Study explains waterhemp's metabolic resistance to topramezone

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Corn naturally tolerates certain herbicides, detoxifying the chemicals before they can cause harm. It's what allows farmers to spray fields with the class of herbicides known as HPPD-inhibitors, which kill weeds such as waterhemp and Palmer amaranth and leave corn unscathed. But in more and more fields, the method is failing; waterhemp isn't dying.

Scientists have studied waterhemp's response to two common HPPD-inhibiting herbicides, mesotrione (trade name Callisto) and tembotrione (Laudis), and found the weed uses the same cellular mechanism as corn to detoxify the chemicals. However, no one had studied waterhemp's metabolic response to a third HPPD-inhibiting herbicide, topramezone (Impact or Armezon), which is in a different chemical subclass than mesotrione and tembotrione, but is just as widely used in corn.

A new study from the University of Illinois identifies the detoxification pathway in two Midwest waterhemp populations that plays a role in rapidly metabolizing topramezone. Unfortunately, the finding is not good news for corn growers.

"Our initial theory was that waterhemp would mimic corn as it does for the other two HPPD-inhibitors, but, no, it found a different way," says Dean Riechers, weed scientist in the Department of Crop Sciences at U of I and co-author on the *Frontiers in Plant Science* study. "We don't know how or why, but it has a different mechanism from what corn naturally has. Bottom line is that you can't use any of the three HPPD-inhibitors to control this population."

The waterhemp population Riechers refers to is from a field in McLean County, Illinois. During the past decade, the field of continuous seed corn has been treated with all three HPPD-inhibitors, and waterhemp was showing resistance to them all. Riechers and his co-authors planted seeds from that population in a greenhouse and sprayed the plants with all three herbicides to assess the degree of damage. Compared with two populations sensitive to the chemicals, the McLean County waterhemp plants looked great.

The researchers also grew up waterhemp plants from a Nebraska field that only had been treated with mesotrione and tembotrione. Despite never having been exposed to topramezone, the plants appeared to be resistant. They didn't look as good as the McLean County population, but they looked much better than the sensitive populations.

Riechers says, "The greenhouse experiment showed the Nebraska population did have resistance to an herbicide it had never been exposed to. Did the other two herbicides select for topramezone resistance? My colleagues at Syngenta and I believe so. Our long-term goal is to find out if each herbicide has its own resistance gene or if there are genes that one or the other could select for."

Using an excised leaf assay they developed to identify herbicide-detoxifying enzymes, the research team discovered the McLean County plants were using a different pathway than corn to detoxify topramezone. Riechers says the finding is scientifically interesting, but might be a tough pill to swallow for the corn industry.

"It's scary because these waterhemp populations find a way to metabolize these compounds, so it makes chemical weed control that much more difficult," he says. "Right now, you could spray any of these three HPPD-inhibitors on corn, not kill the corn, but potentially kill the weeds. But if the weeds are using a different mechanism to detoxify the

chemical, you'd have to develop a different kind of herbicide that doesn't use these same metabolic pathways. It might be effective on the weeds, but who knows if the corn would tolerate it."

Chemical companies could use the information in discovery research to develop new products, but farmers may not have the option to wait. In the meantime, Riechers points to U of I colleagues' work on tank-mixing multiple herbicide sites of action or using a Harrington Seed Destructor as a non-chemical method to limit resistance.

"We're finding out more and more about what these waterhemp populations can do for detoxification, and it's disheartening. Our research just underscores how important it is to take alternative steps to limit the spread of these resistant plants or prevent it from happening in the first place," he says.

More information: Anatoli V. Lygin et al, Metabolic Pathway of Topramezone in Multiple-Resistant Waterhemp (Amaranthus tuberculatus) Differs From Naturally Tolerant Maize, *Frontiers in Plant Science* (2018). DOI: 10.3389/fpls.2018.01644

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