 - 3 pints	Topsin M 70 WP 1 - 2 lb.
Eco-Mate Armcarb 2.5 - 5.0 lb.	Topsin M 70 WDG 1.5 - 2 lb. single application
Equus 500 Zn 2 - 2.8 pints	1 - 1.5 lb. multiple applications
Equus 720 SST 1.37 - 2 pints	Topsin 4.5F 30-40 fl oz single application
Farmsaver thiophanate methyl 85 WDG 0.8-1.6 lb.	20 - 30 fl. oz. multiple applications
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 (chlamydo spores). 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.

Halo Blight, Common 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 1/2"), 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. See labels for additional information including plantback restrictions.

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.

Champion WP 1 - 3 lb.

Kocide 101 1 - 3 lb.

Kocide 2000 0.75 - 2.25 lb.

Kocide 3000 0.50 - 1.25 lb

Kocide 4.5 LF 0.67 - 2 pints

Kocide DF 1 - 3 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 additional information including plantback 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

Ridomil Gold SC 0.5-1.0 pt. as preplant incorporated

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 additional information including plantback restrictions.

List of registered fungicides (rate per acre):

Blocker 4F 2.2 - 3.3 fl.oz./1000 ft. row as an in furrow treatment	Terraclor F 2.2 - 3.3 fl.oz./1000 ft. row as an in furrow treatment
Quadris F 0.40 - 0.80 fl. oz/ 1000 ft. row as in furrow treatment	Terraclor 75WP 1.4 - 2.2 oz. /1000 ft. row as an in furrow treatment
Ridomil Gold PC GR 12 oz./1000 linear ft. (banded)	
Terraclor 2 EC 4.4 - 6.6 fl oz/1000 ft row	

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 _). 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. Avoid rotation to susceptible crops including canola, potatoes, 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> See labels for additional information including plantback restrictions.

List of registered fungicides (rate per acre):

Blocker 4F 4.4 fl. oz./1000 ft. row as banded treatment immediately after planting	Proline 480 SC 4.3 - 5.7 fl. oz
Contans WG 1 - 2 lbs. (biological, to reduce inoculum in soil)	Thiophanate methyl 85 WDG. 0.8 - 1.6 lb.
Endura 8 - 11 oz.	Topsin 4.5 FL 30 - 40 fl. oz. single application
Farmsaver Thiophanate methyl 85 WDG. 0.8 - 1.6 lb	20 - 30 fl. oz. multiple applications
Iprodione 4L 1.5 - 2.0 pints	Topsin M 70 WP- 1 - 2 lb. multiple applications
Rovral 4F 1.5 - 2 pints	1.5 - 2 lb. single application
Rovral 50 WP 1.5 - 2.0 lb.	Topsin M 70WDG 1.5 - 2 lb. single application
	1 - 1.5lb. multiple applications

