

# Weed Management Updates in Hops

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Hop Kickoff

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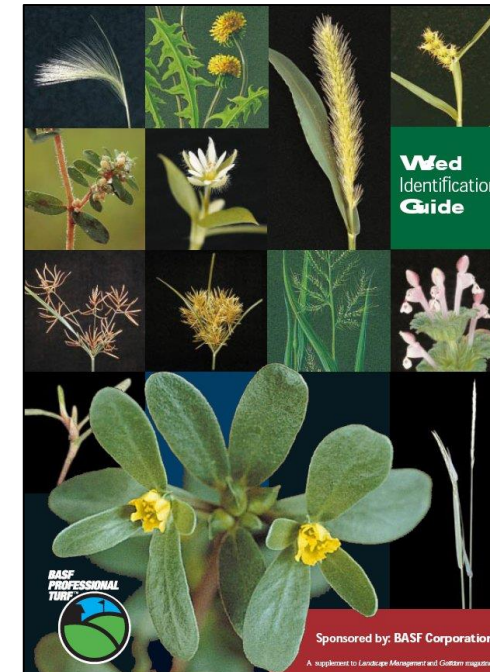
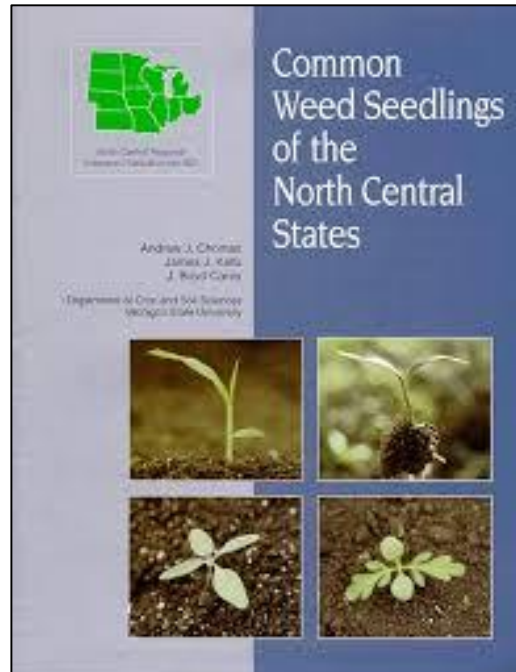
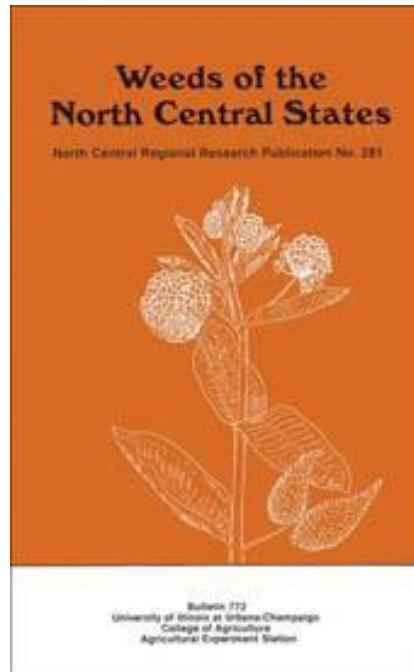
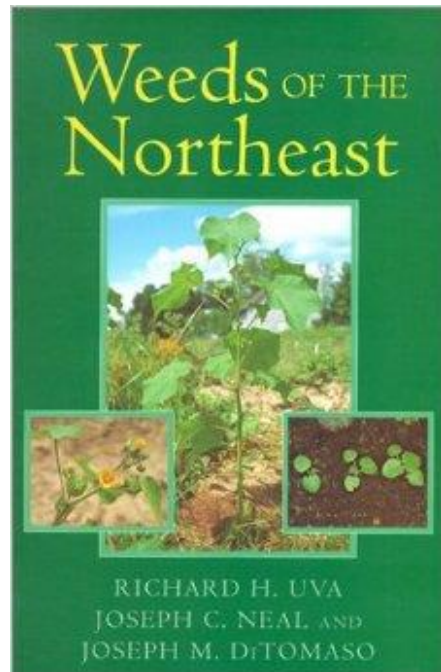
# Importance of weed management in hops

- ❖ Reduce yield through competition for water, nutrient, and light
- ❖ Reduce cone quality
- ❖ Interfere with stringing/training and harvest
- ❖ Serve as alternate hosts for insects and pests
- ❖ Can reduce airflow and prevent drying of foliage – promotes some diseases



# Correct identification of weeds

- ❖ First step is to identify weeds
  - ❖ Monitoring
  - ❖ Identification and knowledge of target weeds





# Major weed problems in hops

## Summer Annuals

- ❖ Common lambsquarters
- ❖ Palmer amaranth
- ❖ Common ragweed
- ❖ Smartweed spp.
- ❖ Nightshade spp.
- ❖ Annual grass spp.



