

2022 Survey Results

Most common weeds

- 1. Giant ragweed 12%
- 2. Waterhemp 11%
- 3. Marestail 10%
- 4. Grass/foxtail 9%
- 5. Volunteer corn 8%



57% of fields were clean





Waterhemp

Driving Survey

2022

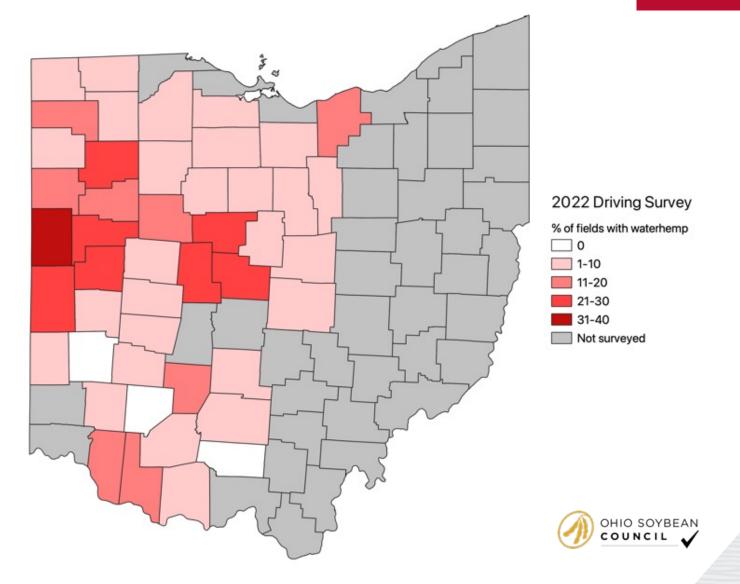
> WH 11% of fields

2021

> WH 7% of fields

2020

Pigweeds 8% of fields



Redroot and smooth pigweed

- Hairy stem and leaves
- Rough, egg-shaped leaves
- Petioles often shorter than leaf
- Smooth pigweed similar with more sparse hair



Powell amaranth

- Sparsely hairy stem
- Diamond shaped leaves
- Petioles can be longer than leaf



Spiny amaranth

- Hairless stem and leaves
- Long ovate leaves
- May have watermark
- Spines on leaf nodes







Palmer amaranth

- Hairless stem and leaves
- Egg-shaped leaves
- Petioles often longer than leaf
- Native to Southwest US and N Mexico

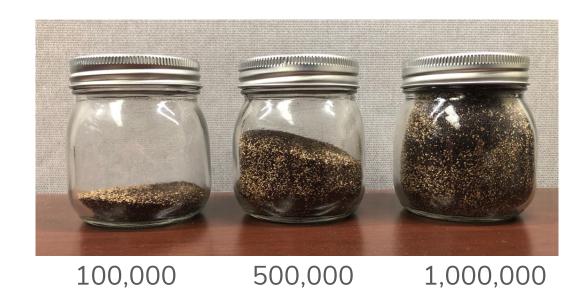


Waterhemp

- Hairless stem and leaves
- Long narrow leaves
- Petioles often shorter than leaf
- Native to the Midwest



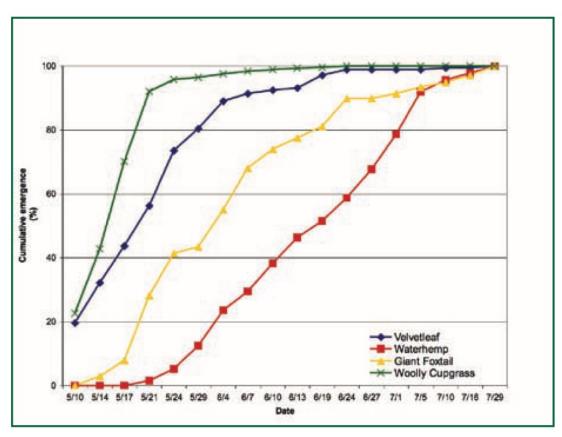
- Immense seed production
- Fast growth rate
- Prolonged emergence window
- High genetic diversity
- Herbicide-resistance



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Hartzler 1999

Waterhemp biology

- Immense seed production
- Fast growth rate
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https://iwilltakeaction.com/weed/common-waterhemp

