

Improving weed management by adding alfalfa to your rotation



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Information is actively disseminated

- Utilize existing stakeholders and their networks
- Resources can be found at several locations
- <https://cropsandsoils.extension.wisc.edu/article-topic/alfalfa/>
- <https://renzweedscience.cals.wisc.edu>

Pest Management in Wisconsin Field Crops

A guide to managing weeds, insects, and diseases in corn, soybean, forage, and small grains



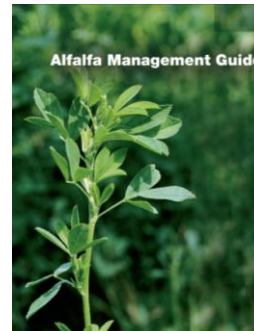
Alfalfa Rotational Restrictions for Herbicides Used in Wisconsin Corn Production

Rotational restrictions for select herbicides commonly used in Wisconsin corn production based on those listed in UW-Ext. pub. A3646. Only intervals ≥ 8 months presented, assuming spring seeding of alfalfa following a corn crop the previous year.

Rotation intervals, notes and footnotes have been compiled here for convenient reference. **Always refer to label** on original package when making final management decision.

Herbicide - Trade Name	Alfalfa Interval	Comments/Restrictions
Axtrex	See Note	Do not plant the year following application or injury may occur.
Accent Q	10M	Differs outside Wisconsin, see label.
Acuron	18M	
Acuron Flexi	10M	If applied after June 1, rotating to alfalfa the following year may result in crop injury.
Acuron GT	10M - 18M	If soil pH is ≤ 6.0 or $\geq 10^{\circ}$ of rainfall + irrigation between application and planting, interval is 18M. If applied after June 30th, rotating to alfalfa may result in crop injury.
Anthem	10M	
Anthem ATZ	See Note	Do not plant the year following application or injury may occur.
Anthem Flex	10M	
Armezon	9M	
Armezon PRO	9M	
Autumn Super 51 WDG	18M - 24M	30" cumulative precipitation (not irrigation) from application to planting required. Soil pH ≥ 7.5 , interval is 24M.
Balance Flexx	10M	15" cumulative precipitation from application to planting required.
Basis Blend	10M - 18M	If drought conditions prevail between application and alfalfa planting, extend to 18M unless sprinkler irrigation applied. If rate applied is above 1.25 oz/A, 18M interval.
Bicop Lite II Magnum	See Note	Do not plant the year following application or injury may occur.
Callisto	10M	
Callisto GT	10M	
Callisto Xtra	See Note	If applied after June 1, rotating to alfalfa the following year may result in crop injury.
Cereson	10M - 18M	Soil pH ≥ 7.5 , interval is 18M; Soil pH < 7.5 and alfalfa is spring seeded, interval is 24M.

Alfalfa Management Guide



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Alfalfa is a cornerstone to dairy livestock enterprises

- In Wisconsin >1 million acres of alfalfa grown (USDA-NASS 2024)
 - Fields rotated between alfalfa and corn, wheat, soybeans



Including alfalfa in the rotation provides MANY BENEFITS!

- Increased forage yield (rotation effect)
- reduced reliance on nitrogen fertilizers
- benefits cattle health and productivity
- Improved soil health
- Nutrient/soil/water runoff
 - Reduced by >40% in alfalfa compared to corn
- Reduced pest populations
 - WEEDS
 - reduction of herbicide resistant weeds and difficult to control weeds

2017 Weed Identification Series



Tall/Common Waterhemp

Annual broadleaf that germinates April – August. Commonly found in agronomic and horticultural crops as well as highly disturbed areas.

Leaves: Lance or spearhead shaped, 3-6 in long that alternate on the stem. Petiole is shorter than the length of the leaf blade.

Stem: Typically, 4-5 ft tall, but can grow > 10 ft. Lacks hair on the stem.

Flowers: Many small green flowers form an inflorescence in July-September. While the terminal inflorescence can be > 1 ft long, many waxy lateral branches occur throughout the inflorescence. Male and female flowers found on separate plants, and can on occasion turn pink – red as they mature.

Similar Plants: This plant is often confused with other common pigweeds, especially palmer and spiny amaranth as they also have no hairs on stems. Palmer amaranth can be differentiated by the petiole as it is longer than its leaf blade unlike Waterhemp. Spiny amaranth has distinct spines below leaves. For more information including a video see visit the [report-a-pigweed link](#) below.

Herbicide Resistance: In Wisconsin resistance to glyphosate has been confirmed in 16 counties and resistance to glyphosate and PPO-inhibitors in one county. It is also believed that many populations are also resistant to ALS herbicides but few have been tested. In nearby states much higher levels of resistance to these and other modes of actions of herbicides have been detected. Currently nearby states have Waterhemp populations resistant to five different herbicide modes of action.

Wisconsin Weed Identification giant ragweed - *Ambrosia trifida*

Life History: Annual, reproducing by seed. Begins to germinate in late March to mid-April.

Leaves: Opposite except at the ends of stems where they may be alternate; large (up to 12" long and 8" wide). Lower stem leaves have 3 to occasionally 5 lobes. Upper stem leaves smaller, may be unlobed. Margins are toothed or entire; surfaces are sometimes hairy and rough.



Stem: 2-18' tall, erect and usually branched with the upper branches often reaching heights equal to the central stem. Stem surface is coarse with spreading hairs.



Flower/Fruit: Similar to common ragweed with yellow to green spike-like inflorescences (racemes) up to 11" long, often branched at the base. Female flowers up to 0.5" long cluster at the base of spikes. Blooms late July to August.

In order to gain these benefits alfalfa must be successfully established!



This presentation will

- Review how alfalfa improves weed management
- What is the benefit to weed management
- How much will weed management cost when alfalfa is incorporated into the rotation
- Risks to successful establishment from weed management in previous crop



Alfalfa is a great tool for suppressing weeds

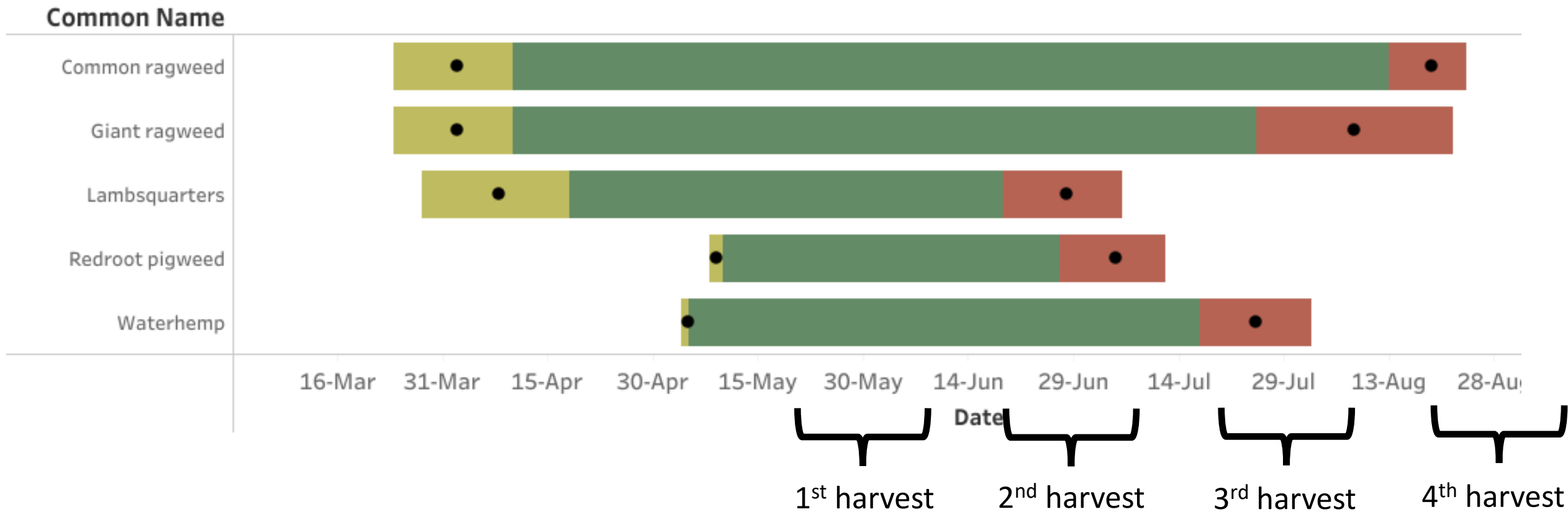
- Competitive once established and **not stressed**
 - Few weeds in production years
- Why?
 - Closes canopy early in season
 - Frequently mowing (2-5 times /yr in midwest)
 - Rapidly regrows and closes canopy
 - Additional management options available



