MICHIGAN STATE UNIVERSITY

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FIELD CROPS INSECT PEST MANAGEMENT GUIDE

Written by:

Dr. Chris DiFonzo, MSU & Dr. Kelley Tilmon, OSU

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TABLE OF CONTENTS

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MSU-OSU Field Crops Insect Pest Management Guide

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Authors

Chris DiFonzo
Field Crops Entomologist
Michigan State University
Department of Entomology
288 Farm Lane
East Lansing, MI
difonzo@msu.edu

Kelley Tilmon
Field Crops Entomologist
The Ohio State University
Department of Entomology
1680 Wooster Ave
Wooster, OH
tilmon.1@osu.edu

How to Use this Guide

This publication is set up as a series of chapters with information on biology, damage, management recommendations, and insecticides related to insect pests in field crops in Michigan and Ohio. Chapters cover field corn, soybean, wheat and other small grains, alfalfa and grass forage, and (for Michigan growers) dry beans and sugar beet. Each chapter stands alone, focusing on a particular crop. This lay out was done so that we can update information frequently without changing the entire publication and you can download or print only the sections you need.

In the preparation of this guide, we checked state databases and consulted labels for each of the pesticides listed in the crop chapters; we made every effort to include correct information and to list most of the commonly-used products for Michigan and Ohio. However, labels do change over time. Always read the labels of the products you use to reconfirm application rate, precautions, PPE, pre-harvest intervals, and other key pieces of information prior to spraying.

Users are the best source of feedback on this guide. If you see information that is not correct or complete, or products which are not listed, please contact us so that we can update the guide accordingly.

The rest of this introduction has the following information:

Introduction Figure 1: How to read the insecticide tables in this bulletin

Active ingredients (AI) are listed alphabetically. Insecticides are listed by Trade Name under each AI to allow for comparison or substitution of products.

See Table 1 to cross reference active ingredients x insecticide.

A letter under an insect indicates it is on the label
• The specific letter corresponds to use rates in column 2.

Compare PHIs between products

A few of the important statements on the label

Active ingredient Trade names	Labeled rate per acre	caterpillars	cutworm	grasshoppe	spider mite	stink bugs	Pre - harvest Interval (PHI) in days	Precautions and Remarks
abamectin Big-Ten SC	(a) 1.7 - 3.5 oz				a		28	• Apply when spider mites are first observed
bifenthrin Brutus Buckeye	(a) 3.5 - 5.0 oz (a) 7.0 - 10 oz	a	a	a		a	18	• Do not make applications less than 30 days apart
chlorantraniliprole O-Hi Advanced	(a) 14 oz (b) 20 oz	a		b			1	• Must be applied before insects reach damaging levels
cyhalothrin (lambda) Izzo AG Green-UP WDG Lansing LV Scarlet 4F Spartan Izzo Extra Spartan Maxx	(a) 3 oz (b) 6 oz (a) 1 oz (b) 2 oz	a	a	b		b	30	• Do not graze or harvest vines as forage or hay

An AI with one trade name with a single rate (a) for one pest, spider mite

An AI with two trade names, each with its own single rate (a) for multiple insects
- For example, for cutworm the rate per acre is 3.5-5.0 oz of Brutus and 7.0-10 oz of Buckeye

An AI with one trade name but different use rates, (a) and (b), for different pests
- For example, the rate per acre is (a) 14 oz for caterpillars and (b) 20 oz for grasshoppers

An AI with many trade names, grouped by use rates; products in a group are similar and interchangeable
- For example, for cutworm use (a) 3 oz of Izzo Ag or 1 oz of Izzo Extra. Use the higher rate (b) for hoppers
- If you can't find Izzo Extra, Spartan Maxx is a similar product

Introduction Table 1: Active ingredient (s), registrants, and EPA registration numbers for insecticides in the MSU-OSU Field Crops Insect Pest Management Guide.

TABLE 1 **Trade name**	**Active** **Ingredient (s)**	**Registrant/ Company**	**EPA Registration #**
Abba Ultra	abamectin	Amvac	5481-621
Acephate 90 Prill	acephate	ADAMA	66222-123
Acephate 90 WDG	acephate	Loveland	34704-1051
Acephate 90 WSP	acephate	Loveland	34704-862
Acephate 97 UP	acephate	UPL NA Inc	70506-8
Acephate 97 WDG	acephate	ADAMA	66222-266
Acramite 4SC	bifenazate	UPL NA Inc	400-514
Admire Pro	imidacloprid	Bayer CropScience	264-827
Advise Four	imidacloprid	WinField United	228-528-1381
Agree WG	Bt aizawai	Certis USA	70051-47
Agri-Mek SC	abamectin	Syngenta	100-1351
Alias 4F	imidacloprid	ADAMA	66222-156
Annex LFR	bifenthrin	TENKOZ Inc	279-3302-55467
Annihilate LV	methomyl	MacDermid Ag Solutions	400-597
Annihilate SP	methomyl	MacDermid Ag Solutions	400-598
Arctic 3.2EC	permethrin	WinField United	1381-187
Asana XL	esfenvalerate	Valent	59639-209
Aztec 4.67G	tebupirimphos cyfluthrin	Amvac	5481-9028
Aztec HC	tebupirimphos cyfluthrin	Amvac	5481-577
Baythroid XL	cyfluthrin (beta)	Bayer CropScience	264-840
Besiege	chlorantraniliprole cyhalothrin (lambda)	Syngenta	100-1402
Bifen 2 Ag Gold	bifenthrin	WinField United	83222-1
Bifender FC	bifenthrin	Vive Crop Protection	89118-2
Bifenthrin 2EC	bifenthrin	Aceto Ag Chem Corp	2749-556
Bifenture EC	bifenthrin	UPL NA Inc	70506-57
Bifenture LFC	bifenthrin	UPL NA Inc	70506-305
BioBit HP	Bt kurstaki	Valent	73049-54
Blackhawk	spinosad	Corteva Agriscience	62719-523
Brigade 2EC	bifenthrin	FMC Corporation	279-3313
Brigadier	bifenthrin imidacloprid	FMC Corporation	279-3332
Capture 3RIVE 3D	bifenthrin	FMC Corporation	279-3467
Capture LFR	bifenthrin	FMC Corporation	279-3302
Carbaryl 4L	carbaryl	Drexel	19713-49
Carbaryl 4L	carbaryl	Loveland	34704-447

TABLE 1 **Trade name**	**Active Ingredient (s)**	**Registrant/ Company**	**EPA Registration #**
Coragen	chlorantraniliprole	FMC Corporation	279-9606
Corrida 90 WSP	methomyl	Sinon USA	82557-2
Counter 20G Smartbox Lock'N Load, or SmartCartridge	terbufos	Amvac	5481-562
Deadline GT	metaldehyde	Amvac	6836-350-5481
Deadline MPs	metaldehyde	Amvac	5481-507
Declare	cyhalothrin (gamma)	FMC Corporation	279-3571
Defcon 4.67G	tebupirimphos cyfluthrin	Helena	5481-9028-5905
Delta Gold	deltamethrin	WinField United	264-1011-1381
Dibrom 8E	naled	Amvac	5481-479
Dimate 4E	dimethoate	WinField United	9779-273
Dimethoate 400	dimethoate	Loveland & FMC	34704-207
Dimethoate 4EC	dimethoate	Drexel	19713-231
Dipel 10G	Bt kurstaki	Valent	73049-14
Dipel ES	Bt kurstaki	Valent	73049-17
Discipline 2EC	bifenthrin	Amvac	5481-517
Empower 2	bifenthrin	Helena	5905-548
Entrust	spinosad	Corteva Agriscience	62719-282
Entrust SC	spinosad	Corteva Agriscience	62719-621
Ethos XB	bifenthrin	FMC Corporation	279-3473
Evergreen EC 60-6	pyrethrins	MGK	1021-1770
Exirel Insect Control	cyantraniliprole	FMC Corporation	279-9615
Fanfare 2EC	bifenthrin	ADAMA	66222-99
Fanfare EC	bifenthrin	ADAMA	66222-261
Fanfare ES	bifenthrin	ADAMA	66222-236
Fastac CS	cypermethrin (alpha)	BASF Ag Products	7969-364
Fastac EC	cypermethrin (alpha)	BASF Ag Products	7969-298
Force 6.5G	tefluthrin	Syngenta	100-1625
Force 10G HL Smartbox, SmartCartridge	tefluthrin	Amvac	100-1615-5481
Force EVO	tefluthrin	Syngenta	100-1610
Fyfanon ULV Ag	malathion	FMC Corporation	279-3540
Grizzly Too	cyhalothrin (lambda)	WinField United	100-1295-1381
Hero	bifenthrin cypermethrin (zeta)	FMC Corporation	279-3315
Hero EW	bifenthrin cypermethrin (zeta)	FMC Corporation	279-3329
Index Liquid At-Plant	chlorethoxyfos bifenthrin	Amvac	5481-587
Intrepid 2F	methoxyfenozide	Corteva Agriscience	62719-442

TABLE 1 **Trade name**	**Active Ingredient (s)**	**Registrant/ Company**	**EPA Registration #**
Javelin WG	Bt kurstaki	Certis USA	70051-66
Kendo 22.8CS	cyhalothrin (lambda)	Helm Agro	74530-54
Kendo Insecticide	cyhalothrin (lambda)	Helm Agro	74530-38
Lambda-Cy	cyhalothrin (lambda)	UPL NA Inc	70506-121
Lambda-Cy Ag	cyhalothrin (lambda)	WinField United	83222-42
Lambda-Cy. 1EC	cyhalothrin (lambda)	Nufarm	228-708
LambdaStar	cyhalothrin (lambda)	LG Life Sciences	71532-20-91026
Lambda-T	cyhalothrin (lambda)	Helena	100-1112-5905
Lamcap II	cyhalothrin (lambda)	Syngenta	100-1295
Lannate LV	methomyl	Corteva Agriscience	352-384
Lannate SP	methomyl	Corteva Agriscience	352-342
Leverage 360	imidacloprid cyfluthrin	Bayer CropScience	264-1104
Malathion 5	malathion	WinField United	9779-5
Malathion 5EC	malathion	Drexel	19713-217
Minecto Pro	cyantraniliprole abamectin	Syngenta	100-1592
Montana 4F	imidacloprid	Rotam North America	83100-21-83979
Movento	spirotetramat	Bayer CropScience	264-1050
Movento HL	spirotetramat	Bayer CropScience	264-1188
Mustang	cypermethrin (zeta)	FMC Corporation	279-3126
Mustang Maxx	cypermethrin (zeta)	FMC Corporation	279-3426
Nudrin LV	methomyl	Rotam North America	83100-27-83979
Nudrin SP	methomyl	Rotam North America	83100-28-83979
Nuprid 2SC	imidacloprid	Nufarm	228-572
Nuprid 4F Max	imidacloprid	Nufarm	228-528
Oberon 2SC	spiromesifen	Bayer CropScience	264-719
Onager	hexythiazox	Gowan	10163-277
Orthene 97	acephate	Amvac	5481-8978
Paradigm VC	cyhalothrin (lambda)	WinField United	33270-41
Permastar AG	permethrin	LG Life Sciences	71532-15-91026
Perm-UP 25DF	permethrin	UPL NA Inc	70506-66
Perm-UP 3.2EC	permethrin	UPL NA Inc	70506-9
Pounce 1.5G	permethrin	FMC Corporation	279-3059
Pounce 25WP	permethrin	FMC Corporation	279-3051
Prevathon	chlorantraniliprole	FMC Corporation	352-844
Prey 1.6	imidacloprid	Loveland	34704-894
Proaxis	cyhalothrin (gamma)	FMC Corporation	279-3583
Province II	cyhalothrin (lambda)	TENKOZ Inc	100-1295-55467
PyGanic EC 1.4 II	pyrethrins	MGK	1021-1771

TABLE 1 **Trade name**	**Active Ingredient (s)**	**Registrant/ Company**	**EPA Registration #**
PyGanic Specialty	pyrethrins	MGK	1021-1772
Radiant SC	spinetoram	Corteva Agriscience	62719-545
Renestra	cypermethrin afidopyropen	BASF Ag Products	7969-436
Sefina	afidopyropen	BASF Ag Products	7969-391
Sevin 4F	carbaryl	Tessenderlo Kerley	61842-38
Sevin XLR Plus	carbaryl	Tessenderlo Kerley	61842-37
S-fenvalostar	esfenvalerate	LG Life Sciences	71532-21-73006
Sherpa	imidacloprid	Loveland	34704-983
Silencer	cyhalothrin (lambda)	ADAMA	66222-104
Sivanto 200SL	flupyradifurone	Bayer CropScience	264-1141
Sivanto HL	flupyradifurone	Bayer CropScience	264-1198
Sivanto Prime	flupyradifurone	Bayer CropScience	264-1141
Skyraider	bifenthrin imidacloprid	ADAMA	66222-247
Sluggo	iron phosphate	Certis USA	67702-3-70051
Smartchoice HC	chlorethoxyfos bifenthrin	Amvac	5481-579
Sniper	bifenthrin	Loveland	34704-858
Sniper Helios	bifenthrin	Loveland	34704-858
Sniper LFR	bifenthrin	Loveland	34704-1089
Spintor 2SC	spinosad	Corteva Agriscience	62719-294
Steed	bifenthrin cypermethrin (zeta)	FMC Corporation	279-3380
Steward EC	indoxacarb	FMC Corporation	279-9596
Swagger	bifenthrin imidacloprid	Loveland	34704-1045
Tombstone	cyfluthrin	Loveland	34704-912
Tombstone Helios	cyfluthrin	Loveland	34704-978
Tracer	spinosad	Corteva Agriscience	62719-267
Transform WG	sulfoxaflor	Corteva Agriscience	62719-625
Tundra EC	bifenthrin	WinField United	1381-196
Vantacor	chlorantraniliprole	FMC Corporation	279-9656
Warrior II w/ Zeon	cyhalothrin (lambda)	Syngenta	100-1295
Willowood Lambda-Cy1EC	cyhalothrin (lambda)	Generic Crop Science	87290-24
Wrangler	imidacloprid	Loveland	34704-931
Xentari Biological	Bt aizawai	Valent	73049-40
Xpedient Plus V	bifenthrin	Amvac	5481-609
Zeal	etoxazole	Valent	59639-123
Zeal Pro	etoxazole	Valent	59639-241
Zeal SC	etoxazole	Valent	59639-202

TABLE 1 **Trade name**	**Active** **Ingredient (s)**	**Registrant/ Company**	**EPA Registration #**
Zyrate	esfenvalerate	Rotam North America	71532-21-83979

Introduction Table 2: RUP status, signal words, reentry intervals for workers, and modes of action numbers to aid in choosing among insecticides in the MSU-OSU Field Crops Insect Pest Management Guide.

- *Restricted Use Pesticides (RUPs*) can only be applied by applicators certified by the state
- *Signal words* rate the acute (short term) toxicity of chemicals; from low to high, the signal words are caution, warning, and danger-poison
- A *Reentry interval (REI)* is the minimum time in hours between a pesticide application and workers entering a field without special protective clothing. This time frame is usually listed in the Ag Use Requirements box on each label. REIs are particularly important in field crops like sugar beets and seed corn which may need detasseling, thinning, or weeding
- *Mode of action classification numbers* were set by IRAC, the Insecticide Resistance Action Committee to aid in rotating insecticide chemistry to delay resistance. Insecticides with the same number have the same mode of action

TABLE 2 **Pesticide trade name**	**Restricted use (RUP)**	**Signal Word**	**Reentry interval (hours)**	**Mode of action classification number(s)**
Abba Ultra	yes	warning	12	6
Acephate 90 Prill	no	caution	24	1B
Acephate 90 WDG	no	caution	24	1B
Acephate 90 WSP	no	caution	24	1B
Acephate 97 UP	no	caution	24	1B
Acephate 97 WDG	no	caution	24	1B
Acramite 4SC	no	caution	12	20D
Admire Pro	no	caution	12	4A
Advise Four	no	caution	12	4A
Agree WG	no	caution	4	11A
Agri-Mek SC	yes	warning	12	6
Alias 4F	no	caution	12	4A
Annex LFR	yes	warning	12	3A
Annihilate LV	yes	danger-poison	48	1A
Annihilate SP	yes	danger-poison	48	1A
Arctic 3.2EC	yes	caution	12	3A
Asana XL	yes	warning	12	3A
Aztec 4.67G	yes	warning	48	1B & 3A
Aztec HC	yes	warning	48	1B & 3A
Baythroid XL	yes	warning	12	3A
Besiege	yes	warning	24	3A & 28
Bifen 2 Ag Gold	yes	warning	12	3A
Bifender FC	yes	warning	12	3A

TABLE 2 **Pesticide trade name**	**Restricted use (RUP)**	**Signal Word**	**Reentry interval (hours)**	**Mode of action classification number(s)**
Bifenthrin 2EC	yes	warning	12	3A
Bifenture EC	yes	warning	12	3A
Bifenture LFC	yes	caution	12	3A
BioBit HP	no	caution	4	11A
Blackhawk	no	caution	4	5
Brigade 2EC	yes	warning	12	3A
Brigadier	yes	warning	12	3A & 4A
Capture 3RIVE 3D	yes	caution	12	3A
Capture LFR	yes	warning	12	3A
Carbaryl 4L	no	caution	by crop	1A
Coragen	no	none	4	28
Corrida 90 WSP	yes	danger-poison	48	1A
Counter 20G (various)	yes	danger-poison	48	1B
Deadline GT	no	caution	12	n/a
Deadline MPs	no	caution	12	n/a
Declare	yes	caution	24	3A
Defcon 4.67G	yes	warning	48	1B & 3A
Delta Gold	yes	danger-poison	12	3A
Dibrom 8E	yes	danger-poison	48	1B
Dimate 4E	no	warning	by crop	1B
Dimethoate 400	no	warning	by crop	1B
Dimethoate 4EC	no	warning	by crop	1B
Dipel 10G	no	caution	4	11A
Dipel ES	no	caution	4	11A
Discipline 2EC	yes	warning	12	3A
Empower 2	yes	caution	24	3A
Entrust	no	caution	4	5
Entrust SC	no	none	4	5
Ethos XB	yes	caution	12	3A
Evergreen EC 60-6	no	caution	12	3A
Exirel Insect Control	no	caution	12	28
Fanfare 2EC	yes	warning	12	3A
Fanfare EC	yes	warning	12	3A
Fanfare ES	yes	warning	12	3A
Fastac CS	yes	caution	12	3A
Fastac EC	yes	danger-poison	12	3A
Force 6.5G	yes	caution	48	3A
Force 10G HL	yes	warning	48	3A
Force EVO	yes	danger-poison	48	3A

TABLE 2 **Pesticide trade name**	**Restricted use (RUP)**	**Signal Word**	**Reentry interval (hours)**	**Mode of action classification number(s)**
Fyfanon ULV Ag	no	caution	by crop	1B
Grizzly Too	yes	warning	24	3A
Hero	yes	caution	12	3A
Hero EW	yes	caution	12	3A
Index Liquid At-Plant	yes	danger-poison	48	1B & 3A
Intrepid 2F	no	caution	4	18
Javelin WG	no	caution	4	11A
Kendo 22.8CS	yes	warning	24	3A
Kendo Insecticide	yes	warning	24	3A
Lambda-Cy	yes	warning	24	3A
Lambda-Cy Ag	yes	warning	24	3A
Lambda-Cyhalothrin 1EC	yes	warning	24	3A
LambdaStar	yes	danger-poison	24	3A
Lambda-T	yes	warning	24	3A
Lamcap II	yes	warning	24	3A
Lannate LV	yes	danger-poison	48	1A
Lannate SP	yes	danger-poison	48	1A
Leverage 360	yes	caution	12	3A & 4A
Malathion 5	no	warning	by crop	1B
Malathion 5EC	no	warning	by crop	1B
Minecto Pro	yes	warning	12	6 & 28
Montana 4F	no	caution	12	4A
Movento	no	caution	24	23
Movento HL	no	caution	24	23
Mustang Insecticide	yes	warning	12	3A
Mustang Maxx	yes	warning	12	3A
Nudrin LV	yes	danger-poison	48	1A
Nudrin SP	yes	danger-poison	48	1A
Nuprid 2SC	no	caution	12	4A
Nuprid 4F Max	no	caution	12	4A
Oberon 2SC	no	caution	12	23
Onager	no	caution	12	10A
Orthene 97	no	caution	24	1B
Paradigm VC	no	caution	24	3A
Permastar AG	yes	caution	12	3A
Perm-UP 25DF	yes	warning	12	3A
Perm-UP 3.2EC	yes	caution	12	3A
Pounce 1.5G	yes	caution	12	3A
Pounce 25WP	yes	caution	12	3A

TABLE 2 **Pesticide trade name**	**Restricted use (RUP)**	**Signal Word**	**Reentry interval (hours)**	**Mode of action classification number(s)**
Prevathon	no	none	4	28
Prey 1.6	no	caution	12	4A
Proaxis	yes	caution	24	3A
Province II	yes	warning	24	3A
PyGanic EC 1.4 II	no	caution	12	3A
PyGanic Specialty	no	caution	12	3A
Radiant SC	yes	caution	4	5
Renestra	yes	warning	12	3A & 9D
Sefina	no	caution	12	9D
Sevin 4F	no	caution	by crop	1A
Sevin XLR Plus	no	caution	by crop	1A
S-fenvalostar	yes	warning	12	3A
Sherpa	no	caution	12	4A
Silencer	yes	warning	24	3A
Sivanto 200SL	no	caution	4	4D
Sivanto HL	no	caution	4	4D
Sivanto Prime	no	caution	4	4D
Skyraider	yes	warning	12	3A & 4A
Sluggo	no	caution	0	n/a
Smartchoice HC	yes	danger-poison	48	1B & 3A
Sniper	yes	warning	12	3A
Sniper Helios	yes	warning	12	3A
Sniper LFR	yes	warning	12	3A
Spintor 2SC	no	none	4	5
Steed	yes	warning	12	3A
Steward EC	no	caution	12	22
Swagger	yes	danger-poison	12	3A & 4A
Tombstone	yes	danger-poison	12	3A
Tombstone Helios	yes	warning	12	3A
Tracer	no	none	4	5
Transform WG	no	danger-poison	24	4C
Tundra EC	yes	warning	12	3A
Vantacor	no	none	4	28
Warrior II w/ Zeon	yes	warning	24	3A
Willowood Lambda-Cy 1EC	yes	warning	24	3A
Wrangler	no	caution	12	4A
Xentari Biological	no	caution	4	11A
Xpedient Plus V	yes	warning	12	3A
Zeal	no	caution	12	10B

TABLE 2 **Pesticide trade name**	**Restricted use (RUP)**	**Signal Word**	**Reentry interval (hours)**	**Mode of action classification number(s)**
Zeal Pro	no	caution	12	10B
Zeal SC	no	caution	12	10B
Zyrate	yes	warning	12	3A

Introduction Table 3: Sites and modes of action for insecticides in field crops. Modes of action are based on the classification by IRAC, the Insecticide Resistance Action Committee, found online at irac-online.org

IRAC number and group	***Target site*** **• Mode of action**	**Example active ingredient(s)**	**Example trade names**
1A carbamates	*Nervous system* • Bind to the acetylcholinesterase enzyme, preventing it from 'cleaning' the gap between nerves. Death from overstimulation of nerves. • The effect is brief, compared to OPs •	carbaryl methomyl	Carbaryl Corrida Lannate Nudrin Sevin
1B organophosphates (OPs)	*Nervous system* • Bind to the acetylcholinesterase enzyme similar to carbamates, but the effect is longer-lasting. This usually makes OPs more hazardous than carbamates	chlorpyrifos chlorethoxyfos dimethoate malathion tebupirimphos terbufos	Aztec (part) Chlorpyrifos Cobalt (part) Counter Dimethoate Index Lorsban Malathion Smartchoice
3A pyrethrins pyrethroids	*Nervous system* • Disrupt sodium channels along the nerve axon, resulting in continuous firing of nerves • Pyrethrins are botanical insecticides extracted from chrysanthemum; Some products may carry an organic registration • Pyrethroids are chemically based on these molecules but are NOT used in organic crops • Performance of pyrethrins & some pyrethroids is increased by adding a synergist to the formulation	<u>botanical:</u> pyrethrin <u>conventional:</u> bifenthrin cyfluthrin Ƛ-cyhalothrin λ-cyhalothrin cypermethrin esfenvalerate permethrin tefluthrin	<u>botanical:</u> Pyganic <u>conventional:</u> Arctic Asana Aztec (part) Baythroid Bifenture Brigade Capture Cobalt (part) Empower Force Lambda-Cy Mustang Perm-Up Pounce Proaxis Silencer Tombstone Warrior

IRAC number and group	*Target site* • Mode of action	Example active ingredient(s)	Example trade names
4A neonicotinoids	*Nervous system* • Hyper-stimulate nerves by binding to their nicotinic acetylcholine receptors in the synapse. The binding is better to insect receptors than to mammalian receptors	clothianidin imidacloprid thiamethoxam	Admire Brigadier (part) Cruiser Leverage (part) Nuprid Poncho
4C sulfoximines 4D butenolides	*Nervous system* • Bind to nicotinic acetylcholine receptors in the synapse, but have a different structure than 4A, neonicotinoids	sulfoxaflor flupyradifurone	Transform Sivanto
5 spinosyns	*Nervous system* • Bind to nicotinic acetylcholine receptors in the synapse, but in a different way than neonicotinoids	spinosad spinetoram	Entrust Radiant Tracer
6 avermectins	*Nervous system* • Block the transmission of signals in nerve and muscle cells, causing paralysis, by increasing the effect of glutamate at glutamate-gated chloride channels. Mammals don't have glutamate-gated channels	abamectin	Agri-mec
9D pyropenes	*Nervous system* • Disrupt proteins in the neurons of insect chordotonal organs, stretch receptors under the cuticle which are important in hearing, movement, balance, and flight. Ultimately impacts feeding and other behaviors	afidopyropen	Renestra Sefina
10A and 10B mite growth inhibitors	*Growth inhibitor* • Not well understood. Disrupts synthesis of chitin (a key component of the mite exoskeleton) during development. Impacts eggs and nymphs, but not adults	hexythiazox etoxazole	Onager Zeal

IRAC number and group	***Target site*** **• Mode of action**	**Example active ingredient(s)**	**Example trade names**
11A *Bacillus thuringiensis* (Bt)	*Midgut membrane* • Cry proteins bind to specific receptors in the gut; gut contents leak into body cavity & insect dies slowly of septicemia	B.t. kurstaki B.t. aizawai	Agree Biobit Dipel Javelin Xentari
18 diacylhydrazines	*Ecdysone (hormone) receptor* • Causes lepidopteran larvae (caterpillars) to molt prematurely, which is lethal	methoxyfenozide	Intrepid
20D bifenazate	*Mitochondria* • Inhibits the process of respiration, so that cells can't utilize energy	bifenazate	Acramite
22 oxadiazines	*Nervous system* • Block sodium channels, and thus disrupt signals along nerve axon	indoxacarb	Steward
23 tetronic & tertramic acid derivatives	*Growth inhibitor* • Inhibit the enzyme acetyl coenzyme A carboxylase, which is important in lipid biosynthesis	spiromesifen	Oberon
28 diamides	*Nervous system* • Activate ryanodine receptors on muscles, causing them to contract; leads to paralysis then death	chlorantraniliprole	Coragen
Others - aldehyde	*Mucus cells* • Irreversibly destroys mucus producing cells, leading to death	metaldehyde	Deadline
Others- iron phosphate	*Digestive tract* • Interferes with calcium metabolism in the gut; snails & slugs stop eating and die	iron phosphate	Sluggo

MSU Field Crops Insect Guide: Management of Insects and Spider Mites in Dry Beans
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Prepared by:
Chris DiFonzo, Field Crops Entomologist
Department of Entomology
288 Farm Lane
East Lansing, MI
difonzo@msu.edu

Scott Bales, Dry Bean Systems Specialist
Saginaw Valley Research & Extension Center
9923 Kruger Rd
Frankenmuth, MI
balessco@msu.edu

How to Use this Guide

This publication is set up as a series of stand-alone tables with information on insect biology, damage, management recommendations, and insecticides registered in Michigan on **dry beans**. Pesticide names and rates are current as of the date at the top of the page.

- ✓ **Table 1** shows the timing of common insect pests in the crop, from early to late season.

- ✓ **Table 2** is a checklist of damage symptoms from these insects to aid in field scouting.

- ✓ **Table 3** has information on the life cycle of each insect, plus a detailed description of its damage and the conditions that may lead to or favor infestations. A rating of pest status (and thus damage potential) is given based on experience in the state. Most insect pests are uncommon or do not increase to damaging levels in a typical year.

- ✓ **Table 4** has information on management of each pest. Most insects are kept in check by natural enemies (biological control) or by adverse environmental conditions. Some pest problems can be reduced by simply changing or avoiding certain agronomic practices. Table 4 also gives scouting and threshold recommendations. Note that these recommendations vary in quality. Key pests tend to have research-based scouting methods and thresholds. But many insects are not at damaging levels often enough to generate good information; sampling recommendations and thresholds for these species are based on observations, experience, or a best guess. This is noted in the table.

- ✓ Insecticides registered in Michigan on the crop are listed in **Table 5** (at planting) and **Table 6** (foliar sprays)**.** Active ingredients (AI) are listed alphabetically in column 1. All products with the same active ingredient are grouped together under each AI for easy comparison or substitution of one product for another. Label rates and pests are listed in columns 2 and 3. A letter under a pest indicates that a particular insect is on the label (i.e., the label claims control of that insect). The letter corresponds to an application rate in column 2. Some insecticides are applied at a single rate for all insects ('a'), while others vary ('a', 'b', 'c'). The final columns in the table list the preharvest interval (PHI) in days and notes on application - for example bee toxicity warnings, minimum recommended spray volumes, or other restrictions.

Dry beans Table 1. Timing of damage from common insects and related pests in Michigan
Pests are listed from early to late-season. Key species are highlighted in bold text.

Common name	Overwintering stage, location	May	June	July	August	September
seedcorn maggot	pupae, in soil	larvae (maggots) feed on seeds and scar cotyledons				
slugs & snails	both eggs and adults, in field	juveniles and adults feed on seedlings				
white grubs	larvae (grubs), underground	larvae (grubs) feed on roots				
aphids (usually black bean & cotton aphids)				nymphs and adults pierce leaves, feed on plant sap		
grasshoppers (multiple species)	egg clusters, underground			nymphs and adults feed on leaves		
green cloverworm	Southern USA, migrate north			larvae (caterpillars) feed on leaves and pods		
Mexican bean beetle	adults, in protected areas			larvae and adults skeletonize leaves		
potato leafhopper	Southern USA, migrate north			nymphs and adults suck plant sap		
spider mite	adult females, at base of hosts			nymphs and adults pierce plant cells, suck plant sap		
Lygus / tarnished plant bug	adults, in protected areas			nymphs and adults suck plant sap		
thrips	depends on species			nymphs and adults 'punch' individual cells, suck plant sap		
western bean cutworm	prepupae, underground			larvae (caterpillars) feed on blossoms and developing pods, then chew into beans		
European corn borer	larvae, in corn residue				second generation larvae bore stems & chew into pods, beans	
stink bug	adults, in & around fields				nymphs and adults suck plant sap, pierce developing pods	

Dry Beans Table 2: Damage checklist to aid in scouting for insects and related pests.

