

MICHIGAN STATE UNIVERSITY

**Insect Pest
Management
in
Organic Field Crops**

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New March 2026



MICHIGAN STATE

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Extension

TABLE OF CONTENTS

INTRODUCTION	How to use this guide	1
	Insecticide list	2
	Insecticide modes of action	4
ALFALFA & GRASS HAY		
ALFALFA & GRASS HAY	Calendar	5
	Damage checklist	6
	Pest biology	7
	Management, scouting, thresholds	10
	Insecticide Table	13
DRY BEANS		
DRY BEANS	Calendar	14
	Damage checklist	15
	Pest biology	16
	Management, scouting, thresholds	19
	Insecticide Table	21
FIELD CORN		
FIELD CORN	Calendar	24
	Damage checklist	25
	Pest biology	27
	Management, scouting, thresholds	32
	Insecticide Table	35
SOYBEANS		
SOYBEANS	Calendar	37
	Damage checklist	38
	Pest biology	40
	Management, scouting, thresholds	44
	Assessing soybean defoliation	47
	Insecticide Table	49
WHEAT & SMALL GRAIN		
WHEAT & SMALL GRAIN	Calendar	51
	Damage checklist	52
	Pest biology	53
	Management, scouting, thresholds	56
	Hessian fly-safe planting dates	57
	Aphid sampling in wheat	58
	Insecticide Table	59

Insect Pest Management in Organic Field Crops in Michigan

New March 2026

This guide provides detailed information on insect pests in organic field crops in Michigan. The guide is set up as a series of stand-alone chapters on individual crops: alfalfa and grass hay; dry beans; field corn; soybean; and wheat. Each chapter has tables providing information on the following:

- A calendar showing the timing of pest presence in the season
- A checklist of the types of damage by pest, to aid in crop scouting
- Biological information such as life cycle, impact on the crop, and conditions which lead to infestation and damage
- Management, scouting, and thresholds
- OMRI-listed insecticide options

Insect pests in Michigan field crops are usually kept in check by other organisms (biological control') and environmental factors, or by modifying agronomic practices such as planting date, harvest timing, tillage, or weed control.

Insecticides are a last resort, but this guide does provide lists of EPA-approved, OMRI (the Organic Materials Review Institute) certified products registered for organic field crops in Michigan. Pest species, rates, and precautions are taken directly from the label, as written and claimed by the company. The efficacy of individual products is not rated due to lack of information from side-by-side comparisons.

Always read the label to reconfirm key items like application rate, timings, precautions, PPE, pre-harvest intervals, etc. before making an application. Labels change over time, but more importantly using a biologically-based product often takes more knowledge and refinement than spraying a conventional pesticide. Labels provide specific details on things like insect life stage, spray timing, and treatment interval which must be followed to optimize effectiveness.

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Table 1: OMRI-listed insecticides in this guide

- **Signal words** rate short term toxicity from low (caution) to high (warning). Rarely, there is no signal word on a label.
- A **Reentry interval (REI)** is the minimum time in hours between a pesticide application and workers entering a field without additional protective clothing. This time frame is usually found in the Ag Use Requirements Box on the label. REIs are particularly important in crops which require hand thinning or weeding.
- **Mode of action classification numbers** are set by the Insecticide Resistance Action Committee (IRAC). Insecticides with the same number have the same mode of action and may need to be rotated with insecticides in a different group to delay resistance.

Trade name	Active Ingredient (s)	Company	EPA Registration #	Signal Word	REI (hours)	Mode of action
Agree WG	Bt aizawai	Certis	70051-47	caution	4	11A
Bug-N-Sluggo	iron phosphate spinosad	Neudorff / Certis	67702-24-70051	caution	4	unknown 5
Debug-ON	cold-pressed neem oil 70%	MGK/ Valent	1021-2879	caution	4	unknown
Debug-Tres	cold-pressed neem oil 4.7% azadirachtin 3%	MGK/ Valent	1021-2877	warning	4	unknown
Debug-Turbo	cold pressed neem oil 65.8% azadirachtin 0.7%	MGK/ Valent	1021-2874	caution	4	unknown
Deliver	Bt kurstaki	Certis	70051-69	caution	4	11A
DES-X Insecticidal Soap Concentrate	potassium salts of fatty acids	Certis	67702-22-70051	warning	12	unknown
Dipel 10G	Bt kurstaki	Valent Biosciences	73049-14	caution	4	11A
Dipel DF	Bt kurstaki	Valent Biosciences	73049-39	caution	4	11A
Entrust	spinosad 80%	Corteva Agriscience	62719-282	caution	4	5

Trade name	Active Ingredient (s)	Company	EPA Registration #	Signal Word	REI (hours)	Mode of action
Entrust SC	spinosad 22.5%	Corteva Agriscience	62719-621	none	4	5
Javelin WG	Bt kurstaki	Certis USA	70051-66	caution	4	11A
M-Pede	potassium salts of fatty acids	Gowan	10163-324	warning	12	unknown
Neemix 4.5	azadirachtin 4.5%	Certis	70051-9	caution	4	unknown
PyGanic EC 1.4 II	pyrethrins 1.4%	MGK	1021-1771	caution	12	3A
Pyganic 5.0	pyrethrins 5%	Valent / MGK	1021-1772	caution	12	3A
Sluggo	iron phosphate	Neudorff / Certis	67702-3-70051	caution	0	unknown
Sluggo Maxx	iron phosphate	Neudorff	67702-55	caution	4	unknown
Socoro	cold-pressed neem oil 70%	Terramera Inc	88760-10	none	4	unknown
Trilogy	extracted neem oil 70%	Certis	70051-2	caution	4	unknown
XenTari Biological	Bt aizawai	Valent Biosciences	73049-40	caution	4	11A

Table 2: Target sites and modes of action for OMRI-listed insecticides

Modes of action are based on the classification scheme developed by the Insecticide Resistance Action Committee (IRAC) at irac-online.org.

IRAC classification number	Target site • Mode of action	Example trade name(s)
3A pyrethrins <i>*extracted from the flowers of several Chrysanthemum species</i>	<i>Nervous system</i> • Disrupts sodium channels along the nerve axon, resulting in continuous firing of nerves. • Some pyrethrin products are OMRI-certified.	PyGanic
5 spinosad <i>* products of bacterial fermentation</i>	<i>Nervous system</i> • Binds to nicotinic acetylcholine receptors in the synapse (the junction between nerves)	Entrust Bug-N-Sluggo
11A Bt or Bacillus thuringiensis <i>*naturally occurring bacteria that produce protein crystals which kill insects</i>	<i>Midgut membrane</i> • Cry proteins bind to specific receptors in the insect gut. Gut contents leak into the body cavity & insects die slowly of infection	Agree Deliver Dipel Javelin XenTari
Not classified		
azadirachtin, see neem		
iron phosphate	<i>Digestive tract</i> • Interferes with calcium metabolism in the gut. Snails & slugs stop eating and die.	Sluggo Bug-N-Sluggo
neem oil <i>*crude extract from the tropical neem tree</i> azadirachtin <i>* active insecticidal component of neem</i>	<i>Multiple target sites</i> • Insect growth regulator interfering with insect hormones. Disrupts development, molting, reproduction, and feeding. Also acts as a repellent to prevent insects from landing or staying in a crop.	Debug ON Socoro Trilogy Debug Tres Debug Turbo Neemix
potassium salts of fatty acids <i>*soap created by reacting fatty acids from plant oils or animal fat with KOH</i>	<i>Exoskeleton</i> • Breaks down the waxy layer of the insect cuticle and disrupts / dries up cells. Insects dehydrate, among other physical effects.	DES-X M-Pede

ORGANIC ALFALFA & GRASS HAY in MICHIGAN

Calendar of insect pests in organic alfalfa and grass hay

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	September
alfalfa weevil	adults, in protected areas	larval defoliation		adults may be present		
clover root curculio	eggs? & adults, in protected areas	egg laying & larval root feeding				Adults laying eggs
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, grasses, 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, migrates north				caterpillars defoliate alfalfa and mixed stands	
winter cutworm	larvae, under residue				caterpillars defoliate alfalfa late into fall; active in winter	

Damage checklist to aid in scouting of organic alfalfa and grass hay

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						x	
stand loss					x	x						x	
Other													
reduced forage quality									x				
shorter stand life	x				x				x			x	
cantharidin toxin in cut hay			x										

Biology and impact of insect pests in organic alfalfa and grass hay

Terms used to describe the pest status of each insect

- **Rarely a pest:** Unusual. May not even be present in the state.
- **Uncommon pest:** Maybe present but below damaging levels. An outbreak once a generation
- **Occasional pest:** Present, sometimes in high numbers. An outbreak once a decade
- **Important pest:** Present in most fields, potentially increasing to damaging levels every season. A common target of scouting, management programs, or insecticide use.
- **Sporadic pest:** Damaging levels occur after favorable weather patterns (such as drought) or mass movement from south to north during the season
- **Localized pest:** Damaging levels occur in specific locations under specific agronomic conditions, for example in no-till production or in older stands.

Pest (abbreviation)	Life cycle and Number of generations	Impact on the Crop	Conditions which favor infestation or damage	Pest Status
alfalfa weevil	Adults (and some eggs) overwinter and become active when temps reach 48°F (~ 200 degree days). Adults lay eggs in stems. There are 4 larval stages, with 80% of the feeding done by the 4 th / 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	<ul style="list-style-type: none"> • Small larvae feed in the folded terminals, chewing small holes. Older larvae feed on leaves throughout the plant • From a distance, heavily skeletonized foliage appears white, like frost damage • Repeated or heavy damage can reduce stand life by 1-2 yrs or lead to weed infestations 	<ul style="list-style-type: none"> • Weevil populations build over time in older stands because adults overwinter nearby. New fields can be infested quickly if they are adjacent to older stands 	Important Pest status seems to be increasing. It's unclear if this is due to a reduction in bio-control levels.
aphids <i>usually pea aphid, a large species which may be yellow, green, or pink</i>	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. Multiple overlapping generations	<ul style="list-style-type: none"> • All stages suck plant sap from stems and leaves • Heavy infestation can lead to stunting, curling of leaves, and weakening of plants • Huge numbers can slow regrowth after cutting 	<ul style="list-style-type: none"> • Nothing specific 	Uncommon Unusual outbreak in central MICH in 2023
blister beetle	Eggs are laid in the soil. Larvae of most species feed on grasshopper eggs and thus are 'beneficial' in some 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.	<ul style="list-style-type: none"> • The body fluid of live and dead blister beetles has cantharidin, a chemical which blisters the mouth and digestive tract of livestock. Horses are very susceptible & can die after eating hay contaminated when beetles are incorporated into bales at harvest • Cantharidin dose varies by blister beetle species 	<ul style="list-style-type: none"> • A grasshopper outbreak in a dry season often precedes a bad blister beetle year in alfalfa • Beetles may be attracted to, and aggregate on, flowering alfalfa or weeds later in the season 	Uncommon and Sporadic May be an issue during or after a dry season
caterpillars <i>cloverworm, loopers, earworm</i>	Many species of caterpillars are found in legume forages. Some overwinter in the region, the adults of others migrate from the south.	<ul style="list-style-type: none"> • Caterpillars feed on leaves and stems; a few species roll or web leaves 	<ul style="list-style-type: none"> • Nothing specific 	Uncommon

Pest (abbreviation)	Life cycle and Number of generations	Impact on the Crop	Conditions which favor infestation or damage	Pest Status
clover root curculio	Adults (and perhaps eggs) 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 and lay eggs in late summer and early fall. One generation per year	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • Older stands, as injury accumulates • New seedlings near older stands may be killed by beetles moving out of the older field 	Rare and Localized
fall armyworm (FAW)	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 climb plants to feed during the day. Pupation in soil. 1-3 generations, if it is warm enough in the late season. Larvae CANNOT overwinter in our area.	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • Strong winds from the SW carry moths northward • Warm conditions in late summer into fall can lead to several generations • Grass hay or mixed stands are likely more attractive for egg laying 	Uncommon and Sporadic A late-season outbreak in 2021 was the worst in ~30 years
grasshoppers <i>multiple species</i>	Eggs overwinter in the soil. Nymphs emerge in June. Feeding increases as they grow. Females lay groups of eggs in the undisturbed soil in late summer. 1 generation per year	<ul style="list-style-type: none"> • Adults and nymphs chew on leaves; feeding has a ragged appearance 	<ul style="list-style-type: none"> • Undisturbed pastures and forage fields are preferred egg-laying sites • A dry summer can lead to an outbreak the following year 	Uncommon in alfalfa Sporadic in pastures, usually after a dry season
plant bugs <i>alfalfa plant bug, lygus bug, & fleahopper</i>	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	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • Nothing specific 	Uncommon
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	<ul style="list-style-type: none"> • 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 & quality loss, and a shorter stand life 	<ul style="list-style-type: none"> • New seedlings are very vulnerable • PLH damage is worse under dry conditions, and leafhopper survival is probably better as well 	Sporadic and Important problematic later in the season if populations become well-established early
spittlebug <i>meadow and two-lined</i>	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 expanding north into our 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	<ul style="list-style-type: none"> • 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, bunched top growth, and yield loss. Losses of 10-40% reported for first-cutting, especially if combined with alfalfa weevil damage 	<ul style="list-style-type: none"> • 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	Impact on the Crop	Conditions which favor infestation or damage	Pest Status
true armyworm (TAW)	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	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • Nothing specific 	Sporadic Outbreaks occur in years with a heavy spring flight from the south
white grubs <i>multiple species</i>	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 to feed for several more years.	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • Populations of many grub species are higher in fields or parts of fields with sandy soil 	Uncommon
winter cutworm <i>The adult moth is the large yellow underwing</i> <i>The official name of the caterpillar, the winter cutworm, was coined in MI</i>	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. In winter, they sometimes crawl on the snow surface on sunny winter days. Larvae resume feeding very early in spring. Pupation occurs underground in May. One generation per year	<ul style="list-style-type: none"> • 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 seedlings planted with an oat companion crop are attractive to moths for egg laying and may be thinned 	<ul style="list-style-type: none"> • Nothing specific 	Uncommon Michigan was the first state to document economic damage by this insect in forage crops

Management of insect pests of organic alfalfa and grass hay

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

Pest (abbreviation)	Management options and notes	Scouting recommendation	Threshold
alfalfa weevil	<ul style="list-style-type: none"> 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 reaches threshold within 10 days of harvest, <i>early cutting is the preferred way to reduce larval numbers</i> while keeping numerous weevil parasitoids in the system. Check regrowth for survivors. 	<p>A sweep net is useful to detect weevil larvae</p> <p>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</p>	<p>Thresholds:</p> <ul style="list-style-type: none"> 40% of stems with feeding On regrowth, after early cutting: 6-8 larvae per ft²
aphids <i>usually pea aphid</i>	<ul style="list-style-type: none"> 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 	<p>Sweep netting can detect aphids colonizing fields</p> <p>Check plant stems for aphids, count # per stem</p>	<p>Guideline for alfalfa x plant height:</p> <ul style="list-style-type: none"> < 10 inches: At least 50 aphids per stem Over 10 inches: 100 aphids per stem <p>Biocontrol often kicks in to reduce numbers</p>
blister beetle	<ul style="list-style-type: none"> Agronomic: Beetles often aggregate on blossoms; cut alfalfa prior to bloom. Crimping forage during harvest can kill beetles; if they are present, cut the 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: Any sort of chemical control is difficult since killed beetles may still end up harvested into bales 	<p>No specific recommendation</p> <p>Walk fields prior to harvest to check for aggregations of beetles</p>	<p>No specific recommendation</p>
caterpillars <i>cloverworm, earworm, loopers</i>	<ul style="list-style-type: none"> Biological: Many predators feed on caterpillars Agronomic: If alfalfa is within 10 days of harvest, early cutting is the preferred way to reduce caterpillar numbers. Check regrowth for survivors. 	<p>No specific recommendation</p>	<p>No specific recommendation</p> <p>Consider using the guidelines for FAW or TAW</p>
fall armyworm (FAW)	<ul style="list-style-type: none"> Biological: Predators and parasitoids kill larvae Agronomic: If alfalfa or hay is within 10 days of harvest, early cutting is the preferred way to reduce larval numbers. Check regrowth for survivors Biological insecticides: Applications are most effective on small larvae (less than ¾ inch). Note that pyrethrum may not be very effective on FAW, since it colonizes from the south where it is sprayed in multiple crops with conventional insecticides. 	<p>No specific recommendation.</p> <p>To detect flight into the region, use bucket pheromone traps starting in mid-July</p> <p>Fall seedings are particularly vulnerable & a priority for scouting</p>	<p>Guideline for small (< ¾ inch) larvae: 2-3 per square ft</p>
grasshoppers	<ul style="list-style-type: none"> Biological: Blister beetle larvae eat eggs. Insects, birds, and mammals eat nymphs & adults. Fungal pathogens kill eggs and nymphs under moist, cool conditions 	<p>No specific recommendation</p>	<p>Guideline for hay or pasture x plant height</p> <ul style="list-style-type: none"> 6 inches: 8 per square yard over 6 inches: 16 per square yard

