

## Palmer Amaranth in Maryland

Palmer amaranth, *Amaranthus palmeri*, is an invasive weed in the pigweed family that has become a major challenge for farmers across the U.S. for much of the last decade. Native to the Sonora Desert of Arizona and Northern Mexico, Palmer amaranth is well adapted to Maryland's hot summers. It was first discovered in Maryland during the mid-twentieth century, but the presence of herbicide-resistant Palmer amaranth was not confirmed until 2014. Since then it has spread to most regions of the state including Eastern, Southern, and Western Maryland. Contaminated equipment (especially combines), feed, and seed from infested areas has hastened the spread of Palmer amaranth.

Palmer amaranth is a summer annual which typically begins to emerge in late April and early May. Seeds are small and typically germinate from the top inch of soil. Germination can continue throughout the summer and early fall. Palmer amaranth is dioecious, meaning it has separate male and female plants. Female plants only produce seeds, while male plants only produce pollen. Plants grow very quickly with recorded growth of 2-3 inches per day in ideal conditions.

Palmer amaranth will typically grow above a crop canopy before flowering. In corn, the weed can grow to 7-8 feet, while in a soybean system most Palmer amaranth plants will be 3-4 feet tall. Seed and pollen are produced on long seed heads. After maturing, seed is retained in the seed head late into the season and eventually drops to the ground where it overwinters until the following spring. Due to its small size, seed is not viable in the soil for long periods, with 20% or less surviving after 3 years.

Palmer amaranth can be challenging to control, especially in soybeans. Preventing seed from entering a field is the most effective method for control. However, effective control requires an integrated weed management strategy that combines cultural control methods with an effective herbicide program for both corn and soybeans.

### **Palmer Amaranth is of Particular Concern because it is Resistant to Multiple Classes of Herbicides Commonly Used in Grain Production**

In Maryland, researchers have confirmed that Palmer amaranth is resistant to ALS (Group 2) and glyphosate (Group 9) herbicides. It has also shown resistance to four other herbicide groups (3, 5, 14, and 27) in some Southern U.S. states. Palmer amaranth is an extremely competitive weed due to its fast, aggressive growth pattern along with its prolific seed production. Palmer amaranth will typically produce 250,000 seeds from one plant

when competing with a crop and up to 500,000 seeds when growing alone (Legleiter, et al).

Since Palmer amaranth came from the desert Sonoran Desert region of North America, it has adapted to growing in much higher temperatures than most other crops and can also tolerate drought conditions. The optimal temperature for photosynthesis in Palmer amaranth is 108°F, while the optimal temperature for corn is between 77°F and 86°F. The adaptation to hot, dry conditions and aggressive growth rate of two to three inches per day allows Palmer amaranth to outcompete other plants, resulting in yield losses of 91% in corn (Massinga, et al.) and 79% in soybeans (Bensch, et al.).



Figure 1. Mature Palmer amaranth plant with long seed heads

## How Can You tell if You Have Palmer Amaranth?

Several other pigweed species are commonly found in Maryland that look similar to Palmer amaranth, but have different management strategies. For this reason, proper identification is critical to controlling the weed. Palmer amaranth has these distinctive features:

- The seed head of Palmer amaranth is distinctive in that it is much longer than other pigweed species, up to 2 feet (Figure 1). While both male and female plants have long seed heads, the male plant looks and feels smooth whereas the female plant appears and feels sharp and prickly. It is critical to identify and remove Palmer amaranth before it forms a seed head. Using a seed head for identification can be useful to identify escapes for hand removal.
- The leaves and stems of the plant are totally hairless (Figures 4 and 5). Other pigweed species, like smooth and redroot pigweed, have hairs on the leaves and stems. The lack of hairs can be very helpful for distinguishing between pigweed species when plants are very small.
- Palmer amaranth has petioles as long as or longer than the leaf blade (Figure 6). A petiole is the structure that connects the leaf to the main stem of the plant. This key identifying characteristic is more commonly found on the older leaves of the plant.
- Some leaves have a “V” shaped watermark on the leaf surface (Figure 6). The watermark is not found on all Palmer plants so use this feature only as a confirmation that it is indeed Palmer amaranth.
- Palmer amaranth displays an apical meristem growth pattern (Figure 7). The leaves of the plant are arranged to form a rosette appearance, or what looks like a poinsettia when viewed from above.