Know when weeds flower!

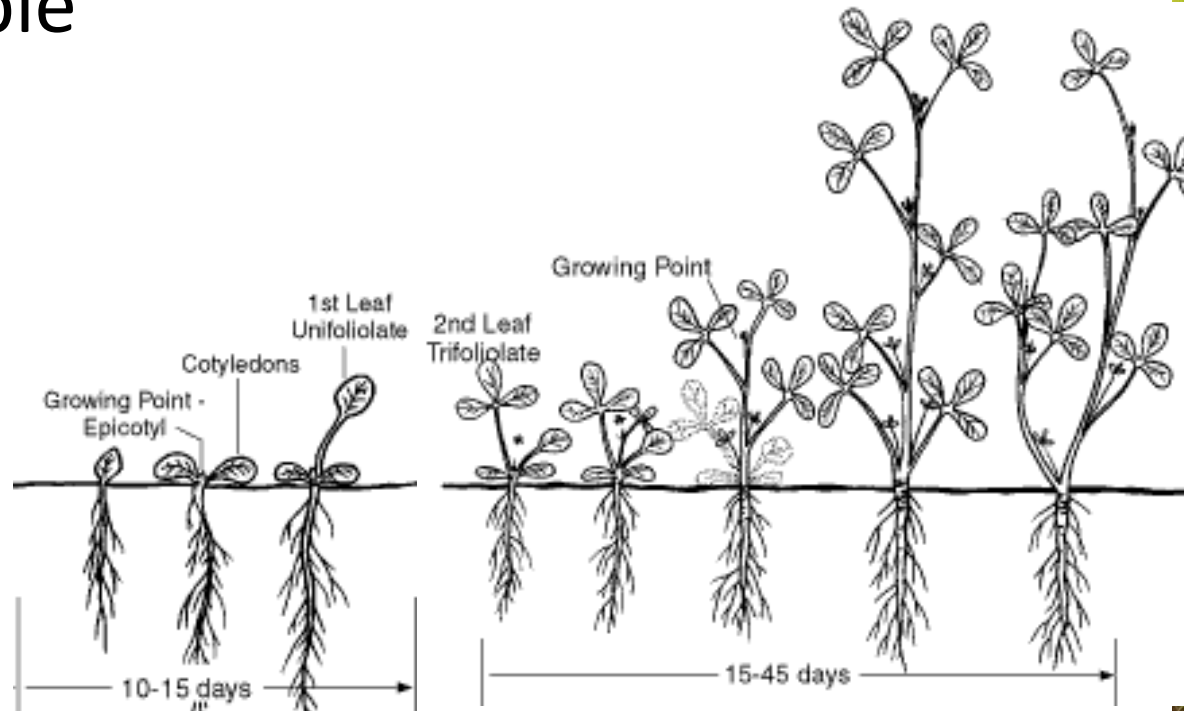
<https://renzweedscience.cals.wisc.edu/toolsresources/weed-o-meter/>

First Emergence and Initiation of Flowering Dates for Common Agronomic Weeds in Arlington, WI



Weeds can be problematic during establishment

- Need to select effective control techniques to
 1. prevent competition (dependent on weed density)
 2. prevent seed production
- Lots of tools available
 - Planting date
 - Companion crops
 - Effective herbicide
 - Early harvest



Remember, alfalfa competitive advantage is lost when stands are stressed

Common types of stress

- ABIOTIC
 - Drought
 - Flooding
 - Fertility
 - Winterkill
 - Wheel traffic
- BIOTIC
 - Insect injury
 - Disease injury



EXAMPLES OF EFFECTIVENESS WITH TWO OF THE MOST COMMON WEEDS

WATERHEMP AND GIANT RAGWEED



Established alfalfa effectively controls waterhemp



Hay & Forage Grower

Established alfalfa effectively controls waterhemp

Hay & Forage Grower is featuring results of research projects funded through the Alfalfa Checkoff, officially named the U.S. Alfalfa Farmer Research Initiative, administered by National Alfalfa & Forage Alliance (NAFA). The checkoff program facilitates farmer-funded research.

RECENT research shows waterhemp — a yield-robbing, herbicide-resistant weed in corn and soybeans — has no impact on the quality or productivity of established alfalfa in the Midwestern and Eastern U.S. “It reaffirmed that alfalfa is a very good weed management tool. We underemphasize its importance in managing weeds in our cropping systems . . . when managed correctly,” said Mark Rens, University of Wisconsin Extension Weed Specialist.

When Rens and his Minnesota, Michigan, and Pennsylvania colleagues started their research in 2019, waterhemp was beginning to show up in alfalfa after hitting corn and soybean fields hard. “We knew it could be a problem when establishing alfalfa; we didn’t have any data on what happened once that alfalfa was established,” Rens said.

The Alfalfa Checkoff-funded research indicates that healthy alfalfa stands prevent establishment of significant amounts of waterhemp. Alfalfa’s competitiveness and dairy-grade alfalfa’s frequent cutting schedules kept the weed’s mortality rate high.

That information should be especially meaningful to corn and soybean growers, said Rens. “This is their opportunity to get waterhemp under control by putting alfalfa in the rotation.”

Waterhemp is widely resistant to many herbicide modes of action and common across the U.S., Rens said. “It is now common to find biotypes resistant to two or more herbicide modes of action, essentially preventing effective control. There are populations resistant to five modes of action, and that’s the trend. So, alfalfa could be a solution or management tool for these populations,” he added.

The research also provided an understanding of the biology of the weed, said Rens, who collaborated with Roger Becker, University of Minnesota extension agronomist, as well as extension weed scientists Erin Burns from Michigan State University and John Wallace from Penn State University.

Apply after cutting, if at all

“We now know when it germinates in established alfalfa,” Rens said. “Few germinate until after we cut it, then emergence occurs if soil moisture is present. Knowing this information allows us to recommend when to apply residual herbicides to get the best effectiveness.” Results found these herbicides were effective when applied either after first or second cut, but Rens advises after second cut. “Typically, alfalfa seems to be more competitive between the first and second cut, resulting in higher mortality of waterhemp.”

