Waterhemp Resistance to Group 15 Herbicides

The continual evolution of weed populations resistant to herbicides from one or more site-of-action groups represents one of the most daunting challenges faced by farmers and weed management practitioners.

Overview

- Waterhemp *(Amaranthus tuberculatus)* has evolved to become resistant to herbicides from more site-of-action groups than any other Midwestern weed species.
- In 2019, the University of Illinois weed science program confirmed resistance to Group 15 herbicides (Table 1) in waterhemp, the first confirmation of resistance to herbicides from this group in a dicot weed species (Figure 1).
- Soybean farmers apply many Group 15 herbicides preplant or preemergence for residual control of annual grass and small-seeded broadleaf weeds, including waterhemp and Palmer amaranth *(Amaranthus palmeri)*.

Table 1. Examples of Group 15 herbicides commonly used in Midwestern soybeans.

TRADE NAME	ACTIVE INGREDIENT
Dual Magnum®	*S*-metolachlor
Stalwart®	metolachlor
Outlook®	dimethenamid
Zidua®	pyroxasulfone
Warrant®	acetochlor

- Additionally, Group 15 herbicides represent most of the soil-residual herbicides applied with postemergence herbicides in a layered residual weed control program.

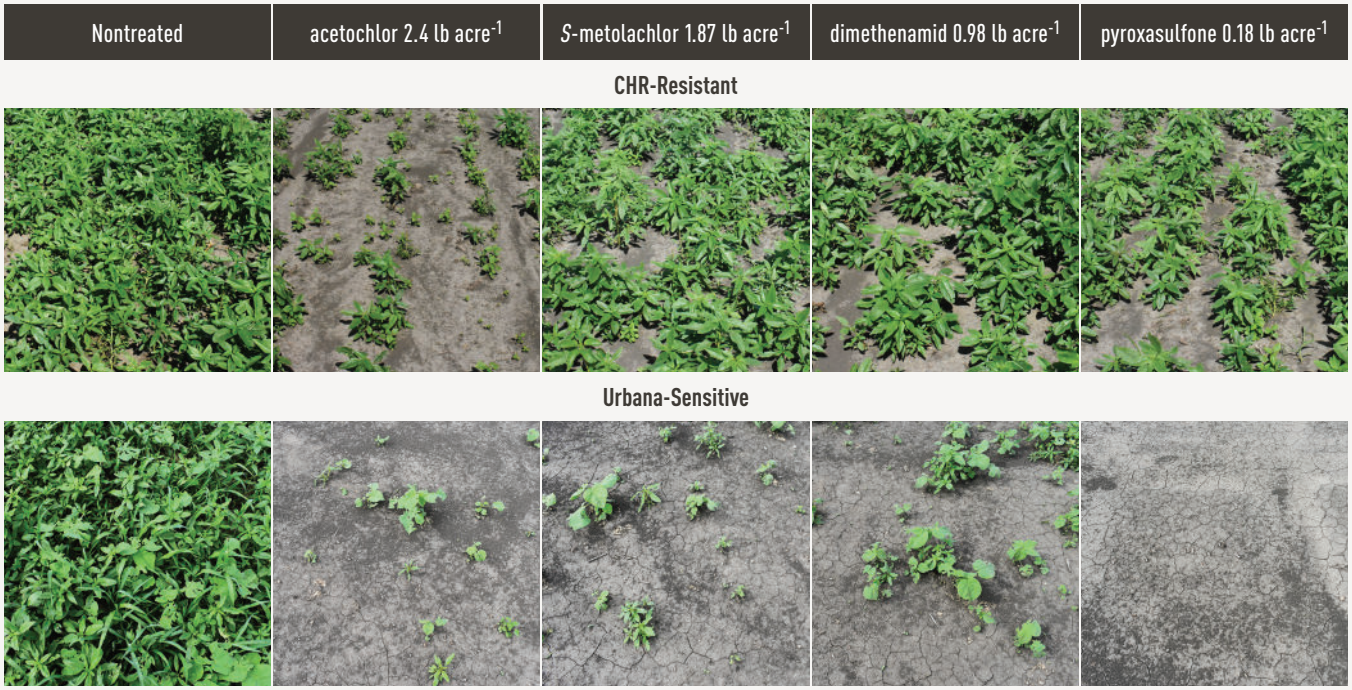

Figure 1. Representative images of Group 15 herbicide efficacy on a Group 15-resistant (CHR) waterhemp population and a sensitive (Urbana) population 28 days after treatment.