Plant part or timing Type of damage or injury	aphids	European corn borer	grasshoppers	green cloverworm	Mexican bean beetle	plant bug	potato leafhopper	seedcorn maggot	slugs & snails	spider mite	stink bugs	thrips	western bean cutworm	white grubs
Stand (emergence)														
seeds fed-on								x	x					x
gaps in row								x	x					x
wilted or cut plants														x
Leaves														
slimy or shiny trails									x					
scraping of leaf surface					x				x					
skeletonizing between veins					x									
irregular leaf feeding			x	x										
severe defoliation			x	x	x									
generalized leaf yellowing	x					x				x				
yellow leaf margins (hopperburn)							x							
tiny yellow spots (stippling)										x		x		
leaves cupped, crinkled	x					x	x			x		x		
sticky leaves or sooty mold	x													
fine webbing										x				
leaf drop, death							x			x		x		
Stems														
boring into stem		x												
powdery frass		x												
Roots														
root hairs missing														x
pruning of whole roots														x
Pods and beans														
large holes chewed into pod		x	x										x	
small holes chewed into pod		x		x									x	
beans fed-on in pod		x	x										x	
shriveled, aborted beans						x					x			
Other														
virus transmission	x													

Dry Bean Table 3: Life cycle, damage, and pest status of insects in dry beans

Pest status is rated as follows. Rating applies to Michigan.

- Rare: Insect is *unusual, not found in most fields*
- Uncommon: Insect is present in many fields, but *typically not in damaging numbers*
- Occasional: Insect is present in most fields, *sometimes increasing to damaging levels*.
- Important: Insect is present in most fields, *often increasing to damaging levels*; often a target of integrated management or insecticide use by growers.

- Sporadic: Economic outbreaks may occur in certain fields or seasons after *extreme weather* or *mass movement* from south to north early in the season
- Localized: Economic outbreaks may occur in specific locations under *specific agronomic conditions*, for example, in no-till or in late plantings.

Pest (abbreviation)	Life cycle and Number of generations	Description of Damage	Conditions which favor infestation or damage	Pest Status in Michigan
aphids	Summer population is all female. Females give birth to live young and do not mate to reproduce (parthenogenesis). Multiple overlapping generations	• All stages suck plant sap from leaves • Heavy infestation may lead to stunting, curling of leaves, weakening of plants • Aphids also transmit plant viruses	• Drought stress may be made worse by aphids removing plant sap	Uncommon Usually present, but numbers not enough to cause damage
bean leaf beetle	Adults overwinter in leaf litter and wooded field margins. Become active in spring; move into alfalfa, then migrate into beans after first alfalfa cutting. Larvae feed underground on roots. 1-2 generations per year	• Adults defoliate younger plants, leaving small round holes between major leaf veins • Adults feed on and scar developing pods, reducing yield and seed quality	• Adults may move into dry beans if nearby soybean fields were infested in the previous or current season	Uncommon Usually present, but numbers rarely high enough to cause damage
European corn borer (ECB)	Mature larvae overwinter in corn residue and pupate in late spring. Moths emerge in late May-early June and lay eggs in corn and other crops. Two generations in south & central Michigan, the first in June & the second in late July/ early August. One generation in the UP and northern Michigan.	• Older larvae bore into stem, disrupt water flow, weaken stem • Larvae also bore into pods, consume seeds, and contaminate harvested beans	• Nearby non-Bt corn production probably increases local ECB risk	Uncommon Populations suppressed by widespread use of Bt GMO corn
grasshoppers *multiple species*	Eggs overwinter in soil. Nymphs emerge in June. Amount of feeding increases with size. Females lay groups of eggs in the undisturbed soil in late summer. 1 generation per year	• All stages chew on leaves; feeding has a ragged appearance	• Fallow areas and pasture are preferred egg-laying sites • A hot dry summer & fall can lead to a high population the next year	Uncommon Outbreaks rare, usually after a dry season
green cloverworm	Adults lay eggs singly on underside of leaves; larvae feed on foliage	• Small caterpillars scrape leaf tissue while older larvae defoliate plants		Uncommon Usually present, but numbers rarely high enough to cause damage

Pest (abbreviation)	Life cycle and Number of generations	Description of Damage	Conditions which favor infestation or damage	Pest Status in Michigan
Mexican bean beetle	Adults overwinter in crop debris, woodlots, etc. Adults move into dry beans in early summer and lay eggs. Larvae mature in 3-4 weeks, pupating on leaf surface. Adults emerge in late July into August, lay eggs for a second generation. Second generation larvae feed, pupate in late August, and new adults overwinter.	• Larvae and adults strip the leaf surface between the veins on the underside of leaves, resulting in windowpane damage or a skeletonized (lacy) appearance. Time frame: mid-July into August. • Pod feeding is rare	• A mild winter increases survival • Planting adjacent to fields with high populations the previous year • Early-planting (adults attracted to these fields)	Uncommon and Localized
potato leafhopper (PLH)	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	• Adults and nymphs lacerate and suck on leaves and stems, damaging cells and blocking vascular tissue; the classic symptom of feeding is tip yellowing or 'hopper burn' • Other symptoms include stunting and curling of leaves and poor pod fill	• PLH damage is worse under dry conditions, and leafhopper survival is probably better too	Sporadic *later in season*: Important, if populations become well-established
seedcorn maggot (SCM)	SCM overwinters as pupae in the soil. Adult flies emerge in early spring and are attracted to lay eggs in disturbed soil with decaying organic matter. Multiple generations	• Tiny larvae (maggots) feed on germinating seed; may cause variable emergence, stand loss, and delayed development	• Cool wet conditions which delay germination • Tillage of fields with high organic matter from a decaying green cover crop, or weeds, or fresh manure	Sporadic and Localized Depends on presence of fresh organic matter and cool, wet conditions
slugs & snails	Slugs overwinter as both eggs & adults; females deposit eggs in soil; these hatch in about one month. Multiple overlapping generations	• Feeding on cotyledons & lower leaves; feeding usually occurs at night • Substantial defoliation can be tolerated in pre-bloom dry beans, but if the growing point is killed, stands can be significantly reduced	• Planting into heavy crop residue • Cool, wet soils which delay germination • Poorly closed furrows (slug highways)	Localized Depends on residue and cool conditions. Dry beans are usually planted after slug risk is past.
spider mite	Adult females overwinter in field borders and sheltered areas. In spring, they move to new growth, and lay eggs. Mites spread from field to field by crawling or blowing in the wind. Multiple overlapping generations	• Adults & nymphs pierce individual plant cells, resulting in tiny yellow spots called stippling • Webbing is a sign of a heavy infestation • Severe damage results in leaf yellowing, death, water loss	• Prolonged hot, dry weather favors outbreaks and enhances the impact of feeding • Infestations often start on dusty edges of fields	Sporadic Outbreaks occur in hot, dry seasons
stink bug *several species including green, onespotted, & the brown marmorated*	Adults overwinter in protected areas. Weeds and early crops like wheat are fed on and colonized first. Stink bug eggs, laid in small clusters, often sport a small 'crown'. Nymphs and adults live and feed in the crop together. Note - some stink bug species are beneficial predators of other insects like caterpillars	• Adults and nymphs feed by injecting salivary enzymes into plants and sucking up plant juices • Feeding on pods can result in aborted or shriveled beans	• May move into dry beans as adjacent wheat fields dry down	Uncommon Numbers rarely high enough to cause damage
tarnished plant bug (TPB)	Adults overwinter in residue and on field edges. Weeds and early crops like alfalfa are fed on and colonized first.	• Adults and nymphs suck plant sap. Tarnished plant bug injects a toxic saliva during feeding. • Feeding on pods can result in aborted or shriveled beans	• May move into dry beans from adjacent alfalfa fields that were recently cut	Uncommon Numbers rarely high enough to cause damage

Pest (abbreviation)	Life cycle and Number of generations	Description of Damage	Conditions which favor infestation or damage	Pest Status in Michigan
thrips	Adults and nymphs overwinter in residue. Populations initially build on grasses and in wheat. Note that thrips are an important food source for some of the beneficial insects, such as pirate bugs, that control other pests.	• Nymphs and adults feed with a single mandible, using it to puncture plant cells and slurp up the liquid inside • Punctured cells dry up, resulting in areas of dead cells; under heavy infestation, leaves dry up, curl, or die	• Dry conditions in early summer • May move into dry beans from adjacent wheat fields or grassy borders that are drying down	Uncommon Usually present, but numbers rarely high enough to cause damage
western bean cutworm (WBC)	Overwinter in pre-pupal stage. Adults emerge in mid-late July; females lay eggs in pre-tassel corn and switch to dry beans as corn matures. Larvae feed on pods at night. In early-September, they drop & burrow into soil to over-winter. Areas with sandy soil appear to have deeper and better overwintering. 1 generation per year	• Tiny larvae feed on leaves and then inside blossoms • Larger larvae drop to the ground & stay under residue or in cracks during the day. They climb into the canopy to feed on pods at night	• Areas with sandy soils, where over-wintering survival is higher • Adjacent corn which is no longer attractive for egg laying (ie. past the pretassel stage)	Occasional - Important Montcalm and surrounding counties + the UP are historic hot spots for WBC
white grubs *multiple species*	Mature grubs overwinter under-ground. Adults emerge May-July, depending on species. Eggs laid in soil in the summer. Grubs feed on roots, then move down in soil profile in late fall to overwinter. In spring, grubs feed for a period, then pupate. 1 generation per year except June beetle, which has a 2-3 year life cycle	• Larvae (grubs) prune root hairs and sometimes whole roots, causing wilting, water and nutrient deficiency, or plant death	• planting into fallow fields or pasture • fields near pasture, home lawns • Fields or parts of fields with sandy soil type	Uncommon

Dry Beans Table 4: Management notes, scouting recommendations, and thresholds.

Pest (abbreviation)	Notes on non-chemical and chemical management	Scouting recommendation	Spray threshold
aphids	• Biological: Predators (such as ladybugs, lacewings, parasitoids) keep populations in check. Under humid conditions, entomopathogenic fungi infect aphids. • Environmental: Heavy rainfall and irrigation can wash off aphids. Adequate moisture reduces feeding stress and increases humidity for infection by pathogens.	Check 100 plants (20 plants x 5 sets)	General guideline: One or more aphid colony (a group of about 30) per plant Rarely justified
bean leaf beetle	• Environment: Extended periods of cold winter temperatures may increase kill of overwintering beetles	Check 100 plants (20 plants x 5 sets)	General guideline: More than 10% of the pods damaged Rarely justified
European corn borer (ECB)	• Biological: Numerous natural enemies kill ECB eggs and larvae. Predators, egg and larval parasitoids, and pathogens are common. • Agronomic: The widespread planting of Bt corn has greatly reduced the European corn borer population in the landscape.	No specific recommendation Note: Trapping can detect large corn borer flights. Michigan moths respond to Z (Iowa) strain pheromone	None
grasshoppers	• Biological: blister beetle larvae and other insects prey on eggs, and insects, birds, and mammals eat nymphs & adults. Fungal pathogens kill eggs and nymphs under wet spring conditions. • Agronomic: Tillage reduces survival of eggs and newly hatched nymphs • Insecticide: May be able to limit sprayed area if hoppers invade from a neighboring field or grassy border	No specific recommendation Have never seen populations high enough to treat in Michigan	General guideline: During flowering & pod fill, 15% overall defoliation by leaf-feeding insects, including hoppers
green cloverworm	• Biological: many natural enemies keep it in check	No specific recommendation Cloverworm can be detected by sweeping or beating plants over a cloth laid between rows	General guideline: During flowering & pod fill, 15% overall defoliation by leaf-feeding insects, including cloverworm
Mexican bean beetle (MBB)	• Biological: natural enemies feed on eggs and larvae • Agronomic: avoid early planting, as overwintered adults colonize these fields first • Environmental: Hot, dry weather and heavy rainfall are both cited as reducing populations	Early-mid July: Scout for # egg masses per meter. Take multiple samples across the field During flowering & pod fill: estimate defoliation	General guideline – 0.5 egg masses per meter/yard or 15% overall defoliation by leaf-feeding insects, including MBB
potato leafhopper (PLH)	• Biological - a naturally occurring fungal pathogen reduces PLH numbers under favorable conditions, usually later in the year • Insecticides: resistance is not an issue with PLH	Check 100 trifoliates from different plants (20 leaves x 5 sets) Count both adults and nymphs	Unifoliate stage: > 0.5 leafhopper per plant Otherwise: > 1 leafhopper per trifoliate leaf
seedcorn maggot (SCM)	• Agronomic: Potential for injury increases in wet, cool springs when seed germinates slower, or when seed is planted into tilled fields where fresh green material (cover crops or weeds) have been worked in. Risk drops after organic matter decomposes. Risk is very low in no-till fields. • Insecticide: Management is preventative, using a seed treatment in tilled fields where weeds and cover crop were recently killed or manure applied.	No specific recommendation	No rescue treatment is available. Consider replanting fields or areas with significant stand loss

Pest (abbreviation)	Notes on non-chemical and chemical management	Scouting recommendation	Spray threshold
slugs & snails	• Biological: Some ground beetle species consume slugs • Agronomic: Tillage and crop rotation reduce corn residue (slug habitat). Avoid planting in wet conditions, as open furrows act as slug highways. • Insecticide: Slugs are not insects, thus soil insecticides and seed treatments have no impact on them. Some studies suggest that seed treatments actually exacerbate slug populations by killing their ground beetle predators.	No specific recommendation Walk fields at night or early morning, turning over residue and looking for slime trials	None established A guess: Consider applying a molluscicide (slug bait) if stand is reduced by 5%
spider mite	• Biological: Under humid conditions, a natural fungal pathogen can infect and wipe out mite populations in a matter of days. Some natural enemies eat mites. • Agronomic: Irrigation mitigates the impact of spider mite feeding and increases humidity for fungal biocontrol, but during a drought, even irrigation isn't enough. • Environmental: Rainfall has a similar effect as irrigation • Insecticide: Insecticide resistance is common in mites. Some insecticides (including most pyrethroids) flare mite populations by killing off natural enemies. Likewise, fungicide applications may disrupt fungal pathogens of mites. Insurance applications of both are discouraged; be cautious about pesticide applications in dry years.	Infestations often start on field edges Look for mites on undersides of leaves using hand lens, or tap leaves over a black piece of paper Webbing is present when populations are high	A guess: Treat when mites appear on >25% of the plants and yellowing is first seen Mites are difficult to control; spraying is often a losing proposition
stink bugs	• Biological: Several parasitoids attack egg masses or bugs	No specific recommendation	None established
tarnished plant bug	• Agronomic: Good weed control reduces alternate hosts for plant bugs	No specific recommendation	General guideline: One bug or more per plant at first flower to green pod stage
thrips	• Biological: Generally kept in check by predators. • Environmental: Rainfall or irrigation reduces populations. • Insecticides: Onion thrips are killed better by pyrethroids than OPs/ carbamates. A caution about spraying: Thrips can be viewed as semi-beneficial, because they are predators of spider mite eggs. Spraying for thrips may contribute to a spider mite outbreak in the future, especially under dry conditions.	Infestations often start on field edges Look for thrips on undersides of leaves using hand lens. Or tap leaves over a white piece of paper or a paper plate	Threshold used in the High Plains (not tested in Michigan): >15 thrips per plant and leaf cupping is present
western bean cutworm	• Biological: many predators consume eggs and larvae; tiny Trichogramma wasps have been seen in the field in Michigan parasitizing egg masses	Sampling beans directly for WBC eggs of larvae is difficult Use bucket-type pheromone traps to detect flight, starting at the end of June. At a cumulative catch of 100-120 moths, scout fields for pod feeding	Action threshold developed In the Great Lakes Region: Treat when >10% of pods are fed-on by WBC larvae
white grubs	• Biological: Some species are attacked by pathogens • Agronomic: If practical, fall plowing of long-standing fallow fields & pasture prior to planting is recommended. Tillage also exposes grubs to mammals and birds. Note: It is important to identify grubs to distinguish annual species from multi-year species of June beetles.	No specific recommendation Grubs tend to be patchy, and in sandy parts of fields Grubs are sometimes detected when plowing in the fall or spring	None established

Dry Beans Table 5: Insecticides registered on dry beans in Michigan for use at planting, with preharvest intervals and precautions

- Insecticides are grouped by active ingredient(s), which are listed alphabetically, allowing for easy comparison of products with the same chemistry.
- Application rates are listed for pests which appear on the manufacturer label; If a column is blank, the pest is not on the label. The letters in the pest columns refer to the label use rate from column two.
- Note that insecticide rates per 1000 feet of row are based on a **30-inch row spacing**. See label for specific per-acre rate and gauge-setting charts for narrower row spacing.

Active ingredient Trade Names	**Labelled rate(s)** per 1000 feet of row or per acre	**seedcorn maggot**	**slugs & snails**	**white grubs**	**Precautions and Remarks**
bifenthrin					
Xpedient Plus V	(a) 0.15 – 0.30 oz per 1000 ft (= 2.56 - 5.12 oz per acre)	a		a	• Apply T-band or in-furrow; see label for PRE and PPI instructions
Bifender FC	(a) 0.17 - 0.34 oz per 1000 ft (= 3.0 - 5.9 oz per acre)				Note: Many of these products can be broadcast soil surface to control black cutworm and armyworm.
Capture 3RIVE3D	(a) 0.19 – 0.46 oz per 1000 ft (= 3.2 - 8 oz per acre)				
Bifenture LFC Capture LFR Sniper LFR	(a) 0.2 - 0.39 oz per 1000 ft (= 3.4 - 6.8 oz per acre)				
bifenthrin + biofungicide *(Bacillus amyloliquefaciens)* Ethos XB	(a) 0.2 - 0.49 oz per 1000 ft (= 3.4 - 8.5 oz per acre)	a		a	• contains a biological fungicide strain for suppression of early season root diseases. • Apply T-band or in-furrow; see label for PRE and PPI instructions
cypermethrin (zeta)					
Mustang	(a) 0.247 oz per 1000 ft (= 4.3 oz per acre)			a	• Apply T band or in-furrow in a minimum of 2-7 gal per acre
Mustang Maxx	(a) 0.23 oz per 1000 ft (= 4 oz per acre)				
iron phosphate					
Sluggo	(a) 0.5 – 1.0 lb per 1000 ft (= 20 - 44 lbs per acre)		a		• Broadcast using a spreader • Apply bait in evening when slugs feed; product works best when the soil is moist

Dry Beans Table 6: Foliar insecticides registered on dry beans in Michigan, with preharvest intervals and precautions.

- Insecticides are grouped by active ingredient(s), which are listed alphabetically, allowing for easy comparison of products with the same chemistry.
- Application rates are listed for pests which appear on the manufacturer label; If a column is blank, the pest is not on the label. The letters in the pest columns refer to the label use rate from column two.
- Acronyms: BLB-bean leaf beetle; ECB-European corn borer; GCW-green cloverworm; MBB-Mexican bean beetle; PLH-potato leafhopper; TPB-tarnished plant bug; WBC-western bean cutworm

Active ingredient Trade Names	**Labelled rate per acre** (unless stated)	**aphids**	**BLB**	**ECB**	**grasshopper**	**GCW**	**MBB**	**PLH**	**spider mite**	**stink bug**	**TPB**	**thrips**	**WBC**	**Pre harvest interval (PHI) in days**	**Precautions and Remark**
abamectin															
Abba Ultra	(a) 4 - 8 oz								a					7	• Ground application recommended (instead of by air), at minimum 10 gal per acre • To avoid the chance of illegal residue, product must be applied with a "non-ionic activator type wetting, spreading or penetrating spray adjuvant" that is approved on dry beans. See label for details
Agri-Mek SC	(a) 1.75 - 3.5 oz														
acephate															
Acephate 90WDG Acephate 90WSP	(a) 4 - 8 oz (b) 8 - 17.6 oz (c) 12.8 - 17.6 oz	b	b	c	a	b	b	b			b	b		14	• Minimum 20 gal per acre (ground) or 2 gal per acre (air) • Do not feed treated vines to livestock • WSP formulation is in water soluble packets
Acephate 90 Prill	(a) 4.4 - 8.9 oz (b) 8.9 - 17.6 oz (c) 13.3 - 17.6 oz														
Acephate 97UP Acephate 97 WDG Orthene 97	(a) 4 - 8 oz (b) 8 - 16 oz (c) 12 - 16 oz														
Bacillus thuringiensis (Bt)															
Agree Biobit HP Dipel ES Javelin Xentari DF	(a) 0.5 - 2.0 lbs (a) 0.5 - 1 lb (a) 1 - 2 pints (a) 0.25 - 1.5 lbs (a) 0.5 - 1.5 lb					a								0	• Larvae must eat treated foliage to be killed, so good coverage is needed • Bt sprays are most effective on small caterpillars • Biobit, Dipel DF, and Xentari can be used on organic beans
bifenazate															
Acramite 4SC	(a) 16-24 oz								a					7	• Apply in minimum of 20 gal per acre (ground) or 7 gal per acre (air) • Max 2 applications per year; 14 days between sprays

Active ingredient Trade Names	**Labelled rate per acre** (unless stated)	**aphids**	**BLB**	**ECB**	**grasshopper**	**GCW**	**MBB**	**PLH**	**spider mite**	**stink bug**	**TPB**	**thrips**	**WBC**	**Pre harvest interval (PHI) in days**	**Precautions and Remark**
bifenthrin Bifen 2AgGold Bifenthrin 2EC Bifenture EC Brigade 2EC Fanfare EC, 2EC, and ES Sniper & Sniper Helios Tundra EC	(a) 1.6 - 6.4 oz (b) 2.1 - 6.4 oz (c) 5.12 - 6.4 oz	b	b	b	b	a b	b	a	c	b	b	b	b	14	• Maximum 0.3 lb/ acre of active ingredient per season • Do not make applications less than 7 days apart • Extremely toxic to bees; See labels for details
bifenthrin + a biofungicide *(Bac. amyloliquefaciens)* Ethos XB	(a) 2.8 - 8.5 oz	a	a	a	a	a	a	a	a	a	a	a	a	14	• Contains a biological fungicide strain - otherwise similar to bifenthrin
bifenthrin + cypermethrin (zeta) Hero Hero EW Steed	(a) 4.0 - 10.3 oz (b) 10.3 oz (a) 4.5 - 11.2 (b) 11.2 oz (c) 3.5 - 4.7 oz	a c	a c	a c	a c	a c	a c	a c	b	a c	b	b c	a c	21	• Do not make applications less than 7 days apart • Max 27.39 oz (Hero), 29.86 (Hero EW) of product per season
bifenthrin + imidacloprid (1:1 ratio) Brigadier Swagger	(a) 3.8 - 5.6 oz (b) 5.6 oz (a) 7.6 - 11.2 oz (b) 11.2 oz	a	b	b	a	b	b	a			a	a		14	• Do not make applications less than 7 days apart • Extremely toxic to bees; See label for details
bifenthrin + imidacloprid (2:1 ratio) Skyraider	(a) 2.1 - 5.6 oz (b) 5.12 - 5.6 oz	a	a	a	a	a	a	a	b	a	a	a	a	14	• Do not make applications less than 7 days apart • Extremely toxic to bees; See label for details
carbaryl Carbaryl 4L Sevin 4F Sevin XLR Plus	(a) 0.5 - 1.0 qt (b) 1.0 qt (c) 1.0 - 1.5 qt		a	c		a	a	b		c	c	b	b	21 beans 14 forage	• Applications interval minimum of 7 days • Application to wet foliage or in periods of high humidity may cause plant injury • "May kill honey bees and other bees in substantial numbers"; do not apply when crop or weeds are in bloom. See labels for additional details
chlorantraniliprole Coragen Prevathon	(a) 2 - 5 oz (b) 3.5 - 7.5 oz (a) 8 - 20 oz (b) 14 - 20 oz			b	a								b	1	• Thorough coverage is important; insects must eat treated foliage for optimum control • See label for specific directions for grasshopper control

Active ingredient Trade Names	**Labelled rate per acre** (unless stated)	**aphids**	**BLB**	**ECB**	**grasshopper**	**GCW**	**MBB**	**PLH**	**spider mite**	**stink bug**	**TPB**	**thrips**	**WBC**	**Pre harvest interval (PHI) in days**	**Precautions and Remark**
chlorantraniliprole + cyhalothrin (lambda) Besiege	(a) 5 - 8 oz (b) 6 - 10 oz (c) 10 oz	b	b	b	b	a	a	b	c	b	b	b	b	21	• Do not graze or harvest vines for forage • For mites, suppression only
cyantraniliprole Exirel	(a) 10.0- 20.5 oz			a										7	• Label lists suppression of potato leafhopper and thrips • See label statement about 'adverse crop response'
cyantraniliprole + abamectin Minecto Pro	(a) 7.5 - 10 oz			a						a				7	• Apply in minimum of 10 gal per acre ground or 5 gal per acre air; ground application recommended for coverage • Label lists suppression of potato leafhopper and thrips • See label statement about 'adverse crop response'
cyfluthrin Baythroid XL Tombstone Tombstone Helios	(a) 0.8 - 1.6 oz (b) 1.6 - 2.4 oz (c) 2.4 - 3.2 oz		c	c	c	c	c	a		b	b		*	7	• Do not feed treated vines or hay to livestock * Western bean cutworm is not on the current labels, but cyfluthrin is labeled for WBC in corn
cyfluthrin + imidacloprid Leverage 360	(a) 2.4 - 2.8 oz	a	a	a	a	a	a	a			a			7	• Label lists suppression of stink bugs at high rate • Do not feed treated vines or hay to livestock
cyhalothrin (gamma) Declare Proaxis	(a) 0.77 - 1.28 oz (b) 1.28 - 1.54 oz (a) 1.92 - 3.30 oz (b) 2.56 - 3.84 oz	b	b	b	b	a	a	b		b	b	b	b	21	• Do not graze or harvest vines for forage
cyhalothrin (lambda) Grizzly Too Lamcap II Province II Warrior w/Zeon Kendo Lambda-Cy Lambda-Cy Ag Lambda Cyhalothrin 1EC LambdaStar Lambda-T Paradigm VC Silencer Willowood Lambda-Cy1EC	(a) 0.96 - 1.60 (b) 1.28 - 1.92 (a) 1.92 - 3.2 (b) 2.56 - 3.84	b	b	b	b	a	a	b		b	b	b	b	21	• Max 7.68 oz / acre per season • Do not graze or harvest vines as forage or hay
cypermethrin (alpha) Fastac EC or CS	(a) 2.7 -3.8 (b) 3.2 - 3.9 oz	b	a	a	b	a	a	a		b	a	b	*	21	• CS formulation is microencapsulated * Western bean cutworm is not on the current labels, but cypermethrin is labeled for WBC in corn

Active ingredient Trade Names	**Labelled rate per acre** (unless stated)	**aphids**	**BLB**	**ECB**	**grasshopper**	**GCW**	**MBB**	**PLH**	**spider mite**	**stink bug**	**TPB**	**thrips**	**WBC**	**Pre harvest interval (PHI) in days**	**Precautions and Remark**
cypermethrin (zeta) Mustang Mustang Maxx	(a) 3.0 - 4.3 oz (b) 3.4 - 4.3 oz (a) 2.72- 4.0 oz (b) 3.2 - 4.0 oz	b	a	a	b	a	a	a		b	a	b	*	21	• Extremely toxic to bees. Do not apply to blooming crops if bees are visiting the field * Western bean cutworm is not on the current labels, but cypermethrin is labeled for WBC in corn
dimethoate Dimate 4E Dimethoate 400 and 4EC	(a) 0.5 - 1.0 pt	a	a		a		a	a	a		a			0	• Max 2 pints/ acre per year; 14-day retreatment interval • Do not feed treated vines • Highly toxic to bees
esfenvalerate Asana XL S-FenvaloStar Zyrate	(a) 2.9 - 5.8 oz (b) 5.8 - 9.6 oz				b	b	a	b					b	21	• Do not feed or graze livestock on treated vines • See label language about grasshopper control • Highly toxic to bees; See label for details
flupyradifurone Sivanto HL Sivanto 200 SL Sivanto Prime	(a) 3.5 - 7.0 oz (a) 7 - 10.5 oz (a) 7 - 14 oz	a						a						7	• Foliar applications have systemic properties; product moves from deposition point to leaf tips and controls insects on underside of leaves
imidacloprid Admire Pro Advise Four Alias 4F Montana 4F Nuprid 4F Max Wrangler Nuprid 2SC Prey 1.6F and Sherpa	(a) 1.2 oz (a) 1.4 oz (a) 2.8 oz (a) 3.5 oz	a						a						7	• Highly toxic to bees; See label for details
indoxacarb Steward	(a) 6.7 - 11.3 oz			a										7	• For ground application use minimum 20 gal per acre
methomyl Annihilate LV Corrida 29SL Lannate LV Nudrin LV	(a) 0.75 - 3 oz (b) 1.5 - 3 oz	b		b			a	a		*	b	b		14	• Kills both eggs and larvae of corn borer. See label for specific on timing • Highly toxic to bees. See label for details * The labels for Lannate list brown marmorated stink bug as a target

Active ingredient Trade Names	**Labelled rate per acre** (unless stated)	**aphids**	**BLB**	**ECB**	**grasshopper**	**GCW**	**MBB**	**PLH**	**spider mite**	**stink bug**	**TPB**	**thrips**	**WBC**	**Pre harvest interval (PHI) in days**	**Precautions and Remark**
methomyl continued Annihilate SP Corrida 90WSP Lannate SP Nudrin SP	 (a) 0.25- 1 oz (b) 0.5 - 1 oz														
methoxyfenozide Intrepid 2F	(a) 8 - 16 oz			a										7	• Apply in minimum of 20 gal per acre (ground) in a full canopy or 10 gal per acre (air) • See label for information on application timing • Endangered species warning on label for applications made in these Michigan counties: Allegan, Monroe, Montcalm, Muskegon, Newaygo, Oceana
naled Dibrom 8E	(a) 1 pint (b) 1.5 pint	a				a		a	a	b	a			1	
pyrethrins Evergreen EC 60-6 PyGanic EC 1.4 II PyGanic Specialty	(a) 2.0 - 12.6 oz (a) 16 - 64 oz (a) 4.5 - 15.6 oz	a	a	a	a	a	a	a		a	a	a	a	0 when sprays dry	• Plant-derived insecticides that knock down insects quickly but have very short residual control. Coverage is critical • Max 10 applications per season, min 3-day spray interval • PyGanic is OMRI listed for use on organic crops; Evergreen does not have OMRI certification because it contains PBO (piperonyl butoxide), a synergist which improves kill • Highly toxic to bees exposed to direct treatment; do not apply on or drift onto blooming crops or weeds
spinosyns **(spinetoram & spinosad)** Entrust Blackhawk Radiant SC Entrust SC Spintor 2SC	 (a) 1 - 2 oz (b) 1.5 - 2 oz (a) 1.7-3.3 oz (b) 2.5 - 3.3 oz (a) 3 - 8 oz (b) 5 - 8 oz (a) 3 - 6 oz (b) 4.5 - 6 oz			a								b		28	• Maximum 12 oz / acre per year • Do not make more than two consecutive applications of products with spinetoram or spinosad • For European corn borer, sprays must target eggs and small larvae; see label for information on application timing • For thrips, control improved by adding an adjuvant; see label for details • Do not feed forage to meat or dairy animals

Active ingredient Trade Names	**Labelled rate per acre** (unless stated)	**aphids**	**BLB**	**ECB**	**grasshopper**	**GCW**	**MBB**	**PLH**	**spider mite**	**stink bug**	**TPB**	**thrips**	**WBC**	**Pre harvest interval (PHI) in days**	**Precautions and Remark**
spirotetramat Movento Movento HL	(a) 4 - 5 oz (a) 2 - 2.5 oz	a												7	• Movento label also lists 'suppression' of spider mites and some species of thrips
sulfoxaflor Transform WG	(a) 0.75-1.0 oz (b) 1.5 - 2.25 oz	a									b			7	• Translaminar product, which moves within the leaf to target sucking pests • Label also lists 'suppression' of thrips and some species of stink bug

MSU-OSU Field Crops Insect Guide: Management of Insects and Spider Mites in Field Corn
Updated: January 2022

Chris DiFonzo, Field Crops Entomologist
Michigan State University
Department of Entomology
288 Farm Lane
East Lansing, MI
difonzo@msu.edu

Kelley Tilmon, Field Crops Entomologist
The Ohio State University
Department of Entomology
1680 Wooster Ave
Wooster, OH
tilmon.1@osu.edu

How to Use this Guide

This publication is set up as a series of stand-alone tables with information on insect biology, damage, management recommendations, and insecticides registered in Michigan and Ohio on **field corn**. Pesticide names and rates are current as of the date at the top of the page.

