

Pesticides registered for use on hops in Michigan 2016



The information presented is intended as a guide for Michigan hop growers in selecting pesticides for use on hops grown in Michigan and is for educational purposes only. The efficacies of products listed have not been evaluated on hops in Michigan. Reference to commercial products or trade names does not imply endorsement by Michigan State University Extension or bias against those not mentioned. Information presented here does not supersede the label directions. To protect yourself, others, and the environment, always read the label before applying any pesticide.

Compiled by:

Diane Brown-Rytlewski, Erin Lizotte, and Rob Sirrine, Extension Educators

MICHIGAN STATE
UNIVERSITY

Extension

Weed Management Tips to Achieve Best Results¹

Weeds in the row can be a major source of competition in hops, especially in new plantings. Weeds compete for nutrients and moisture, and can interfere with crop management practices. As with most crops, as weed densities increase, hop yields decrease. Consequently, it is important to manage weeds in the hop row.

Most Midwest hopyards maintain permanent cover crops between the rows. The benefits of this practice include less erosion and soil compaction, better water infiltration, and a habitat to attract beneficial insects.

The width of the in-row weed-free strip depends on soil type, and grower preference. Generally, the strip should be wider on soils that have low moisture holding capacity. A width of 4 feet is probably adequate, but there is limited experience with hops on Michigan soils. Either mechanical or chemical means (or a combination of both methods) can be used to manage weeds in this strip.

Mechanical Controls

Mechanical cultivation is very effective at reducing weed populations. However, too frequent cultivation can destroy soil structure and may damage hop crowns. Avoid cultivating when soil is wet — heavier soils are particularly susceptible to compaction. Hand hoeing and pulling are effective but labor intensive.

Chemical Controls

There are a limited number of herbicides registered for use on hops in Michigan. Normally, growers will use both pre- and post-emergent herbicides to achieve the best results.

Herbicide application methods vary according to their activity. Applicators must apply pre-emergent herbicides very accurately to properly control weeds and avoid damaging the crop. An applicator must have a carefully calibrated sprayer capable of accurately maintaining pressure, flow rate, and ground speed. Applying pre-emergent herbicides with a backpack sprayer is not recommended because they cannot be applied precisely enough.

Post-emergence herbicides are easier to apply with hand-held equipment because they are applied as a dilution instead of a rate per acre. They can be applied at a volume necessary to cover the weeds without exact control over volume per acre. Backpack sprayers, wipers, and other hand-held equipment are suitable for post-emergence herbicides. Some products require crop oil concentrate or a surfactant added for best results, while others may already have an adjuvant added. Be sure to read the label to determine what type of adjuvant (if any) is needed.

Remember that there is always a potential that herbicides can unintentionally injure the crop. Some post-emergence herbicides should not contact any portion of the green hop plant or injury will occur. 2,4-D and glyphosate are examples of herbicides that must be used very carefully to avoid injury.

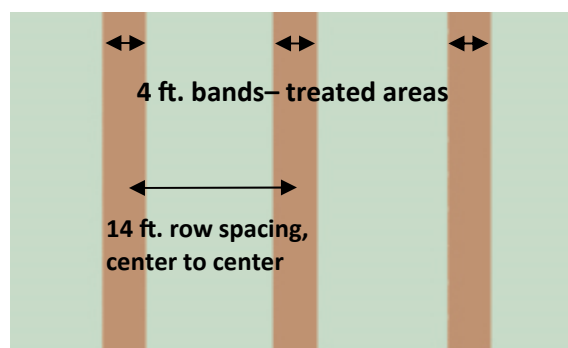
Applying Banded Applications of Herbicides

It is very important to understand the label recommendations and the difference between broadcast rate and banded rate. Herbicide labels typically give application rates as some unit of measure (pounds, quarts, etc.) per acre. However, when applying herbicides in a hopyard remember that only a narrow band along the row will be treated, so applicators must adjust the rate for the band width and the row spacing. An example of applying herbicides as a banded application follows.

An acre is 43,560 square feet. In this example, an acre of a hopyard has rows planted 14 feet apart. That would mean that it has 3,111 feet of row ($43,560 \div 14$). If an applicator applies a 4-foot wide band to each row, the total area treated in the acre of hops will be 12,444 square feet ($3,111 \times 4$), or approximately 0.28 of the total acre. So if the herbicide label recommends a rate of 1 pound per acre and the applicator applies that full pound banded to the rows in the 1-acre hopyard, that herbicide is actually applied at 3.5 times the labeled rate, enough to severely damage the hop plants.

In the example given, 0.28 pounds of the herbicide should be applied in the appropriate volume of water to treat just the band area. Herbicide labels usually recommend application volumes of 10-40 gallons of water per acre (30 gallons per acre is a common volume). Remember, that is the broadcast volume. In the example given, the sprayer would be calibrated to apply 30 gallons per acre, and the tank filled with 8.4 gallons of water (30×0.28). The 0.28 pounds of product would be added and mixed with the water, and applied carefully to the band beneath the hop plants. That would apply the herbicide at the correct rate of 1 pound per acre in 30 gallons of water per acre to the band beneath the rows in the hopyard example provided.

Fig. 1 Example for determining banded rates for herbicide application



1) Divide acre in sq. ft. by row spacing in ft. to get feet of row per acre $43,560/14 = 3,111$ ft.

2) Multiply the feet of row by the band width to get the area to be treated. $3,111 \text{ ft} \times 4 \text{ ft} = 12,444$ sq. ft.

3) Divide the treated area by 43,560 to get the percentage of treated acre. $12,444/43,560 = \text{approx. } 0.28$

4) Multiply the herbicide broadcast rate by the percentage of an acre determined in 3) $1 \text{ pound} \times 0.28 = 0.28$ pound

5) Multiply the recommended volume of water for an acre by the percentage of an acre from 3) $30 \text{ gallons} \times 0.28 = 8.4$ gallons

¹Information source: ID-462-W Hops Production in Indiana – Integrated Pest Management Guide for Hops in Indiana 2015, page 2

Herbicides registered for use on hops in Michigan 2016

	Broadleaf or grasses	WSSA code ¹	Common name	Trade names	REI ²	PHI ³	Notes
PREEMERGENCE	Annual grasses and broadleaf weeds	3	trifluralin	Treflan D, Treflan 4L, Treflan HFP, Treflan TR-10, Trifluralin 10G, Trifluralin 4EC, Triflurex HFP, Trust	12 h	—	Rate determined by soil type- see label. Apply during dormancy. No composite or mustard control. Do not spray or till over top of crowns.
	both	12	norflurazon	Solicam DF	12 h	60 d	Rate determined by soil type- wait 6 months after planting for first application.
	both	14	flumioxazin	Chateau Herbicide SW, Tuscany, Warfox	12 h	30 d	No more than 6 oz/A. Apply as a 1-1.5 ft. band to dormant hops. See label for sucker control directions. One application/year
POSTEMERGENCE	grasses-annual and perennial	1	clethodim	Intensity One, Select Max, Tapout	24 h	21 d	Annual grasses- 9-16 fl oz/A; perennial grasses-12-16 fl oz/A. 14 d interval; 64 fl oz /season/A max. Use NIS at 0.25% v/v.
	grasses-annual and perennial	1	clethodim	Arrow 2EC, Avatar, Avatar S2, Cleanse 2EC, Clethodim 2EC, Clethodim 2E, Intensity, Section 2EC, Shadow, Tide Clethodim 2EC, Volunteer	24 h	21 d	6-8 fl oz/A/application. 14 d retreatment interval. Add crop oil concentrate 1%v/v.
	grasses-annual and perennial	1	clethodim	Section Three, Shadow 3EC	24 h	21 d	4-5.33 fl oz/A. No more than 21.33 fl oz/A/season. Add crop oil concentrate 1% v/v.
	broadleaf	4	2,4-D	2,4 D Amine 4, Base Camp Amine 4, Clean Amine, Drexel De-Amine 4, Radar AM, Rugged, Shredder Amine 4, Weedar 64	48 h	28 d	Controls most annual and perennial broadleaf weeds. Use as a directed spray to row middles. No more than three applications per crop cycle, 30 days between applications.
	broadleaf	4	clopyralid	Spur	12 h	30	1/3-2/3 pt/A; no more than 2 broadcast application/crop/year. 21 d retreatment interval. For control of Canada thistle.