Pest (abbreviation)	Management options and notes	Scouting recommendation	Threshold
plant bugs <i>alfalfa plant bug,</i> <i>lygus bug,</i> <i>flea hopper</i>	<ul style="list-style-type: none"> • Agronomic: When alfalfa is cut, adult plant bugs may move in large numbers into neighboring fields. This can be a problem for susceptible vegetable crops which may need to be monitored 	No specific recommendation	None Spraying is not recommended
potato leafhopper (PLH)	<ul style="list-style-type: none"> • Biological - A naturally occurring fungal pathogen kills PLH under favorable conditions, usually infecting by mid-August • Agronomic: If alfalfa is within 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 hairy varieties trap nymphs and repel adults. The level of resistance varies plant by plant but overall, resistant stands can tolerate more leafhoppers than regular alfalfa • Detailed dynamic thresholds which vary with plant height, spray cost, and 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: <ul style="list-style-type: none"> • < 3 inch = 20 • 4-7 inch = 50 • 8-11 inch = 100 • > 12 inch = 200 For resistant varieties: <ul style="list-style-type: none"> • New seeding, use the regular threshold • Older stands, use 3x the regular threshold
spittlebug <i>meadow and two-lined</i>	<ul style="list-style-type: none"> • 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)	<ul style="list-style-type: none"> • Biological: Predators, a tachinid parasitoid, and fungal pathogens all kill armyworm larvae • Agronomic: If alfalfa is within 10 days of harvest, early cutting is preferred to reduce larval numbers. Check regrowth for survivors 	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
white grubs	<ul style="list-style-type: none"> • Biological: Natural enemies, pathogens, birds, and rodents all kill grubs. • Agronomic: Fields and parts of fields that are sandy tend to support higher grub populations, while numbers are low elsewhere. <p>Note: it is important to identify grubs to distinguish annual species like European chafer and Asiatic garden beetles from multiyear species of June beetles</p>	In poor stands, use a shovel to check for grubs and root pruning Target the sandy parts of fields for scouting	None established
winter cutworm	<ul style="list-style-type: none"> • Biological: During outbreaks, numerous insects, birds, and mammals were recorded to feed on caterpillars • Agronomic: If a field is due to be harvested a last time in late summer/fall, cutting is the preferred way to reduce caterpillar numbers. • Insecticides: If caterpillars are invading a forage crop from an adjacent field, a limited border treatment can be made 	No specific recommendation	None established use guideline for FAW: 2 to 3 per square foot

List of OMRI-certified insecticides for organic alfalfa, grass hay, and pasture

- Insecticides are grouped by active ingredients, which are listed alphabetically, allowing for easy comparison of similar products
- 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

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
azadirachtin Neemix 4.5	(a) 4 – 16 oz	a	a		a	a	a	a	a	a	a	a	0	<ul style="list-style-type: none"> • Azadirachtin, an extract of neem oil, interferes with insect molting and acts as a repellent & antifeedant. Unlike neem oil, it does <u>not</u> have miticidal and fungicidal properties • Labeled for alfalfa and grasses grown for hay • See label for specific rates by insect pest. Kills only immature insects, but may repel adults from feeding
azadirachtin + neem oil Debug Tres (3% azad /4.7% neem oil) Debug Turbo (0.7% azad / 65.8% neem oil)	(a) 8 – 22.5 oz a) 16 – 104 oz	a	a		a	a	a	a	a	*	a	a	0	<ul style="list-style-type: none"> • Azadirachtin, an extract of neem oil, interferes with insect molting and acts as a repellent & antifeedant. The neem oil in the formulation adds miticidal and fungicidal properties. • Labeled for alfalfa and forage grasses • Coverage is important. Spray must cover entire plant. • Similar precautions for crop injury and interactions with fungicides as neem oil alone (below) * not listed on label, but may have efficacy
Bacillus thuringiensis (Bt) Agree WG Deliver Dipel DF Javelin WG XenTari	(a) 1.0 - 2.0 lbs (a) 0.25 - 1.5 lbs (a) 0.5 - 2.0 lbs (a) 0.25 - 1.5 lbs (a) 0.5 - 2.0 lbs				a	a					a		0	<ul style="list-style-type: none"> • Bts are biological insecticides that must be eaten to kill, so coverage is important. Applications ideally are made when larvae are small. Check labels for rates on specific caterpillar species, larval sizes, and infestation levels • Labeled for grass forage, fodder, & hay (Crop Group 17) AND alfalfa, clover, & other nongrass animal feeds (Crop Group 18)
neem oil, cold-pressed Debug ON Socoro	(a) depends on spray volume used (a) 0.625-1.8% v/v spray solution	*	a		a	a	a	a	a	*	a	a	0	<ul style="list-style-type: none"> • Neem interferes with insect molting and acts as a repellent & antifeedant. It also has miticidal and fungicidal properties. • Labeled for alfalfa, grasses • See labels for information on oz needed by spray volume • Formulations are oil based; leaf injury may occur from application at temps >90F. Apply early or late in day. See labels for info on interactions w/ sulfur and other fungicides • Debug ON has a bee warning: Do not apply product while bees are actively visiting the area * not listed on label, but may have efficacy

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
neem oil, clarified extract Trilogy	(a) 1.0 – 2.0% v/v spray solution		a										0	<ul style="list-style-type: none"> Clarified neem oil has a much narrower pest spectrum than cold-pressed neem oil (above). Otherwise, remarks are similar Labeled for alfalfa See label for a table of the oz/acre needed by spray volume
potassium salts of fatty acids DES-X Insecticidal Soap M-Pede	(a) 2% v/v spray solution (a) 2-4% v/v spray solution		a					a					0	<ul style="list-style-type: none"> Contact insecticide; spray solution must touch target pest to be effective, so coverage is critical. See label for specifics about spray volume and frequency of treatments Labeled for alfalfa See label for precautions on plant sensitivity. Combinations w/ certain fungicides can lead to leaf damage. Do not spray in full sun – apply early or late in day, or under cloudy conditions Note that both products have a 2(ee) recommendation for use as a deer repellent
pyrethrins PyGanic EC 1.4 II PyGanic 5.0	(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	<ul style="list-style-type: none"> Plant-derived insecticides that knock down insects quickly but have very short residual control. Coverage is critical Labeled for alfalfa, grasses grown for hay and silage, pasture Highly toxic to bees exposed to direct treatment. Do not apply or drift onto blooming crops or weeds

ORGANIC DRY BEANS in MICHIGAN

Calendar of insect pests in organic dry beans

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 (often black bean aphid)				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 the base of hosts			nymphs and adults pierce plant cells, suck plant sap		
Lygus or 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	

Damage checklist to aid in scouting of organic dry beans

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
<u>Stand (emergence)</u>														
seeds fed-on								x	x					x
gaps in row								x	x					x
wilted or cut plants														x
<u>Leaves</u>														
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		
<u>Stems</u>														
boring into stem		x												
powdery frass		x												
<u>Roots</u>														
root hairs missing														x
pruning of whole roots														x
<u>Pods and beans</u>														
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			
<u>Other</u>														
virus transmission	x													

Biology and impact of insect pests in organic dry beans

Terms used to describe the pest status of each insect

- **Rarely a pest:** Unusual. May not even be present in the state
- **Uncommon pest:** Maybe present but below damaging levels. An outbreak once a generation
- **Occasional pest:** Present, sometimes in high numbers. An outbreak once a decade
- **Important pest:** Present in most fields, potentially increasing to damaging levels every season. A common target of scouting, management programs, or insecticide use.
- **Sporadic pest:** Damaging levels occur after favorable weather patterns (such as drought) or mass movement from south to north during the season
- **Localized pest:** Damaging levels occur in specific locations under specific agronomic conditions, for example in no-till production or in older stands.

Pest (abbreviation)	Life cycle and Number of generations	Impact on the crop	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 (this is called parthenogenesis). Multiple overlapping generations	<ul style="list-style-type: none"> • All stages suck plant sap from leaves • Heavy infestation may lead to stunting, curling of leaves, weakening of plants • Aphids also transmit plant viruses like common mosaic 	<ul style="list-style-type: none"> • Drought stress may be made worse by aphids removing plant sap 	Uncommon Usually present, but numbers rarely high enough to cause damage
bean leaf beetle	Adults overwinter in leaf litter and wooded field margins. They become active in spring, often moving into alfalfa. Then they move into beans after the first alfalfa cutting. Larvae feed underground on roots. 1-2 generations per year	<ul style="list-style-type: none"> • Adults defoliate younger plants, leaving small round holes between major leaf veins • Adults feed on and scar developing pods, reducing yield and seed quality 	<ul style="list-style-type: none"> • Adults may move between dry beans and adjacent alfalfa or soybeans 	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.	<ul style="list-style-type: none"> • Older larvae bore into stems, disrupting water flow & weakening stem • Larvae also bore into pods, consume seeds, and contaminate harvested beans 	<ul style="list-style-type: none"> • Nearby non-Bt corn production probably increases local ECB risk 	Uncommon Populations suppressed by widespread planting of Bt corn in conventional fields
grasshoppers <i>multiple species</i>	Eggs overwinter in soil. Nymphs emerge in June. Their feeding increases as they grow. Females lay groups of eggs in the undisturbed soil in late summer. 1 generation per year	<ul style="list-style-type: none"> • All stages chew on leaves. The feeding has a ragged appearance 	<ul style="list-style-type: none"> • Fallow areas and pasture are preferred egg-laying sites • A hot dry summer & fall can lead to a high population the following year 	Uncommon Outbreaks rare, usually after a dry season
green cloverworm	Adults lay eggs one by one on the undersides of leaves. Larvae feed on foliage.	<ul style="list-style-type: none"> • 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	Impact on the crop	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 or August & lay eggs for a second generation. Second generation larvae feed then pupate in late August. New adults overwinter.	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • A mild winter (increases survival) • Planting adjacent to fields with a high population 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	<ul style="list-style-type: none"> • Adults and nymphs lacerate and suck 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 	<ul style="list-style-type: none"> • PLH damage is worse under dry conditions, and leafhopper survival is probably better too 	Sporadic <i>later in season:</i> Can be important, if populations become well-established earlier in summer
seedcorn maggot (SCM)	SCM overwinters as pupae in the soil. Adult flies emerge in early spring and are attracted to disturbed soil with decaying organic matter for egg laying. Multiple generations	<ul style="list-style-type: none"> • Tiny larvae (maggots) feed on germinating seeds. May cause variable emergence, stand loss, and delayed development of plants that do emerge 	<ul style="list-style-type: none"> • Cool wet conditions which delay germination • Planting into tilled fields with high organic matter from a decaying green cover crop, decaying weeds, or fresh manure application 	Sporadic and Localized Depends on presence of tillage, fresh organic matter and/or cool, wet conditions
slugs & snails	Slugs overwinter as both eggs and adults; females deposit eggs in soil; these hatch in about one month. Multiple overlapping generations	<ul style="list-style-type: none"> • Feeding on cotyledons and 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 	<ul style="list-style-type: none"> • Planting into heavy crop residue • Cool, wet soils which delay germination • Poorly closed furrows give slugs access to seed 	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	<ul style="list-style-type: none"> • Adults and nymphs pierce individual plant cells, resulting in tiny yellow spots called stippling • Webbing is a sign of heavy infestation • Severe injury results in leaf yellowing, death, water loss 	<ul style="list-style-type: none"> • Prolonged hot, dry weather favors an outbreak and enhances the impact of feeding • Infestations often start on dusty edges of fields 	Sporadic Outbreaks usually occur in hot, dry seasons
stink bug <i>several species including green, one-spotted, & brown marmorated</i>	Adults overwinter in protected areas. Weeds and early crops like wheat are fed on and colonized first. Stink bug eggs often sport a distinct spiky 'crown' and are laid in small clusters. Nymphs and adults live and feed in the crop together. Note - some stink bug species are beneficial predators of other insects like caterpillars	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • May move into dry beans as adjacent wheat fields dry down and get harvested 	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. 3-5 generations per season	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • 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	Impact on the crop	Conditions which favor infestation or damage	Pest Status in Michigan
thrips	<p>Adults and nymphs overwinter in residue. Populations initially build up on grasses and in wheat.</p> <p>Note that thrips are an important food source for some of the beneficial insects, such as pirate bugs, that control other pests.</p>	<ul style="list-style-type: none"> • 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 speckled or silvery patches of dead cells. Under heavy infestation, leaves dry up, curl, or die 	<ul style="list-style-type: none"> • Dry conditions in early summer • May move into dry beans from adjacent wheat fields or grassy borders that are drying down 	<p>Uncommon</p> <p>[Only have seen some injury to dry beans in the Thumb during a dry spell in 2018]</p>
western bean cutworm (WBC)	<p>WBCs overwinter in pre-pupal stage. Adults emerge in mid-late July. Moths lay eggs first in pre-tassel corn and switch to dry beans as the corn matures. Larvae feed on pods at night. In early September, they drop and burrow into soil to over-winter. Areas with sandy soil appear to have deeper and better overwintering.</p> <p>1 generation per year</p>	<ul style="list-style-type: none"> • Tiny larvae feed on leaves and then inside blossoms • Larger larvae move to the ground and hide under residue or in cracks during the day. They climb into the canopy to feed on pods at night 	<ul style="list-style-type: none"> • Areas with sandy soil, where over-wintering survival is higher • When adjacent corn is past the pre-tassel stage and no longer attractive for egg-laying (moths switch to beans) 	<p>Occasional - Important</p> <p>Montcalm and surrounding counties + the UP are historic hot spots for WBC</p>
white grubs <i>multiple species</i>	<p>Mature grubs overwinter underground. Adults emerge May-July, depending on the species. Eggs laid in soil in the summer. Grubs feed on roots during the summer. They move down in the soil profile in late fall to overwinter. In spring, grubs feed again for a period, then pupate.</p> <p>1 generation per year except June beetle, which has a 2-3 year life cycle</p>	<ul style="list-style-type: none"> • Larvae (grubs) prune root hairs and sometimes whole roots, causing wilting, water and nutrient deficiency, or plant death 	<ul style="list-style-type: none"> • Planting into fallow fields or pasture • Fields near home lawns or pasture • Fields or parts of fields with sandy soil type 	<p>Uncommon</p>

Management of insect pests of organic dry beans

Pest (abbreviation)	Management options and notes	Scouting recommendation	Threshold
aphids	<ul style="list-style-type: none"> 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 per plant (a colony is a group of about 30 aphids) Rarely justified
bean leaf beetle	<ul style="list-style-type: none"> 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)	<ul style="list-style-type: none"> Biological: Numerous natural enemies kill ECB eggs and larvae. Predators, egg and larval parasitoids, and pathogens are common Agronomic: Note that the widespread planting of Bt corn in conventional production 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	<ul style="list-style-type: none"> Biological: Blister beetle larvae and other ground-dwelling insects eat hopper eggs. Insects, birds, and mammals eat nymphs and 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 are invading from a neighboring field or grassy border 	No specific recommendation I 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	<ul style="list-style-type: none"> Biological: Many natural enemies keep cloverworm 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)	<ul style="list-style-type: none"> Biological: Predators 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 MBB populations. 	Early to 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)	<ul style="list-style-type: none"> Biological: A naturally occurring fungal pathogen reduces PLH numbers under favorable conditions, usually later in the year 	Check 100 trifoliates from different plants (20 leaves x 5 sets) Count both adults and nymphs	Unifoliolate stage: > 0.5 leafhopper <u>per plant</u> Otherwise: > 1 leafhopper per trifoliolate leaf
seedcorn maggot (SCM)	<ul style="list-style-type: none"> Agronomic: Potential for injury increases in wet, cool springs when seeds germinate 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 breaks down. Risk is very low in no-till fields. 	No specific recommendation	No rescue treatment is available. Consider replanting fields or areas with significant stand loss

