

# 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:

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## Weed Management Tips to Achieve Best Results<sup>1</sup>

**W**eeds 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.

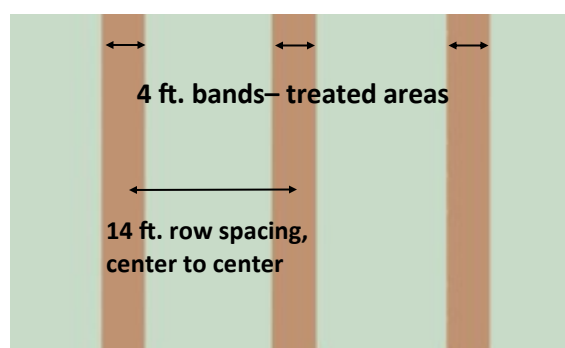
### Applying Banded Applications of Herbicides

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 ( $30 \times 0.28$ ). 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 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 gallons  $\times 0.28 = 8.4$  gallons

<sup>1</sup>Information 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 <sup>1</sup>	Common name	Trade names	REI <sup>2</sup>	PHI <sup>3</sup>	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 app.
	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 app/yr
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/app. 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 apps per crop cycle, 30 d between apps.
	broadleaf	4	clopyralid	Spur	12 h	30 d	1/3-2/3 pt/A; no more than 2 broadcast app/crop/yr. 21 d retreatment interval. For control of Canada thistle.

<sup>1</sup>WSSA = Weed Science Society of America mode of action code listed for resistance management planning. <sup>2</sup>REI= restricted entry interval. <sup>3</sup>PHI= preharvest interval, expressed as hours -h or days -d. <sup>4</sup>OMRI 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](http://greenbook.net), [cdms.com](http://cdms.com), and [agrian.com](http://agrian.com) are free online databases for looking up label and SDS information.

## Herbicides registered for use on hops in Michigan 2016

POSTEMERGENCE	Broadleaf or grasses	WSSA code <sup>1</sup>	Common name	Trade names	REI <sup>2</sup>	PHI <sup>3</sup>	Notes
	both	***	ammoniated soap of fatty acids	Finalsan Total Vegetation Killer <sup>0</sup>	24 h	—	26 oz/1 gal water; 2-5 gal/1000 sq ft or as spot treatment. Avoid spraying desirable plants.
	Both-burndown	***	ammonium nonanoate	AXXE <sup>0</sup>	24 h	0 d	A 6–13% volume to volume (V/V) dilution (8–16 fl oz per gal 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 X-tra, 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 app method.
	Burndown and sucker control	14	carfentrazone	Aim EC <sup>4</sup>	12 h	7 d	2 fl oz/A per app. 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 <sup>0</sup>	0 h	0 d	Non-selective contact herbicide; exempt from registration. OMRI listed.

<sup>1</sup>WSSA = Weed Science Society of America mode of action code listed for resistance management planning. <sup>2</sup>REI= restricted entry interval. <sup>3</sup>PHI= preharvest interval, expressed as hours -h or days -d. <sup>4</sup>Growers 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. <sup>0</sup>OMRI 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](http://greenbook.net), [cdms.com](http://cdms.com), and [agrian.com](http://agrian.com) are free online databases for looking up label and SDS information.



# Downy Mildew in Michigan hopyards

Doug Higgins<sup>1</sup>, Mary Hausbeck<sup>1</sup>, and Diane Brown<sup>2</sup>

## 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 preventive 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 preventive 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

<sup>1</sup> Michigan State University Department of Plant, Soil and Microbial Sciences; <sup>2</sup> Michigan State University Extension

**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](http://www.hops.msu.edu)

## Powdery Mildew in Michigan hopyards

Doug Higgins<sup>1</sup>, Mary Hausbeck<sup>1</sup>, and Diane Brown<sup>2</sup>

**P**owdery 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. Preventive management of and reduction of initial inoculum load are key components of effective control of the disease.

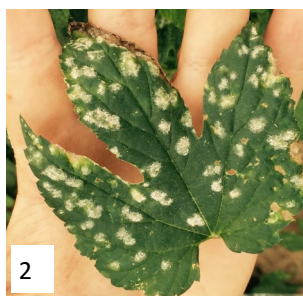
Crowning or spring pruning will reduce the number of flag shoots. After bines have grown far enough up the string (8.2 ft. – 9.8 ft.) basal growth should be periodically removed by mechanical or chemical defoliation. Fungicide applications should be applied as a preventive measure and coupled with cultural 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 registered for use in the state and follow the label instructions 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.