¹WSSA = Weed Science Society of America mode of action code listed for resistance management planning. ²REI= restricted entry interval. ³PHI= preharvest interval, expressed as hours -h or days -d. ⁰OMRI listed products for organic production.

Although efforts have been made to check the accuracy of information presented at the time of printing, it is still the responsibility of the person using this information to verify that it is correct by reading the corresponding pesticide label in its entirety before using the product. Labels can and do change— greenbook.net, cdms.com, and agrian.com are free online databases for looking up label and SDS information.

Herbicides registered for use on hops in Michigan 2016

	Broadleaf or grasses	WSSA code ¹	Common name	Trade names	REI ²	PHI ³	Notes
POSTEMERGENCE	both	***	ammoniated soap of fatty acids	Finalsan Total Vegetation Killer ^o	24 h	—	26 oz/1 gallon water; 2.0-5.0 gal/1000 sq ft or as spot treatment. Avoid spraying desirable plants.
	Both-burndown	***	ammonium nonanoate	AXXE ^o	24 h	0 d	A 6–13% volume to volume (V/V) dilution (8–16 fl oz per gallon of water) is recommended for most weed control situations, depending on weed size. See label for specifics.
	both	9	glyphosate	Abundit Extra, Alecto 41-S, Alecto 41HL, Alecto 41S, Buccaneer, Buccaneer Plus, Bullzeye, Cornerstone Plus, Credit 41, Credit 41 Extra, Credit Xtreme, CropSmart Glyphosate 41% Drexel Imitator, Duramax, Envy, Envy Intense, Gly Star Original, Glyfos, Glyfos Xtra, Glyphogan, Honcho, Honcho Plus, Roundup PowerMAX, Roundup WeatherMAX, and others	4 h	14 d	Apply in row middles to control emerged annual and perennial weeds. Do not allow spray to contact hop plants or suckers. See label for rates. Rates depend on weeds to be controlled and application method.
	Burndown and sucker control	14	carfentrazone	Aim EC ⁴	12 h	7 d	2.0 fl oz/A per application. No more than 7.6 fl oz/A/season. 14 d treatment interval. Use shielded sprayers.
	Both-burndown	27	pelargonic acid	Scythe	12 h	24 h	Uses in hops-vegetative burndown, directed spray, prior to crop emergence, dormant or post harvest spray.
	both	***	cinnamon and clove oil	Weed Zap ^o	0 h	0 d	Non-selective contact herbicide; exempt from registration OMRI listed.

¹WSSA = Weed Science Society of America mode of action code listed for resistance management planning. ²REI= restricted entry interval. ³PHI= preharvest interval, expressed as hours -h or days -d. ⁴Growers must print and retain a copy of the 24C Special Local Needs Label to apply Aim, available via the Michigan Department of Agriculture and Rural Development webpage, from pesticide dealers or at the online databases listed below. ^oOMRI listed products for organic production. Although efforts have been made to check the accuracy of information presented at the time of printing, it is still the responsibility of the person using this information to verify that it is correct by reading the corresponding pesticide label in its entirety before using the product. Labels can and do change— greenbook.net, cdms.com, and agrian.com are free online databases for looking up label and SDS information.

DOWNY MILDEW IN MICHIGAN HOPYARDS

Doug Higgins and Diane Brown

QUICK FACTS ABOUT DOWNY MILDEW

- The spread and rapid development of the downy mildew is influenced by temperature, and relative humidity.
- Sporulation is favored by relative humidity greater than 80-90%; night temperatures greater than 40°F; and day temperatures between 60-68°F.
- Downy mildew systemically infects hop plants and can overwinter in the buds of crowns and roots.
- The occurrence of basal spikes in the spring results from systemic infection of buds the previous year. Basal “spikes” are stunted and chlorotic in appearance.
- Leaf lesions are typically yellow in color (eventually turning brown) and are angular in shape. Dark colored spores appear on the underside of the leaves.
- Using a combination of resistant cultivars, field sanitation practices and timely preventative fungicide application are important for effective control of downy mildew.

The most common and important disease problem of hops in Michigan is downy mildew (*Pseudoperonospora humuli*) a fungus-like organism classified as an oomycete (water mold). It can systemically infect plants and overwinter in crown buds and roots, to become a perennial disease management issue.

There are cultivars available that are tolerant or resistant to downy mildew; however the market for varieties is strongly influenced by brewer preference. It is important to start a new hopyard with disease free planting material.

Good field sanitation practices help reduce the amount of inoculum present in a field. Hand removal of spikes is time consuming but can be very effective in reducing downy mildew. Spring pruning, before training, should occur as late as possible without affecting yield. Later if needed, remove diseased shoots by hand and retrain healthy shoots in their place. Use drip rather than overhead irrigation. Keep weed growth under control and consider stripping the lower leaves in established hop plantings, chemically or mechanically to help improve airflow.

An early season preventative fungicide program for downy mildew is recommended. Subsequent fungicide applications should be applied just before or directly after conditions that favor downy mildew. Make use of systemic fungicides and rotate to different modes of action to delay fungicide resistance.



Fig. 1 left: Basal spikes in spring—leaves are stunted. photo: Diane Brown



Fig.2 right: Basal spikes later in the season. (mid-June) Leaves are chlorotic, brittle and tend to curl under. Photo: Doug Higgins



Fig.3 Aerial spike on left; leaf with typical gray-black sporulation on underside of leaf on right. Photo: Doug Higgins



Fig. 4 Angular, water soaked lesions on hop leaf. Photo: Doug Higgins



Fig. 5 Shortened internodes on aerial spike. Photo: Doug Higgins

Reference: Mahaffee, W. F., Pethybridge, S. J., & Gent, D. H. (2009). Compendium of hop diseases and pests. American Phytopathological Society (APS Press).

Michigan Resources for Hop Production: www.hops.msu.edu

POWDERY MILDEW IN MICHIGAN HOPYARDS

Doug Higgins and Diane Brown

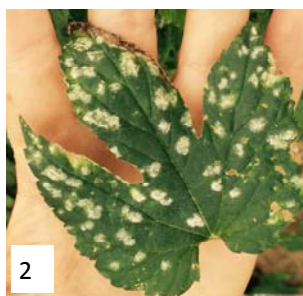
Powdery mildew (*Podosphaera macularis*) is an emerging and potentially serious fungal disease of hops in Michigan. All green tissues are susceptible to infection. Early season infections appear on emerging shoots (flag shoots). Fungal colonies can appear individually on leaves (Fig. 1 and 2) or completely cover upper and lower surfaces of any green tissue. As colonies age they will turn dull and glandular in appearance and may develop necrotic areas beneath them. Other symptoms include raised blisters that sometimes appear on the upper leaf surface. Infections that occur on the underside of the leaves may produce pale to chlorotic spots on the upper surface. White colonies also appear on infected burrs and cones which progress to develop brown necrotic tissue (Fig. 3 and 4). If cones are infected late in development visible symptoms may not occur until near harvest or during drying.