PROJECT RESULTS

1. Residual herbicides applied after first or second cutting effectively managed waterhemp; applications after second cut are recommended due to the high level of weed mortality after first cut.
2. Herbicide treatments did not improve alfalfa quality and yield, and waterhemp didn’t reduce forage quality and was minimal in forage biomass.
3. Waterhemp seeds were found in two of the fields, but seed production was near zero. Management reduced seed production further but didn’t eliminate seeds.

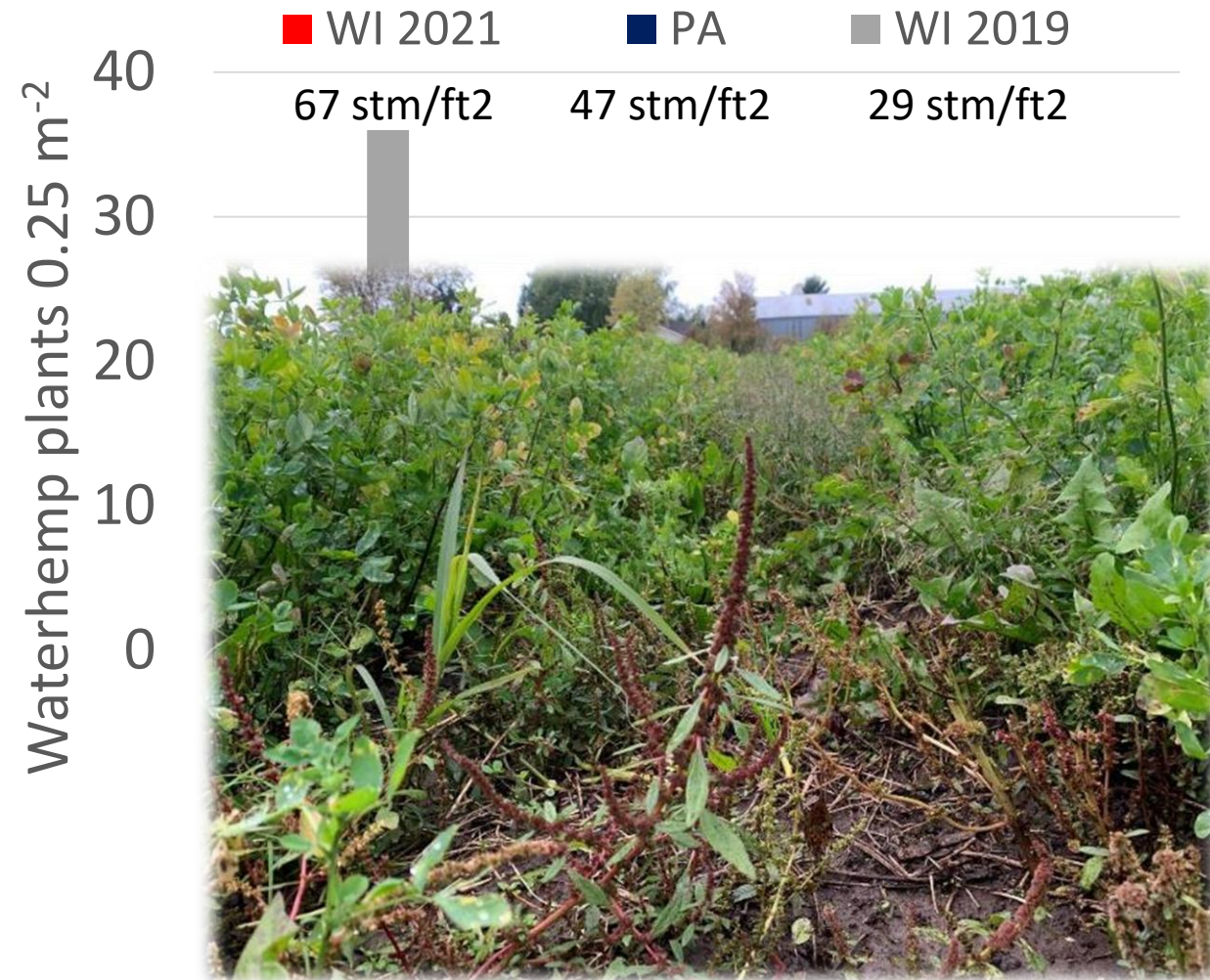
Waterhemp density in established alfalfa at each harvest (June, July, Aug, Sep, 2019)

Waterhemp plants (per m ²)	June	July	Aug.	Sep.
Large	0	0	13	3
Medium	63	13	20	7
Small	64	85	13	2



How does alfalfa reduce waterhemp populations?

- Waterhemp was outcompeted by established alfalfa
 - Emergence was low in dense stands
 - mortality of emerged was high ($> 75\%$)
 - Biomass was never $> 5\%$ in any harvest
- Waterhemp didn't impact forage quantity or quality
- **Seed production was very low**
 - < 50 seeds per plant