### 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 occur 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.



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**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



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<sup>1</sup> Michigan State University Department of Plant, Soil and Microbial Sciences; <sup>2</sup> Michigan State University Extension

**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](http://www.hops.msu.edu)



## Controlling downy mildew on hop

Mary Hausbeck<sup>1</sup>, Doug Higgins<sup>1</sup>, and Erin Lizotte<sup>2</sup>

Growers should consider an aggressive spring control program for downy mildew on hop. The 2015 weather was especially favorable for downy mildew on hop, and growers should expect problems with this pathogen to continue into this season. Disease symptoms include stunted basal shoots, sidearms and terminal buds that appear yellowish, vines that fail to climb the coir, and yellow to brownish leaf lesions. Disease signs include a gray to brown, fuzzy appearance on the underside of infected leaves due to the pathogen reproducing (see page 5).

The downy mildew pathogen survives Michigan winters in dormant hop buds or crowns and then moves into the expanding basal shoots in the spring. The downy mildew pathogen reproduces via spores on the underside of infected leaves. These spores move to healthy hop buds, growing points, cones and leaves via wind. If the terminal growing point becomes infected, then the pathogen becomes “systemic” and can grow down through the plant toward the crown where it persists in the buds and crown. Mild to warm temperatures of 60-70 degrees Fahrenheit are optimum for the pathogen along with at least 1.5 hours of free moisture from rain or dew.

Although our temperatures have been cool recently, we’ve had rain and plenty of free moisture. When the free moisture persists for 24 hours or longer, infection can occur at low temperatures of 40 F or higher. With this in mind, an aggressive spring control program is warranted since the most popular hop varieties being grown are susceptible to this destructive pathogen.

For 10 years I’ve worked to help Michigan cucumber growers manage downy mildew on their crops and my lab has tested dozens of products each year since 2005. Since the hop downy mildew is a “sister species” to the cucumber downy mildew, I’m basing my current hop recommendations on my experience with this closely related pathogen. I’ve also worked extensively with other downy mildew pathogens that cause damage to impatiens, coleus and basil.

I like to think of the registered fungicide tools as a “team” with each product playing a particular role. Some members of the fungicide team are “starters” and make up the “A” team, whereas other fungicide team members can offer a moderate level support and are members of the “second string” or the “B” team. A strong program can consist of products from both the A and B teams as long as a program is put together carefully with a sharp eye to those conditions that favor downy mildew (prolonged wet and humid weather). Use A team products when the disease pressure is high or when the weather favors disease. The B team products can be used when disease is absent/low or when the weather is hot and dry. Alternating A team products with B team products is also an approach that can be used during periods of moderate downy mildew pressure

### “A” team downy mildew fungicides

- **Ridomil Gold SL** should be applied at the beginning of this growing season given the downy mildew pressure of last summer and the rainy spring conditions. This fungicide can either be applied as a drench or as a spray. If the fungicide is used as a drench, then one application can be made at 0.5 pints per acre (equals 0.25 pounds of active ingredient). If the fungicide is used as a foliar spray then up to two applications can be made at the same rate as the drench. Foliar sprays of Ridomil Gold SL must be tank-mixed with a copper fungicide that is registered for hop.
- **Ranman** should be applied as a foliar spray. No more than six applications per growing season are allowed. Also, no more than three consecutive applications can be made.
- **Curzate 60DF** should also be applied as a foliar spray and must be tank-mixed with a labeled rate of a fungicide such as copper hydroxide. A maximum of four applications can be made in a 12-month period. One of the active ingredients in Tanos is the same active ingredient that is in Curzate 60DF.

### “B” team downy mildew fungicides

- **Forum** should be applied as a spray and followed by a fungicide with a different mode of action. No more than three applications are allowed per season. **Zampro** is a combination of two fungicides with one of them being the same active ingredient as Forum. Zampro should be applied as a spray with no more than three sprays per growing season. Apply no more than two consecutive sprays before changing to a fungicide with a different mode of action. An adjuvant is recommended.
- **Revus** should be applied as a spray in conjunction with a surfactant with no more than three sprays total for the growing season. No more than two consecutive applications should be made before alternating to a fungicide of a different mode of action. This fungicide does not control cucumber downy mildew, but does offer control of impatiens and basil downy mildew. Hop grow-

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ers choosing this product should assess whether they are achieving the desired control.