Cultivars that are tolerant or resistant to powdery mildew are available; however the market for varieties is strongly influenced by brewer preference. Good cultural practices include maintaining healthy plants with adequate but not excessive application of fertilizer and water. Preventative management of and reduction of initial inoculum load are key components of effective control of the

disease. Crowning or spring pruning will reduce the number of flag shoots. After bines have grown far enough up the string (8.2 ft. – 9.8 ft.) basal growth should be periodically removed by mechanical or chemical defoliation. Fungicide applications should be applied as a preventive measure and coupled with cultural practices. Apply fungicides at regular intervals and fungicides band onto hills before hill closure (the point at which the ground is not visible through the shoots). Once bines are trained fungicides should also be applied after any disturbance in basal growth. Always check to make sure any fungicide used is register for use in the state and follow the labeled instruction as required by state and federal law. Fungicides labeled for use on hop and registered for use in the state of Michigan can be found in the tables following these pages.



1



2

QUICK FACTS ABOUT POWDERY MILDEW

- Hop powdery mildew caused by the fungus *Podosphaera macularis* is actually the oldest known fungal disease of hops.
- Hop powdery mildew was first detected in Michigan in 2014.
- Powdery, white colonies of the fungus can appear individually on leaves or completely cover upper and lower surfaces of any green tissue.
- The pathogen can overwinter as mycelia in crown buds or as resting spores (known as chasmothecia) in shoot and leaf litter.
- It is not known whether the pathogen overwinters as mycelia or resting spores in Michigan.
- Optimal conditions for infection, growth and sporulation occurs between 64.4°F to 69.8°F.
- For best results, fungicide applications should be applied as a preventive measure and coupled with cultural practices.

Fig. 1 Powdery mildew beginning on leaf. Photo: Doug Higgins

Fig. 2 More developed powdery mildew on leaf. Photo: Diane Brown

Fig. 3 Cones at various stages of development infected with powdery mildew. Photo: Doug Higgins

Fig. 4 Young cone completely colonized by powdery mildew. Photo: Doug Higgins



3



4

Reference: Mahaffee, W. F., Pethybridge, S. J., & Gent, D. H. (2009). Compendium of hop diseases and pests. American Phytopathological Society (APS Press).

Michigan Resources for Hop Production: www.hops.msu.edu

Fungicides registered for use on hops in Michigan 2016¹

How to use these tables: Fungicides are listed alphabetically by common name and organized into several categories. First, those that act against fungi at a single site, then those that act at multiple sites, followed by pre-mixes, then biologicals. A fungicide which binds to and affects only one target in the fungal cell, is called a single site inhibitor. The risks of developing resistance is naturally higher for single site fungicides than multi-site ones. The mode of action code (FRAC code) is important for resistance management planning. Follow label directions for rotating modes of action to delay the development of resistance. For best results, rotate to a product with a different mode of action code each time you make a fungicide application.

Common name	FRAC ² code/ resistance risk L, M, H ³	Trade names	Diseases listed on label	Rates/notes	REI ⁴	PHI ⁵
cyazofamid	21/unk.; assumed to be M to H	Ranman, Ran- man 400 SC	Downy mildew (DM)	2.1-2.75 fl oz/A. No more than 6 apps/crop or 3 consecutive applications. No more than 16.5 fl oz/A/growing season.	12 h	3 d
cymoxamil	27/ L-M	Curzate 60DF	DM	3.2 oz/A. Use only with a labeled rate of pro- tectant fungicide such as copper hydroxide. 10 -14 d treatment interval. No more than 4 apps/ 12 months.	12 h	7 d
dimethomorph	40/ L-M	Forum	DM	6 fl oz/A. No more than 3 applications/18 fl oz/ season; minimum application interval 10 d; rotate to another mode of action after 1 appli- cation.	12 h	7 d
fosetyl-Al	33/ L	Aliette WDG	DM	2.5 lb/A. Apply when: shoots are 6-12 in tall, after training when vines are 5-6 ft tall, 3 wks after 2nd application, at bloom. Maximum 10 lb/A/season. Do not use with copper com- pounds– see label.	12 h	24 d
mandipropamid	40/ L-M	Revus	DM	8.0 fl oz/A/app. No more than 24 fl oz/season; no more than 2 consecutive applications. NIS recommended. MI supplemental label has additional directions for use.	4 h	7 d
mefanoxam	4/ H	Ridomil Gold	DM	0.50 pt/A soil drench when shoots are 6 in. or less- after pruning, before training; or foliar spray at sign of secondary infection- combined with copper fungicide registered for hops. 0.5 lb. ai/A max. per crop for foliar app.	48 h	45 d
		Ultra Flourish		1 pt/A soil drench when shoots are 6 in. or less - after pruning, before training; or foliar spray at sign of secondary infection- combined with copper fungicide registered for hops. 2 pt/A (0.5 lb ai/A) max. per crop for foliar app.		
metalaxyl	4/ H	MetaStar 2E, Metalaxyl 2E Ag	DM	Soil drench 1 qt/ A when shoots are 6 inches or less -after pruning, before training; foliar spray at sign of secondary infection- 1 qt/A + 2 lb/A Kocide 101	48 h	45 d
metrafenone	U8/ M	Vivando	Powdery mildew (PM)	Supplemental label for hops. used as a preventative for powdery mildew 15.4 fl oz/A; Maximum 2 application/year 7-14 d interval Do not mix with horticultural oil.	12 h	3 d

¹Efforts have been made to check the accuracy of information presented at the time of printing, but it is still the responsibility of the person using this information to verify that it is correct by reading the corresponding pesticide label in its entirety before using the product. Labels can and do change– greenbook.net, cdms.com, and agrian.com are free online databases for looking up label and SDS information. ²FRAC= Fungicide Resistance Action Committee ³L=low, M=med, H=high ⁴REI= restricted entry interval. ⁵PHI= preharvest interval. ⁶OMRI listed for organic production.

Fungicides registered for use on hops in Michigan 2016¹

Common name	FRAC ² code/ resistance risk L, M, H ³	Trade names	Diseases listed on label DM = downy mildew PM = pow- dery mildew	Rates/notes	REI ⁴	PHI ⁵
mono and di- potassium salts of phosphorus acid	33/L	Agri-Fos	DM	1.25 qt/100 gal/A. Apply at 2-3 week intervals.	4 h	0 d
mono and di- potassium salts of phosphorus acid	33/L	Fosphite, Ram- part, Resist 57 KPHITE 7LP	DM DM, PM, alternaria, anthracnose	1-3 qt/100 gal/A. Apply at 2-3 week intervals. 1-4 qt in a minimum of 20 gal/A don't apply at less than 3 d intervals.	4 h	0 d
mono-and dibasic sodium, potassi- um and ammoni- um phosphites	33/L	Phostrol Phiticide	DM	2.5 pt/A in a minimum of 10 gal/A as directed foliar spray 2.5-6 pt/A in a minimum of 10 gal/A apply: when shoots are 6 to 12 inches high; after training when vines are 5 to 6 feet tall; about 3 weeks after the second application; and during bloom.	4 h	0 d
potassium phos- phite	33/L	Prophyt	DM	2-4 pt/A when : shoots are 6-12 in high, after training when vines are 5-6 ft tall, 3 wks after 2nd application, during bloom.	4 h	0 d
potassium bicarbonate	NC/ resist. not known	MilStop Kaligreen [◊]	PM, DM, anthracnose PM	2.0-5 lb/A 2.5-5 lb/A	1h 4 h	0 d 1 d
paraffinic oil	NC/ resist. not known	Stylet oil [◊]	PM	1-2 gal/100 gal water. Discontinue at burr de- velopment. Be cautious- phytotoxicity has been documented.	4 h	**
quinoxifen	13/ M	Quintec	PM	4-8.2 fl oz/A . No more than 4 applications/ season or more than 2 consecutive sprays be- fore rotating to a different mode of action. 14 d treatment interval.	12 h	21 d
tebuconazole	3/ M	AmTide Tebu 3.6F, Monsoon, Onset 3.6 L, Orius 3.6 F, Tebu-Crop 3.6 F, Tebucure 3.6, Tebusha 3.6 FL, TebuStar 3.6 L, Tebuzol 3.6 F, Willowood Teb 3.6 SC	PM	4-8 fl oz/A. 10-14 d interval. 32 fl oz limit/crop/ season. Surfactant recommended. Needs 2-4 hr drying time to become rainfast.	12 h	14 d

