Synthetic Auxin Resistance in Waterhemp

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HERBICIDE RESISTANCE ACTION COMMITTEE

Auxin Resistant Waterhemp

Waterhemp is a significant weed of corn and soybean production in the Midwest of the US. Waterhemp has evolved resistance to six herbicide mechanisms of action. Synthetic auxin resistant waterhemp was found in Nebraska in 2009 in a grass seed production field that had been sprayed with atrazine, metolachlor and 2,4-D for 13 years.

Levels of Resistance and Cross-Resistance

The level of resistance to 2,4-D in this population is greater than 10 fold, and resistance to dicamba appears to be low at 2 fold. Early indications are that the mechanism is probably metabolic.

Rate of Spread

Synthetic auxin resistant waterhemp has only been found in the one 80-acre field used for seed production of little bluestem. Given the massive number of maize (corn) acres infested with waterhemp, and treated with synthetic auxin herbicides for decades, it is clear that this is quite a rare genetic mutation. For this reason it is very important to prevent it's spread, as it is not likely to appear in many sites through independent mutation events.

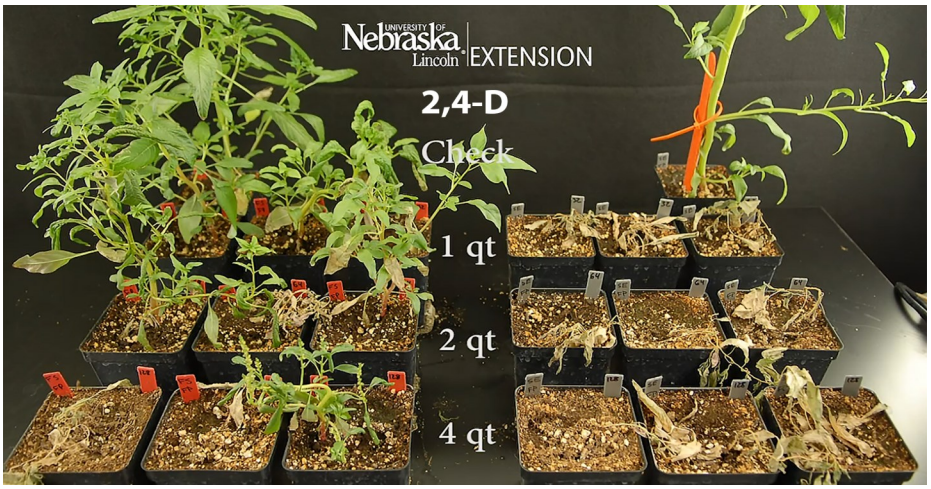
Resistance to Other MOA's

In addition to synthetic auxin resistance, waterhemp has evolved resistance to five other herbicide mechanism of actions.

1. PSII-inhibitors — first identified in 1994, and now in the US states of IA, IL, KS, MO, NE and in Ontario Canada.
2. ALS-inhibitors — first identified 1993, ALS inhibitor resistant waterhemp occurs in IA, IL, IN,KS, MI, MN, MO, OH, OK, TN, WI and in Ontario Canada.
3. Glyphosate — first identified 2005 and it has been reported in the US states of AR, IA, IL, IN, KS, KY, MN, MO, MS, ND, NE, OH, OK, ON, SD, TN, TX, WI, and in Ontario Canada
4. PPO inhibitors — first identified in 2001 and reported in IA, IL, IN, KS, and MO.
5. HPPD inhibitors — first identified in 2009, now found in IA, IL, and NE.

Multiple Resistance

Multiple resistance in waterhemp is very common, and different combinations of all of the 5 herbicide mechanisms of action above have been reported in many US states. Multiple resistance in waterhemp is one of the biggest threats to maize/ soybean production in the US Midwest.



Synthetic auxin resistant and susceptible waterhemp at 3 rates of 2,4-D | Photo: Dr. Greg Kru

Best Management Practices

The fact sheet "Synthetic Auxin Resistant Weeds" provides more detail on how to delay and mitigate resistance.