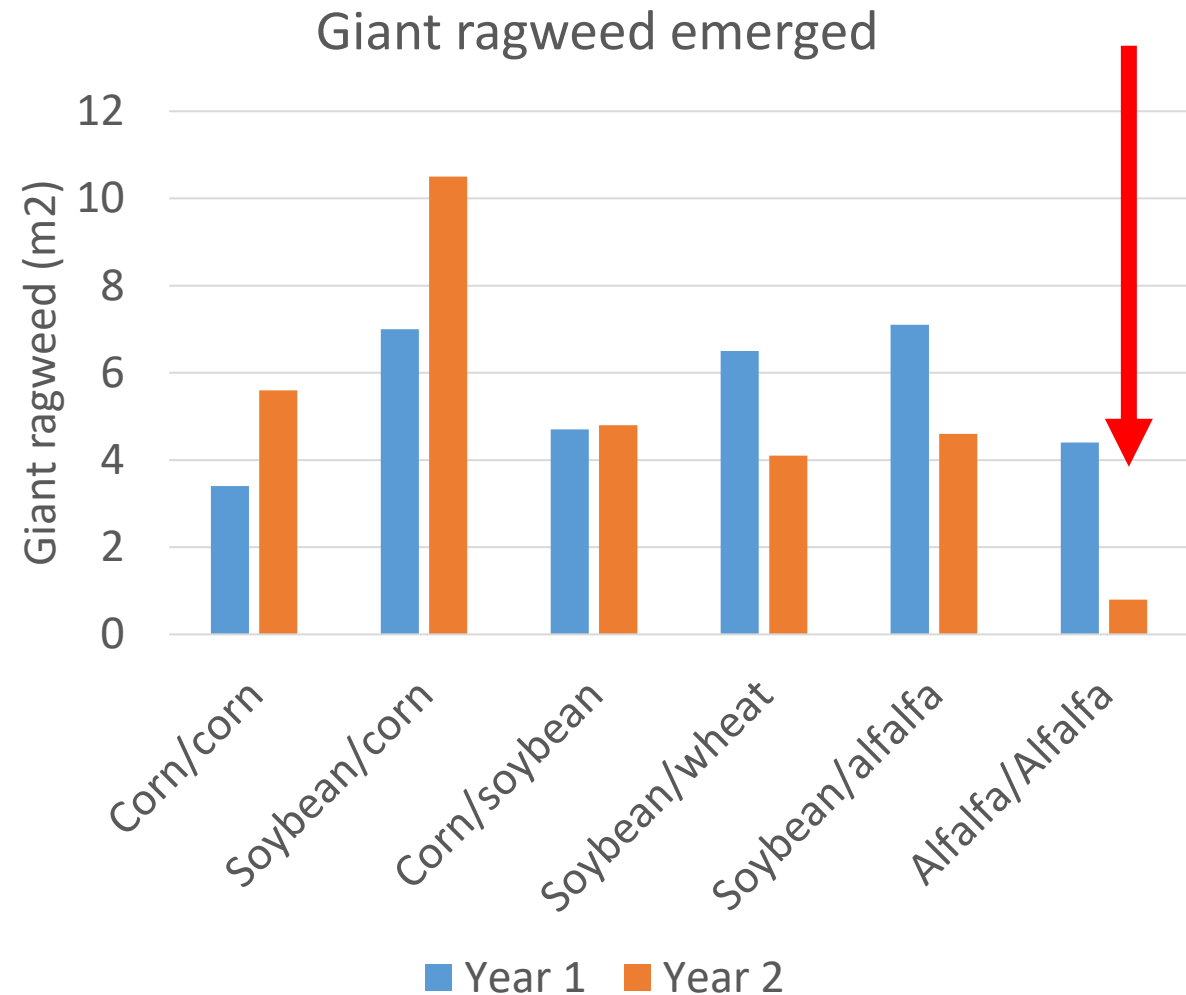


How does alfalfa help reduce giant ragweed?

Results from MN....

Goplen et al. 2017

- Evaluated giant ragweed emergence in crop rotations
 - Corn/corn
 - Soybean/corn
 - Soybean/wheat
 - Soybean/alfalfa
 - Alfalfa/alfalfa
- Giant ragweed controlled in all rotations
 - Corn and soy 3 passes with herb.
 - Wheat 1 pass
 - Alfalfa 1 pass only during establishment



Conclusions from MN study

- Weed seed bank of giant ragweed was reduced by 99% by alfalfa!

Goplen et al. 2017



that the inclusion of alfalfa in the cropping system has the greatest potential to improve giant ragweed control. Although the emergence period was longer in the AAC system, the harvesting schedule of established alfalfa prevents seedbank inputs without reliance on herbicides. Overall, these results indicate



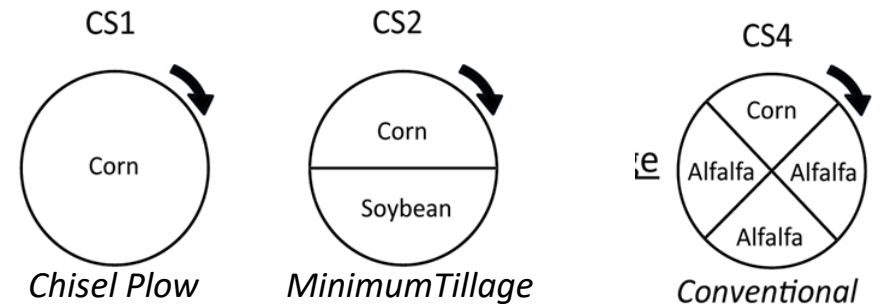
To summarize established alfalfa controls weeds by

- Early emergence of alfalfa in spring
 - Few annual weeds emerge before alfalfa
- Fast growth/canopy closure
 - Few annuals can outgrow established alfalfa
- Frequent mowing (2-5 times /yr in midwest)
 - Few annuals can produce viable seed
- Ability to add management to further improve control



What benefit does alfalfa provide?

Use data from Wisconsin Integrated Cropping Systems Trial (WICST) 1989-2024



- Corn (CS1)
- Corn / Soybean (CS2)
- Corn / 3 years Alfalfa (CS4)

Weeds aggressively managed in each system

What are the common weed species?

Almost all annuals

75% annual broadleaf weeds

- 1. Lambsquarter
- 2. Redroot pigweed
- 3. E. Black nightshade

25% annual broadleaf weeds

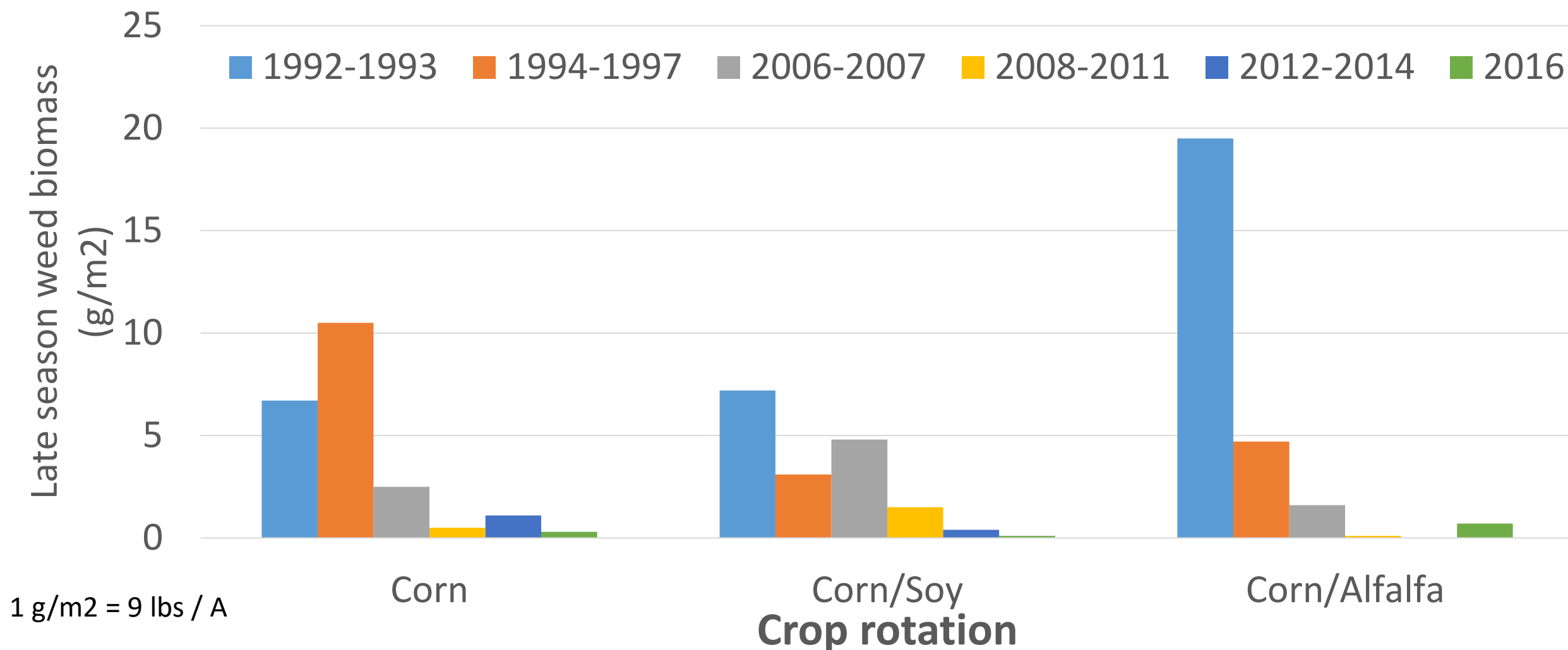
- 1. Fall panicum
- 2. Giant, yellow, and green foxtail