¹Efforts have been made to check the accuracy of information presented at the time of printing, but it is still the responsibility of the person using this information to verify that it is correct by reading the corresponding pesticide label in its entirety before using the product. Labels can and do change— greenbook.net, cdms.com, and agrian.com are free online databases for looking up label and SDS information. ²FRAC= Fungicide Resistance Action Committee ³L=low, M=med, H=high ⁴REI– restricted entry interval. ⁵PHI= preharvest interval. [◊]OMRI listed for organic production.

Fungicides registered for use on hops in Michigan 2016¹

	Common name	FRAC ² code/ resistance risk	Trade names	Diseases listed on label DM = downy mildew PM = powdery mildew	Rates/notes	REI ⁴	PHI ⁵
MULTISITE FUNGICIDES	basic copper sulfate	M1/L	Agristar Basic Copper 53 [◊] CS 2005 [◊] Cuprofix-Ultra 40 Disperss Cuproxtat Mastercop	DM	1 lb/A per app. Max. 5 lb/A/year. 19.2 oz/A per app. Max. 2.65 lb/A/year. 1-1.25 lb/A. no more than 6.6 lb product / year. 2.25 pt/A/app. Max. 13.1 pt/A/year. 0.5-1.0 pt/A/app. Max. 6 pt/A/crop cycle Make crown treatment after pruning but before training. After training additional treatments are needed 10 d intervals.	48 h	14 d
	copper diammonia diacetate complex	M1/L	Copper-Count-N	DM	2 qt/A .Apply as needed at no less than 10 day intervals. Begin with crown treatment (after pruning but before training) and continue until 2 weeks before harvest. No more than 13.7 qt/A/yr.	48 h	14 d
	copper hydroxide	M1/L	Champ DP Dry Prill Champ Formula 2 Flowable Champ WG [◊] Champion++ [◊] Kocide 2000 Kocide 3000 Nu-Cop 3L Nu-Cop 50 DF [◊] Nu-Cop 50 WP [◊] Nu-Cop HB [◊]	DM	1.33 lb/A/app. Max. 7.07 lb/A/year 1.33 pt/A/app. Max. 7.3 pt/A/year 1.06 lb/A/app. Max. 5.3 lb/A/year 0.75-1.5 lb/A/app. Max. 8.33 lb/A/year 1.5 lb/A/app. Max 7.57. lb/A/year 0.75-1.5 lb/A/app. Max. 8.8 lb/A/year 1.33 pt/A/app. Max. 7 pt/A/year 1.0 lb/A/app. Max. 5.0 lb/A/year 1.0 lb/A/app. Max. 5.0 lb/A/year 1.0 lb/A/app. Max. 5.0 lb/A/year Make crown treatment after pruning but before training. After training additional treatments are needed 10 d intervals.	48 h	14 d
	copper octanoate	M1/L	Cueva [◊]	Anthrachnose, DM, PM, cercospora leafspot	0.5-2.0 gal/100 gal water. Apply 50-100 gal/A. Do not apply more than 884 gal of diluted spray per acre per year.	4 h	0 d
	copper oxychloride	M1/ L	COC DF	DM	1 lb/A/app. Max. 5 lb/A/ year. Apply as a fungicide crown treatment– after pruning but before training. After training, make additional treatments at 10 day intervals.	48 h	14 d

¹Efforts have been made to check the accuracy of information presented at the time of printing, but it is still the responsibility of the person using this information to verify that it is correct by reading the corresponding pesticide label in its entirety before using the product. Labels can and do change— greenbook.net, cdms.com, and agrion.com are free online databases for looking up label and SDS information. ²FRAC= Fungicide Resistance Action Committee ³L=low, M=med, H=high ⁴REI– restricted entry interval. ⁵PHI= preharvest interval [◊]OMRI listed for organic production.

Fungicides registered for use on hops in Michigan 2016¹

	Common name	FRAC ² code/ resistance risk	Trade names	Diseases listed on label DM = downy mildew PM = powdery mildew	Rates/notes	REI ⁴	PHI ⁵
MULTISITE FUNGICIDES	copper oxychloride and basic copper sulfate	M1 /L	C-O-C-S WDG		1.0 lb/A/app. 5.1 lb product/A year. Apply soon after training vines.	48 h	0 d
	cuprous oxide	M1/ L	Nordox 75 WG ^o	DM	1.25 lb/A/app. Apply as needed at 10 d intervals. Begin with crown treatment— after pruning but before training.	12 h	14 d
	sulfur	M2/L	Cosavet DF ^o , Cosavet DF Edge ^o , Thiolux ^o	PM	Apply 4-6 lb/A 14 d intervals	24 h	0 d
PREMIXES	ametoctradin and dimethomorph	45 + 40/M	Zampro	DM	11-14 fl oz/A per application. No more than two sequential applications before changing to a different mode of action or three total per season. 40 fl oz/A maximum per season. CPDA certified adjuvant is recommended.	12 h	7d
	boscalid and pyraclostrobin	7+11/M-H	Pristine	DM PM	28 oz./A. Max. 84 oz/A/year. 14 oz/100 gal/A	12 h	14 d
	famoxadone + cymoxanil	11+27	Tanos	DM	8 oz/A/app. No more than 6 applications/ cropping cycle. Tank mix with a contact fungicide. Alternate with a fungicide with a different mode of action for the following application.	12 h	7d
	Phosphorous acid, mono and di-potassium salts + hydrogen peroxide	33+NC/L	OxiPhos	DM, PM	5.0 qt/A. Apply product as a dilute spray (not to exceed 2.5% v/v (1:40) concentration in water). Ensure complete coverage of foliage. Repeat applications at 7–14 day intervals.	4 h	0 d
	tebuconazole + sulfur	3 +M2/L-M	Unicorn DF	PM	2.5-5.0 lb/A in a minimum of 10 gal/A. No more than 20 lb/A/season. Needs 2-4 h of drying time on plant foliage before rain or irrigation. Do not mix with other DMI fungicides.	12 h	14 d

¹Efforts have been made to check the accuracy of information presented at the time of printing, but it is still the responsibility of the person using this information to verify that it is correct by reading the corresponding pesticide label in its entirety before using the product. Labels can and do change— greenbook.net, cdms.com, and agrian.com are free online databases for looking up label and SDS information. ²FRAC= Fungicide Resistance Action Committee ³L=low, M=med, H=high ⁴REI– restricted entry interval. ⁵PHI= preharvest interval. ^oOMRI listed for organic production. Check the OMRI website for the most current information. <https://www.omri.org>