Pest (abbreviation)	Management options and notes	Scouting recommendation	Threshold
slugs & snails	<ul style="list-style-type: none"> Biological: Some ground beetle species consume slugs. Agronomic: Tillage and crop rotation will reduce corn residue (slug habitat). Avoid planting in wet conditions, as open furrows act as slug highways 	<p>No specific recommendation</p> <p>Walk fields at night or early morning, turning over residue and looking for slime trails</p>	<p>None established</p> <p>A guess: Consider applying a molluscicide (slug bait) if stand is reduced by 5%</p>
spider mite	<ul style="list-style-type: none"> 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: Some insecticides flare mite populations by killing off natural enemies. Likewise, fungicide applications may disrupt fungal pathogens of mites. Be cautious about pesticide applications in dry years 	<p>Infestations often start on field edges</p> <p>Look for mites on the undersides of leaves using hand lens, or tap leaves over a black piece of paper</p> <p>Webbing is present when populations are high</p>	<p>A guess: Treat when mites appear on >25% of the plants and yellowing is first seen</p> <p>Mites are difficult to control. Spraying is often a losing proposition</p>
stink bugs	<ul style="list-style-type: none"> Biological: Several parasitoids attack egg masses or bugs 	<p>No specific recommendation</p>	<p>None established</p>
tarnished plant bug	<ul style="list-style-type: none"> Agronomic: Good weed control reduces alternate hosts for plant bugs 	<p>No specific recommendation</p>	<p>General guideline: One bug or more per plant at first flower to green pod stage</p>
thrips	<ul style="list-style-type: none"> Biological: Generally kept in check by predators. Environmental: Rainfall or irrigation reduces populations. <p>Note: Thrips can be viewed as semi-beneficial, because they are predators of spider mite eggs.</p>	<p>Infestations often start on field edges</p> <p>Look for thrips on the undersides of leaves using hand lens. Or tap leaves over a white piece of paper or a paper plate</p>	<p>Threshold used in the High Plains: >15 thrips per plant and leaf cupping is present</p> <p>(this threshold has not been tested in MI)</p>
western bean cutworm	<ul style="list-style-type: none"> Biological: Many predators consume eggs and larvae. Tiny Trichogramma wasps have been seen in the field in Michigan parasitizing egg masses and sometimes egg masses appear to be infected with fungus Sampling: WBC moths can be monitored using bucket traps with a pheromone lure. A local source for the reusable traps and lures is Great Lakes IPM in Vestaburg MI, https://www.greatlakesipm.com/ 	<p>Sampling dry bean plants directly for WBC eggs of larvae is difficult</p> <p>Use bucket traps to detect flight, starting at the end of June. At a cumulative catch of 100-120 moths, scout fields for pod feeding.</p>	<p>Action threshold developed in the Great Lakes Region:</p> <p>Treat when >10% of pods are fed on by WBC larvae</p>
white grubs	<ul style="list-style-type: none"> 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. <p>Note: It is important to identify grubs to species distinguish annual species from multi-year species of June beetles</p>	<p>No specific recommendation</p> <p>Grubs tend to be patchy, often in sandy parts of fields</p> <p>Grubs are sometimes detected when plowing in the fall or spring</p>	<p>None established</p>

List of OMRI-certified insecticides for organic dry beans

- 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 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

Active ingredient Trade Names	Labelled rate per acre (unless stated)	aphids	bean leaf beetle	European corn borer	grasshopper	green cloverworm	Mex bean beetle	plant bugs	potato leafhopper	slugs	spider mite	stink bugs	thrips	western bean cutworm	Pre harvest interval (PHI) in days	Precautions and Remark
azadirachtin Neemix 4.5	(a) 4 – 16 oz	a		a	a	a	a	a	a			a	a	*	0	<ul style="list-style-type: none"> • Azadirachtin, an extract of neem oil, interferes with insect molting and acts as a repellent & antifeedant. Unlike neem oil, it does not have miticidal and fungicidal properties • See label for specific rates by insect pest. Kills only immature insects, but may repel adults from feeding * not listed on label, but may have efficacy
azadirachtin + neem oil Debug Tres (3% azad/4.7% neem oil) Debug Turbo (0.7% azad/65% neem oil)	(a) 8 – 22.5 oz a) 16 – 104 oz	a	a	*	a	a	a	a	a		a	a	a	*	0	<ul style="list-style-type: none"> • Azadirachtin, an extract of neem oil, interferes with insect molting and acts as a repellent & antifeedant. The neem oil in the formulation adds miticidal and fungicidal properties. • Coverage is key. Spray must cover entire plant. • Similar precautions for crop injury and interactions with fungicides as neem oil alone (below) * not listed on label, but may have efficacy
Bacillus thuringiensis-Bt Agree Deliver Dipel DF Javelin XenTari DF	(a) 0.5 - 2.0 lbs (a) 0.25 - 2.0 lbs (a) 0.5 - 2.0 lbs (a) 0.25 - 1.5 lbs (a) 0.5 - 1.5 lbs			a	a										0	<ul style="list-style-type: none"> • Bts are biological insecticides that must be eaten to kill, so coverage is important. Applications ideally are made when larvae are small. Labels list specific larval size recommendations • Check labels for varying rates on specific caterpillar species, sizes, and infestation levels
iron phosphate Sluggo Sluggo Maxx	(a) 20 - 44 lbs (a) 4 – 25 lbs									a					0	<ul style="list-style-type: none"> • Bait must be eaten. Slugs stop feeding and die in about 3-6 days. Scatter granules using a spreader, applying a higher rate for a heavy infestation • Optimal application to moist soil in the evening, as slugs usually feed at night and early morning • Do not apply to or near surface water

Active ingredient Trade Names	Labelled rate per acre (unless stated)	aphids	bean leaf beetle	European corn borer	grasshopper	green cloverworm	Mex bean beetle	plant bugs	potato leafhopper	slugs	spider mite	stink bugs	thrips	western bean cutworm	Pre harvest interval (PHI) in days	Precautions and Remark
iron phosphate + spinosad Bug-N-Sluggo	(a) 20 - 44 lbs									a					28	<ul style="list-style-type: none"> Combination of Sluggo with spinosad insecticide, which gives some control of early-season cutworms. Similar remarks as iron phosphate
neem oil, cold pressed Socoro Debug ON	(a) 0.625-1.8% v/v solution (a) depends on spray volume	a	a	a	a	a	*	a	a		a	a	a	*	0	<ul style="list-style-type: none"> Neem interferes with insect molting & acts as a repellent & antifeedant. It also has miticidal and fungicidal properties See labels for information on oz needed by spray volume Formulation is oil based; leaf injury may occur from application at temps >90F. Apply early or late in day. See labels for interactions w/ sulfur and other fungicides Debug ON has a bee warning: Do not apply product while bees are actively visiting the area * not specifically on label, but may have efficacy
neem oil, clarified extract Trilogy	a) 1.0 – 2.0% v/v solution	a									a				0	<ul style="list-style-type: none"> Trilogy has a narrower pest spectrum than Socoro (cold-pressed neem oil). Otherwise, remarks are similar
potassium salts of fatty acids DES-X Insecticidal Soap	(a) 2% v/v spray solution	a						a			a				0	<ul style="list-style-type: none"> Contact insecticide; Spray solution must touch target pest to be effective, so coverage is critical. See label for specifics about spray volume and frequency of treatments See label for precautions on plant sensitivity. Combination w/ certain fungicides can lead to leaf damage. Do not spray in full sun – apply early or late in day, or under cloudy conditions Note that DES-X has a 2(ee) recommendation for use as a deer repellent.
pyrethrins PyGanic EC 1.4 _{II} PyGanic EC 5.0 _{II}	(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	<ul style="list-style-type: none"> Plant-derived insecticides that knock down insects quickly but have short residual. Coverage is critical Highly toxic to bees exposed to direct treatment; do not apply or drift on blooming crops or weeds

Active ingredient Trade Names	Labelled rate per acre (unless stated)	aphids	bean leaf beetle	European corn borer	grasshopper	green cloverworm	Mex bean beetle	plant bugs	potato leafhopper	slugs	spider mite	stink bugs	thrips	western bean cutworm	Pre harvest interval (PHI) in days	Precautions and Remark
spinosad/spinosyns Entrust Entrust SC	(a) 1 - 2 oz (b) 1.5 - 2 oz (a) 3 - 6 oz (b) 4.5 - 6.0 oz			a									b	*	28	<ul style="list-style-type: none"> Do not make more than two consecutive applications of products with spinosad For European corn borer and western bean cutworm, time sprays to target eggs and small larvae (see label). Pheromone trapping is key to knowing when peak flight & egg laying are happening Do not feed forage to meat or dairy animals <p>*WBC is not listed on Entrust labels under dry beans, but it is listed under corn</p>

ORGANIC FIELD CORN in MICHIGAN

Calendar of insect pests in organic field corn

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
white grubs	larvae (grubs), underground	Asiatic garden Euro Chafer Japanese beetle June beetle				
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 seedlings	feeding on lower leaves			
billbug	adults, on field edges	adult feeding	larval feeding - root crown			
black cutworm	Southern USA, migrate north	larvae feed on leaves and cut off plants at the base				
true armyworm	Southern USA, migrate north	1 st generation larvae feed on leaves	2 nd generation larvae may defoliate plants			
corn rootworm	eggs, underground		larvae feed on roots	adult beetles clip silks and feed on ear tip		
corn blotch leafminer	adult flies		larvae mine leaf tissue			
grasshoppers (multiple species)	egg clusters, underground		nymphs, then adults, feed on leaves			
European corn borer	5 th instar, in crop residue		1 st generation larvae feed on leaf and stalk	2 nd generation larvae feed on leaf, ear, stalk		
Japanese beetle adult	larvae (grub), underground			adult beetles clip silks		
corn earworm	Southern USA, migrate north				larvae feed in the ear	
fall armyworm	Southern USA, migrate north			larvae feed on leaves and then in ears		
western bean cutworm	prepupae, underground			larvae feed on tassels and silks, then on the ear tip and kernels		
stink bug	adults, nymphs(?), in & around fields		feed on young corn leaves	feed on juicy kernels		
corn leaf aphid	Southern USA, migrate north			multiple generations feed on plant sap		
spider mite	adult females, at base of hosts			multiple generations pierce plant cells		
sap or picnic beetles	pupae & adults, crop residue				adults & larvae feed in ear tips	

Damage checklist to aid in scouting of organic field corn

Plant part or timing	aphids	billbug	black cutworm	corn earworm	corn leafminer	corn rootworm larvae	corn rootworm adults	European corn borer	fall armyworm	flea beetle	grasshoppers	Japanese beetle adult	sap beetle	seedcorn maggot	slugs & snails	spider mite	stink bug	true armyworm	western bean cutworm	wireworm	white grubs	
Type of damage or injury																						
Stand (emergence)																						
seeds fed-on														X	X						X	
gaps in row			X											X	X						X	X
wilted or cut plants			X																		X	
hole through base of plant			X																		X	
seedling top cut-off straight			X																			
variable plant stages, heights																						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				
stippling (tiny yellow spots)																X						
purpling deficiency symptom																						X
brown 'crispy' dead leaves	X															X						
sticky leaves or sooty mold	X																					
webbing																X						

Plant part or timing	aphids	billbug	black cutworm	corn earworm	corn leafminer	corn rootworm larvae	corn rootworm adults	European corn borer	fall armyworm	flea beetle	grasshoppers	Japanese beetle adult	sap beetle	seedcorn maggot	slugs & snails	spider mite	stink bug	true armyworm	western bean cutworm	wireworm	white grubs
Type of damage or injury																					
<u>Tassels</u>																					
fed-on				x															x		
broken								x													
sticky or with sooty mold	x																				
<u>Stalks</u>																					
tunneling into stalk								x													
stalk breakage								x													
lodging, goosenecking						x															
<u>Roots</u>																					
brown tracks, scarring						x															
root hairs missing						x															x
pruning of whole roots						x															x
<u>Ear</u>																					
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				
poor pollination / ear fill	x						x														x
brown frass, messy or pellets				x					x									x	x		
white frass, powdery								x													

Biology and impact of insect pests in organic field corn

Terms used to describe the pest status of each insect

- **Rarely a pest:** Unusual, typically goes unnoticed. May not even be present in the state.
- **Uncommon pest:** Often present but well-below damaging levels. An outbreak once a generation
- **Occasional pest:** Present in most fields, sometimes in high numbers. An outbreak once a decade
- **Important pest:** Present in most fields, potentially increasing to damaging levels every season. A common target of scouting, management programs, or insecticide use.
- **Sporadic pest:** Damaging levels occur after favorable weather patterns (such as drought) or mass movement from south to north during the season
- **Localized pest:** Damaging levels occur in specific locations under specific agronomic conditions, for example in no-till production or in older stands.

Pest (abbreviation)	Life cycle and Number of generations	Impact on the Crop	Conditions which favor infestation or damage	Pest Status in MI & OH
aphids <i>Usually the corn leaf aphid</i>	<p>The summer population is female. Females do not mate to reproduce (this is called parthenogenesis). They also give birth to live young.</p> <p>Multiple overlapping generations.</p> <p>Large numbers of winged migrants may build up on corn in southern states and be carried south to north, raining out over fields in MI and OH.</p>	<ul style="list-style-type: none"> • Aphids suck plant sap (water and nutrients) from leaves • In rare outbreaks (plants covered with aphids) leaf death sometimes occurs • Aphids secrete sticky honey dew as a waste product. Sticky leaves get coated with black sooty mold growth - mostly cosmetic, but photosynthesis is reduced if mold is severe • Sticky honeydew on tassels & fresh silks may inhibit pollen shed & pollination. If severe, this can impact ear-fill and thus yield 	<ul style="list-style-type: none"> • Plant stress under dry conditions may be exacerbated if feeding from high numbers of aphid removes a lot of water. Lack of rainfall also leaves sticky honeydew on plants • Insurance use of insecticides and fungicides can favor aphids, since their natural enemies and fungal pathogens may be killed 	<p>Uncommon</p> <p>Populations are rarely high enough to cause damage</p> <p>The most recent infestation in southern Michigan in 2024 resulted from an intense migration from the south.</p>
billbug	<p>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 roots and the root crown. Adults emerge between midsummer and fall</p> <p>1 generation per year</p>	<ul style="list-style-type: none"> • Adults cut slits in the whorl, resulting in extensive tillering • Another symptom of feeding is oblong shot-holing that appears as leaves unfurl • Larvae can damage the root crown by feeding 	<ul style="list-style-type: none"> • Continuous corn • No / reduced tillage • Field edges • Fields with heavy nutsedge infestation (an alternate host) 	Rare
corn blotch leafminer (CBL)	<p>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.</p> <p>Several generations per summer</p>	<ul style="list-style-type: none"> • Females create numerous tiny pinholes wounds • In heavy infestations, entire leaf is mined by multiple larvae • Mined foliage dries up and shrivels, giving plants a frosted appearance 	<ul style="list-style-type: none"> • High levels in Michigan were observed in muck fields 	Rare
corn earworm (CEW)	<p>Moths move north into Michigan and Ohio in July or August. Eggs are laid on silks or upper leaves. Larvae (caterpillars) feed on leaves, then on silks and ears. Larvae drop and pupate in soil. Overwintering is not successful in our region.</p>	<ul style="list-style-type: none"> • Larval feeding can damage tassel, silks, kernels in ear • Ear injury is associated w/ invasion of other insects and ear molds that produce mycotoxins 	<ul style="list-style-type: none"> • Late-planted fields which are silking during egg-laying 	<p>Uncommon</p> <p>Rarely impacts field corn in the region, but it is a major pest of sweet corn</p>