Smartweed



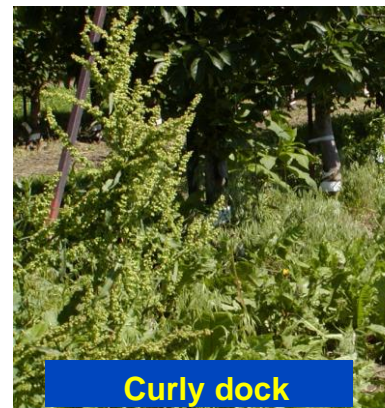
Horsenettle



Horseweed

## Winter Annuals

- ❖ Horseweed (marestail)
- ❖ Common chickweed
- ❖ Common groundsel



Curly dock



Common dandelion



Virginia creeper

## Perennials

- ❖ Canada thistle
- ❖ Wild carrot
- ❖ Dandelion
- ❖ Field bindweed
- ❖ Horsenettle
- ❖ Quackgrass
- ❖ Yellow nutsedge
- ❖ Virginia creeper vine
- ❖ Green-brier
- ❖ Goldenrod
- ❖ Poison ivy



Canada thistle



Yellow nutsedge



Field bindweed



# Weed management practices

- ❖ Non-chemical
  - ❖ Hand-weeding
  - ❖ Mowing
  - ❖ Cultivation
  - ❖ Mulching/Covering
  
- ❖ Chemical
  - ❖ Herbicide





# Michigan Hop Management Guide



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FOR COMMERCIAL FRUIT GROWERS

# Michigan Fruit Management Guide 2022

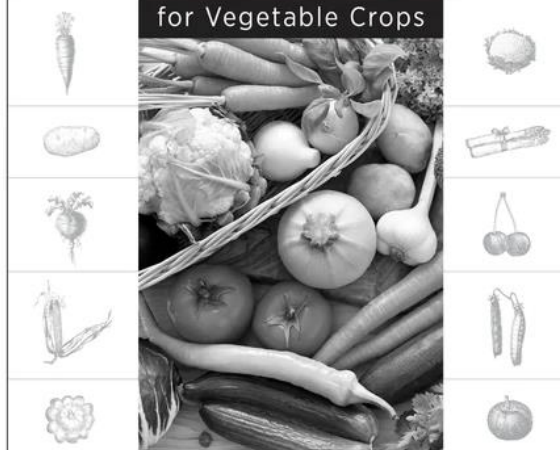


Extension Bulletin E54 • Information Current as of November 1, 2021 • Revised Annually • DESTROY PREVIOUS EDITIONS

Extension Bulletin E-433 • Revised • November 2021

# 2022

## Weed Control Guide for Vegetable Crops



Information current as of November 1, 2021

## HOPS

### Active Ingredient and Product

Weed Problem	Chemical	per acre	Remarks
Preemergence	flumioxazin (Chateau 51 SW)	0.191 lb ai 6 oz	Apply to dormant hops as a band on each side of the row. One application per year. 30-day PHI.
	norflurazon (Solicam 80 DF)	2 - 4 lb ai 2.5 - 5 lb	Apply as a directed spray to soil on each side of row. Use low rate on sandy soil. Apply 6 or more months after crop establishment. 60-day PHI.
	pendimethalin (Prowl H2O 3.8 CS)	1 - 4 lb ai 1.1 - 4.2 qt	Apply to recently planted, dormant, or vegetative hop plants. Apply to bare soil before weeds emerge. Avoid contact with vines or cones. A second application may be applied 30 days after the first application. Max. of 4.2 qt/acre/year. 90-day PHI.
	indaziflam (Alion 1.67 SC)	0.045 - 0.065 lb ai 3.5 - 5 fl oz	Apply to hops that have been established at least one year. Apply in fall or early spring with buds <2 inches. Apply in a minimum 2 ft band on each side of row. Max. of 2 applications and 10 fl oz/acre/year.
	trifluralin (Treflan 4 EC)	0.5 - 0.75 lb ai 1 - 1.5 pt	Apply and incorporate in established hops. Do not spray or till over top of crowns. No composite or mustard control.