Fungicides Registered on Dry Beans in Michigan

Trade name	Common name	Recommended for:	PHI days	REI hrs	Precautions and remarks
Armicarb 100, Eco-mate Armicarb "O"	Potassium bicarbonate	Anthraco-nose Powdery mildew	0	4	
Blocker 4 F	pentachloronitro-benzene (PCNB)	Rhizoctonia root rot White mold	*	12	Maximum 10 lb actual PCNB per season *For Rhizoctonia, apply only at planting. For white mold do not apply after pod formation.
Champ Dry Prill, Formula 2 Flowable, WG Champion WP Kocide 101, DF, 4.5 LF, 2000, 3000	copper hydroxide	Brown spot Common blight Halo blight	1	24	Formula 2 Flowable also labeled for downy mildew. Note: Corrosive - causes irreversible eye damage
Chloronil 720 Chlorothalonil 720 F Initiate 720	chlorothalonil	Anthraco-nose, Downy mildew, rust	14	12	Maximum rate is 8.0 pt/A/year. Maximum 4 applications per season. Do not graze or feed treated plant parts to livestock
Bravo Ultrex Echo 90 DF, Echo Ultimate Equus 90 DF Farmsaver Equus DF	chlorothalonil	Anthraco-nose Downy mildew rust	14	12	Maximum rate is 7.2 lb/A/year 7.3 lb/A/year for Bravo Ultrex maximum 4 applications per season. Do not graze or feed treated plant parts to livestock.
Bravo Zn, Echo Zn Equus 500 ZN Farmsaver Equus 500 ZN	chlorothalonil	Anthraco-nose Downy mildew rust	14	12	Maximum rate is 11.5 pt/A/year. Do not graze or feed treated plant parts to livestock.
Endura	boscalid	White mold	21	12	Maximum rate 22 oz./A.season Max. 2 applications per season.
Headline 2.09 EC	pyraclostrobin	Anthraco-nose, rust, Cercospora leaf spot, Downy mildew, Powdery mildew	21	12	Maximum 2 sequential foliar applications/season; maximum of 18 fl oz/A per season
Iprodione 4L AG, Rovral 4F, 50WP	iprodione	White mold	*	24	*Do not apply later than peak bloom. Make initial application from first bloom to 10% bloom; maximum 2 applications/season.
Maneb 75 DF	maneb	Anthraco-nose, downy mildew, rust	30	24	Maximum rate is 12.8 lb/A/season
Maneb 80 WP	maneb	Anthraco-nose, downy mildew, rust	30	24	Maximum rate is 12 lb/A/season
Manex	maneb	Anthraco-nose, downy mildew, rust	30	24	Maximum rate is 9.6 qt/A/season
Proline 480 SC	prothioconazole	White mold	7	48	Apply at first sign of disease; maximum of 17.1 oz/season
Quadris F Amistar 80 WG	azoxystrobin	Rhizoctonia root rot, Anthraco-nose, rust	14	4	Do not apply more than 1.5 lb a.i./A per season of products containing azoxystrobin
Quadris Opti	azoxystrobin +chlorothalonil	Anthraco-nose, rust	14	12	No more than 2 successive applications without alternating to a product with a different mode of action
Ridomil Gold PC GR, SL	PCNB + metalaxyl	Rhizoctonia and Pythium root rots		48**	** REI is 0 for soil-incorporated applications
Terraclor 2EC, F, 75WP	pentachloronitro-benzene (PCNB)	Rhizoctonia root rot	*	12	* apply only at planting time
Topsin 4.5 FL, T-methyl 4.5 FL	thiophanate methyl	Anthraco-nose White mold	28	12	Maximum rate is 80 fl oz /A/season
Topsin M 70 WDG, 70 WP, WSB	thiophanate methyl	Anthraco-nose White mold	28	12	Do not apply more than 4 lb product/A per season
Thiophanate Methyl 85 WDG, Farmsaver Thio- phanate Methyl 85 WDG	thiophanate methyl	Anthraco-nose White mold	28	12	Do not apply more than 3.2 lb product/A per season

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 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 share several root disease fungi in common with corn. Smuts and bunts can be controlled with seed treatments; see the seed treatments on pages 13-14.

***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.

See labels for additional information including plantback restrictions.

List of registered fungicides (rate per acre or as noted).

Caramba 14 – 17 fl oz

Folicur 3.6 F 4 fl. oz.

Proline 480 SC 4.3-5.7 fl. oz.

Prosaro 421 SC 6.5 – 8.2 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.

See labels for additional information including plantback 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.

Prosaro 421 SC 6.5 - 8.2 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)

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 seedborne 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. See labels for additional information including plantback restrictions.

List of registered fungicides (rate per acre or as noted):

Armicarb 100 2.5 - 5 lb

Eco-Mate Armicarb 2.5-5 lb

Bumper 41.8 EC 4 fl. oz

Caramba 10 - 14 fl oz

Champ Dry Prill 1 - 1.3 lb

Champ Formula 2 Flowable 1 - 1.33 pints

Champion WP 1.5 - 2 lb

Champion WG 1.5 - 2 lb

Dithane DF Rainshield 2.1 lb

Dithane F45 Rainshield 1.6 quarts

Folicur 3.6 F 4 fl oz

Headline 6 - 9 fl oz

Kocide 101 1.5-2 lb

Kocide 2000 1-1.5 lb

Kocide 3000 0.5- 0.75 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 Pro-stick 2 lbs

Penncozeb 4FL 0.8 - 1.6 quarts

Penncozeb 75 DF 1 - 2 lb

Penncozeb 80 WP 1 - 2 lb

Proline 480 SC 4.3-5.7 fl oz

Prosaro 421 SC 6.5 - 8.2 fl oz

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 o. (wheat and triticale)

Stratego 7 fl. oz (barley and oats)

Stratego 10 fl oz (Wheat)

Tilt EC 4 fl oz

TwinLine 6 - 11 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. See labels for additional information including plantback restrictions.