Pest (abbreviation)	Life cycle and Number of generations	Impact on the Crop	Conditions which favor infestation or damage	Pest Status in MI & OH
corn rootworm (CRW)	Eggs overwinter in the soil and hatch in late May-early June. Larvae feed on corn roots for about three weeks and pupate in soil. Adults begin to emerge in early July and feed through the summer. Eggs are laid in soil of corn fields, except in areas with the rotation-resistant variant of western corn rootworm, which lays eggs in other crops (this variant hasn't been reported in MI for some years). 1 generation per year	<u>Larvae</u> <ul style="list-style-type: none"> • 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 <u>Adults:</u> <ul style="list-style-type: none"> • Scraping of leaf surface • Silk-clipping • Feeding on the ear tip 	<ul style="list-style-type: none"> • Continuous corn is by far the biggest risk for CRW root damage • Volunteer corn from the previous season attracts adults to lay eggs in soybean. This can lead to root damage in rotated corn • Late-planted corn may attract adults to feed on silks and impact pollination 	<u>Larval damage:</u> Important & Localized <i>In continuous corn production</i> <u>Adult beetles consuming silks:</u> Occasional & Localized <i>In continuous corn & sometimes adjacent rotated corn fields</i>
cutworm <i>Mostly black cutworm but also dingy, sandhill, and variegated</i>	Adult moths migrate north in early spring. Eggs laid on low-growing weeds or crop residue. Small larvae feed on weeds, then shift to corn after herbicide is applied. Larvae hide during the day and feed at night. Pupation in soil. Several generations per season, but the 1st is most damaging.	<ul style="list-style-type: none"> • Small larvae create shot-holes in leaves • Older larvae feed on leaves (variegated cutworm), or tunnel or cut into base of stalk (black cutworm) • Stalk cutting leads to stand loss 	<ul style="list-style-type: none"> • Low, dense weeds are egg-laying sites • No-till fields • Fields with high crop residue • Planting into cover crops or wet areas • Late-planted corn 	Sporadic Outbreaks occur after a heavy spring flight from the south
European corn borer (ECB)	Mature larvae overwinter in corn residue and pupate late spring. Moths emerge in late May- early June. Females lay egg masses on the undersides of corn leaves. Larvae feed on all above-ground parts of plants. Pupation in stalk (1 st gen) or residue (2 nd 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.	<ul style="list-style-type: none"> • Small larvae scrape leaf surface (windowpaning) or chew through whorl, resulting in shot-holing damage • Larger larvae bore into midrib & stalk, disrupting water flow, weakening stalk, or causing breakage • Both shank boring (ear drop) and direct kernel feeding reduce yield • Ear injury is associated with infection of ear molds that produce mycotoxins. Stalk boring is associated with stalk rot, breakage, and ear drop 	<ul style="list-style-type: none"> • Early-planted (taller) fields are at risk for 1st generation • Late-planted fields are at risk for 2nd generation <p>Note: Besides field corn, hosts include sweet corn, snap & dry beans, potato, tomato, peppers</p>	Occasional & Localized <i>in non-Bt corn</i> Region-wide outbreaks are suppressed by the widespread planting of Bt hybrids in conventional ag
fall armyworm (FAW)	FAW is a tropical species that cannot survive freezing temperatures. Adult moths migrate north, arriving in mid to late season. Eggs are laid on corn leaves. Larvae feed in the whorl or in the ear. Pupation in the soil. 1-3 generations at end of season, if temp is warm enough. Larvae cannot overwinter in our area.	<ul style="list-style-type: none"> • Leaf damage to whorl-stage corn • Kernel feeding (part of the caterpillar complex feeding in the ear) and subsequent risk of ear molds 	<ul style="list-style-type: none"> • Late-planted corn is attractive to moths for egg-laying • Edge rows may be damaged by larvae marching from infested grassy edge, pasture, or forages 	Uncommon in field corn
flea beetle	Adults overwinter and emerge in the spring. Eggs are laid in soil around corn plants. Larvae feed and pupate in soil. Several generations per year	<ul style="list-style-type: none"> • Adults feed on upper leaf surface, leaving white scraping or scratches. Direct damage is rarely a concern • Infected adults transmit Stewart's wilt bacteria during feeding (not a problem in field corn but can cause loss in susceptible inbred lines used for seed production) 	<ul style="list-style-type: none"> • Mild winters favor survival of overwintering beetles & increases Stewart's wilt risk. Risk is 'high' if the avg daily temps for months of Dec + Jan + Feb sums to >90°F. 	Rare in field corn

Pest (abbreviation)	Life cycle and Number of generations	Impact on the Crop	Conditions which favor infestation or damage	Pest Status in MI & OH
grasshoppers <i>several species</i>	Eggs overwinter in soil. Nymphs emerge in June. Leaf feeding increases with size. Females deposit groups of eggs in the undisturbed soil in late summer. 1 generation per year	<ul style="list-style-type: none"> Defoliation of plants by nymphs and adults. Feeding has a ragged appearance 	<ul style="list-style-type: none"> Fallow areas and pastures that border fields are preferred egg-laying sites A hot summer and 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 corn leaves, silks, and pollen, plus on hundreds of other hosts. Eggs laid in soil in July -September 1 generation per year	<ul style="list-style-type: none"> Adults skeletonize leaves but damage is usually limited Beetles also clips silks, similar to rootworm adults. Severe clipping can reduce pollination 	<ul style="list-style-type: none"> Populations often are higher on field edges, especially near turf and grassy areas 	Uncommon
sap beetle <i>= picnic beetle</i>	Adults overwinter. Eggs are laid on or near decaying and fermenting stuff. Thus, adults are attracted to ear tips with insect damage, insect poop, and mold growth. Larvae feed in ear and pupate in soil. Several generations per season	<ul style="list-style-type: none"> Larvae and adults are secondary pests in ears fed on by other insects like rootworm adults or caterpillars. Sap beetles create additional damage and areas for ear mold infection 	<ul style="list-style-type: none"> Ears opened and injured by other insects (such as CEW, ECB, WBC) Cool, wet weather late in the season, which enhances ear mold growth 	Uncommon
seedcorn maggot (SCM)	Overwinter as pupae in soil. Adult flies emerge in early spring, laying eggs in tilled or disturbed soil with decaying organic matter. Larvae (maggots) feed on decaying matter and germinating seeds. Several generations per year, only the first causing damage in field corn	<ul style="list-style-type: none"> Larvae feed on germinating seeds which can result in variable emergence and stand loss. Damage often occurs over a large part of field 	<ul style="list-style-type: none"> Tillage Recent (w/in 2 weeks) incorporation of organic matter such as alfalfa, green cover crops, weeds, or fresh manure Cool, wet weather which delays emergence Peak egg laying near planting time 	Localized Occurs under specific field and environmental conditions
slugs & snails	Slugs overwinter as eggs and adults, so both are present at planting. Eggs laid in soil in spring hatch in about one month and these slugs feed through the summer	<ul style="list-style-type: none"> Feeding on germinating seeds, cotyledons, & lower leaves as the plant grows. Feeding tends to occur at night Heavy feeding on small corn plants may slow development or reduce stand 	<ul style="list-style-type: none"> No or reduced-till Planting into heavy stubble, crop residue Cool, wet weather delaying emergence Poorly-closed furrows act as slug buffet lines 	Localized (but increasing) Occurs under specific field conditions
spider mites (two-spotted)	Adults overwinter in field borders and other sheltered areas. In spring, adults move to new growth and lay eggs on undersides of leaves. Mites spread from field to field by crawling or blowing in the wind. Multiple generations	<ul style="list-style-type: none"> Adults & nymphs pierce individual plant cells, creating tiny yellow spots (stippling) Severe damage results in leaf yellowing, death, water loss Webbing is a sign of a heavy infestation 	<ul style="list-style-type: none"> Prolonged hot, dry weather favors outbreaks and increases the impact of mite feeding Infestations often start on dusty edges of fields 	Sporadic Outbreaks occur in hot, dry seasons
stink bugs <i>several species</i>	Adults and nymphs feed by injecting salivary enzymes into plants and sucking up plant juices	<ul style="list-style-type: none"> 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, growing point can die Ear feeding can cause aborted or shriveled kernels 	<ul style="list-style-type: none"> No-till corn Rye cover crop or weeds which were killed by herbicide 	Uncommon

Pest (abbreviation)	Life cycle and Number of generations	Impact on the Crop	Conditions which favor infestation or damage	Pest Status in MI & OH
true armyworm (TAW)	<p>Adult moths migrate into Michigan in early spring. Eggs of the 1st generation are 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 in wheat move into nearby crops, including corn, in June as wheat dries down. Larvae pupate in the soil and adults emerge in a week. 2nd generation moths lay eggs in weedy or cover-cropped corn in July, or move in to corn from adjacent infested hay fields.</p> <p>2 to 3 generations per year, the first is usually the most damaging.</p>	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • Adjacent areas where eggs were laid, such as field margins, small grains (1st gen) or hay fields • Heavy weed growth or a cover crop are favored egg laying sites within a field. Organic fields are often very susceptible 	<p>Sporadic</p> <p>Outbreaks usually occur after a heavy spring flight from the south.</p>
western bean cutworm (WBC)	<p>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 tassels and silks, then in the ear. Feeding ends in early- to mid-September when caterpillars drop and burrow into soil.</p> <p>1 generation per year</p>	<ul style="list-style-type: none"> • Larger larvae feed in the ear, usually at the tip, but sometimes directly through the husk into the side • In heavy infestations, there can be multiple larvae per ear • Feeding damage allows other insects like sap beetles to infest. Damaged ears also have an increased risk of ear mold infection and quality reduction from mycotoxins 	<ul style="list-style-type: none"> • 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 	<p>Important and often Localized</p> <p>Corn stage during flight is often key to infestation</p>
white grubs - Asiatic garden beetle (AGB)	<p>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, soybean or potato). Grubs feed on roots from July-fall, then move down in the soil profile in late fall to overwinter. Feeding resumes in the spring until pupation.</p> <p>1 generation per year.</p> <p>See free AGB pocket guide at: https://aginsects.osu.edu/news/new-agb-pocket-field-guide-available</p>	<ul style="list-style-type: none"> • AGB 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. Interestingly, adults do not appear to feed on corn leaves 	<ul style="list-style-type: none"> • Previous crop of soybean, potato, alfalfa, or late season infestations of weeds like marestail • Fields or portions of fields with a sandy (> 80% sand) profile 	<p>Localized</p> <p>Damage in field crops has been found in northern Ohio, northern Indiana, and southern Michigan where sandy soils are present</p>
white grubs - European chafer	<p>Mature grubs overwinter in field. Adults emerge in June and mate at dusk near a landmark (ex, tall tree). Grubs feed on roots from July into fall then move down in soil profile in late fall.</p> <p>1 generation per year</p>	<ul style="list-style-type: none"> • Chafer grubs feed on cotyledons and roots, reducing stand and uniformity • Adults do not feed 	<ul style="list-style-type: none"> • Corn following soybeans • Field edges near lawns, golf courses, tree lines • Fields or portions of fields with sandy (> 80% sand) soil • Spring populations tend to be higher after a dry summer 	<p>Uncommon and Localized</p>

Pest (abbreviation)	Life cycle and Number of generations	Impact on the Crop	Conditions which favor infestation or damage	Pest Status in MI & OH
white grubs - Japanese beetle (JB)	Mature grubs overwinter in field. Adults emerge in July-August. Eggs laid in soil July-Sept. Grubs feed on root from July-fall then move down in soil profile in late fall. 1 generation per year	<ul style="list-style-type: none"> • JB grubs feed on cotyledons and roots, reducing stand and uniformity • Adults also feed on corn (see JB adults) 	<ul style="list-style-type: none"> • Planting into fallow fields or pasture • Fields bordered by pasture, home lawns • 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 soil. Grubs feed for three summers, with the 3 rd (last) stage causing the most damage to roots. Between summers, larvae move to a lower depth in soil. Late in the third summer, grubs pupate underground. Adults emerge the following spring, some years in very large numbers. 1 generation takes three years	<ul style="list-style-type: none"> • Prune cotyledons prior emergence, reducing stand • Prune root hairs and sometimes whole roots, causing wilting, water and nutrient deficiency, or plant death 	<ul style="list-style-type: none"> • Planting into fallow fields or pasture • Parts of fields near tree lines 	Uncommon
wireworm	Wireworms are the immature form of click beetles. They spend up to six years underground in the immature stage. Overlapping generations	<ul style="list-style-type: none"> • Feed on newly planted corn seeds & roots • May tunnel straight through the base of seedlings below the soil surface 	<ul style="list-style-type: none"> • Planting into long-standing fallow fields and pasture 	Uncommon & Localized Related to field history

Management of insect pests of organic field corn

Pest	Management options and notes	Scouting recommendation	Threshold
aphids	<ul style="list-style-type: none"> Biological: Predators (such as ladybugs, lacewings, parasitoids) usually keep populations in check. Under humid conditions, entomopathogenic fungi kill 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)	<p>Tassels covered w/ aphids & honeydew on 50% of VT stage plants & field is under moisture stress.</p> <p>Treatment probably not justified</p>
billbug	<ul style="list-style-type: none"> Agronomic: Crop rotation (adult billbugs are slow and don't move far) and tillage both reduce populations. Control of sedges removes an alternate host. 	No specific recommendation	No specific recommendation
corn blotch leafminer	<ul style="list-style-type: none"> Biological: Numerous wasp parasitoids attack larvae Insecticide: Not effective because larvae are protected in leaf mines. Spraying also disrupts parasitism. 	None	<p>none</p> <p>Do not spray!</p>
corn earworm	<ul style="list-style-type: none"> Biological: Several predators attack eggs and larvae Agronomic: Planting early or on time might reduce risk Insecticide: Difficult. Optimal timing and repeat sprays would be needed to protect ears 	None	<p>None</p> <p>Not an economic pest of field corn in MI</p>
corn rootworm larvae	<ul style="list-style-type: none"> Agronomic: Crop rotation is the most effective way to control CRW. Eliminating 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 help plants recover from larval feeding 	<p>Scout fields for beetles to predict what to do the <u>following season</u></p> <ul style="list-style-type: none"> In continuous corn: Check 100 plants after adult emergence (20 plants x 5 sets) 	<p>1 beetle per plant</p> <p>Threshold indicates that CRW control is needed next season i.e. Rotate the field out of corn</p>
corn rootworm adults	<ul style="list-style-type: none"> Agronomic: Crop rotation is 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	<ul style="list-style-type: none"> Biological: Ground beetles and parasitoids kill larvae Agronomic: Good weed control and timely cover crop termination prior to planting reduce likelihood of infestation 	<p>Walk fields to determine % wilted or cut plants</p> <p>Dig around base of plants to confirm cutworm larvae are present</p> <p>Note: Pheromone traps can indicate flight and aid in timing of scouting</p>	> 5% plants cut or damaged
European corn borer	<ul style="list-style-type: none"> Biological: Numerous natural enemies eat larvae. Egg and larval parasitoids and pathogens are common Agronomic: Early-planted fields are most at risk for first generation infestation while late-planted fields are most at risk for second generation. Plowing and shredding stalks reduce overwintering larval numbers to some extent, but not enough to make a difference in the next season Insecticide: Timing is critical because larvae eventually tunnel into midribs and stalks, out of reach from sprays. Percent control is usually better for applications against first generation ECB on whorl stage corn than against second generation larvae in the ear zone. <p>Note: To see ECB trapping data online in the summer, visit the 'Great Lakes and Maritimes Pest Monitoring Network'</p>	<ul style="list-style-type: none"> <u>1st Generation</u>: count # of plants (20 plants x 5 sets) with windowpane or shot hole damage. Unroll whorls to check for live larvae <u>2nd Generation</u>: count # of plants (20 plants x 5 sets) with egg masses on undersides of leaves <p>Note: Trapping can aid in timing of scouting. ECB in Michigan moths respond to the Z (Iowa) strain pheromone</p>	<p>General guidelines:</p> <p><u>1st Generation</u>: > 50% of plants with damage and live larvae still present in whorls</p> <p><u>2nd Generation</u>: > 50% of plants with egg masses</p> <p>Economic thresholds varying by expected yield, spray cost, and market price are calculated using worksheets available in extension pubs</p>