Table 4. Herbicide Effectiveness on Annual Weeds in Tree Fruit Plantings.

Herbicide	Application*	Annual broadleaves							Annual grasses							
		Common Chickweed	Common Lambsquarters	Horseweed (Marestail)	Mustards	Nightshade, eastern black	Pigweeds	Ragweed	Smartweeds	Velvetleaf	Barnyardgrass	Bromegrass	Crabgrass, large	Fall Panicum	Foxtail	Sandbur
Alion	Pre	G	F	F	G	G	G	F	F	G	G	G	G	G	P	G
Callisto	Pre	G	E	F	G	E	E	F	G	G	P	N	G	N	N	N
Casoron	Pre	E	E	F	E	G	E	E	E	G	G	P	F	F	G	G
Chateau	Pre	G	G	P	G	E	E	F	F	G	F	P	F	F	G	F
Devrinol	Pre	G	G	P	P	N	G	P	F	N	E	E	E	E	E	P
Dual Magnum	Pre	N	P	N	P	G	G	P	F	P	E	E	E	G	E	E
Goal	Pre	G	E	F	F	G	E	G	G	G	F	P	F	F	P	F
Karmex	Pre	E	E	F	E	G	E	G	E	G	G	F	G	G	E	F
Kerb	Pre	G	P	P	F	N	F	F	F	P	E	E	E	G	G	E
Matrix	Pre	F	F	F	G	P	E	F	F	F	G	P	G	F	G	F
Mission	Pre	G	G	F	G	P	G	G	G	F	F	G	F	P	G	F

Table 5. Herbicide Effectiveness on Perennial Weeds in Tree Fruit Plantings.

Herbicide	Application*	Perennial weeds																
		Bindweed, field, hedge	Canada Thistle	Carrot, wild	Dandelion	Goldenrod	Grape, wild	Ground Ivy	Horsenettle	Mallow, common	Milkweed, common	Nutsedge, yellow	Plantains	Poison Ivy	Quackgrass	Sowthistle	Vetches	Virginia creeper
Alion	Pre	N	N	P	F	P	N	F	P	P	N	P	G	F	P	G	G	P
Callisto	Pre	P	N	G	N	N	N	F	N	N	N	N	N	N	N	N	N	N
Casoron	Pre	P	P	G	G	P	P	F	F	E	P	G	G	P	G	G	G	N
Chateau	Pre	P	P	N	G	P	N	P	P	G	N	N	P	N	N	N	N	N
Devrinol	Pre	N	N	N	P	N	N	N	N	N	N	P	P	N	P	G	P	N
Goal	Pre	P	P	N	P	N	N	N	P	N	P	P	G	N	P	P	P	N
Karmex	Pre	P	P	F	F	N	N	N	P	F	P	N	G	N	P	F	P	N
Kerb	Pre	N	N	N	N	N	N	N	N	N	N	P	N	N	G	P	N	N
Matrix	Pre	F	F	G	G	P	N	P	N	F	N	F	F	N	F	F	F	N
Mission	Pre	F	P	P	G	P	N	P	P	F	F	P	N	F	F	P	F	N
Prowl H2O	Pre	P	N	N	P	N	N	N	N	P	N	P	P	N	N	P	P	N

# Key points to achieve optimum weed control with herbicides

- ❖ Timely application of herbicide in fall, spring, and summer (during the season)
- ❖ Most of residue herbicide in fall and spring
- ❖ At least three residual herbicides with different site of action
- ❖ Add appropriate adjuvants with POST herbicides
- ❖ Clean out sprayer properly (especially after 2,-4,D)
- ❖ Follow herbicide label

# Selection of herbicides

- ❖ Based on method of application
  - ❖ Preemergence (PRE)
    - ❖ Applied to soil prior to emergence of weeds
    - ❖ Cannot kill weeds that are already growing
    - ❖ Provide residual control (4 to 8 weeks)
    - ❖ Can be combined with POST
  - ❖ Postemergence (POST)
    - ❖ Applied to the foliage of emerged weeds
    - ❖ Ideal temperatures between 65 and 80, but can be applied 40 to 60 F
    - ❖ Can have “contact” or “systemic” activity