Integrated weed management including herbicide rotation, mixtures, and cultural/ mechanical controls should be practiced to delay the selection of synthetic auxin resistant waterhemp. Waterhemp seeds are very small and well suited to reduced tillage systems where the seed remains close to the surface. Increased burial depth by tillage can be effective at reducing seed survival and emergence. Use of pre-emergence herbicides can help provide different herbicide mechanisms of action for control of waterhemp.

Additional information on herbicide resistance can be found at weedscience.org

Application of soil residual herbicides with long pre-emergence activity close to planting time can increase the period of waterhemp control after the crop has emerged. As the residual herbicide dissipates new flushes of waterhemp will need to be controlled with cultivation or a post-emergence herbicide. Timing of post-emergence herbicides for waterhemp control is important because it emerges in several flushes. Ideally plants should be between 4 and 6 inches tall and actively growing.

Facts about Waterhemp

SCIENTIFIC NAME

Amaranthus tuberculatus

SYNONYM

Amaranthus rudis

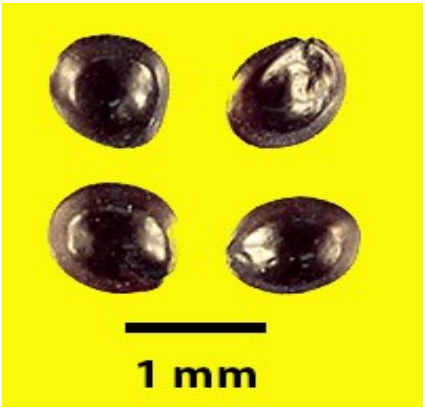
OTHER COMMON NAMES

Tall Waterhemp, Common Waterhemp

Common and tall waterhemp were classified as different species up until 2001, when research showed they were a single waterhemp continuum exhibiting geographic variation.

THE RISE OF WATERHEMP

Waterhemp has dramatically increased in abundance in maize and soybean production in the Midwest over the last 40 years. Adoption of reduced tillage practices and reliance on herbicides for weed control have contributed to this increase.



EMERGENCE AND GROWTH

Waterhemp germinates and emerges later in the season than many summer annual weed species and has a longer emergence period with several flushes. Early flushes may be controlled by pre-emergence herbicides, however later flushes often require post-emergence herbicides for control.

Waterhemp can grow quite rapidly, 50-70% faster than other annual weeds. This allows even late-emerging plants to compete well with crops and produce large amounts of seed. Therefore it is critical to remove escaped plants throughout the growing season.

Genetic Variability

Waterhemp plants are dioecious (individuals are either male or female) and thus must outcross, resulting in long distance dispersal of resistance. Wind-blown pollen is thought to be a key source of genetic dispersal. Outcrossing also leads to an increase in the genetic diversity of waterhemp, and combined with being a prolific seed producer (up to 2 million seeds per plant, but typically around 100,000 seeds per plant) allows the plant to rapidly evolve resistance to herbicides.

It may be that the current *Amaranthus tuberculatus* evolved by hybridization between *A. tuberculatus* and *A. rudis* and therefore some designate the current weedy waterhemp as *A. tuberculatus* var. *rudis*. The ability of waterhemp to cross with other *Amaranthus* species and incorporate traits from these crosses may contribute to the high levels of multiple resistance in this weed.

REFERENCES

Bernards, M.L., Crespo R.J., Kruger G.R., Gaussoin R., and P.J. Tranel. 2012. A Waterhemp (*Amaranthus tuberculatus*) Population Resistant to 2,4-D. *Weed Science*: July-September 2012, Vol. 60, No. 3, pp. 379-384.

Hager, A. G., Wax, L. M., Bolleroa, G. A., and F.W. Simmonsc. 2002. Common waterhemp (*Amaranthus rudis* Sauer) management with soil-applied herbicides in soybean (*Glycine max* (L.) Merr.). *Crop Protection* 21, 277–283

Pratt, D. B. and L. G. Clark. 2001. *Amaranthus rudis* and *A. tuberculatus* – one species or two? *Journal of the Torrey Botanical Society*. 128(3) pp. 282-296.

Spaunhorst, D. J. and K. W. Bradley. 2013. Influence of Dicamba and Dicamba plus Glyphosate Combinations on the Control of Glyphosate-Resistant Waterhemp (*Amaranthus rudis*). *Weed Technology* 27:675–681