### Other fungicides

What about all of the other fungicides that are registered for hop? Where do they fit in a downy mildew program? Some fungicides registered for hop target only powdery mildew, and that is a completely different problem from downy mildew. Although the Aliette program has been used successfully for downy mildew in the Pacific Northwest, I'm not convinced it can stand up to the intense and season-long disease pressure that hop growers experience in Michigan. Phostrol has similar activity to Aliette. My concern is that neither of these products has proven helpful for limiting downy mildew on cucumber and is the primary reason I hesitate to recommend them to Michigan hop growers. Overall, the strobilurin fungicides such as trifloxystrobin (contained in Luna Sensation) and pyraclostrobin (contained in Pristine) have not been good downy mildew fungicides in other crops.

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Common name	Trade names	A or B team
cyazofamid	Ranman, Ranman 400 SC	A
cymoxanil	Curzate 60DF	A
dimethomorph	Forum	B
fosetyl-Al	Aliette WDG, Linebacker WDG	B
mandipropamid	Revus	B
mefenoxam	Ridomil Gold, Ultra Flourish	A
metalaxyl	MetaStar 2E, Metalaxyl 2E Ag	A
metrafenone	Vivando	A
quinoxifen	Quintec	A
tebuconazole	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	A
ametoctradin + dime-thomorph	Zampro	B
boscalid + pyraclostrobin	Pristine	B for powdery mildew only
famoxadone + cymoxanil	Tanos	B
fluopyram + tebuconazole	Luna Experience	A
fluopyram + trifloxystrobin	Luna Sensation	A
tebuconazole + sulfur	Unicorn DF	A

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## Fungicides registered for use on hops in Michigan 2016<sup>1</sup>

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 <sup>2</sup> code/ resistance risk L, M, H <sup>3</sup>	Trade names	Diseases listed on label	Rates/notes	REI <sup>4</sup>	PHI <sup>5</sup>
cyazofamid	21/unk.; assumed to be M to H	Ranman, Ran- man 400 SC	DM	2.1-2.75 fl oz/A. No more than 6 apps/crop or 3 consecutive apps. 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 protectant fungicide such as copper hydroxide. 10 -14 d treatment interval. Max. 4 apps/12 mo.	12 h	7 d
dimethomorph	40/L-M	Forum	DM	6 fl oz/A. No more than 3 apps/18 fl oz/season; min app interval 10 d; rotate to another mode of action after 1 app.	12 h	7 d
Aluminum tris	33/L	Aliette WDG Linebacker WDG	DM	2.5 lb/A. 5 lb/A. Apply when: shoots are 6-12 in tall, after training when vines are 5-6 ft tall, 3 wks after 2nd app, at bloom. Max 10 lb/A/season. Do not use with copper compounds— see label.	12 h	24 d
mandipropamid	40/L-M	Revus	DM	8 fl oz/A/app. No more than 24 fl oz/season; no more than 2 consecutive apps. NIS recommended. MI supplemental label has additional directions for use. Max 3 apps/season.	4 h	7 d
mefenoxam	4/H	Ridomil Gold	DM	0.5 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 in 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	PM	Supplemental label for hops. Used as a preventive for powdery mildew 15.4 fl oz/A; Max 2 app/yr 7-14 d interval Do not mix with horticultural oil.	12 h	3 d

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## Fungicides registered for use on hops in Michigan 2016<sup>1</sup>