- Immense seed production
- Fast growth rate
- Prolonged emergence window
- High genetic diversity
- Herbicide-resistance

Confirmed Sites of Action

2 (ALS), 9 (glyphosate)



Herbicide resistance

Site of action	Waterhemp
2 - ALS	Y
4 – Auxin	Maybe**
5 - PSII	Y
9 - Glyphosate	Y
14 - PPO	Y
15 - VLCFAI	Probably**
27 - HPPD	Probably**

M. Loux



Prevention

- Contaminated equipment
- Livestock feed/manure
- CREP/cover crop seed



Applications

Spring residual**

Timely POST

Overlapping residual

Target application	Waterhemp/ Palmer
Fall burn	_
Spring burn	Not usually
Spring residual	Y
POST	Υ
POST residual	Υ
2 nd POST	Possibly

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No resistance

Rating of 8 or 8+

- Flumioxazin
- Metribuzin (>0.38 lb)
- Sulfentrazone
- Pyroxasulfone
- Isoxaflutole (Alite 27)

Rating of 7 or 7+

- Metolachlor, s-metolachlor
- Dimethenamid
- Pendimethalin
- Acetochlor
- Linuron (Lorox)

PPO resistance (Group 14)

Rating of 8 or 8+

- Metribuzin (>0.38 lb)
- Pyroxasulfone
- Isoxaflutole (Alite 27)

Rating of 7 or 7+

- Metolachlor, s-metolachlor
- Dimethenamid
- Pendimethalin
- Acetochlor
- Linuron (Lorox)
- Flumioxazin
- Sulfentrazone

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PPO and VLCFA resistance (Group 14 and 15)

Rating of 8 or 8+

- Metribuzin (>0.38 lb)
- Isoxaflutole (Alite 27)

Rating of 7 or 7+

- Pendimethalin
- Linuron (Lorox)
- Flumioxazin
- Sulfentrazone

Residual herbicides - add to POST for extended control of waterhemp, Palmer in soybeans

More effective

- Pyroxasulfone*
 - Zidua, Anthem Maxx, Perpetuo
- Metolachlor/s-metolachlor
 - Dual II Magnum, Parallel, etc
- S-metolachlor/acetochlor + fomesafen
 - Warrant Ultra, Prefix/Vise

Less effective

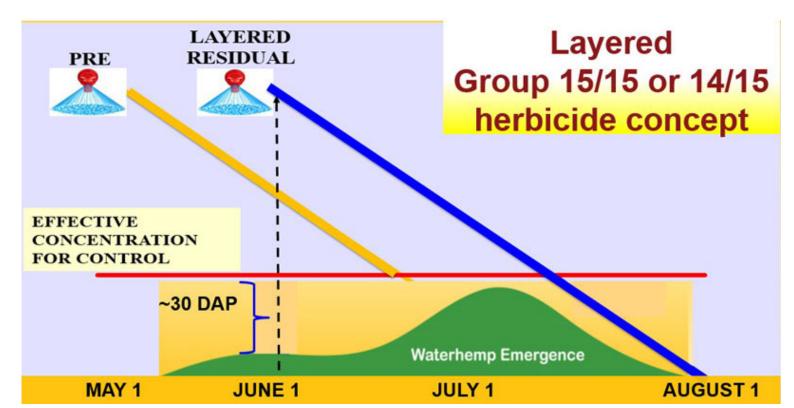
- Acetochlor
 - Warrant
- Dimethanamid
 - Outlook

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Layered/overlapping residual herbicide

