

# Palmer Amaranth Management in Soybeans



## Palmer Amaranth Distribution and Biology

- Native to the southwestern United States, Palmer amaranth (aka Palmer pigweed) has become a devastating weed problem in the South and has recently spread to the Upper Midwest.
- Palmer amaranth is the most competitive and aggressive pigweed species. Season-long competition by Palmer amaranth at 2.5 plants per foot of row can reduce soybean yield by as much as 79%.
- Palmer amaranth emerges later than many summer annual weeds and continues to emerge throughout the growing season. This extended emergence pattern makes it difficult for preemergence and nonresidual post-emergence herbicides to control later-emerging plants.
- The high relative growth rate of Palmer amaranth makes control with post-emergence herbicides difficult. In the southern United States, Palmer amaranth has been documented to grow as much as 2.5 inches per day. In Michigan, Palmer amaranth grows 4 inches in less than five days during the time of post-emergence herbicide applications.



Joseph M. DiTomaso, University of California, Davis, Bugwood.org

Entire plant (pictured): Palmer amaranth has a dense cluster of leaves at the top of the canopy.

- Prolific seed production has perpetuated the establishment and spread of Palmer amaranth. A single female Palmer amaranth can produce approximately 600,000 seeds per plant.
- Compared with many other summer annual weeds, Palmer amaranth seed is relatively short-lived in the soil. Research has shown that only 2% of Palmer amaranth seed remains viable in the soil seedbank after six years. However, the sheer number of seeds produced by one female plant makes the eradication of Palmer amaranth difficult once it is established.

## Genetic Diversity and Herbicide Resistance in Palmer Amaranth

- Palmer amaranth is dioecious, meaning its male and female flowers grow on separate plants. This increases the genetic diversity of this species and facilitates the spread of herbicide resistance and other adaptive traits that improve the survival of Palmer amaranth in agronomic systems.
- Since the late 1980s, Palmer amaranth has evolved resistance to eight different herbicide sites of action.
- Several populations across the United States exhibit resistance to multiple herbicides. For example, many Palmer amaranth populations exhibit resistance to both ALS-inhibiting herbicides (Group 2) and glyphosate (Group 9). More recently, Palmer amaranth has been identified as being resistant to as many as five different herbicide sites of action within different populations. Resistance to combinations of ALS inhibitors (Group 2), microtubule inhibitors (Group 3), synthetic auxins (Group 4), photosystem II inhibitors (Group 5), glyphosate (Group 9), PPO inhibitors (Group 14) and long-chain fatty acid-inhibiting herbicides (Group 15) have been identified in Kansas and Arkansas populations. As the selection pressure from other herbicides increases, multiple resistant populations will evolve.

## Palmer Amaranth Management in Soybeans

Table 1. Different Palmer amaranth populations around the U.S. have evolved resistance to one or more of the following herbicide sites of action.

Group #	Group 2	Group 3	Group 4	Group 5	Group 9	Group 14*	Group 15	Group 27
Site of Action	ALS Inhibitors	Micro-tubule Inhibitors	Synthetic Auxins	Photo-system II Inhibitors	EPSP Synthase Inhibitors	PP0 Inhibitors	Long-Chain Fatty Acid Inhibitors	HPPD Inhibitors
Product Examples	Classic <sup>®</sup> , Pursuit <sup>®</sup>	Treflan <sup>®</sup>	2,4-D	atrazine, metribuzin	glyphosate	Flex-star <sup>®</sup> , Cobra <sup>®</sup> , Ultra Blazer <sup>®</sup>	Dual II Magnum <sup>®</sup>	Callisto <sup>®</sup> , Laudis <sup>®</sup>

\*Several preemergence Group 14 herbicides may still be effective (i.e., Valor and Authority products).

### Management of Herbicide-Resistant Palmer Amaranth in Soybeans

Palmer amaranth with resistance to one or more herbicides is one of the most difficult weeds to manage in soybeans. If you have herbicide-resistant Palmer amaranth in your soybean fields, it is important to follow the steps below for best management. Additionally, cultural practices such as earlier planting, narrow row spacing and optimum planting populations can increase the soybean plant's ability to compete with this weed and will also improve the consistency of the herbicide programs listed below.

**Consider planting soybean varieties with different herbicide-resistant traits:** Soybean varieties with different herbicide-resistant traits provide additional options for management of herbicide-resistant Palmer amaranth.

**LibertyLink<sup>®</sup>, LibertyLink GT27 or Enlist E3<sup>®</sup> soybeans:** Due to the limited post-emergence (POST) herbicide options available, label restrictions and lack of consistency observed with post-emergence herbicides, control of multiple-resistant Palmer amaranth is a challenge in Roundup Ready soybeans. With LibertyLink, LibertyLink GT27 and Enlist E3 soybeans, there is more flexibility in use rates and the number of glufosinate (Liberty<sup>®</sup>, Interline<sup>®</sup>, Scout<sup>™</sup>, etc.) applications that can be made. Information on glufosinate use for POST control of Palmer amaranth is outlined in Step 3.

