

HERBICIDE-TOLERANT GRAIN SORGHUM

Update

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Acknowledgement: *Brent Bean*, USCP

K-STATE
Research and Extension

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Limited herbicide options

- Controlling grassy weeds postemergence is especially challenging
- Fewer grain sorghum acres compared to corn or soybean
 - Fewer herbicides registered
 - Less interest in transgenic hybrids



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History of HT grain sorghum

- 1999 – ACCase resistant sudangrass found in Bolivia at KSU research facility
- 2003 – ALS-resistant shattercane in KS
- Mid 2000's – KSU moved traits into sorghum lines and licensed to Pioneer
- 2016 – Dupont/Pioneer receive USEPA approval for Zest herbicide
- 2018 – S&W files ACCase-tolerant sorghum patent
- 2019 – igrowth sorghum planted in Australia and Argentina
- 2020 (Dec) – USEPA approves igrowth sorghum
- 2021 – First commercial sale of HT sorghum in the US (igrowth)
- 2022 – DoubleTeam grain sorghum commercially available om US

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Inzen

- Seed from Pioneer/Corteva
 - ≈ \$360/bag
 - Limited availability of P 85Z65
 - 114 CRM / 70 RM

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Zest

- From Corteva
 - ≈\$14/oz
 - Common use rate 0.68 oz/A = \$9.52 per acre
- Active ingredient: nicosulfuron
 - Same a.i. in Accent
 - ALS-inhibiting herbicide
 - Very good activity on grass species, but limited broadleaf activity
 - SU grass resistance may be present in some fields

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igrowth

- Seed from Advanta (Alta)
 - ≈ \$261/bag MSRP
 - Availability: Book early to get the seed you want.

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IMIFLEX

- From UPL
 - ≈ \$380/gal (price varies)
 - \$17.80 to \$23.90 per acre
- Active ingredient – imazamox
 - Same a.i. in Beyond, Raptor
 - ALS-inhibiting herbicide in the IMI subclass
 - Both grass and broadleaf activity
 - Longer residual than the other two technologies
- Apply PRE at 9 oz with an acetamide herbicide
OR
POST at 6 oz following an acetamide PRE treatment

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Double Team

- Seed from S&W (Sorghum Partners)
 - ≈ \$306/bag
 - Seed sold in 600,000 seed/bag
 - Should have a good supply, but book early

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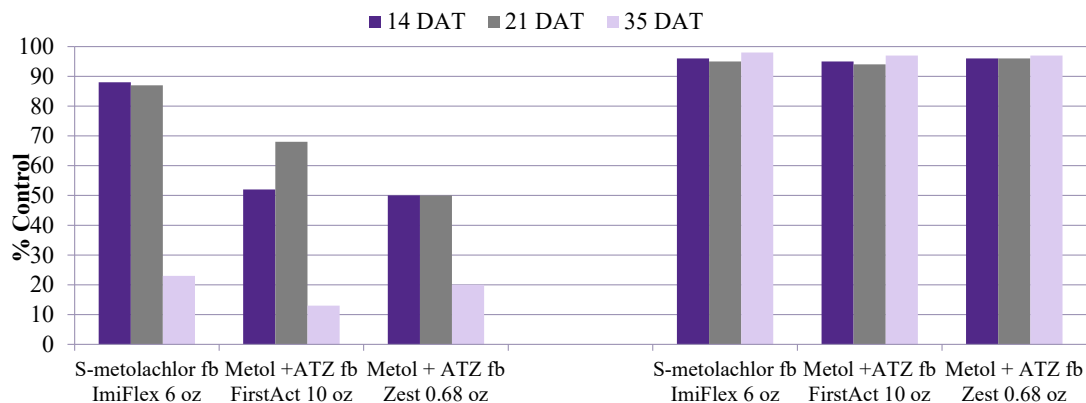
First Act

- From ADAMA
 - ≈ \$1.00/oz
 - Most common use rate 10 fl oz = \$10/acre
- Active ingredient: quizalofop
 - Same a.i. in Assure II, Aggressor
 - ACCase-inhibiting herbicide
 - POST grass control
 - Apply to > 11 inch sorghum for crop safety
 - Do not apply mixed with other herbicides
 - Resistance usually develops more slowly than to ALS chemistries

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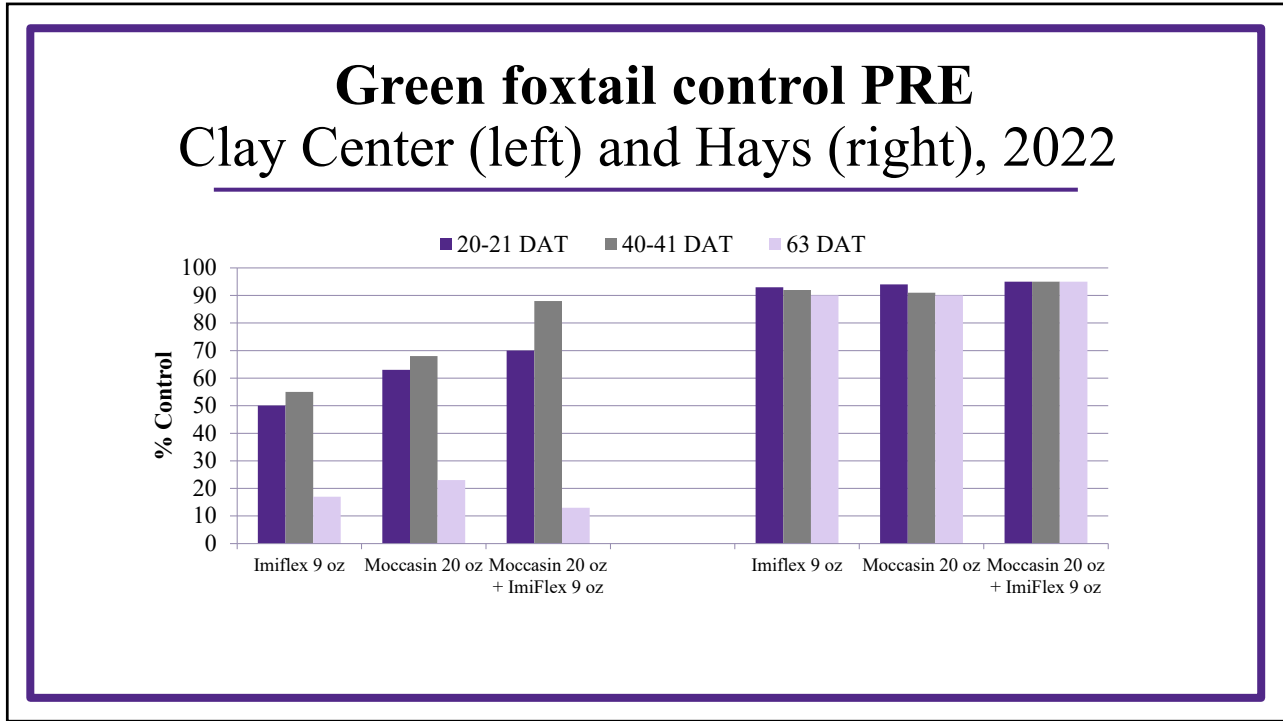
Herbicide Comparison