Pest	Management options and notes	Scouting recommendation	Threshold
fall armyworm	<ul style="list-style-type: none"> Biological: Parasitized by several wasp and fly species Insecticide: Spraying to protect the ear is difficult 	Check 100 plants (20 plants x 5 sets) for larvae, feeding, and frass	> 50% of plants infested with small (under 1 inch) larvae
flea beetle	<ul style="list-style-type: none"> Agronomic: Most corn hybrids are resistant to Stewart's Wilt disease transmitted by flea beetles. Environmental: Cold winters reduce the survival of beetles and thus the incidence of Stewart's Wilt 	<u>In seed corn production</u> Check 100 plants (20 plants x 5 sets) for beetles	<u>On susceptible inbreds</u> 5 or more beetles per plant, up to the four-leaf stage
grasshoppers	<ul style="list-style-type: none"> Biological: Blister beetle larvae and other insects feed on eggs. 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 the sprayed area if hoppers are invading from a neighboring field or grassy border 	No specific recommendation	General guideline: 5 or more hoppers per plant I have never seen populations high enough to treat in Michigan
Japanese beetle adults	<ul style="list-style-type: none"> Biological: A specific pathogen called <i>Ovavesicula popilliae</i> infects both adults and grubs of JB in Michigan. Agronomic: Adults move around the landscape, so tillage and other practices in nearby fields do not have much impact 	Check 100 plants (20 plants x 5 sets) for silk clipping by the combo of Japanese beetle & CRW	Silks clipped shorter than ½ inch (usually in tandem w/ rootworm adults)
seedcorn maggot (SCM)	<ul style="list-style-type: none"> Agronomic: Potential for injury decreases with 1) shallow seeding into warm soil and 2) delaying of planting until herbicide-killed or disced cover crops and weeds decompose Agronomic: Problems rarely occur in no-till fields A degree day model predicts when peak flight & egg-laying will occur based on MSU weather station data. See this site: https://enviroweather.msu.edu/crops/corn 	No specific recommendation To assess risk of SCM before planting, check the degree day model listed in the previous column	No rescue treatment is available. Consider replanting fields or areas with significant stand loss
slugs & snails	<ul style="list-style-type: none"> Biological: Some insects consume slugs, like ground beetles and firefly larvae 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 	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 slug bait (molluscicide) if stand is reduced by 5%
spider mites (two-spotted)	<ul style="list-style-type: none"> 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 irrigation still isn't enough. Environmental: Rainfall can have a similar effect as irrigation Miticides: Resistance is common in mites. Some insecticides (perhaps pyrethrin) may 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 insecticide and fungicides are discouraged. Be especially cautious about applications in dry seasons 	Infestations often start on field edges Look for mites on the undersides of leaves using a hand lens or tap leaves over a 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 that make spraying pay: * population is still growing * forecast is for hot and dry weather * humidity is low under the canopy * corn is pollinating * excellent spray coverage is possible
stink bugs	<ul style="list-style-type: none"> Agronomic: Proper adjustment of planter to close furrows, so overwintered stink bugs cannot feed on the growing point early in the season 	No specific recommendation	None established

Pest	Management options and notes	Scouting recommendation	Threshold
true armyworm	<ul style="list-style-type: none"> Biological: Often controlled by predators and 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 <p><i>Note: To see armyworm trapping data online in the summer, visit the 'Great Lakes and Maritimes Pest Monitoring Network'</i></p>	<p>Check 100 plants (20 plants x 5 sets) for larvae, feeding, or frass. Target fields that had a cover crop or heavy weed pressure early</p> <p>During the day, larvae hide in the whorl, at base of plants, or under crop residue</p>	<p><u>Seedlings:</u> 10% stand loss</p> <p><u>Whorl stage:</u> 25% of plants with ≥ 2 larvae per whorl OR 75% of plants with 1 larva</p> <p>Treat only if larvae are less than 1.25 inch</p>
western bean cutworm	<ul style="list-style-type: none"> Biological: Many predators consume eggs and larvae, and tiny parasitoids attack eggs <p><i>Note: To see WBC trapping data online in the summer, visit the 'Great Lakes and Maritimes Pest Monitoring Network'</i></p>	<p>To detect first flight, use pheromone bucket traps starting at end of June</p> <p>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</p>	<p>In the Great Lakes Region: 5% of plants with egg masses or small larvae.</p> <p>This is a <u>cumulative</u> threshold - add % infestation from one week to the next towards the 5% threshold</p>
white grubs	<ul style="list-style-type: none"> Biological: Some species are attacked by pathogens. For example, A specific pathogen called <i>Ovavesicula popilliae</i> infects both adults and grubs of Japanese beetle in Michigan. Agronomic: 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 the planting of infested fields may avoid most of the feeding <p><i>Note: it is important to identify grubs to distinguish annual species from species of June beetle, which remain in fields for multiple seasons</i></p>	<p>Sampling methods aren't well-defined. Use a shovel to check 1x1 ft² sections in fall or spring. Grubs tend to be patchy. Sandy knolls are often hot spots.</p> <p>Grubs may be detected while plowing in fall or spring, especially when birds follow tillage equipment</p>	<p><u>June beetle:</u> 1 grub per ft²</p> <p>European chafer, 2 grubs per ft²</p> <p>Japanese beetle and Asiatic garden, use chafer threshold</p>
wireworm	<ul style="list-style-type: none"> Agronomic: Depending on species, wireworms remain in the larval stage for 1-5 years, thus they are favored by undisturbed soil. Fall plowing of long-standing fallow fields & pasture prior to planting is recommended 	<p>Sampling must be done 2-3 weeks before planting using wireworm bait traps (described online or in extension pubs). This method is often impractical and difficult</p>	<p>At least 1 wireworm per bait trap</p> <p>Otherwise, no recommendation</p>

List of OMRI-certified insecticides for organic field corn

- 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 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

Active ingredient Trade Names	Use rate(s) per acre (unless specified)	aphids	cutworm	Euro corn borer	fall armyworm	flea beetle	grasshoppers	Japanese beetle	rootworm adults	slugs	spider mite	stink bugs	true armyworm	western bean	Pre-harvest interval (PHI) in days	Precautions and Remarks
azadirachtin Neemix 4.5	(a) 4 – 16 oz	a	a	a	a		a					a	a	*	0	<ul style="list-style-type: none"> • Azadirachtin, an extract of neem oil, interferes with insect molting and acts as a repellent & antifeedant. Unlike neem oil, it <u>does not</u> have miticidal and fungicidal properties • See label for specific rates by insect pest. Kills only immature insects, but may repel adults from feeding * not listed on label, but may have efficacy
azadirachtin + neem oil Debug Tres (3% azad/4.7% neem oil) Debug Turbo (0.7% azad/65% neem oil)	(a) 8 – 22.5 oz a) 16 – 104 oz	a	a	*	a	a	a	a	a		a	*	a	*	0	<ul style="list-style-type: none"> • Azadirachtin interferes with insect molting and acts as a repellent & antifeedant. The neem oil in the formulation adds miticidal and fungicidal properties. • Coverage is important. Spray must cover entire plant. • Similar precautions for crop injury and interactions with fungicides as neem oil alone (below) * not listed on label, but may have efficacy
Bacillus thuringiensis (Bt) Agree WG Deliver Dipel DF Javelin WG XenTari Dipel 10G	(a) 1.0 - 2.0 lbs (a) 0.5 - 1.5 lbs (a) 0.5 - 2.0 lbs (a) 0.25 - 1.5 lbs (a) 0.5 - 2.0 lbs (a) 10 lbs granules applied into whorl			a	a								a	*	0	<ul style="list-style-type: none"> • 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 or 2nd stage) larvae * Western bean cutworm is not specifically on labels, but 'cutworms' are. Corn earworm (not on this table) is on many Bt labels as well.
iron phosphate Sluggo Sluggo Maxx	(a) 20 - 44 lbs (a) 4 - 25 lbs									a					0	<ul style="list-style-type: none"> • Bait must be eaten. After consuming, slugs stop feeding and die in about 3-6 days • Scatter granules using a spreader, applying a higher rate for a heavy infestation. • Optimal application is to moist (not saturated) soil in the evening, as slugs usually feed at night and early morning • Do not apply to or near surface water

Active ingredient Trade Names	Use rate(s) per acre (unless specified)	aphids	cutworm	Euro corn borer	fall armyworm	flea beetle	grasshoppers	Japanese beetle	rootworm adults	slugs	spider mite	stink bugs	true armyworm	western bean	Pre-harvest interval (PHI) in days	Precautions and Remarks
iron phosphate + spinosad Bug-N-Sluggo	(a) 20 - 44 lbs		a							a					28 grain 7 forage	<ul style="list-style-type: none"> Combination of Sluggo with spinosad insecticide, which gives some control of early-season cutworms Similar remarks as iron phosphate
neem oil, cold pressed Socoro Debug ON	(a) 0.625-1.8% v/v spray solution (a) depends on spray volume used	a	a	a	a	a	a	a	a		a	a	a	*	0	<ul style="list-style-type: none"> Neem interferes with insect molting & acts as a repellent & antifeedant. It also has miticidal and fungicidal properties. See label for table of oz/acre by spray volume Formulation is oil based; leaf injury may occur from application at temps >90F. Apply early or late in day. See labels for info on interactions w/ sulfur and other fungicides * WBC not specifically on label, but cutworms are
neem oil, clarified extract Trilogy	(a) 1.0 – 2.0% v/v spray solution	a									a				0	<ul style="list-style-type: none"> Trilogy has a much narrower pest spectrum than Socoro/ cold-pressed neem oil. Otherwise, similar remarks
pyrethrins PyGanic EC 1.4 II PyGanic 5.0	(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	<ul style="list-style-type: none"> Plant-derived insecticides that knock down insects quickly but have short residual. Coverage is critical PyGanic is OMRI listed for organic use, Evergreen is not Highly toxic to bees exposed to direct treatment; do not apply or drift on blooming crops or weeds
spinosad/spinosyns Entrust Entrust SC	(a) 0.5 - 2.0 oz (b) 1.0 - 2.0 oz (a) 1.5 - 6.0 oz (b) 3.0 - 6 oz			a	a								a	b	28 grain 7 forage 1 seed	<ul style="list-style-type: none"> Time sprays to coincide with peak egg hatch. Frequent retreatments may be needed every few days. Max three applications per calendar year For resistance management, rotate to other modes of action. See labels for specific recommendations

ORGANIC SOYBEAN in MICHIGAN

Calendar of insect pests of organic soybeans

Pests are listed from early to late in the 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	larvae (maggots) damage germinating plants				
wireworm	larvae, in soil	larvae damage roots				
slugs & snails	both eggs and adults, in field	feeding on seedlings and lower leaves of bigger plants				
black cutworm	Southern USA, migrate north	larvae feed on leaves and cut off plants				
bean leaf beetle	adults, woodlots & residue		adults chew small holes in leaves		adults chew holes in leaves and pods	
soybean aphid	eggs, on buckthorn trees		nymphs and adults pierce leaves, feed on plant sap, and secrete sticky honeydew			
silver spotted skipper	pupae		larvae feed on leaves and live in a distinctive shelter made of leaves folded or tied together			
leaf-defoliating caterpillars (multiple species)	beet armyworm, webworm, yellow woolly bear - pupae All others: Southern USA, migrate north		larvae feed on leaves (defoliation). Earworms and loopers may also feed on pods. Timing depends on species. <ul style="list-style-type: none"> • 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 and adults feed on leaves		
Japanese beetle adults	larvae (grubs), underground			adults skeletonize leaves, mainly along field edges		
spider mite	adult females, at base of hosts			nymphs and adults pierce plant cells		
soybean gall midge	pupae, on/in ground			maggots feed on lower stems <i>To date, not found in MI or OH</i>		
thrips	depends on species			Nymphs and adults 'punch' and suck plant cells		
stink bug	adults, in & around fields			adults and nymphs pierce pods & beans		

Damage checklist to aid in scouting organic soybeans

Plant part or timing	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
Type of damage or injury																					
<u>Stand (emergence)</u>																					
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
<u>Leaves</u>																					
slimy or shiny trails									x												
outer leaf surface scraped (windowpane feeding)									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 or 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 sooty mold coating											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 in pod					x	x							x					x			
discolored beans															x						
shriveled, aborted beans															x						
Other																					
virus transmission	x										x						x				

Biology and impact of insect pests in organic soybeans

Terms used to describe the pest status of each insect

- **Rarely a pest:** Unusual, typically goes unnoticed. May not even be present in the state.
- **Uncommon pest:** Often present but well-below damaging levels. An outbreak once a generation
- **Occasional pest:** Present in most fields, sometimes in high numbers. An outbreak once a decade
- **Important pest:** Present in most fields, potentially increasing to damaging levels every season. A common target of scouting, management programs, or insecticide use.
- **Sporadic pest:** Damaging levels occur after favorable weather patterns (such as drought) or mass movement from south to north during the season
- **Localized pest:** Damaging levels occur in specific locations under specific agronomic conditions, for example in no-till production or in older stands.

Pest (abbreviation)	Life cycle and Number of generations	Impact on the crop	Conditions which favor infestation or damage	Pest Status in MI
bean leaf beetle (BLB)	Adults overwinter in wooded areas, leaf litter, & field margins. Beetles emerge in spring. May first move into alfalfa OR directly into early-planted soy. Eggs are laid on the ground around plants. Larvae feed underground on roots and nodules, and pupate in soil. New (first generation) adults feed on leaves and pods. Potential for a second generation in southern Michigan and most of Ohio.	<ul style="list-style-type: none"> • Overwintering adults feed on younger plants, leaving small round holes • Later in the season, adults feed on leaves and the surfaces of pods. Pod injury creates entry wounds for pathogens and can result in shriveled or moldy beans • Adults may clip pods off • Adults can transmit bean pod mottle virus (BPMV) which affects yield and bean color, and contributes to 'stay green' syndrome in the fall 	<ul style="list-style-type: none"> • Fields planted near alfalfa or planted very early are at risk for colonization by overwintering beetles • Late-planted fields avoid overwintering beetles but may attract beetles that feed on pods later in the season 	Occasional BLB is a common insect in soybean, but few fields go over threshold. Pod damage is typically more important than defoliation.
cutworm <i>including black and variegated cutworm</i>	Black cutworm moths migrate into Michigan 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 is the most-damaging	<ul style="list-style-type: none"> • Small larvae chew holes in leaves • Larger larvae damage the stem at the soil line or cut seedlings off, reducing stand 	<ul style="list-style-type: none"> • Winter annual weeds and weedy field edges are egg-laying sites • No-till fields with high crop residue • Planting into cover crops or wet areas 	Uncommon I have only seen BCW in soybean a few times.
grasshoppers <i>several species including red-legged & differential</i>	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	<ul style="list-style-type: none"> • Defoliation of plants by nymphs and adults. Feeding has a ragged appearance • Hoppers may also chew into green pods and consume beans 	<ul style="list-style-type: none"> • Undisturbed fallow areas, roadsides, and pasture are common egg-laying sites. Hoppers move into fields from these areas • A dry summer & fall can lead to high numbers the following year 	Uncommon Outbreaks rare
green cloverworm	GCW overwinters roughly south of a line from Ft Wayne IN to Findlay OH (this may be shifting north as winters warm). It recolonizes Michigan in early spring. Eggs are laid on undersides of leaves and larvae feed on foliage. When disturbed, larvae flop around and wriggle violently. 2 generations per season	<ul style="list-style-type: none"> • Larvae defoliate plants, eating the leaf tissue between the veins. Plants can appear tattered 	<ul style="list-style-type: none"> • Strong weather systems from the south may carry large numbers north in the spring. 	Uncommon Outbreaks rare

Pest (abbreviation)	Life cycle and Number of generations	Impact on the crop	Conditions which favor infestation or damage	Pest Status in MI
Japanese beetle adults	Larvae (grubs) feed on roots of many hosts and overwinter. Adults emerge in mid-summer and feed on hundreds of hosts, including soybean. Adults may persist into the fall. Eggs laid in the soil in July and August. 1 generation per year	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • Field edges near favorite hosts (wild grape, ornamentals) or turf (with high grub infestation) may have more beetles and damage 	Occasional JB is common in Michigan soy fields, but I have yet to see a field that justified spraying
seedcorn maggot (SCM)	Pupae overwinter in soil. Adult flies emerge in early spring (roughly mid-April in southern MI), laying eggs in tilled soil with decaying organic matter. Larvae (maggots) feed primarily on decaying stuff, but also on seeds and emerging seedlings. Several generations per year. The first (damaging) generation is done by mid-May in southern to central Michigan.	<ul style="list-style-type: none"> • Larvae feed on germinating seeds, resulting in variable emergence, stand loss, and delayed development • Plants that do emerge often have scarring on cotyledons • Damage can occur over a large part of field <p>Note: maggots may be present when seeds rot for another reason such as pathogen infection or wet conditions</p>	<ul style="list-style-type: none"> • Tillage • Recent incorporation (w/in 2 weeks of planting) of green organic matter such as alfalfa, weeds or cover crops, or of fresh manure • Cool, wet weather (delays emergence) • Early planting into peak adult activity and egg laying 	Localized Occurs under specific field conditions and planting times
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	<ul style="list-style-type: none"> • Larvae feed on leaves around their shelter 	<ul style="list-style-type: none"> • Nothing specific 	Uncommon Larvae are weird-looking and get noticed during scouting, but they are harmless.
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. 1-2 generations	<ul style="list-style-type: none"> • Feed on seeds, cotyledons, & leaves, usually at night • Heavy feeding on young plants may slow stand development or even cause stand loss 	<ul style="list-style-type: none"> • No or reduced till • Planting into heavy stubble, crop residue • Cool, wet weather (delays emergence) • Stand loss can occur when furrows are poorly closed, as slugs enter and feed down the slot 	Localized Occurs under specific 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, females and a generation of males return to buckthorn. This is the only time mating occurs, between males and the daughters of the females. Eggs are laid near buds on buckthorn. Multiple overlapping generations	<ul style="list-style-type: none"> • All stages suck plant sap, removing water and nutrients. • Large infestations impact yield by reducing pod number, beans per pod, and bean size, and covering 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 	<ul style="list-style-type: none"> • Late-planted or double-cropped fields are often overwhelmed by summer migrants, resulting in heavy infestation • K deficiency leads to heavy infestation because aphids grow faster, reproduce sooner, and more • Drought stress enhances damage and reduces onset of aphid-killing fungi 	Occasional to Important <i>SBA was a major pest for a decade after its discovery in the 2000s. But currently in MI, fields that are over threshold are uncommon due to high levels of biocontrol</i>