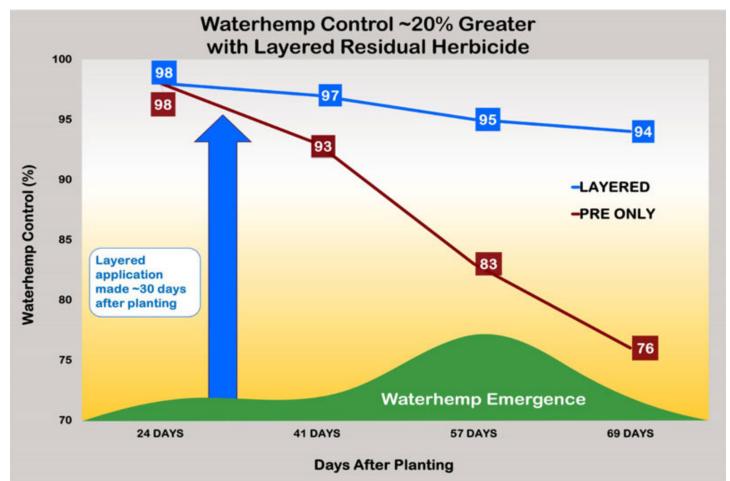
At plant + 30 days later



University of Minnesota



Layered residual herbicides



University of Minnesota



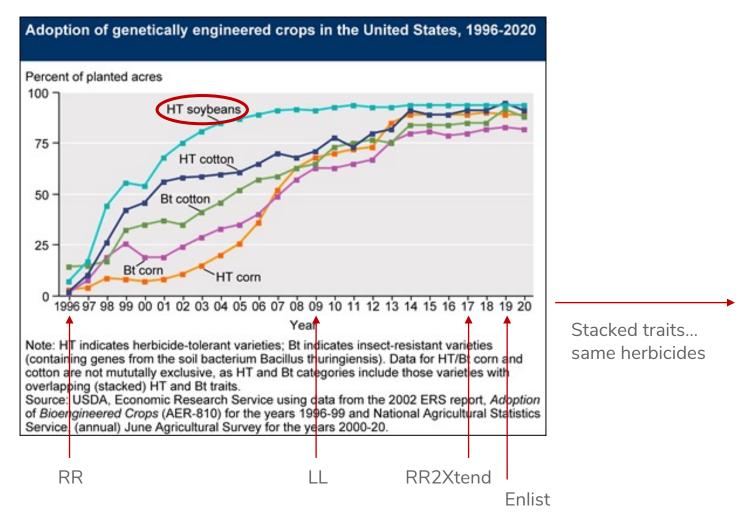
Effectiveness of soybean trait systems

System	Waterhemp/Palmer
nonGMO	P-G
RR	P-G
LibertyLink	G
LL-GT27	G
Xtend	G
XtendFlex	E
Enlist	E

M. Loux



How we've addressed weeds in soybean production



DEALING WITH HERBICIDE RESISTANCE

Proactive vs reactive

How do we combat the current situation and prevent future instances of resistance?



Integrated pest management

"Many small hammers"

Biological control

Cultural controls

Mechanical controls

Chemical control



Cover crops

One of many small hammers needed in fighting herbicide resistant weeds



Cover crop benefits

Reduce erosion

Build organic matter

Decrease nutrient losses

Improve infiltration

Increase soil biodiversity

Habitat for beneficial insects & fungi

Suppress weeds







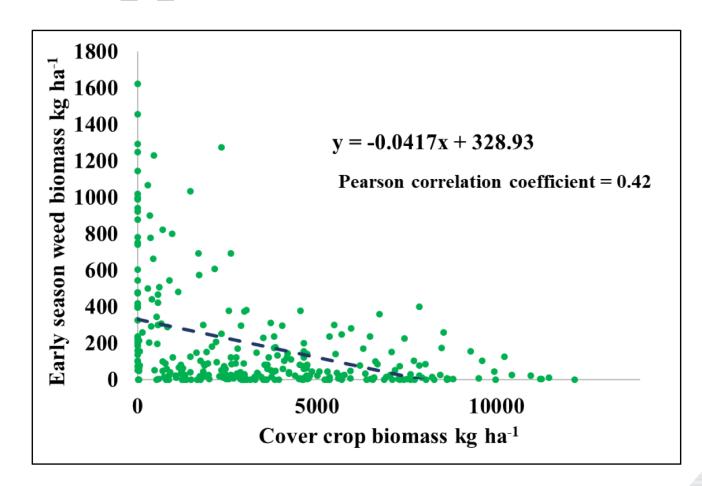
- Physical suppression
 - Mulch layer hinders germination & growth
- Competition
 - > Lights, nutrients, water
- Allelopathy
 - Chemical compounds inhibit germination & growth
- Termination
 - Spraying, mowing, tilling cover crop
- Alter seed environment
 - Soil moisture, temperature, light, pests





Two main drivers

Biomass (lb/A)