# Selection of herbicides

## ❖ Based on selectivity

### ❖ Selective

- ❖ Provide species specific control

- ❖ i.e. SelectMax

### ❖ Non-selective

- ❖ Control or severely damage all or most species

- ❖ i.e. glyphosate, Pelargonic acid or nonanoate acid (Scythe/Axxe)

## ❖ Based on mechanism/site or mode of action (MOA)

- ❖ Important for management of herbicide resistance

- ❖ WSSA (Weed Science Society of America) or HRAC (Herbicide Resistance Action Committee)

# Categorization by Mechanism of Action

## Summary of Herbicide Mechanism of Action According to the Weed Science Society of America (WSSA)



1

### Acetyl CoA Carboxylase (ACCase) Inhibitors

Aryloxyphenoxypropionate (FOPs) cyclohexanedione (DIMs) and phenylpyrazolin (DENs) herbicides inhibit the enzyme acetyl-CoA carboxylase (ACCase), the enzyme catalyzing the first committed step in *de novo* fatty acid synthesis (Burton 1989; Focke and Lichtenthaler 1987). Inhibition of fatty acid synthesis presumably blocks the production of phospholipids used in building new membranes required for cell growth. Broadleaf species are naturally resistant to cyclohexanedione and aryloxyphenoxy propionate herbicides because of an insensitive ACCase enzyme. Similarly, natural tolerance of some grasses appears to be due to a less sensitive ACCase (Stoltenberg 1989). An alternative mechanism of action has been proposed involving destruction of the electrochemical potential of the cell membrane, but the contribution of this hypothesis remains in question.



2

### Acetolactate Synthase (ALS) or Acetohydroxy Acid Synthase (AHAS) Inhibitors

Imidazolinones, pyrimidinylthiobenzoates, sulfonylaminocarbonyl triazolones, sulfonyleureas, and triazolopyrimidines are herbicides that inhibit acetolactate synthase (ALS), also called acetohydroxyacid synthase (AHAS), a key enzyme in the biosynthesis of the branched-chain amino acids isoleucine, leucine, and valine (LaRossa and Schloss 1984). Plant death results from events occurring in response to ALS inhibition and low branched-chain amino acid production, but the actual sequence of phytotoxic processes is unclear.



3

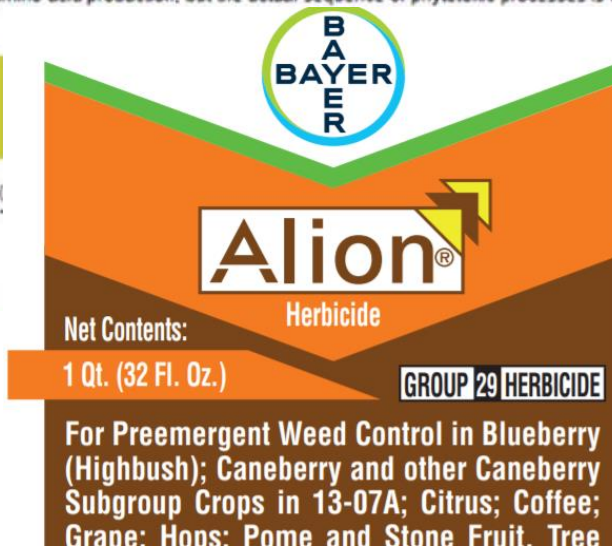
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Benzamide, benzoic acid (examples of herbicides that...)

The numbering system assigns each herbicide to a mechanism of action group.

[Link to herbicide mechanism of action classification](#)

The EPA recommends that labels display the group number that identifies the



ACTIVE INGREDIENT: Indaziflam\* ..... 19.05%  
 OTHER INGREDIENTS: ..... 80.95%  
 Contains 1.67 pounds of indaziflam per gallon. TOTAL: 100.00%  
 \*(CAS No: 730979-19-8)

EPA Reg. No. 264-1106

**KEEP OUT OF REACH OF CHILDREN**  
**CAUTION**

**WSSA/HRAC**  
 (1-866-992-2937)

See additional precautionary statements and

on for the  
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 t.