Green foxtail 4-5" Clay Center, (left) and 4-11" Hays (right), 2022

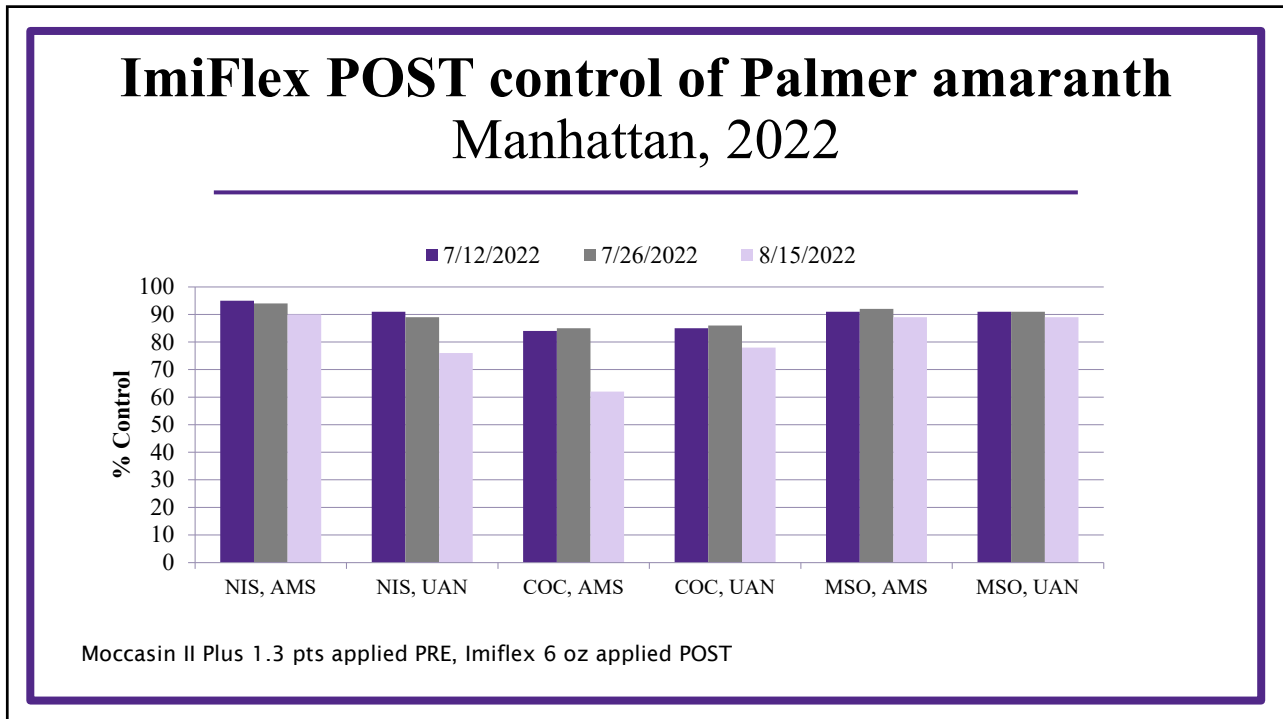


Treatments applied following PRE ATZ, FirstAct applied 1 week later than the other two treatments.

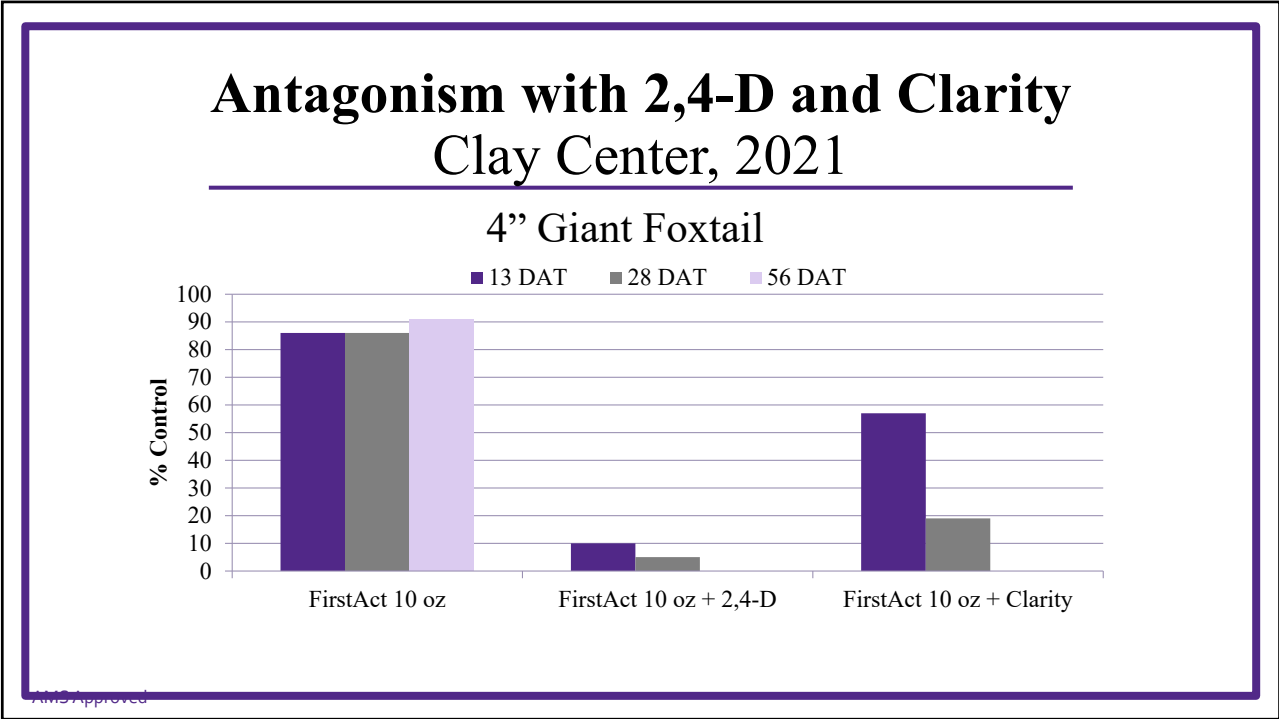
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Summary