List of registered fungicides (rate per acre or as noted):

Bumper 41.8 EC 4 fl.oz	Proline 480 SC 4.3 - 5.7 fl oz
Dithane DF Rainshield 2.1 lb	Prosaro 421 SC 6.5 - 8.2 fl oz
Dithane F45 Rainshield 1.6 quarts	Propimax EC 4 fl oz
Folicur 3.6 F 4 fl oz	Quilt 7 - 14 fl oz (barley, wheat and triticale)
Headline 6-9 fl.oz	Quadris Flowable 6 - 12 fl oz (barley)
Manzate Flowable 1.6 quarts	Quadris Flowable 4 - 12 fl.oz.(wheat and triticale)
Manzate Pro-stick 2 lbs.	Stratego 7 fl.oz.(barley and oats)
Penncozeb 4FL 0.8-1.6 quarts	Stratego 10 fl.oz.(Wheat)
Penncozeb 75 DF 1 - 2 lb	Tilt EC 4 fl.oz
Penncozeb 80 WP 1 - 2 lb	TwinLine 6 - 11 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.

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. See labels for additional information including plantback restrictions.

List of registered fungicides (rate per acre or as noted):

Bumper 41.8 EC 4 fl.oz	Quilt 7 - 14 fl. oz.
Folicur 3.6 F 4 fl oz	Quadris F 4 - 12 fl oz.
Headline 6 - 9 fl.oz.	Stratego 10 fl oz
Propimax EC 4 fl oz.	Tilt EC 4 fl oz
Prosaro 421 SC 6.5 - 8.2 fl oz	TwinLine 6.-.11 fl oz

Fungicides Registered for Small Grains in Michigan

Trade name	Common name	Recommended for:	PHI days	REI hrs	Precautions and remarks
Armcarb 100, Eco-mate Armcarb "O"	Potassium bicarbonate	Powdery mildew	0	4	
Bumper 41.8 EC Propimax EC	propiconazole	Powdery mildew, leaf rust, Septoria leaf blight, Stagonospora leaf and glume blotch, net blotch, spot blotch, tan spot	* 40**	24	Maximum 8 fl oz/ A per season *apply no later than full head emergence (Feekes 10.5) **30 d PHI for forage, 40 d for grain and straw, 45 d for hay
Caramba	metconazole	Head scab, Powdery mildew, rusts, Septoria leaf blight, Stagonospora leaf and glume blotch, net blotch, spot blotch, tan spot	30	12	Maximum of 34 fl oz/A per season No more than 2 applications per season.
Dithane Rainshield DF, F45	mancozeb	Septoria leaf blotch, Stagonospora leaf and glume blotch, leaf rust, tan spot	26	24	No more than 3 applications per season. Do not apply after heading
Folicur 3.6 F	tebuconazole	Head scab, leaf, stem and stripe rust	30	12	Maximum 4 fl oz/ A per season on barley and wheat
Headline 2.09 EC	pyraclostrobin	Powdery mildew, rusts, Septoria leaf blight, Stagonospora leaf and glume blotch, net blotch, spot blotch, tan spot	*	12	*Apply no later than 50% head emergence for barley and rye, no later than the beginning of flowering for wheat and triticale. Maximum 18 fl oz/ A per season; no more than 2 applications
Champ Dry Prill, Formula 2 Flowable, WG Champion WP Kocide 101, DF, 4.5 LF, 2000, 3000	copper hydroxide	Powdery mildew, Septoria leaf blotch, Stagonospora leaf and glume blotch,		24	Corrosive; causes irreversible eye damage
Proline 480 SC	prothioconazole	Head scab, Septoria leaf blight, Stagonospora leaf and glume blotch, leaf rust.	30	48	No more than 2 applications per season. Maximum of 9.37 fl oz/A/season
Prosaro 421 SC	prothioconazole+ tebuconazole	Head scab, Powdery mildew, rusts, Septoria leaf blight, Stagonospora leaf and glume blotch, net blotch, spot blotch, tan spot	30	48	No more than 2 applications per season. Maximum of 8.2 fl oz/A/season
Quadris	azoxystrobin	Powdery mildew, rusts, Septoria leaf blight, Stagonospora leaf and glume blotch, tan spot	45*	4	*PHI for grain and straw. Do not apply later than Feekes 10.5 (heading) No more than 2 applications per season.
Stratego 250 EC	propiconazole+ trifloxystrobin	Powdery mildew, rusts, Septoria leaf blight, Stagonospora leaf and glume blotch, net blotch, spot blotch, tan spot	35	24	Barley oats, and wheat Do not apply after full head emergence. No more than 2 applications/ season. See label for grazing restrictions.
TwinLine	metconazole + pyraclostrobin	Powdery mildew, rusts, Septoria leaf blight, Stagonospora leaf and glume blotch, net blotch, spot blotch, tan spot	30	12	Maximum 22 fl oz/A/season maximum 2 applications/season