# Pre-emergence herbicides for use in hops

<b>Common name (trade name)</b>	<b>MOA/HRAC</b>
Indaziflam (Alion)	29
Norflurazon (Solicam)	12
Isoxaben (Trellis)	29
Trifluralin (Treflan)	3
Pendimethalin (Prowl H <sub>2</sub> O)	3
Flumioxazin (Chateau)	14
Dimethenamid (Outlook)	15

# Herbicide selection

- ❖ Hop age: PRE weed control in new hopyards
- ❖ Apply herbicides after soil has settled around plants

Herbicide	Weeds	Activity duration	Remarks
Outlook	Annual grasses/broadleaves/nutsedge	4-6 weeks	Use low rates on light soils
Trellis	Broadleaves	4 weeks	Max 2 applications/year
Solicam	Annual grasses/broadleaves	4-5 weeks	Apply 6 or more months after crop establishment
Prowl	Annual grasses/broadleaves	3-4 weeks	Apply to hops in year of planting or to established hops



## Trifluralin (Treflan, others)

- ❖ Apply prior to weed and hop emergence (on established hops only)
- ❖ Requires mechanical incorporation (shallow)
- ❖ Rate determined by soil type- see label
- ❖ Broad spectrum annual grass and some broadleaf control
- ❖ No control of most mustards, composite, and nightshades

# Pendimethalin (Prowl H2O, Satellite HydroCap)

- ❖ Apply prior to weed emergence
- ❖ Apply prior to main hop emergence or keep off hop foliage
- ❖ May apply sequential treatments at least 30 days apart
- ❖ Pre harvest interval 90 days
- ❖ Broad spectrum annual broadleaf and grass weed control
- ❖ If broadcast, may injure small grain cover crops



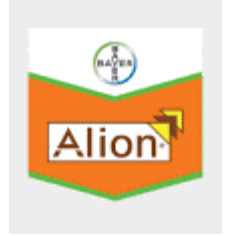
# Norflurazon (Solicam)

- ❖ Hops must be established at least 6 months
- ❖ Apply prior to weed emergence (late fall or early spring)
- ❖ Apply as a directed spray to soil on each side of row
- ❖ Pre harvest interval 60 days
- ❖ Broad spectrum annual broadleaf and grass weed control
- ❖ Persistent and may injure cover crops if broadcast
- ❖ Adjust rates for soil type (see label)

**Table 1: Maximum SOLICAM DF Rates (Lbs. of Product per Treated Acre per Year) by Soil Texture**

	Coarse		Medium	Fine
Crop	Sand, Loamy Sand	Sandy Loam	Loam, Silt Loam, Silt, Sandy Clay Loam	Sandy Clay, Clay Loam, Silty Clay Loam, Silty Clay, Clay
Hops/	2.5	2.5	3.75	5.0

# Alion (indaziflam)



- ❖ Cellulose synthesis inhibitor (G-29)
- ❖ Apply to hops that have been established at least one year
- ❖ **Late fall through early spring early spring with buds <2 inches**
- ❖ Sol. 2040 ppm. Do not use on sand or gravel
- ❖ Controls grasses and broadleaves for 8-12 weeks



## Dose Rate Chart for Hops

Soil Texture	Alion Herbicide (fl oz product / broadcast acre)			Minimum Plant Age
Sand	Do Not Use			
Any other soil except those that contain 20% or greater gravel content	Soil percent Organic Matter Content	Rate Per Application	Max Rate Per Year	1 year
	%	fl oz/A	fl oz/A	
	<1	3.5 (0.045 lb ai/A)	7.0 (0.09 lb ai/A)	
	≥1	5.0 (0.065 lb ai/A)	10.0 (0.13 lb ai/A)	

**Do not apply** more than a total of 7.0 fl oz product/A (0.09 lb ai/A) per year on soils containing < 1 % organic matter content, or 10.0 fl oz product/A (0.13 lb ai/A) per year on soils containing ≥1 % organic matter content in a 12 month period when used in any hops planting.

