

INTRODUCING QUAD-STACK WATERHEMP: POPULATIONS CONTAINING INDIVIDUALS RESISTANT TO FOUR HERBICIDE MODES OF ACTION. Michael S. Bell, Patrick J. Tranel, and Aaron G. Hager, Graduate Research Assistant, Professor and Associate Professor, Department of Crop Sciences, University of Illinois, Urbana, IL 61801.

A waterhemp population from western Illinois was reported resistant to glyphosate. Results from on-site field trials in 2008 indicated the population contained other herbicide resistances as well. Thus, seeds were collected from female waterhemp plants for greenhouse studies. By treating greenhouse-grown plants with atrazine, lactofen, imazamox, or glyphosate, it was confirmed that the population contains resistance to each of these four herbicides. Further experiments were conducted to test for individual plants with multiple resistance. To reduce potential antagonism among herbicides, some of the herbicides were applied sequentially. In one run, seedlings were treated with an atrazine-imazamox tank mix. Survivors were then treated with a glyphosate-lactofen tank mix, and four-way resistant individuals were identified. In a second run, imazethapyr was applied to the soil soon after sowing the seeds, and emerged seedlings were then treated with atrazine at the four-leaf growth stage. Survivors of the atrazine treatment were then sprayed with a tank mix of glyphosate and lactofen. Again, four-way resistant individuals were identified.

In a parallel study, an F<sub>2</sub> waterhemp population was derived from a cross between a parental line that was fixed for resistance to atrazine, ALS-inhibitors, and PPO-inhibiting herbicides, and a parental line that demonstrated near-uniform resistance to glyphosate. Individuals in this F<sub>2</sub> population were screened for resistance to each of four herbicides, and all four types of resistance were confirmed to be present in the population. This F<sub>2</sub> population was then screened for four-way resistant individuals. Imazethapyr was applied to the soil soon after the seeds were sown, and emerged seedlings were sprayed with atrazine at the four-leaf stage. Survivors of this treatment were then sprayed with a glyphosate-lactofen tank mix and survivors were identified. This population was also used to test for any possible linkage between the resistance genes by using molecular markers as well as phenotypic data from sequential herbicide treatments.

Waterhemp's obligate outcrossing provides an efficient mechanism for combining different herbicide resistances within a single individual. As evidence for this, a field-evolved biotype possessing four different herbicide resistances has now been confirmed. Greenhouse crossing experiments suggested there are no obstacles to combining the four different resistances. Thus, continued evolution of multiple resistant waterhemp populations is expected.