- ✓ **Table 1** shows the timing of common insect pests in the crop, from early to late season.

- ✓ **Table 2** is a checklist of damage symptoms from these insects to aid in field scouting.

- ✓ **Table 3** has information on the life cycle of each insect, plus a detailed description of its damage and the conditions that may lead to or favor infestations. A rating of pest status (and thus damage potential) is given based on experience in the state. Most insect pests are uncommon or do not increase to damaging levels in a typical year.

- ✓ **Table 4** has information on management of each pest. Most insects are kept in check by natural enemies (biological control) or by adverse environmental conditions. Some pest problems can be reduced by simply changing or avoiding certain agronomic practices. Table 4 also gives scouting and threshold recommendations. Note that these recommendations vary in quality. Key pests tend to have research-based scouting methods and thresholds. But many insects are not at damaging levels often enough to generate good information; sampling recommendations and thresholds for these species are based on observations, experience, or a best guess. This is noted in the table.

- ✓ Insecticides registered in Michigan and Ohio on the crop are listed in **Table 5** (at planting) and **Table 6** (foliar sprays)**.** Active ingredients (AI) are listed alphabetically in column 1. All products with the same active ingredient are grouped together under each AI for easy comparison or substitution of one product for another. Label rates and pests are listed in columns 2 and 3. A letter under a pest indicates that a particular insect is on the label (i.e. the label claims control of that insect). The letter corresponds to an application rate in column 2. Some insecticides are applied at a single rate for all insects ('a'), while others vary ('a', 'b', 'c'). The final columns in the table list the preharvest interval (PHI) in days and notes on application - for example bee toxicity warnings, minimum recommended spray volumes, or other restrictions.

Corn Table 1. Timing of damage from common insects and related pests in Michigan and Ohio. Pests are listed from early to late-season. Key species are highlighted in bold text.

Common name	Overwintering stage, location	May	June	July	August	Sept
white grubs	larvae (grubs), underground	Asiatic garden Euro Chafer				
		Japanese beetle grubs				
		June beetle grubs				
seedcorn maggot	pupae, in soil	larval damage				
wireworm	larvae, in soil	larval damage				
flea beetle	adults, on field edge	adult feeding				
slugs & snails	both eggs and adults, in field	feeding on seedling				
billbug	adults, on field edges	adult feeding	larval feeding - root, crown			
sandhill crane	-----	birds pull out & consume seeds				
black cutworm	Southern USA, migrate north	larval feeding, cutting of plants				
true armyworm	Southern USA, migrate north	larval feeding on foliage				
corn rootworm	eggs, underground		larval root feeding		adult silk clipping	
corn blotch leafminer	adult flies		larvae mine leaf tissue			
grasshoppers (multiple species)	egg clusters, underground			nymphs, then adults, feed on foliage		
European corn borer	5th instar, in crop residue		1st generation larval feeding	2nd generation larval feeding		
Japanese beetle adult	larvae (grub), underground			adult silk clipping		
corn earworm	Southern USA, migrate north				larval feeding in ear	
fall armyworm	Southern USA, migrate north			larval feeding on leaves and in the ear		
western bean cutworm	prepupae, underground			larval feeding in ear		
stink bug	adults, nymphs(?), in & around fields		damage to young corn		kernel damage	
corn leaf aphid	Southern USA, migrate north			multiple generations remove plant sap		
spider mite	adult females, at base of hosts			multiple generations pierce plant cells		
sap or picnic beetles	pupae & adults, crop residue				adult & larval feeding in damaged ears	

Corn Table 2: Damage checklist to aid in scouting for insects and related pests.

Plant part or timing Type of damage or injury	aphids	billbug	black cutworm	corn earworm	corn leafminer	corn rootworm larvae	corn rootworm adults	Euro. corn borer	fall armyworm	flea beetle	grasshoppers	white grubs	Japanese beetle adult	sap beetle	seedcorn maggot	slugs & snails	spider mite	stink bug	true armyworm	western bean cutworm	wireworm
Stand (emergence)																					
seeds fed-on															x	x					x
gaps in row			x									x			x	x					x
wilted or cut plants			x																		x
hole thru base of plant			x																		x
seedling top cut-off straight			x																		
Leaf tissue																					
slimy or shiny trails																x					
scraping of top layer of leaf							x			x						x					
leaf mining					x																
shot-, pin-, or round holes								x													
parallel oblong holes		x																x			
small hole in midrib								x													
skeletonized between veins							x						x								
irregular leaf feeding			x	x					x		x								x		
severe defoliation, midrib left											x								x		
large frass pellets				x					x										x		
white powdery frass								x													
stippling (tiny yellow spots)																	x				
brown, ‘crispy’, dead leaves																	x				
sticky; sooty mold	x																				

Plant part or timing Type of damage or injury	aphids	billbug	black cutworm	corn earworm	corn leafminer	corn rootworm larvae	corn rootworm adults	Euro. corn borer	fall armyworm	flea beetle	grasshoppers	white grubs	Japanese beetle adult	sap beetle	seedcorn maggot	slugs & snails	spider mite	stink bug	true armyworm	western bean cutworm	wireworm
webbing																	x				
Tassels																					
fed-on				x																x	
broken								x													
sticky or with sooty mold	x																				
Stalks																					
tunneling into stalk								x													
stalk breakage								x													
lodging, goosenecking						x															
Roots																					
brown tracks, scarring						x															
root hairs missing						x						x									
pruning of whole roots						x						x									
Ear																					
silk clipping				x			x						x							x	
feeding on ear tip				x				x	x					x						x	
scraping of kernel surface								x												x	
tunneling into side									x											x	
tunneling in shank								x													
ear drop								x													
shriveled kernels																		x			
messy frass									x											x	

Corn Table 3: Life cycle, damage, and pest status of insects in field corn.

Pest status is rated as follows. Rating applies to Michigan and Ohio.

- Rare: Insect is *unusual, not found in most fields*
- Uncommon: Insect is present in many fields, but *typically not in damaging numbers*
- Occasional: Insect is present in most fields, *sometimes increasing to damaging levels*
- Important: Insect is present in most fields, *often increasing to damaging levels*; often a target of integrated management or insecticide use by growers

- Sporadic: Economic outbreaks may occur in certain fields or seasons after *extreme weather* or *mass movement* from south to north early in the season
- Localized: Economic outbreaks may occur in specific locations under *specific agronomic conditions*, for example, in no-till or in late plantings

Pest (abbreviation)	Life cycle and Number of generations	Description of Damage	Conditions which favor infestation or damage	Pest Status in MI & OH
aphids *Usually corn leaf aphid*	The summer population is female. Females do not mate to reproduce (parthenogenesis); they also give birth to live young. Multiple overlapping generations	• Suck plant sap from leaves, removing water and nutrients • Honeydew secretions may result in sticky leaves and tassels, inhibiting pollen shed or weakening plants	• Drought stress may be amplified by aphids removing plant sap	Uncommon Populations rarely high enough to cause damage
billbug	Adults overwinter along field borders, and emerge during corn planting, usually walking to corn. Eggs laid in soil or in holes chewed in stalk. Larvae feed on crown, roots. Adults emerge between midsummer and fall 1 generation per year	• Adults cut slits in whorl, resulting in extensive tillering • Common symptom-oblong shot-holing as leaves unfurl • Larvae can damage root crown by feeding	• Continuous corn • No or reduced till corn • Field edges • Fields with heavy nutsedge infestation	Rare No recent reports of significant numbers in this region
corn blotch leafminer (CBL)	Flies lay eggs on leaf surface. Larvae (maggots) tunnel between leaf layers, creating mines that widen as larvae grow. Mature larvae chew out of the leaf and drop to the soil to pupate. Several generations per summer	• Females create numerous tiny pinhole feeding wounds • In heavy infestations, entire leaf is mined by multiple larvae • Mined foliage dries up and shrivels, giving the plants a frosted appearance	• Highest populations in Michigan have been observed in muck fields	Rare
corn earworm (CEW)	Major adult flights move north into Michigan and Ohio in July or August. Eggs laid on silks or upper leaves. Larvae (caterpillars) feed on leaves, then on silks and ears. Larvae drop and pupate in soil.	• Larval feeding can damage tassel, silks, kernels in ear • Ear injury is associated w/ invasion of other insects and ear molds that produce mycotoxins	• Late-planted fields which are silking during egg-laying	Uncommon Rarely impacts field corn in the region
corn rootworm (CRW)	Overwinter as eggs in the soil. Eggs hatch in late May-early June. Larvae feed on corn roots for about three weeks; pupate in soil. Adults emerge in early July and feed through the summer. Eggs laid in soil of corn fields, except in areas with the rotation-resistant variant of western corn rootworm, which will lay eggs in soybean and other crops. 1 generation per year	Larvae • root scars, tunneling, severe pruning of nodes of roots • plant stress & yield loss from poor water/ nutrient uptake • lodging and goose necking of plants results in harvest issues Adults: • Scrape leaf surface • Silk-clipping • Feeding on the ear tip	• Continuous corn • late-planted corn (adults attracted to silks for feeding) • Volunteer corn plants in field the previous season • A rotation-resistant variant of western CRW, which lays eggs in soybean and other crops, occurs in SW Michigan	Important *in continuous (corn-after-corn) corn production* Localized *in some first-year corn in SW Michigan*

Pest (abbreviation)	Life cycle and Number of generations	Description of Damage	Conditions which favor infestation or damage	Pest Status in MI & OH
cutworm *Mostly black but also dingy, sandhill, variegated*	Adult moths migrate into north in early spring. Eggs laid on low-growing weeds or crop residue. Small larvae first feed on weeds then shift to corn after herbicide is applied. Larvae hide during the day, & feed at night. Pupation in soil. Several generations per season, but the 1st is most damaging.	• Small larvae create shot-holes in leaves • Older larvae feed on leaves (variegated), tunnel into base of stalk (black) or cut seedlings off (black), reducing stand	• Low, dense weed mats (egg-laying site for females) • No-till fields • Fields with high crop residue • Planting into cover crops or wet areas • Late-planted corn	Sporadic Outbreaks occur after heavy spring flight from the south
European corn borer (ECB)	Mature larvae overwinter in corn residue; pupate late spring. Moths emerge in late May- early June. Females lay egg masses on undersides of corn leaves larvae feed on all above-ground parts of plants. Pupation in stalk (1st gen) or residue (2nd gen). Two generations in south & central Michigan & all of Ohio, the first in June & the second in late July/ early August. One generation in northern Michigan and its upper peninsula	• Small larvae scrape leaf surface (window paning) or chew through whorl, resulting in shot-holing damage • Larger larvae bore into midrib & stalk, disrupting water flow, weakening stalk, or resulting in breakage • Boring of shank can result in ear drop and kernel feeding reduces yield • Ear injury is associated w/ invasion of ear molds that produce mycotoxins; stalk injury associated w/ stalk rot	• No-till fields with corn residue • Areas with a high % of non-Bt corn • Early planted (taller) fields at risk for 1st generation; late-planted fields at risk for 2nd gen. Note: Besides field corn, hosts include sweet corn, snap & dry beans, potato, tomato, peppers	Was important, now occasional Outbreaks in field corn currently suppressed due to wide-spread use of Bt corn
fall armyworm (FAW)	FAW is a tropical species that cannot survive freezing temperatures. Adult moths migrate north, arriving in mid to late season. Eggs laid on corn leaves. Larvae feed in whorl during the day or in the ear. Pupation in soil. 1-3 generations at end of season, if temp is warm enough. Larvae CANNOT overwinter in our area.	• Leaf damage to whorl-stage corn • Kernel feeding (part of the caterpillar complex feeding in the ear)	• Late-planted corn attracts moths for egg-laying • Edge rows may be damaged by larvae marching in from infested grassy edge, pasture, or forages	Uncommon in MI Sporadic in Ohio
flea beetle	Adults overwinter, emerge in the spring. Eggs laid in soil around corn plants. Larvae feed and pupate in soil. Several generations per year	• Adults feed on upper leaf surface, leaving white scraping or scratches. Direct damage rarely a concern. • Infected adults transmit Stewart's wilt bacteria from gut during feeding. Usually not a problem in field corn but causes yield loss in susceptible inbred lines used for seed production.	• Mild winters favor survival of adult beetles, and thus overwintering of Stewart's wilt bacteria in the beetle gut	Uncommon in field corn May be of more concern as a disease vector in seed corn production
grasshoppers *several species*	Eggs overwinter in soil. Nymphs emerge in June. Amount of feeding increases with size. Females deposit groups of eggs in the undisturbed soil in late summer. 1 generation per year	• Defoliation of plants by nymphs and adults; feeding has a ragged appearance	• Fallow areas bordering fields and pasture are preferred egg-laying sites • A hot summer & fall can lead to a high population the following season	Uncommon Outbreaks rare
Japanese beetle adults	Larvae (grubs) feed underground on roots of many hosts. Adults emerge mid-summer, and feed on leaves, silks, and pollen, plus on hundreds of other hosts. Eggs laid in soil in July - September 1 generation per year	• Silk-clipping, similar to rootworm adults; severe clipping can reduce pollination • Feeding skeletonizes leaves but damage isn't economic	• populations often higher on field edges, especially near turf	Uncommon

Pest (abbreviation)	Life cycle and Number of generations	Description of Damage	Conditions which favor infestation or damage	Pest Status in MI & OH
seedcorn maggot (SCM)	Overwinter as pupae in soil. Adult flies emerge in early spring, laying eggs in disturbed soil with decaying organic matter. Larvae (maggots) feed on decaying matter and seeds. Several generations per year, only the first causing crop damage	• Larvae feed on germinating seeds and cause variable emergence, stand loss, and delayed development • Damage often occurs over large part of field	• Cool, wet soil conditions which delay germination • Recent (within 2 weeks) tillage of green organic matter such as cover crops or weeds • Recent application of fresh manure	Localized Occurs under certain field and environmental conditions
sap beetle *= picnic beetle*	Adults overwinter. Eggs deposited on/ near decaying vegetation, including in ears opened by other insects. Larvae feed in ear, and pupate in soil. Several generations per season	• Larvae and adults are secondary pests in ears fed on by other insects, creating additional damage and areas for ear mold infection	• Ears opened and injured by other insects (such as CEW, ECB, WBC) • Cool, wet late season conditions which enhance ear mold growth	Uncommon
slugs & snails	Slugs overwinter as eggs & adults, so both are present at planting. Eggs laid in soil; these hatch in about one month. Multiple overlapping generations	• Feed on seeds, cotyledons, & leaves • Heavy feeding on small corn plants may slow development or reduce stand • Feeding usually occurs at night	• No or reduced-till • Planting into wheat stubble or heavy crop residue • Cool, wet soil conditions which delay germination • Poorly closed furrows act as slug highways	Localized (but increasing) Occurs under certain field conditions
spider mites (two-spotted)	Adults overwinter in field borders and sheltered areas. In spring, adults move to new growth, lay eggs on underside of leaves. Mites spread from field to field by crawling or blowing in the wind. Multiple overlapping generations	• Adults & nymphs pierce individual plant cells, creating tiny yellow spots called stippling • Webbing is a sign on a heavy infestation • Severe damage results in leaf yellowing, death, water loss	• Prolonged hot, dry weather favors outbreaks and enhances the impact of feeding • Infestations often start on dusty edges of fields	Sporadic Outbreaks occur in hot, dry seasons
stink bugs *several species*	Adults and nymphs feed by injecting salivary enzymes into plants and sucking up plant juices	• Feeding in V4-V5 corn creates characteristic pattern of circular holes with yellow margins as the whorl unrolls • In severe case, plants may be twisted, deformed; growing point can die • Feeding on the ear later in season can result in aborted or shriveled kernels	• No-till corn • Rye cover crop or weeds which were killed by herbicide	Uncommon This rating could change as brown marmorated stink bug moves into the region
true armyworm (TAW)	Adult moths migrate into Michigan in early spring. Eggs laid on weedy grasses before corn emerges, and on small grains like wheat. In corn, small larvae first feed on weeds then shift to the crop after herbicide is applied. Larvae on wheat move into neighboring crops, including corn. Larvae pupate in the soil and adults emerge in a week. 2 to 3 generations per year, the 1st generation most damaging	• Larvae feed on leaf margins, sometimes completely defoliating plants, leaving only the midrib • Corn plants usually recover if growing point is not injured, but a severe infestation can defoliate a field in several days	• Reduced tillage • Adjacent small grain fields	Sporadic Outbreaks occur after heavy spring flight from the south

Pest (abbreviation)	Life cycle and Number of generations	Description of Damage	Conditions which favor infestation or damage	Pest Status in MI & OH
western bean cutworm (WBC)	Overwinter in pre-pupal stage. Adults emerge in July; females key in on late whorl & pre-tassel stage corn for egg laying. Larvae feed first on tassel and silks, then on kernels in ear. Feeding ends in early- to mid-September when caterpillars drop and burrow into soil. 1 generation per year	• Larger larvae feed in the ear, usually at the tip, but sometimes directly thru the husk into the side of the ear • In rare, heavy infestations, there can be multiple caterpillars per ear • Feeding damage allows other insects to infest; damaged ears also have an increased risk of ear mold infection and quality reduction from mycotoxins	• Fields in the pre-tassel stage • Areas with sandy soils which increase the overwintering survival of larvae • Areas where both corn and dry beans (an alternate host) are grown	Important and often Localized Corn stage during flight is key to infestation level
white grubs - **Asiatic garden beetle (AGB)**	Mature grubs overwinter in field. Adults emerge in June, move and mate at dusk (come to lights). Females attracted to low growing canopy for egg laying (for ex, a soybean field). Grubs feed on roots from July-fall; move down in soil profile in late fall. 1 generation per year	• Grubs feed on cotyledons and roots, reducing stand and plant uniformity • In severe cases, stand loss has been documented • Adults feed on ornamentals plus some veg & fruit crops; however, feeding on field corn leaves appears to be rare	• Previous crop of soybean, potato, alfalfa, or late season infestations of weeds like marestail • Fields or portions of fields with a sandy (> 80% sand) soil type	Localized Damage currently limited to counties in southern MI and northern OH
white grubs - **European chafer**	Mature grubs overwinter in field. Adults emerge in June, mate at dusk near a landmark (ex, tall tree). Grubs feed on roots from July into fall; move down in soil profile in late fall. 1 generation per year	• Grubs feed on cotyledons and roots, reducing stand and uniformity • Adults do not feed	• Corn following soybeans • Field edges near lawns, golf courses, tree lines • Fields or portions of fields with a sandy (> 80% sand) soil type • Spring populations tend to be higher after a dry summer	Uncommon and Localized *No recent reports of losses from EC grubs in corn*
white grubs - **Japanese beetle (JB)**	Mature grubs overwinter in field. Adults emerge July-August. Eggs laid in soil July-Sept. Grubs feed on root from July-fall; move down in soil profile in late fall. 1 generation per year	• Grubs feed on cotyledons and roots, reducing stand and uniformity • Adults are also a pest of corn (see JB adults)	• Planting into fallow fields or pasture • Fields near pasture, lawns, ornamentals • Spring populations are higher after a wet summer	Uncommon
white grubs - **multiple species of June beetle**	Adults emerge in May/June, move and mate at dusk (come to lights. Eggs laid in groups in soil. Grubs feed for three summers, with 2nd and 3rd stage grubs causing the most damage to roots. Between summers, larvae move to a lower depth in soil. Late in third summer, grubs pupate underground; adults overwinter in soil until next spring. 1 generation takes three years	• Prune cotyledons prior emergence, reducing stand • Prune root hairs and sometimes whole roots, causing wilting, water and nutrient deficiency, or plant death	• Planting into fallow fields & pasture • Fields near pasture, home lawns, tree borders	Uncommon
wireworm	Wireworms are the immature form of click beetles. They spend up to six years in the immature stage. Overlapping generations	• Feed on newly planted corn seeds & roots • May tunnel straight through the base of seedlings below the soil surface	• Planting into long-standing fallow fields and pasture	Uncommon & Localized Related to field history

Corn Table 4: Management notes, scouting recommendations, and thresholds.

Pest	Notes on non-chemical and chemical management	Scouting recommendation	Spray threshold
aphids	• Biological: Predators (such as ladybugs, lacewings, parasitoids) usually keep populations in check. Under humid conditions, entomopathogenic fungi infect aphids • Environmental: Heavy rainfall and irrigation can wash off aphids. Adequate moisture reduces feeding stress and increases humidity for infection by pathogens	Check 100 plants (5 plants x 20 sets)	> 50 aphids per plant on 50% of plants Rarely justified in Michigan or Ohio
billbug	• Agronomic: Crop rotation (adult billbugs are slow and don't move far) and tillage reduce populations. Control of sedges removes an alternate host. • Insecticide: Note that granular soil insecticides, applied at planting for another insect, will control billbug	No specific recommendation	No specific recommendation Have never seen infestations in Michigan in Ohio
corn blotch leafminer	• Biological: Numerous wasp parasitoids attack larvae • Insecticide: Not effective because larvae are protected in leaf mines. Spraying also disrupts parasitism.	None	none Not justified in Michigan or Ohio
corn earworm	• Biological: Several predators attack eggs and larvae • Agronomic: Planting early or on-time avoids egg-laying • Insecticide: Spraying to protect the ear is generally not effective • Seed selection: Some Bt corn hybrids provide control; See Bt trait table for details	None	None Not an economic pest of field corn in Michigan or Ohio
corn rootworm larvae	• Agronomic: Crop rotation is by far the most effective way to control CRW. Control of volunteer corn in the rotational crop is important to achieving larval reduction. • Environmental: Wet conditions during egg hatch usually reduce populations in a field (but this can also negatively impact root growth). Adequate soil moisture and nutrients promote good root growth later in the season, and helps blunt the impact of larval feeding. • Seed selection: Some Bt corn hybrids provide control; See Bt trait table for details	Scout fields for beetles to predict the need for an insecticide or a Bt trait the <u>following season</u>. • In continuous corn: Check 100 plants after adult emergence (20 plants x 5 sets) • In soybean: monitor yellow sticky cards placed just above the canopy across field	In continuous corn- 1 beetle per plant In soybean - > 5 beetles per trap per day in late July thru August
corn rootworm adults	• Agronomic: Crop rotation is by far the most effective way to reduce larval, and thus adult, populations	Check 100 plants (20 plants x 5 sets) for silk clipping by CRW & Japanese beetle	Silks clipped shorter than ½ inch before/ during pollination, <u>and</u> adults are still feeding
cutworm	• Biological: Ground beetles and parasitoids kill larvae • Agronomic: Good weed control and timely cover crop termination prior to planting reduce likelihood of infestation • Insecticide: Rescue (post-planting) treatments are effective and preferred, as populations vary by year & location • Seed selection: Some Bt corn hybrids provide control; see Bt trait table for details	Walk fields to determine % wilted or cut plants Dig around base of plants to confirm cutworm larvae are present Note: Pheromone traps can indicate flight and aid in timing of scouting	> 5% plants cut or damaged
European corn borer	• Biological: Numerous natural enemies: egg and larval parasitoids, and pathogens are common • Agronomic: Early-planted fields are most at risk for 1st generation infestation; late-planted fields are most at risk for 2nd generation infestation. Plowing and shredding of stalks reduce overwintering larval numbers to some extent, but not enough to make a difference in the next season. • Insecticide: Spray timing is critical because larvae eventually tunnel into midribs and stalks, out of reach from sprays.	• 1st Generation: count # of plants (20 plants x 5 sets) with windowpane or shot hole damage; unroll whorls to be sure live larvae are still present.	General guidelines: 1st Generation: > 50% of plants with damage and live larvae are still in whorl

Pest	Notes on non-chemical and chemical management	Scouting recommendation	Spray threshold
European corn borer continued	Percent control is usually higher for applications against 1st generation ECB on whorl stage corn than against 2nd generation larvae in the ear zone. • Seed selection: Many Bt corn hybrids provide excellent ECB control; see Bt trait table for details.	• 2nd Generation: count # of plants (20 plants x 5 sets) with egg masses on undersides of leaves Note: Trapping can aid in timing of scouting. Michigan & Ohio ECBs respond to the Z (= Iowa) strain pheromone	2nd Generation: > 50% of plants with egg masses Economic thresholds varying by expected yield, spray cost, and market price are calculated using worksheets available in extension pubs
fall armyworm	• Biological: Parasitized by several wasp and fly species • Insecticide: Spraying to protect the ear is generally not effective • Seed selection: Some Bt corn hybrids provide control; see Bt trait table for details	Check 100 plants (20 plants x 5 sets) for larvae, feeding, frass	> 50% of plants infested with small (under 1 inch) larvae
flea beetle	• Agronomic: Most corn hybrids are resistant to Stewart's Wilt disease transmitted by flea beetles. Avoid early planting of susceptible inbred lines used in seed production. • Environmental: Cold winters reduce the survival of beetles and thus the incidence of Stewart's Wilt	In seed corn production: Check 100 plants (20 plants x 5 sets) for beetles	On susceptible inbred lines, 5 or more beetles per plant, up to the four-leaf stage
grasshoppers	• Biological: Blister beetle larvae and other insects prey on eggs, and insects, birds, and mammals eat nymphs & adults. Fungal pathogens kill eggs and nymphs under wet spring conditions. • Agronomic: Tillage reduces survival of eggs and newly hatched nymphs • Insecticide: May be able to limit sprayed area if hoppers invade from a neighboring field or grassy border	No specific recommendation	General guideline: 5 or more hoppers per plant Have never seen populations high enough to treat in Michigan or Ohio
Japanese beetle adults	• Biological: predation and parasitism by other insects on adult beetles is likely low; birds do feed on adults • Agronomic: adults can move around the landscape, so tillage and other practices in nearby fields ay not have much impact	Check 100 plants (20 plants x 5 sets) for silk clipping by Japanese beetle & CRW	Silks clipped shorter than ½ inch (usually in tandem w/ rootworm adults)
seedcorn maggot (SCM)	• Agronomic: Potential for injury decreases with 1) shallow seeding into warm soil and 2) delaying of planting into herbicide-killed or disced cover crops and weeds until organic matter decomposes. • Agronomic: Problems rarely occur in no-till fields • Insecticide: Management is essentially preventative. If choosing to plant early and into a recently tilled field, an insecticide seed treatment can help, but may not be 100% effective if the maggot population is high. Note that granular soil insecticides, applied at planting for another insect, will help to control SCM.	No specific recommendation	No rescue treatment available; consider replanting fields or areas with significant stand loss
slugs & snails	• Biological: Some ground beetles consume slugs • Agronomic: Fields with a history of slug damage could be planted early, so the crop is further along by the time slug feeding starts. Tillage and crop rotation reduce corn residue (slug habitat). Zone tillage and row cleaners help to dry a band along the row and may quicken crop growth. Avoid planting in wet conditions, as open furrows act as slug highways. • Insecticide: Slugs are not insects, so soil insecticides and seed treatments have no impact on them. Some studies suggest that seed treatments make slug problems worse by killing ground beetle predators.	No specific recommendation Walk fields at night or early morning, turning over residue and looking for slime trails	None established A guess - Consider applying a molluscicide (slug bait) if stand is reduced by 5%

Pest	Notes on non-chemical and chemical management	Scouting recommendation	Spray threshold
spider mites (two-spotted)	• Biological: under humid conditions, a natural fungal pathogen can infect and wipe out mite populations in a matter of days. Some natural enemies eat mites. • Agronomic: irrigation mitigates the impact of spider mite feeding and increases humidity for fungal biocontrol, but during a drought, even irrigation isn't enough. • Environmental: rainfall has a similar effect as irrigation • Insecticide: Insecticide resistance is common in mites. Some insecticides (including most pyrethroids) flare mite populations by killing off natural enemies. Likewise, fungicide applications may disrupt fungal pathogens of mites. This is one reason that insurance applications of both are discouraged; be cautious about pesticide applications in dry years.	Infestations often start on field edges Look for mites on undersides of leaves using hand lens, or tap leaves over a black piece of paper Webbing is present when populations are high	A guess: At least a third of plants have mites and leaves Are yellowing Factors to consider: *mite population is still growing *weather forecast remains hot and dry *corn is pollinating *low humidity under the canopy *good coverage is possible
stink bugs	• Agronomic: Proper adjustment of planter to close the furrow, so stink bugs cannot feed on the growing point	No specific recommendation	None established Have never seen populations high enough to treat in Michigan or Ohio
true armyworm	• Biological: Often controlled by predators, parasitoids • Agronomic: Good weed control (especially grassy weeds) and timely cover crop termination prior to planting reduce likelihood of infestation • Insecticide: May be able to limit spray to the field edge if larvae invade from a neighboring field or grassy border • Seed selection: Some Bt corn hybrids provide control; see Bt trait table for details	Check 100 plants (20 plants x 5 sets) for larvae, feeding, frass. Target fields that had a cover crop or heavy weed pressure early. During the day, larvae hide in the whorl, at base of plants, under residue	Seedlings: 10% stand loss Whorl stage: 25% of plants w/ $\geq$2 larvae per whorl, OR 75% of plants w/ 1 larva Treat only if larvae are less than 1.25 inch
western bean cutworm	• Biological: Many predators consume eggs and larvae; Trichogramma parasitoids attack eggs • Seed selection: Only Bt corn hybrids with the Vip3A Bt trait provide effective control of WBC. Corn with all other Bt traits should be managed for WBC like non-Bt corn; see Bt trait table for details • Insecticides: Adding an insecticide to a fungicide spray simply as insurance is discouraged, unless the field is really over threshold for WBC. But if a tank mix is being done anyway, default to the optimal timing for your disease target (ear molds, tar spot, etc). WBC control may not be as good, but fungicides are expensive and proper timing is critical for disease control.	To detect first flight, use pheromone bucket traps starting at end of June. Just after peak flight, check 100 plants (20 plants x 5 sets) weekly for egg masses on leaves and young larvae in the tassel or silks. Target pre-tassel and just-tasseling fields for scouting.	In the Great Lakes Region: 5% of plants with egg masses or small larvae. This is a <u>cumulative</u> threshold (i.e. add % infestation from one week to the next towards the 5% threshold)
white grubs	• Biological: Some species are attacked by pathogens. • Agronomic: If practical, fall plowing of long-standing fallow fields & pasture prior to planting is recommended. Tillage also exposes grubs to mammal and bird predation. For Asiatic garden beetle in southern Michigan and northern Ohio, delaying planting may avoid most grub feeding. • Insecticide: Note that granular soil insecticides, applied at planting for another insect, may have some effect on grubs. Seed treatments often have mixed results, especially on Asiatic garden beetle. There are no rescue treatments. Note: it is important to identify grubs to distinguish annual species from species of June beetle, which remain in fields for multiple seasons.	Check 20 one foot x one foot shovel samples in fall or spring. Grubs tend to be patchy, especially on sandy knolls or near tree lines. Grubs may also be detected while plowing in fall or spring, especially when birds follow tillage equipment	<u>June beetle:</u> 1 grub per ft^2 <u>Annual grubs</u> European chafer: 2 grubs per ft^2 Japanese beetle and Asiatic garden: use chafer threshold

Pest	Notes on non-chemical and chemical management	Scouting recommendation	Spray threshold
wireworm	• Agronomic: Depending on species, wireworms remain in the larval stage for 1-5 years, thus they are favored by undisturbed soil. If practical, fall plowing of long-standing fallow fields & pasture prior to planting is recommended. • Insecticide: Note that granular soil insecticides, applied at planting for another insect, will have some effect on wireworms. Seed treatments protect seed, but not seedlings. Rescue treatments are not effective.	Scout target fields for wireworms with 5-10 bait traps (directions online or in extension pubs), 2-3 weeks before planting	At least 1 wireworm per bait trap. Otherwise, consider a soil insecticide or seed treatment in fields coming out of fallow, pasture, alfalfa, or that have a history of wireworm

Corn Table 5: Insecticides registered on field corn in Michigan and Ohio for use at planting, with preharvest intervals and precautions.