Common name	FRAC <sup>2</sup> code/ resistance risk L, M, H <sup>3</sup>	Trade names	Diseases listed on label DM = downy mildew PM = pow- dery mildew	Rates/notes	REI <sup>4</sup>	PHI <sup>5</sup>
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	DM	1-3 qt/100 gal/A. Apply at 2-3 week intervals.	4 h	0 d
		KPHITE 7LP	DM, PM, alternaria, anthracnose	1-4 qt in a min of 20 gal/A. Do not apply at less than 3 d intervals.		
mono-and dibasic sodium, potassi- um and ammoni- um phosphites	33/L	Phostrol  Phiticide	DM	2.5 pt/A in a min of 10 gal/A as directed foliar spray. 2.5-6 pt/A in a min of 10 gal/A. Apply: when shoots are 6 to 12 in high; after training when vines are 5 to 6 feet tall; about 3 weeks after the second app; 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 app, during bloom.	4 h	0 d
potassium bicarbonate	NC/resist. not known	MilStop	PM, DM, anthracnose	2-5 lb/A	1h	0 d
		Kaligreen <sup>°</sup>	PM	2.5-5 lb/A	4 h	1 d
paraffinic oil	NC/resist. not known	Stylet oil <sup>°</sup>	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 apps/season or more than 2 consecutive sprays before 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 h drying time to become rainfast.	12 h	14 d

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## Fungicides registered for use on hops in Michigan 2016<sup>1</sup>

	Common name	FRAC <sup>2</sup> code/ resistance risk	Trade names	Diseases listed on label DM = downy mildew PM = powdery mildew	Rates/notes	REI <sup>4</sup>	PHI <sup>5</sup>
MULTISITE FUNGICIDES	basic copper sulfate	M1/L	Agristar Basic Copper 53 <sup>°</sup> CS 2005 <sup>°</sup> Cuprofix-Ultra 40 Disperss Cuproxat Mastercop	DM	1 lb/A per app. Max. 5 lb/A/yr.  19.2 oz/A per app. Max. 2.65 lb/A/yr. 1-1.25 lb/A. no more than 6.6 lb product/yr. 2.25 pt/A/app. Max. 13.1 pt/A/yr. 0.5-1 pt/A/app. Max. 6 pt/A/crop cycle  Make crown treatment after pruning but before training. After training additional treatments are needed at 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 d 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 <sup>°</sup> Champion++ <sup>°</sup> Kocide 2000 Kocide 3000 Nu-Cop 3L Nu-Cop 50 DF <sup>°</sup> Nu-Cop 50 WP <sup>°</sup> Nu-Cop HB <sup>°</sup>	DM	1.33 lb/A/app. Max. 7.07 lb/A/yr      1.33 pt/A/app. Max. 7.3 pt/A/yr  1.06 lb/A/app. Max. 5.3 lb/A/yr 0.75-1.5 lb/A/app. Max. 8.33 lb/A/yr 1.5 lb/A/app. Max 7.57. lb/A/yr 0.75-1.5 lb/A/app. Max. 8.8 lb/A/yr 1.33 pt/A/app. Max. 7 pt/A/yr 1 lb/A/app. Max. 5 lb/A/yr 1 lb/A/app. Max. 5 lb/A/yr 1 lb/A/app. Max. 5 lb/A/yr  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 <sup>°</sup>	Anthrachnose, DM, PM, cercospora leafspot	0.5-2 gal/100 gal water. Apply 50-100 gal/A. Do not apply more than 884 gal of diluted spray/A/yr.	4 h	0 d
	copper oxychloride	M1/L	COC DF	DM	1 lb/A/app. Max. 5 lb/A/yr. Apply as a fungicide crown treatment— after pruning but before training. After training, make additional treatments at 10 d intervals.	48 h	14 d

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## Fungicides registered for use on hops in Michigan 2016<sup>1</sup>