**Enlist E3 soybeans:** In addition to glufosinate resistance, Enlist E3 soybeans are also resistant to the choline salt of 2,4-D and glyphosate. The use of Enlist One<sup>®</sup> (2,4-D choline) or Enlist Duo<sup>®</sup> (2,4-D choline + glyphosate) in Enlist E3 soybeans provides additional POST options for Palmer amaranth control (see Step 3). These products will not control

Palmer amaranth resistant to 2,4-D herbicides (Group 4). Make sure to follow Enlist One and Enlist Duo labels for specific use guidelines, precautions and restrictions.

**Roundup Ready 2 Xtend<sup>®</sup> soybeans:** The use of registered dicamba products in Roundup Ready 2 Xtend (dicamba-resistant) soybeans provides growers with an additional option for POST Palmer amaranth control. However, due to label restrictions, growers should weigh the risks associated with POST dicamba applications prior to using this technology. Currently, if Xtend soybeans are used, the dicamba formulations of XtendiMax<sup>®</sup>, FeXapan<sup>®</sup> or Engenia<sup>®</sup> may be applied as the POST herbicide option (see Step 3) if farmers or commercial applicators have existing stocks and the herbicides are applied prior to individual state label cutoffs or July 31, 2020, whichever is more restrictive. Another herbicide option in Xtend soybeans is Tavium<sup>®</sup>. This premixture not only includes dicamba, but also includes Dual Magnum<sup>®</sup> (s-metolachlor), providing additional residual Palmer amaranth control outlined in Step 4. If using any of the registered dicamba formulations in Xtend soybeans,



Palmer amaranth has rounded leaves, with some having petioles longer than the leaf blade.

Bruce Ackley, The Ohio State University, Bugwood.org

make sure to follow the specific state restrictions and additional restrictions and precautions outlined on the label. The Environmental Protection Agency is currently reviewing new registrations for dicamba-containing herbicides for 2021 and beyond. Following the five steps outlined below helps ensure successful management, regardless of soybean trait.

## Steps to Successful Palmer Amaranth Management

- 1. Start clean!** Make sure that all Palmer amaranth plants are controlled with tillage or an effective burndown herbicide, i.e., Gramoxone (Group 22), Liberty (Group 10), 2,4-D or dicamba (Group 4), prior to planting soybeans. Some herbicides may require certain soybean traits or waiting a certain number of days before planting. Read and follow all label requirements.
- 2. Effective soil-applied (preemergence) herbicides are essential.** Apply the full rate (according to label guidelines for soil type and organic matter content) of an effective soil-residual herbicide, prior to or soon after soybean planting. Valor® (Group 14), Fierce® (Groups 14 and 15) and Fierce® MTZ (Groups 5, 14 and 15) have been the most consistent control options. Dimetric® Charged and Trivence® (Groups 5 and 14), Envive®, Surveil® and Valor® XLT (Groups 2 and 14) are also Valor (flumioxazin)-based products that have provided good control. Premixes that contain the Group 14 herbicide Spartan® (sulfentrazone), Authority® MTZ (Groups 5 and 14), Authority Edge®, Authority Supreme and Authority Elite or BroadAxe® (Groups 14 and 15), Authority Assist, Authority First, Authority MAXX, Authority XL and Sonic® (Groups 2 and 14) have also shown positive results. However, rates need to be equivalent to 8 fl oz/A of Spartan (0.25 lb ai/A of sulfentrazone). Adding metribuzin (Group 5) to Valor or an Authority brand herbicide or applying premixtures that contain these products may provide additional residual control of Palmer amaranth. Remember, higher rates of the Group 14 herbicides also increase the likelihood for soybean injury. Group 15 herbicides have provided fair to good initial control of glyphosate/multiple-resistant Palmer amaranth. Of the Group 15 herbicides, Zidua® (pyoxasulfone) and pyoxasulfone-based products have provided the most consistent control even on Group 15 resistant Palmer amaranth, followed by Warrant® (acetochlor) and then Outlook® (dimethenamid-P) products. Control with Dual II®, Dual II Magnum and Cinch® (s-metolachlor) products has been most affected by Group 15 resistance. However, Group 15 herbicides may be

best utilized as tank mixtures with the post-emergence herbicide application.

### 3. Timely post-emergence herbicide applications.

Proper timing is everything! Post-emergence herbicides must be applied before Palmer amaranth are 3 inches tall. Spray coverage is essential with any of these herbicides, so a minimum of 15 gallons per acre of spray solution should be used. Once plants exceed 3 inches tall, control with many of the post-emergence herbicides is substantially reduced.

- Glyphosate-tolerant soybeans: The Group 14 herbicides, such as Flexstar®, Cobra® or Ultra Blazer, should be used. Flexstar has been the most consistent of these herbicides for Palmer amaranth control. The use of a methylated seed oil with these herbicides may also improve control.