- Insecticides are grouped by active ingredient(s), which are listed alphabetically, allowing for easy comparison of products with the same chemistry
- Application rates are listed for pests which appear on the manufacturer label; if a column is blank, the pest is not on the label. The letters in the pest columns refer to the label use rate from column two.
- Note that insecticide rates per 1000 feet of row are based on a **30-inch row spacing**. See label for specific per-acre rate and gauge-setting charts for narrower row spacing.
- Acronym: CRW - Corn rootworm

Active ingredient Trade Names	**Labelled rate(s)** per 1000 feet of row or per acre	**cutworm**	**CRW larvae**	**white grubs**	**seedcorn maggot**	**slugs & snails**	**wireworm**	**Precautions and Remarks**
bifenthrin (granular) Empower2	(a) 3.2 - 8 oz in furrow or 6.4 - 8 oz T-band per 1000 ft (= 3.4 - 8.7 lbs/acre) (b) 8 oz per 1000 ft (= 8.7 lbs/acre)	a	b	a	a		a	• Do not apply as a T-band application, unless you can incorporate granules into top 1 inch of soil using tines or chains • Rootworm rate controls light to moderate larval pressure
bifenthrin (liquid) Bifen 2 Ag Gold Bifenthrin 2EC Bifenture EC Brigade 2EC Discipline 2EC Fanfare EC, 2EC, ES Sniper & Sniper Helios	(a) 0.15 - 0.30 oz per 1000 ft (= 2.6 - 5.2 oz/acre) (b) 0.30 oz per 1000 ft (= 5.12 oz/acre)	a	b	a	a		a	• Apply as a 5-7 inch T-band over the open seed furrow • In-furrow pop-up fertilizer may be applied alone or in tank mixes with bifenthrin; see label for instructions • Some labels say 'Do not apply to soil with >30% crop residue' • See label for separate instructions on pre-plant incorporated (PPI) or pre-emerge applications (PRE) with herbicides Note: Bifenture LFC and Capture LFR labels specifically support a rate of 8.5 oz per acre to control Asiatic garden beetle grubs in Michigan and Ohio
Xpedient Plus V Tundra EC	(a) 0.15 - 0.60 oz per 1000 ft (= 2.6 - 10.24 oz/acre) (b) 0.30 - 0.75 oz per 1000 ft (= 5.2 - 12.8 oz/acre)							
Bifender FC	(a) 0.17 - 0.67 oz per 1000 ft (= 2.9 - 11.6 oz/acre) (b) 0.34 - 0.84 oz per 1000 ft (= 5.9 - 18.2 oz/acre)							
Annex LFR Sniper LFR	(a) 0.20 - 0.39 oz per 1000 ft (= 3.4 - 6.8 oz/acre) (b) 0.39 - 0.49 oz per 1000 ft (= 6.8 - 8.5 oz/acre)							
Bifenture LFC Capture LFR	a) 0.20 - 0.78 oz per 1000 ft (= 3.4 - 13.6 oz/acre) (b) 0.39 - 0.98 oz per 1000 ft (= 6.8 - 17.0 oz/acre)							
Capture 3RIVE3D	(a) 0.23 - 0.92 oz per 1000 ft (= 4 - 16 oz/acre) (b) 0.46 - 0.92 oz per 1000 ft (= 8 - 16 oz/acre)							

Active ingredient Trade Names	**Labelled rate(s)** per 1000 feet of row or per acre	**cutworm**	**CRW larvae**	**white grubs**	**seedcorn maggot**	**slugs & snails**	**wireworm**	**Precautions and Remarks**
bifenthrin + biofungicide *(Bac. amyloliquefaciens)* Ethos XB	a) 0.2 - 0.98 oz per 1000 ft (= 3.4 - 17.0 oz/acre) (b) 0.39 - 0.98 oz per 1000 ft (= 6.8 - 17.0 oz/acre)	a	b	a	a		a	• Contains a biological fungicide strain for suppression of early-season root diseases; otherwise similar to bifenthrin
bifenthrin+ **cypermethrin (zeta)** Hero Hero EW	 (a) 4.0 - 10.3 oz/acre (a) 4.5 - 11.2 oz/acre	a		a	a		a	• Apply in-furrow or as a 3-4 inch T-band for seedcorn maggot, grub, and wireworm control; apply on the soil surface in a 5-7 inch band or broadcast for cutworms • Max 41.2 (Hero) and 44.8 (Hero EW) oz per acre per season for all uses; see label for max use rates for all bifenthrin products combined
chlorethoxyfos **+ bifenthrin** Index At-Plant Liquid Smartchoice HC (Smartbox)	 (a) 0.44 - 0.72 oz (b) 0.65 - 0.72 oz (a) 1.0 - 1.67 oz (b) 1.5 - 1.67 oz	a	b	a	a		a	• Apply in-furrow only (do not apply T-band or other banded application); apply Index in a minimum of 2 gal water per acre • Must be applied with an enclosed tractor cab and a closed handling system, e.g., a 'Dosatron' or modified Raven system for Index or the Smartbox system for Smartchoice • 30-day rotational interval for all crops except corn (anytime) • Index has a special 2ee label for Asiatic garden beetle control in MI and OH
cyfluthrin Baythroid XL Tombstone Tombstone Helios	(a) 2.0 - 2.8 oz per 1000 ft (= 35 - 49 oz/acre)				a		a	• Application may suppress white grubs • Apply in water or in pop-up fertilizer, in open furrow ahead of closing wheel • Do not mix with fertilizers containing zinc • Max 11.2 oz total per acre per year
cyhalothrin (lambda) Kendo LambdaStar Lambda-Cy Lambda-T Lambda Cy 1EC Paradigm VC Silencer Grizzly Too Lamcap II Province II Warrior II	(a) 0.66 oz per 1000 ft (= 11.5 oz/acre) (a) 0.33 oz per 1000 ft (= 5.75 oz/acre)	a	a	a	a		a	• Apply in-furrow, as a T-band, or a 7-inch band behind the press wheel • Max 0.12 lbs of active ingredient per acre per year from at-plant + foliar applications • Do not harvest, graze, or cut treated crop for feed within 21 days of application
iron phosphate Sluggo	(a) 20 - 44 lbs/acre					a		• Product includes a bait to attract slugs • Pellets must be broadcast across field • Apply in evening before slugs are active
metaldehyde Deadline GT Deadline MPs	(a) Maximum 33.3 lbs/ acre (a) Maximum 25 lbs/acre					a		• Products include a bait to attract slugs • GT formulation has uniform prills ideal for blending with dry fertilizer • Apply in evening just before slugs are active, especially after a rain or irrigation • Label has specific application instructions • Note: Fatal to some domestic animals (especially dogs)
permethrin Pounce 1.5G Arctic 3.2EC Permastar Ag Perm-Up 3.2EC	(a) 8 oz per 1000 ft (=8.7 lbs/acre) (a) 0.3 oz per 1000 ft (= 6 oz/acre)	a			a		a	• Apply in-furrow, band, or T-band • Check label for specific instructions for pre-emergence or pre-plant incorporated applications

Active ingredient Trade Names	**Labelled rate(s)** per 1000 feet of row or per acre	**cutworm**	**CRW larvae**	**white grubs**	**seedcorn maggot**	**slugs & snails**	**wireworm**	**Precautions and Remarks**
tebupirimphos + cyfluthrin Aztec 4.67G Defcon 4.67G Aztec HC for SmartBox Aztec HC SmartCartidge	(a) 3 oz per 1000 ft (= 3.27 lbs/acre) (a) 1.5 oz per 1000 ft (= 1.63 lbs/acre)	a	a	a	a		a	• Apply in-furrow, as a T-band, or a 7-inch band behind the press wheel; incorporate as instructed on label • Apply in-furrow or T-band for optimal control of all pests except cutworms. For cutworms, apply as a band or T-band • 30-day rotation for all crops except corn • Will not interact with corn herbicides
tefluthrin Force 6.5G Force 10G Smartbox Force 10G SmartCartidge Force EVO	(a) 1.8 - 2.3 oz /1000 ft (= 2.0 -2.3 lbs) (a) 1.25 - 1.5 oz /1000 ft (= 1.4 - 1.6 lbs/ acre) (a) 0.46 - 0.57 oz per 1000 ft (= 8-10 fl oz/acre)	a	a	a	a		a	• Apply in-furrow (optimal method for all pests except cutworm) or as a T-band • Use highest rate for heavy infestations • Make only one application per year • See label for specific instructions on how to make and incorporate applications of granular formulations at cultivation within 30 days of seedling emergence
terbufos Counter 20G (Lock'N Load, Smartbox, or SmartCartidge)	 (a) 4.5-6 oz per 1000 ft (4.9-6.5 lbs/acre)		a	a	a		a	• Apply in-furrow or as a 7-inch band over the row; max 6.5 lbs per acre per year • If crop debris prevents proper placement of granules, an in-furrow application is recommended; in-furrow applications also reduce run-off from rain • Application also controls flea beetle and corn nematodes, and may suppress cutworm • DO NOT use an ALS-inhibiting herbicide if Counter has been applied at planting

Corn Table 6: Foliar insecticides registered on field corn in Michigan and Ohio, with preharvest intervals and precautions.

- Insecticides are grouped by active ingredient(s), which are listed alphabetically, allowing for easy comparison of products with the same chemistry.
- Letters under a pest name indicate which rate to use from the previous column. If a letter is not listed, that pest is not on the label.
- Acronyms: CRW - corn rootworm; ECB - European corn borer; WBC - western bean cutworm

Active ingredient Trade Names	**Labelled rate(s)** per acre (unless specified)	**aphids**	**CRW adults**	**cutworm**	**ECB**	**fall armyworm**	**flea beetle**	**grasshoppers**	**Japanese beetle**	**spider mite**	**stink bugs**	**true armyworm**	**WBC**	**Pre-harvest interval (PHI) in days**	**Precautions and Remarks**
***Bacillus thuringiensis* (Bt)** subspecies *aizawai* Agree WG Xentari Insecticide subspecies *kurstaki* BioBit HP Dipel 10G Dipel ES Javelin WG	 (a) 1.0 - 2.0 lbs (a) 0.5 - 2.0 lbs (a) 0.5 - 2.0 lbs (a) 10 lbs in whorl (a) 1.5 - 4.0 pints (a) 0.25 - 1.5 lbs				a	a						a	*	0	• Selective biological insecticide to control caterpillars. Larvae must eat treated foliage to be controlled so good coverage is important. Must be targeted on small (1st - 2nd stage) larvae • All listed here can be used on organic crops, except Dipel ES * Western bean cutworm is on the Dipel ES label Corn earworm (not in this table) is on many Bt labels too
bifenthrin Bifenthrin 2EC Bifenture EC Brigade 2EC Discipline 2EC Fanfare EC, 2EC, & ES Sniper & Sniper Helios Tundra EC Bifender FC	(a) 2.1 - 6.4 oz (b) 5.1 - 6.4 oz (a) 2.4 - 7.4 oz (b) 5.9 - 7.4 oz	a	a	a	a	a	a	a	a	b	a	a	a	30	• Max 0.3 lb per acre active ingredient for all applications • Do not apply as a ULV (ultralow volume) application • Do not apply if heavy rainfall is imminent • Check label for Bee Warning
bifenthrin + biofungicide Ethos XB	(a) 2.8 - 8.5 oz (b) 6.8 - 8.5 oz	a	a	a	a	a	a	a	a	b	a	a	a	30	• Contains a biological fungicide strain *(Bacillus amyloliquefaciens)*; otherwise, similar to bifenthrin
bifenthrin+ cypermethrin (zeta) Hero Hero EW Steed	(a) 2.6 - 6.1 oz (b) 4.0 - 10.3 oz (c) 10.3 oz (a) 2.8 - 6.7 oz (b) 4.5 - 11.2 oz (c) 11.2 oz (a) 2.5 - 3.5 oz (b) 3.5 - 4.7 oz	b	b	a	b	b	a	b	b	c	b	b	a	30 grain 30 graze 60 forage	• Max 41.2 (Hero), 44.8 (Hero EW), or 18.7 (Steed) oz per acre per season for all uses; see label for max use rates for all bifenthrin products combined • Do not apply as a ULV (ultralow volume) application • Do not apply if heavy rainfall is imminent • Spider mite is not listed on the Steed label • Check label for Bee Warning

Active ingredient Trade Names	**Labelled rate(s)** per acre (unless specified)	**aphids**	**CRW adults**	**cutworm**	**ECB**	**fall armyworm**	**flea beetle**	**grasshoppers**	**Japanese beetle**	**spider mite**	**stink bugs**	**true armyworm**	**WBC**	**Pre-harvest interval (PHI) in days**	**Precautions and Remarks**
carbaryl Carbaryl 4L Sevin 4F Sevin XLR Plus	(a) 1 - 2 qts (b) 1.5 - 2 qts (c) 2 qts		a	c	b	a	a		a			a	c	14 silage 14 graze 48 grain	• Max 8 quarts per acre and 4 applications per year • REI = 24 hours. Exception: REI of 21 days for workers detasseling seed corn • Check label for Bee Warning
chlorantraniliprole Coragen Prevathon	(a) 3.5 - 5.0 oz (a) 14 - 20 oz				a	a						a	a	14 grain 1 seed	• Do not make more than 2 sequential applications
chlorantraniliprole + lambda-cyhalothrin Besiege	(a) 5 - 10 oz (b) 6 - 10 oz		b	a	b	b	b	b	b		b	b	a	21	• Max 31 oz per acre per year • Minimum 7 days between applications • Use higher rates for heavier infestations • Check labels for specifics on max application rates of products containing gamma & lambda cyhalothrin
cyfluthrin or beta cyfluthrin Baythroid XL Tombstone Tombstone Helios	(a) 0.8 - 1.6 oz (b) 1.6 - 2.8 oz (c) 2.8 oz		b	a	b	c	a	c	b		b	b	b	21 grain 21 fodder 0 forage	• Max 2.8 oz per acre allowed per 7-day interval • Max 11.2 oz per acre and 4 applications per year • Check label for Bee Warning
cyhalothrin (gamma) Declare Proaxis	(a) 1.0 - 1.5 oz (b) 1.5 oz (a) 1.92 - 3.2 oz (b) 2.56 - 3.84 oz	b	b	a	b	b	b	b	b		b	b	a	21 grain 21 silage	• Max 0.38 (Declare) or 0.96 (Proaxis) pints per acre. • Bee Warning: Highly toxic to bees. Do not apply to pollinating corn or drift to flowering weeds if bees are visiting field. • Check labels for specifics on max application rates of products containing gamma & lambda-cyhalothrin
cyhalothrin (lambda) Kendo LambdaStar Lambda-Cy Lambda-T Lambda Cyhalothrin 1EC Paradigm VC Silencer Grizzly Too Lamcap II Province II Warrior II	(a) 1.92 - 3.20 oz (b) 2.56 - 3.84 oz (a) 0.96 - 1.60 oz (b) 1.28 - 1.92 oz		b	a	b	b	b	b	b		b	b	a	21	• Max 0.12 lbs of active ingredient per acre per year from at-plant + foliar applications • For armyworm, only small caterpillars (1st & 2nd instars) are controlled • Check labels for specifics on max application rates of products containing gamma & lambda cyhalothrin • Check label for Bee Warning

Active ingredient Trade Names	**Labelled rate(s)** per acre (unless specified)	**aphids**	**CRW adults**	**cutworm**	**ECB**	**fall armyworm**	**flea beetle**	**grasshoppers**	**Japanese beetle**	**spider mite**	**stink bugs**	**true armyworm**	**WBC**	**Pre-harvest interval (PHI) in days**	**Precautions and Remarks**
cypermethrin (alpha) Fastac CS Fastac EC	(a) 1.3 - 2.8 oz (b) 1.8 - 3.8 oz (c) 2.7 - 3.8 oz (d) 3.2 - 3.8 oz	c	c	a	c	d	c	c	c		c	d	b	30 grain 60 forage	• Max 11.4 oz per acre, including both soil and foliar applications. • Do not use other products containing cypermethrin or zeta-cypermethrin during the same year as this product • Check label for Bee Warning
cypermethrin (zeta) Mustang Mustang Maxx	(a) 1.4 - 3.0 oz (b) 1.9 - 4.3 oz (c) 2.9 - 4.3 oz (d) 3.4 - 4.3 oz (a) 1.3 - 2.8 oz (b) 1.8 - 4.0 oz (c) 2.7 - 4.0 oz (d) 3.2 - 4.0 oz	c	c	a	c	d	c	c	c		c	d	b	7	• Max 17.2 (Mustang) or 16 oz (Maxx) per acre • Check label for Bee Warning
deltamethrin Delta Gold	(a) 1.0 - 1.5 oz (b) 1.5 - 1.9 oz	b	b	a	b	b	a	a	b		b	b		12 silage 12 graze 21 grain	• Max 8.1 oz per acre and 5 applications per year • Make applications at least 21 days apart
dimethoate Dimate 4E Dimethoate 4EC & 400	(a) 1 pint	a	a					a						14 silage 28 grain	• Max 1 pint per year • REI = 48 hours. Exception: REI of 4 days for detasseling • Check label for Bee Warning
esfenvalerate Asana XL S-Fenvalostar Zyrate	(a) 2.9 - 5.8 oz (b) 5.8 - 9.6 oz (c) 7.8 - 9.6 oz	b	b	b	c		b	b	b			b	a	21 grain 1 seed	• Check label for Bee Warning
etoxazole Zeal or Zeal WSP Zeal SC	(a) 1 - 3 oz (a) 2 - 6 oz									a				21	• Max 6 oz per acre and 2 applications per year. • Make applications at least 14 days apart • For resistance management, alternate with a different miticide
flupyradifurone Sivanto 200SL Sivanto HL Sivanto Prime	(a) 7.0 - 10.5 oz (a) 3.5 - 7.0 oz (a) 7.0 - 14.0 oz	a												7 forage 21 grain	• Systemic insecticide, effective on sucking pests • Also controls whiteflies
hexythiazox Onager	(a) 10-24 oz									a				30	• Limit of 1 application per year
indoxacarb Steward	(a) 6.0 - 11.3 oz				a	a							a	14 grain 1 forage 1 silage	• Label also lists suppression of stink bugs and Japanese beetle

Active ingredient Trade Names	**Labelled rate(s)** per acre (unless specified)	**aphids**	**CRW adults**	**cutworm**	**ECB**	**fall armyworm**	**flea beetle**	**grasshoppers**	**Japanese beetle**	**spider mite**	**stink bugs**	**true armyworm**	**WBC**	**Pre-harvest interval (PHI) in days**	**Precautions and Remarks**
malathion Malathion 5 and 5EC Fyfanon ULV Ag	(a) 1.5 pints (a) 4-8 oz	a	a					a						7	• Max 2 applications per year • REI = 12 hours. Exception: REI of 3 days for detasseling • ULV formulation be applied by air or ground using specialized equipment; aphids are not listed on the Fyfanon ULV label •
methomyl Annihilate LV Lannate LV Nudrin LV Annihilate SP Corrida 90WSP Lannate SP Nudrin SP	(a) ¾ - 1½ pints (a) ¼ - ½ pints	a	a		a	a	a					a		21 grain 3 forage 21 stover	• Check label for Bee Warning
methoxyfenozide Intrepid 2F	(a) 4 - 16 oz				a							a	a	21	• Max 64 oz per acre per season
permethrin Perm-Up 25DF Pounce 25WP Arctic 3.2EC Permastar Ag Perm-Up 3.2EC	(a) 6.4 - 9.6 oz (b) 3.2 - 6.4 oz (a) 4 - 6 oz (b) 2 - 4 oz		a	a	a	a	a					a	b	30 grain 0 forage	
permethrin (granular) Pounce 1.5G	(a) 6.7 - 10 lbs			a	a	a						a		30 grain 0 forage	• Broadcast by air or with ground equipment, directing granules into the whorl
pyrethrins Evergreen EC 60-6 PyGanic EC 1.4 II PyGanic Specialty	(a) 2.0 - 12.6 oz (a) 16 - 64 oz (a) 4.5 - 15.6 oz	a	a	a	a	a	a	a	a		a	a	a	0 when sprays dry	• Plant-derived insecticides that knock down insects quickly but have very short residual control. Coverage is critical • Max 10 applications per season, min. 3-day spray interval • PyGanic is OMRI listed for use on organic crops; Evergreen does not have OMRI certification because it contains PBO • Highly toxic to bees exposed to direct treatment; do not apply on or drift onto blooming crops or weeds
spinetoram Radiant SC	(a) 3 - 6 oz				a	a						a	a	28 grain 3 forage 1 seed	• Max 36 oz per acre per season • For resistance management, no more than 2 consecutive application of spinetoram or spinosad

Active ingredient Trade Names	**Labelled rate(s)** per acre (unless specified)	**aphids**	**CRW adults**	**cutworm**	**ECB**	**fall armyworm**	**flea beetle**	**grasshoppers**	**Japanese beetle**	**spider mite**	**stink bugs**	**true armyworm**	**WBC**	**Pre-harvest interval (PHI) in days**	**Precautions and Remarks**
spinosad Blackhawk Tracer	(a) 1.67 - 3.3 oz (b) 2.2 - 3.3 oz (a) 1 - 3 oz (b) 2 - 3 oz				a	a						a	b	28 grain 1 seed	• Important to time sprays with egg hatch • PHI for forage is 7 days (Blackhawk) or 3 days (Tracer)
spiromesifen Oberon 2SC	(a) 5.7 - 16 oz									a				5 silage 30 grain	• Max 17 oz per acre and 2 applications per year • Make applications at least 14 days apart • Active against all mite stages, including eggs • Complete coverage is important. Adjuvants may be used to improve coverage
sulfoxaflor Transform WG	(a) 0.75 - 1.5 oz	a												14 grain 7 grazing 7 forage	• Translaminar product, moves in leaf to target sucking pests • "Do not apply product 3 days before bloom, or until after seed set"

MSU-OSU Field Crops Insect Guide: Management of Insects in Alfalfa and Grass Forage
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Chris DiFonzo, Field Crops Entomologist
Michigan State University
Department of Entomology
288 Farm Lane
East Lansing, MI
difonzo@msu.edu

Kelley Tilmon, Field Crops Entomologist
The Ohio State University
Department of Entomology
1680 Wooster Ave
Wooster, OH
tilmon.1@osu.edu

How to Use this Guide

This publication is set up as a series of stand-alone tables with information on insect biology, damage, management recommendations, and insecticides registered in Michigan and Ohio on **alfalfa and grass hay.** Pesticide names and rates are current as of the date at the top of the page.

- ✓ **Table 1** shows the timing of common insect pests in the crop, from early to late season.

- ✓ **Table 2** is a checklist of damage symptoms from these insects to aid in field scouting.

- ✓ **Table 3** has information on the life cycle of each insect, plus a detailed description of its damage and the conditions that may lead to or favor infestations. A rating of pest status (and thus damage potential) is given based on experience in the state. Most insect pests are uncommon or do not increase to damaging levels in a typical year.

- ✓ **Table 4** has information on management of each pest. Most insects are kept in check by natural enemies (biological control) or by adverse environmental conditions. Some pest problems can be reduced by simply changing or avoiding certain agronomic practices. Table 4 also gives scouting and threshold recommendations. Note that these recommendations vary in quality. Key pests tend to have research-based scouting methods and thresholds. But many insects are not at damaging levels often enough to generate good information; sampling recommendations and thresholds for these species are based on observations, experience, or a best guess. This is noted in the table.

- ✓ Insecticides registered in Michigan and Ohio on the crop are listed in **Table 5** and **Table 6.** Active ingredients (AI) are listed alphabetically in column 1. All products with the same active ingredient are grouped together under each AI for easy comparison or substitution of one product for another. Label rates and pests are listed in columns 2 and 3. A letter under a pest indicates that a particular insect is on the label (i.e., the label claims control of that insect). The letter corresponds to an application rate in column 2. Some insecticides are applied at a single rate for all insects ('a'), while others vary ('a', 'b', 'c'). The final columns in the table list the preharvest interval (PHI) in days and notes on application - for example bee toxicity warnings, minimum recommended spray volumes, or other restrictions.

Forages Table 1: Timing of damage from common insects in Michigan and Ohio.
Pests are listed from early to late-season. Key species are highlighted in bold text.

Common name	Overwintering stage, location	April / May	June	July	August	Sept
alfalfa weevil	adults, in protected areas	Larval defoliation		(adults present)		
clover root curculio	adults, in protected areas		egg laying	larval feeding on roots		
white grubs	larvae (grubs), underground	damage to stand from root feeding				
true armyworm	Southern USA, migrates north	caterpillars feed on grasses in mixed stands or pasture				
potato leafhopper	Southern USA, migrates north	avg arrival ~20 May	overlapping generations of nymphs and adults suck plant sap from alfalfa leaves and stems			
spittlebug	eggs, on residue	nymphs suck plant sap		adults suck plant sap		
plant bugs	adults or eggs, in protected areas		nymphs and adults suck plant sap from alfalfa leaves and stems			
aphids (usually pea aphid)	eggs?		nymphs and adults suck plant sap from alfalfa leaves and stems			
caterpillars (multiple species)	depends on species		caterpillars feed on leaves of legumes, grass, or both			
grasshoppers (multiple species)	egg clusters, underground			nymphs, then adults, feed on leaves		
blister beetles (multiple species)	larvae, in soil cells			adult beetles feed on alfalfa leaves and blossoms		
fall armyworm	Southern USA, migrate north					
winter cutworm	larvae, under residue				caterpillars defoliate alfalfa late into fall; active in winter	

Forages Table 2: Damage checklist to aid in scouting for insects.

Plant part or timing Type of damage or injury	alfalfa weevil	aphids	blister beetles	caterpillars	clover root curculio	fall armyworm	grasshoppers	plant bug	potato leafhopper	spittlebug	true armyworm	white grubs	winter cutworm
Leaves													
small holes in leaves	x			x		x							
tip feeding	x												
large holes			x	x		x	x						x
irregular, ragged leaf feeding				x		x	x						
skeletonized 'frosted' appearance	x												x
complete defoliation - alfalfa						x							x
complete defoliation - grasses						x					x		
generalized leaf yellowing		x						x					
yellow leaf margins (hopperburn)									x				
red leaf margins									x				
leaves cupped or crinkled		x						x	x				
leaf drop									x				
sticky leaves or sooty mold		x											
spittle masses										x			
webbed, rolled leaves				x									
Roots													
root hairs missing												x	
pruning of whole roots												x	
chewing scars on taproots					x								
chewed furrows on taproots					x								
girdling of the taproot					x								
Stand													
stand thinning or weediness					x							x	
stand loss					x							x	
Other													
reduced forage quality									x				
shorter stand life	x				x				x			x	
cantharidin toxin in cut hay			x										

Forages Table 3: Life cycle, damage, and pest status of insects in alfalfa and grass hay.

