

Differential sensitivity to glyphosate among biotypes of common waterhemp (*Amaranthus rudis* Sauer)

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Summary In 1996, soybean varieties with resistance to the herbicide glyphosate were released in the USA. Broad selectivity and flexibility in the target size of weeds, along with minimal crop injury, has resulted in over 68% of the US soybean production area in 2001 planted with transgenic soybean. In 1999, a producer in Missouri and in Illinois reported incomplete control of common waterhemp with glyphosate. Plants from each site (designated Monticello for the Missouri site and Sutter for the Illinois site) were collected and allowed to reproduce under controlled conditions. Under greenhouse conditions, seed were germinated in polypropylene flats containing an enriched soil media, and seedlings at 15 cm were treated with 0.84 kg a.e. ha⁻¹ of glyphosate. Two weeks following treatment, visual observations of herbicide injury were made and plants assigned to one of three categories; 0–35% injury, 36–90% injury, and 91–100%. These plants were designated as the original population. Plants from the 0–35% injury category were transplanted into large pots containing an enriched soil media, and allowed to complete their life cycle. Only plants from the same respective field site were allowed to cross-pollinate, since waterhemp is dioecious. Seed collected from plants were designated as first generation, and were germinated under greenhouse conditions and treated as described above. Survivors from the low injury category were again allowed to reproduce and seed collected was designated as second generation. The second generation seed was treated as described above to characterise response to glyphosate. Our results indicate that, for the Monticello location, the original population, first generation, and second generation contained 10.0, 26.6, and 13.4% waterhemp, respectively, that showed little injury to glyphosate. For the Sutter location, the original population, first generation, and second generation contained 15.3, 13.7, and 13.0% waterhemp, respectively, that showed little

injury to glyphosate. For a known glyphosate sensitive population, less than 2% of plants survive.

Further research under field conditions at the Monticello location was to determine the response of waterhemp to post-emergence applications of glyphosate, and the ability of treated plants to reproduce. Under non-crop conditions, waterhemp was allowed to reach 10–20 cm or 30–40 cm. At each height, plants were treated with 0 to 6.72 kg ha⁻¹ of glyphosate. Plant fresh weight was measured up to eight weeks after treatment (WAT). Results indicate that fresh weight of 10–20 cm treated waterhemp increased up to 300% for plants treated with rates as high as 6.72 kg ha⁻¹. However, at all glyphosate rates, 30–40 cm treated waterhemp lost fresh weight at eight compared to 2 WAT. At each plant size, the use of a sequential application of glyphosate (0.84 followed by 0.84 kg ha⁻¹ when plants showed 4 cm new growth) was highly effective in killing plants. At rates of up to 6.72 kg ha⁻¹, waterhemp surviving treatment produced viable seed.

Because of the variability in glyphosate insensitivity for each population, it has been difficult to assess the extent of waterhemp survival to glyphosate. Recently, waterhemp seed from the second generation were germinated under greenhouse conditions, and plants treated at 15 cm with 0.84 kg ha⁻¹. Surviving plants were allowed to reach 75 cm, then 10 cm shoot cuttings were taken and placed in a liquid growth medium. Within two weeks, plants produced roots and were transplanted to pots containing soil media. These cloned plants were treated at 12 cm with rates of glyphosate from 0 to 3.36 kg ha⁻¹. Results indicate 25 and 31 of 36 plants from Monticello and Sutter, respectively, initiate new growth at glyphosate rates ≥ 0.84 kg ha⁻¹. Only one of 24 plants from the sensitive population has survived at this rate.

Keywords Glyphosate, waterhemp, herbicide resistance.