MANAGING GLYPHOSATE-RESISTANCE IN COTTON

Kenneth L. Smith
University of Arkansas
Monticello, AR
L. E. Steckel
University of Tennessee
Jackson, TN

Abstract

It was once thought that weeds would not become resistant to herbicides. However, in 1968, the first case of evolved resistance was reported. Since then, over 180 species have developed resistance to one or more of 19 herbicide families. Horseweed (*Conyza canadensis*) was the first weed to demonstrate glyphosate resistance in the mid south. Extensive research has developed recommendations for good control of this altered biotype. *Amaranthus palmeri* (also referred to as Palmer amaranth and Palmer pigweed) is considered the most troublesome weed in mid-south cotton production. The rapid growth, aggressive competition, extremely prolific seed production and germination throughout the season make pigweed a multimillion dollar pest each year in our area. Glyphosate tolerant crops, especially cotton has been readily adopted by farmers and greater than 98% of all cotton planted in the mid-South contains the glycol gene and is considered glyphosate tolerant. Adoption of glyphosate tolerant crops has allowed farmers to increase conservation tillage programs and farm larger number of acres with less equipment and labor. In Arkansas, the number of farms with greater than 2000 acres has increased by 30% since the adoption of glyphosate tolerant crops. Most of the commonly used agricultural practices in use today are built around the use of this technology. Glyphosate has also been the most effective means of controlling Palmer amaranth in cotton. For this reason, there is great concern over the development of glyphosate-resistant pigweeds. Pigweeds that cannot be controlled with glyphosate will add tremendous cost and cause major shifts in our agricultural community. This threat has resulted in an intense interest in developing plans for the prevention and management of pigweed in cotton. Populations of Palmer amaranth were identified in both Georgia (Culpepper et al., 2005) and Tennessee (Meuller et al., 2005) that were resistant to glyphosate, the active ingredient in Roundup brand herbicides. Recently, populations of Palmer amaranth have been discovered in Arkansas that have proven to be glyphosate-resistant to rates as high as 8X normal field rates. In a preliminary screen, glyphosate-tolerance was recorded in 17 locations in 13 counties. Eleven locations survived 0.5 lb ae/A, while six survived 0.25 lb ae/A of glyphosate. Glyphosate-tolerant Palmer amaranth proved to be present in 13 of the 17 counties screened. In October of 2007, 236 Palmer amaranth samples were taken from 51 locations in 13 counties in Arkansas. These samples have been dried and thrashed and will be tested in January 2008.

Field and greenhouse experiments have identified two very distinct responses to glyphosate. Although phenotypically similar, each is considered a distinct biotype.

Biotype 1 demonstrates a lower level of resistance and when treated with field doses of glyphosate shows varying levels of symptoms as chlorosis, necrosis, and stunting. The apical bud is often destroyed, but regrowth occurs from lower axillary buds. The F_2 and F_3 generations continue to segregate exhibiting varying levels of susceptibility and resistance. Since succeeding generations continue to segregate, the population of escapes is scattered over a large area of the field with no definite pattern. Multiple applications and higher glyphosate rates improves control of this biotype. This biotype is widespread throughout Arkansas and Tennessee cotton cropping areas. Utilizing residual herbicides and maintaining full labeled rates of all herbicides are effective in controlling these weeds.

Biotype 2 has been found in less than 10 fields throughout the state, but when found is localized in areas usually smaller than 150 m^2. The plant population in the infested area is as high as 100 plants/m^2. This pattern suggests that all plants in the infested area are offspring from a single parent plant. Each plant in the infested area demonstrates greater than 8X resistance. This biotype exhibits little or no symptomology when treated with doses as high as 8X normal field rates. The F_1 generation from this biotype does not segregate and each offspring is as resistant as the parent. It is strongly suggested that farmers and consultants scout fields carefully for these “spots” of Palmer amaranth. If a spot is observed, it should be immediately destroyed using whatever means is necessary to prevent any pollen or seed production.

Weed scientists feel that other weeds will also evolve to resistance populations under heavy selection pressure where glyphosate is the major herbicide used.

Resistance Management Plan for Cotton

Acceptable weed control in cotton has required a combination of herbicides without sole reliance upon glyphosate. Although this is a step toward good resistance management, careful planning is required to maximize the protection against the development or infestation of glyphosate-resistant pigweed.

- In fields where pigweed is a problem, additional measures may be in order to keep fields clean. Adopting as many of the following options as possible will help keep fields clean and control any pigweeds that are not controlled by glyphosate.
- Utilizing a long residual herbicide such as Valor or Reflex in the preplant- burndown application. A yellow herbicide such as Treflan or Prowl applied PPI will prevent many pigweeds from becoming established in early season.

  Applying Cotoran, Caparol or Direx PRE will also delay the emergence of pigweed.

  Metolachlor products such as Dual Magnum applied with the glyphosate before the fifth leaf growth stage of cotton will control pigweed until the cotton is large enough to make post-directed herbicide applications.

  Post-directed and layby applications that include a herbicide with residual properties will keep pigweeds under control until the cotton creates sufficient shade to control pigweed seedlings.

  Herbicides such as Caparol and Direx in post-directed programs or Valor in layby programs have been extremely effective in keeping pigweeds under control.

All of these options may not be feasible on all fields, but the more of these options that are adopted; the less chance there is of pigweed escapes.

Crop rotation to Liberty Link™ cotton, conventional corn or grain sorghum is also a good resistance management strategy. It is imperative to remember that each pigweed plant is capable of producing a half-million seed that drop back onto the soil. One plant that is not controlled with glyphosate is sufficient to cause problems for many years to come. Escapes must be controlled prior to seed production.

More information on pigweed control and weed resistance can be found in the University of Arkansas publication, MP44, available at your county office or at www.uaex.edu.

References

Culpepper, S., et al. 2006. *Glyphosate-Resistant Palmer Amaranth Confirmed in Georgia*.Weed Sci. (*in Press*).
Mueller, T. C., L. E. Steckel, J. S. McElroy and T. C. Teuton. 2006. *An update on herbicide resistance in Tennessee*. Proc. South Weed Sci Soc. 59:133.

Scott, R. C., K. Smith, J. Boyd. 2006. *Recommended Chemicals for Weed and Brush Control*. University of Arkansas. Cooperative Extension Service. MP44.
Smith, K., et al. 2006. *Herbicide Resistance: A Growing Concern in Arkansas*. Broch. www.uaex.edu.