Pest status is rated as follows. Rating applies to Michigan and Ohio

- Rare: Insect is *unusual, not found in most fields*
- Uncommon: Insect is present in many fields, but *typically not in damaging numbers*
- Occasional: Insect is present in most fields, *sometimes increasing to damaging levels*
- Important: Insect is present in most fields, *often increasing to damaging levels*; often a target of integrated management or insecticide use by growers

- Sporadic: Economic outbreaks may occur in certain fields or seasons after *extreme weather* or *mass movement* from south to north early in the season
- Localized: Economic outbreaks may occur in specific locations under *specific agronomic conditions*, for example, in no-till or in late plantings

Pest (abbreviation)	Life cycle and Number of generations	Description of Damage	Conditions which favor infestation or damage	Pest Status in MI & OH
alfalfa weevil	Adults (and some eggs) overwinter and become active when temps each 50F (~ 200 degree days). Adults lay eggs in stems. There are 4 larval stages, 80% of the feeding done by the 4th and last instar. By mid-June, development is complete, and weevils pupate in spun cocoons on the plant or in residue. Adults feed for a few weeks, then go into summer dormancy in protected areas outside the field. They re-emerge to feed for a time in late summer and early fall. One generation per year	• Small larvae feed in the folded terminals, chewing small holes. Older larvae feed on leaves throughout the plant • From a distance, heavily skeletonized foliage looks white, like frost damage • Repeated or heavy damage can reduce stand life by 1-2 yrs or lead to weedy stands	• Weevil populations build over time in older stands because adults overwinter nearby	Occasional Over threshold in some fields in some seasons
aphids *usually pea aphid*	Assumed overwintering as eggs. Summer population is all female. Females give birth to 12-14 live young per day and do not mate to reproduce (parthenogenesis). Multiple overlapping generations	• All stages suck plant sap from stems and leaves • Heavy infestation can lead to stunting, curling of leaves, and weakening of plants	• Nothing specific	Uncommon Always present, but not enough to cause damage
blister beetle	Eggs are laid in soil. Larvae of most species feed on grasshopper eggs, and thus are 'beneficial' in this sense. Larvae overwinter and adults emerge in spring. The beetles are distinctive with a round head, narrow 'neck', and loose wings that may not cover the abdomen. Multiple species are found in fields in the region.	• Body fluid of live and dead beetles has cantharidin, a chemical which blisters the mouth and digestive tract of livestock. Horses are very susceptible & can die after eating contaminated hay. Hay is contaminated when beetles are incorporated into bales at harvest • Cantharidin dose varies by blister beetle species •	• Grasshopper outbreaks (and thus a dry season) often precedes a bad blister beetle year • Beetles may be attracted to, and aggregate on, flowering alfalfa or weeds later in the season	Uncommon and Sporadic Usually an issue during or after a dry season
caterpillars *cloverworm, loopers, earworm*	Many species of caterpillars are found in legume forages. Some overwinter in the region, others migrate from the south	• Caterpillars feed on leaves and stems; a few species roll or web leaves	• Nothing specific	Uncommon Always present, but not enough to cause damage

Pest (abbreviation)	Life cycle and Number of generations	Description of Damage	Conditions which favor infestation or damage	Pest Status in MI & OH
clover root curculio	Adults overwinter and become active in early spring. Small larvae feed on root nodules, and larger larvae on lateral and taproot. Pupation is in soil. Adults feed for a few weeks, then go into summer dormancy. They re-emerge to feed for a time in late summer and early fall. One generation per year	• Feeding by small larvae on root nodules could reduce N fixation • Larger larvae create scars, tunnel roots, and girdle the taproot. The injury reduces nutrient flow and creates entry points for root pathogens • Damage accumulates each season. May reduce stand life	• Older stands, as injury accumulates • New seedings near older stands may be killed by beetles moving out of the older stand	Uncommon and Localized
fall armyworm	FAW is a tropical species that cannot survive freezing temperatures. Adult moths migrate north, arriving mid to late season. Eggs are laid on leaves. Larvae feed up on plants during the day. Pupation in soil. 1-3 generations, if temp is warm enough in August into fall. Larvae CANNOT overwinter in our area.	• Larvae prefer grasses but will eat legumes. Feeding starts on leaf margins; all leaves and small stems can be consumed under heavy infestations, leaving non-host weeds as the only vegetation in the field • Mass numbers may move into a field from adjacent crops (corn, wheat), ditches, or turf	• Strong winds from the SW carry moths northward • Warm conditions in late summer into fall can lead to several FAW generations • Grass hay or mixed stands are likely more attractive for egg laying	Uncommon and Sporadic Late-season outbreak in 2021 was the worst in ~30 years
grasshoppers *multiple species*	Eggs overwinter in soil. Nymphs emerge in June. Feeding increases with size. Females lay groups of eggs in the undisturbed soil in late summer. 1 generation per year	• Adults and nymphs chew on leaves; feeding has a ragged appearance	• Undisturbed forage fields and pasture are preferred egg-laying sites • A dry summer can lead to an outbreak the following year	Uncommon in alfalfa Sporadic in pasture Usually after a dry season
plant bugs *e.g alfalfa plant bug, lygus bug, & fleahopper*	Alfalfa plant bugs overwinter as eggs, while Lygus adults overwinter in residue and on field edges. Weeds and early season crops like alfalfa are preferred hosts. Probably one generation	• In legume forage, adults and nymphs suck plant sap; leaves may be curled or stunted • In legumes grown for seed, feeding damages blossoms and seeds, reducing germination	• Nothing specific	Uncommon Always present, but not enough to cause damage in forage fields
potato leafhopper (PLH)	Adults are carried into the region from the south on weather fronts in late May. Females insert eggs in stems. Nymphs hatch in 7-10 days, begin feeding immediately, and reach the winged adult stage in 2-3 weeks. Multiple overlapping generations	• Adults and nymphs lacerate and suck on leaves and stems, damaging cells and blocking vascular tissue • The classic symptom of feeding is tip yellowing or 'hopper burn' (this symptom may be red in some legumes) • Other symptoms include stunting and curling of leaves • Long term impacts are yield and quality loss and shorter stand life	• New seedings are very vulnerable • PLH damage is worse under dry conditions, and leafhopper survival is probably better as well	Sporadic *later in season*: Important, if populations become well established
spittlebug *meadow and two-lined*	Eggs hatch in spring. Nymphs of Meadow SB feed near the soil surface on forage plants or weeds and move higher as they grow. Two-lined SB, a species moving into the region, feeds on roots or stems near the soil surface for its entire juvenile stage. Nymphs of both species excrete and live in a spittle mass which protects them from predation and drying out. Adult spittlebugs lay eggs in late summer. One generation per year	• Adults and nymphs feed on dilute xylem sap moving from the roots into the plant; they must remove a lot of fluid to get nutrients • Early-season feeding by nymphs can result in plant stress, stunting, bunchy top growth, and yield loss • Losses of 10-40% reported for first-cutting yield especially if combined with alfalfa weevil damage	• Nymphs are present early in the season, so first cutting alfalfa is usually the most affected stage	Uncommon

Pest (abbreviation)	Life cycle and Number of generations	Description of Damage	Conditions which favor infestation or damage	Pest Status in MI & OH
true armyworm	Adult moths migrate into the region in early spring. Eggs are laid on grassy weeds or crops, where larvae (caterpillars) feed. Larvae pupate in the soil and adult moths emerge in a week. 2 to 3 generations per year	• Prefer to feed on the grass portion of mixed stands or in pastures, but will feed on legumes if forced to • Mass numbers may move into a field from adjacent crops (corn, wheat), ditches, or turf	• Nothing specific	Sporadic Outbreaks occur in years with a heavy spring flight from the south
white grubs *multiple species*	Adults (scarab beetles) emerge May-July, depending on species. Eggs are laid in the soil in the summer. Grubs feed on organic matter and roots, then move down in soil profile in late fall to overwinter. In spring, annual grub species feed for a period, then pupate. June beetle grubs have a longer life cycle and may continue feeding for several more years.	• Larvae (grubs) in general prune roots, causing wilting, deficiencies, or plant death • June beetle and European chafer feed in grass hay or pasture, creating dead areas • Asiatic garden beetle has been found in parts of alfalfa fields with a thin stand	• Populations of many grub species are higher in fields or parts of fields with sandy soil	Uncommon
winter cutworm *The adult moth is called the 'large yellow underwing'*	Winter cutworm is a European species which was first recorded in Canada in 1979. Moths lay eggs in the summer. Caterpillars feed on numerous hosts. The cold tolerant larvae feed well into fall and may emerge on sunny winter days (active on a 22^{o}F day in Traverse City MI in 2008). Larvae resume feeding very early in spring. Pupation occurs underground in May. One generation per year	• During outbreaks, larvae can defoliate alfalfa stands in fall. In mixed stands, they prefer to feed on alfalfa first • Late-season feeding reduces stubble that traps snow (thus increasing winter injury) and depletes root reserves (reducing spring growth) • New alfalfa seedings planted with an oat companion crop are attractive to moths for egg laying and may be thinned	• Nothing specific	Uncommon Michigan was the first state to report economic damage by this insect in forage crops

Forage Table 4: Management notes, scouting recommendations, and thresholds for insect pests of alfalfa and grass hay.

A 15-inch sweep net is a must for alfalfa, especially to monitor weevil and potato leafhopper. A supplier for nets in the Great Lakes region is Great Lakes IPM Inc in Vestaburg MI. Visit https://www.greatlakesipm.com/

Pest (abbreviation)	Notes on non-chemical and chemical management	Scouting recommendation	Spray threshold
alfalfa weevil	• Biological: Multiple egg, larval, and adult parasitoids (some introduced from the weevil's native range in Europe) often provide good, free control. Numerous predators eat weevils and a fungal pathogen kills larvae under humid conditions • Agronomic: If alfalfa is within 7-10 days of harvest, early cutting is the preferred way to reduce larval numbers while keeping numerous weevil parasitoids in the system. Check regrowth for survivors.	A sweep net is useful to detect weevil larvae Starting in early May, walk a pattern in the field & pick 50-100 stems into a sweep net or bucket; target older stands, since weevils overwinter locally	Threshold: • If it is more than 2 weeks until cutting: 40% of stems with feeding • On regrowth, after early cutting: 6-8 larvae per ft^2
aphids *usually pea aphid*	• Biological: Aphids are attacked by numerous predators (ladybugs, lacewings, syrphid fly larvae) & parasitoids which keep populations in check. Under humid conditions, entomopathogenic fungi wipe out aphids too • Host plant resistance: Most alfalfa varieties have some resistance to pea aphid • Environmental: Adequate moisture (rainfall or irrigation) reduces feeding stress and increases humidity for infection by fungal pathogens. Pea aphid populations tend to decline in mid-season when temps exceed 85°F.	Sweep netting can detect aphids colonizing fields Check plant stems for aphids, count # per stem	Guideline for alfalfa x plant height: • <10 inches: at least 50 aphids per stem • Over 10 inches: 100 aphids per stem Spraying rarely justified
blister beetle	• Agronomic: Beetles often aggregate on blossoms, so cut alfalfa prior to bloom. Crimping forage during harvest can kill beetles, so if they are present, cut forage and give them time to escape before baling. • Agronomic: First and second cutting hay has a lower chance of beetle contamination than later cuttings • Insecticides: Chemical control is difficult since residue must last thru harvest. Furthermore, dead beetles killed by insecticide may still end up harvested into bales	No specific recommendation Walk fields prior to harvest to check for aggregations of beetles	No specific recommendation
caterpillars *cloverworm, earworm, loopers*	• Biological: many predators feed on caterpillars • Agronomic: If alfalfa is within 7-10 days of harvest, early cutting is the preferred way to reduce caterpillar numbers; check regrowth for survivors	No specific recommendation	No specific recommendation See guidelines for FAW or TAW
fall armyworm (FAW)	• Biological: Predators and parasitoids kill larvae • Agronomic: If alfalfa or hay is within 7-10 days of harvest, early cutting is the preferred to reduce larval numbers; check regrowth for survivors • Insecticides: Applications are most effective on small larvae (less than ¾ inch). If caterpillars are invading from an adjacent field, a limited border treatment can save money. • Pesticide resistance: Note that pyrethroids may not be very effective on FAW, since it colonizes from the south where it is sprayed in multiple crops.	No specific recommendation. To detect flight into the region, use bucket pheromone traps starting in mid-July Fall seedings are particularly vulnerable & a priority for scouting	Guideline for small (< ¾ inch) larvae: 2 -3 per square foot
grasshoppers	• Biological: Blister beetle larvae prey on eggs. Insects, birds, and mammals eat nymphs & adults. Fungal pathogens kill eggs and nymphs under moist, cool conditions.	No specific recommendation	Guideline for hay or pasture x plant height • 6 inches: 8 per square yard • > 6 inches: 16 per square yard

Pest (abbreviation)	Notes on non-chemical and chemical management	Scouting recommendation	Spray threshold
plant bugs *alfalfa plant bug, lygus bug, fleahopper*	• Agronomic: Adult plant bugs will leave a field after cutting, pushing bugs into neighboring fields of other crops. This can be a problem for a crop like sugar beets or some vegetables, which are susceptible to damage and may need to be monitored	No specific recommendation	None Spraying is not recommended
potato leafhopper (PLH)	• Biological - A naturally occurring fungal pathogen kills PLH numbers under favorable conditions, usually by August • Agronomic: If alfalfa is within 7-10 days of harvest, early cutting is the best way to manage PLH; many eggs and nymphs will die. Check regrowth for survivors, and treat only if over threshold. • Host plant resistance: PLH-resistant glandular haired varieties trap nymphs and repel adults. The level of resistance varies plant by plant but overall, resistant stands can tolerate many more leafhoppers than regular alfalfa • Insecticides: Dynamic thresholds which vary with plant height x spray cost x hay value are available in extension bulletins or online	Using a sweep net, take 5 sets of 20 sweeps. Count the total # of PLH (adults and nymphs) Hint: Mark the net handle with inches and use it to measure the stand height	Economic threshold for alfalfa, based on #PLH in 100 sweeps: • < 3 inch = 20 • 4-7 inch = 50 • 8-11 inch = 100 • > 12 inch = 200 For resistant varieties: • New seeding, use the regular threshold • Older stands, use 3x the regular threshold
spittlebug *meadow and two-lined*	• Biological: Spittle masses protect nymphs from predation • Agronomic: Nymphs usually pupate before first cutting, so early cutting may be less of an option for control	No specific recommendation	Threshold: 1 or more spittle mass per stem
true armyworm (TAW)	• Biological: Predators, a tachinid parasitoid, and fungal pathogens all kill armyworm larvae • Agronomic: If alfalfa is within 7-10 days of harvest, early cutting is preferred to reduce larval numbers; check regrowth for survivors • Insecticides: If caterpillars are invading a forage crop from an adjacent field, a limited border treatment can be made	No specific recommendation Feeding occurs at night or on cloudy days - check for larvae or big frass pellets on the ground	Guideline for mixed stands or pasture: 4 to 6 larvae per ft^2 Note: For mixed stands, both alfalfa and grass hay must be on the label
white grubs	• Biological: Natural enemies keep grubs in check in most fields. Note: it is important to identify grubs to distinguish annual species like European chafer and Asiatic garden beetle from multiyear species of June beetles	In poor stands, use a shovel to check for grubs and root pruning Grubs tend to be patchy, infesting sandy parts of fields	None established There are no rescue treatments in hay and limited options in pasture
winter cutworm	• Biological: During outbreaks, numerous insects, birds, and mammals were recorded to feed on caterpillars • Insecticides: If caterpillars are invading a forage crop from an adjacent field, a limited border treatment can be made	No specific recommendation	None established Suggest using the guideline for FAW: 2 -3 per square foot

Forages Table 5: Foliar insecticides registered on alfalfa in Michigan and Ohio, with preharvest intervals and precautions.

- Insecticides are grouped by active ingredient(s), which are listed alphabetically, allowing for easy comparison of products with the same chemistry.
- Application rates are listed for pests which appear on the manufacturer label; If a column is blank, the pest is not on the label. The letters in the pest columns refer to the label use rate from column two.
- **NOTE: An insecticide must be registered on both alfalfa and grass to be used on intentionally-mixed stands.**

Active ingredient Trade Names	**Labelled rate per acre** (unless stated)	**alfalfa weevil**	**aphids**	**blister beetle**	**caterpillars**	**fall armyworm**	**grasshoppers**	**plant bugs**	**potato leafhopper**	**spittlebug**	**true armyworm**	**winter cutworm**	**Pre harvest interval (PHI) in days**	**Precautions and Remarks**
Bacillus thuringiensis (Bt) Agree WG Biobit HP Dipel ES Javelin WG Xentari	(a) 1.0 - 2.0 lbs (a) 0.5 - 2.0 lbs (a) 1.0 - 4.0 lbs (a) 0.25 - 1.5 lbs (a) 0.5 - 2.0 lbs				a	a					a		0	• Labeled for alfalfa, clover, many nongrass forage crops • Biological insecticides that must be eaten to kill; coverage important. Applications must be made when larvae are small • Check labels for specific caterpillars • Some products can be used in organic production
carbaryl Carbaryl 4L Sevin 4F Sevin XLR Plus	(a) 0.5 - 1.0 quart (b) 1.0 quart (c) 1.0 - 1.5 quart (d) 1.5 quart	d		a	c	c		c	b		c	c	7 harvest & grazing	• Labeled for "alfalfa, clover, birdsfoot trefoil" • On dense growth apply in 25-40 gal water for good coverage • Max 1.5 quarts per cutting • May temporarily bleach tender foliage • Bee caution: Do not apply to blooming crops or weeds
chlorantraniliprole Coragen Prevathon Vantacor	(a) 3.5 - 7.5 oz (b) 2.0 - 5.0 oz (a) 14.0 - 20.0 oz (b) 8.0 - 20.0 oz (a) 1.2 - 2.5 oz (b) 0.7 - 1.7 oz				a	a	b				a		0	• Labeled for "non-grass animal feeds" including alfalfa • Max 1 application per cutting • See Prevathon label for specific adjuvants and spray timings related to grasshopper control
chlorantraniliprole + cyhalothrin (lambda) Besiege	(a) 5.0 - 8.0 oz (b) 6.0 - 10.0 oz	b	b	b	a b	b	b	b	a	b	b	a	1 forage 7 dry hay	• Labeled for alfalfa • Max 1 application per cutting • Pest note: Check labels for specific rates x caterpillar species • Spray when bees are not foraging (early morning or evening)

Active ingredient Trade Names	**Labelled rate per acre** (unless stated)	**alfalfa weevil**	**aphids**	**blister beetle**	**caterpillars**	**fall armyworm**	**grasshoppers**	**plant bugs**	**potato leafhopper**	**spittlebug**	**true armyworm**	**winter cutworm**	**Pre harvest interval (PHI) in days**	**Precautions and Remarks**
cyfluthrin Baythroid XL Tombstone Tombstone Helios	(a) 0.8 - 1.6 oz (b) 1.6 - 2.8 oz (c) 2.0 - 2.8 oz	b			a b	b	c	b	a	a	b	a	7 grazing harvest	• Labeled for alfalfa (for mixed stands, see Table 6) • Max 5.6 oz per cutting • Pest note: Check labels for specific rates x caterpillar species • Fall armyworm = control of 1st & 2nd instars only • Helios formulation has UV protection for extended residual
cyhalothrin (gamma) Declare Proaxis	(a) 0.77-1.28 oz (b) 1.02 - 1.54 oz (a) 1.92 - 3.20 oz (b) 2.56 - 3.84 oz	b	b	b	a b	b	b	b	a	b	b	a	1 forage 7 hay	• Labeled for alfalfa (pure stands) • Pest note: Check labels for specific rates x caterpillar species • Spray when bees are not foraging (early morning or evening)
cyhalothrin (lambda) Grizzly Too Kendo 22.8CS Lamcap II Province II Warrior w/Zeon Tech. Grizzly Z Kendo Lambda Cyhalothrin 1EC Lambda-Cy & Lambda-Cy Ag LambdaStar Lambda-T Paradigm VC Silencer Willowood Lambda-Cy1EC	(a) 0.96 - 1.60 oz (b) 1.28 - 1.92 oz (a) 1.92 - 3.20 oz (b) 2.56 - 3.84 oz	b	b	b	a b	b	b	b	a	b	b	a	1 forage 7 hay	• Labeled for alfalfa (pure stands) only • Spray when bees are not foraging (early morning or evening) • Fall armyworm: some labels indicate control of 1st & 2nd instars only
cypermethrin (alpha) Fastac EC or CS	(a) 2.2 - 3.8 oz (b) 2.8 - 3.8 oz	a	a		a	b	b	b	a	a	b	a	3	• Labeled for alfalfa (not labeled for grasses) • Max 3.8 oz per cutting
cypermethrin (zeta) Mustang Mustang Maxx	(a) 2.4 - 4.3 oz (b) 3.0 - 4.3 oz (a) 2.24 - 4.0 oz (b) 2.8 - 4.0 oz	a	a		a	b	b	b	a	a	b	a	3	• Labeled for alfalfa and "nongrass animal feeds" like clover, trefoil, lupine, etc. • Max 8.0 oz (Mustang Maxx) or 8.6 oz (Mustang) per cutting

Active ingredient Trade Names	**Labelled rate per acre** (unless stated)	**alfalfa weevil**	**aphids**	**blister beetle**	**caterpillars**	**fall armyworm**	**grasshoppers**	**plant bugs**	**potato leafhopper**	**spittlebug**	**true armyworm**	**winter cutworm**	**Pre harvest interval (PHI) in days**	**Precautions and Remarks**
dimethoate Dimate 4E Dimethoate 400 and 4EC	(a) 0.5 - 1.0 pint		a				a	a	a				10	• Labeled for alfalfa (not labeled for grasses) • Max one application per cutting • Highly toxic to bees. Do not apply if bees are visiting the treated area when crop or weeds are in bloom
flupyradifurone Sivanto HL Sivanto 200 SL Sivanto Prime	(a) 3.5 - 7.0 (a) 7.0 - 10.5 oz (a) 7.0 - 14.0 oz		a						a				7	• Labeled for alfalfa (not labeled for grasses) • Systemic insecticide, effective on sucking pests • Max two applications per year
indoxacarb Steward	(a) 4.6 - 11.3 oz (b) 6.7 - 11.3 oz	b			b		a						7	• Labeled for alfalfa • Max 11.3 oz per cutting
methomyl Annihilate LV Lannate LV Nudrin LV Annihilate SP Corrida90WSP Lannate SP Nudrin SP	(a) 1.5 - 3.0 lbs (b) 3 lbs (a) 0.5 - 1.0 lb (b) 1 lb	b	a		a	a		a			a		7	• Labeled for alfalfa
methoxyfenozide Intrepid 2F	(a) 4 - 8 oz				a	a					a		0 grazing 3 hay	• Labeled for non-grass forages (alfalfa, clover, lupin, etc.) • Max 1 application per cutting and 32 oz per year • Must begin applications at first sign of feeding damage
permethrin Perm-Up 25DF Pounce 25WP Arctic 3.2 PermaStar AG Perm-Up 3.2EC	(a) 3.2 - 12.8 oz (b) 6.4 - 12.8 oz (a) 2 - 8 oz (b) 4 - 8 oz	b	a		a	a		b	b	b		a	0 or 14 see remarks on label	• Labeled for alfalfa. Do not apply to mixed stands with grasses or other legumes • Spray when bees are not foraging (early morning or evening) • PHI is 0 days at rates below 0.1 lb active ingredient [Ambush, Perm-Up25DF, & Pounce = 6.4 oz; Arctic, PermaStar & Perm-Up 3.2EC = 4oz] and 14 days above 0.1 lb
pyrethrins Evergreen EC 60-6 PyGanic EC 1.4 II PyGanic Specialty	(a) 2.0 - 12.6 oz (a) 16 - 64 oz (a) 4.5 - 15.6 oz	a	a	a	a	a	a	a	a	a	a	a	0 when sprays dry	• Plant-derived insecticides that knock down insects quickly but have very short residual control. Coverage is critical • Max 10 applications per season, min. 3-day spray interval • PyGanic is OMRI listed for use on organic crops; Evergreen does not have OMRI certification because it contains PBO • Highly toxic to bees exposed to direct treatment; do not apply on or drift onto blooming crops or weeds

Active ingredient Trade Names	**Labelled rate per acre** (unless stated)	**alfalfa weevil**	**aphids**	**blister beetle**	**caterpillars**	**fall armyworm**	**grasshoppers**	**plant bugs**	**potato leafhopper**	**spittlebug**	**true armyworm**	**winter cutworm**	**Pre harvest interval (PHI) in days**	**Precautions and Remarks**
sulfoxaflor Transform WG	(a) 0.75- 1.0 oz (b) 1.5 - 2.75 oz		a					b					7	• Labeled for alfalfa. Translaminar product, moves within leaf to target sucking pests • Max 2 applications per cutting

Forages Table 6: Foliar insecticides registered on pasture and grass hay in Michigan and Ohio, with preharvest intervals and precautions.

- Insecticides are grouped by active ingredient(s), which are listed alphabetically, allowing for easy comparison of products with the same chemistry.
- Application rates are listed for pests which appear on the manufacturer label; If a column is blank, the pest is not on the label. The letters in the pest columns refer to the label use rate from column two.
- **NOTE: An insecticide must be registered on both alfalfa and grasses to be used on intentionally-mixed stands.**

Active ingredient Trade Names	**Labelled rate per acre** (unless stated)	**caterpillars**	**fall armyworm**	**grasshoppers**	**spittlebug**	**true armyworm**	**white grubs**	**winter cutworm**	**Pre harvest interval (PHI) in days**	**Precautions and Remarks**
Bacillus thuringiensis (Bt) Agree WG Biobit HP Javelin WG Xentari	 (a) 1.0 - 2.0 lbs (a) 0.5 - 2.0 lbs (a) 0.25 - 1.5 lbs (a) 0.5 - 2.0 lbs	 a				 a			 0	• Labeled for grass forage, fodder, day • Biological insecticides that must be eaten to kill; coverage important. Applications must be made when larvae are small • Check labels for specific caterpillars • Can be used in organic production
carbaryl Carbaryl 4L Sevin 4F Sevin XLR Plus	 (a) 1.0 - 1.5 quart	 a	 a			 a			 14 grazing 14 harvest	• Labeled for pastures and grasses grown for forage, fodder, and hay • Max 3 quarts (2 applications) per year • Bee caution: Do Not apply to blooming crops or weeds
chlorantraniliprole Coragen Prevathon Vantacor	 (a) 3.5 - 7.5 oz (b) 2.0 - 5.0 oz (a) 14.0 - 20.0 oz (b) 8.0 - 20.0 oz (a) 1.2 - 2.5 oz (b) 0.7 - 1.7 oz	 a	 a	 b		 a			 0	• Labeled for "grass forage, fodder, and hay... that will be fed on or grazed by livestock", and pasture. Teff is also on the label • See Prevathon label for specific adjuvants and spray timings for grasshopper control
chlorantraniliprole + cyhalothrin Besiege	 (a) 5.0 - 8.0 oz (b) 6.0 - 10.0 oz	 b	 b	 b	 b	 b		 a	 0 grazing 7 harvest	• Labeled for pasture and "grass grown for hay or silage"
cyfluthrin Baythroid XL Tombstone Tombstone Helios	 (a) 1.6 - 1.9 oz (b) 2.6 - 2.8 oz	 a b	 b	 b	 a	 a		 a	 0 grass 7 mixed stands	• Labeled for grass, "grass for hay", "grass in mixed stands with alfalfa" • Pest note: Check labels for specific rate x caterpillar species • Fall armyworm = control of 1st & 2nd instars only • Helios formulation has UV protection for extended residual

Active ingredient Trade Names	**Labelled rate per acre** (unless stated)	**caterpillars**	**fall armyworm**	**grasshoppers**	**spittlebug**	**true armyworm**	**white grubs**	**winter cutworm**	**Pre harvest interval (PHI) in days**	**Precautions and Remarks**
cyhalothrin (gamma) Declare	(a) 0.77-1.28 oz (b) 1.02 - 1.54 oz	a b	b	b	b	b		a	0 grazing & forage 7 dry hay	• Labeled for pasture, "grass grown for hay or silage"
cyhalothrin (lambda) Warrior w/Zeon Tech. Grizzly Too Kendo 22.8CS Lamcap II Province II Grizzly Z Kendo Lambda Cyhalothrin 1EC Lambda-Cy Lambda-Cy Ag LambdaStar Lambda-T Paradigm VC Silencer Willowood Lambda-Cy1EC	(a) 0.96 - 1.60 oz (b) 1.28 - 1.92 oz (a) 1.92 - 3.20 oz (b) 2.56 - 3.84 oz	b	b	b	b	b		a	0 grazing & forage 7 dry hay	• Labeled for pasture, "grass grown for hay or silage" • Max 1.92 oz per cutting and 5.76 oz per season
cypermethrin (zeta) Mustang Mustang Maxx	(a) 2.4 - 4.3 oz (b) 3.0 - 4.3 oz (a) 2.24 - 4.0 oz (b) 2.8 - 4.0 oz	a	b	b	a	b		a	0 hay & forage	• Labeled for pasture, grass forage and hay • Max 4.0 oz (Mustang Maxx) or 4.3 oz (Mustang) per cutting
methoxyfenozide Intrepid 2F	(a) 4 - 8 oz		a			a			0 grazing 7 hay	• Labeled for grass forage, fodder, and hay • Max 1 application per cutting and 32 oz per year • Must begin applications at first sign of feeding damage
pyrethrins Evergreen EC 60-6 PyGanic EC 1.4 II PyGanic Specialty	(a) 2.0 - 12.6 oz (a) 16 - 64 oz (a) 4.5 - 15.6 oz	a	a	a	a	a		a	0 when sprays dry	• Plant-derived insecticides that knock down insects quickly but have very short residual control. Coverage is critical • Max 10 applications per season, min. 3-day spray interval • PyGanic is OMRI listed for use on organic crops; Evergreen does not have OMRI certification because it contains PBO • Highly toxic to bees exposed to direct treatment; do not apply on or drift onto blooming crops or weeds
spinosad Blackhawk Tracer	(a) 1.1 - 2.2 oz (a) 1.0 - 2.0 oz	a	a			a		a	0 forage 3 hay	• Labeled for pastures, grass crops • Must target egg hatch and small larvae

MSU-OSU Field Crops Insect Guide: Management of Insects in Small Grains
Updated: January 2022

Chris DiFonzo, Field Crops Entomologist
Michigan State University
Department of Entomology
288 Farm Lane
East Lansing, MI
difonzo@msu.edu

Kelley Tilmon, Field Crops Entomologist
The Ohio State University
Department of Entomology
1680 Wooster Ave
Wooster, OH
tilmon.1@osu.edu

How to Use this Guide

This publication is set up as a series of stand-alone tables with information on insect biology, damage, management recommendations, and insecticides registered in Michigan and Ohio on **wheat and other small grains.** Pesticide names and rates are current as of the date at the top of the page.

- ✓ **Table 1** shows the timing of common insect pests in the crop, from early to late season.

- ✓ **Table 2** is a checklist of damage symptoms from these insects to aid in field scouting.

- ✓ **Table 3** has information on the life cycle of each insect, plus a detailed description of its damage and the conditions that may lead to or favor infestations. A rating of pest status (and thus damage potential) is given based on experience in the state. Most insect pests are uncommon or do not increase to damaging levels in a typical year.

- ✓ **Table 4** has information on management of each pest. Most insects are kept in check by natural enemies (biological control) or by adverse environmental conditions. Some pest problems can be reduced by simply changing or avoiding certain agronomic practices. Table 4 also gives scouting and threshold recommendations. Note that these recommendations vary in quality. Key pests tend to have research-based scouting methods and thresholds. But many insects are not at damaging levels often enough to generate good information; sampling recommendations and thresholds for these species are based on observations, experience, or a best guess. This is noted in the table.

- ✓ Insecticides registered in Michigan and Ohio (except where noted) on the crop are listed in **Table 5.** Active ingredients (AI) are listed alphabetically in column 1. All products with the same active ingredient are grouped together under each AI for easy comparison or substitution of one product for another. Label rates and pests are listed in columns 2 and 3. A letter under a pest indicates that a particular insect is on the label (i.e., the label claims control of that insect). The letter corresponds to an application rate in column 2. Some insecticides are applied at a single rate for all insects ('a'), while others vary ('a', 'b', 'c'). The final columns in the table list the preharvest interval (PHI) in days and notes on application - for example bee toxicity warnings, minimum recommended spray volumes, or other restrictions.

Small Grains Table 1: Timing of damage from common insects and related pests.
Pests are listed from early to late-season. Key species are highlighted in bold text.

Common name	Overwintering stage, location	May	June	July	August	Sept
white grubs, especially European chafer	larvae (grubs), in soil	grubs feed on roots			grubs can destroy new stands by feeding on roots	
cereal leaf beetle	adults, in protected areas near field	larvae feed on leaves		adults feed on leaves		
true armyworm	Southern USA, migrate north	larvae feed on leaves first; may clip heads by mid June				
aphids	Southern USA, migrate north	sucking plant sap (on fall planted grain)		sucking plant sap (on spring planted grain)		BYDV spread (fall plantings)
Hessian fly	puparia (flax seed), on plants	larvae feed on lower stem				larvae feed on seedlings
grass sawfly	pupae, underground		caterpillars feed on wheat stems			
grasshoppers (multiple species)	egg clusters, underground			nymphs, then adults, defoliate plants		
fall armyworm	Southern USA, migrate north			larvae feed on leaves and strip plants under high infestations		

Small Grains Table 2: Damage checklist to aid in scouting for insects.