Rebekah D. Wallace, University of Georgia, Bugwood.org

*A large flush of Palmer amaranth in soybeans. Palmer amaranth generally have long terminal branches greater than a half inch in diameter.*

None of these herbicides will control Group 14-resistant Palmer amaranth which is widespread in many Midsouth and lower Midwest states.

- LibertyLink or LibertyLink GT27 soybeans: Use 32–43 fl oz/A of Liberty (Group 10) or other glufosinate herbicides. Ammonium sulfate should always be included. Use the higher glufosinate rate to control taller plants or plants that have escaped initial control.
- Enlist E3 soybeans: Apply Enlist One (32 fl oz/A), Enlist Duo (4.75 pt/A), Liberty (32–43 fl oz/A) or a combination of Enlist One + Liberty POST prior to Palmer amaranth exceeding 4 inches in height. Under high Palmer amaranth populations, the combination of Enlist One + Liberty or sequential applications of Enlist Duo and Liberty herbicides provide more consistent control. Only approved spray additives and herbicides can be tank mixed with these products. The list of these approved products is found at [EnlistTankMix.com](http://EnlistTankMix.com).

- Roundup Ready 2 Xtend soybeans: Apply XtendiMax, FeXapan (22 fl oz/A) or Engenia (12.8 fl oz/A) POST prior to Palmer amaranth exceeding 4 inches in height. These products may only be applied if farmers or commercial applicators have existing stocks and can only be used through individual state label cutoffs or July 31, 2020, whichever is more restrictive. Tavium (56.5 fl oz/A), the premixture of dicamba + s-metolachlor, can also be applied POST. Only approved spray additives and herbicides can be tank mixed with these products. Consult the label for days after planting and crop growth stage restrictions and additional precautions for use of these products.
- 4. Residual product tank mixtures with post-emergence herbicides.** A residual Group 15 herbicide (i.e., Dual II Magnum, Warrant, Outlook or Zidua) should be tank mixed with the post-emergence herbicide application. It is essential for the post-emergence herbicide — Flexstar, Cobra, Ultra Blazer, Liberty (LibertyLink, LibertyLink GT27 or Enlist E3 soybeans only), Enlist One, Enlist Duo (Enlist E3 soybeans only) or registered dicamba products (Xtend soybeans only) — to have effective control of herbicide-resistant Palmer amaranth, since the residual herbicides will not control emerged plants. Several premixes (i.e., Prefix and Warrant Ultra) contain an effective POST with a residual herbicide. In Xtend soybeans, the premixture Tavium contains an effective POST with a residual herbicide. Consult the appropriate label or product website to confirm whether a tank mixture is approved.
- 5. Additional post-emergence herbicide applications if needed.** In conventional or glyphosate-resistant soybeans, if Flexstar was used in the first post-emergence application, Cobra or Ultra Blazer are the only Group 14 herbicide options remaining. If plants are larger than 3 inches, you will have to use 12.5 fl oz/A of Cobra. The use of a methylated seed oil with these mixes may also improve control. In LibertyLink, LibertyLink GT27 or Enlist E3 soybeans, Liberty should be applied at rates ranging from 32 to 43 fl oz/A, depending on weed height. In Enlist E3 soybeans, a second application of Enlist One or Enlist Duo may be applied if applications occur no later than R2 soybeans. Follow-up applications in Xtend soybeans with a registered dicamba formulation may be more difficult

due to the 45 days after planting cutoff date and some state restrictions.

While following these strategies may not be 100% effective, they can substantially reduce herbicide-resistant Palmer amaranth populations. Additional cultural control measures, such as hand-weeding, should be implemented to eliminate any remaining herbicide-resistant Palmer amaranth plants from the field. It is also important to manage Palmer amaranth around field edges and ditch banks. Remember, one female plant can produce approximately 600,000 seeds. It is important to reduce seed production from this weed to stop its further spread. If you think you have this weed or other glyphosate-resistant/multiple resistant weeds in any of your fields, make sure these are the last fields you harvest. This will reduce the transportation of resistant weed seed to your other fields.



Ross Recker, University of Wisconsin-Madison, Bugwood.org

*Entire plant (pictured): Palmer amaranth grows 4 inches in less than five days during the time of post-emergence herbicide applications. A single female Palmer amaranth can produce approximately 600,000 seeds per plant.*

**For more information and links to additional resources, visit [www.IWillTakeAction.com](http://www.IWillTakeAction.com).**

Technical editing for this publication was led by Christy Sprague, Ph.D., Michigan State University, in partnership with other universities in the soybean-growing regions of the United States. Take Action is supported by BASF, Bayer, Corteva, FMC, Syngenta and Valent, and corn, cotton, sorghum, soy and wheat organizations. The United Soybean Board and all Take Action partners neither recommend nor discourage the implementation of any advice contained herein, and are not liable for the use or misuse of the information provided. ©2020 United Soybean Board. 59783 08/2020

Brought to you by the soy checkoff.