Fungicides registered for use on hops in Michigan 2016¹

	Common name	FRAC ² group/ resistance risk ³ L,M,H	Trade name	Diseases listed on label DM = downy mildew PM = powdery mildew	Rates/notes	REI ⁴	PHI ⁵
BIOPESTICIDES	Bacillus amyloliquefaciens strain D747	44/resist. not reported; assumed L	Double Nickel 55 ^o	PM	0.5-1 lb/100 gal of water. Apply a minimum of 20 gal/A emergence to training, 50 gal/A training to wire, and 100 gal/A wire touch to harvest.	4 h	0 d
	Bacillus pumilus strain QST 2808	44/resist. not reported; assumed L	Sonata	PM	2-4 qts/100 gallons at 7-14 d intervals. Max. spray volume 400 gal/A	4 h	0 d
	Bacillus subtilis QST 713	44/resist. not reported; assumed L	Serenade Max ^o Serenade ASO ^o	PM	2-4 lb/100 gal See label for spray volumes /A related to hop growth stages. 4-6 qt/100 gal See label for spray volumes /A related to hop growth stages.	4 hr	0 d
	Extract of Reynoutria sachalinensis	P5/L	Regalia ^o	DM, PM	Apply preventatively or when symptoms are first noticed. 1-4 qts/A for downy mildew control, must be tank mixed with another fungicide labeled for downy mildew. PM-rates depend on growth stage-see label	4 h	0 d
	Streptomyces lydicus WYEC 108		Actinovate AG	Verticillium wilt, DM, PM	Soil treatment: (Verticillium wilt) 3-12 oz/A as a soil drench. Foliar treatment: (downy and powdery mildew, anthracnose) 3-12 oz/A every 7-14 d. Use with a sticker-spreader for best results.	1 h	0 d
	<i>Trichoderma asperellum</i> strain ICC 012 and <i>T. gamsii</i> strain ICC 080	NC	Bio-Tam ^o Tenet WP ^o	Phytophthora root rot, verticillium wilt	Should be applied up to 7 d before planting to initiate soil colonization before the crop is planted and reapplied at planting. 0.025-0.075 oz/gal water. Use sufficient volume to thoroughly wet the soil. See label for additional use information.	1 h	0 d

¹Efforts have been made to check the accuracy of information presented at the time of printing, but it is still the responsibility of the person using this information to verify that it is correct by reading the corresponding pesticide label in its entirety before using the product. Labels can and do change—greenbook.net, cdms.com, and agrian.com are free online databases for looking up label and SDS information. ²FRAC= Fungicide Resistance Action Committee ³L=low, M=med, H=high ⁴REI= restricted entry interval. ⁵PHI= preharvest interval ^oOMRI listed for organic production. Check the OMRI website for the most current information. <https://www.omri.org>

Insecticides and miticides labeled for use on hops in Michigan 2016¹

How to use these tables: Insecticides and miticides are listed alphabetically by common name and mode of action code. The Insecticide Resistance Action Committee (IRAC) has devised a classification system based on how the insecticides work. Specific miticides are listed first. The mode of action code (IRAC code) is important for resistance management planning. Follow label directions for rotating modes of action to delay the development of resistance. For best results, rotate to a product with a different mode of action code each time you make an insecticide or miticide application.

Mode of action code (IRAC ² group)	Common name	Trade names	Pests	Japanese beetle elsewhere on label ³	Rates/notes	REI ⁴	PHI ⁵	
MITICIDES	6	abamectin	Abacus, Abba 0.15, Abamectin 0.15EC, Agri-Mek 0.15EC, Borrada, Epi-mek 0.15 EC, Reaper 0.15 EC, Reaper Clearform, Reaper Advance, Timectin 0.15EC AG, Zoro	mites	no	8.0-16.0 fl oz/A. No more than two applications/season. 32 fl oz/season maximum. See label for GPA requirements 21 d retreatment interval. All are RUP	12 h	28 d
	6	abamectin	Abba Ultra ^{RUP} Agri-Mek SC ^{RUP}	mites	no	4.0-8.0 fl oz/A 1.75-3.5 fl oz/A; must use NIS See label for max. amts/ season and GPA requirements 21 d retreatment interval.	12 h	28 d
	20B	acequinocyl	Kanemite 15 SC	mites	no	31 fl oz/A in no less than 100 gal/A. No more than 2 apps/year. Min. 21 d between treatments	12 h	7 d
	UN	bifenazate	Acramite 50 WS	mites	no	0.75-1.5 lb/A, 1 app/season min. 50 gallons of water /A.	12 h	14 d
	UN	dicofol	Dicofol 4E	mites	no	2-2.33 pts/A. No more than 1 app/season. Note: 29 d REI.	29 d	7 d
	10 A	hexythiazox	Savey DF	mite eggs and immatures	no	4.0-6.0 oz/A. Apply up to burr formation. Limit 1 application/year.	12 h	*
	10B	etoxazole	Zeal	mite eggs and immatures	no	3.0 - 4.0 oz/A in a minimum of 50 gals water/A. 1 application/season.	12h	7 d
	21A	fenpyroximate	Portal, Portal XLO	mites	no	2.0-3.0 pt/A in a minimum of 100 gal water/A . Apply before mites exceed 5 mites/leaf. 1 app/season.	12 h	15 d

MITICIDES CONTINUE ON NEXT PAGE

¹Although efforts have been made to check the accuracy of information presented at the time of printing, it is still the responsibility of the person using this information to verify that it is correct by reading the corresponding pesticide label in its entirety before using the product. Labels can and do change— greenbook.net, cdms.com, and agrian.com are free online databases for looking up label and SDS information.

²IRAC= Insecticide Resistance Action Committee. Code included for resistance management planning. ³**Japanese beetle is not a pest of hops in Washington, Oregon and Idaho, where the majority of US hops are produced. Hence, it is not listed under pests for hops on many insecticide labels. The site (crop) must be listed on the label in order to legally use the product on that crop. It is legal to use a pesticide for a pest that is not listed on the label, but the rate listed on for use on the crop (hops) cannot be exceeded. Insecticides that have Japanese beetle listed for a crop other than hops have been noted in the table. Be aware that none of these products have been evaluated for efficacy against Japanese beetle on hops in Michigan.** ⁴PHI=preharvest interval ⁵REI=restricted entry interval. RUP= restricted use pesticide- requires RUP applicator's certificate from Michigan Department of Agriculture and Rural Development to purchase. ⁶OMRI certified for organic production.

Insecticides and miticides registered for use on hops in Michigan 2016¹

Chemical class (IRAC ² group)	Common name	Trade names	Pests	Japanese beetle elsewhere on label ³	Rates/notes	REI ⁴	PHI ⁵
	12C	propargite	Omite 6E ^{RUP}	mites	no	32 fl oz in 50 gal total volume/A. Minimum spray interval is 21 d, no more than 2 apps/season. Basal treatment only. Not compatible with petroleum oils. Note: 21 d REI.	21 d 14 d
MITICIDES	UN	sulfur	Acoidal ^o , Defend DF ^o Microthiol Dispers ^o Micro Sulf ^o	spider mites	no	2-6 lb/100 gal/A . Do not use within 2 weeks of an oil treatment.	24 h 0 d
	UN	sulfur	Cosavet DF ^o , Cosavet DF Edge ^o , Kumulus DF ^o Sulfur DF ^o , Thiolux ^o	spider mites	no	2-4 lb./A repeat as needed to suppress mites. Do not use within 2 weeks of an oil treatment.	24 h 0 d
	UN	sulfur	Microfine Sulfur, Yellow Jacket wettable sulfur	spider mites	no	33-44 lb./A when infestation first appears; repeat at 5-10 d intervals. Do not use with oil or within 21-60 d of an oil spray.	24 h 0 d
	UN	sulfur	Drexel Suffa 6 L, Sulfur 6L, Yellow Jacket flowable sulfur	mites	no	1/3-7 1/2 gallons per acre when infestation first occurs—repeat as needed. See cautions about oil listed on label.	24 h 0 d
	23	spirodiclofen	Envidor 2SC	mites	no	18.0-24.7 fl oz/A . 1 app/season . Min. app volume 50 GPA.	12 h 14 d
23	spirotetramat	Movento	aphids, mites	no	5.0-6.0 fl oz/A. 14 d treatment interval. 12.5 fl oz/A max. per 12 months. Systemic.	24 h 7 d	
1B	malathion	Malathion 57EC, Drexel Malathion 5EC, Malathion 5 Malathion 8 Aquamul	aphids, spider mites	yes	1 pt/A retreatment interval is 7 d. Max 3 treatments/year. 0.63 pt/A; retreatment interval is 7 d. Maximum 3 treatments/year.	12 h 10 d	
1B	naled	Dibrom 8 Emulsive ^{RUP}	armyworms, hop aphid	no	1 pt/A.	7 d 48 hr	
3A	beta-cyfluthrin	Baythroid XL ^{RUP} ,	hop aphid, flea beetle, looper, plant bug	yes	3.2 fl oz/A. Maximum 16 fl oz/season.	12 h 7 d	