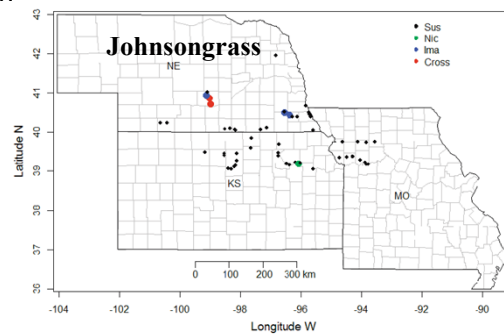
Herbicide	Grp	Timing	Grass	Pigweed	\$/A	Other comments
Nicosulfuron (Zest)	2	POST	Weakest on crabgrass	Good+	10	Availability
Imazamox (Imiflex)	2	PRE or POST	Weaker on crabgrass and sandbur	Excellent+	18 to 24	Adjuvants
Quizalofop (First Act)	1	POST	Generally good to excellent	None	10	Antagonism

+Assuming susceptible biotypes

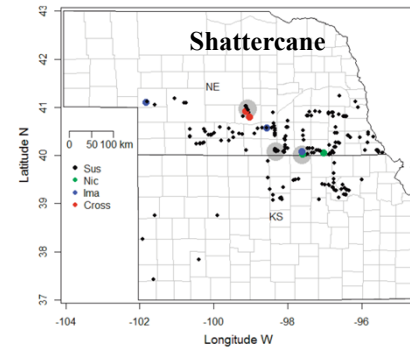
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Why stewardship

- Similar to other herbicide-tolerant crops, good stewardship practices are **CRITICAL** for these sorghum technologies to last!!!
- Resistance developing in johnsongrass and shattercane is of particular concern



Werle et al., 2016



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Gene flow



Johnsongrass and shattercane are both close relatives of grain sorghum – so cross-pollination can occur

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1. Use Pre-emergence herbicide

- Use pre-emergence herbicide containing one of the following Group 15 herbicides:
 - S-metolachlor or metolachlor
 - Acetochlor
 - Dimethenamid



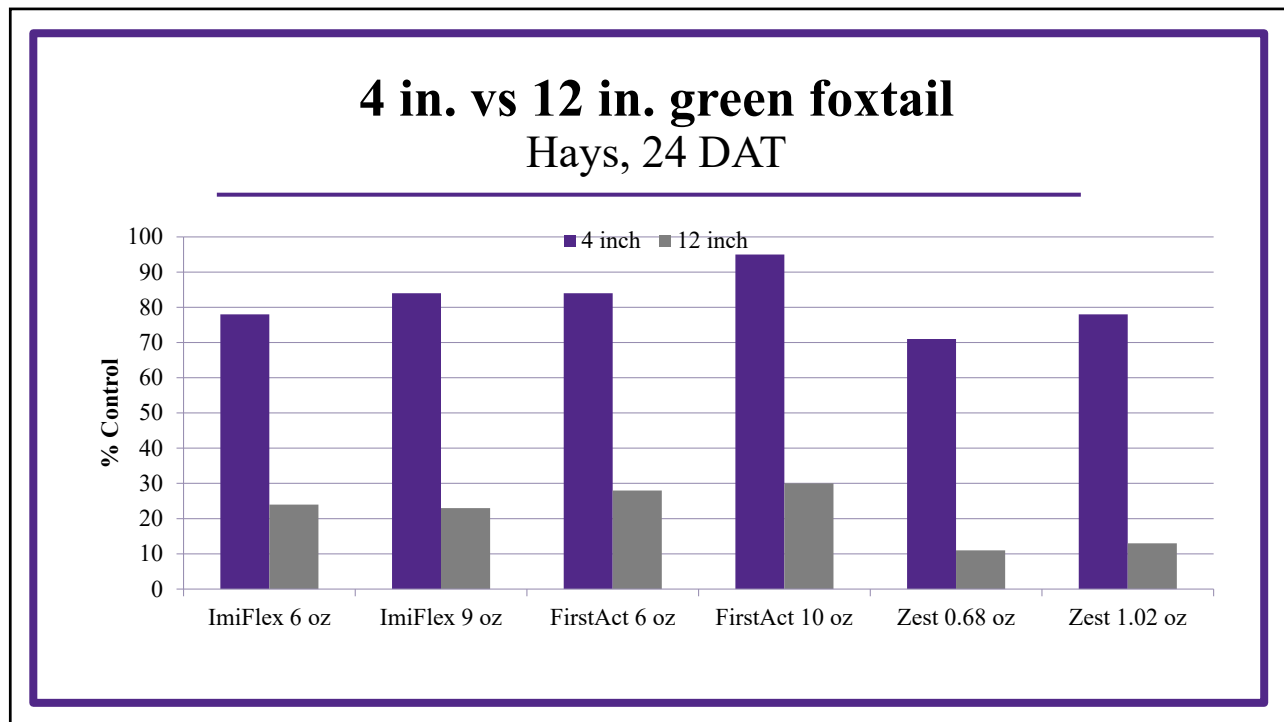
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2. Make application to small grass

- Control grasses when they are small, preferably less than 3 inches tall.



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3. Don't use if resistant plants present

- Do not use if grasses are present in the field that are known to be resistant to the herbicide technology being planned.
- These biotypes will not be controlled and will only get worse unless controlled by other weed control options.



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4. Control johnsongrass and shattercane in field

- Johnsongrass and shattercane no flowering at the same time as the HT sorghum
 - Grain sorghum pollen shed will occur for about 10 days if flowering is uniform
 - Longer if late tillers
 - Shattercane typically flowers for 6 to 22 days
 - Johnsongrass can flower much longer



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5. Control johnsongrass and shattercane near field

- Manage johnsongrass and shattercane in road ditches, fence rows and nearby places
 - Pollen from grain sorghum can travel hundreds of feet
 - There is no set distance from the HT sorghum field in which johnsongrass and shattercane should be controlled
 - The more the better - especially downwind in the prevailing wind direction
 - The goal is to not allow johnsongrass or shattercane to be flowering at the same time as the sorghum
 - Mowing just prior to sorghum flowering will accomplish this goal



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6. Control volunteer sorghum

- Control all volunteer sorghum/off-types in the following year prior to flowering
- Not only does this prevent cross-pollination to nearby johnsongrass and shattercane, but also the establishment of resistant volunteer/feral sorghum in and near the field.



