

Mechanism for herbicide resistance in Palmer amaranth identified

May 18 2016



Populations of Palmer amaranth have been shown to resist the effects of certain herbicides. Credit: Aaron Hager

Corn and soybean farmers might as well be soldiers locked in an ever-escalating war against the weeds that threaten their crops. New weapons—herbicides—only work for so long before the enemy retaliates by developing resistance and refusing to die. So farmers attack with new herbicides or new mixtures of existing herbicides until the cycle starts again. This has been the case for decades for two familiar enemies, waterhemp and its aggressive cousin, Palmer amaranth.

A new study co-authored by University of Illinois weed scientist Patrick Tranel shows that Palmer amaranth populations from Arkansas are now resistant to a class of herbicides known as PPO-inhibitors (PPOs).

PPOs were used extensively in the early 1990s in soybeans after waterhemp developed resistance to the class of herbicides known as ALS-inhibitors. But when Roundup Ready crops came along, most farmers switched to using glyphosate, with PPOs applied to soil prior to weed emergence. Thus, when glyphosate stopped working on waterhemp and farmers went back to PPOs for post-emergence control, they were surprised to find that they no longer worked on waterhemp in some fields.

"The PPOs applied pre-emergence were providing selection pressure and increasing the resistance to PPOs without farmers really knowing about it. That's one of the reasons we think we have so much PPO resistance now," Tranel explains.

But PPO resistance in waterhemp is old news. What's interesting is the mechanism of resistance to PPOs.

The [genetic code](#) of an organism, which determines all of its physical traits, is housed in its DNA in molecules known as nucleotides. Normally, mutations in genetic sequences that give rise to herbicide resistance happen at the scale of a single nucleotide.

In PPO-resistant waterhemp, however, Tranel's group found a different mutation. Instead of a change in a single nucleotide, they found the deletion of three nucleotides. "It seems like it would be really rare and difficult for this particular mutation to occur. It just shouldn't happen," Tranel says. But, for waterhemp, it did.

This mutation probably happened because the sequence of three nucleotides was repeated, and this repeat just happened to be in the right place in waterhemp's genetic code.

So the team looked at the genetic sequences of related pigweeds, to see if they had the repeat in the right place, and found that most did not. However, when they looked at the genetic code for Palmer amaranth, they found the repeat. They predicted that, someday, they'd see Palmer amaranth developing resistance to PPOs.

"Palmer has this repeat. It's predisposed to PPO resistance. If waterhemp can do it, Palmer can too," Tranel notes.

Soon, several of Tranel's colleagues started hearing reports from farmers about Palmer amaranth that wasn't being killed by PPOs. When Tranel tested samples sent from Arkansas and Tennessee, he found the mutation. His prediction had been right.

"We predict PPO resistance is going to spread very rapidly in Palmer, like it did in waterhemp. By now, we know PPO-resistant Palmer is present in at least three states. If a farmer has Palmer, they should not rely on PPO as an effective herbicide. It might only work for a couple of years," Tranel says.

In fact, when Tranel and his colleagues tested the effectiveness of the PPO inhibitor fomesafen on an Arkansas population of Palmer amaranth, they found that each successive generation had a higher

frequency of the mutation and required more and more PPO to be applied to achieve a 50 percent growth reduction.

The rapid spread of the mutation in these populations is bad news for farmers, but intriguing from an evolutionary science point of view.

"That's why [resistance](#) is so cool: it's just evolution," Tranel says. "We can study it at warp speed. Most people who study evolution have to deal with time scales of hundreds or thousands of years. We can study evolution in five or ten years."

How can [farmers](#) deal with this new threat? Tranel says they should "pray for a new herbicide."

But for the time being, he suggests they use as many different pre- and post-emergence herbicides with as many modes of action as possible in every field in every year.

The battle continues.

More information: Reiofeli A Salas et al, Resistance to PPO-inhibiting herbicide in Palmer amaranth from Arkansas, *Pest Management Science* (2016). [DOI: 10.1002/ps.4241](https://doi.org/10.1002/ps.4241)

Provided by University of Illinois at Urbana-Champaign

Citation: Mechanism for herbicide resistance in Palmer amaranth identified (2016, May 18) retrieved 6 May 2024 from <https://phys.org/news/2016-05-mechanism-herbicide-resistance-palmer-amaranth.html>

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