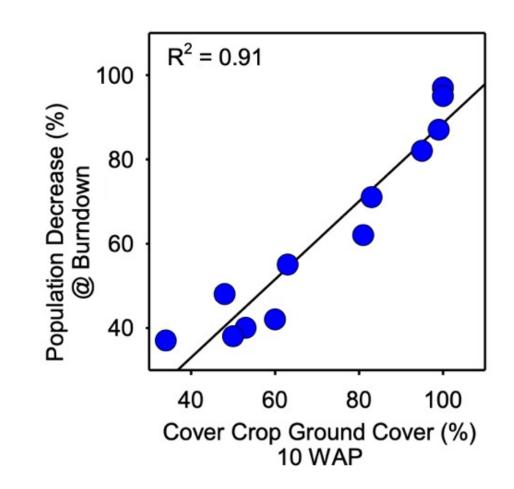
Johnson 2021



Two main drivers

Biomass (lb/A)

Ground cover (%)



Wallace et al. 2019



- Reduction in number and size of weeds
- Herbicide-resistance management
 - Lower weed density = less weeds exposed to herbicides
 - Smaller weeds = longer window of control
 - Potential to reduce herbicide inputs



No cover crop vs. cereal rye



Environmental factors

GDD

Cover crop growth

Time of weed emergence

Weather patterns

Cover crop growth

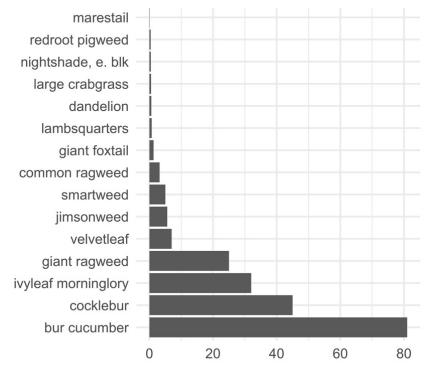
Field operations

Soil fertility

Weed species

Life cycle, seed characteristics, emergence patterns

SEED MASS (mg)



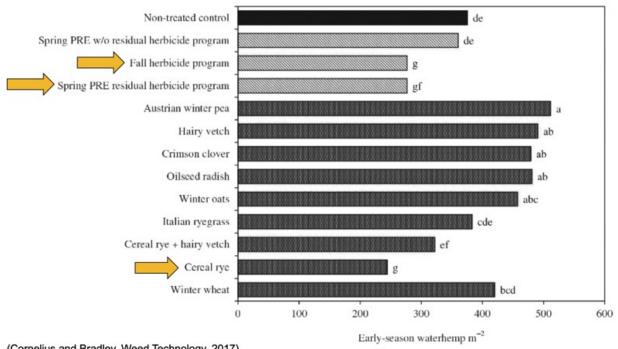
Wallace 2020



Cultural

- Fall-seeded cover crops
- Row spacing

Cereal Rye and residual herbicide programs had similar effects on early-season waterhemp emergence (results summarized across 5 sites in 2 years in Missouri)



(Cornelius and Bradley, Weed Technology, 2017)

Cover crops

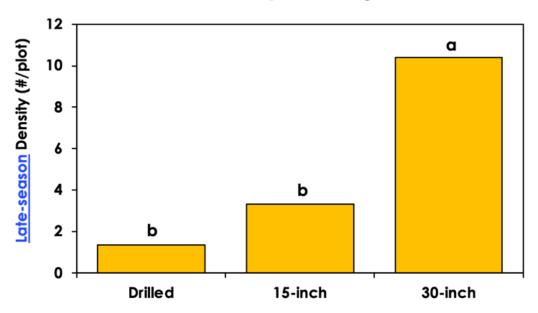
- One part of a comprehensive weed management program
 - > IPM and chemical control strategies
 - Systems approach needed to manage herbicide resistance
- Effectiveness depends on management and environmental factors
- Most successful when implemented in a tailored plan
 - Year by year, field by field
- The effects of cover cropping compound over time, benefits realized with continued use
 - > A 401k for your fields



Cultural

- Fall-seeded cover crops
- Row spacing

Effects of soybean row spacing on waterhemp density



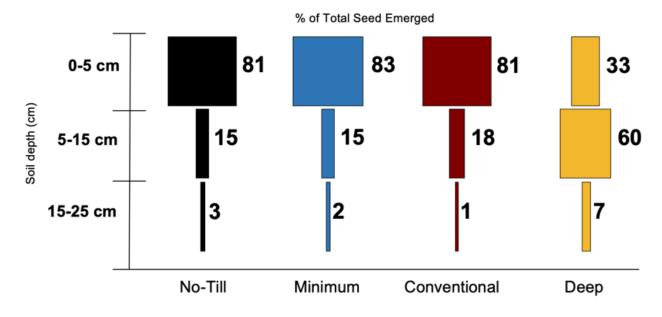
^{*}Results summarized across herbicide programs, tillage types, and planting populations.