	Common name	FRAC <sup>2</sup> code/ re- sistance risk	Trade names	Diseases listed on label DM = downy mildew PM = powdery mildew	Rates/notes	REI <sup>4</sup>	PHI <sup>5</sup>
MULTISITE FUNGICIDES	copper oxychloride + basic copper sulfate	M1/L	C-O-C-S WDG		1 lb/A/app. 5.1 lb product/A yr. Apply soon after training vines.	48 h	0 d
	cuprous oxide	M1/L	Nordox 75 WG <sup>o</sup>	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 <sup>o</sup> , Cosavet DF Edge <sup>o</sup> , Thiolux <sup>o</sup>	PM	Apply 4-6 lb/A 14 d intervals.	24 h	0 d
PREMIXES	ametoctradin + dimethomorph	45+40/M	Zampro	DM	11-14 fl oz/A per app. No more than two sequential apps before changing to a different mode of action or three total per season. 40 fl oz/A max per season. CPDA certified adjuvant is recommended.	12 h	7d
	boscalid + pyra- clostrobilin	7+11/M-H	Pristine	DM PM	28 oz/A. Max. 84 oz/A/yr.  14 oz/100 gal/A.	12 h	14 d
	famoxadone + cymoxanil	11+27	Tanos	DM	8 oz/A/app. No more than 6 apps/ cropping cycle. Tank mix with a contact fungicide. Alternate with a fungicide with a different mode of action for the follow- ing app.	12 h	7d
	fluopyram + tebuconazole	7+3	Luna Experience	PM	8-17 fl oz/A apply increasing product rate as plant size increases. Max 34 fl oz per season. No more than 2 sequential apps before rotating to other chemical classes. 14 d intervals.	12 h	14 d
	fluopyram + tri- floxystrobin	7+11	Luna Sensation	PM	3-7.6 fl oz/A. apply increasing product rate as plant size increases. Max 27.3 fl oz per season. No more than 2 sequential apps before rotating to other chemical classes. 14 d intervals		14 d
	Phosphorous acid, mono and di-potassium salts + hydrogen peroxide	33+NC/L	OxiPhos	DM, PM	5 qt/A. Apply product as a dilute spray (not to exceed 2.5% v/v (1:40) con- centration in water). Ensure complete coverage of foliage. Repeat apps at 7–14 d intervals.	4 h	0 d

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## Fungicides registered for use on hops in Michigan 2016<sup>1</sup>

	Common name	FRAC <sup>2</sup> group/ resistance risk <sup>3</sup> L,M,H	Trade name	Diseases listed on label DM = downy mildew PM = powdery mildew	Rates/notes	REI <sup>4</sup>	PHI <sup>5</sup>
PREMIXES	tebuconazole + sulfur	3+M2/L-M	Unicorn DF	PM	2.5-5 lb/A in a min 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
	<i>Bacillus amyloliquefa- ciens</i> strain D747	44/resist. not reported; as- sumed L	Double Nick- el 55 <sup>°</sup>	PM	0.5-1 lb/100 gal of water. Apply a min 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
BIOPESTICIDES	<i>Bacillus pumilus</i> strain QST 2808	44/resist. not reported; as- sumed L	Sonata	PM	2-4 qt/100 gal at 7-14 d intervals. Max. spray volume 400 gal/A.	4 h	0 d
	<i>Bacillus subtilis</i> QST 713	44/resist. not reported; as- sumed L	Serenade Max <sup>°</sup> Serenade ASO <sup>°</sup>	PM	2-4 lb/100 gal. See label for spray vol- umes/A. related to hop growth stages. 4-6 qt/100 gal See label for spray vol- umes/A related to hop growth stages.	4 h	0 d
	Extract of <i>Reynoutria sachalinensis</i>	P5/L	Regalia <sup>°</sup>	DM, PM	Apply preventively or when symptoms are first noticed. 1-4 qt/A for downy mil- dew control, must be tank mixed with another fungicide labeled for downy mil- dew. PM-rates depend on growth stage- see label.	4 h	0 d
	<i>Streptomyces lydicus</i> 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, anthrac- nose) 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 <sup>°</sup>  Tenet WP <sup>°</sup>	Phytophthora root rot, verticillium wilt	Should be applied up to 7 d before planting to initiate soil colonization be- fore 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

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# Insecticides and miticides labeled for use on hops in Michigan 2016<sup>1</sup>

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 <sup>2</sup> group)	Common name	Trade names	Pests	Japanese beetle else-where on label <sup>3</sup>	Rates/notes	REI <sup>4</sup>	PHI <sup>5</sup>
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	8-16 fl oz/A. No more than two apps/season. 32 fl oz/season max. See label for GPA requirements. 21 d retreatment interval. All are RUP.	12 h 28 d
	6	abamectin	Abba Ultra <sup>RUP</sup> Agri-Mek SC <sup>RUP</sup>	mites	no	4-8 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/yr. 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	4-6 oz/A. Apply up to burr formation. Limit 1 app/yr.	12 h *
	10B	etoxazole	Zeal	mite eggs and immatures	no	3-4 oz/A in a min of 50 gals water/A. 1 app/season.	12h 7 d
	21A	fenpyroximate	Portal, Portal XLO	mites	no	2-3 pt/A in a min of 100 gal water/A. Apply before mites exceed 5 mites/leaf. 1 app/season.	12 h 15 d