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 can travel to Michigan as spores on wind currents and in rain, but so far, the disease has not been detected in Michigan. 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. There will probably be sentinel plots for soybean rust in southern states, to provide an early warning for Michigan growers. 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 plantback restrictions.

List of registered fungicides, rate per acre:

Alto 100SL 2.75 - 4 fl oz

Bravo Ultrex 1.4 - 2.2 lb

Bravo Weatherstik 1.6 - 3.6 fl oz.

Bumper 41.8EC 4 - 8 fl oz

Domark 230 ME 4 - 5 fl oz

Echo 720 16 - 40 fl oz

Echo 90 DF 24 - 48 oz

Echo Ultimate 825 1.3 - 2.27 lb

Equus 720 SST 1.5 - 2.4 pts

Folicur 3.6F 3 - 4 fl oz

Headline 6 - 12 fl oz

Laredo EW 4.8 - 9.6 fl oz

Proline 480 SC 4.3 - 5.7 fl oz

Punch 3.-4 fl oz (Section 18 labeling continues until 2010)

Quadris F 6 - 15.5 fl oz

Quadris Xtra 4 - 6.8 fl oz

Quilt 14 - 20.5 fl oz

Stratego 5.5 - 10 fl oz

Thiophanate methyl 4.5 F 20 fl oz

Tilt 3.6EC 4 - 6 fl oz

Topguard 7 fl oz (Section 18 labeling continues until 2010)

Brown Stem Rot

Cause: *Phialophora gregata* (fungus)

Symptoms: There are two pathotypes of this fungus. Pathotype 1 produces foliar symptoms and 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.

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 plantback restrictions.

List of registered fungicides (rate per acre or as noted):

Alto 100 SL 4.0-5.5 fl oz	Farmsaver Equus 720 SST 1.5 - 2.4 pints
Bravo Ultrex 1.4-2.2 lb	Farmsaver Equus Zn 500 2.1 - 3.4 pints
Bravo Weatherstik 1.5 - 2.25 pints	Headline 6 - 12 fl. oz
Bumper 41.8 EC 4 - 6 fl oz	Initiate 720 F 1 - 2.25 pints
Chloronil 720 1.5 - 2.4 pints	Quadris F 6 - 15.5 fl oz
Chlorothalonil 720F 1.5 - 2.25 pints	Quadris Xtra 5 - 6.8 fl oz
Domark 125 SL 4 - 5 fl. oz.	Quilt 14 - 20.5 fl oz
Echo 90 DF 1.25 - 2 lb	Farmsaver Thiophanate methyl 85WDG 6.4 - 12.8 oz
Echo 500 Zn 2.1 - 3.4 pints	Stratego 10 fl oz
Echo 720 24 - 40 fl.oz	Thiophanate methyl 85WDG 6.4 - 12.8 oz
Echo Ultimate 1.36-2.27 lb	Tilt 3.6 EC 4 - 6 fl oz
Endura 5.5 fl oz	Topsin 4.5FL 10 - 20 fl oz
Equus 500 Zn 2.1 - 3.4 pints	Topsin M 70 WP 8 - 16 oz
Equus 720 SST 1.5 - 2.4 pints	Topsin M 70 WDG 8 - 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 plantback restrictions.

