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Agriculture and Natural Resources

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Prevention and Control of Glyphosate-Resistant Pigweed in Soybean and Cotton

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Amaranthus palmeri (also referred to as Palmer amaranth or Palmer pigweed) is considered the most troublesome weed in Arkansas crop production. The rapid growth, aggressive competition, extremely prolific seed production and germination throughout the season make Palmer amaranth a multimillion dollar pest each year in our state.

Glyphosate-tolerant crops, especially cotton and soybean, have been readily adopted by farmers. Currently, greater than 98% of these crops planted in Arkansas are glyphosate-tolerant. Adoption of glyphosate-tolerant crops has allowed farmers to increase conservation tillage programs and farm a larger number of acres with less equipment and labor. In Arkansas, the number of farms with greater than 2,000 acres has increased by 30% since the adoption of glyphosate-tolerant crops.

Most of the common agricultural practices in use today are built around the use of Roundup Ready®. 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 Palmer amaranth. Pigweeds that cannot be controlled with glyphosate add tremendous cost and cause major shifts in our agricultural production practices. This threat has resulted in an intense interest in developing plans for the prevention and management of Palmer amaranth in cotton and soybean.

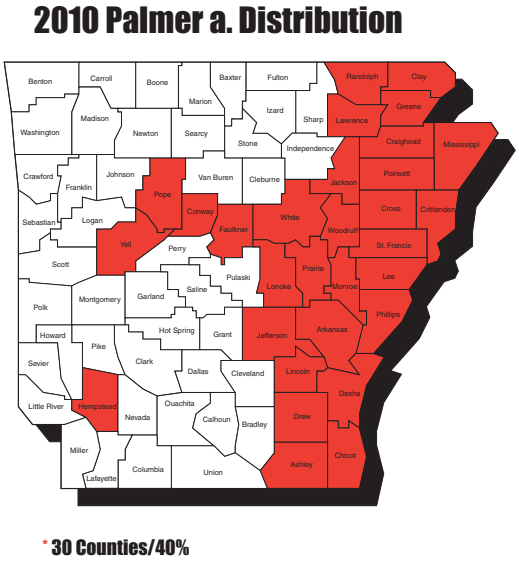

FIGURE 1. Counties highlighted in red contain confirmed cases of glyphosate-resistant pigweed.

A Palmer amaranth population found in Mississippi County during the 2005 growing season was the first confirmed case of glyphosate-resistant pigweed in Arkansas. Since that time, the resistant biotypes have infested all cropping counties in eastern and central Arkansas.

Field and greenhouse experiments have identified Palmer amaranth biotypes that demonstrate varying levels of resistance. Biotype 1 is considered to have a lower level of resistance, and when treated with field doses of glyphosate shows varying levels of symptoms such as chlorosis, necrosis and stunting. The apical bud is often destroyed, but regrowth occurs from lower auxiliary buds.

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FIGURE 2. Pigweed regrowth following a glyphosate application. *(Photo by Dr. Larry Steckle)*

FIGURE 4. Clumped pigweed distribution pattern.

The succeeding generations of this biotype continue to segregate, exhibiting varying levels of susceptibility and resistance. This is sometimes referred to as "creeping 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 improve control of this biotype.

Biotype 2 is less common, but when first 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. These populations exhibit fewer or no symptomology when treated with glyphosate doses as high as four times normal field rates. 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. Both biotypes are widespread throughout Arkansas and Tennessee cropping areas.

Palmer amaranth is a dioecious species having male and female plants. A single female is capable of producing more than 1.5 million seed when allowed to grow with little competition and commonly produces 150,000 to 200,000 when competing with cotton or soybean.

FIGURE 3. Scattered pigweed distribution pattern.

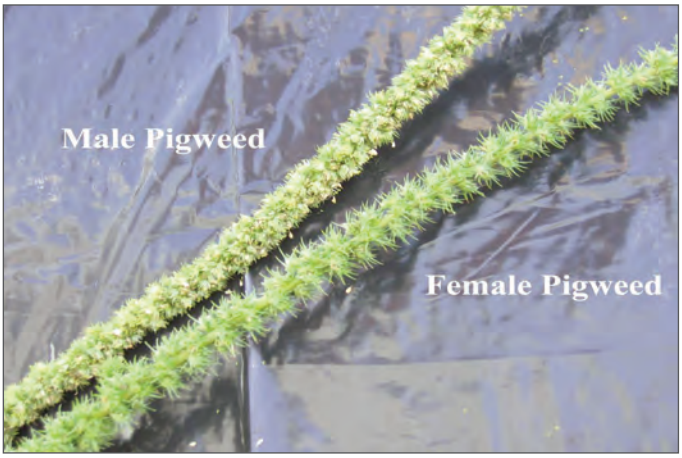

FIGURE 5. Reproductive structures of male and female pigweed plants.

This highly prolific characteristic allows pigweed to completely dominate a field under less than optimum management. An example would be to assume only one female plant escaped that produced 150,000 seed in year one. Pigweed seed are not long-lived in the soil, and predation by soil insects and microorganisms is high. But if only 10% of the seed survive and an effective herbicide program is imposed that controls 99% of these, 150 plants are present the following year. If only 50 of these are females and this same scenario of 10% survival and 99% control is carried out one more year, there are now 7,500 surviving plants. For this reason, there is no economic threshold for pigweed management. Near zero tolerance is required each year.

Utilizing residual herbicides and maintaining full labeled rates of all herbicides are essential to control these weeds. Mechanical removal of scattered weeds escaping herbicide programs is an effective means to reducing the soil seedbank.

FIGURE 6. This pigweed plant produced over 1.5 million seed.