MITICIDES CONTINUE ON NEXT PAGE

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<sup>2</sup>IRAC= Insecticide Resistance Action Committee. Code included for resistance management planning. <sup>3</sup>**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.** <sup>4</sup>PHI=preharvest interval <sup>5</sup>REI=restricted entry interval. RUP= restricted use pesticide- requires RUP applicator's certificate from Michigan Department of Agriculture and Rural Development to purchase. <sup>6</sup>OMRI certified for organic production.

## Insecticides and miticides registered for use on hops in Michigan 2016<sup>1</sup>

Chemical class (IRAC <sup>2</sup> group)		Common name	Trade names	Pests	Japanese beetle elsewhere on label <sup>3</sup>	Rates/notes	REI <sup>4</sup>	PHI <sup>5</sup>
MITICIDES	12C	propargite	Omite 6E <sup>RUP</sup>	mites	no	32 fl oz in 50 gal total volume/A. Min 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
	UN	sulfur	Acoidal <sup>o</sup> , Defend DF <sup>o</sup> Microthiol Disperss <sup>o</sup> Micro Sulf <sup>o</sup>	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 <sup>o</sup> , Cosavet DF Edge <sup>o</sup> , Kumulus DF <sup>o</sup> Sulfur DF <sup>o</sup> , Thiolux <sup>o</sup>	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/A when infestation first occurs—repeat as needed. See cautions about oil listed on label.	24 h	0 d
	23	spirodiclofen	Envidor 2SC	mites	no	18-24.7 fl oz/A. 1 app/season. Min. app volume 50 GPA.	12 h	14 d
	23	spirotetramat	Movento	aphids, mites	no	5-6 fl oz/A. 14 d treatment interval. 12.5 fl oz/A max./yr. 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/yr.  0.63 pt/A; retreatment interval is 7 d. Max 3 treatments/yr.	12 h	10 d
	1B	naled	Dibrom 8 Emulsive <sup>RUP</sup>	armyworms, hop aphid	no	1 pt/A.	7 d	48 h
	3A	beta-cyfluthrin	Baythroid XL <sup>RUP</sup> ,	hop aphid, flea beetle, looper, plant bug	yes	3.2 fl oz/A. Max 16 fl oz/season.	12 h	7 d

INSECTICIDES CONTINUE ON NEXT PAGE

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<sup>2</sup>IRAC= Insecticide Resistance Action Committee. Code included for resistance management planning. <sup>3</sup>**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.** <sup>4</sup>PHI=preharvest interval <sup>5</sup>REI=restricted entry interval. <sup>4</sup>RUP= restricted use pesticide- requires RUP applicator's certificate from Michigan Department of Agriculture and Rural Development to purchase. <sup>°</sup>OMRI certified for organic production. UN=unclassified.

# Insecticides and miticides registered for use on hops in Michigan 2016<sup>1</sup>

Chemical class (IRAC group)	Common name	Trade names	Pests	Japanese beetle elsewhere on label	Rates/notes	REI <sup>4</sup>	PHI <sup>5</sup>
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. Min retreatment interval = 21 d. See labels for gallons/acre requirements. All are RUP.	12 h	14 d
3A	bifenthrin	Bifenture 10DF <sup>RUP</sup>	aphids, mites, armyworms, cutworms	yes	9.6-16 oz/A use high rate for mites. Min retreatment interval = 21 d. see labels for gal/acre requirements.	12 h	14 d
3A	cyfluthrin	Tombstone <sup>RUP</sup> , Tombstone Helios <sup>RUP</sup>	Hop aphid, flea beetle, looper, plant bug	yes	3.2 fl oz/A max./14-d interval Min app volume (water): 25 GPA.	12 h	7 d
3A	pyrethrins	Evergreen EC60-6  Pyganic EC 1.4 II <sup>0</sup> , Pyganic EC 5.0 <sup>0</sup> ,  Tersus	aphids, caterpillars, leafhoppers, Japanese beetle see label for others		2-16 fl oz/A in a min. 10 GPA. 1 pt-2 qt/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 apps when insects first appear.	12 h	0 d
PREMIXES	3A 4A	beta-cyfluthrin imidacloprid	Leverage 360 <sup>RUP</sup>	Aphids, beetles, loopers, plant bugs	yes	3.2 fl oz/A. 1 app/season.	12 h 28 d
	3A 4A	bifenthrin imidacloprid	Avenger S3 <sup>RUP</sup> , Avenger Systemic <sup>RUP</sup> , Swagger <sup>RUP</sup>	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. Max, amount of bifenthrin allowed per season: 0.30 lb ai/A. Max amount of imidacloprid allowed per season: 0.30 lb ai/A.	12 h 28 d
	3A 4A	bifenthrin imidacloprid	Brigadier <sup>RUP</sup>	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 2016<sup>1</sup>