Plant part or timing Type of damage or injury	aphids	cereal leaf beetle	fall armyworm	grasshoppers	grass sawfly	Hessian fly	true armyworm	white grubs
Stand (emergence)								
wilted or stunted plants								x
gaps in row								x
fewer, or dead, tillers						x		x
widespread stand loss or thinning								x
Roots								
root hairs missing								x
pruning of whole roots								x
Leaf tissue								
feeding on/ scraping leaf surface		x						
skeletonizing		x						
irregular leaf feeding			x	x	x		x	
severe defoliation			x	x			x	
stems stripped of all leaves			x				x	
leaf yellowing from feeding	x							
leaf yellowing, reddening from virus	x							
leaves dark bluish-green						x		
field appears whitish or 'frosted'		x						
sticky leaves or head (honeydew)	x							
Stem								
short internodes and stems						x		
stunting of plants						x		
stems cut into small sections					x			
stem breakage, lodging						x		
Head								
awns clipped off							x	
heads clipped off					x		x	
Other								
barley yellow dwarf (BYDV) transmission	x							
large square frass pellets on ground							x	
numerous stem segments on ground					x			

Small Grains Table 3: Life cycle, damage, and pest status of insects in wheat and other small grains

Pest status is rated as follows. Rating applies to Michigan and Ohio.

- Rare: Insect is *unusual, not found in most fields*
- Uncommon: Insect is present in many fields, but *typically not in damaging numbers*
- Occasional: Insect is present in most fields, *sometimes increasing to damaging levels*
- Important: Insect is present in most fields, *often increasing to damaging levels*; often a target of integrated management or insecticide use by growers

- Sporadic: Economic outbreaks may occur in certain fields or seasons after *extreme weather* or *mass movement* from south to north early in the season
- Localized: Economic outbreaks may occur in specific locations under *specific agronomic conditions*, for example, in no-till or in late plantings.

Pest (abbreviation)	Life cycle and Number of generations	Description of Damage	Conditions which favor infestation or damage	Pest Status in MI & OH
aphids *usually English grain aphid, bird cherry-oat aphid, and corn leaf aphid*	English grain & corn leaf aphids probably move from the south, but bird cherry-oat aphid may be able to overwinter locally. The summer population is all female. Females give birth to multiple live nymphs per day and do not mate to reproduce (known as parthenogenesis). Multiple overlapping generations	• All stages suck plant sap from stems, leaves, and the head, removing water and nutrients • Heavy infestations are rare, but may stress plants and coat leaves and heads in sticky honeydew • Grain aphids, especially the bird cherry-oat aphid, transmit barley yellow dwarf virus; in winter wheat, infection is more serious if it occurs in fall	• A warm fall can extend aphid activity and result in BYDV transmission to winter wheat	Uncommon
cereal leaf beetle *Historic note: CLB was first found in the US in 1962, in Berrien County Michigan*	The handsome blue and red beetles overwinter in tree lines, wooded areas, and leaf litter near last year's wheat fields. Beetles colonize small grains in the early spring, laying eggs on leaves. The slug-like larvae feed by scraping the leaf surface, then pupate underground. Newly emerged adults feed for a short period on small grains, grasses, or corn leaves, then become inactive for the rest of the summer. They move to an overwintering spot in fall. 1 generation per year	• Larvae scrape or skeletonize long strips of leaf. The oldest larvae, which occur in May, do the most feeding • Fields with heavy feeding on the flag leaf appear white or frosted • Early, heavy feeding can reduce plant growth and yield	• CLB will feed on all small grains, but spring-planted cereals are preferred over fall-planted • Late-planted fields in the fall, or thin stands, may attract more beetles in spring • Hot spots can be impressive & tend to be on field edges near tree lines where adults overwinter • Tillage may reduce local parasitoid populations	Uncommon & Localized But may be increasing to 'occasional'
fall armyworm (FAW)	FAW is a tropical species that cannot survive freezing temperatures. Adult moths migrate north, arriving mid to late season. Eggs laid on leaves. Larvae feed on plants during the day. Pupation in soil. 1-3 generations, if temp is warm enough in August into fall. Larvae cannot overwinter in our area.	• Present later in the season, and thus a risk to winter wheat and fall planted cover crops • Feeding starts on leaf margins; all leaves and small stems can be consumed under heavy infestations.	• Strong winds from the SW carry moths northward • Warm conditions in late summer into fall can lead to several FAW generations	Uncommon and Sporadic Late-season outbreak in 2021 was the worst in ~30 years

Pest (abbreviation)	Life cycle and Number of generations	Description of Damage	Conditions which favor infestation or damage	Pest Status in MI & OH
grasshoppers *multiple species*	Eggs overwinter in soil. Nymphs emerge in June. Feeding increases with size with large nymphs and adults consuming the most. Females lay groups of eggs in the undisturbed soil in late summer. 1 generation per year	• Adults and nymphs chew on leaves, stems, or the head; feeding has a ragged appearance • Parts of leaves or the head may be clipped off	• Undisturbed forage, pasture, and field margins are preferred egg-laying sites, so damage may be greater on edges near these habitats • A dry summer can lead to higher populations the following year	Uncommon
grass sawfly	Sawflies are in the Order Hymenoptera, related to bees and wasps. Adults emerge in spring and lay eggs in April - early May. Larvae resemble caterpillars, but have 8 pairs of fleshy prolegs down the length of the body (vs 5 pairs for armyworm). Larvae are bright to light green. Older larvae have a distinct dark stripe like a raccoon mask between the eyes. In June, larvae drop to the ground and remain underground to pupate then overwinter. 1 generation per year	• Larvae feed on leaves, but more importantly they tend to clip heads; a single caterpillar may clip 10-12 heads before dropping to the ground • After clipping a head, larvae often continue to chop off pieces of the stem, apparently to feed on the fresh ends (this results in a pile of stem pieces littering the ground)	• On the East Coast, outbreaks tend to happen after an abnormally warm spring, which leads to more egg laying	Uncommon
Hessian fly	For winter wheat, adult flies emerge in fall and lay eggs on young plants. The mobile first stage maggots settle under leaf sheaths or in the crown to feed. Larvae are full grown before winter, overwintering in a protective shell (puparium) resembling a flax seed. Pupation occurs in spring, and adults emerge to infest wheat during stem elongation. Maggots of this generation feed and pupate under leaf sheathes. Pupae remain in wheat stubble until adult emergence in fall. 1 generation per year	• Maggot rasp the stem and rupture cells, effecting plant growth around the feeding site; leaf blades on damaged tillers are wide, erect, and darker green or bluish in color compared to healthy plants • Tillers infested <u>in fall</u> can be stunted or dead by spring, thinning the overall stand; Heads, if present, will be small • Stems infested <u>in spring</u> can be weak and lodge; heads may be smaller or poorly filled •	• Wheat fields planted near or into stubble of a previous wheat crop, a field with a wheat cover crop or volunteer wheat, or a wildlife plot; all of these are sources of infestation • Continuous no-till Note: Hessian fly is not an issue in oats or rye	Rare in Michigan Uncommon in Ohio
true armyworm (TAW)	Adult moths migrate north in early spring and lay eggs on small grains like wheat. Larvae develop in wheat and may move into neighboring crops, including corn. Larvae pupate in the soil and adults emerge in a week. 2 to 3 generations per year; the 1st generation is most damaging	• Larvae feed from the ground up, often eating the flag leaf last. Large numbers can totally defoliate a field, then move into a neighboring crop • Larvae also clip heads off, especially if most foliage is gone, leaving heads on the soil surface	• Nothing specific	Sporadic Outbreaks occur in years with a heavy spring flight from the south

Pest (abbreviation)	Life cycle and Number of generations	Description of Damage	Conditions which favor infestation or damage	Pest Status in MI & OH
white grubs *especially European chafer*	Adults (scarab beetles) emerge May-July, depending on species. Eggs are laid in the soil in the summer. The C-shaped larvae, or grubs, feed on organic matter and roots then move down in the soil profile in late fall to overwinter (note that Euro chafer grubs feed late into the fall). In spring, annual grub species like chafer feed for a period, then pupate. June beetle grubs have a longer life cycle and may continue feeding for several seasons.	• Larvae (grubs) prune roots, causing wilting, deficiencies, or plant death. Euro chafer attacks winter wheat in the fall and again in spring. June beetles may be present throughout the year • Heavy populations can thin or destroy areas of small grains; entire fields of winter wheat have been destroyed in the fall by European chafer • Adults of most species do not feed	• June beetle and Euro chafer grubs are more common in fields with sandy soil types	Uncommon When present, often localized to sandy areas

Small Grains Table 4: Management notes, scouting recommendations, and thresholds

Pest (abbreviation)	Notes on non-chemical and chemical management	Scouting recommendation	Spray threshold
aphids	• Biological: Aphids are attacked by numerous predators (ladybugs, lacewings, syrphids) & parasitoids which usually keep populations in check. These beneficials then move into neighboring crops later in the season. Under humid conditions, entomopathogenic fungi wipe out aphids. • Agronomic: Planting after the Hessian fly 'fly safe' date in the fall also reduces aphid infestation and BYDV transmission in winter wheat • Environmental: Adequate moisture (rainfall or irrigation) reduces aphid feeding stress and increases humidity for infection by fungal pathogens	Direct sampling: Count aphids on 100 tillers and calculate the average number per tiller Presence/absence method: Determine the number of tillers with aphids ('presence')	Direct sampling: 12-15 aphids per tiller in seedling to boot stage Presence/absence: See Table 4A for decision criteria
cereal leaf beetle	• Biological: After CLB was found in the US in the 1960s, it was the target of a highly successful biological control program. The parasitoids released by the USDA reduced CLB across the Midwest and they continue to provide free control, unless disrupted by spraying • Insecticides: Do not add an insecticide to a fungicide spray simply as insurance, since this disrupts biocontrol. This practice may be why CLB is reemerging as a pest for some growers. Since infestations often start on field edges, limit treatment to that area to preserve local parasitoid numbers.	Scout 20 plants in at least 5 sites in the field; Count the number of adult beetles, yellow eggs, and larvae	• Before boot: 3 or more eggs and/or larvae per stem • At heading: 1 or more larvae per stem
fall armyworm (FAW)	• Biological: Predators and parasitoids kill larvae • Agronomic: Planting after the Hessian fly 'fly safe' date in the fall should avoid FAW infestation • Insecticides: Applications are most effective on small larvae (less than ¾ inch)	No specific recommendation Note: To detect flight into the region, use bucket pheromone traps	• Rough Guideline: 2 or more larvae per foot of row
grasshoppers	• Biological: Blister beetle larvae prey on eggs and many animals eat nymphs and adults. Fungal pathogens kill eggs and nymphs under moist, cool conditions • Agronomic: Tillage reduces survival of eggs and newly hatched nymphs • Insecticide: May be able to limit spray area to the edge if hoppers invade from a neighboring field or grassy border	No specific recommendation Estimate number of hoppers per yd^2	Rough Guideline: • On the edge: > 15 nymphs or > 8 adults per yd^2 • Within a field: >3 hoppers per yd^2
grass sawfly	• Insecticides: Although they resemble caterpillars, sawflies larvae are not in the Order Lepidoptera. Instead, they are in the Order Hymenoptera, closely related to bees, wasps, and ants. Thus, insecticides registered for caterpillar control may not work as well on sawflies.	No specific recommendation	Untested guideline: Use a threshold of >2 larvae/ ft^2 at heading for the combo of armyworm and sawfly larvae Note: If larvae are >1 inch & have a dark bar on the head, it is probably too late to treat
Hessian fly	• Variety: Resistant varieties are readily available; these disrupt maggot feeding • Agronomic: Plant after the 'fly-safe' date for your area; most egg-laying flies will have died out by this time. See Table 4B for dates by county • Agronomic: Do not plant winter wheat near (within 400 yds) fields with wheat stubble. Tillage of wheat residue kills or buries puparia. Controlling volunteer wheat in harvested fields reduces egg laying sites. • Agronomic: If using a grass cover crop in your system, choose rye or oats, which are not a host for Hessian fly	In fall: Check stems for symptoms ~ 3 weeks after emergence In spring: Check for broken stems	No thresholds are established Manage Hessian fly using planting date and resistant varieties

Pest (abbreviation)	Notes on non-chemical and chemical management	Scouting recommendation	Spray threshold
true armyworm (TAW)	• Biological: Predators, a tachinid parasitoid, and fungal pathogens kill armyworm larvae • Insecticides: Protect the flag leaf from feeding, but if it is gone, treatments may be justified if the stem is still green and contributing to filling the head. Spraying with a ground rig is often more effective than aerial application in getting insecticide down into the canopy, but better coverage is balanced by yield loss from wheel tracks. • Insecticides: If caterpillars are present in just a part of the field, or if they are marching from one field to another, a limited spot or border treatment can be made. Remember, soybeans are a non-host and do not need to be sprayed!	Scout at least 5 sites in the field for leaf feeding and small larvae. Larvae hide during the day, so shake plants and check on the ground for caterpillars and frass pellets. Record the number and size of larvae. Note: Pheromone traps aid in timing of scouting	Before heading: 4 or more larvae / ft^2 At heading 2 or more larvae/ ft^2 • If heads are being clipped, lean towards spraying. If larvae are > 1 inch (nearing pupation) spraying is less effective
white grubs	• Biological: Natural enemies usually keep grubs in check Note: it is important to identify grubs to distinguish annual species like European chafer from multi-year species of June beetles	No specific recommendation In poor stands, use a shovel to check for grubs and root pruning; Grubs tend to be patchy, especially in sandy fields	No spray threshold A density of 4 chafer grubs per ft^2 can reduce stand and biomass. At this level of infestation, consider tillage before fall planting, or plant elsewhere

Small Grains Table 4A: Presence/ Absence decision table for aphids in wheat

Instructions: Presence/absence sampling involves sampling and classifying tillers simply as infested (aphids present) or not. Aphid species or number per tiller does not matter.

- *Start by picking 25 tillers. Count the number which are infested, then use the first line of the table to determine if you have enough information to make a decision (spray or do not spray) or if you need to sample 5 more tillers. Keep sampling groups of 5 tillers until a decision is reached, or 100 tillers are examined.*

	Cumulative number of infested tillers		
Total number of tillers examined	***Decision made:*** *Stop sampling & don't spray*	***No decision yet:*** *Keep sampling; Pick 5 more tillers*	***Decision made:*** *Stop sampling and spray*
25	< 18	19 - 24	25
30	< 22	23 - 29	30
35	< 27	28 - 34	35
40	< 31	32 - 39	40
45	< 35	36 - 43	44 - 45
50	< 40	41 - 48	49 - 50
55	< 44	45 - 53	54 - 55
60	< 48	49 - 58	59 - 60
65	< 53	54 - 62	63 - 65
70	< 57	58 - 67	68 - 70
75	< 61	62 - 72	73 - 75
80	< 66	67 - 77	78 - 80
85	< 70	71 - 81	82 - 85
90	< 75	76 - 86	87 - 90
95	< 79	80 - 91	92 - 95
100	< 84	84 - 100 tillers = spray	

Small Grains Table 4B: Hessian fly 'fly-safe' dates for Michigan and Ohio.

Based on your location (county), plant winter wheat after this date in the fall to avoid egg-laying by Hessian flies, as well as to reduce infestation by grain aphids which may transmit of barley yellow dwarf virus

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

OHIO			
County	**Date**	**County**	**Date**
Adams	Oct 4	Licking	Sept 29
Allen	Sept 26	Logan	Sept 28
Ashland	Sept 26	Lorain	Sept 23
Ashtabula	Sept 22	Lucas	Sept 22
Athens	Oct 2	Madison	Sept 30
Auglaize	Sept 27	Mahoning	Sept 25
Belmont	Sept 29	Marion	Sept 27
Brown	Oct 3	Medina	Sept 24
Butler	Oct 1	Meigs	Oct 3
Carroll	Sept 27	Mercer	Sept 27
Champaign	Sept 29	Miami	Sept 29
Clark	Sept 29	Monroe	Sept 30
Clermont	Oct 3	Montgomery	Sept 30
Clinton	Oct 2	Morgan	Oct 1
Columbiana	Sept 26	Morrow	Sept 27
Coshocton	Sept 28	Muskingum	Sept 29
Crawford	Sept 26	Noble	Sept 30
Cuyahoga	Sept 23	Ottawa	Sept 22
Darke	Sept 29	Paulding	Sept 24
Defiance	Sept 23	Perry	Sept 30
Delaware	Sept 28	Pickaway	Oct 1
Erie	Sept 23	Pike	Oct 3
Fairfield	Sept 30	Portage	Sept 24
Fayette	Oct 1	Preble	Sept 30
Franklin	Sept 30	Putnam	Sept 25
Fulton	Sept 22	Richland	Sept 26
Gallia	Oct 4	Ross	Oct 2
Geauga	Sept 23	Sandusky	Sept 23
Greene	Sept 30	Scioto	Oct 4
Guernsey	Sept 29	Seneca	Sept 24
Hamilton	Oct 3	Shelby	Sept 28
Hancock	Sept 25	Stark	Sept 26
Hardin	Sept 26	Summit	Sept 24
Harrison	Sept 28	Trumbull	Sept 23
Henry	Sept 23	Tuscarawas	Sept 28
Highland	Oct 3	Union	Sept 28
Hocking	Oct 1	Van Wert	Sept 26
Holmes	Sept 27	Vinton	Oct 3
Huron	Sept 24	Warren	Oct 2
Jackson	Oct 3	Washington	Oct 2
Jefferson	Sept 28	Wayne	Sept 26
Knox	Sept 28	Williams	Sept 22
Lake	Sept 22	Wood	Sept 23
Lawrence	Oct 5	Wyandot	Sept 26

Small Grains Table 5: Foliar Insecticides to manage insects in wheat and other small grains.

- Insecticides are grouped under their active ingredient(s), which are listed alphabetically. This allows for comparison of products with the same chemistry.
- Application rates are listed for pests which appear on the manufacturer label. The letter under the pest name indicates the label rate from the previous column. If a column is blank, the pest is not on the label.

Active ingredient Trade Names	**Labelled rate per acre** (unless stated)	**aphids**	**cereal leaf beetle**	**fall armyworm**	**grasshoppers**	**grass sawfly**	**Hessian fly**	**true armyworm**	**Pre harvest interval (PHI)** in days	**Precautions and Remarks**
Bt (*Bacillus thuringiensis*) Biobit HP & Xentari Dipel ES Javelin WG	(a) 0.5 - 2.0 lb (a) 2.0 - 4.0 pints (a) 1.0 - 1.5 lbs			a				a	0	• Labeled for wheat & barley, millet, oats, rye, triticale • Selective biological insecticide to control caterpillars. Larvae must eat treated foliage to be controlled so good coverage is important. Must be targeted on small (1st & 2nd instar) larvae
chlorantraniliprole Coragen Prevathon Vantacor	(a) 3.5 - 5.0 oz (b) 2.0 - 5.0 oz (a) 14.0 - 20.0 oz (b) 8.0 - 20.0 oz (a) 1.2 - 2.5 oz (b) 0.7 - 1.7 oz			a	b			a	1 grain 1 straw	• Labeled for wheat & barley, millet, oats, rye, sorghum, triticale • Novel mode of action - insect are paralyzed & stop feeding. Must be applied before populations reach damaging levels
chlorantraniliprole + cyhalothrin (lambda) Besiege	(a) 6 oz - 10 oz (b) 8 oz - 10 oz (c) 10 oz	c	a	a	a	b	a	a	30 grain 30 straw 7 hay 7 grazing	• Labeled for wheat & barley, oats, rye, triticale
cyfluthrin Baythroid XL Tombstone Tombstone Helios	(a) 1.0 - 1.8 oz (b) 1.8 - 2.4 oz	b	a	b	b	b		b	30 grain 30 straw 3 grazing	• Baythroid - labeled for wheat & barley, oats, rye, triticale; Tombstone labeled only on wheat • Fall armyworm = control of 1st & 2nd instars only • Helios formulation has UV protection for extended residual
cyhalothrin (gamma) Declare Proaxis	(a) 1.02 - 1.54 oz (b) 1.28 - 1.54 oz (a) 2.56 - 3.84 oz (b) 3.20 - 3.84 oz	a	a	a	a	b	a	a	30 grain 30 straw 7 grazing	• Declare is labeled for wheat & barley, oats, rye, triticale • Proaxis is labeled only for wheat, wheat hay, and triticale

Active ingredient Trade Names	**Labelled rate per acre** (unless stated)	**aphids**	**cereal leaf beetle**	**fall armyworm**	**grasshoppers**	**grass sawfly**	**Hessian fly**	**true armyworm**	**Pre harvest interval (PHI)** in days	**Precautions and Remarks**
cyhalothrin (lambda) Grizzly Too Kendo 22.8CS Lamcap II Province II Warrior w/Zeon Tech. Kendo Lambda Cyhalothrin 1EC Lambda-Cy Lambda-Cy Ag LambdaStar Lambda-T Paradigm VC Silencer Willowood Lambda-Cy1EC	(a) 1.28 - 1.92 (b) 1.60 - 1.92 (a) 2.56 - 3.84 oz (b) 3.20 - 3.84 oz	a	a	a	a	b	a	a	30 grain 30 straw 7 grazing 7 feed	• Labeled for wheat & barley, oats, rye, and triticale • Aphid control is variable with species • Fall armyworm: some labels indicate control of 1st & 2nd instars only
cypermethrin (alpha) Fastac EC or CS	(a) 1.8 - 3.8 oz (b) 3.2 - 3.8 oz	b	a	b	b	b		a	14	• Labeled for wheat & triticale • Aphid control may be 'variable' depending on which species is present
cypermethrin (zeta) Mustang Mustang Maxx	(a) 1.9 - 4.3 (b) 3.4 - 4.3 (a) 1.76 - 4.0 oz (b) 3.2 - 4.0 oz	b	a	b	b	b		a	14	• Labeled for wheat & barley, oats, rye, triticale • Aphid control may be 'variable' depending on which species is present
dimethoate Dimate 4E Dimethoate 400 and 4EC	(a) 0.5 - 0.75 pints (b) 0.75 pints	a			b				35 grain	• Labeled for wheat only • Max 1 point per acre per year • Highly toxic to pollinators
flupyradifurone Sivanto HL Sivanto 200 SL Sivanto Prime	(a) 3.5 - 7.0 oz (a) 7.0 - 10.5 oz (a) 7.0 - 14.0 oz	a							21 grain 21 straw	• Labeled for wheat & barley, millet, oats, rye, triticale • Systemic insecticide, particularly effective on sucking pests
pyrethrins Evergreen EC 60-6 PyGanic EC 1.4 II PyGanic Specialty	(a) 2.0 - 12.6 oz (a) 16 - 64 oz (a) 4.5 - 15.6 oz	a	a	a	a			a	0 when sprays dry	• Plant-derived insecticides that knock down insects quickly but have very short residual control. Coverage is critical • Max 10 applications per season, min. 3-day spray interval • PyGanic is OMRI listed for use on organic crops; Evergreen does not have OMRI certification because it contains PBO • Highly toxic to bees exposed to direct treatment; do not apply on or drift onto blooming crops or weeds

Active ingredient Trade Names	**Labelled rate per acre** (unless stated)	**aphids**	**cereal leaf beetle**	**fall armyworm**	**grasshoppers**	**grass sawfly**	**Hessian fly**	**true armyworm**	**Pre harvest interval (PHI)** in days	**Precautions and Remarks**
spinosad Blackhawk Tracer	(a) 1.1 - 1.3 oz (b) 1.7 - 3.3 oz (a) 1.5 - 3.0 oz			b				a	21 grain 21 straw 3 hay	• Labeled for wheat & barley, millet, oats, rye, triticale • For armyworm, time applications to coincide w/ egg hatch & small larvae • Application may suppress grasshoppers
sulfoxaflor Transform WG	(a) 0.75 - 1.5 oz	a							14 grain 14 straw 7 hay	• Labeled for wheat & barley, oats, rye, triticale • Max 2 applications per crop

MSU-OSU Field Crops Insect Guide: Management of Insects and Spider Mites in Soybean
Updated: August 2021

Chris DiFonzo, Field Crops Entomologist
Michigan State University
Department of Entomology
288 Farm Lane
East Lansing, MI
difonzo@msu.edu

Kelley Tilmon, Field Crops Entomologist
The Ohio State University
Department of Entomology
1680 Wooster Ave
Wooster, OH
tilmon.1@osu.edu

How to Use this Guide

This publication is set up as a series of stand-alone tables with information on insect biology, damage, management recommendations, and insecticides registered in Michigan and Ohio on **soybean**. Pesticide names and rates are current as of the date at the top of the page.

- ✓ **Table 1** shows the timing of common insect pests in the crop, from early to late season.

- ✓ **Table 2** is a checklist of damage symptoms from these insects to aid in field scouting.

- ✓ **Table 3** has information on the life cycle of each insect, plus a detailed description of its damage and the conditions that may lead to or favor infestations. A rating of pest status (and thus damage potential) is given based on experience in the state. Most insect pests are uncommon or do not increase to damaging levels in a typical year.

- ✓ **Table 4** has information on management of each pest. Most insects are kept in check by natural enemies (biological control) or by adverse environmental conditions. Some pest problems can be reduced by simply changing or avoiding certain agronomic practices. Table 4 also gives scouting and threshold recommendations. Note that these recommendations vary in quality. Key pests tend to have research-based scouting methods and thresholds. But many insects are not at damaging levels often enough to generate good information; sampling recommendations and thresholds for these species are based on observations, experience, or a best guess. This is noted in the table.

- ✓ Insecticides registered in Michigan and Ohio (except where noted) on the crop are listed in **Table 5.** Active ingredients (AI) are listed alphabetically in column 1. All products with the same active ingredient are grouped together under each AI for easy comparison or substitution of one product for another. Label rates and pests are listed in columns 2 and 3. A letter under a pest indicates that a particular insect is on the label (i.e., the label claims control of that insect). The letter corresponds to an application rate in column 2. Some insecticides are applied at a single rate for all insects ('a'), while others vary ('a', 'b', 'c'). The final columns in the table list the preharvest interval (PHI) in days and notes on application - for example bee toxicity warnings, minimum recommended spray volumes, or other restrictions.

Soybean Table 1: Timing of damage from common insects and related pests.
Pests are listed from early to late-season. Key species are highlighted in bold text.

Common name	Overwintering stage, location	May	June	July	August	Sept
white grubs	larvae (grubs), underground	root feeding by annual grubs				
		root feeding by June beetle grubs				
seedcorn maggot	pupae, in soil	larval (maggot) damage to germinating plants				
wireworm	larvae, in soil	larval damage to roots				
slugs & snails	both eggs and adults, in field	feeding on seedlings				
black cutworm	Southern USA, migrate north	larval feeding on leaves and cutting of plants				
bean leaf beetle	adults, woodlots & residue		chew small holes in leaves		chew holes in leaves &into pods	
soybean aphid	eggs, on buckthorn		nymphs and adults pierce leaves, feed on plant sap and secrete honeydew			
silver spotted skipper	pupae		larvae feed on leaves & live in a distinctive shelter made of leaves folded or tied together			
leaf-feeding caterpillars = defoliators (multiple species)	beet armyworm, webworm, yellow woolly bear - pupae All others: Southern USA, migrate north		larval feeding on leaves (defoliation). Earworm and looper may also feed on pods. Timing depends on species. • As early as June: beet armyworm, green cloverworm, thistle caterpillar, webworm, woolly bear • Later, July - August: earworm, fall armyworm, soybean looper, velvetbean caterpillar			
grasshoppers (multiple species)	egg clusters, underground			nymphs, then adults, feed on leaves		
Japanese beetles	larvae (grubs), underground			adult skeletonizing, mainly along field edges		
spider mite	adult females, at base of hosts			multiple generations pierce plant cells		
soybean gall midge	pupae, on/in ground			maggots feed on lower stems; *not yet reported in MI or OH*		
thrips	depends on species			adults and nymphs 'punch' and suck plant cells		
stink bug	adults, in & around fields				piercing of pods & beans	

Soybean Table 2: Damage checklist to aid in scouting for insects and related pests.

Plant part or timing Type of damage or injury	bean leaf beetle	black cutworm	caterpillars (various)	earworm	grasshoppers	green cloverworm	Japanese beetle	seedcorn maggot	silver-spotted skipper	slugs & snails	soybean aphid	soybean gall midge	soybean looper	spider mite	stink bug	thistle caterpillar	thrips	velvetbean caterpillar	webworm	white grubs	wireworm
Stand (emergence)																					
seeds fed-on								x		x										x	x
cotyledons fed on underground								x		x										x	
cotyledons fed on at emergence		x								x											
seedlings cut before emerging		x																		x	
plants cut at ground level		x																			
gaps in row / stand loss		x						x		x										x	x
Leaves																					
slimy or shiny trails										x											
outer leaf surface scraped (windowpaning)										x											
small round holes	x																				
skeletonizing							x			x			x								
irregular leaf feeding			x	x	x	x	x		x	x			x			x		x	x		
generalized leaf yellowing											x			x							
stippled - tiny yellow spots														x							
pale scarring along veins																	x				
silvering of leaves																	x				
leaves cupped, crinkled											x			x							

Plant part or timing Type of damage or injury	bean leaf beetle	black cutworm	caterpillars (various)	earworm	grasshoppers	green cloverworm	Japanese beetle	seedcorn maggot	silver-spotted skipper	slugs & snails	soybean aphid	soybean gall midge	soybean looper	spider mite	stink bug	thistle caterpillar	thrips	velvetbean caterpillar	webworm	white grubs	wireworm
Leaves, continued																					
sticky or with sooty mold											x										
webbing														x		x			x		
leaf rolling									x							x					
leaf drop											x			x							
plant death												x		x							
Stems																					
discoloration at plant base												x									
brittle stems, lodging												x									
Roots																					
root hairs missing																				x	x
pruning of whole roots																				x	
Pods and beans																					
pods clipped off	x																	x			
pod surface-scarring	x																				
small holes chewed in pod	x																				
large holes chewed in pod				x	x								x					x			
beans chewed <u>in pod</u>				x	x								x					x			
discolored seed															x						
shriveled, aborted beans															x						
Other																					
virus transmission	x										x						x				

Soybean Table 3: Life cycle, damage, and pest status of insects in soybean.

Pest status is rated as follows. Rating applies to Michigan and Ohio.

- Rare: Insect is *unusual, not found in most fields*
- Uncommon: Insect is present in many fields, but typically *not in damaging numbers*
- Occasional: Insect is present in most fields, *sometimes increasing to damaging levels*.
- Important: Insect is present in most fields, *often increasing to damaging levels*; often a target of integrated management or insecticide use by growers.

- Sporadic: Economic outbreaks may occur in certain fields or seasons after *extreme weather* or *mass movement* from south to north early in the season
- Localized: Economic outbreaks may occur in specific locations under *specific agronomic conditions*, for example, in no-till or late-planted fields.