Pest (abbreviation)	Life cycle and Number of generations	Impact on the crop	Conditions which favor infestation or damage	Pest Status in MI
soybean gall midge NOTE: there is a similar-looking native midge (an orange maggot) that feeds on white mold!	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. Mature larvae are bright orange maggots. They feed on stems and drop off plants to pupate. 2 generations per season?	<ul style="list-style-type: none"> Larvae feed at the base of plants in the early vegetative through reproductive stages Signs of infestation include brown discolored stems; wilting, broken, or lodged plants; and dead plants Damage often starts in rows on field edges 	<ul style="list-style-type: none"> Infestation usually heaviest on edges next to last-year's soybean 	None Current (2025) distribution: IA, KS, MN, MO, ND, NE, and SD As of 2026, this pest is NOT in Michigan
soybean looper	One of the most abundant pests of soybean in the southern US. Adults migrate from the south, arriving mid to late season (July/ August).	<ul style="list-style-type: none"> Larvae defoliate plants and in rare cases feed on pods 	<ul style="list-style-type: none"> Nothing specific 	Uncommon I have never seen high populations in our area
spider mites <i>two-spotted</i>	Adults overwinter in field borders and sheltered areas. In spring, adults move to new growth and lay eggs on the undersides of leaves. Mites spread from field to field by crawling or blowing in the wind. Multiple overlapping generations	<ul style="list-style-type: none"> Adults & nymphs pierce and dehydrate individual plant cells, resulting in tiny yellow spots called 'stippling' Severe damage results in leaf yellowing, leaf drop, leaf death, and water loss Webbing is a sign of a heavy infestation 	<ul style="list-style-type: none"> Prolonged hot, dry weather favors mite outbreaks and enhances the impact of their feeding Infestations often start on dusty edges of fields 	Sporadic Outbreaks occur in hot, dry seasons
stink bugs <i>multiple species</i> Note: some stink bug species are predators of other insects	Adults overwinter and emerge in spring to complete a generation on weeds, clover, and wheat. Sampling of Michigan fields shows that bugs tend to move into soybean fields after wheat is harvested. Egg masses are laid on soybean leaves. Adults and nymphs feed by injecting digestive enzymes and sucking plant juices from stems, leaves and pods.	<ul style="list-style-type: none"> Pod feeding can result in shriveled, deformed, smaller, or discolored beans. In some specialty beans like natto, feeding punctures may not be apparent until processing Punctures can be entry points for plant pathogens Stink bug feeding can be related to stay-green syndrome 	<ul style="list-style-type: none"> For brown stink bug - fields near wheat For the invasive brown marmorated stink bug - fields near woods or buildings 	Occasional in bulk soybean more important in food-grade specialty beans
thistle caterpillar <i>AKA painted lady butterfly</i>	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	<ul style="list-style-type: none"> Caterpillars web and fold leaves together to make a distinctive shelter, then feed in and around the structure 	<ul style="list-style-type: none"> Nothing specific 	Uncommon Outbreaks are rare, but webbed leaves & the spikey colorful larvae are noticed during scouting
thrips <i>several species</i>	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.	<ul style="list-style-type: none"> 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 virus 	<ul style="list-style-type: none"> Prolonged hot, dry weather favors an outbreak and enhances the impact of thrips feeding Thrips develop in small grain fields first and may move into adjacent soybeans after dry-down 	Uncommon Thrips are often on soybeans, but rarely cause damage
webworm <i>garden & alfalfa webworm</i>	Overwinter as pupae. 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	<ul style="list-style-type: none"> The tied shelter can have both windowpane damage and defoliation. Under heavy infestation, leaves may be entirely skeletonized, dry out and turn brown 	<ul style="list-style-type: none"> Patchy infestations can occur in fields with pigweed (a favorite host) or on field margins near alfalfa 	Uncommon

Pest (abbreviation)	Life cycle and Number of generations	Impact on the crop	Conditions which favor infestation or damage	Pest Status in MI
white grubs - annual <i>including Asiatic garden beetle (AGB) and Japanese beetle</i>	Adults emerge in June into July, depending on species. Eggs are laid in soil during July-August. Grubs feed on roots through the fall, then move down in soil profile to overwinter. 1 generation per year	<ul style="list-style-type: none"> • Mature grubs overwinter in fields, then feed again the next spring on cotyledons and roots of seedlings at planting time • Root feeding may reduce stand or increase variability • Japanese beetle adults feed on soybean leaves (see Japanese beetle in list) 	<ul style="list-style-type: none"> • Fields or parts of fields with a sandy >80% texture (AGB) • Planting into fallow fields or pasture, or field margins near turf where grubs are present (JB) 	Localized Soybean stand loss from AGB is documented in sandy fields in southern MI, northern OH, & northern IN
white grubs - June beetle	Adults emerge in May/June. They move and mate at dusk, often coming to lights. Eggs are laid in soil. Grubs feed for three summers, with 2 nd and 3 rd stage grubs causing the most damage to roots. Between summers, larvae move to a lower depth in soil. Late in the 3 rd summer, grubs pupate underground. Adults overwinter until next spring. 1 generation takes three years	<ul style="list-style-type: none"> • Grubs may be present for the entire season, feeding on roots and cotyledons of seedlings as well as roots of larger plants • At planting, root injury may reduce stand and uniformity. Later in season, symptoms include wilting, water and nutrient deficiency, or plant death 	<ul style="list-style-type: none"> • Sandy fields or parts of fields • Planting into fallow fields or pasture 	Uncommon & Localized In Michigan, there have been a few cases of stand loss in sandy fields in the Thumb
wireworm <i>multiple species</i>	Wireworms are the immature form of click beetles. They spend up to six years in the immature stage. Overlapping generations	<ul style="list-style-type: none"> • Feed on newly planted soybean seeds & roots 	<ul style="list-style-type: none"> • Planting into long-standing fallow fields or pasture 	Uncommon & Localized

Management of insect pests of organic soybeans

The defoliation recommendation in this guide was updated based on results from a grower-funded regional research project in the Midwest. **For details on assessing defoliation, see the pages following this table.**

Pest	Management options and notes	Scouting recommendation	Threshold
bean leaf beetle (BLB)	<ul style="list-style-type: none"> Environment: Extended periods of subfreezing winter temperatures can increase death of overwintering beetles 	<p>For general detection of beetles, use a sweep net</p> <p>To estimate defoliation, use the leaflet method described on the pages following this table</p>	<p>Overall defoliation threshold:</p> <ul style="list-style-type: none"> V stages - R2: 30% R3 - R5: 10% R6: 15% <p>Threshold for pod feeding: 10%</p>
caterpillars	<p>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</p> <ul style="list-style-type: none"> Biological: Natural enemies keep most species in check 	<p>For general detection, use a sweep net</p> <p>To estimate defoliation, use the leaflet method described on the pages following this table</p>	<p>Overall defoliation threshold:</p> <ul style="list-style-type: none"> V stages – R2: 30% R3 - R5: 10% R6: 15%
cutworm <i>including black and variegated cutworm</i>	<ul style="list-style-type: none"> Biological: Ground beetles and parasitoids kill larvae Agronomic: Good weed control and timely cover crop termination reduce likelihood of infestation 	<p>Walk fields to check stand. Larvae feed at night and on overcast days. During the day, dig around base of plants to locate them</p> <p>Pheromone traps for black cutworm can aid in timing of scouting</p>	<p>Guideline: Treat if reduction in stand count is unacceptable based on target plant population</p> <p>(soy can compensate for some stand loss)</p>
grasshoppers <i>several species including red-legged & differential</i>	<ul style="list-style-type: none"> 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 spraying to a field border if hoppers are coming in from a neighboring field or grassy border 	<p>No specific recommendation</p> <p>To estimate defoliation, use the leaflet method described on the pages following this table</p>	<p>Overall defoliation threshold:</p> <ul style="list-style-type: none"> V stages - R2: 30% R3 - R5: 10% R6: 15%
green cloverworm	See "caterpillars"		
Japanese beetle adults	<ul style="list-style-type: none"> Insecticide: May be able to limit spray area to the edge, since beetles often congregate there 	<p>To estimate defoliation, use the leaflet method described on the pages following this table</p>	<p>Overall defoliation threshold:</p> <ul style="list-style-type: none"> V stages - R2: 30% R3 - R5: 10% R6: 15%
seedcorn maggot (SCM)	<ul style="list-style-type: none"> Agronomic: Delay planting at least 2 weeks into disced cover crops, weeds, manure, or heavy residue. It is especially important to avoid early (mid-April) planting under these circumstances when cold soils are expected to delay soybean emergence Agronomic: SCM almost never infests no-till fields A degree day model predicts when peak flight & egg-laying will occur based on MSU weather station data. See this site: https://enviroweather.msu.edu/crops/corn 	<p>No specific recommendation</p> <p>To assess potential risk of SCM before planting, check the degree day model listed in the previous column</p>	<p>No rescue treatment. Consider replanting fields or areas with significant stand loss</p> <p>An insecticide seed treatment is not recommended when replanting, as SCM risk has passed</p>
silver-spotted skipper	See "caterpillars"		

Pest	Management options and notes	Scouting recommendation	Threshold
slugs & snails	<ul style="list-style-type: none"> • Biological: Some ground beetle species consume slugs • Agronomic: Tillage and crop rotation reduce crop residue (slug habitat). Row cleaners can sweep away residue and create a warm band of soil above the seed bed • Agronomic: Avoid planting in wet conditions that result in open furrow slots. Open furrows remain cool and moist, and slugs can move along them from seed to seed 	<p>No specific recommendation</p> <p>Place shingles in fields before planting to detect slugs, which hide under them during the day</p>	<p>None established</p> <p>Consider treating or replanting only areas with significant stand loss</p>
soybean aphid (SBA)	<ul style="list-style-type: none"> • Biological: Numerous predators and several species of parasitoids usually keep SBA in check. 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. <u>Do not</u> spray populations below the threshold. This disrupts natural enemies and aphid numbers can quickly rebound. Insecticide resistance is reported in aphid populations in western states - insurance or early sprays created the problem. If the threshold is reached, use nozzles which provide good coverage and a high enough water volume to achieve excellent coverage 	<p>Begin scouting at end of June. Sample a minimum of 30 whole plants, taking several paces between them. Count and record the total # of SBA on each, including '0s'. A tally counter makes it much easier to count. Then calculate the average # per plant</p> <p><i>[In practical terms, if the top-third of every plant is covered with several hundred juicy, green, healthy-looking aphids, this is likely threshold]</i></p>	<p>Economic threshold:</p> <ul style="list-style-type: none"> • R1-R5: 250 per plant • After R5: <u>don't treat</u> <p>You have ~7 days to treat after reaching threshold, as lag time was built into the threshold</p> <p><u>Factors which reduce the need to spray:</u></p> <ul style="list-style-type: none"> * Are there numerous predators beginning to control the aphids? * Are there fungus-killed aphids, which suggests population is about to crash? * Are the aphids tiny 'white dwarves' which indicates a decreasing population?
soybean gall midge	<ul style="list-style-type: none"> • Agronomic: Infestations start on field edges adjacent to previous year's soybean 	<p>Split bases of wilted, broken, or dead plants in edge-rows. Check for black tissue and bright orange maggots</p>	<p><i>Gall midge has not been found in MI. If you suspect it, contact an MSU Extension specialist or educator to confirm</i></p>
soybean looper	<i>See "caterpillars"</i>		
spider mites <i>two-spotted</i>	<ul style="list-style-type: none"> • 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: Insecticides (like pyrethrins) sprayed to control insects may flare mite populations by killing natural enemies. Fungicides may also flare mites by disrupting natural fungal pathogens. Therefore, be cautious about pesticide applications in dry seasons. 	<p>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)</p> <p>Also look for stippling and yellowing of leaves</p>	<p>Guideline: Treat when stippling is widespread on lower leaves and progressing into the middle canopy</p> <p><u>Factors which reduce the need to spray:</u></p> <ul style="list-style-type: none"> * Will the forecast remain favorable for mites, i.e. hot & dry? * Is excellent spray coverage possible? * Will there be yield loss from running over beans?
stink bugs <i>multiple species</i>	<ul style="list-style-type: none"> • Biological: Several parasitoids attack egg masses or bugs 	<p>Use a sweep net to take 5 sets of 20 sweeps across the field</p>	<p>Guideline: 40 stink bugs in 100 total sweeps</p>
thistle caterpillar	<i>See "caterpillars"</i>		

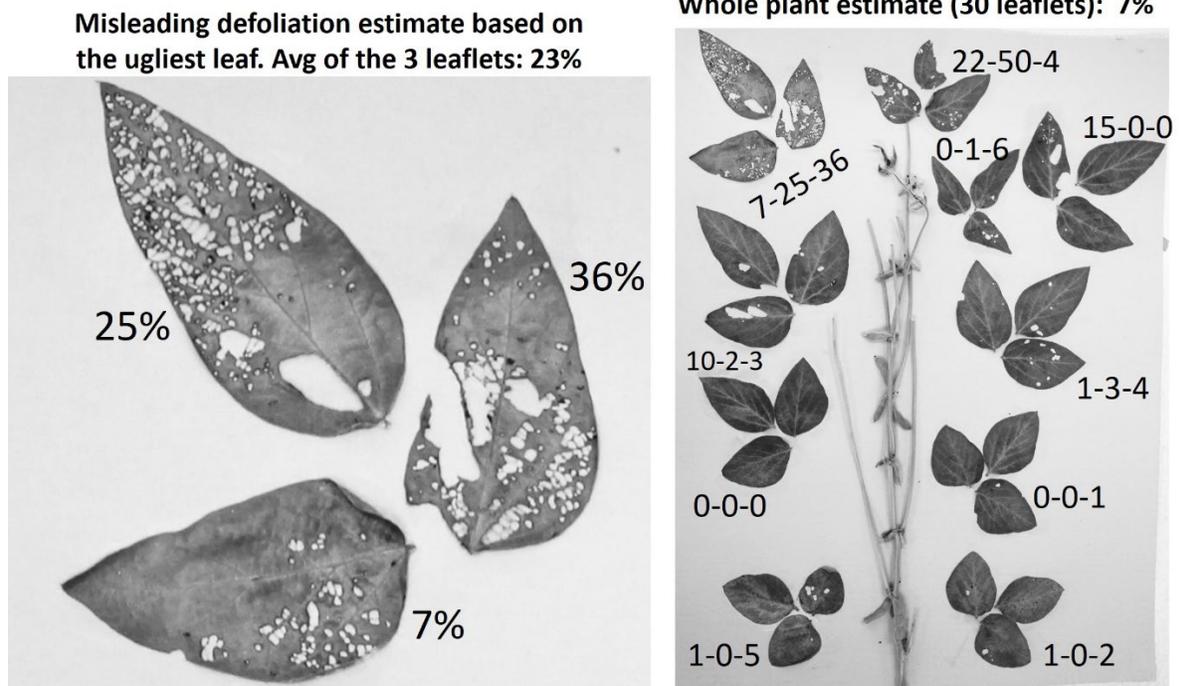
Pest	Management options and notes	Scouting recommendation	Threshold
thrips <i>(several species)</i>	<ul style="list-style-type: none"> Biological: Many small-sized natural enemies (pirate bugs, predatory mites, predatory thrips) build their populations early in the season by feeding on thrips. Also, some thrips provide significant biological control by feeding on spider mite eggs and tiny nymphs 	Pick leaves from several locations in the field, from the mid-canopy and use a hand lens to count the total number of thrips per leaf	Guideline: 8 thrips per leaf I have seen 'sprayable' numbers only once, during the terrible 2012 drought
webworm	<i>See "caterpillars"</i>		
white grubs <i>including Japanese beetle, Asiatic garden beetle (AGB), and June beetle</i>	<ul style="list-style-type: none"> Biological: Grubs are eaten by other insects, birds, and rodents; infected by several pathogens; and attacked by several species of beneficial nematodes Agronomic: If practical, fall plowing of at-risk fields is recommended. For Asiatic garden beetle in southern Michigan and northern Ohio, planting at-risk fields later may avoid most feeding <p>Note: it is important to identify grubs in the field to distinguish annual species from June beetles, which remain in fields for multiple seasons</p>	No specific recommendation Grubs tend to be patchy, often in the sandiest parts of fields. Fields with a history of grubs can be checked with a shovel in early spring	No rescue treatment is available Consider replanting fields or areas with significant stand loss
wireworm	<ul style="list-style-type: none"> 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 and pasture prior to planting is recommended 	No specific recommendation	No rescue treatment is available Consider replanting fields or areas with significant stand loss

See the following pages for information on assessing defoliation in soybean

Insect defoliation in soybean

Soybean is attacked by many defoliating insects, such as bean leaf beetle, Japanese beetle, loopers, cloverworm, and grasshoppers. Management decisions are based on the combination of their feeding.