Chemical class (IRAC group)	Common name	Trade names	Pests	Japanese beetle elsewhere on label	Rates/notes	REI <sup>4</sup>	PHI <sup>5</sup>
PREMIXES	3A 4A	bifenthrin imidacloprid	Skyraider <sup>RUP</sup>	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 <sup>RUP</sup>	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 aza-dirachtin	Azera <sup>o</sup>	Aphids, leafroller and other caterpillars, Japanese beetle, spider mites		1-3.5 pt/A in a min of 30 gallons of water/A. Limit of 10 apps 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	imidacloprid	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	imidacloprid	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	imidacloprid	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 app.	12 h 12 h 28 d
	4A	imidacloprid	Couraze 1.6 F, Nuprid 1.6 F, Pasada 1.6 F, Prey 1.6 F, Sherpa	aphids	yes	8 fl oz/A as a foliar app.	12 h 28 d
	4A	imidacloprid	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 app.	12 h 12 h 28 d
	4A	imidacloprid	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 app.	12 h 12 h 28 d
	4A	imidacloprid	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 app.	12 h 28 d

INSECTICIDES CONTINUE ON NEXT PAGE

## Insecticides and miticides registered for use on hops in Michigan 2016<sup>1</sup>

Chemical class (IRAC group)	Common name	Trade names	Pests	Japanese beetle elsewhere on label	Rates/notes	REI <sup>4</sup>	PHI <sup>5</sup>
4A	imidacloprid	Malice 75 WSP Montana 2F Montana 4F	aphids		2.1 oz/A foliar app only. 6.4 fl oz/A foliar app only. 3.2 fl oz/A foliar app only.	12 h	28 d
4A	thiamethoxam	Platinum  Platinum 75SG	hop aphid, root weevils, garden symphlan	yes	8 fl oz/A as banded soil app. Limit 8 fl oz/growing season. 2.67 oz/A as a banded app. irrigate to incorporate into root zone.	12 h	65 d
4D	flupyradifurone	Sivanto 200SL	aphids	no	7-10.5 fl oz/A. Min app volume 25 GPA.	4 h	21 d
5	spinosad	Entrust <sup>o</sup> ,	Armyworm, loop-er, thrips	no	1.25-2 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 <sup>o</sup> , SpinTor 2SC	Armyworm, loop-er, 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 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/app in a min of 120 gal/A 14 d interval. Use NIS.	12 h	14 d
11	B. thuringiensis var. kurstaki	Dipel DF <sup>o</sup> , Xentari <sup>o</sup> Biobit HP <sup>o</sup> Deliver <sup>o</sup> Javelin WG <sup>o</sup>	loopers, armyworms	no	0.5-2 lb/A.  0.5-1.5 lb/A. 0.25-1 lb/A.	4 h	0 d
11	B. thuringiensis var. kurstaki	Dipel ES <sup>o</sup>	loopers armyworms	no	1-2 pt/A. 2-4 pt/A.	4 h	0 d
11	Chromobacterium subtsugae	Grandevo <sup>o</sup>	armyworms, loopers  aphids, mites, thrips, whiteflies (Leafhoppers elsewhere on label)	no	1-3 lb/A.  2-3 lb/A.	0 d	4 h
28	chlorantraniliprole	Coragen	Western yellow striped armyworm		3.5-5 fl oz/A. No more than 4 app/A/crop. Min treatment interval is 7 d. No more than 0.2 lb a.i. of chlorantraniliprole products per yr.	4 h	0 d
29	flocanimid	Beleaf 50 SG	aphids	no	1.7-2.8 oz/app. in a min 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 2016<sup>1</sup>