INSECTICIDES CONTINUE ON NEXT PAGE

¹Although efforts have been made to check the accuracy of information presented at the time of printing, it is still the responsibility of the person using this information to verify that it is correct by reading the corresponding pesticide label in its entirety before using the product. Labels can and do change—greenbook.net, cdms.com, and agrian.com are free online databases for looking up label and MSDS information.

²IRAC= Insecticide Resistance Action Committee . Code included for resistance management planning. ³**Japanese beetle is not a pest of hops in Washington, Oregon and Idaho, where the majority of US hops are produced. Hence, it is not listed under pests for hops on many insecticide labels. The site (crop) must be listed on the label in order to legally use the product on that crop. It is legal to use a pesticide for a pest that is not listed on the label, but the rate listed on for use on the crop (hops) cannot be exceeded. Insecticides that have Japanese beetle listed for a crop other than hops have been noted in the table. Be aware that none of these products have been evaluated for efficacy against Japanese beetle on hops in Michigan.** ⁴PHI=preharvest interval ⁵REI=restricted entry interval. ⁴RUP– restricted use pesticide- requires RUP applicator's certificate from Michigan Department of Agriculture and Rural Development to purchase. ^oOMRI certified for organic production. UN=unclassified.

Insecticides and miticides registered for use on hops in Michigan 2016¹

Chemical class (IRAC group)	Common name	Trade names	Pests	Japanese beetle elsewhere on label	Rates/notes	REI ⁴	PHI ⁵
3A	bifenthrin	Bifen 2 Ag Gold, Bifen 25% EC, Brigade 2EC, Bifenthrin 2EC, Bifenture EC, Discipline 2EC, Fanfare 2EC, Fanfare EC, Fanfare ES, Reveal, Reveal Endurx, Sniper, Tailgunner, Tundra EC	aphids, mites, armyworms, cutworms	yes	3.8-6.4 fl oz/A. Use high rate for mites. Minimum retreatment interval = 21 d. See labels for gallons/acre requirements. All are RUP.	12 h	14 d
3A	bifenthrin	Bifenture 10DF ^{RUP}	aphids, mites, armyworms, cutworms	yes	9.6-16.0 oz/A use high rate for mites. Minimum retreatment interval = 21 d. see labels for gallons/acre requirements.	12 h	14 d
3A	cyfluthrin	Tombstone ^{RUP} , Tombstone Helios ^{RUP}	Hop aphid, flea beetle, looper, plant bug	yes	3.2 fl oz/A max./ 14-d interval. Minimum application volume (water): 25 GPA	12 h	7 d
3A	pyrethrins	Evergreen EC60-6, Pyganic EC 1.4 II ⁰ , Pyganic EC 5.0 ⁰ , Tersus	aphids, caterpillars, leafhoppers, Japanese beetle see label for others		2-16 fl oz/A– in a min. 10 GPA 1 pt-2 qts/A 4.5-17 fl oz/A in sufficient water for coverage 17 fl oz/A Adjust spray pH to 5.5-7.0 to retain effectiveness of pyrethrins. Begin applications when insects first appear.	12 h	0 d
PREMIXES	3A 4A	beta-cyfluthrin imidacloprid	Leverage 360 ^{RUP}	Aphids, beetles, loopers, plant bugs	yes	3.2 fl oz/A . 1 app/season.	12 h 28 d
	3A 4A	bifenthrin imidacloprid	Avenger S3 ^{RUP} , Avenger Systemic ^{RUP} , Swagger ^{RUP}	Aphid, leafhoppers Armyworm spp., Cutworm spp. Leafrollers Looper spp. Root weevil Two spotted spider mite	yes	7.6-25.6 fl oz/A 25.6 fl oz/A Min. retreatment interval =21 d 76.8 oz /A/ season limit. Maximum, amount of Bifenthrin allowed per season: 0.30 lb ai/A. Maximum amount of Imidacloprid allowed per season: 0.30 lb ai/A.	12 h 28 d
	3A 4A	bifenthrin imidacloprid	Brigadier ^{RUP}	aphids, leafhoppers, armyworm and other lep. larvae, mites	yes	Aphid and leafhopper-3.8-12.8 fl oz/A Armyworm, loopers, root weevils, spider mites-12.8 fl oz/A. 21 d treatment interval.	12 h 28 d

INSECTICIDES CONTINUE ON NEXT PAGE

Insecticides and miticides registered for use on hops in Michigan 2016¹

Chemical class (IRAC group)	Common name	Trade names	Pests	Japanese beetle elsewhere on label	Rates/notes	REI ⁴	PHI ⁵
PREMIXES	3A 4A	bifenthrin imidacloprid	Skyraider ^{RUP}	Aphid spp. Armyworm spp. Cutworm spp. Leafrollers Looper spp. mites	yes	3.8-6.4 fl oz/A use high rate for mites and beet armyworm. 21 d treatment interval.	12 h 28 d
	3A 6	bifenthrin abamectin	Athena ^{RUP}	Two-spotted spider mite, aphids, armyworms, cutworms, leafroller, loopers	yes	10-17 fl oz/A. 34 fl. oz/season limit. Min. retreatment interval=21 d. No more than 2 treatments/season of a product containing avermectin or bifenthrin.	12 h 28 d
	3A UN	pyrethrins azadirachtin	Azera ^o	Aphids, leafroller and other caterpillars, Japanese beetle, spider mites		1-3.5 pt/A in a minimum of 30 gallons of water per acre. Limit of 10 applications per season. Hand sprayers: 1-2 fl oz/ gallon of water. Adjust spray pH to 5.5-7.0 to retain effectiveness of pyrethrins.	12 h 0 d
	4A	imidicloprid	Alias 2F, Advise 2 FL, Macho 2.0 FL, Malice 2F, Widow	aphids	yes	19.2 fl oz/A applied to hills as a soil drench.	12 h 60 d
	4A	imidicloprid	Alias 2F, Advise 2 FL, Macho 2.0 FL, Malice 2F, Widow	aphids	yes	19.2 fl oz/A applied to hills as a soil drench.	12 h 60 d
	4A	imidicloprid	Advise 2 FL, Am-Tide Imidacloprid 2 F, Couraze 2F, Midash 2SC AG, Nuprid 2SC	aphids	yes	19.2 fl oz/A applied to hills as a soil drench. 6.4 fl. oz /A as a foliar application.	12 h 28 d
	4A	imidicloprid	Couraze 1.6 F, Nuprid 1.6 F, Pasada 1.6 F, Prey 1.6 F, Sherpa	aphids	yes	8.0 fl oz/A as a foliar application	12 h 28 d
	4A	imidicloprid	Alias 4F, Couraze 4, Midash Forte, Wrangler	aphids	yes	9.6 fl oz/A applied to hills as a soil drench. 3.2 fl. oz /A as a foliar application.	12 h 28 d
	4A	imidicloprid	Willowood Imidacloprid 4SC, Macho 4.0, Alias 4F, Provoke, S-Cloprid 4AG	aphids	yes	3.2-9.6 fl oz/A applied to hills as a soil drench. 3.2 fl. oz /A as a foliar application.	12 h 28 d
	4A	imidicloprid	Admire Pro Systemic Protectant, Nuprid 4.6 F Pro	aphids	yes	2.8-8.4 fl oz/A applied as a soil drench.	12 h 60 d
			Admire Pro Systemic Protectant			2.8 fl oz /A as a foliar application.	12 h 28 d