List of registered fungicides (rate per acre or as noted):

Ridomil Gold EC, Ridomil Gold SL surface application: 0.37 - 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
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Soybean sudden death syndrome (SDS)

Cause: *Fusarium virguliforme* (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). Other symptoms include smaller root systems; some degree of decay to the roots; and 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, (chlamydospore) 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 15). 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. Avoid rotation to susceptible crops-including canola, potatoes, 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>

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 plantback restrictions.

List of registered fungicides (rate per acre):

Cobra- (white 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)

Domark 230 ME 4 - 5 fl oz

Endura 5.5 - 11 oz

Farmsaver Thiophanate methyl 85 WDG 9.6 - 12.8 oz

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

Fungicides Registered for Soybean in Michigan

Trade name	Common name	Recommended for:	PHI days	REI hrs	Precautions and remarks
Alto 100 SL	cyproconazole	Asian soybean rust	30	12	Maximum 8 fl oz/A per season
Bumper 41.8 EC	propiconazole	Anthracnose, Frogeye leaf spot, Septoria brown spot, Asian soybean rust	*	24	Maximum 12 fl oz/A/ season *Applications may be made up to R6
Domark 230 ME	tetraconazole	Asian soybean rust	*	12	Maximum 10 fl oz/A / year *No applications after R5
Bravo Weatherstik, Chloronil 720 Chlorothalonil 720 F, 720 SC, Echo 720, Equus 720 SST Initiate 720	chlorothalonil	Anthracnose, Diaporthe pod and stem blight, Frogeye leaf spot, Cercospora leaf spot, Septoria brown spot, Purple seed stain, Asian soybean rust	42	12	No more than 3 applications per season. Maximum 6 pts/A/season Do not feed soybean hay or threshings from treated fields to livestock.
Bravo Ultrex., Echo 90 DF, Ultimate Equus 90 DF Farmsaver Equus DF	chlorothalonil				Maximum 5.4 lb./A/season. Do not feed soybean hay or threshings from treated fields to livestock.
Echo Zn, Equus500 ZN	chlorothalonil				Maximum 8.6 pt./A/season. Do not feed soybean hay or threshings from treated fields to livestock.
Endura	boscalid	Brown spot, Cercospora leaf spot, Frogeye leaf spot, White mold	21	12	Maximum 22 fl oz/A per season No more than 2 applications per season.
Folicur 3.6 F	tebuconazole	Asian soybean rust	21	12	Maximum 12 fl oz/ A per season
Headline 2.09 EC	pyraclostrobin	Anthracnose, Diaporthe pod and stem blight, Frogeye, leaf spot, Cercospora leaf spot, Septoria brown spot, Asian soybean rust	21	12	Maximum 24 fl oz/A per season
Laredo	myclobutanil	Asian soybean rust	28	24	Maximum 16 fl oz/A per season
Punch	flusilazole	Asian soybean rust	30	7 days	Maximum of 2 applications/year. Do not use soybean hay or forage for livestock feed.
Quadris 2.08 EC	azoxystrobin	Anthracnose, Diaporthe pod and stem blight, Frogeye leaf spot,	14	4	Maximum 31 fl oz/ A per season No more than 2 applications per season.
Quadris Xtra	azoxystrobin +cyproconazole	Cercospora leaf spot, Septoria brown spot, Asian soybean rust	30	12	Maximum 1 3.6 fl oz/A/season
Quilt 1.67 SC	propiconazole+ azoxystrobin	Asian soybean rust	*	24	Maximum 40 fl oz/A per season *No applications after R5
Ridomil Gold PC GR,SL	PCNB + metalaxyl	Phytophthora and Pythium root rots	*	48	*Apply at planting time as in-furrow or banded application
Stratego 250 EC	propiconazole+ trifloxystrobin	Anthracnose, Diaporthe pod and stem blight, Frogeye leaf spot, Cercospora leaf spot, Septoria brown spot, Asian soybean rust	21*	24	Maximum 20 fl oz/A per season *No applications after R5 for soybean rust
Tilt 250 EC	propiconazole	Asian soybean rust	*	12	Maximum 12 fl oz/A per season *No applications after R5
Topguard	flutriafol	Asian soybean rust	21	12	Maximum 14 fl oz/A per season
Thiophanate methyl 85 WDG, Farmsaver Thiophanate methyl 85 WDG	thiophanate methyl	Anthracnose, Diaporthe pod and stem blight, Frogeye leaf spot, Cercospora leaf spot, Septoria brown spot, Purple seed stain	*	12	* No applications once beans form in pods. Max two applications per year. Do not graze or feed treated vines to livestock.
Topsin 4.5 FL T-methyl 4.5 FL	thiophanate methyl		21	12	Maximum 40 fl oz/A per season Maximum of two applications/yr.