Chemical class (IRAC group)	Common name	Trade names	Pests	Japanese beetle elsewhere on label	Rates/notes	REI <sup>4</sup>	PHI <sup>5</sup>
UN	azadirachtin	Aza-Direct <sup>o</sup> ,	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 <sup>o</sup> ,  Azatin-O <sup>o</sup> , 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 <sup>o</sup>	aphids, beetles, true bugs, caterpillars, leafminers, mites, others		15-30 fl oz/A. Kills only immature stages (larvae and nymphs) repeat app in 7-10 d. Buffer spray solution to pH of 5.5-6.5.	4 h	0 d
UN	azadirachtin	Molt-X <sup>o</sup>	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 <sup>o</sup>	aphids, beetles, true bugs, caterpillars, leafminers, mites, others	yes	4-16 fl oz/A, in a min 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 <sup>o</sup>	aphids, beetles, true bugs, caterpillars, leafminers, mites, others	yes	Use as a 1-2% solution in a min of 25 gal/A. Kills only immature stages (larvae and nymphs).	4 h	0 d
UN	sulfur	Acoidal <sup>o</sup> , Defend DF <sup>o</sup> Microthiol Dispers <sup>o</sup> Micro Sulf <sup>o</sup>	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 <sup>o</sup> , Cosavet DF Edge <sup>o</sup> , Kumulus DF <sup>o</sup> Sulfur DF <sup>o</sup>	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/A 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 2016<sup>1</sup>

Chemical class (IRAC group)	Common name	Trade names	Pests	Japanese beetle elsewhere on label	Rates/notes	REI <sup>4</sup>	PHI <sup>5</sup>
NL	Beauvaria bassiana	Mycotrol O	aphids, thrips	no	0.25-1 qt/A. Read label for adjuvant and tank mix restrictions.	4 h	0 d
NL	kaolin	Surround <sup>o</sup>	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 <sup>o</sup> JMS Stylet-Oil <sup>o</sup> Ultra-Pure Oil  Pure Spray GREEN <sup>o</sup>	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 <sup>o</sup>	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 <sup>o</sup>	aphids, spider mites	no	2 gal product/100 gal water. Apply 75-200 gal/A. Do not use within 3 d of a sulfur app. See label for tank mix precautions.	12 h	0 d
NL	potassium salts of fatty acids	M-Pede <sup>o</sup>	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 min of 50 gal/A. Do not use within 3 d of a sulfur app. See label for tank mix precautions.	12 h	0 d
NL	potassium silicate	Sil-matrix <sup>o</sup>	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 <sup>o</sup>	spider mites, thrips	no	1-4 pt/100 gal/A. Spreader/adjuvant recommended.	0 h	0 d

<sup>1</sup>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](http://greenbook.net), [cdms.com](http://cdms.com), and [agrian.com](http://agrian.com) are free online databases for looking up label and MSDS information. <sup>2</sup>IRAC= Insecticide Resistance Action Committee. Code included for resistance management planning. <sup>3</sup>**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.** <sup>4</sup>PHI=preharvest interval <sup>5</sup>REI=restricted entry interval. RUP= restricted use pesticide- requires RUP applicator's certificate from Michigan Department of Agriculture and Rural Development to purchase. <sup>o</sup>OMRI 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**

<b>Fungicides</b>		<b>Beneficial arthropod IOBC rankings<sup>1</sup></b>			
<b>Active Ingredient</b>	<b>Signal Word</b>	<b>Trade Name</b>	<b>Predatory mites</b>	<b>Lady beetles</b>	<b>Lacewing larvae</b>
<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 <sup>2</sup>	OK <sup>2</sup>	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
<b>Herbicides</b>					
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 <sup>2</sup>	OK <sup>2</sup>	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 22.

**Continued from page 21- Signal Words and Relative Impact of Pesticides Registered for Use on Hop  
on Representative Non-target Beneficial Arthropods**

Insecticides/Miticides		Beneficial	arthropod	IOBC	rankings <sup>1</sup>
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 <sup>2</sup>	OK <sup>2</sup>	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

<sup>1</sup>International 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.

<sup>2</sup>IOBC 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**

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