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7. Scout for grass escapes

- If resistance is suspected, treat the escaped grass with a herbicide with a different mode-of-action (or tank mixes) from that used in the initial application and/or use nonchemical methods to achieve control where possible
- An indicator of possible resistance is a failure to control a grass species known to be susceptible to the herbicide used, especially if other adjacent grass of the same species and size were controlled

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8. If Grasses are not controlled

- Contact the crop protection company immediately
 - The company can help with a control plan and if necessary confirm resistance
 - Also, let your local Extension agent know



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9. Consider a harvest aid

- A desiccant at the end of the season can help to control escapes and minimize viable grass seed production



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10. Tarp grain trucks

- Avoid spills along road sides that could lead to volunteer HT sorghum



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11. Rotate crops AND chemistries



Herbicides must be rotated to control any weeds that may be resistant



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Take aways

- HR sorghums will provide additional tools but will not be 'silver bullets'
- HR sorghums will require careful product stewardship
- This presentation does NOT replace label requirements communicated by seed and/or crop protection companies

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Managing
**TUMBLE
WINDMILLGRASS**
Chloris verticillata

Sarah Lancaster

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Outline

Identification

Biology

Control options

Recent research



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Distribution

- Native to low-lying areas of the Central Plains
 - Now found throughout most of the continental US as a weed of roadsides and turfgrass
 - Overgrazing increases abundance, leads to invasion⁺
- Any soil type
- Prefers full sun
- Grows in clumps
 - Can form large colonies



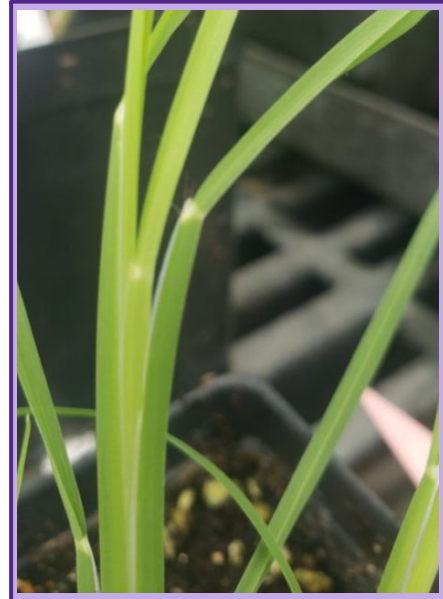
⁺Smith 1940

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Identification

- Leaves are up to 6 inches long and less than 0.1 inches wide
 - Leaves are flat, folded
- Several leaves sheathed together
 - Form a fan shape at the base
- Leaf sheath has membranous margin
- Ligule membrane with short fringe of hairs
 - Fringe of wispy hairs near the ligule

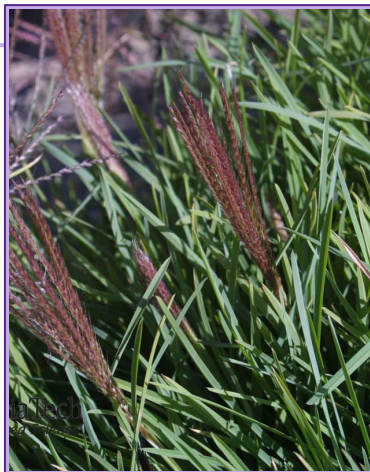


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Identification

- Flowering stalk is about 5 to 15 inches tall
 - 2 to 4 alternate leaves about 3 to 4 inches long
 - Can root at lower nodes
- Panicles have 10 to 16 branches arranged in 2 to 4 whorls
 - About 5 inches tall and 11 inches wide
- Panicle will separate from the stem at the top node

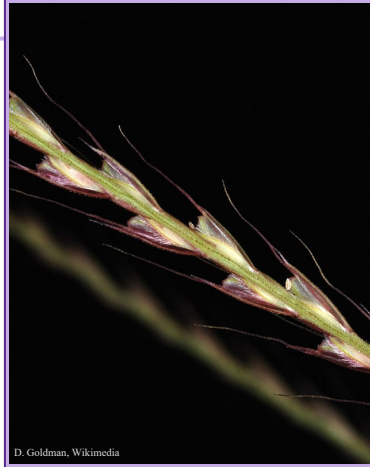


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Identification

- Spikes about 2 to 6 inches long
 - One short terminal branch
- Spikelets are awned with a V-shaped base
 - Green to reddish-green, then tan to brown
- Wind-pollinated
 - Will cross with other *Chloris* species



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Biology

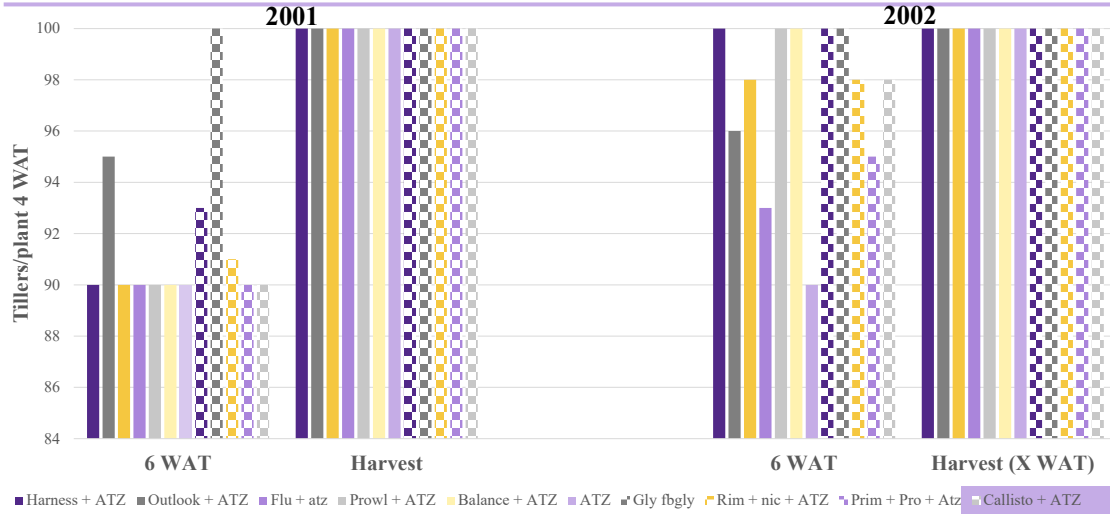
- Warm season
- Perennial
 - Short rhizomes
 - Regrowth from crowns



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1-2” seedling control in the field