© Dr. Kevin Bradley, University of Missouri

^{**}Means followed by the same letter are not different, P≤0.05

Mechanical

Conventional and minimum tillage were not effective in burying *Amaranthus* seed



K. Bradley

*Across 4 Site-Years (Farmer et al. 2017) Tillage Treatment



Monitor

- Escapes are likely
- Scouting & ID
- Remove plants before they set seed***



Waterhemp

The Achilles Heel

- Short-lived seeds, control over 3-5 years can eradicate waterhemp
- Go Rogue, Stop the Seed



Cover crop fact sheet series





Cover crops are grown in rotation with cash crops during

cropping system, cover crops can also be grazed or harvested, assuming herbicide rotation restrictions are followed, or grown for seed. Some herbicides allow cover crops to be fed to cattle, while others don't.

Cover Cron Benefits

Build organic matter and biodiversity in the soil. Decrease nutrient loss from leaching and runoff Provide habitat for beneficial insects and fungi.

Species Selection

to first identify goals of using the cover crop. Species selection will largely depend on the desired outcomes. There is often a species or mix of species that addresses the primary goals of cover cropping.

The main objectives for cover cropping may vary based on conditions at different field sites, crop rotation sequence, length of growing season and time of year. Although many species have overlapping benefits, a primary objective of fixing nitrogen, for example, may ultimately lead to a different species than aiming to suppress weeds.

Much like contributing to a 401(k), the benefits of cover

reasons growers use cover crops, second only to soil health.

cover crops can be an additional tool for implementing integrated pest management strategies. By reducing the size and number of weeds present at the time of the POST

Cover crops compete with weeds for resources such as light, nutrients and water. Some cover crop species produce high play a role in suppressing small-seeded weeds.

· In general, weed suppression by cover crops increases as

terminated, the more biomass is produced. · Planting a crop just before or after cover termination leads

Biomass production is also dependent on environn

that can impact a cover crop's ability to suppress weeds Some species, such as legumes and brassicas, are most



Cover Crops for Weed Management:



. Timely cover crop establishment allows for the higher establishment and growth.

· Planting method and seed quality are two factors a farmer establishment. Test seed for germination and screen for weed

Along with planting date and method, seeding rate is an important management factor to consider in cover crop-



The planting date that will maximize weed suppression is rotation, tillage system and weather.

Grass species such as cereal rue and wheat have a relativel flexible planting window and can tolerate planting date

biomass and ground cover before the first frost. Brassica and legume species require planting by early fall to establish

planting dates than winter-hardy grass species, and winter-hardy grass species can dominate late-planted

planted winter annual cover crops, but this does not always

application (broadcast) allow for establishment prior to cash crop harvest.

when sunlight still reaches the soil surface to facilitate

before harvest. Farmers can broadcast seed into soybeans around leaf drop or into corn nearing maturity.

seedbed or broadcast on the soil surface.

Depending on crop rotation, some cover crop species can also be established in early spring or summer. In cool regions, some species (such as red clover) can be frost



Cover Crops for Weed Management:



Terminating, or killing, cover crops using the right methods in the right time frame is important to ensure maximum cash crop yield. Excessive competition from the cover crops can hinder early growth of cash crops and increase risk of

planting, depending on crop rotation and grower preference Cover crop species, growth stage, weather and cover cropping goals should all be considered when planning a termination method and timing. These decisions require a balance between growing the cover long enough to maximize benefits and terminating in time to avoid negatively affecting



· The use of winter-killed cover crop species can simplify spring management. Summer- and fall-planted cover crops that die naturally over the winter in much of the Midwest include oats, sorghum-sudangrass, tillage and offseed radish, turnips and winter peas (if planted before September in cool rectors). On occasion, some species, such as radish

all the management factors, termination timing has the

Delayed termination in the spring can increase cover cro

persistence by slowing the rate of degradation. The high

which can lengthen the window of weed suppression.

carbon-to-nitrogen ratios found in the vegetation of cereal

greatest influence on biomass production.