There is a tendency to overestimate insect defoliation by limiting scouting to field edges (where insects like Japanese beetle accumulate) or by focusing the eye on the most-heavily damaged leaves (usually at the top of a plant). In the example below, a scanner was used to measure % defoliation accurately for every leaflet on a whole plant. The three leaflets on the most-damaged whole leaf (left picture) averaged 23% defoliation. But the true defoliation for the whole plant (right picture), across all 30 leaflets, was only 7%.



When defoliation is determined by assessing whole plant feeding across entire fields, few soybean fields reach threshold in Michigan. Even if insects feed on upper leaves or on field edges, soybeans have a high capacity to compensate for defoliation because lower leaves or neighboring undamaged plants 'pick up the slack'.

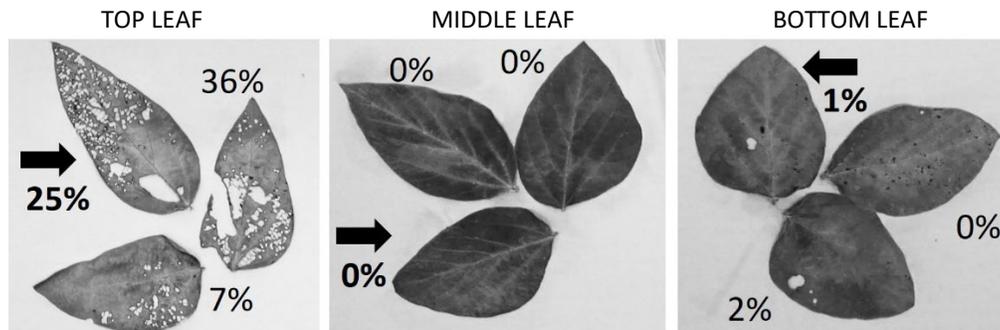
The next page gives a recommended method to measure overall defoliation when scouting.

The Leaflet Method to Assess Defoliation

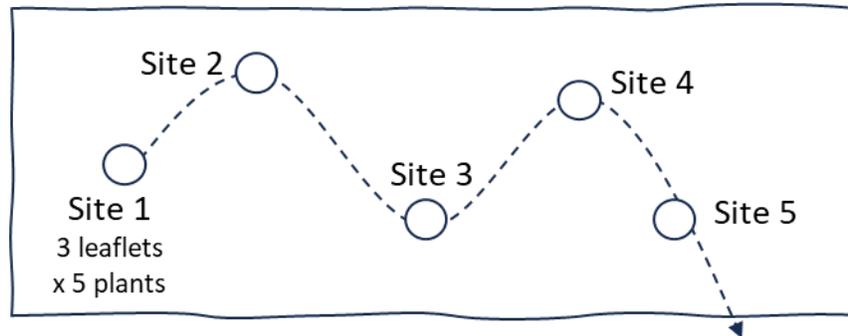
You need a small container or bag to collect leaflets + a way to take data/ calculate an average

[start at least 20 feet beyond the field edge]

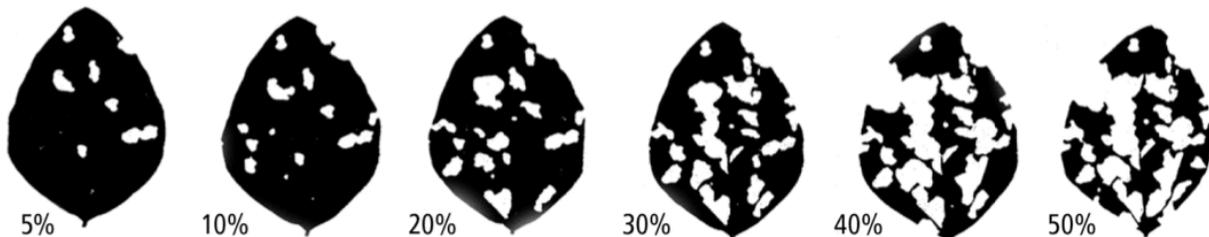
1. Pick a trifoliate leaf from the bottom, middle and top of a plant. From each leaf, discard the least-damaged and most-damaged leaflet, keeping only the leaflet with the 'middle' amount of defoliation (arrows below). Don't rate defoliation yet. Simply throw away the leaflets with least and most feeding, based on your quick visual impression, and keep the 'middle' ones.



2. Sample four more plants, 10 paces apart, for a total of 15 leaflets at this site (5 plants x 3 leaflets). Then repeat the process at four more sites across the field, as in the diagram below. Your total sample will be 75 leaflets (15 leaflets x 5 sites).



3. Estimate and record the % defoliation for each leaflet. This is easiest done outside the field. Estimates can be made visually (the scale below helps to visualize different levels of feeding) or digitally using a phone app like Bioleaf (<https://www.quantitative-plant.org/software/bioleaf>).



4. Finally, average the scores from the 75 leaflets to get an estimated % defoliation for the field.

List of OMRI-certified insecticides for organic soybeans

- Insecticides are grouped by active ingredient(s), which are listed alphabetically, allowing for easy comparison of similar products
- Application rates are listed for pests which appear on the label. If a column is blank, the pest is not on the label. The letters in the pest columns refer to the use rate from column two
- Note: The caterpillar category includes cloverworm, earworm, silver-spotted skipper, soybean looper, thistle caterpillar, velvetbean caterpillar, and webworm. These are combined 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	soybean aphid	spider mite	stink bugs	thrips	Pre-harvest interval (PHI) in days	Precautions and Remarks
azadirachtin Neemix 4.5	(a) 4 – 16 oz	a	a	a	a	a		a		a	a	0	<ul style="list-style-type: none"> • Azadirachtin, an extract of neem oil, interferes with insect molting and acts as a repellent & antifeedant. Unlike neem oil, it does not have miticidal and fungicidal properties • See label for specific rates by insect pest. Kills only immature insects, but may repel adults from feeding
azadirachtin + neem oil Debug Tres (3% azad/4.7% neem oil) Debug Turbo (0.7% azad/65% neem oil)	(a) 8 – 22.5 oz a) 16 – 104 oz	a	a	a	a	a		a	a	*	a	0	<ul style="list-style-type: none"> • Azadirachtin, an extract of neem, interferes with insect molting and it is a repellent & antifeedant. The oil in the formulation adds miticidal and fungicidal properties • Coverage is important. Spray must cover entire plant. • Similar precautions for crop injury and fungicide interactions as neem oil alone (below) <p>* Stink bugs are not on label, but there may be some control</p>
<i>Bacillus thuringiensis - Bt</i> Agree WG Deliver Dipel DF Javelin WG XenTari	(a) 0.25 - 2.0 lbs (a) 0.25 - 2.0 lbs (a) 0.5 - 1.0 lbs (a) 0.25 - 1.5 lbs (a) 0.5 - 2.0 lbs		a									0	<ul style="list-style-type: none"> • Bts are biological insecticides that must be eaten to kill, so good coverage is important. Applications must be made when larvae are small. Labels list specific larval size recommendations
iron phosphate Sluggo Sluggo Maxx	(a) 20 - 44 lbs (a) 4 – 25 lbs						a					0	<ul style="list-style-type: none"> • Bait must be eaten. Slugs stop feeding and die in 3-6 days • Scatter granules using a spreader, using a higher rate for a heavy infestation. Optimal application is to moist (not saturated) soil in the evening, as slugs usually feed at night and early morning
iron phosphate + spinosad Bug-N-Sluggo	(a) 20 - 44 lbs						a					28	<ul style="list-style-type: none"> • Similar remarks as iron phosphate/ Sluggo • Do not feed treated forage or hay to meat and dairy animals

Active ingredient Trade Names	Labelled rate(s) per acre (unless stated)	bean leaf beetle	caterpillars	cutworm	grasshoppers	Japanese beetle	slugs	soybean aphid	spider mite	stink bugs	thrips	Pre-harvest interval (PHI) in days	Precautions and Remarks
neem oil, cold-pressed Debug ON Socoro	(a) depends on spray volume used (a) 0.625-1.8% v/v spray solution	a	a	a	a	a		a	a	a	a	0	<ul style="list-style-type: none"> The active fraction of neem oil interferes with insect molting and acts as a repellent & antifeedant. The oil itself provides miticidal and fungicidal properties See label for table of oz/acre by spray volume Formulation is oil based. Leaf injury may occur from spraying at temps >90F. Apply early or late in day. See labels for info on interactions w/ sulfur and other fungicides Toxic to bees. Do not apply if bees are visiting field
neem oil, clarified extract Trilogy	(a) 1.0 – 2.0% v/v spray solution							a	a			0	<ul style="list-style-type: none"> Clarified neem oil has a narrower pest spectrum than cold-pressed neem oil (Socoro) and it doesn't have fungicidal properties. Otherwise, similar remarks as Socoro Toxic to bees. Do not apply if bees are visiting field
potassium salts of fatty acids DES-X Insecticidal Soap M-Pede	(a) 2% v/v spray solution (a) 2-4% v/v spray solution							a	a			0	<ul style="list-style-type: none"> Contact insecticide. Spray solution must touch target pest to be effective, so coverage is critical. See label for specifics about spray volume and frequency of treatments See label for precautions on plant sensitivity. Combinations w/ certain fungicides and adjuvants can lead to leaf damage. Do not spray in full sun - apply early or late in day Note that both products have a 2(ee) recommendation for use as a deer repellent
pyrethrins PyGanic EC 1.4 II PyGanic 5.0	(a) 16 - 64 oz (a) 4.5 - 15.6 oz	a	a	a	a	a		a		a	a	0 when sprays dry	<ul style="list-style-type: none"> Plant-derived insecticides that knock down insects quickly but have short residual control. Coverage is critical Toxic to bees exposed to direct treatment. Do not apply on blooming soybeans or drift onto blooming crops or weeds
spinosad Entrust Entrust SC	(a) 0.75 – 1.25 oz (a) 2.25 – 4 oz		a									28	<ul style="list-style-type: none"> Time applications to target small larvae and use enough water to get good coverage. Rates for specific caterpillar species are listed on the label Avoid two consecutive applications of spinosad insecticides Do not feed treated forage or hay to meat and dairy animals

ORGANIC WHEAT in MICHIGAN

Calendar of insect pests of organic wheat and other small grains

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 (in particular, European chafer)	larvae (grubs), in soil	grubs feed on roots			grubs can destroy new stands by feeding on roots (Euro chafer will feed into late October)	
wheat curl mite	nymphs & adults, on hosts in and around fields	Mites suck plant juices from leaves, primarily on new growth				Infest new stands. May spread viruses
cereal leaf beetle	adults, in protected areas near fields	larvae feed on leaves		adults feed on leaves		
true armyworm	Southern USA, migrate north	larvae feed on leaves and may clip heads after they form				
aphids (multiple species)	Southern USA, migrates north	suck plant sap (on fall planted grain)		suck plant sap (on spring planted grain)		BYDV spread (fall plantings)
Hessian fly	puparia 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	

Damage checklist to aid in scouting of organic wheat and other small grains

Plant part or timing	aphids	cereal leaf beetle	fall armyworm	grasshoppers	grass sawfly	Hessian fly	true armyworm	wheat curl mite	white grubs
Type of damage or injury									
Stand (emergence)									
wilted or stunted plants									x
gaps in row									x
fewer, or dead, tillers						x			x
widespread stand loss or thinning			x						x
Roots									
root hairs or entire roots pruned off									x
Leaf tissue									
Scraping of the 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 edges curled inward								x	
new leaf trapped in previous leaf								x	
leaf yellowing from feeding	x								
leaf yellowing, reddening from virus	x							x	
leaves dark bluish-green						x			
field appears whitish or 'frosted'		x							
sticky leaves or head from honeydew	x								
Stem									
short internodes and stems						x			
stunting of plants						x			
small lengths of cut stems on ground					x				
stem breakage, lodging						x			
Head									
awns clipped off							x		
heads clipped off					x		x		
Other									
barley yellow dwarf (BYDV) transmission	x								
wheat streak mosaic transmission								x	
large square frass pellets on ground			x				x		
numerous stem segments on ground					x				

Biological and impact of insect pests in organic wheat and other small grains

Terms used to describe the pest status of each insect

- **Rarely a pest:** Unusual, typically goes unnoticed. May not even be present in the state.
- **Uncommon pest:** Often present but well-below damaging levels. An outbreak once a generation
- **Occasional pest:** Present in most fields, sometimes in high numbers. An outbreak once a decade
- **Important pest:** Present in most fields, potentially increasing to damaging levels every season. A common target of scouting, management programs, or insecticide use.
- **Sporadic pest:** Damaging levels occur after favorable weather patterns (such as drought) or mass movement from south to north during the season
- **Localized pest:** Damaging levels occur in specific locations under specific agronomic conditions, for example in no-till production or in older stands.