# Trellis (isoxaben)

- ❖ Cell wall synthesis inhibitor (G-29)
- ❖ In fall or spring before weeds emerge
- ❖ Apply in band on each side of the row before emergence
- ❖ Controls annual broadleaves for 4-6 weeks

**Trellis<sup>®</sup> SC**  
HERBICIDE

# POST herbicides

## ❖ Grass – SelectMax

- ❖ Apply to actively growing grasses (not stressed)
- ❖ PHI 21-days

## ❖ Broadleaves – Aim, Venue, Spur (Stinger), 2,4-D

## ❖ Broadleaves and grasses – Axxe\*, HomePlate\*, Scythe, Roundup

\* OMRI listed for organic production



# POST herbicides

- ❖ **Contact or burndown herbicides:** Aim, Venue, Axxe\*, HomePlate\*, Scythe
  - ❖ Control many small broadleaf weeds postemergence (no soil residual activity)
  - ❖ Removal of early shoots (postemergence vegetation control)
  - ❖ Sucker control: Burn back of unwanted basal sucker growth and foliage growth on bines. Apply only to unwanted vegetative parts. Apply before suckers become woody. **Wait until trained hops have woody stems.**
- ❖ **Systemic herbicides:** SelectMax, Spur (Stinger), 2,4-D, Roundup

\* OMRI listed for organic production

# Glyphosate

- ❖ Glyphosate controls most emerged weeds. Apply before hop emergence
- ❖ Spot spray perennial weeds
- ❖ Alley ways for control of emerged weeds
- ❖ Prior to hop emergence in hop row
- ❖ Do not spray on hop foliage
- ❖ Early spring applications safer than fall applications



Glyphosate injury on new growth from previous fall application

# Management of troublesome weeds



# Grasses in Hops

	Annual grasses	Perennial grasses
	Large Crabgrass, Foxtail spp., Fall panicum, Sandbur, Witchgrass, Barnyardgrass, Bromegrass	Quackgrass, Orchardgrass, Wirestem muhly, Nimblewill, Bermudagrass, Annual bluegrass (per. type), Tall fescue
Reproduce /spread	Mainly reproduce by seeds	seeds and vegetative plant parts (stolon, rhizome, crown)
PRE herbicide	Alion, Prowl, Solicam, Treflan, Chateau	Solicam

# Postemergence Graminicides

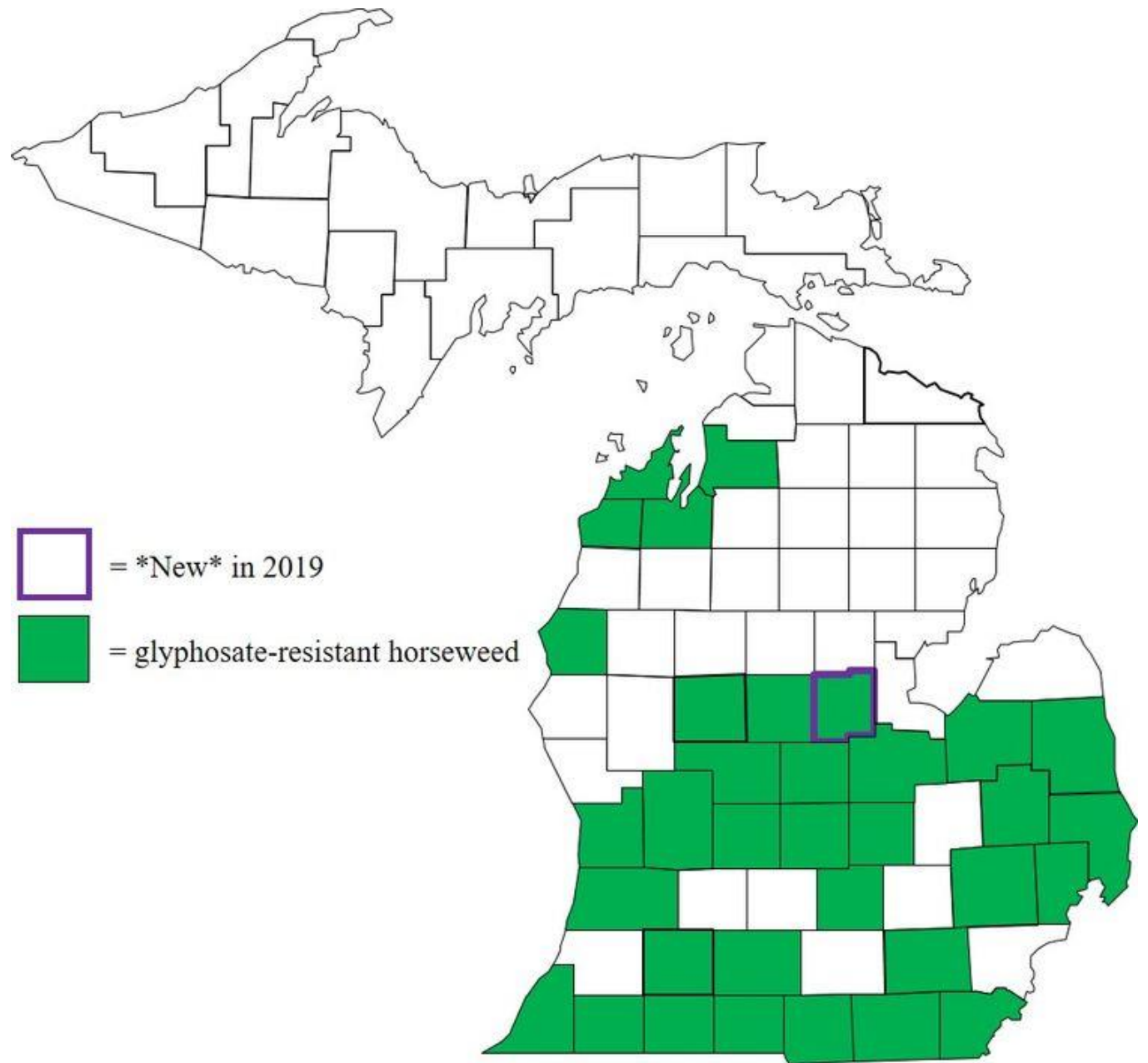
- ❖ Roundup (PHI 14-days), Axxe\*, HomePlate\*, Scythe
- ❖ SelectMax (4 applications/year)
  - ❖ Apply to actively growing grasses (not stressed)
  - ❖ 14 or more days between applications
  - ❖ PHI –21 days