Common name	Latin binomial name	Bayer code
Barnyardgrass	Echinochloa crus-galli (L.) Beauv.	ECHCG
Broadleaf plantain	Plantago major L.	PLAMA
Common lambsquarters	Chenopodium album L.	CHEAL
Common ragweed	Ambrosia artemisiifolia L.	AMBEL
Dandelion	Taraxacum officinale G.H. Weber ex Wiggers	TAROF
Eastern black nightshade	Solanum ptychanthum Dunal	SOLPT
Fall panicum	Panicum dichotomiflorum Michx.	PANDI
Foxtail, giant	Setaria faberi Herrm.	SETFA
Foxtail, green	Setaria viridis L. Beauv.	SETVI
Foxtail, yellow	Setaria pumila (Poir.) Roemer and J.A. Schultes	SETLU
Ladysthumb	Polygonum persicaria L.	POLPE
Large crabgrass	Digitaria sanguinalis (L.) Scop.	DIGSA
Redroot pigweed	Amaranthus retroflexus L.	AMARE
Shepherd's-purse	Capsella bursa-pastoris (L.) Medik.	CAPBP
Velvetleaf	Abutilon theophrasti Medik.	ABUTH
White campion	Silene latifolia Poir.	MELAL
Other broadleaf species ^a		OTHBL
Other grass species ^b		OTHGR

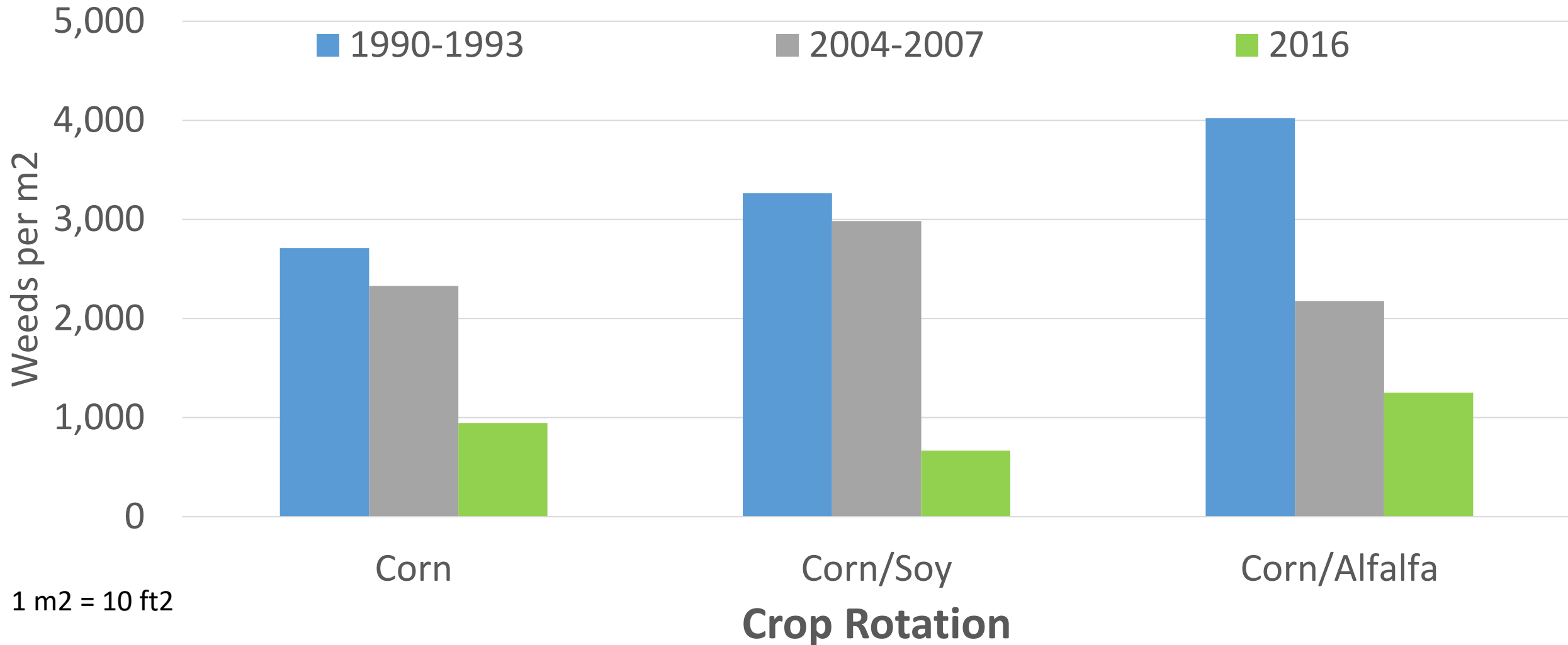
Measured changes in weed populations at intervals over-time

- **Late season weed biomass:** Estimate of effectiveness of weed control measures
 - Biomass collected prior to harvest
- **Weed density in the seedbank:** Estimate of change in weed populations
 - Collected soil samples and estimated viable seedbank from GH germination
 - ALWAYS COLLECTED AFTER CORN PHASE!

Late season weed biomass over 27 years of crop rotation



Weed seedbank over 27 years of crop rotation



Which weed species with alfalfa

- Dandelion (*Taraxacum officinale*)
- Shepherd's-purse (*Capsella bursa-pastoris*)
- fall panicum (*Panicum dichotomiflorum*)
- white campion (*Silene latifolia*)