The use of species that winter-kill provides a shorter period of soil protection, especially if planted after a late harvest.

Weed suppression is also primarily limited to winter annual weed suppression is also primarily immed to winter amus weed species. For this reason, species that winter-hill are often included in some sort of species mixture with grass-legume species that overwinter in order to provide weed suppression and soil protection in the spring.

rolling/crimping and mowing

- Tillage from field cultivators can terminate burying the plant residue and cutting the roots. Vertical
tillage is a less effective termination option, and many types level of control. Strip-tillage can be performed to break up avet or controls, entry-tanger can on personness or becaute presented and increase soil warning in the row. Termination via tillage speeds up the breakdown of residue and incorporates it into the soil. In general, this method of termination can negate some of the benefits associated with

Dollard /

Cover Crops for Weed Management: Herbicide Persistence and Carryover



· Herbicide-resistant weed issues have been escalating in gronomic crop production across the U.S. As a result, armers have increased their reliance on residual herb

· In addition to residual herbicides, cover crops can be a tool for suppressing herbicide-resistant weeds. Cover crops have the potential to reduce the density and size of weeds early in

factors in cover crop adoption. However, herbicide carryover from the provious summer cash cron to suscentible cover in biomass, variable stands or death of the cover crop Any restdual herbicide program used before fall cover crop

establishment should be taken into account when selecting cover crop species. · More research is needed to fully understand the response of

interseeded cover crops (planted in late June through July · When unsure of how an herbicide will interact with a specie

determine possible outcomes. Collect soil from areas that were treated and areas that were not treated in August.



Carryover Rick Factors- External

Herbicides with higher water solubility are more likely to be moved by water deeper into the soil profile following precipitation or irrigation, thus reducing concentration at the

nfluence its ability to be degraded to inactive metabolites by microbial activity or chemical reactions.3

Herbicide half-life, or the amount of time it takes for 50% of the active ingredient to degrade, can be useful when deciding which herbicide within a family to use

The product with the lowest half-life may reduce dama susceptible cover crop species, especially within site of action groups 2 (ALS inhibitors), 14 (PPO inhibitors), 15 (very long-chain fatty acid synthesis inhibitors) and 27 (HPPD inhibitors). More research is needed to better understand cove

organic matter and clay content of soils. As a result, higher cation exchange capacity (CEC) levels are also associated

Low or blob soil nEL can increase or decrease herbicide Soil microbial activity is one of the most important factors

herbicide breakdown and is highest in warm, fertile, aerated softs with relatively neutral pH.

Conversely, herbicide carryover tends to increase normal in the months following application.

These factors vary from year to year and field to field and are at

https://iwilltakeaction.com/news/cover-crop-fact-sheet-series

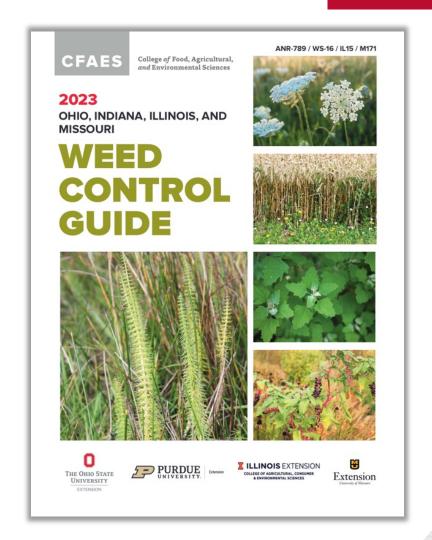


2023 Weed Control Guide

Ohio, Indiana, Illinois, and Missouri

PDF or hard copy + PDF

- OSU Extension eStore
- Local OSU Extension Office



OSU Weed Science Team

CFAES



Dr. Mark Loux



Tony Dobbels



Bruce Ackley



Betsy Cunningham



Emily McCormick



Weed Management Resources

OSU C.O.R.N. Newsletter

http://corn.osu.edu/

OSU Weed Science Website

http://u.osu.edu/osuweeds

2023 Weed Control Guide for OH/IN/IL/MO

OSU Extension ANR-789

OSU Extension eStore

OSU Weed Management Website