# Horeweed (marestail)

- ❖ Winter or summer annual
- ❖ Emerges in fall or early spring as a rosette
- ❖ Fall-emerged plants becomes dormant over the winter and start to bolt in April/May, begin to flower in July, seed set from Aug to Oct
- ❖ Limited seed dormancy
  - ❖ up to 86% germinate immediately upon seed shed
- ❖ PRE: Alion, Chateau, Trellis (Fall/Spring)
- ❖ POST: Glyphosate, Stinger, 2,4-D, Venue, Axxe, HomePlate, Scythe



Horseweed resistance to the ALS-inhibitors (Group 2), triazines (Group 5), and glyphosate (Group 9) have been identified in Michigan.





# Canada thistle

- ❖ Perennial, emerges in spring and flowers when days are the longest
- ❖ Reproduce: seeds and roots
- ❖ Sequential herbicide applications
  - ❖ March to May (rosette to bolting): only top growth
  - ❖ **Mid-May to mid-June (prior to flowering)**
  - ❖ **Sep to Oct (rosette growth and shoot emergence)**
    - ❖ *Ideal times for high levels of control due to translocation of herbicides towards roots*
- ❖ Stinger, 2,4-D, Glyphosate
- ❖ Two mowing (mid-June and Sept) prior to flowering in help reduce stand — but will not kill



# Root of Canada thistle

## 2 years growth from 1 foot of root!



Source: Purdue University Department of Botany  
[www.btny.purdue.edu/Pubs/WS/CanadaThistle/CanadaThistle.html](http://www.btny.purdue.edu/Pubs/WS/CanadaThistle/CanadaThistle.html)



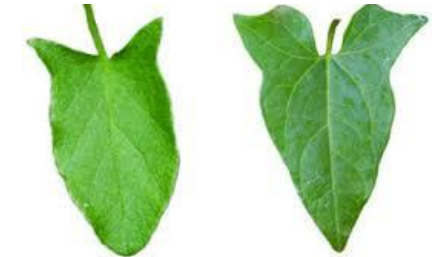
# Field Bindweed

- ❖ Twining, creeping perennial vine
- ❖ Reproduce: seeds, creeping roots and rhizomes
- ❖ Extensive root system: Depths up to 30' but 70% in top 2'