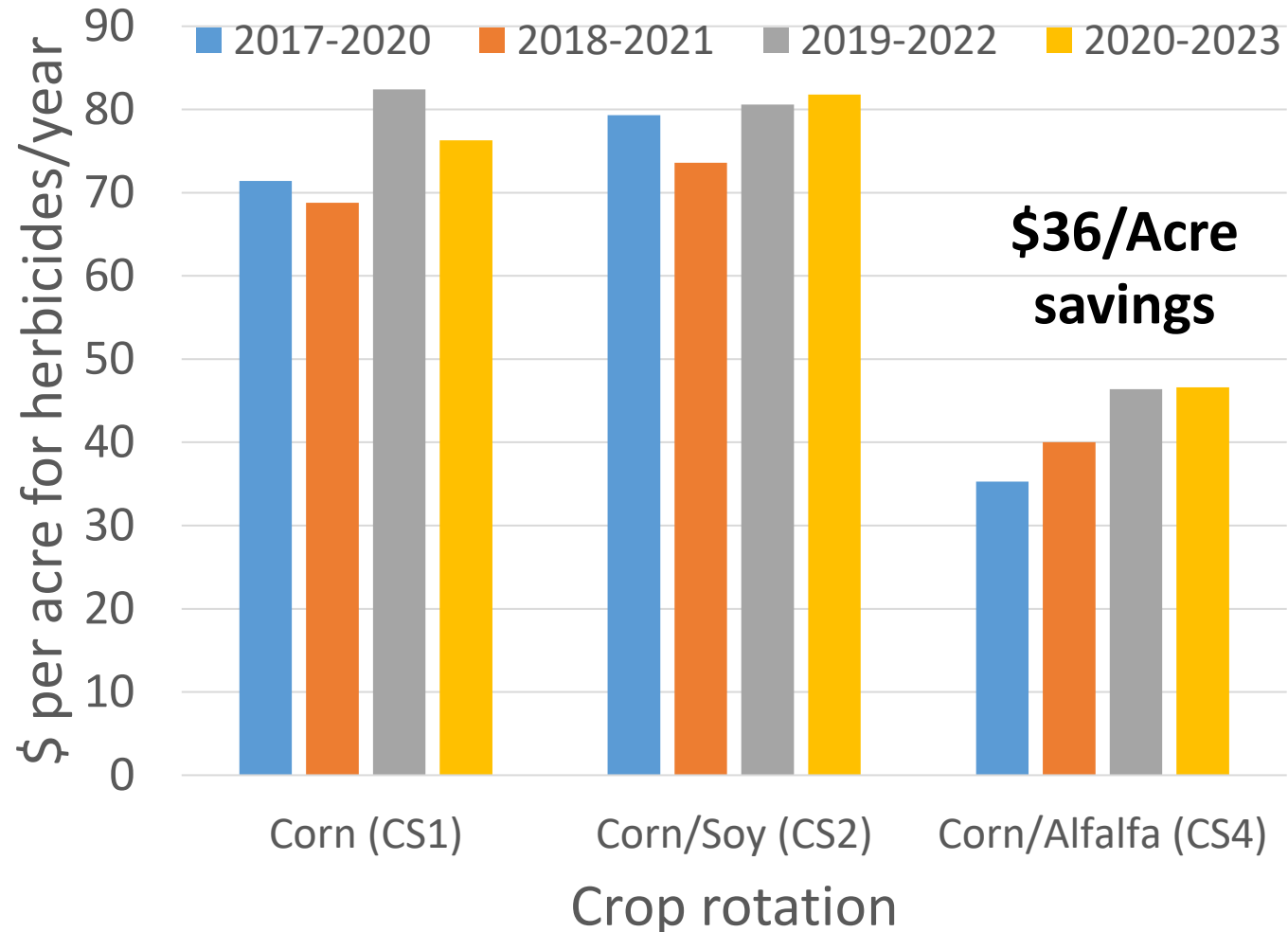


Conclusions

- after 27 years: weed competition and weed seedbank **were similar** across three crop rotations
 - Late season weed biomass = VERY LOW!
 - Weed seedbank = LOW
- Improvements over time driven by improved weed management tools in corn/soy
 - No changes in weed management practices in alfalfa rotation

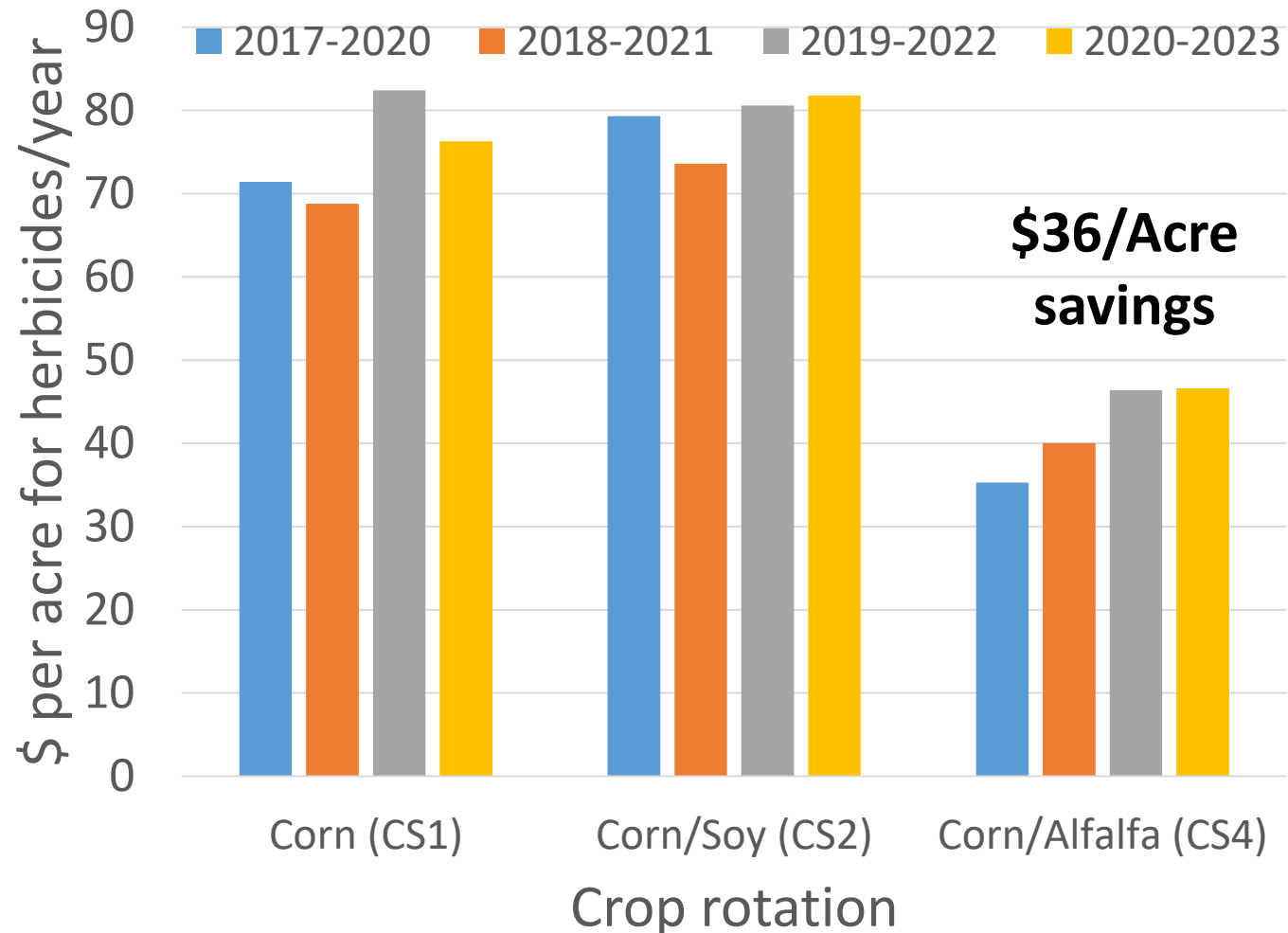
If no benefit from alfalfa in weed management, why am I talking about this?

- Costs to manage weeds are much less when alfalfa is included in the rotation
- Summarized costs OF HERBICIDES in WICST trials
 - 2017-2020
 - 2018-2021
 - 2019-2022
 - 2020-2023



Why the difference in cost? FEWER APPLICATIONS

- Corn and corn/soy applied herbicides 2-3 x per year
- Alfalfa herbicides applied 1 x per year
 - 1st: 1-2 POST
 - 2nd : 30% of time
 - 3rd :
 - 40% of time POST
 - 100 % of time burndown



How does this look at a farm scale: Arlington Research station

- Acres used for calculations 1,415 acres
 - Corn 712
 - Soybean 309
 - Alfalfa 394
 - Est 332
 - new seeding 62
- Herbicides + application for alfalfa cost
 - \$25 less than corn
 - \$35 less than Soybean



Summary

- Alfalfa has the potential to reduce weed populations
 - Especially effective on hard to kill/herbicide resistant weeds
- Weeds can effectively be managed in Corn/Alfalfa systems for less \$\$
 - Very Low weed biomass
 - Savings of \$25-45 per acre
- Seedbank when including alfalfa in rotation was similar in WICST
 - Manure added to alfalfa = more weed seed
 - Seed sampled AFTER corn phase
 - Less competitive weeds present?
- Reduced potential to develop herbicide resistance or cost to manage resistant weeds

How much more will it cost to manage herbicide resistant weeds?



cost to manage glyphosate resistant weeds



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Managing glyphosate-resistant weeds can significantly increase weed control costs, with estimates suggesting an increase of several times the price of standard glyphosate application due to the need for more complex herbicide mixtures, often resulting in a cost increase of **\$30-\$100 per acre** depending on the level of resistance and specific weed species involved. [Link](#)

Key points about the cost of managing glyphosate-resistant weeds:

Higher herbicide costs:

Switching to alternative herbicides with different modes of action to combat resistance often means using more expensive products. [Link](#)

Multiple applications:

To effectively control resistant weeds, farmers may need to apply herbicides multiple times throughout the growing season, increasing application costs. [Link](#)



Herbicide Options for Managing Glyphosate-resistant ...