INSECTICIDES CONTINUE ON NEXT PAGE

Insecticides and miticides registered for use on hops in Michigan 2016¹

Chemical class (IRAC group)	Common name	Trade names	Pests	Japanese beetle elsewhere on label	Rates/notes	REI ⁴	PHI ⁵
4A	imidicloprid	Malice 75 WSP Montana 2F Montana 4F	aphids		2.1 oz/A foliar application only 6.4 fl oz/A foliar application only 3.2 fl oz/A foliar application only	12 h	28 d
4A	thiamethoxam	Platinum Platinum 75SG	hop aphid, root weevils, garden symphlan	yes	8 fl oz/A as banded soil application. Limit 8 fl oz/growing season. 2.67 oz/A as a banded application. irrigate to incorporate into root zone.	12 h	65 d
4D	flupyradifurone	Sivanto 200SL	aphids	no	7.0-10.5 fl oz/A . Minimum application volume 25 GPA.	4 h	21 d
5	spinosad	Entrust ^o ,	Armyworm, looper, thrips	no	1.25-2.0 oz/A. mi treatment interval 5 d. No more than 2 consecutive apps. 9.5 oz/A season limit.	4 h	1 d
5	spinosad	Entrust SC ^o , SpinTor 2SC	Armyworm, looper, thrips	no	4-6 fl oz/A. No more than 2 consecutive apps. 30 fl oz/A total for season. Min. treatment interval 5d.	4 h	1 d
5	spinetoram	Delegate WG	Armyworm, cutworm, lepidopterous larvae	no	2.5-4.0 oz/A. No more than 2 consecutive apps, 3 total for season. Min treatment interval 4 d.	4 h	1 d
9B	pymetrozine	Fulfill	aphids	no	4-6 fl. oz/application in a minimum of 120 gal/A 14 day interval. Use NIS	12 hr	14 d
11	B. thuringiensis var. kurstaki	Dipel DF ^o , Xentari ^o Biobit HP ^o Deliver ^o Javelin WG ^o	loopers, armyworms	no	0.5-2 lb/A 0.5-1.5 lb/A 0.25-1.0 lb/A	4 h	0 d
11	B. thuringiensis var. kurstaki	Dipel ES ^o	loopers armyworms	no	1-2 pt/A 2-4 pt/A	4 h	0 d
11	Chromobacterium subtsugae	Grandevo ^o	armyworms, loopers aphids, mites, thrips, whiteflies (Leafhoppers elsewhere on label)	no	1-3 lb/A 2-3 lb/A	0 d	4 hr
28	chlorantraniliprole	Coragen	Western yellow striped armyworm		3.5-5.0 fl oz/A. No more than 4 app/A/crop. Minimum treatment interval is 7 d. No more than 0.2 lb a.i. of chlorantraniliprole products per year.	4 h	0 d
29	flocanimid	Beleaf 50 SG	aphids	no	1.7-2.8 oz/app. in a minimum of 50 gal/A. 7 d retreatment interval; 8.4 oz. max/season.	12 h	10 d

INSECTICIDES CONTINUE ON NEXT PAGE

Insecticides and miticides registered for use on hops in Michigan 2016¹

Chemical class (IRAC group)	Common name	Trade names	Pests	Japanese beetle elsewhere on label	Rates/notes	REI ⁴	PHI ⁵
UN	azadirachtin	Aza-Direct ^o ,	aphids, beetles, true bugs, caterpillars, leafminers, mites, others		1-2 pt/A kills only immature stages (larvae and nymphs). Buffer spray solution to pH of 5.5-6.5.	4 h	0 d
UN	azadirachtin	AzaGuard ^o , Azatin-O ^o , Azatin XL,	aphids, beetles, true bugs, caterpillars, leafminers, mites, others		10-16 fl oz/A in a min of 30 gal/A. Buffer spray solution to pH of 5.5-6.5 10-16 fl oz/A in a min of 30 gal/A. Buffer spray solution to pH of 3-7. kills only immature stages (larvae and nymphs).	4 h	0 d
UN	azadirachtin	Ecozin Plus 1.2 ME ^o	aphids, beetles, true bugs, caterpillars, leafminers, mites, others		15-30 fl oz/A kills only immature stages (larvae and nymphs) repeat application in 7-10 d. Buffer spray solution to pH of 5.5-6.5	4 h	0 d
UN	azadirachtin	Molt-X ^o	aphids, beetles, true bugs, caterpillars, leafminers, mites, others		8-10 oz/A kills only immature stages (larvae and nymphs). Buffer spray solution to pH of 5.5-6.5	4 h	0 d
UN	azadirachtin	Neemix 4.5 ^o	aphids, beetles, true bugs, caterpillars, leafminers, mites, others	yes	4-16 fl oz/A, in a minimum of 30 gal/A. Kills only immature stages (larvae and nymphs). pH of spray solution must be between 3-8.	4 h	0 d
UN	azadirachtin	Trilogy ^o	aphids, beetles, true bugs, caterpillars, leafminers, mites, others	yes	Use as a 1.0-2.0% solution in a minimum of 25 gal/A kills only immature stages (larvae and nymphs).	4 h	0 d
UN	sulfur	Acoidal ^o , Defend DF ^o Microthiol Dispers ^o Micro Sulf ^o	spider mites	no	2-6 lb/100 gal/A . Do not use within 2 weeks of an oil treatment.	24 h	0 d
UN	sulfur	Cosavet DF ^o , Cosavet DF Edge ^o , Kumulus DF ^o Sulfur DF ^o	spider mites	no	2-4 lb./A repeat as needed to suppress mites. Do not use within 2 weeks of an oil treatment.	24 h	0 d
UN	sulfur	Microfine Sulfur, Yellow Jacket wettable sulfur	spider mites	no	33-44 lb./A when infestation first appears; repeat at 5-10 d intervals. Do not use with oil or within 21-60 d of an oil spray.	24 h	0 d
UN	sulfur	Drexel Suffa 6 L, Sulfur 6L, Yellow Jacket flowable sulfur	mites	no	1/3-7 1/2 gallons per acre when infestation first occurs—repeat as needed. See cautions about oil listed on label.	24 h	0 d