Sugarbeet Diseases

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.

List of registered fungicides, rate per acre or 1000 row feet:

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
Enable 2F 8 fl oz	Proline 480SC 4.3 – 5.7 fl. oz
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 500SC 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
Inspire SB 7 fl oz	T-methyl 70W WSB 6 – 8 oz
Kocide 101 2 - 5 lb	Tilt 4 fl 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

Powdery Mildew

Cause: *Erysiphe polygoni*

Symptoms: The first symptoms are a delicate growth of white to light gray threadlike filaments that spread out from a central point usually first seen on the lower leaves. Within about a week powdery white or gray-white growth can cover the leaf and new spots/points appear on the middle leaves and upper leaves. Powdery mildew may be more severe in low nitrogen status plants and in areas of fields yellow in color due to depletion of nitrogen. Severely affected leaves turn yellow within a month of initial symptoms.

Disease cycle The sexual stage has not been observed in Michigan, North Dakota or Minnesota; however, it has been observed in Colorado, Idaho, Nebraska and Wyoming. The fungus must have a living host for growth and reproduction. Conidia (asexually reproduced spores) are released into the air after dew lifts in the morning and air currents increase. Conidia germinate in the light about 80 – 85°F on susceptible host leaves after about noon, depending on temperature, and the infection occurs overnight. Appresoria (infection cushions) form best during the evening at 59-68°F. The period from infection to development of a new sporulating lesion can be as little as five days around 77°F.

Conditions favoring disease: Long periods of dry weather and a wide range in daily temperature favor powdery mildew.

Management: Varieties resistant to powdery mildew are available but may not be readily available. Strobilurin fungicides labeled for sugarbeet for e.g. Rhizoctonia crown and root and Cercospora leaf spot, such as Gem, Headline and Quadris, can be used to manage powdery mildew. Sulfur fungicides such as Microthiol Disperss, Micro Sulf and Thiolux suppress powdery mildew. Eminent, Tilt and Inspire SB (triazole fungicides) have good efficacy against powdery mildew.

List of registered fungicides, rate per acre or 1000 row feet:

Gem 500SC 2.9 - 3.6 fl. oz

Inspire SB 7 fl oz

Microthiol Disperss 5-10 lb

Micro Sulf 10-15 lb

Quadris Flowable 9-15.5 fl oz

Thiolux Jet 10-20 lb

Tilt 4 fl oz

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

Amistar 80WG foliar 3.0 - 5.0 oz

Gem 500 SC 2.9 - 3.6 fl. Oz (suppression)

Proline 480SC apply in 7-in band to row closure stage
5.7 fl oz/ A

Quadris F 0.4-0.6 fl. oz./1000 row feet at planting

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
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: Safety and environmental ratings for fungicides used in field crops.

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

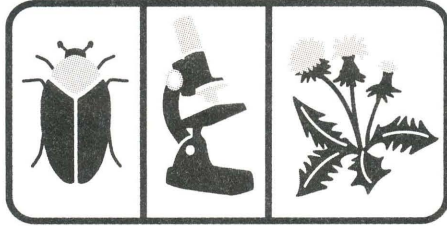
Trade Name	Common Name	Runoff potential	Leaching potential	LD ₅₀ mg/kg oral	LD ₅₀ mg/kg dermal
Kocide	copper hydroxide	1	3	646	>5000
Kodiak	<i>Bacillus subtilis</i>	NA	NA	NE	NE
Manzate	ethylene bisdithiocarbamate	1	3	>5000	>2000
Maxim 4FS	fludioxonil	1	3	5050	2020
Maxim XL	fludioxonil + mefanoxam	1	3	2830	2020
Orius	tebuconazole	1	2	3710-3776	2011
Penncozeb	dithiocarbamate	1	3	>5000	>2000
Proline	prothioconazole	-	-	-	
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 + fludioxynil	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
Trilex	trifloxystrobin	2	3	5000	5000
Trilex 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

Submittal form at
www.pestid.msu.edu
or contact your county
Extension agent.