Mar 1, 2018 — Herbicide Options for Managing Glyphosate-resistant Common Ragweed in LibertyLin...



The cost of implementing effective herbicide mixtures for resistance ...

Glyphosate resistance (SOA Group 9) has minimal impact on the cost of weed control (increasing the co...



Challenges to successful alfalfa establishment

- Site specific
 - Soil type
- Agronomic
 - Seed to soil contact
- Weather
 - precipitation
- Pests
 - aphanomyces



National alfalfa agronomist: ***“Over 50% of establishment failure complaints are due to herbicide carryover”***

What is herbicide carryover?

- Persistence of residual herbicide from the previous crop that injures establishing alfalfa



What are the symptoms of herbicide carryover injury?

Obvious symptoms

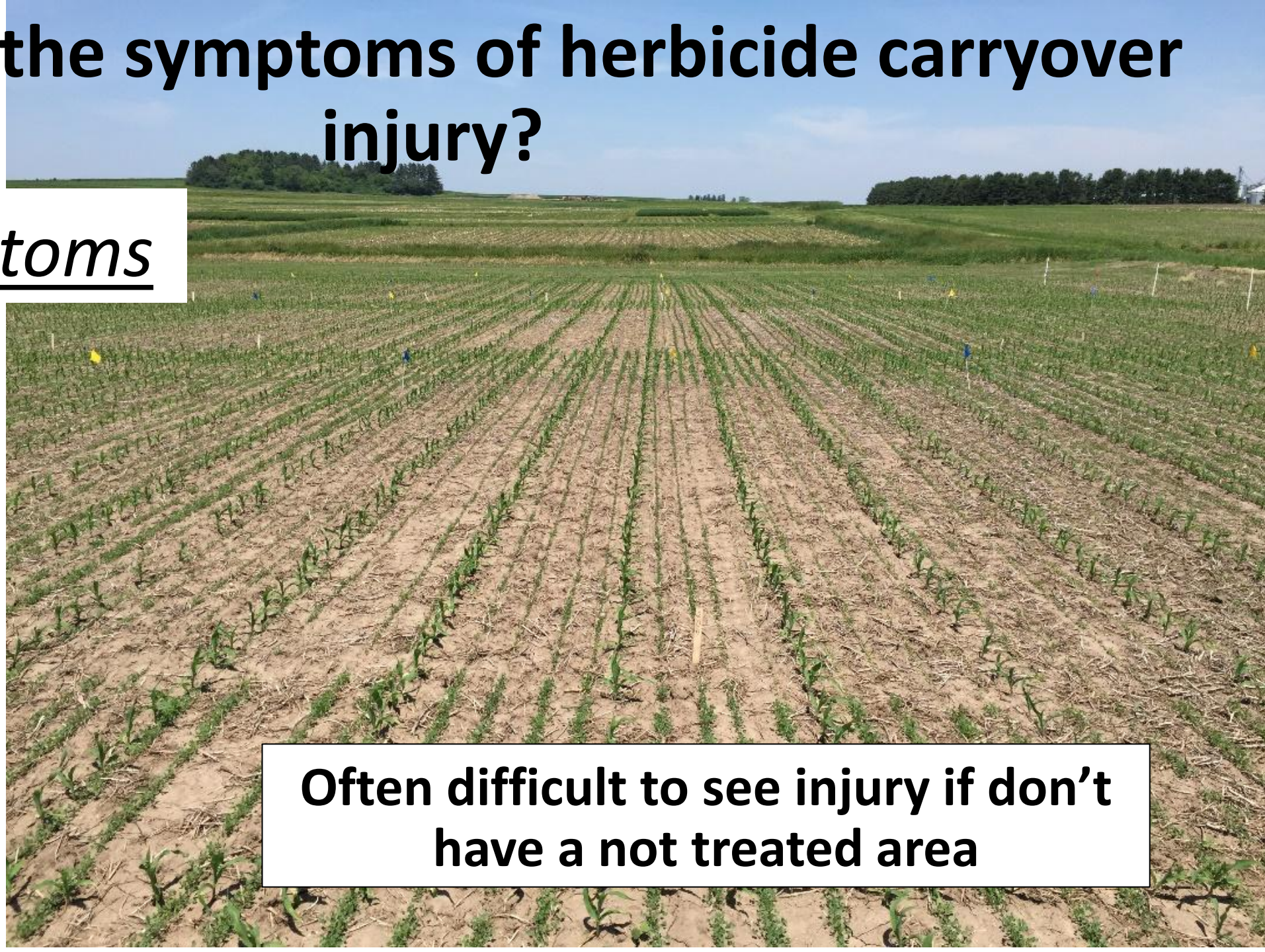
- Yellowing, Bleaching
- Leaf malformation, Dead leaves/shoots



What are the symptoms of herbicide carryover injury?

Subtle symptoms

- Yellowing
- Reduced shoot growth
- Root pruning
- Reduced root growth



Labels always have provided guidance

- Plant-back restrictions
 - required for registration
- Sometimes wording confusing
- Easy to forget when applied when planning for next year



Crop	Rotational Interval ²	Minimum Precipitation Requirement ¹
Field corn	0 Months	None
Wheat, Triticale, Cereal and rye	4 Months	None
Barley, Soybean, Sweet corn ³ , Popcorn ³	9 Months	15 inches of cumulative precipitation from application to planting of rotational crop
Rice ³ , Cotton ³	10 Months	15 inches of cumulative precipitation from application to planting of rotational crop
Peanuts ³	11 Months	15 inches of cumulative precipitation from application to planting of rotational crop
Tobacco ³	12 Months	15 inches of cumulative precipitation from application to planting of rotational crop
Alfalfa, Green and Dry Beans, Oats, Sorghum ⁴ , Sunflower, Canola, Potato, Sugar beet and all other crops ⁵	17 Months ³	30 inches of cumulative precipitation from application to planting of rotational crop

- ¹. The amount of cumulative precipitation required before planting a rotational crop is in addition to the required rotational interval given in months. Furrow or flood irrigation should not be included in total. No more than 7 inches of overhead irrigation should be included in total.
- ². Crop varieties planted back at intervals of one year or less should not have known acute sensitivity to ALS-inhibiting and/or SU herbicides.
- ³. When soil pH is 7.5 or above crop plant back should be delayed to the next interval, and to 24 months for crops listed in the 17 month interval above.
- ⁴. For CORVUS Herbicide used at 2.25 fl. oz. per acre or less and the total of Thienencarbazone-methyl from all sources is 0.014 pounds active ingredient per acre or less, sorghum can be planted at the 9 month or longer interval.