INSECTICIDES CONTINUE ON NEXT PAGE

Insecticides and miticides registered for use on hops in Michigan 2016¹

Chemical class (IRAC group)	Common name	Trade names	Pests	Japanese beetle elsewhere on label	Rates/notes	REI ⁴	PHI ⁵
NL	Beauvaria bassiana	Mycotrol O	aphids, thrips	no	0.25-1.0 qt/A. Read label for adjuvant and tank mix restrictions.	4 h	0 d
NL	kaolin	Surround ^o	flea beetles	yes	25-50 lb/A. Works as protective barrier so complete coverage is essential.	4 h	0 d
NL	mineral oil	BioCover MLT Drexel Damoil Glacial Spray Fluid ^o JMS Stylet-Oil ^o Ultra-Pure Oil Pure Spray GREEN ^o	spider mites, (powdery mildew) leafhoppers elsewhere on label	no	1-2 gallons/100 gallons/A every 10-14 d. Discontinue at burr development. Oils not compatible with sulfur. 1-2 gal/A in a min 50 gal water/A.	4 h	***
NL	mineral oil	SuffOil-X ^o	Aphids, leafrollers, mites, powdery mildew; leafhoppers elsewhere on label	no	1-2 gal/100 gal water-use 20-100 gal/A. Discontinue at burr development. Oils not compatible with sulfur.	4 h	0 d
NL	potassium salts of fatty acids	Des-X ^o	aphids, spider mites	no	2 gal product/100 gal water. Apply 75-200 gal/A. Do not use within 3 d of a sulfur application. See label for tank mix precautions.	12 h	0 d
NL	potassium salts of fatty acids	M-Pede ^o	aphids, spider mites	no	1 to 2% v/v. A 2% solution is prepared by adding 2 gal M-Pede to 98 gal water. Use a minimum of 50 gal/A. Do not use within 3 d of a sulfur application. See label for tank mix precautions.	12 h	0 d
NL	potassium silicate	Sil-matrix ^o	Suppression of spider mites, aphids	no	2-4 qt/100 gal. Non-ionic surfactant (NIS) recommended.	4 h	0 d
NL	rosemary oil peppermint oil	Ecotec ^o	spider mites, thrips	no	1.0-4.0 pt/100 gal/A. Spreader/adjuvant recommended.	0 h	0 d

¹Although efforts have been made to check the accuracy of information presented at the time of printing, it is still the responsibility of the person using this information to verify that it is correct by reading the corresponding pesticide label in its entirety before using the product. Labels can and do change— greenbook.net, cdms.com, and agrian.com are free online databases for looking up label and MSDS information. ²IRAC= Insecticide Resistance Action Committee. Code included for resistance management planning. ³**Japanese beetle is not a pest of hops in Washington, Oregon and Idaho, where the majority of US hops are produced. Hence, it is not listed under pests for hops on many insecticide labels. The site (crop) must be listed on the label in order to legally use the product on that crop. It is legal to use a pesticide for a pest that is not listed on the label, but the rate listed on for use on the crop (hops) cannot be exceeded. Insecticides that have Japanese beetle listed for a crop other than hops have been noted in the table. Be aware that none of these products have been evaluated for efficacy against Japanese beetle on hops in Michigan.** ⁴PHI=preharvest interval ⁵REI=restricted entry interval. RUP= restricted use pesticide- requires RUP applicator's certificate from Michigan Department of Agriculture and Rural Development to purchase. ^oOMRI certified for organic production. NL=not listed

**Signal Words and Relative Impact of Pesticides Registered for Use on Hop on Representative
Non-target Beneficial Arthropods**

Fungicides	Signal Word	Trade Name	Beneficial arthropod IOBC		rankings ¹
			Predatory mites	Lady beetles	
Active Ingredient	Signal Word	Trade Name	Predatory mites	Lady beetles	Lacewing larvae
<i>Bacillus pumilus</i>	Caution	Sonata	1	ND	ND
boscalid	Caution	Pristine	1	ND	ND
copper	Caution	Various formulations	1	ND	ND
cymoxanil	Warning	Curzate 60DF	ND	ND	ND
dimethomorph	Caution	Acrobat (renamed Forum)	ND	ND	ND
famoxadone & cymoxanil	Caution	Tanos	ND	ND	ND
fosetyl-Al	Caution	Aliette WDG	ND	ND	ND
kaolin	Caution	Surround	3	ND	ND
mandipropamid	Caution	Revus	OK ²	OK ²	ND
mefenoxam	Caution	Ridomil	ND	ND	ND
metalaxyl	Warning	MetaStar	ND	ND	ND
mineral oil/petroleum distillate	Caution	Various formulations	2	ND	ND
phosphorous acid	Caution	Fosphite & other formulations	ND	ND	ND
pyraclostrobin	Caution	Pristine	ND	ND	ND
quinoxifen	Caution	Quintec	1	ND	ND
sulfur	Caution	Various formulations	2	ND	ND
tebuconazole	Caution	Folicur 3.6F	1	ND	ND
Herbicides					
2,4-D	Danger	Weedar 64 & other formulations	ND	ND	ND
carfentrazone	Caution	Aim EC	1	ND	ND
clethodim	Warning	Select Max	1	ND	ND
clopyralid	Caution	Stinger	1	ND	ND
flumioxazin	Caution	Chateau	OK ²	OK ²	ND
glyphosate	Caution	Roundup & other formulations	1	ND	ND
norflurazon	Caution	Solicam	ND	ND	ND
pelargonic acid	Warning	Scythe	ND	ND	ND
trifluralin	Caution	Treflan & other formulations	2	ND	ND

Continued on page 20.

Continued from page 19- Signal Words and Relative Impact of Pesticides Registered for Use on Hop
on Representative Non-target Beneficial Arthropods

Insecticides/Miticides		Beneficial	arthropod	IOBC	rankings ¹
Active Ingredient	Signal word	Trade Name	Predatory mites	Lady beetles	Lacewing larvae
abamectin	Warning	Agri-Mek & other formulations	3	3	ND
<i>B. thuringiensis</i> subsp. aizawal	Caution	Xentari & other formulations	1	2	ND
<i>B. thuringiensis</i> subsp. kurstaki	Caution	Dipel & other formulations	1	2	ND
beta-cyfluthrin	Warning	Baythroid XL	4	4	4
bifenazate	Caution	Acramite-50WS	1	2	ND
bifenthrin	Warning	Brigade & other formulations	4	4	4
cyfluthrin	Danger	Baythroid 2E	4	4	4
dicofol	Caution	Dicofol	1	1	ND
etoxazole	Caution	Zeal	OK ²	OK ²	ND
fenpyroximate	Warning	Fujimite	1	3	ND
hexythiazox	Caution	Savey 50DF	1	1	ND
imidacloprid	Caution	Various formulations	1	3	3
malathion	Warning	Various formulations	2	4	3
naled	Danger	Dibrom	2	4	3
pymetrozine	Caution	Fulfill	1	1	1
pyrethrin	Caution	Pyganic & other formulations	2	2	2
spinosad	Caution	Success & other formulations	2	2	1
spirodiclofen	Caution	Envidor	2	2	1
spirotetramat	Caution	Movento	1	1	1
thiamethoxam	Caution	Platinum Insecticide	1	1	ND

¹International Organization for Biological Control (IOBC) has categorized pesticides using a ranking of 1 to 4. Rankings represent relative toxicity based on data from studies conducted with tree fruit, hop, mint and grape. 1= less than 30% mortality following direct exposure to the pesticide; 2 = 30 to 79% mortality; 3 = 79 to 99% mortality; and 4 = greater than 99%. ND = not determined.

²IOBC rankings not available for this newly registered product. Tests in 2009/2010 determined these compounds safe on predatory mites and *Stethorus*.

Source: Pacific Northwest Hop Handbook 2010

MICHIGAN STATE
UNIVERSITY

Extension


Project GREEN

MSU is an affirmative-action, equal-opportunity employer, committed to achieving excellence through a diverse workforce and inclusive culture that encourages all people to reach their full potential. Michigan State University Extension programs and materials are open to all without regard to race, color, national origin, gender, gender identity, religion, age, height, weight, disability, political beliefs, sexual orientation, marital status, family status or veteran status. Issued in furtherance of MSU Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Jeff Dwyer, Director, MSU Extension, East Lansing, MI 48824. This information is for educational purposes only. Reference to commercial products or trade names does not imply endorsement by MSU Extension or bias against those not mentioned.