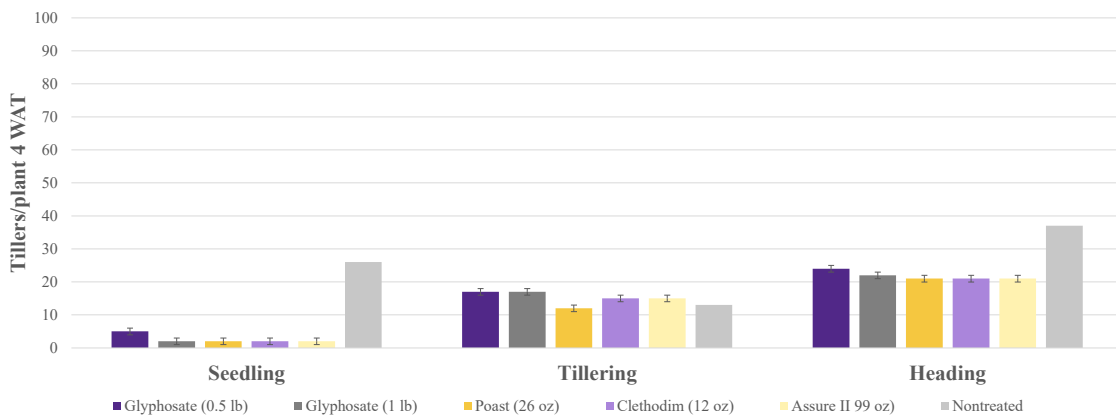


Hennigh et al. 2005

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Control of mature plants more challenging



Hennigh et al. 2005

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Glyphosate translocation

- Reduced after tillering begins

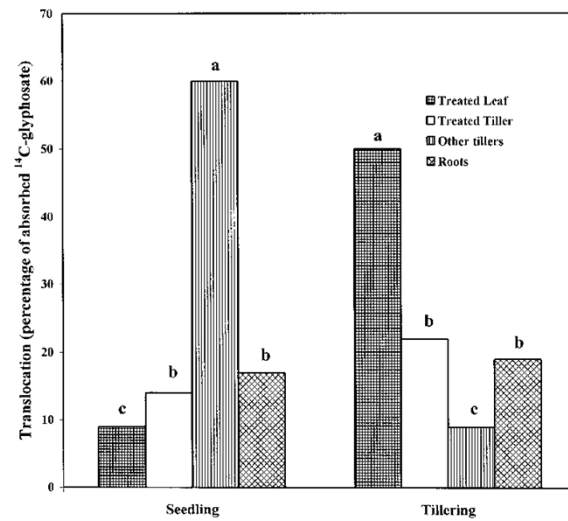


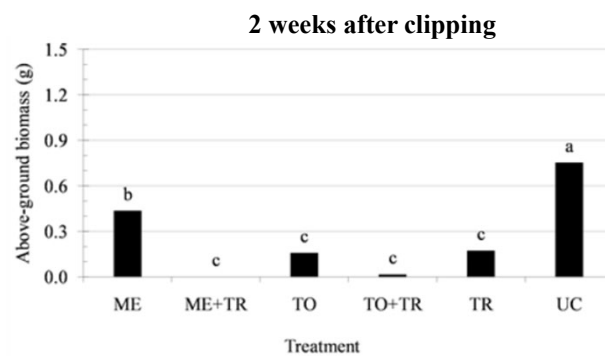
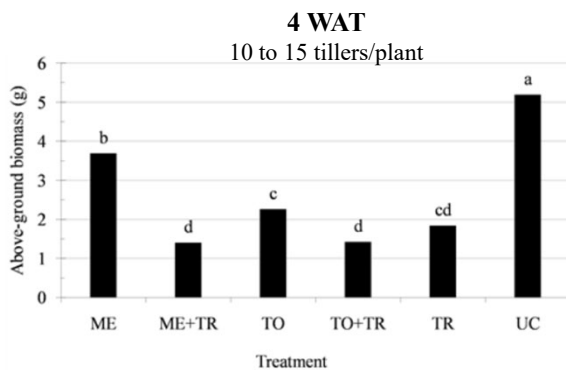
FIGURE 3. Translocation of glyphosate in windmillgrass at seedling and tillering growth stages 10 d after treatment. Means with the same letter are not different at $P = 0.05$.

Hennigh et al. 2005

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Greenhouse studies promising... but plants not completely killed

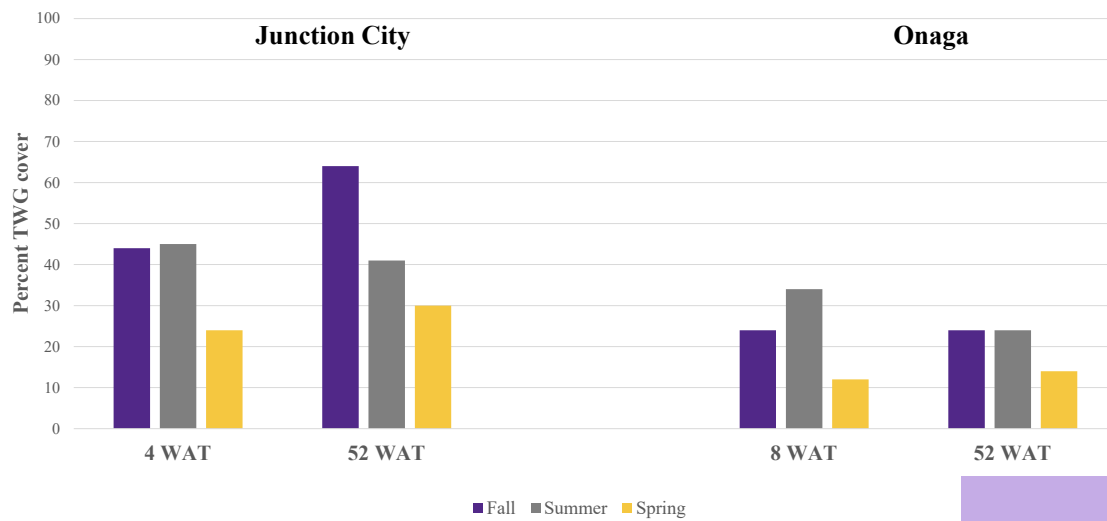


Smeda and Xiong 2019;

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Turfgrass studies suggest season influence

