Single gene controls Corn Belt weed's resistance to soil-applied herbicide, study finds

November 8 2023, by Lauren Quinn

The ability of waterhemp (pictured) to survive soil-applied residual herbicides comes down to a single gene, according to new research from the University of Illinois. Lead scientist Dean Riechers says when herbicide resistance is linked to a single, dominant gene, the trait can spread more quickly. So far, soil-applied herbicides still work much of the time, but the study suggests producers should add non-chemical control methods to their toolbox. Credit: Lauren Quinn,

Waterhemp, the aggressive weed threatening Corn Belt crop production, is throwing curveballs once again, according to researchers at the University of Illinois Urbana-Champaign. The weed has famously developed resistance to not one or two, but seven herbicide sites-of-action classes, nearly exhausting the chemical tools farmers can use to defend their livelihood.

In a new *Weed Science* study, U. of I. researchers show that a single major gene is responsible for waterhemp's resistance to S-metolachlor (active ingredient in Dual Magnum and Dual II Magnum), an important soil-applied residual product in the class of VLCFA-inhibiting herbicides. The group's previous research showed waterhemp detoxifies the chemical with P450s, enzymes that remove electrons from toxic compounds, making them less reactive inside plant cells.

"The lingering question was which P450s? Plants have hundreds of them, and they often work in tandem to deactivate toxins. So, when we found just one major gene responsible for S-metolachlor resistance in waterhemp, we were very surprised," said study co-author Dean Riechers, professor in the Department of Crop Sciences, part of the College of Agricultural, Consumer and Environmental Sciences (ACES) at U. of I. "Waterhemp threw us a curveball once again."

Riechers' group routinely hunts for genes responsible for waterhemp's herbicide-dodging superpowers. A decade ago, his group traced waterhemp's resistance to atrazine—a herbicide in a separate class from S-metolachlor—to a single GST gene. But he says it's rare to find simple genetic control for a non-target-site resistance mechanism in weeds.

Tracing the genetic basis of resistance takes a great deal of hard work, precision, and time. In this case, first author Dylan Kerr, Riechers' master's student at the time, selected resistant plants and iteratively crossed them with other resistant plants for three generations in the greenhouse. Having purified the genetic stock, he then mated resistant parents with sensitive ones and looked for genetic differences in their offspring.

"Studying soil-applied herbicide resistance is very difficult because if the herbicide is doing its job, then sensitive plants won't even exist," Riechers said. "Dylan went above and beyond the call of duty. He was very diligent and persistent in the greenhouse in making these crosses so the results would be clean and easy to interpret."

What does it mean that only one major gene controls S-metolachlor resistance in waterhemp?

"Unfortunately, it's not encouraging news for growers," Riechers said. "Whenever resistance is controlled by a single gene and it's a dominant trait, the risk for spread is higher."

The worst-case scenario hasn't happened yet. Riechers notes that metolachlor has been used in corn, soybean, and grain sorghum for about 45 years, and waterhemp populations with resistance to the herbicide are not yet widespread.

"As a soil-applied residual tool, S-metolachlor is valuable for managing waterhemp," Riechers said. "Resistance is not a huge problem yet, but if S-metolachlor or other VLCFA-inhibitor herbicides ever stopped working on a broader scale, that would take even more effective tools away."

The way forward, Riechers says, is for the industry to move toward more

holistic weed management methods—including physically destroying seeds and adding more diverse crops to the rotation—and away from complete reliance on chemical weed control. He suggests that planting winter wheat, cover crops, or even double-cropping soybeans after wheat could significantly cut down on weed pressure.

"I realize it's getting tiring to keep saying diversify your weed control, but it's true and our research findings at ACES support this strategy," Riechers said.

The study, "Inheritance of resistance to S-metolachlor in a waterhemp (*Amaranthus tuberculatus*) population from central Illinois," is published in *Weed Science*. Authors include Dylan R. Kerr, Jeanaflor Crystal T. Concepcion, and Dean E. Riechers.

More information: Dylan R. Kerr et al, Inheritance of resistance to S-metolachlor in a waterhemp (Amaranthus tuberculatus) population from central Illinois, *Weed Science* (2023). DOI: 10.1017/wsc.2023.63

Provided by University of Illinois at Urbana-Champaign