Pest (abbreviation)	Life cycle and Number of generations	Description of Damage	Conditions which favor infestation or damage	Pest Status in MI & OH
bean leaf beetle (BLB)	Adults overwinter in wooded areas, leaf litter, field margins. Beetles emerge in spring, moving into alfalfa and then into soy after first cutting, OR directly into early-planted soy. Eggs are laid on ground around plant. Larvae feed underground on roots & nodules and pupate in soil. New (1st generation) adults feed on leaves and pods. Potential for a 2nd generation in southern Michigan and most of Ohio.	• Overwintering adults feed on younger plants, leaving small round holes • Later in the season, adults feed both on leaves and the surfaces of pods; pod injury creates entry wounds for pathogens & results in shriveled or moldy beans • Adults may clip pods off • Adults can transmit bean pod mottle virus (BPMV) which can affect yield and discolor beans. BPMV contributes to 'stay green' syndrome	• Fields planted near alfalfa or planted very early are at risk for colonization by overwintering beetles • Late-planted fields avoid overwintering beetles, but can act as a trap crop and can have high late-season pod injury	Occasional BLB is a very common insect in soybean, but few fields go over threshold. Pod damage is typically more important than defoliation.
cutworm *including black and variegated cutworm*	Black cutworm moths migrate into Michigan and Ohio in early spring. Eggs are laid on low-growing weeds or residue. Small larvae feed on weeds, but shift to the crop after herbicide is applied. Larvae hide during the day & feed at night. Pupation in soil. 1st generation most damaging	• Small larvae may chew holes in leaves • Larger larvae damage the stem at the soil line or cut seedlings off, reducing stand	• Low, dense weeds or field edges (egg-laying sites) • No-till fields with high crop residue • Planting into cover crops or wet areas	Uncommon We have only seen BCW in soybean a few times.
grasshoppers *several species including redlegged & differential*	Eggs overwinter in soil. Nymphs emerge in June. Feeding increases as nymphs grow. Females deposit groups of eggs in the undisturbed soil in late summer. 1 generation per year	• Defoliation of plants by nymphs and adults; feeding has a ragged appearance • Hoppers may also chew into green pods and consume beans	• Undisturbed fallow areas, roadsides, & pasture are preferred egg-laying sites; hoppers move into field edges from these areas • A dry summer & fall can lead to high populations the following year	Uncommon Outbreaks rare
green cloverworm	Overwinters in the south. Moths migrate north in the spring, arriving in May/June. Eggs laid on underside of leaves. Larvae feed on leaves and pupate there. A second generation occurs in late summer.	• Larvae defoliate plants, eating the leaf tissue between the veins; plants can appear tattered	• Nothing specific	Uncommon Outbreaks rare

Pest (abbreviation)	Life cycle and Number of generations	Description of Damage	Conditions which favor infestation or damage	Pest Status in MI & OH
Japanese beetle adults	Larvae (grubs) feed on roots of many hosts, and overwinter. Adults emerge mid-summer and feed on hundreds of hosts, including soy. Adults may persist into fall. Eggs laid in the soil in July-Sept. 1 generation per year	• Beetles feed between the veins of leaves, leaving a skeletonized appearance • A pheromone draws beetles together to feed & mate, so leaf injury may look dramatic. Don't be fooled - damage is often patchy & limited to upper leaves on field edges	• Field edges near favorite hosts (wild grape, ornamentals) or turf/lawns with a high grub infestation may have more beetles	Occasional JB is common in Michigan & Ohio soy fields, but we have yet to see a field that justified spraying
seedcorn maggot (SCM)	Pupae overwinter in soil. Adult flies emerge in early spring, laying eggs in disturbed soil with decaying organic matter. Larvae (maggots) feed on decaying matter and newly planted seeds. Several generations per year	• Larvae feed on germinating seeds, resulting in variable emergence, stand loss, delayed development • Plants that do emerge often have scarring on cotyledons • Damage can occur over a large part of field	• Cool, wet conditions which delay germination • Recently (w/in 2 weeks) incorporated fresh manure or green organic matter such as cover crops, weeds	Localized Occurs under certain field conditions
silver-spotted skipper	Pupae overwinter. Adults emerge in May and lay eggs on several hosts, including soy. Small caterpillars cut and fold a section of leaf to make a shelter; larger larvae roll several leaves together. Older instars are distinctive with a yellow body, constricted red 'neck', oversized head, and orange eye spots. 2 generations per year	• Larvae feed on leaves around their shelter	• Nothing specific	Uncommon But larvae are weird-looking and often are noticed during scouting
slugs & snails	Slugs overwinter as eggs & adults, so both may be present at planting. Females deposit eggs in soil; these hatch in about one month. Multiple overlapping generations	• Feed on seeds, cotyledons, & leaves, usually at night • Heavy feeding on young plants may inhibit stand development	• No or reduced till • Planting into heavy stubble, crop residue • Cool, wet conditions which delay germination • Poorly-closed furrows, AKA slug buffet lines	Localized Occurs under certain field conditions
soybean aphid (SBA)	Eggs overwinter on buckthorn trees. Females move from buckthorn to soybeans in spring; depending on the planting date, fields can miss being colonized at this time. Aphids - all female - reproduce quickly, giving live birth to nymphs. During the summer, winged migrants invade new fields. In the fall, aphids return to buckthorn to mate and lay eggs. Multiple overlapping generations	• All stages suck plant sap, removing water and nutrients. • Large infestations can impact yield by reducing pod number, beans per pod, and bean size , plus cover plants with sticky honey dew and sooty mold • In sandy fields, top-down symptoms of K deficiency (yellow leaf margins, leaf cupping, stunting) can occur • SBA also transmits soybean mosaic virus. This virus does not limit yield in our area, but discoloration of seed can occur	• Late-planted or double-cropped fields may be overwhelmed by summer migrants and end up with • Potassium deficiency or drought stress • Drought stress enhances damage & reduces onset of aphid-killing fungi	Occasional to Important SBA was a key pest after its discovery in our area the 2000s. Infested fields over threshold are now much less common.
soybean gall midge	First documented in Nebraska in 2011, now spreading east. Larvae overwinter in soil, then pupate in spring. Adults (tiny flies) don't feed, but lay eggs at the base of soy plants. The larvae are bright orange maggots when mature. They feed on stems and drop off plants to pupate. 2 generations per season?	• Larvae feed at the base of plants from V3 - reproduction • Signs of infestation include brown, discolored stems; wilting, broken, or lodged plants; and dead plants • Damage often is first seen in rows on the field edge	• Infestation usually heaviest on edges next to last-year's soybean	None This pest has not yet been found in Michigan or Ohio. Distribution: NE + IA, MN, MO, SD

Pest (abbreviation)	Life cycle and Number of generations	Description of Damage	Conditions which favor infestation or damage	Pest Status in MI & OH
soybean looper	One of the most abundant pests of soybean in the southern U.S. Adults migrate from the south, arriving mid to late season (July/ August).	• Larvae defoliate plants and in rare cases feed on pods	• Nothing specific	Uncommon We have never seen high popula-tions in our area
spider mites *two-spotted*	Adults overwinter in field borders and sheltered areas. In spring, adults move to new growth, lay eggs on underside of leaves. Mites spread from field to field by crawling or blowing in the wind. Multiple overlapping generations	• Adults & nymphs pierce and dehydrate individual plant cells, resulting in tiny yellow spots ('stippling') • Severe damage results in leaf yellowing, leaf death/drop, and water loss • Webbing is a sign of a heavy infestation	• Prolonged hot, dry weather favors outbreaks and enhances the impact of feeding • Infestations often start on dusty edges of fields	Sporadic Outbreaks occur in hot, dry seasons
stink bugs *multiple species*	Adults overwinter and emerge in spring to complete a generation on weeds, clover, wheat. Sampling in Michigan shows that bugs move into soybean after wheat harvest. Egg masses are laid on soybean leaves. Adults and nymphs feed by injecting digestive enzymes and sucking plant juices from stems, leaves and pods, but especially tender growth	• Pod feeding can result in shriveled, deformed, smaller, or discolored beans. In some specialty beans like those grown for natto, stink bug punctures may not be apparent until processing. • Punctures also are entry points for plant pathogens • Stink bug feeding can be related to 'stay green' syndrome	• For brown stink bug - fields near wheat • For the invasive brown marmorated stink bug - fields near woods or buildings	Occasional, in bulk soybean Important, in edible specialty beans Note: some stink bug species are beneficial predators
thistle caterpillar *AKA painted lady butterfly*	Adult butterflies migrate from the south, arriving in June. Eggs are laid on many hosts, including beans. Caterpillars feed on leaves and pupate on the plant. 2 generations per year	• Caterpillars web leaves together to make a distinctive shelter, then feed in and around the structure.	• Nothing specific	Uncommon Outbreaks rare, but webbed leaves & spikey colorful larvae are noticed during scouting
thrips *several species*	Soybean thrips migrate from the south, but other species may be local. Eggs are inserted into plant tissue. Juveniles and adults both feed on (suck) leaf tissue.	• Thrips feed in a unique way using a single mandible to 'punch' into and rupture individual plant cells, then suck up the contents; ruptured cells collapse • Leaves with a lot of damaged cells have a silvery appearance • Thrips also transmit soybean vein necrosis disease	• Prolonged hot, dry weather favors outbreaks and enhances the impact of feeding	Uncommon Thrips are very abundant on soybeans, but rarely cause damage
webworm *garden & alfalfa webworm*	Overwinters as a pupa. Moths emerge and lay eggs on many crops and weeds. Caterpillars tie leaves together with webbing and feed in a silk-lined shelter. 2 generations per year	• The tied shelter can have both windowpane damage and defoliation; under a heavy infestation, leaves may be entirely skeletonized, dry out and turn brown	• Patchy infestations can occur in areas with pigweed (a favorite host) or near alfalfa	Uncommon
white grubs - annual *including Japanese beetle, Asiatic garden beetle (AGB)*	Adults emerge June-July. Eggs laid in soil July-August. Grubs feed on roots until the fall, then move down in soil profile to overwinter. 1 generation per year	• Mature grubs overwinter in fields; feed on cotyledons and roots of seedlings at planting • May reduce stand or increase variability • Japanese beetle adults feed on soybean (see JB in list)	• Fields or parts of fields with >80% sand (AGB) • planting into fallow fields or pasture, or field margins near turf	Localized We have seen stand loss from AGB in sandy soy fields in southern MI & northern OH

Pest (abbreviation)	Life cycle and Number of generations	Description of Damage	Conditions which favor infestation or damage	Pest Status in MI & OH
white grubs - June beetle	Adults emerge in May/June, move and mate at dusk (often come to lights). Eggs laid in soil. Grubs feed for three summers, with 2nd and 3rd stage grubs causing the most damage to roots. Between summers, larvae move to a lower depth in soil. Late in the 3rd summer, grubs pupate underground; adults overwinter until next spring. 1 generation takes three years	• Grubs may be present for the entire season, feeding on roots and cotyledons of seedling as well as roots of larger plants • At planting, may reduce stand and uniformity; later in season, symptoms include wilting, water and nutrient deficiency, or plant death	• Sandy fields or parts of fields • Planting into fallow fields & pasture	Uncommon & Localized In Michigan, there have been a few cases of stand loss in sandy fields in the Thumb
wireworm *multiple species*	Wireworms are the immature form of click beetles. They spend up to six years in the immature stage. Overlapping generations.	• Feed on newly planted soybean seed & roots	• Planting into long-standing fallow fields & pasture	Uncommon & Localized Occurs under certain field conditions

Soybean Table 4: Management notes, scouting recommendations, and thresholds.

For chewing insects in soybean, a general defoliation threshold is used for the combination of species usually present in fields. See the end of this table for information to aid in estimating this defoliation.

Pest	Notes on non-chemical and chemical management	Scouting recommendation	Spray threshold
bean leaf beetle (BLB)	• Environment: Extended periods of subfreezing winter temperatures can increase death of overwintering beetles	For general detection of beetles, use a sweep net To estimate defoliation, visually examine whole plants (minimum of 20) from various locations in a field	General defoliation guideline for insects: • Veg stages: 40% • R1-R6 (pod fill): 15% Threshold for pod feeding: 10% + beetles still present
caterpillars	*The leaf-feeding caterpillars (cloverworm, earworm, skipper, soybean looper, thistle caterpillar, velvetbean caterpillar, webworm) do similar damage and can be grouped together for management recommendations* • Biological: Natural enemies keep most species in check	To estimate defoliation, visually examine whole plants (minimum of 20) from various locations in a field	General defoliation guideline for insects: • Veg stages: 40% • R1-R6 (pod fill): 15%
cutworm *including black and variegated cutworm*	• Biological: Ground beetles and parasitoids kill larvae • Agronomic: Good weed control and timely cover crop termination reduce likelihood of infestation • Insecticide: Rescue (post-planting) treatments are effective and preferred, as cutworm is uncommon in soybean	Walk fields to check stand. Larvae feed at night and on overcast days. During the day, dig around base of plants to locate them Pheromone traps for black cutworm can and aid in timing of scouting	Guideline - treat if reduction in stand count is unacceptable based on target plant population (soy can compensate for some stand loss)
grasshoppers *several species including redlegged & differential*	• Biological: Blister beetle larvae prey on eggs, while insects, birds, and mammals eat nymphs & adults. Fungal pathogens kill eggs and nymphs under wet spring conditions • Agronomic: Tillage reduces survival of eggs and newly hatched nymphs • Insecticide: May be able to limit spray area if hoppers invade from a neighboring field or grassy border	No specific recommendation	General defoliation guideline for insects: • Veg stages: 40% • R1-R6 (pod fill): 15%
green cloverworm	*See "caterpillars" above*		
Japanese beetle adults	• Insecticide: May be able to limit spray area to the edge, since beetles often congregate there	To estimate defoliation, visually examine whole plants (minimum of 20) from various locations in a field	General defoliation guideline for insects: • Veg stages: 40% • R1-R6 (pod fill): 15%
seedcorn maggot (SCM)	• Agronomic: Delay planting at least 2 weeks into disced cover crops, weeds, manure, or heavy residue. It is especially important to avoid early (April) planting under these circumstances when cold soils delay emergence • Agronomic: Problems almost never occur in no-till fields • Insecticide: Management is essentially preventative. If choosing to plant early and into a recently tilled field, an insecticide seed treatment can help, but may not be 100% effective if the maggot population is high	No specific recommendation	No rescue treatment available. Consider replanting fields or areas with significant stand loss. An insecticide seed treatment is not recommended for replant situations (SCM risk has passed)
silver-spotted skipper	*See "caterpillars" above*		

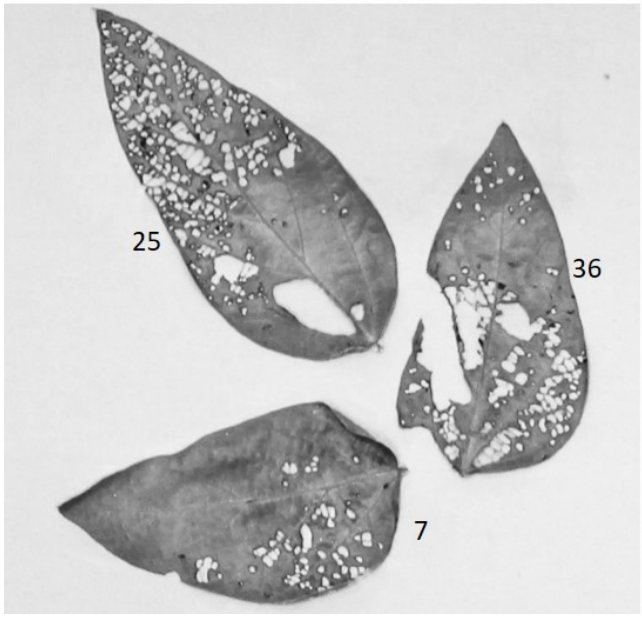
Pest	Notes on non-chemical and chemical management	Scouting recommendation	Spray threshold
slugs & snails	• Biological: Some ground beetle species consume slugs • Agronomic: Tillage and crop rotation reduce residue (slug habitat); avoid planting in wet conditions, as open furrows act as slug buffet lines • Insecticide: Slugs are not insects; soil insecticides and neonicotinoid seed treatments (NSTs) do not kill them. In fact, NSTs can increase slug problems because slug-eating ground beetles are killed by the insecticide	No specific recommendation Place shingles in fields before planting to detect slugs, which hide under them during the day	None established Consider treating and replanting fields or areas with significant stand loss
soybean aphid (SBA)	• Biological: Numerous predators and several species of parasitoids keep SBA in check in recent years. Later in the season, aphids are also controlled by insect-killing fungi • Agronomic: In fields with sandy soils, adequate potassium levels reduce SBA risk and yield loss • Insecticides: Timing and coverage are key. Do not spray early (below the threshold); this disrupts natural enemies and aphid numbers can rebound. Insecticide resistance is reported in aphid populations in some western states, and insurance or early sprays created these resistance issues. If the threshold is reached, do use nozzles which provide good coverage and a high enough water volume to achieve excellent coverage	Begin scouting at end of June. Pick a minimum of 30 whole plants, spreading the sampling out. Count the total # of SBA on each (including '0s'). Calculate the average # per plant. For quicker sampling, use the "Speed Scouting" technique developed by Iowa State University	Economic threshold: • R1-R5: 250 per plant • After R5: don't treat Factors to consider: * Spraying may be unnecessary if there are a lot of predators, or tiny white aphids, or fungus-killed aphids
soybean gall midge	• Agronomic: Infestations start on field edges adjacent to previous year's soybean. **Gall midge has not been found yet in Michigan or Ohio. If you suspect it, contact a local Extension Educator.**	In edge-rows with wilted, broken, or dead plants, split base of plants to check for black tissue and bright orange maggots	None established
soybean looper	*See "caterpillars" above*		
spider mites *two-spotted*	• Biological: Under humid conditions, a natural fungal pathogen can infect and wipe out mites in a matter of days. Some natural enemies consume mites • Agronomic: Irrigation reduces the impact of spider mite feeding and increases humidity for fungal pathogens, but in a prolonged drought, even irrigation isn't enough • Environmental: Rainfall has a similar effect as irrigation • Insecticide: Insecticide resistance is common in spider mite. Some insecticides (including most pyrethroids) sprayed to control insects flare mite populations by killing natural enemies. Also, fungicides may flare mites by disrupting natural fungal pathogens. Therefore, insurance applications of both are discouraged; in other words, be cautious about pesticide applications in dry years	Infestations often start on field edges. Confirm mites are present by tapping leaves over a paper plate or piece of paper (black construction paper works well) Also look for stippling and leaf yellowing, drying, & drop	Guideline: Treat when stippling is widespread on lower leaves and progressing into the middle canopy Factors to consider: * Will the forecast remain hot and dry? * Is good coverage possible? * Yield loss from running over beans?
stink bugs *multiple species*	• Biological: Several parasitoids attack egg masses or bugs	Use a sweep net to take 5 sets of 20 sweeps across the field	Guideline: 40 stink bugs in 100 total sweeps
thistle caterpillar	*See "caterpillars" above*		
thrips *(several species)*	• Biological: Many small-sized natural enemies (pirate bugs, predatory mites, predatory thrips) build up their populations by feeding on thrips. Interesting, some thrips provide biological control by feeding on spider mite eggs! • Agronomic: Thrips develop in small grain fields first, and may move into soybeans after dry-down • Insecticides: Seed treatments may control thrips for a few weeks after soy emergence. However, this removes a source of prey to build natural enemy populations in soy	Pick leaves from several locations in the field, from the mid-canopy Use a hand lens to count the total number of thrips per leaf	Guideline: 8 thrips per leaf We have seen 'sprayable' numbers only once, in the 2012 drought.
webworm	*See "caterpillars" above*		

Pest	Notes on non-chemical and chemical management	Scouting recommendation	Spray threshold
white grubs *including Japanese beetle, Asiatic garden beetle (AGB), and June beetle*	• Biological: Some species are attacked by pathogens • Agronomic: If practical, fall plowing of at-risk fields is recommended. For Asiatic garden beetle in southern Michigan and northern Ohio, planting later may avoid most feeding. • Insecticide: Grubs have 'eaten through' seed treatments in some cases. Rescue treatments are not available Note: it is important to identify grubs in the field to distinguish annual species from June beetles, which remain in fields for multiple seasons.	No specific recommendation Grubs tend to be patchy, especially in the sandiest parts of fields. Fields with a history of grubs can be checked with a shovel in early spring.	No rescue treatment available. Consider replanting fields or areas with significant stand loss.
wireworm	• Agronomic: Depending on species, wireworms remain in the larval stage for 1 to 6 years, thus they are favored by undisturbed soil. If practical, fall plowing of long-standing fallow & pasture prior to planting is recommended • Insecticides: Seed treatments may be helpful. Rescue treatments are not available	No specific recommendation	No rescue treatment available. Consider replanting fields or areas with significant stand loss.

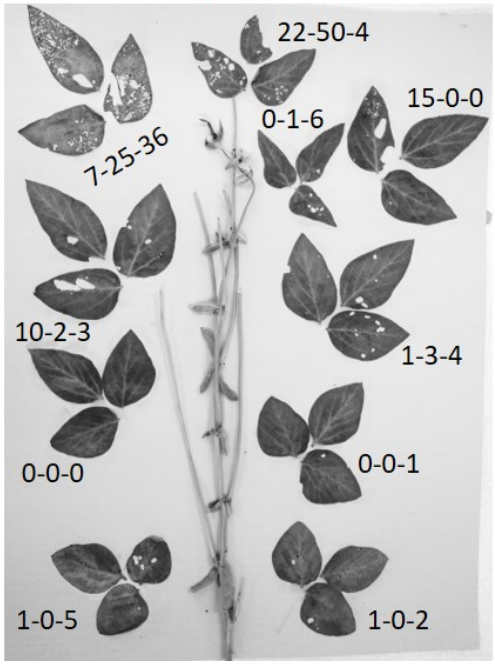
Soybean Figure 1: Estimating defoliation

Defoliation thresholds in soybean are based on an overall estimate of feeding on whole plants across the field, not on defoliation on a field edge or on the worst parts of a plant. Soybean has a great capacity to compensate for defoliation because lower leaves can 'pick up the slack' for damage to upper leaves. The plant below was pulled apart and % defoliation measured by leaflet with a scanner. Defoliation on the three leaflets of the worst leaf (left) averages 23% which is at 'threshold'. This is misleading because defoliation averaged across the 30 leaflets of the whole plant (right) is only 7%, a much truer estimate that is well below threshold.

Misleading defoliation based on the Worst leaf (3 leaflets): Avg: 23%



Whole Plant (30 leaflets): Avg: 7%



SOYBEAN Table 5: Foliar insecticides registered in Michigan and Ohio to manage soybean insects and related pests, with preharvest intervals and precautions.

- Insecticides are listed alphabetically by active ingredient(s), with trade names below. Thus, similar pesticides are grouped together for easy comparison.
- Letters under each pest indicate which rate to use, from the previous column. If a letter is not given, that pest is not on the label.
- Note: The caterpillar category includes cloverworm, earworm, silver-spotted skipper, soybean looper, thistle caterpillar, velvetbean caterpillar, and webworm. These are grouped together because they defoliate soybeans in the same way.

Active ingredient Trade Names	**Labelled rate(s) per acre** (unless stated)	**bean leaf beetle**	**caterpillars**	**cutworm**	**grasshoppers**	**Japanese beetle**	**slugs & snails**	**soybean aphid**	**spider mite**	**stink bugs**	**thrips**	**Pre-harvest interval (PHI) in days**	**Precautions and Remarks**
abamectin Agri-Mek SC	(a) 1.75 - 3.5 oz								a			28	• Apply when spider mites are first observed • To avoid illegal residues, product must be mixed with a specific spray adjuvant. See label for details • For best control, apply by ground instead of air • Maximum two sequential applications of an abamectin product • Do not allow livestock to graze or harvest treated vines as feed
acephate Acephate 90 Prill Acephate 90 WDG Acephate 90 WSP Acephate 97 UP Acephate 97 WDC Orthene 97	(a) 0.28 - 0.56 lbs (b) 0.56 - 1.1 lbs (c) 0.83 - 1.1 lbs (a) 0.25 - 0.5 lbs (b) 0.5 - 1.0 lbs (c) 0.75 - 1.0 lbs	c	c		a			c		b	a	14	• Do not graze or use treated vines for hay or forage
afidopyropen Sefina also see *cypermethrin + afido.*	(a) 3.0 oz							a				7	• Controls sucking pest by disrupting feeding & other behaviors, creating 'zombie' aphids that die a slow death • Do not graze or feed soybean hay or forage
Bacillus thuringiensis - Bt Agree WG Biobit HP Javelin WG Xentari	 (a) 0.25 - 2.0 lbs (a) 0.5 - 2.0 lbs (a) 0.25 - 1.5 lbs (a) 0.5 - 2.0 lbs		a									n/a	• Biological insecticides that must be eaten to be effective, so coverage is important • Most effective against young larvae (early instars) • Check label for rates for specific caterpillars and pest pressure • Can be used in organic production
bifenthrin Bifen 2 Ag Gold Bifenture EC Bifenthrin 2EC Brigade 2EC Discipline 2EC Fanfare EC, 2EC, & ES	(a) 2.1 - 6.4 oz (b) 5.12 - 6.4 oz	a	a	a	a	a		a	b	a	a	18	• Do not make applications less than 30 days apart

Active ingredient Trade Names	**Labelled rate(s) per acre** (unless stated)	**bean leaf beetle**	**caterpillars**	**cutworm**	**grasshoppers**	**Japanese beetle**	**slugs & snails**	**soybean aphid**	**spider mite**	**stink bugs**	**thrips**	**Pre-harvest interval (PHI) in days**	**Precautions and Remarks**
bifenthrin continued Sniper Sniper Helios Tundra EC Bifender FC	(a) 2.4 - 7.4 oz (b) 5.9 - 7.4 oz												
bifenthrin + bio-fungicide *(Bacillus amyloliquefaciens)* Ethos XB	(a) 2.8 - 8.5 oz (b) 6.8 - 8.5 oz	a	a	a	a	a		a	b	a	a	18	• The biological fungicide in this formation is labeled for suppression of white mold and several other foliar pathogens • Do not make applications less than 30 days apart
bifenthrin + cypermethrin Steed Hero Hero EW	(a) 2.5 - 3.5 oz (b) 3.5 - 4.7 oz (a) 2.6 - 6.1 oz (b) 4.0 - 10.3 oz (c) 10.3 oz (a) 2.8 - 6.7 oz (b) 4.5 - 11.2 oz (c) 11.2 oz	b	b	a	b	b		b	c	b	b	21	• Do not graze or harvest treated vines for livestock feed
bifenthrin + imidacloprid Brigadier Skyraider Swagger	(a) 5.1 - 6.1 oz (a) 2.1 - 6.0 oz (b) 5.12 - 6.0 oz (a) 7.6 - 12.2 oz (b) same for mites	a	a	a	a	a		a	b	a	a	21	• Do not make applications less than 30 days apart
carbaryl Carbaryl 4L Sevin 4F Sevin XLR Plus	(a) 0.5 - 1.5 qts	a	a	a		a				a	a	21	• Check label for specific rates for various pest species • Bee warning. May kill honeybees. If application can't be avoided and the crop is blooming, limit application to within 2 hrs of sunrise or sunset. Notify beekeepers within 1 mile, 48 hrs prior • Do not apply this product w/ 2-4D herbicide (= crop injury)
chlorantraniliprole Coragen Prevathon	(a) 3.5 - 5.0 oz (a) 14 - 20 oz		a		a							1	• Novel mode of action - insect are paralyzed & stop feeding. Must be applied before populations reach damaging levels • Check labels for specific species, as they differ: Coragen = earworm, armyworm. Prevathon = earworm, armyworm, loopers, cloverworm, velvetbean caterpillar & hoppers

Active ingredient Trade Names	**Labelled rate(s) per acre** (unless stated)	**bean leaf beetle**	**caterpillars**	**cutworm**	**grasshoppers**	**Japanese beetle**	**slugs & snails**	**soybean aphid**	**spider mite**	**stink bugs**	**thrips**	**Pre-harvest interval (PHI) in days**	**Precautions and Remarks**
chlorantraniliprole + lambda-cyhalothrin Besiege	(a) 5.0 - 10.0 oz (b) 10 oz	a	a	a	a	a		a	b	a	a	30	• Check label for specific rate ranges (5-8 oz, 8-10 oz) for various pest species • Spider mites - 'suppression only' • Do not graze or feed treated plants
cyfluthrin Tombstone Tombstone Helios	(a) 0.8 - 1.6 (b) 1.6 - 2.8 (c) 2.0 - 2.8	b	b	a	c	b		c		b	a	45	• 15d PHI to feed green forage • Helios formulation has UV protection for extended residual
cyfluthrin (beta) Baythroid XL	(a) 0.8 - 1.6 (b) 1.6 - 2.8 (c) 2.0 - 2.8	b	b	a	c	b		c		b	a	21	• 15 day PHI to feed green forage and hay
cyfluthrin + imidacloprid Leverage 360	(a) 2.8 oz	a	a	a	a	a		a		a	a	21	• 15 day PHI to feed green forage and hay
cyhalothrin (gamma) Declare Proaxis	(a) 0.77 - 1.28 oz (b) 1.28 - 1.54 oz (a) 1.92 - 3.2 oz (b) 3.2 - 3.84 oz	a	a	a	b	b		a		b	a	45	• Do not graze or feed treated foliage to livestock
cyhalothrin (lambda) Grizzly Too Kendo 22.8CS Lamcap II Province II Warrior II w/ Zeon Tech. Kendo Lambda-Cyhalothrin 1EC Lambda-Cy EC, 1EC, & AG Lambda-T LambdaStar Paradigm VC Silencer	(a) 0.96 - 1.60 oz (b) 1.60 - 1.92 oz (a) 1.92 - 3.20 oz (b) 3.20 - 3.84 oz	a	a	a	b	b		a		b	a	30	• Do not graze or harvest treated area for forage or hay
cypermethrin (alpha) Fastac CS & Fastac EC	(a) 1.3 - 3.8 oz (b) 3.2 - 3.8 oz	a	a	a	b	a		a		b	b	21	• Do not graze or harvest treated area for forage or hay

Active ingredient Trade Names	**Labelled rate(s) per acre** (unless stated)	**bean leaf beetle**	**caterpillars**	**cutworm**	**grasshoppers**	**Japanese beetle**	**slugs & snails**	**soybean aphid**	**spider mite**	**stink bugs**	**thrips**	**Pre-harvest interval (PHI) in days**	**Precautions and Remarks**
cypermethrin (zeta) Mustang Mustang Maxx	(a) 1.4 - 4.3 oz (b) 3.4 - 4.3 oz (a) 1.28 - 4.0 oz (b) 3.2 - 4.0 oz	a	a	a	b	a		a		b	b	21	• Do not graze or harvest treated area for forage or hay
cypermethrin + afidopyropen Renestra	(a) 6.8 oz	a	a	a	a	a		a		a	a	21	• Afidopyropen controls sucking pests by disrupting feeding & other behaviors, creating 'zombie' aphids that die a slow death • Do not graze or feed hay and forage
deltamethrin Delta Gold	(a) 1.0 - 1.5 oz (b) 1.5 - 2.4 oz	b	b	a	b	b		b		b		21	• Do not graze or harvest treated area for forage or hay
dimethoate Dimate 4E Dimethoate 4EC and 400	(a) 1 pint	a			a			a	a			21	• Highly toxic to bees and other pollinators. Do not apply to blooming crops if bees are present • Do not graze or feed within 5 days of last application
esfenvalerate Asana XL S-Fenvalostar Zyrate	(a) 2.9 - 5.8 oz (b) 5.8 - 9.6 oz	b	a	b	b	b		b		b		21	• Do not graze or feed livestock on treated fields • See labels for additional information about tank mixes with OP (organophosphate) insecticides for soybean aphid control
etoxazole Zeal SC Zeal Pro	(a) 2.0 - 6.0 oz (a) 11.5 - 34.6 oz								a			Do not apply after **R5**	• Kills eggs and mites • Minimum 20 gal per acre ground or 3 gal per acre air • Maximum **1 application per year**; Do NOT apply after the R5 stage • Do not graze or feed treated area
flupyradifurone Sivanto HL Sivanto 200SL Sivanto Prime	(a) 3.5 - 7.0 oz (a) 7.5 - 10.5 oz (a) 7.0 - 14.0 oz							a				21	• Systemic insecticide, particularly effective on sucking pests
imidacloprid Admire Pro Advise Four Alias4F Montana4F Nuprid4F Max Wrangler Nuprid 2SC Prey 1.6 Sherpa	(a) 1.3 oz (a) 1.5 oz (a) 3.0 oz (a) 3.75 oz	a				a		a				21	• Thorough coverage is needed