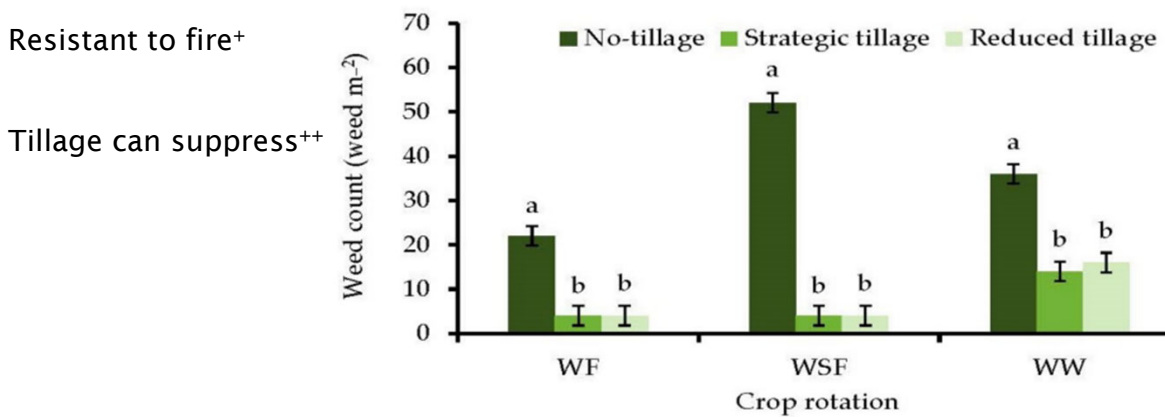


Mitchell 2016

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Cultural control options



Resistant to fire⁺

Tillage can suppress⁺⁺

⁺Trlica & Schuster 1969; ⁺⁺Obour et al. 2021

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Methods

- Established in conventionally-tilled wheat stubble
- No-till
- Sweep plow
 - April 27
 - Flex-King, 6' blades
 - 4-5" deep



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Methods

- Sprayed June 3 and September 12*
 - 2 to 4" clumps and 12 to 14" clumps*
 - 15 GPA, TTJ 1102 tips
 - 64 oz Roundup PowerMax II*
 - 32 oz SelectMax + 1% COC*
 - 3 oz Callisto + 1% MSO
 - 2 oz Impact + 1% MSO
 - 28 oz Sinate + 1% MSO
 - 2 pts Remedy Ultra (applied with HPPD-inhibitors)

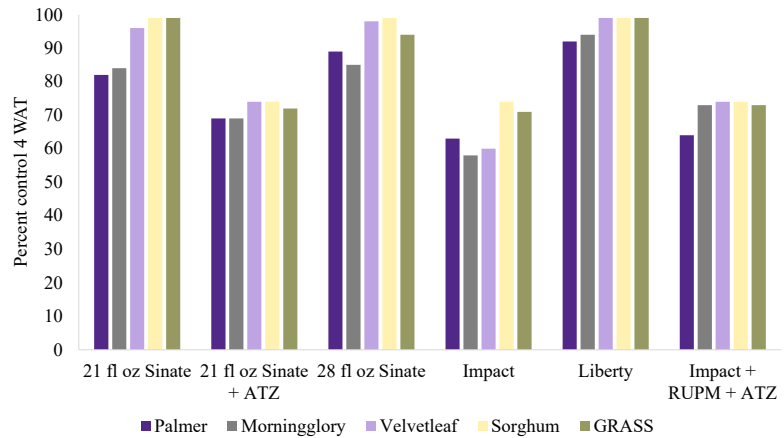


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Sinate

- Impact + Liberty
- Registered in corn
- AMVAC considering 2(ee) recommendation
- Allows use of herbicide



Sprayed June 9 2020, 3-4" weeds, V4 corn

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Methods

- Rated July 8, August 8, September 12
- Data analyzed for interactions of tillage and herbicides