Weed scientists feel that other weeds will also evolve to resistance populations under heavy selection pressure where glyphosate is the major herbicide used. Following good resistance management practices for pigweed may also reduce the occurrence of future weeds that are resistant to glyphosate.

Recommendations for the Control of Glyphosate-Resistant Pigweeds in Soybean

A carefully planned herbicide program may provide effective control of Palmer amaranth and other pigweed species in soybean. Various herbicides may be used interchangeably and selected based on weed spectrum, price and availability. In addition to herbicides, certain practices such as drill seeding, irrigation to activate pre herbicides and crop rotation can have significant impact on the success of managing Palmer pigweed.

The following are some possible specific program approaches for the control or prevention of glyphosate-resistant pigweed in soybean. See the publication MP44, *Recommended Chemicals for Weed and Brush Control*, for a complete listing of herbicides that offer good control of Palmer amaranth in soybean and other crops.

- Begin with clean fields by utilizing a good burndown program of glyphosate or Gramoxone (paraquat) plus Valor at recommended rates. Tillage can also be utilized instead of chemical control and is good resistance management. Valor and other residuals should not be applied more than 10-14 days prior to planting soybean.

- Where tillage is used to start with a clean seedbed, begin with a true preemergence application of Dual, Valor, Authority MTZ or one of the Valor-containing premixes, such as Envive. In addition pendimethalin (Prowl) or trifluralin (Treflan) products applied preplant incorporated will also provide control or suppression of Palmer amaranth. Whether used in a burndown or preemergence application, both Valor and Dual Magnum should provide 3-4 weeks of residual control of Palmer amaranth under favorable conditions. Prefix (Dual + Reflex) is an excellent residual material for pigweed control; however, due to label restrictions on the total amount of fomesafen (Reflex/Flexstar) that can be used in a single growing season, this treatment should be reserved for POST application of either Prefix, Flexstar or Flexstar GT (fomesafen + Roundup).

- Flexstar at 1.25 pints per acre in-crop will provide good control of Palmer amaranth that is below two inches tall. This may be as early as 10-14 days after soybean emergence. Flexstar can be tank-mixed with glyphosate for effective control of other weeds present.

- Prior to Palmer amaranth emergence, Sequence herbicide (glyphosate + metolachlor) or a similar tank-mix can be used early-POST to extend the residual control of pigweed.

- Crop rotation to rice is a good resistance management strategy. However, care should be taken to control Palmer amaranth around the edge of rice fields and on the levees.

  Rotation to Liberty Link® soybean and proper use of Ignite herbicide is a good resistance management option. Ignite should be applied to 2-3 inch pigweed, following an effective residual (pre-emerge) treatment, such as Prefix. If no residual is used, Ignite should be tank mixed with a residual product like Dual, Warrant (acetochlor) or Prefix and applied to 2-3 inch pigweed approximately 7-14 days after soybean emergence. Use full labeled rates. Make a sequential application of Ignite when pigweeds reemerge, prior to canopy closure.

- If you suspect a field has resistant Palmer amaranth, always clean equipment prior to moving from that field to another area. Combines and other equipment will spread resistant pigweed from one field to the next.

Recommendations for the Control of Glyphosate-Resistant Pigweed in Cotton

Acceptable weed control in cotton has traditionally required a combination of herbicides without sole reliance upon glyphosate. However, glyphosate did

offer a very effective postemergence option to remove existing pigweed. There are no effective over-the-top postemergence herbicide options for removing glyphosate-resistant pigweed after they germinate in cotton. For this reason, it is imperative that pigweed never be allowed to germinate and all escapes be mechanically removed.

- **Start Clean:** This may be accomplished with tillage or by using a residual herbicide such as Valor or Direx in burndown programs. If pigweeds have germinated and are present at planting time, they must be removed either by tillage or with paraquat herbicide. Reflex alone is not an extremely effective herbicide for removal of existing pigweed.

- **Use a Preplant or Preemergence Herbicide:** Reflex preplant or Cotoran, Direx or Caparol applied PRE is essential for a good start on pigweed control. It is felt that Reflex is too injurious to apply preemergence on most Arkansas soils. However, when applied preplant and allowed to receive a rainfall event prior to planting, crop safety is very good. If Reflex cannot be applied preplant, a preemergence herbicide applied at planting is essential.

- **Overlapping residual herbicides:** The only way to ensure pigweeds do not germinate is to overlap residual herbicides. Metolachlor (Dual Magnum) or acetochlor (Warrant) applied over-the-top of 1-2 true leaf cotton and again when the cotton reaches 6-7 leaf will provide control after the preplant herbicide begins to break.

- **Scouting:** Although cultivation is the only effective technique available to remove pigweed from young cotton, directed postemergence applications are very effective after cotton reaches 6-8 leaf and begins to develop bark on the lower stem. Careful scouting can identify escapes or breaks in residual herbicides and allow post-directed applications of herbicides such as Caparol + MSMA while weeds are still young and a height differential between cotton and weeds is present.

- **Layby:** A post-directed application of residual herbicides combined with something to remove any late-germinating small pigweed will help to keep fields clean until harvest.

Crop rotation to Liberty Link™ cotton, conventional corn or grain sorghum is also a good resistance management strategy. Although Palmer amaranth plants produce a tremendous number of seed, the seed do not live long in the soil. One to two years of an alternate crop that can be kept Palmer amaranth-free will significantly reduce the population level of pigweeds. It is imperative to remember that each Palmer amaranth plant is capable of producing a quarter-million seed that drop back onto the soil. One plant not controlled is sufficient to cause problems next year. Escapes must be controlled prior to seed production.

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

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