Pest (abbreviation)	Life cycle and Number of generations	Impact in the crop	Conditions which favor infestation or damage	Pest Status
aphids <i>multiple species: English grain aphid, bird cherry-oat aphid, corn leaf aphid, and greenbug</i>	<p>English grain & corn leaf aphids move from the south, but bird cherry-oat aphid perhaps may overwinter locally (unsure about this). The summer population is all female. Females do not mate to reproduce and they give birth to multiple live nymphs per day.</p> <p>Multiple overlapping generations</p>	<ul style="list-style-type: none"> • All stages suck plant sap from stems, leaves, and 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 	<ul style="list-style-type: none"> • A warm fall can extend aphid activity and result in more BYDV transmission to winter wheat 	<p>Occasional</p> <p><i>Note: aphids are prey for many beneficial insects. They help build beneficial insect populations that move into other crops.</i></p>
cereal leaf beetle <i>Historic note: CLB was first found in the USA in 1962 in Berrien Co. Michigan</i>	<p>The handsome blue and red adults 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 overwintering sites in the fall.</p> <p>1 generation per year</p>	<ul style="list-style-type: none"> • Larvae scrape or skeletonize long strips of leaf. Older larvae, which occur in May, do the most feeding • Fields with heavy feeding on the flag leaf appear to be white or frosted • Heavy feeding can reduce plant growth and yield 	<ul style="list-style-type: none"> • CLB feeds 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 and tend to be on field edges near tree lines where adults overwinter • Tillage and spraying will reduce local parasitoid populations 	<p>Occasional & Localized</p>
fall armyworm (FAW)	<p>FAW is a tropical species. Adult moths migrate north, arriving mid to late summer. Eggs are laid on leaves. Larvae feed on plants during the day. Pupation in soil.</p> <p>1-2 generations, if the fall is warm. Larvae cannot overwinter in our area.</p>	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • Strong winds from the SW carry moths northward • Warm conditions in late summer into fall can lead to several FAW generations 	<p>Uncommon and Sporadic</p> <p>A late-season outbreak in 2021 was the worst in ~30 years</p>

Pest (abbreviation)	Life cycle and Number of generations	Impact in the crop	Conditions which favor infestation or damage	Pest Status
grasshoppers <i>multiple species</i>	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 undisturbed soil in late summer. 1 generation per year	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • 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 Lepidoptera 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 across the eyes. In June, larvae drop to the ground and remain underground to pupate and overwinter. 1 generation per year	<ul style="list-style-type: none"> • 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 stem pieces littering the ground • Note – sawflies feed up in the wheat canopy during the daytime. This differentiates them from true armyworm (below) which tends to feed at night or on cloudy days 	<ul style="list-style-type: none"> • On the East Coast, outbreaks tend to happen after an abnormally warm spring, which leads to more egg laying 	Uncommon
Hessian fly	Adult flies emerge in fall and lay eggs on young plants of the new winter wheat crop. 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 sheaths. Pupae remain in wheat stubble until adults emerge in fall. 1 generation per year	<ul style="list-style-type: none"> • Maggots rasp the stem and rupture cells, affecting 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 lodge over. Heads may be smaller or poorly filled 	<ul style="list-style-type: none"> • 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 	Rare in Michigan <i>Note: Hessian fly is not an issue in oats or rye</i>
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	<ul style="list-style-type: none"> • Larvae feed from the ground up, often eating the flag leaf last. Large numbers can defoliate a field, then move into a neighboring crop • Larvae also clip heads off, especially if most foliage is gone. This results in heads scattered on the soil surface • Note – armyworms tend to feed at night or on cloudy days. During the day, they hide on the ground at the base of plants 	<ul style="list-style-type: none"> • Specific weather patterns carry moths northward in the spring 	Sporadic Outbreaks occur in years when a heavy spring flight comes from the south

Pest (abbreviation)	Life cycle and Number of generations	Impact in the crop	Conditions which favor infestation or damage	Pest Status
<p>wheat curl mite</p> <p><i>Curl mites are microscopic, difficult to see with a hand lens in the field</i></p>	<p>The tiny, white immature and adult mites overwinter on wheat and alternate hosts, surviving brief exposures down to 0°F. In spring, eggs are laid on the host. A generation is completed in as little as 8-10 days under favorable (77°F) conditions. Mites cannot survive long off the plant, so when the wheat begins to dry, they move to the head and flag leaf to get picked up and transported for miles on wind currents. Field edges may be colonized first.</p> <p>Alternate hosts include corn, foxtail, and barnyard grass (plus volunteer wheat), until winter wheat is planted in the fall. In corn, mite feeding causes distinctive 'kernel red streak'.</p> <p>Multiple generations</p>	<ul style="list-style-type: none"> • Mites pierce and suck leaves, especially of new growth. Feeding causes the leaf edge to curl inward. Mites live in the curl. • Emerging leaves may get 'stuck' in the previous leaf's roll. As leaves mature, mites move to younger leaves • The most important impact is as a vector of a complex of viral diseases - wheat streak mosaic (WSMV), Triticum mosaic, and High Plains wheat mosaic 	<ul style="list-style-type: none"> • Volunteer wheat provides a green bridge for mites to survive between July and fall planting • Hail damage prior to harvest increases volunteer wheat • Planting before the fly-free date enables mites to colonize the new crop from alternate hosts • Hot, dry weather 	<p>Unknown</p> <p><i>In 2024 and 2025, wheat streak mosaic virus was frequently found in surveys of MI wheat fields</i></p>
<p>white grubs</p> <p><i>especially European chafer</i></p>	<p>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).</p> <p>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.</p>	<ul style="list-style-type: none"> • Larvae (grubs) prune roots, causing wilting, deficiencies, or plant death. Euro chafer attacks winter wheat late into 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 • The adult beetles of most species do not feed 	<ul style="list-style-type: none"> • June beetle and Euro chafer grubs are more common in fields with sandy soil types 	<p>Occasional</p> <p>When present, they are often localized to sandy parts of fields</p>

Management of insect pests of organic wheat and other small grains

Pest (abbreviation)	Management options and notes	Scouting recommendation	Threshold
aphids	<ul style="list-style-type: none"> 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 'safe' date in the fall reduces aphid infestation and BYDV transmission in winter wheat. (See dates on next page) Environmental: Adequate moisture (rainfall or irrigation) reduces aphid feeding stress and increases humidity for infection by fungal pathogens 	<p>Direct sampling: Count aphids on 100 tillers then calculate the average number per tiller</p> <p>Presence/absence method: Determine the number of tillers with aphids (presence)</p>	<p>Direct sampling: 12-15 aphids <u>per tiller</u> between the seedling to boot stages</p> <p>Presence/absence method: See table at end of this chapter for instructions and decision criteria</p>
cereal leaf beetle	<ul style="list-style-type: none"> 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 they are disrupted by unnecessary spraying Insecticides: CLB is reemerging as a pest in some areas. The reasons are unclear but might relate to disruption to biocontrol. Insurance insecticide applications on wheat have become more common in Michigan. 	Scout 20 plants in a minimum of 5 sites in the field. Count the number of yellow eggs and larvae	<ul style="list-style-type: none"> Before boot: 3 or more eggs and/or larvae <u>per stem</u> At heading: 1 or more larvae <u>per stem</u>
fall armyworm (FAW)	<ul style="list-style-type: none"> Biological: Predators and parasitoids kill larvae Agronomic: Planting after the Hessian fly 'safe' date in the fall should avoid FAW infestation. (See dates on next page) Insecticides: Applications are effective only on small larvae (less than ¼ inch) 	<p>No specific recommendation</p> <p>Note: To detect FAW flight into the region, use bucket pheromone traps</p>	<ul style="list-style-type: none"> Rough Guideline: 2 or more larvae per foot of row
grasshoppers	<ul style="list-style-type: none"> Biological: Blister beetle larvae prey on eggs. Many insects, rodents, and birds eat nymphs and adults. Fungal pathogens kill eggs and nymphs under moist, cool conditions Agronomic: Tillage reduces survival of eggs and newly hatched nymphs 	<p>No specific recommendation</p> <p>Estimate number of hoppers per square yard</p>	<p>Rough Guideline:</p> <ul style="list-style-type: none"> On the edge: > 15 nymphs or > 8 adults per yd² Within a field: > 3 hoppers per yd²
grass sawfly	<ul style="list-style-type: none"> Biological: Predators of caterpillars probably eat grass sawflies. Sawflies likely have their own specific parasitoids. Insecticides: Although they resemble caterpillars, sawflies larvae are not Lepidoptera (butterflies and moths). Instead, they are in the Order Hymenoptera, closely related to bees, wasps, and ants. Insecticides effective only for Lepidoptera caterpillar control, like Bts, do not control sawflies. 	No specific recommendation	<p>Untested guideline: Use a threshold of >2 larvae per ft² at heading for a combo of sawfly and armyworm larvae</p> <p>If larvae are >1 inch long & have a dark bar on their head, it is too late to treat</p>
Hessian fly	<ul style="list-style-type: none"> Variety: Fly resistant varieties are readily available Agronomic: Plant after the 'safe' date for your area. Most egg-laying flies will have died out by this time. See the table at the end of this chapter for dates by Michigan County Agronomic: Avoid planting winter wheat adjacent to wheat stubble (fields harvested this season). Controlling volunteer wheat in harvested fields reduces egg laying sites Agronomic: If using a grass cover crop, rye and oats are not hosts for Hessian fly 	<p>In fall: Check stems for symptoms ~ 3 weeks after emergence</p> <p>In spring: Check for broken stems</p>	<p>No thresholds are established</p> <p>Manage Hessian fly using a combination of planting date and resistant varieties</p>

Pest (abbreviation)	Management options and notes	Scouting recommendation	Threshold
true armyworm (TAW)	<ul style="list-style-type: none"> Biological: Predators, parasitoids, and fungal pathogens kill armyworm larvae Insecticides: Applications are effective only on small larvae (less than ¾ inch). Protect the flag leaf from feeding. <p>If caterpillars are present in a limited part of a field or if they are marching from one field to another, a limited spot or border treatment can be made</p>	<p>Scout at least 5 sites in the field for leaf feeding and small larvae. Larvae hide during the day, so shake plants <u>and</u> check the ground to record their number and size</p> <p>Note: Pheromone traps aid in timing of scouting</p>	<p>Before heading: *4 larvae per ft²</p> <p>At heading *2 larvae per ft²</p> <ul style="list-style-type: none"> If heads are being clipped, lean towards spraying Larvae > 1 inch long are nearing pupation so spraying is not effective
wheat curl mite	<ul style="list-style-type: none"> Agronomic: Control volunteer wheat 2-3 weeks prior to planting and plant after the fly-safe date to reduce the green bridge for mites and wheat streak mosaic virus (WCMV) Varieties: Some varieties are resistant to WSMV infection 	No specific recommendation	No threshold
white grubs	<ul style="list-style-type: none"> Biological: Natural enemies and pathogens kill grubs <p>Note: it is important to identify grubs to species to distinguish annual species like European chafer from multi-year species of June beetle</p>	<p>No specific recommendation</p> <p>In poor stands, use a shovel to check for grubs and root pruning. Grubs tend to be patchy, especially in sandy fields</p>	<p>No threshold</p> <p>A density of 4 chafer grubs per ft² can reduce stand and biomass. In such fields, consider tillage before planting in fall or shift wheat elsewhere</p>

Hessian fly 'safe' dates for Michigan

Based on the county, winter wheat should be planted after the date given to avoid infestation by Hessian fly and reduce wheat curl mite & aphids which transmit viruses in the fall.

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

Presence/ absence decision table for aphids in wheat

Presence/absence sampling involves classifying tillers simply as infested (aphids present) or not. The aphid species and the number per tiller do not matter. When infestations are very low or high, this method quickly determines if a spray is needed.

Instructions

Pick 25 tillers and count the number infested with aphids.

Use the first line of the table to determine the next step.

- If the infestation is low (18 or fewer tillers infested), stop sampling and do not spray. But check the field again in a week.
- If the infestation is high (all 25 tillers infested), you can stop sampling and spray.
- If the infestation is moderate (19 to 24 tillers infested), a decision can't be reached using a small sample of only 25 tillers.

Keep sampling additional groups of 5 tillers, using the line with the new total as a guide, until a decision is reached.

Cumulative number of tillers examined	Cumulative number of infested tillers		
	<i>Decision made Stop sampling & do not spray</i>	<i>No decision yet Pick five more tillers</i>	<i>Decision made Stop sampling & spray</i>
25	1 - 18	19 - 24	25
30	19 - 22	23 - 29	30
35	23 - 27	28 - 34	35
40	28 - 31	32 - 39	40
45	32 - 35	36 - 43	44 - 45
50	36 - 40	41 - 48	49 - 50
55	41 - 44	45 - 53	54 - 55
60	45 - 48	49 - 58	59 - 60
65	49 - 53	54 - 62	63 - 65
70	54 - 57	58 - 67	68 - 70
75	58 - 61	62 - 72	73 - 75
80	62 - 66	67 - 77	78 - 80
85	67 - 70	71 - 81	82 - 85
90	71 - 75	76 - 86	87 - 90
95	76 - 79	80 - 91	92 - 95
100	79 - 84	84 - 100 tillers = spray	

List of OMRI-certified insecticides for organic wheat and other small grains

- Insecticides are grouped by active ingredient(s), which are listed alphabetically, allowing for easy comparison of products that are similar
- Application rates are listed for pests which appear on the 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

Active ingredient Trade Names	Labelled rate per acre (unless stated)	aphids	cereal leaf beetle	fall armyworm	grasshoppers	slugs	true armyworm	Pre harvest interval (PHI) in days	Precautions and Remarks
azadirachtin + neem oil Debug Tres (3% azad /4.7% neem oil) Debug Turbo (0.7% azad / 65.8% neem oil)	(a) 8 – 22.5 oz a) 16 – 104 oz	a	*	a	a		a	0	<ul style="list-style-type: none"> • Labeled for wheat + barley, millet, oats, rye, sorghum, triticale • Azadirachtin, an extract of neem, interferes with insect molting and it is a repellent & antifeedant. The oil in the formulation adds miticidal and fungicidal properties • Coverage is important. Spray must cover entire plant. • Similar precautions for crop injury and fungicide interactions as neem oil alone (below) * Cereal leaf beetle is not specifically on label, but related beetles are listed
Bt (<i>Bacillus thuringiensis</i>) Deliver Dipel DF Javelin WG XenTari	(a) 0.5 - 1.5 lbs (a) 0.5 - 2.0 lbs (a) 1.0 - 1.5 lbs (a) 0.5 - 2.0 lbs			a			a	0	<ul style="list-style-type: none"> • Labeled for wheat + barley, buckwheat, millet, oats, rye, sorghum, 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 or 2nd stage) larvae
iron phosphate Sluggo Sluggo Maxx	(a) 10 - 44 lbs a) 4 - 25 lbs						a	0	<ul style="list-style-type: none"> • Labeled for wheat (Sluggo) or wheat + barley, buckwheat, millet, oats, rye, sorghum, triticale (Sluggo Maxx) • Bait must be eaten. After consuming, slugs stop feeding and die in 3-6 days • Scatter granules using a spreader, using a higher rate for a heavy infestation. Optimal application is to moist (not saturated) soil in the evening, as slugs usually feed at night and early morning
iron phosphate + spinosad Bug -N-Sluggo	(a) 10 - 44 lbs						a	21 grain 21 straw 3 hay	<ul style="list-style-type: none"> • Labeled for wheat + barley, buckwheat, millet, oats, rye, sorghum, triticale • Combination of Sluggo with spinosad. Similar remarks as iron phosphate/ Sluggo
neem oil, cold pressed Debug ON Socorro	(a) depends on spray volume used (a) 0.625-1.8% v/v spray solution	a	*	a	a		a	0	<ul style="list-style-type: none"> • Labeled for wheat + barley, buckwheat, millet, oats, rye, sorghum, triticale • The active fraction of neem oil interferes with insect molting and acts as a repellent & antifeedant. The oil itself provides miticidal and fungicidal properties • See label for a table of oz/acre needed by spray volume • Formulation is oil based; leaf injury may occur from application at temps >90F. See label for information on interactions w/ sulfur and other fungicides * Cereal leaf beetle is not specifically on label, but related beetles are listed

Active ingredient Trade Names	Labelled rate per acre (unless stated)	aphids	cereal leaf beetle	fall armyworm	grasshoppers	slugs	true armyworm	Pre harvest interval (PHI) in days	Precautions and Remarks
neem oil, clarified extract Trilogy	(a) 1.0 - 2.0% v/v spray solution	a						0	<ul style="list-style-type: none"> Labeled for wheat + barley, buckwheat, oats, sorghum and other cereal grains Clarified neem oil has a narrower pest spectrum than Socoro/ cold-pressed neem oil and it doesn't have miticidal or fungicidal properties. Otherwise, similar remarks. See label for plant injury warnings
potassium salts of fatty acids DES-X Insecticidal Soap M-Pede	(a) 2% v/v spray solution (a) 2-4% v/v spray solution	a						0	<ul style="list-style-type: none"> Labeled for wheat Contact insecticide; Spray solution must touch target pest to be effective, so coverage is critical. See label for specifics about spray volume and frequency of treatments See label for precautions on plant sensitivity. Combination w/ certain fungicides can lead to leaf damage.
pyrethrins PyGanic EC 1.4 II PyGanic 5.0	(a) 16.0 – 64.0 oz (a) 4.5 - 15.6 oz	a	a	a	a		a	0 when sprays dry	<ul style="list-style-type: none"> Labeled for wheat + barley, buckwheat, millet, oats, rye, sorghum, tritiale Plant-derived insecticides that knock down insects quickly but have short residual control. Coverage is critical Toxic to bees exposed to direct treatment. Do not drift onto blooming crops or weeds near the treated field
spinosad Entrust Entrust SC	(a) 0.5 – 2.0 oz (b) 1.0 – 2.0 oz (a) 2.0 – 6.0 oz (b) 3.0 – 6.0 oz		a	b	*		a	21 grain 21 straw 3 hay	<ul style="list-style-type: none"> Labeled for wheat + barley, buckwheat, millet, oats, rye, sorghum, tritiale For armyworm, time applications to coincide w/ egg hatch & small larvae Do not make more than two consecutive applications of products with spinosad Maximum of 3 applications in a calendar year Do not allow cattle to graze treated field until sprays have dried <p>* label indicates spinosad may suppress grasshoppers</p>