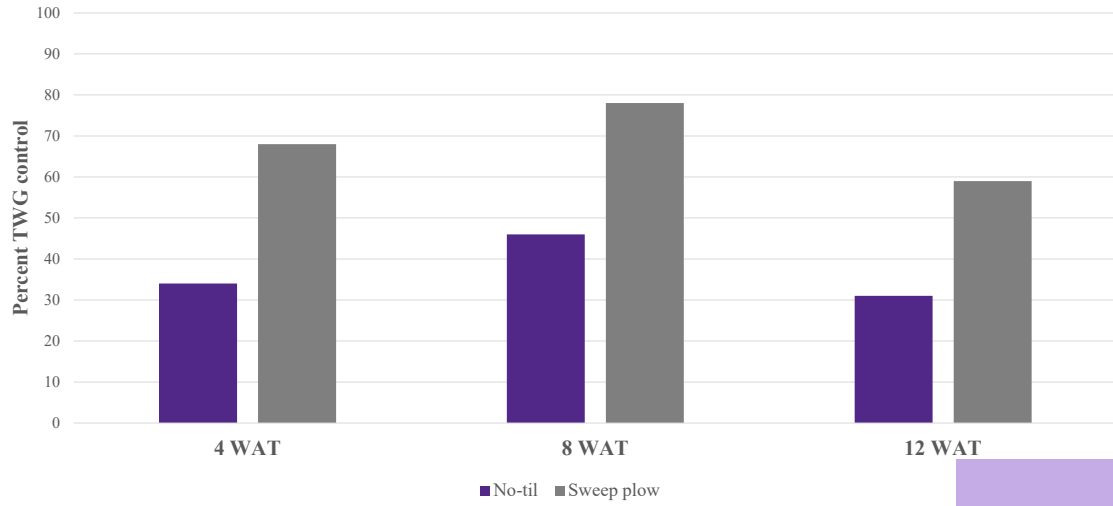


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Results – Tillage

Statistical differences at all ratings



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Select – No till

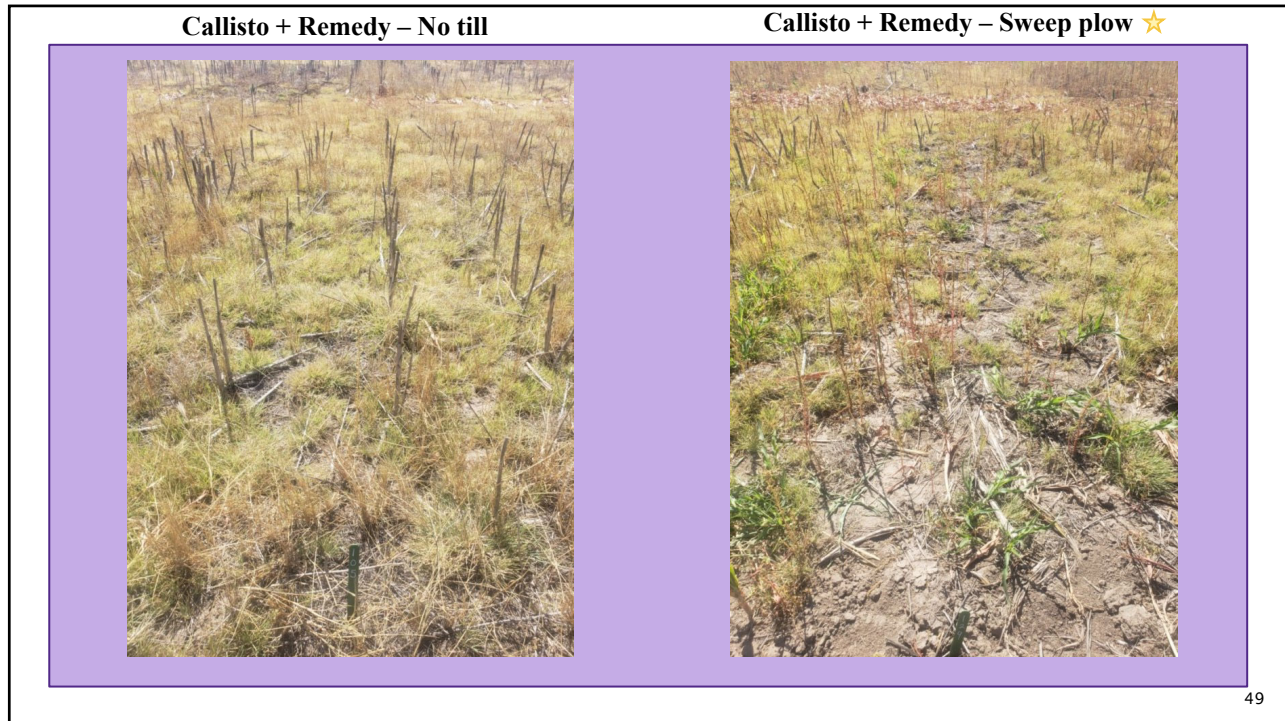
Select – Sweep plow



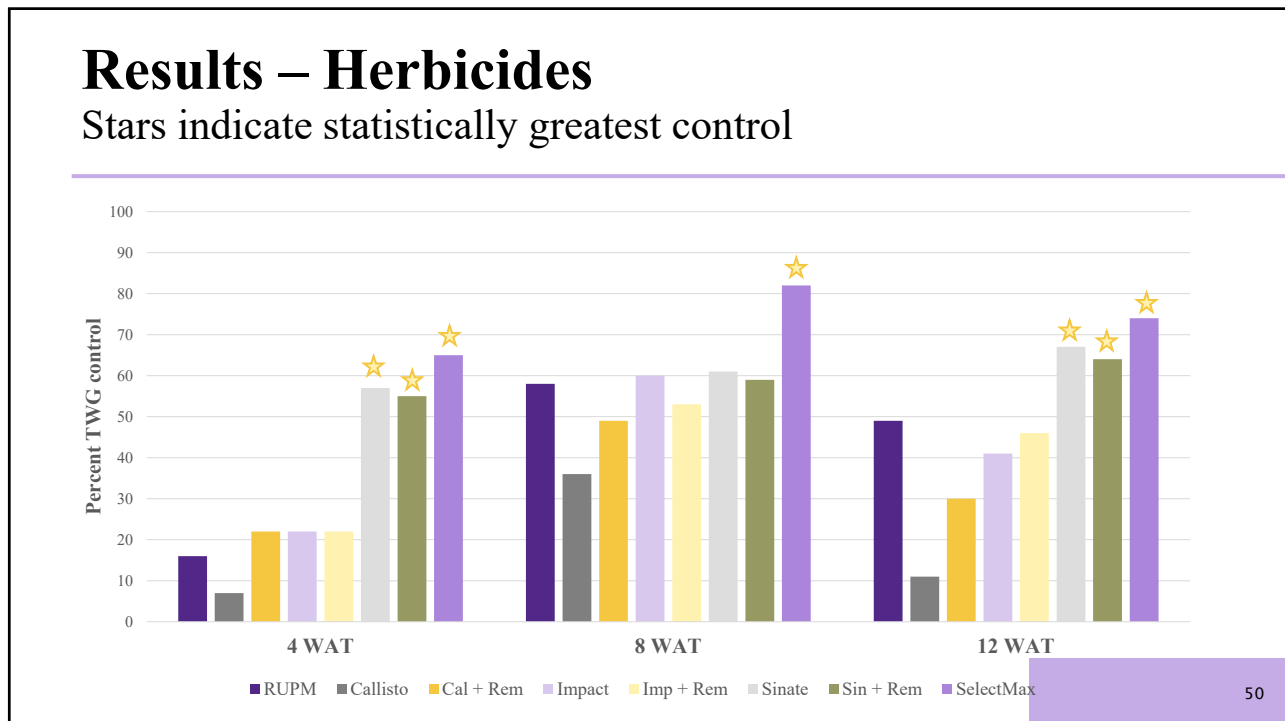
September 12, 2022

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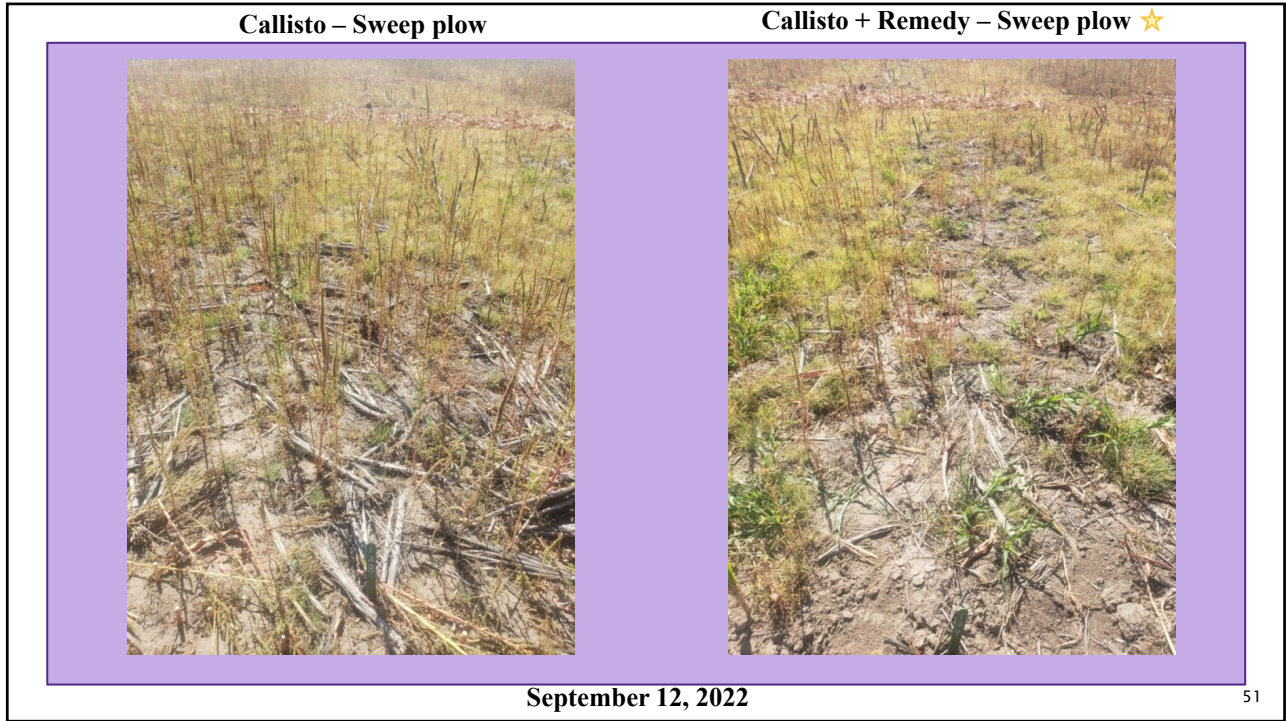
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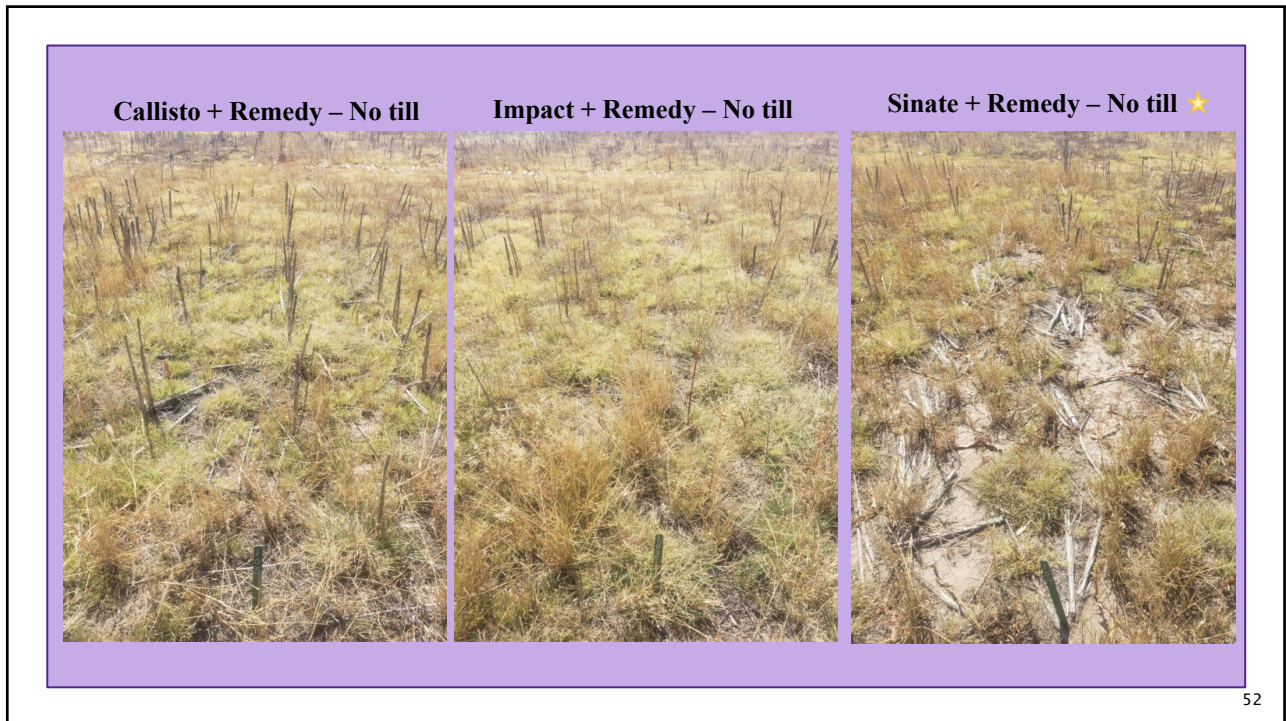
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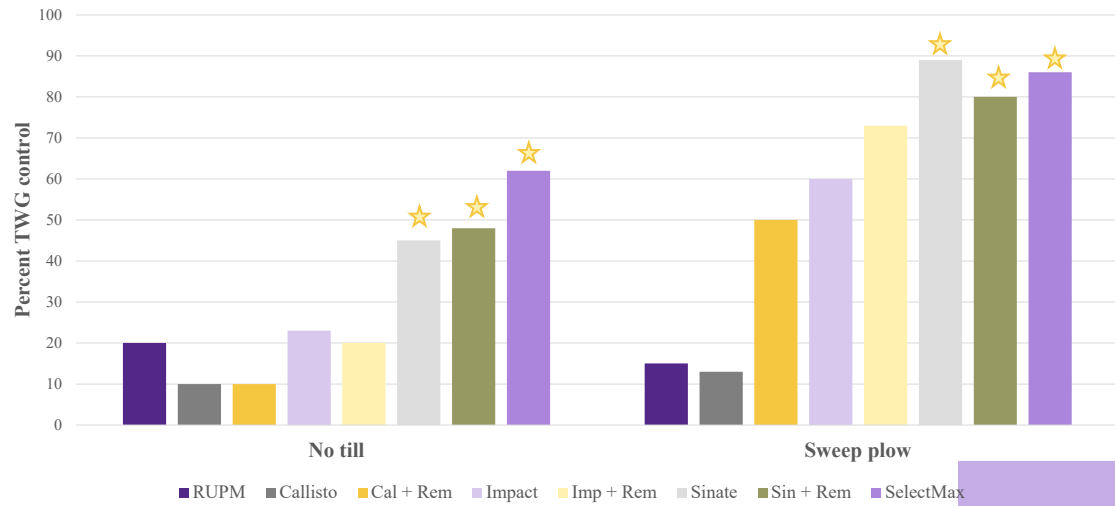
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Results – Interactions

Stars indicate statistically greatest control Sept. 12, 2022



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Future research

- Evaluate control in/after wheat
- Additional locations
- Timing of tillage

2 pass Select – No till
January 25, 2023



Sinate + Remedy – Sweep plow
January 25, 2023

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The image shows the cover of a report titled "2023 Chemical Weed Control" for Field Crops, Pastures, Rangeland, and Noncropland. The cover features a detailed botanical illustration of a weed plant with white flowers and green leaves against a teal background. The text on the cover includes "Report of Progress 1176" at the top right, the title "2023 Chemical Weed Control" in large green letters, and the subtitle "for Field Crops, Pastures, Rangeland, and Noncropland" below it. The K-State Research and Extension logo is at the bottom left, with the text "Kansas State University Agricultural Experiment Station and Cooperative Extension Service" underneath.

Report of Progress 1176

**2023
Chemical
Weed
Control**

*for Field Crops, Pastures,
Rangeland, and
Noncropland*

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