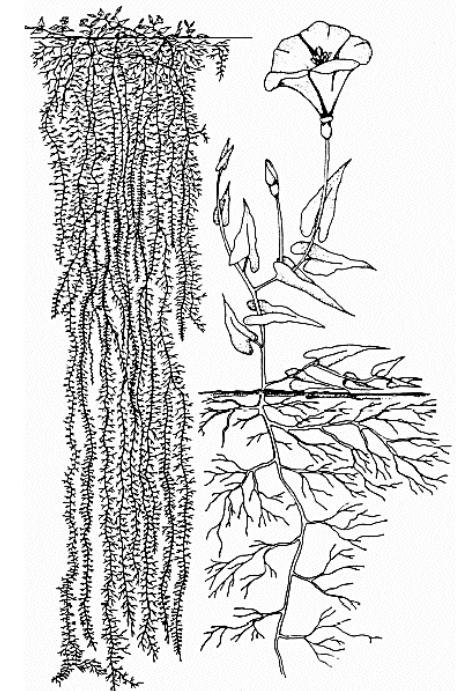
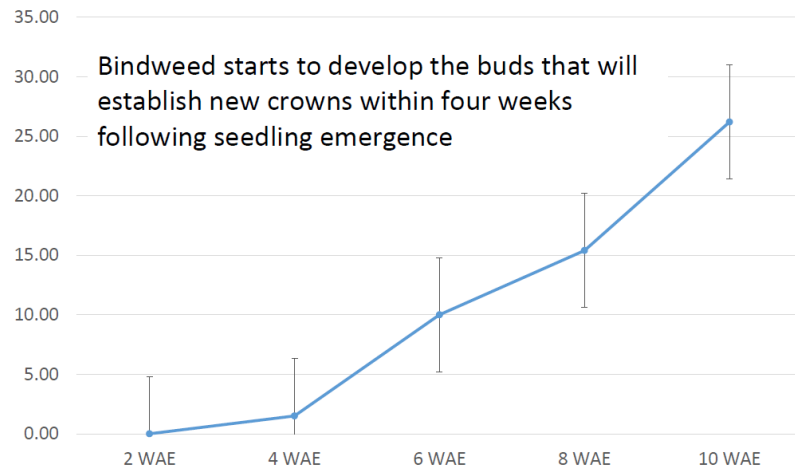


Field Bindweed

Hedge Bindweed



Rhizome buds per plant over time  
(Sosnoskie 2017, unpublished data)



# Field Bindweed

## ❖ Mowing/Hand-weeding

- ❖ Must be applied approximately every 14 days to exhaust root reserves

## ❖ Herbicide:

- ❖ PRE: Trellis (only kill seeds as they germinate)

### ❖ POST: Glyphosate, 2,4-D

- ❖ The best time to control bindweed with glyphosate herbicides is when the plants are flowering (late summer or early fall)
- ❖ Repeated applications of herbicide will be necessary to control bindweed



**What's new in the research pipeline  
(not registered to use in hops)**

# Tiafenacil: Potential Alternative for Paraquat

- ❖ Protoporphyrinogen IX oxidase (PPO) inhibitor (WSSA group 14)
- ❖ Nonselective contact herbicide (broadleaf and grasses)
- ❖ Current US Federal registrations (Trade name: Reviton 2.83 SC):
  - ❖ Preplant or preemergence burndown [1-3 fl oz/ac (0.022-0.067 lb ai/ac)],
  - ❖ Corn, soybean, wheat, and cotton
- ❖ Low-risk to non-target organisms
- ❖ No identified dietary, residential, aggregate, or occupational risks for human health

TIAFENACIL GROUP 14 HERBICIDE



A nonselective burndown herbicide with the active ingredient TERGEO™

ACTIVE INGREDIENT: TIAFENACIL*	30.0 %
OTHER INGREDIENTS	70.0 %
TOTAL	100.0 %

\*methyl N-[2-[[2-chloro-5-[3,6-dihydro-3-methyl-2,6-dioxo-4-(trifluoromethyl)-1(2H)-pyrimidinyl]-4-fluorophenyl]thio]-1-oxopropyl]-β-alaninate

## Glufosinate (Rely280)

- ❖ Nonselective postemergence herbicide, hop sucker control
- ❖ Excessive hop injury if apply before hops are 6 ft. tall
- ❖ Longer suppression of hop sucker regrowth at base of plant than Aim

# Thank You

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## Questions?