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 / TSWV 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: \$25.00
- Total nematode community analysis: \$50.00
- HG Type testing \$50.00
- *Verticillium* analysis
 - Wet sieving: \$25.00
 - Dilution plating: \$20.00

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 / TSW V ELISA tests:	\$20
Bacterial ID (BIOL OG!™):	\$25
Insect / Plant Identification Fees	
Common ID:	N/C
Key out ID:	\$10
Herbicide Resistance/ Pesticide Analysis:	contact lab (see below)
Nematode Sample Fees	
Out of State Fees Triple	
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	Good Fair Poor	Sunny or Shaded?
Entire Plant Stems	Field Garden	PROBLEM DISTRIBUTION	HERBICIDE HISTORY
Leaves/Needles Trunk	Nursery House Plant		Upland Near Drive/Road
Roots Twigs/Limbs	Greenhouse Pasture	Slopes Edge of Field	_____
Fruit Flowers	Orchard Natural Area	Low Areas Near a Residence	Last year: _____
	Turf/Lawn		_____
	City/Recreation		
NATURE OF THE INJURY		OTHER BACKGROUND	
Poor or Abnormal Growth		How long at site?	INSECTICIDE HISTORY
Spots Yellowing	PREVALENCE	Height of plant?	This year: _____
Wilting Boring	Entire Planting	How many plants affected?	FUNGICIDE HISTORY
Plant Death Cupping	Single Localized Area	How often watered?	This year: _____
Chewing Dieback	Several Localized Areas	How fertilized?	CROP HISTORY
Galls/Cankers Rot	Few Scattered Plants		Last year: _____
Leaf/Needle Drop			This year: _____
	EXTENT OF THE DAMAGE		
	Light Moderate Severe		
SOIL TYPE			
Sandy Clay			
Muck Silt Loam	DRAINAGE		

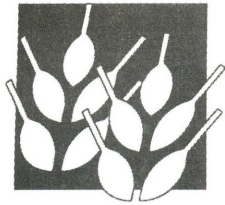
INSECT / ARTHROPOD ID SAMPLES ONLY (indicate all that apply)
 Where was the insect found? _____ What was the insect doing there? _____
 How many insects are there? One Few Several Hundreds Do you have small children living with you? _____

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 (\$25/sample)	Foliar nematode analysis (\$25/sample)	No. of samples: _____
Total nematode community structure analysis (\$50/sample)	Hg Type test (\$50/sample)	Sample/Field ID: _____
<i>Verticillium dahliae</i> analysis (potato soil/ stem only)	Dilution (\$20/sample)	Wet-sieving (\$25/sample)
		Both (\$40/sample)



The Field Crop Advisory Team Alert newsletter

Dependable pest management information from MSU Extension

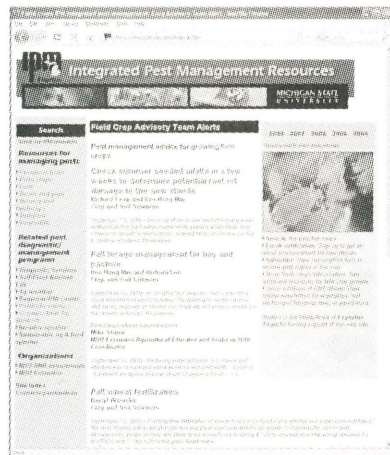
The CAT Alert is MSU Extension's targeted advice for growing field crops under Michigan conditions

The *Field CAT Alert* newsletter is very timely with articles posted to the web the same day they are received from authors. Our print version is created from articles collected throughout the week. 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 affect Michigan crops. Get the latest advice on topics such as soybean aphids and other insect pests, soil nutrients, planting successful cover crops, preventing plant diseases and weather impacts.



Read the newsletter **free** on the Internet at:

www.ipm.msu.edu/field-cat.htm

To learn how to purchase a print subscription, visit: www.ipm.msu.edu/subsc-field.htm or call 517-353-4703.



New weather resource available

MSU's Enviro-weather web site provides current weather data and forecasts, integrated pest management models, and decision making tools. View the web site at:

www.enviroweather.msu.edu