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How Researchers Test for Resistance

- Weed scientists characterize the magnitude of resistance — how resistant the plants are to the herbicide — by conducting dose-response experiments.
  - Typically, a range of herbicide rates — often 8 to 10 rates, some more and some less than a typical field use rate — is applied to the resistant population and to one or more known sensitive populations.
- After application (generally 14-28 days), plant response (percent injury, mortality, plant dry weight, etc.) is determined for resistant (R) and sensitive (S) populations, and a statistical equation is used to determine the herbicide rate that reduced the measured parameter by some value (frequently 50%). This allows comparison of responses between populations and calculation of a resistance ratio (R/S).
  - The higher the resistance ratio, the greater the magnitude of resistance.
  - The R/S ratios for two Illinois waterhemp populations presented in Table 2 indicate these populations show variation in their response to the Group 15 herbicides *S*-metolachlor, dimethenamid, pyroxasulfone and acetochlor.
- Figure 2 shows the results of a greenhouse dose-response experiment 21 days after *S*-metolachlor was applied preemergence. Four waterhemp populations aligned in rows were treated with *S*-metolachlor at rates equivalent to 0.0078-7.87 pints per acre of Dual Magnum. CHR-M6 and MCR-NH40 are resistant to Group 15 herbicides, while WUS and ACR are sensitive. No treatment was applied to the pots in the far-left column, while pots in the far-right column were treated with the highest rate (7.87 pints) of Dual Magnum. The recommended application rate for the soil used in this experiment is 2.5 pints per acre, but some resistant plants survived 7.87 pints of Dual Magnum.

RESULTS 21 DAT: *S*-METOLACHLOR

Figure 2. Dose-response experiment with four waterhemp populations treated with soil-applied S-metolachlor (Dual Magnum).
Recommended rate for soil used in this experiment is 2.5 pints per acre.

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Table 2. Resistance ratios for two Illinois waterhemp populations resistant to Group 15 herbicides. LD_{50} values represent the rates required to reduce waterhemp emergence/survival by 50%.

HERBICIDE	RESISTANT POPULATIONS (CHR-M6 and MCR-NH40)	SENSITIVE POPULATIONS (ACR and WUS)	R/S RATIO
	LD_{50} (g ai ha^{-1})		
***S*-metolachlor**	1,808–3,360	53–101	18–64
dimethenamid	729–1,463	26–35	21–56
pyroxasulfone	65–153	9–10	7–17
acetochlor	178–226	13–40	5–18

S. Strom, 2021

- Resistance to soil-applied herbicides is generally more difficult to detect in the field than resistance to foliar-applied herbicides because resistance to soil-applied herbicides usually results in a reduced duration of residual control rather than an initial failure in control.
  - It is not always possible to predict if residual control will be reduced by two days, eight days, 14 days, etc., as populations vary in their response to individual Group 15 herbicides.
  - However, this does emphasize the necessity of applying label-recommended rates instead of reduced rates, as reduced rates will further curtail the duration of residual control.

Best Management Practices for Group 15 Resistance

- Whether applied at planting or with a postemergence herbicide after crop emergence, Group 15 herbicides will continue to be important weed management tools. The evolution of resistance to this important class of herbicides should serve as another warning that herbicide stewardship is as important as herbicide and trait selection.
- Selection for herbicide resistance occurs each time an herbicide is applied, regardless of the herbicide or whether it is applied to the soil or plant foliage. However, the overall intensity of selection for resistance to any particular herbicide or site-of-action group is reduced when multiple different tactics are used to control the weed population.
- Integrated weed management programs offer the greatest potential for long-term, sustainable solutions for weed populations like waterhemp that demonstrate resistance to herbicides from multiple groups. The need is urgent for integrated weed management programs, including chemical and nonchemical, that return zero weed seed to the soil seedbank.

*For more information and links to additional resources, visit www.**IWillTakeAction**.com*

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Take ACTION Herbicide-Resistance Management