Active ingredient Trade Names	**Labelled rate(s) per acre** (unless stated)	**bean leaf beetle**	**caterpillars**	**cutworm**	**grasshoppers**	**Japanese beetle**	**slugs & snails**	**soybean aphid**	**spider mite**	**stink bugs**	**thrips**	**Pre-harvest interval (PHI) in days**	**Precautions and Remarks**
indoxacarb Steward	(a) 4.6 - 11.3 oz		a									21	• Use higher rate for higher population or spraying in dense canopy • Do not graze or feed livestock on treated fields • Also labeled for suppression of stink bugs
iron phosphate Sluggo	(a) 22-44 lbs						a					n/a	• Sluggo is a bait that must be eaten to kill slugs • Apply in evening. Scatter pellets using a broadcast spreader & use a higher rate for severe infestations or after long periods of rain • OMRI certified for use in organic fields
metaldehyde Deadline GT Deadline M-Ps	(a) Max 13.3 lbs (a) Max 10 lbs						a					n/a	• **NOT registered on soy in Michigan - only for use in Ohio** • Deadline is a bait and must be eaten to kill slugs • Growth stages V4-R1: no application after pod formation • Apply in evening as a band between rows
methomyl Annihilate LV Lannate LV Nudrin LV Annihilate SP Corrida 90WSP Lannate SP Nudrin SP	(a) 0.4 - 1.5 pints (a) 0.125 - 0.5 lbs	a	a					a			a	14	• Rates vary by insect and by 'severity' of infestation; check labels for details • The Lannate label lists brown marmorated stink bug • PHI 3 days for forage, 12 days for hay
methoxyfenozide Intrepid 2F	(a) 4 - 8 oz		a									14	• Apply when first signs of feeding damage appear • PHI for hay and forage, 7 days
permethrin Perm-Up 25DF Pounce 25WP Arctic 3.2EC PermaStar Ag Perm-Up 3.2EC	(a) 3.2 -12.8 oz (b) 6.4 - 12.8 oz (a) 2.0 - 4.0 oz (b) 2.0 - 8.0 oz	a	b	a		a						60	• Rates range higher for several caterpillar species; check label • Do not graze or harvest treated area for forage or hay
pyrethrins Evergreen EC 60-6 PyGanic EC 1.4 II PyGanic Specialty	(a) 2.0 - 12.6 oz (a) 16 - 64 oz (a) 4.5 - 15.6 oz	a	a	a	a	a		a		a	a	0 when sprays dry	• Plant-derived insecticides that knock down insects quickly but have very short residual control. Coverage is critical • Max 10 applications per season, min. 3-day spray interval • PyGanic is OMRI listed for use on organic crops; Evergreen is not OMRI certified because it contains PBO • Highly toxic to bees exposed to direct treatment; do not apply on or drift onto blooming crops or weeds •

Active ingredient Trade Names	**Labelled rate(s) per acre** (unless stated)	**bean leaf beetle**	**caterpillars**	**cutworm**	**grasshoppers**	**Japanese beetle**	**slugs & snails**	**soybean aphid**	**spider mite**	**stink bugs**	**thrips**	**Pre-harvest interval (PHI) in days**	**Precautions and Remarks**
spinetoram Radiant SC	(a) 2.0 - 4.0 oz		a									28	• Time applications to target small larvae • Some (not all) caterpillar species are listed on the label
spinosad Blackhawk Tracer	(a) 1.1 - 2.2 oz (a) 1.0 - 2.0 oz		a									28	• Time applications to target small larvae • Not all caterpillar species are listed on the label • Do not feed treated forage or hay
sulfoxaflor Transform WG	(a) 0.75 - 1.0 oz							a				7	• Translaminar product, moves within leaf to target sucking pests • Label lists 'suppression' of stink bugs at a 2-2.25 oz rate

MSU Field Crops Insect Guide: Management of Insects and Spider Mites in Sugar Beet
New August 2021

Prepared by:
Chris DiFonzo
Field Crops Entomologist
Department of Entomology
288 Farm Lane
East Lansing, MI
difonzo@msu.edu

Daniel Bublitz
Sugar Beet Extension Specialist
Saginaw Valley Research & Extension Center
9923 Kruger Rd
Frankenmuth, MI
bublitzd@msu.edu

How to Use this Guide

This publication is set up as a series of stand-alone tables with information on insect biology, damage, management recommendations, and insecticides registered in Michigan on **sugar beets.** Pesticide names and rates are current as of the date at the top of the page.

- ✓ **Table 1** shows the timing of common insect pests in the crop, from early to late season.

- ✓ **Table 2** is a checklist of damage symptoms from these insects to aid in field scouting.

- ✓ **Table 3** has information on the life cycle of each insect, plus a detailed description of its damage and the conditions that may lead to or favor infestations. A rating of pest status (and thus damage potential) is given based on experience in the state. Most insect pests are uncommon or do not increase to damaging levels in a typical year.

- ✓ **Table 4** has information on management of each pest. Most insects are kept in check by natural enemies (biological control) or by adverse environmental conditions. Some pest problems can be reduced by simply changing or avoiding certain agronomic practices. Table 4 also gives scouting and threshold recommendations. Note that these recommendations vary in quality. Key pests tend to have research-based scouting methods and thresholds. But many insects are not at damaging levels often enough to generate good information; sampling recommendations and thresholds for these species are based on observations, experience, or a best guess. This is noted in the table.

- ✓ Insecticides registered in Michigan on the crop are listed in **Table 5** (at planting) and **Table 6** (foliar sprays)**.** Active ingredients (AI) are listed alphabetically in column 1. All products with the same active ingredient are grouped together under each AI for easy comparison or substitution of one product for another. Label rates and pests are listed in columns 2 and 3. A letter under a pest indicates that a particular insect is on the label (i.e., the label claims control of that insect). The letter corresponds to an application rate in column 2. Some insecticides are applied at a single rate for all insects ('a'), while others vary ('a', 'b', 'c'). The final columns in the table list the preharvest interval (PHI) in days and notes on application - for example bee toxicity warnings, minimum recommended spray volumes, or other restrictions.

Sugar beets Table 1. Timing of damage from common insects and related pests in Michigan.
Pests are listed from early to late-season. Key species are highlighted in bold text.

Common name	Overwintering stage, location	May	June	July	August into September
springtails	in soil and residue	damage to seedlings			
cutworm (several species)	Winter cutworm: larvae in residue Black cutworm: migrates north	feeding on seedlings			
white grubs	larvae (grubs), underground	root damage to seedlings		larval damage to tap root by June beetle sp.	
wireworm	larvae in soil	root damage to seedlings		larval damage to tap root	
spinach leafminer	pupae in soil	leaf mining by larvae			
flea beetle	adults, in residue & protected areas	feeding by adults on leaves (shot holing)			
sugar beet root aphid	on roots of lambsquarters		multiple generations puncture root cells to feed		
armyworm	Southern USA, migrate north		caterpillars feed on foliage		
grasshoppers (multiple species)	egg clusters, underground		nymphs, then adults, feed on foliage		
webworms (beet, garden, alfalfa)	larvae or pupae in soil		caterpillars feed on foliage (timing depends on species)		
aphids on leaves (several species)	depends on species			multiple generations pierce leaves to feed on plant sap	
Japanese beetle	grubs in soil			adults feed on leaves	
leafhoppers (several species)	depends on species			nymphs and adults pierce leaves to feed on plant sap	
spider mite	adult females, at base of hosts			multiple generations pierce plant cells to feed	
lygus bug (tarnished plant bug)	adults, in residue & protected areas			nymphs and adults pierce leaves to feed on plant sap	
thrips	depends on species			adults and nymphs 'punch' and suck plant cells	
wooly bears & zebra caterpillars	depends on species			caterpillars feed on foliage	

Sugar Beet Table 2: Damage checklist to aid in scouting for insects and related pests.

Plant part or timing Type of damage or injury	aphids (leaves)	armyworm	cutworms	flea beetle	grasshoppers	Japanese beetle	leafhoppers	lygus bug	spider mite	spinach leafminer	springtails	sugarbeet root aphid	thrips	webworm	white grub	wireworm	wooly/ zebra caterpillar
Stand (emergence)																	
stand loss / gaps in row											x				x	x	
wilted or cut plants			x												x	x	
Stand (later in season)																	
wilting or dead plants												x					
Leaves																	
scraping of leaf surface											x						
leaf mining										x							
shot- or pin holes				x							x						
irregular leaf feeding		x	x		x									x			
skeletonizing between veins						x								x			x
defoliation		x			x	x								x			x
leaf curling	x						x										
sticky honeydew	x																
yellowing of leaf tips, margins								x									
tiny yellow spots (stippling)							x		x				x				
generalized leaf yellowing							x		x								
wilted plants			x									x			x	x	
webbing									x					x			
Roots																	
roots pruned or cut															x	x	
chewing into tap root															x	x	
white, waxy coating												x					

Sugar Beet Table 3: Life cycle, damage, and pest status of insects in sugar beets

Pest status is rated as follows. Rating applies to Michigan.

- Rare: Insect is *unusual, not found in most fields*
- Uncommon: Insect is present in many fields, but *typically not in damaging numbers*
- Occasional: Insect is present in most fields, *sometimes increasing to damaging levels*
- Important: Insect is present in most fields, *often increasing to damaging levels*; often a target of integrated management or insecticide use by growers

- Sporadic: Economic outbreaks may occur in certain fields or seasons after *extreme weather* or *mass movement* from south to north early in the season
- Localized: Economic outbreaks may occur in specific locations under *specific agronomic conditions*, for example, in no-till or in late plantings

Pest (abbreviation)	Life cycle and Number of generations	Description of Damage	Conditions which favor infestation or damage	Pest Status in Michigan
aphids *on leaves* *On roots, see sugarbeet root aphid*	Summer population is all female. Females do not mate to reproduce (parthenogenesis) and give birth to live young. Multiple overlapping generations	• All stages suck plant sap from leaves • Heavy infestation may lead to stunting, curling of leaves, weakening of plants	• Drought stress may be made worse by aphids removing plant sap	Uncommon Often present, but numbers rarely high enough to cause damage
armyworm	Adult moths migrate into Michigan in early spring. Eggs are laid on low-growing weeds, in grassy field margins, or in pasture or wheat.	• Caterpillars defoliate beets • Feeding often occurs at night • Larvae may march enmasse from one field to another (hence the name 'army')	• Weedy fields • Beets adjacent to infested pasture or wheat.	Uncommon Infestations of wheat and corn occur after a heavy spring flight from the south; beets not preferred
cutworm - black	Adult moths migrate into Michigan in early spring. Eggs are laid on low-growing weeds or crop residue. Larvae often hide during the day & feed at night. Pupation in soil.	• Young larvae feed on leaves • Extensive damage occurs when older larvae cut at or below soil surface, leading to wilting and death of plants	• Fields with a weed problem or planted to cover crop (egg-laying site for females) • No-till fields	Uncommon Outbreaks occur after a heavy spring flight from the south
cutworm - winter	Cold-tolerant larvae overwinter in residue and thatch; they may be active very early in the season. Pupates in the soil in spring. New moths emerge and lay eggs in June.	• Larvae feed on seedling and leaves • During rare outbreaks, large numbers of larvae sometimes move in a wave across a road or field	• Unknown	Uncommon
flea beetle *several species*	Adults overwinter in crop residue. They emerge in spring and feed on weeds and crops, including beets.	• Adult beetles chew small round holes in leaves	• Weedy fields or borders	Uncommon Shot holing is noticeable, but rarely enough to cause concern
grasshoppers *several species*	Eggs overwinter in soil. Nymphs emerge in June. The amount of feeding increases with size. Females lay groups of eggs in the undisturbed soil in late summer. 1 generation per year	• All stages defoliate leaves; feeding has a ragged appearance	• Adjacent fallow areas or pasture, which are egg laying sites • A hot dry summer & fall can lead to a high population the following year	Uncommon Often present, but outbreaks are rare in Michigan

Pest (abbreviation)	Life cycle and Number of generations	Description of Damage	Conditions which favor infestation or damage	Pest Status in Michigan
Japanese beetle	Larvae (grubs) overwinter. Adults typically begin to emerge in July, feed, mate, and lay eggs in soil. Adults may be active into early fall.	• Adult beetles feed on numerous host plants, including beets; feeding has a skeletonized appearance	• Nothing specific	Uncommon Present, but not at damaging levels
leafhoppers	Several species feed on beets. Adults lay eggs in plant stems.	• Both adults and nymphs suck plant sap; symptoms under high populations include leaf curling and yellowing	• Nothing specific	Uncommon Present, but not at damaging levels
lygus bug *including tarnished plant bug*	Adults overwinter in residue and on field edges. Weeds and early crops like alfalfa are fed on and colonized first There are multiple generations during the summer	• Adults and nymphs inject a toxic saliva during feeding and suck plant sap • Fed-on leaves turn yellow or brown at tips and edges; damaged plants may wilt • Damage to beets is difficult to recreate or quantify in plots; when symptoms appear, feeding occurred days prior	• Movement into beets may coincide with cutting of adjacent alfalfa fields or with dry down of weeds on field edge	Localized Numbers may be higher in fields adjacent to alfalfa
spider mites	Adult females overwinter in field borders and sheltered areas. In spring, they move to new growth, and lay eggs. Mites spread from field to field by crawling or blowing in the wind. Multiple overlapping generations	• Adults & nymphs pierce individual plant cells, resulting in tiny yellow spots called stippling • Webbing is a sign of a heavy infestation • Severe damage results in leaf yellowing or death, and water loss	• Prolonged hot, dry weather favors outbreaks, enhances the impact of feeding • Infestations often start on dusty edges of fields	Sporadic Outbreaks occur in hot, dry seasons
spinach leafminer	Pupae overwinter and flies emerge in spring. Females lay eggs on beet leaves. Larvae (maggots) feed, then drop to the soil surface to pupate. Multiple generations, but only the first is important on sugarbeet	• Larvae create distinctive, winding mines as they feed internally in the leaf	• Nothing specific	Occasional Mining is noticeable, but rarely enough to cause concern
springtails	Common arthropods related to insects. Assist decomposition by breaking down crop residue. Some feed on fungi. Often an indicator of good soil health, but when populations are high, may damage beet seedlings	• Nymphs and adults scrape or scar cotyledons just as they emerge from the soil • Heavy feeding is reported to destroy seedlings and reduce stand	• Planting into heavy residue, particularly corn stalks, where springtails are abundant • Moist conditions & slow emergence after planting	Occasional Damage is rare unless numbers are very high
sugarbeet root aphid (SBRA)	Females overwinter locally in soil or on roots of weeds (especially lambsquarter), moving onto beets planted in the same field. Winged forms can also move to new fields. Summer population is all female. Females reproduce without mating and give birth to live young. Multiple overlapping generations	• All stages suck plant sap from roots • Root aphids cover themselves in a protective layer of wax; under heavy infestation, this wax can reduce water and nutrient uptake by beets.	• Lambsquarters infestation, because aphids overwinter on its roots • Dry conditions help root aphids spread, as soil cracks allow them to access roots; drought also enhances the impact of SBRA root feeding	Occasional and Localized SBRA persists on lambsquarter; Infested areas show up in beet fields in hot, dry seasons
thrips	Adults and nymphs overwinter in residue. Populations initially build on grasses and in wheat. Note that thrips are an important food source for some of the beneficial insects (such as pirate bugs) that control other pests.	• Nymphs and adults feed with a single mandible, using it to puncture plant cells and slurp up the liquid inside • Punctured cells dry up, resulting in areas of dead cells; under heavy infestation, leaves dry up, curl, or die	• Dry conditions in early summer • Adults may move into beets from adjacent wheat fields or grassy borders as they dry down	Uncommon Usually present, but numbers rarely high enough to cause damage.

Pest (abbreviation)	Life cycle and Number of generations	Description of Damage	Conditions which favor infestation or damage	Pest Status in Michigan
webworms *several species*	Larvae overwinter. Adult moths emerge in spring and lay eggs on a number of hosts. Beet webworm caterpillars occur in June and again in August.	• Caterpillars spin webs and feed on beet leaves, usually near the leaf base	• Weedy fields, as moths may lay eggs on some weed species	Uncommon
white grubs - *several species*	Mature grubs overwinter under-ground. Adults emerge May - July, depending on species. Eggs laid in soil in the summer. Grubs feed on roots, then move down in soil profile in late fall to overwinter. In spring, grubs feed for a period, then pupate. 1 generation per year except for June beetle with a multiyear life cycle	• Larvae (grubs) prune root hairs or whole roots of small plants • On larger plants, grubs chew into or sever the tap root, causing wilting, water and nutrient deficiency, or plant death	• Planting after a grass sod or fallow • Sandy fields or parts of fields	Uncommon and Localized Often tied to fields or parts of fields with a sandy soil type
wireworm *several species*	Wireworms are the larval stage of click beetle; adults are harmless Depending on species, wireworms spend several years in the larval stage, feeding on seeds, roots, and tubers.	• Larvae feed on germinating seeds, seedlings, and on the growing tap root • A heavy infestation may reduce stand	• Planting after fallow or pasture, or into a field that had a grass weed control issue last season • Cool, wet weather that delays crop development • Sandy fields or parts of fields	Uncommon
Wooly bear and zebra caterpillars	Depends on species, but larvae are present in July and August	• Larvae feed on leaves	• Nothing specific	Uncommon High numbers may be noticed in some years, but usually are not damaging

Sugar Beet Table 4: Management notes, scouting recommendations, and thresholds.

Pest	Notes on non-chemical and chemical management	scouting recommendation	Spray threshold
aphids *on leaves* *On roots, see sugarbeet root aphid*	• Biological: Predators (such as ladybugs, lacewings, and parasitoids keep populations in check. Under humid conditions, entomopathogenic fungi infect and kill aphids • Environmental: Heavy rainfall and irrigation may wash off aphids. Adequate moisture reduces feeding stress and increases humidity for infection by pathogens	Check 100 plants (20 plants x 5 sets)	Rough guideline: one colony (group of ~30 aphids) per plant Rarely justified in Michigan
armyworm	• Biological: Predators (such as ladybugs) and parasitoids can reduce numbers • Agronomic: Good weed control reduces egg laying in a field • Insecticides: A border treatment may be possible if armyworms are moving into beets from an adjacent field	No specific recommendation Edges of fields are at greater risk	Rough guideline: >25% defoliation
cutworm - black	• Biological: Ground-dwelling predators (beetles) • Agronomic: Good weed control reduces egg laying	Check 100 plants (20 plants x 5 sets), particularly in low areas of the field, for cutting and wilting Dig around base of cut plants to find larvae	5% of plants cut
cutworm - winter	• Biological: Ground-dwelling predators (such as beetles) and birds likely provide some control	Same as black cutworm	5% of plants cut A rare, odd outbreak occurred in 2007
flea beetle	• Agronomic: Good weed control reduces alternate hosts	Check 100 seedlings (20 plants x 5 sets) for feeding damage; newly-emerged plants are most vulnerable	Rough guideline: 25% of seedlings with feeding damage
grasshoppers	• Biological: Blister beetle larvae prey on eggs, while insects, birds, and mammals eat nymphs & adults; Natural fungal pathogens kill eggs and nymphs under wet spring conditions • Agronomic: Tillage reduces survival of eggs and newly hatched nymphs • Insecticide: May be able to limit sprayed area if hoppers invade from a neighboring field or grassy border	No specific recommendation	Rough guideline: >25% defoliation I have never seen populations high enough to treat in Michigan
Japanese beetle	• Agronomic: Tillage reduces survival of overwintering grubs	No specific recommendation	Rough guideline - 25% or more defoliation by JB and other insects
leafhoppers	• No specific guidelines	No specific recommendation	None I have never seen populations high enough to treat in Michigan
lygus bug	• Insecticides: Not very effective at managing this insect; by the time damage (yellowing) is seen on older leaves, the feeding occurred days ago and the insects may not be present	Check 100 plants (20 plants x 5 sets) for bugs or for the distinctive yellowing Note: Lygus are fast and hard to scout for	Rough guideline - 1 bug per plant or when significant yellowing occurs on new growth
spider mites	• Biological: Under humid conditions, a natural fungal pathogen can infect and wipe out mite populations in a matter of days. Some natural enemies eat mites • Agronomic: Irrigation mitigates the impact of spider mite feeding and increases humidity for fungal biocontrol, but during a drought, even irrigation isn't enough • Environmental: Rainfall has a similar effect as irrigation	Infestations often start on field edges Look for mites on undersides of leaves using hand lens or tap leaves over a black piece of paper	A guess: Treat when mites appear on >25% of the plants and first yellowing is seen

Pest	Notes on non-chemical and chemical management	scouting recommendation	Spray threshold
spider mites ***continued***	• Insecticide: Insecticide resistance is common in mites. Some insecticides (including most pyrethroids) will flare mite populations by killing off natural enemies. Likewise, fungicide applications may disrupt fungal pathogens of mites. Insurance applications of both are discouraged; be cautious about pesticide applications in dry years	Webbing is present when populations are high	Mites are difficult to control and spraying is often a losing proposition
spinach leafminer	• Insecticide: Sprays are most effective when applied just before or during egg hatch	Check 100 small plants (20 plants x 5 sets) for leaf mines	Treat if 50% or more of plants have egg masses and small mines are present
springtails (foliar)	• Agronomic: Tillage to incorporate and destroy crop residue the fall prior to planting beets • Insecticide: No insecticides registered for sugarbeet specifically list foliar-feeding springtails on the label, although some probably provide control. Note that the manufacturer is not responsible for poor performance	No specific recommendation	None established If stand is severely damaged, follow guidelines for making a replant decision
sugarbeet root aphid (SBRA)	• Agronomic: Resistant varieties are available; control of the alternate weed host, lambsquarters, also helps to reduce the local population in a field • Insecticides: Soil insecticides are not very effective at managing this pest	No specific recommendation Look for aphids and wax on roots in areas with wilted beets	None established Use resistant varieties if you have SBRA in a field
thrips	• Biological: Generally kept in check by predators • Environmental: Rainfall or irrigation reduces populations • Insecticides: A caution about spraying: Thrips can be viewed as semi-beneficial, because they are predators of spider mite eggs. Spraying for thrips may contribute to a spider mite outbreak in the future, especially under dry conditions	Infestations often start on field edges Look for thrips on undersides of leaves using hand lens or tap leaves over a piece of paper	None established
webworm	• Biological: Many parasites and predators attack caterpillars	No specific recommendation Check leaves in several locations in the field	Rough guideline: small larvae present on 50-75% of leaves
white grubs	• Biological: Some species are attacked by pathogens. • Agronomic: If practical, fall plowing of long-standing fallow fields & pasture prior to planting is recommended. Tillage also exposes grubs to mammals and birds Note: It is important to identify grubs found in the field to distinguish annual species from multiyear June beetle species	No specific recommendation Grubs tend to be patchy, and in sandier parts of fields. They may be detected when plowing in the fall or spring, or if birds follow tillage equipment	None established
wireworm	• Agronomic: Tillage and longer rotations can reduce wireworm infestations	No specific recommendation	None established
Wooly bears & zebra caterpillar	• Nothing specific	No specific recommendation	None established Rough guideline: >25% defoliation

Sugar Beet Table 5: Insecticides registered on sugar beet in Michigan for use at planting, with preharvest intervals and precautions

- Insecticides are grouped by active ingredient(s), which are listed alphabetically, allowing for easy comparison of products with the same chemistry
- Application rates are listed for pests which appear on the manufacturer label; if a column is blank, the pest is not on the label. The letters in the pest columns refer to the label use rate from column two
- Note that insecticide rates per 1000 feet of row are based on a **30-inch row spacing**. See label for specific per-acre rate and gauge-setting charts for narrower row spacing

Active ingredient Trade Names	**Labelled rate(s)** per 1000 feet of row or per acre	**cutworms**	**root aphid**	**slugs & snails**	**white grub**	**wireworm**	**Precautions and Remarks**
cypermethrin (zeta) Mustang Mustang Maxx	(a) 4.3 oz per acre (a) 4.0 oz per acre	a			a	a	• For cutworm, apply on soil surface or broadcast in 3-5 gal water • For grubs and wireworm, apply in-furrow or in a 3-4 inch T-band over the open furrow
esfenvalerate Asana XL S-FenvaloStar Zyrate	(a) 0.45 oz per 1000 ft	a					• Apply in-furrow, T-band or banded
iron phosphate Sluggo	(a) 20-44 lbs per acre			a			• Broadcast pellets; use higher rate for heavy infestations • For best results, apply bait in the evening and on moist soil • Product certified for organic production
terbufos Counter 20G (Lock'N Load, Smartbox, or SmartCartidge)	(a) 3 - 6 oz per 1000 ft		*		a	a	• Apply banded or 'modified' in-furrow (2-3 inches behind the seed after some soil has covered the seed); do not let granules directly contact seed, as injury may occur • Maximums 9.8 lbs per acre for any row spacing • Higher rate may also suppress cutworms and sugar beet cyst nematode * See label for banded postemergence use against sugar beet root aphid. Note the 90 day pre-harvest interval for this application.

Sugar Beet Table 6: Foliar insecticides registered on sugar beets in Michigan, with preharvest intervals and precautions

- Insecticides are grouped by active ingredient(s), which are listed alphabetically, allowing for easy comparison of products with the same chemistry
- Application rates are listed for pests which appear on the manufacturer label; If a column is blank, the pest is not on the label. The letters in the pest columns refer to the label use rate from column two
- Caterpillars = woollybear, saltmarsh, thistle, & zebra caterpillars

Active ingredient Trade Names	**Labelled rate per acre**	**aphids (foliar)**	**armyworm**	**caterpillars**	**cutworms**	**flea beetle**	**grasshopper**	**leafhopper**	**lygus bug**	**spider mite**	**spinach leafminer**	**springtails**	**thrips**	**webworm**	**Pre harvest interval (PHI) in days**	**Precautions and Remarks**
Bacillus thuringiensis (Bt) Agree WG* Javelin WG Xentari DF	(a) 0.5 - 2.0 lb (a) 0.25 - 1.5 lb (a) 0.5 - 1.5 lb		a	a	a									a	0	• Selective biological insecticide to control caterpillars. Larvae must eat treated foliage to be controlled so good coverage is important. Must be targeted on small (1st - 2nd stage) larvae • All are certified for organic production * The Agree WG label only lists armyworm
carbaryl Carbaryl 4L Sevin 4F Sevin XLR Plus	(a) 1.0 - 1.5 quarts		a		a	a								a	28	• Max 3 quarts per acre • For cutworm, effective on species feeding on top of plant • Toxic to bees - do not apply if weeds in field are in bloom
cyantraniliprole Dupont Exirel Exirel	(a) 13.5 - 20.5 oz (b) 10.0 - 20.5 oz	a	b		b	a							*		1	• Thorough coverage is essential; application for aphid control requires an effective adjuvant (see label) *Application may suppress thrips
cypermethrin (alpha) Fastac CS Fastac EC*	(a) 2.2 - 3.8 oz	a	a		a	a	a								50	• Minimum spray volume 2 gal by air and 10 gal by ground • Do not graze or harvest treated tops for feed • Fastac CS is a microencapsulated formulation * Fastac EC does not list aphids & armyworm on the label
cypermethrin (zeta) Mustang Mustang Maxx	(a) 2.4 - 4.3 oz (a) 2.24 - 4.0 oz	a	a	a	a	a	a	a	a		a			a	50	• Minimum spray volume 2 gal by air and 10 gal by ground • Max 12.9 oz per acre per season, including at plant use • Aphid control depends on species
esfenvalerate Asana XL S-FenvaloStar Zyrate	(a) 5.8 - 9.6 oz		a	a	a	a	a	a							21	• Max 28.8 oz per acre per season

Active ingredient Trade Names	**Labelled rate per acre**	**aphids (foliar)**	**armyworm**	**caterpillars**	**cutworms**	**flea beetle**	**grasshopper**	**leafhopper**	**lygus bug**	**spider mite**	**spinach leafminer**	**springtails**	**thrips**	**webworm**	**Pre harvest interval (PHI) in days**	**Precautions and Remarks**
methomyl Annihilate LV Lannate LV Nudrin LV Annihilate SP Corrida 90WSP Lannate SP Nudrin SP	(a) 0.75 - 3.0 pints (b) 1.5 pints (a) 0.25 - 1 lb (b) 0.5 lb			a	b	a								a	21 beets 30 tops	• Highly toxic to bees; be careful about drift onto nearby crops or application on blooming weeds • See label for set-back requirements from surface water
methoxyfenozide Intrepid 2F	(a) 8 - 16 oz		a	a	a									a	7	• Minimum spray volume 10 gal by air and ground • Cutworms, suppression only • Narrow spectrum, targets caterpillars. Product has a novel mode of action that disrupts molting. Spray timing is important; applications need to be made at egg hatch or just as feeding starts
naled Dibrom 8E	(a) 1 pint	a	a				a	a	a	a					2	• See label for setback requirements from surface water
pyrethrins Evergreen EC 60-6 PyGanic EC 1.4 II PyGanic Specialty	(a) 2.0 - 12.6 oz (a) 16 - 64 oz (a) 4.5 - 15.6 oz	a	a	a	a	a	a	a	a			a	a	a	0 when sprays dry	• Plant-derived insecticides that knock down insects quickly but have very short residual control. Coverage is critical • Max 10 applications per season, min. 3-day spray interval • PyGanic is OMRI listed for use on organic crops; Evergreen does not have OMRI certification • Highly toxic to bees exposed to direct treatment; do not apply on or drift onto blooming crops or weeds
spinosyns **(spinetoram & spinosad)** Radiant SS	(a) 6 - 8 oz		a			a							a		7	• Must target egg hatch or small larvae • Flea beetles - suppression only. Thrips control is improved adding an adjuvant as detailed on the label. Be careful using oil-based adjuvants in sugarbeet tank mixes.
spirotetramat Movento Movento HL	(a) 5 - 9 oz (a) 2.25-4.5 oz	a													28	• Systemic - moves through plant into leaves and roots; systemic activity may be limited in cold or dry weather when plant isn't actively growing • Minimum spray volume 5 gal by air and 15 gal for ground; see label for recommendation to add an adjuvant • Also controls root aphid and suppresses cyst nematode