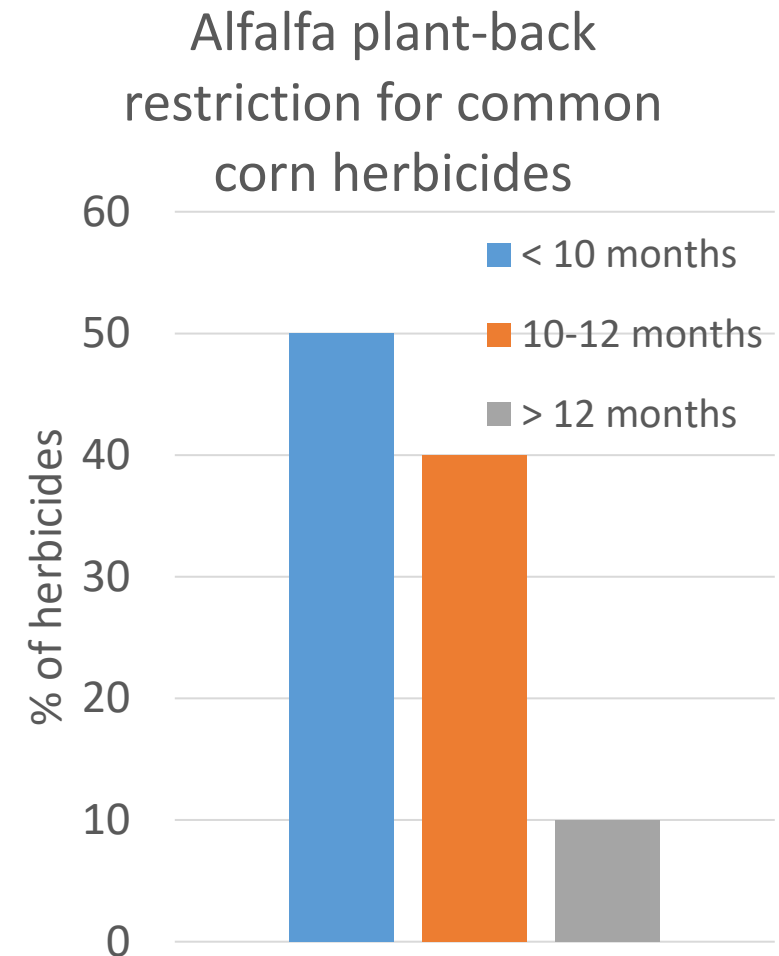


AAtrex[®]4L

Rotational Crops – All Uses: (1) Do not rotate to any crop except corn or sorghum until the following year, or injury may occur. (2) If applied after June 10, do not rotate with crops other than corn or sorghum the next year, or crop injury may occur. (3) In the High Plains and Intermountain areas of the West where rainfall is sparse and erratic or where irrigation is required, use only when corn or sorghum is to follow corn or sorghum or when a crop of untreated corn or sorghum is to precede other rotational crops. (4) In eastern parts of the Dakotas, KS, western MN, and NE, do not rotate to soybeans if the rate applied to corn or sorghum was more than 4 pts./A of AAtrex 4L or equivalent band application rate, or soybean injury may occur. (5) Injury may occur to soybeans planted the year following application on soils having a calcareous surface layer. (6) Do not plant sugar beets, tobacco, vegetables (including dry beans), spring-seeded small grains, or small-seeded legumes and grasses the year following application, or injury may occur.

So why increased herbicide carryover in alfalfa now?

1. More residual herbicides are being used in crops rotated with alfalfa
 - Tend to have longer plant-back restrictions
2. Residual herbicides are being applied mid-season
 - Herbicide resistance weed management
3. Weather
 - Drought increases persistence
 - Precip. delayed applications
4. Frequency of application
 - May increase persistence



What active ingredients should we be concerned about?

Corn

Alfalfa Rotational Restrictions for Herbicides Used in Wisconsin Corn Production

Rotational restrictions for select herbicides commonly used in Wisconsin corn production based on those found in UW-Ext. pub. A3646. Only intervals ≥ 8 months presented, assuming spring seeding of alfalfa following a corn crop the previous year.

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Herbicide - Trade Name	Alfalfa Interval	Comments/Restrictions
Aatrex	See Note	Do not plant the year following application, or injury may occur.
Accent Q	10M	Differs outside Wisconsin, see label.
Acuron	18M	
Acuron Flexi	10M	If applied after June 1, rotating to alfalfa the following year may result in crop injury.
Acuron GT	10M - 18M	If soil pH is ≤ 6.0 or $\leq 18"$ of rainfall + irrigation between application and planting, interval is 18M. If applied after June 30th, rotating to alfalfa may result in crop injury.
Anthem	10M	

Soybean

Alfalfa Rotational Restrictions for Herbicides Used in Wisconsin Soybean Production

Rotational restrictions for select herbicides commonly used in Wisconsin soybean production based on those found in UW-Ext. pub. A3646. Only intervals ≥ 8 months presented, assuming spring seeding of alfalfa following a soybean crop the previous year.

Rotation intervals, notes and footnotes have been compiled here for convenient reference. **Always refer to label** on original packaging when making final management decisions.

Herbicide - Trade Name	Alfalfa Interval	Comments/Restrictions
Afforia	4M - 10M	See label; Interval based on rate applied, tillage performed and rainfall between application and planting.
Anthem	10M	
Anthem Maxx	10M	
Authority Assist	12M	
Authority Edge	12M - 24M	12M interval. If lacking adequate soil moisture following application, interval extended one additional year & bioassay required.
Authority Elite	12M	
Authority First	12M	

Wheat

Alfalfa Rotational Restrictions for Herbicides Used in Wisconsin Wheat Production

Rotational restrictions for select herbicides commonly used in Wisconsin wheat production based on those found in UW-Ext. pub. A3646. Only intervals ≥ 4 months presented.

Rotation intervals, notes and footnotes have been compiled here for convenient reference. **Always refer to label** on original packaging when making final management decisions.

Herbicide - Trade Name	Alfalfa Interval	Comments/Restrictions
Callisto	10M	
Clarity	4M	
Huskie	4M	Thorough tillage prior to planting and minimum 12" rainfall/irrigation required between application and seeding.
Huskie Complete	9M	Thorough tillage prior to planting and minimum 12" rainfall/irrigation required between application and seeding.
Orion	9M	
Starane Flex	4M-9M	May be planted 4M after application if total rainfall + irrigation > 10"; If < 10" rainfall, 9M.

<https://cropsandsoils.extension.wisc.edu/articles/alfalfa-herbicide-rotation-restrictions/>

How can you minimize the impact?

1. **Follow label restrictions**

- Apply the labeled rate
- Follow plant-back restrictions (FOOTNOTES)

2. Note climate between application and next crop

- Dry conditions, hot temperature

3. Rotate active ingredient to avoid buildup in soil

4. Work the soil

- Dilute herbicides, increase degradation

5. Plant cover crops?



We benefit when alfalfa is included in the rotation!

- ESTABLISHED ALFALFA PROVIDES BENEFITS

- Agronomic

- Yield, reduced problematic weeds, improved animal health

- Environmental

- Soil health, increased
- reduced nutrient/soil/water runoff

- Economic

- Less weed management costs

Thank you.... Questions?

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<https://renzweedscience.cals.wisc.edu/>

<https://cropsandsoils.extension.wisc.edu/article-topic/alfalfa/>



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