*Figure 2. Palmer amaranth just starting to form flower buds*



*Figure 3. Mature Palmer amaranth plants in a soybean field. Palmer amaranth will often grow above the crop canopy before setting seeds.*





*Figure 4. Female palmer amaranth plant. Female palmer amaranth plants can have a prickly feel due to stiff bracts at the leaf axil. Palmer amaranth has no long thorns like spiny amaranth. Male plants do not have these stiff bracts and thus have a softer feel*



**Redroot Pigweed**

**Palmer Amaranth**

*Figure 5. Palmer amaranth plants lack hairs along the stem and leaves. Redroot pigweed and Smooth pigweed both have small pubescent hairs that line the stem and leaves. This is a very helpful identification tool, especially when the plants are very small.*



*Figure 6. Redroot pigweed (on the left) will have petioles that are shorter than the leaf blade. Palmer amaranth (three leaves on the right) will have petioles as long as or longer than the leaf blade. The watermark on the leaf (second from the right) is not found on all Palmer plants and other pigweed species may have a watermark as well, so do not use this feature only as a confirmation that it is indeed of Palmer amaranth.*



*Figure 7. Palmer amaranth's growth pattern, when viewed from above, has a rosette like appearance where the leaves circle around the stem resembling a poinsettia.*



## **Due to its Aggressive Growth Habit, Herbicide Tolerance and Prolific Seed Production, Palmer Amaranth is Classified as a 'Zero-tolerance' Weed, Meaning Just One Plant is too Many**

Once introduced, controlling Palmer amaranth, especially in soybeans, is not easy. Farmers should use several management strategies in an integrated approach to adequately manage this new weed. Chemical control options are most effective when used in combination with cultural practices like cover crops, crop rotation, managing the seed bank, and isolating infested fields.

### **Most Effective Management Strategy is Prevention and Early Detection**

Scouting your fields regularly so you can recognize and eliminate Palmer amaranth plants before they produce seeds is the first step in a control program. If you observe weeds that survive an herbicide application, be sure to take extra time to identify those plants and determine why the herbicide did not work.

Bag and remove Palmer amaranth plants you find in the field. Palmer amaranth is very good at re-rooting or re-sprouting, so you should carry plants out of the field that are greater than 12 inches in height. In cases where there are too many plants to remove, consider hiring a weeding crew or destroying the crop and Palmer amaranth for that year. Mowing can reduce seed production, but you will need to mow repeatedly since new growth occurs from the base of the plant.

Preventing seeds from entering the farm is also important. Equipment is the most common method for moving seeds. Palmer amaranth seeds move readily in and on equipment, particularly combines. When harvesting crops, do not move equipment between infested and non-infested fields. Clean equipment thoroughly between fields using a leaf blower or compressed air. Sending one or two bales of clean straw through the combine before entering non-infested fields can also help to dislodge seeds. Be careful when buying used equipment. Ask where the equipment originated from and whether that area has Palmer amaranth or other herbicide-resistant weeds.

Cotton meal or hulls used for livestock feed as well as straw, hay or mulch from infested fields can carry Palmer seeds. Palmer amaranth seed can survive the digestive system of most animals and the seeds remain viable in manure. In Maryland, we have not observed any movement of Palmer amaranth seeds in chicken litter. We have observed movement from beef and dairy cattle. Waterfowl and other wildlife can also carry Palmer amaranth. A study in Missouri during the 2015 and 2016 confirmed the presence of viable Palmer amaranth seeds, among many other weeds in ducks and geese (Farmer, et al. 2017).

### **Soybeans are one of the Most Difficult Crops in Which to Manage Palmer Amaranth**

Palmer amaranth is broadleaved and the herbicide options are much more limited for soybeans compared to corn or sorghum. In addition, soybeans are often planted later in the season when temperatures are higher and Palmer amaranth grows faster.

The following suggestions are all important for successful Palmer amaranth management in soybeans:

- **Start clean.** Options for effective post-emergent control in soybean are limited and you should use the few options available when Palmer amaranth plants are less than 3-4 inches tall. Palmer amaranth plants bigger than 4 inches are often only partly suppressed by herbicides and will grow back after a period of recovery. Fields should be cleaned of all Palmer amaranth before the crop emerges. Paraquat (Gramoxone® or generic alternatives) is an effective burn down treatment for smaller plants provided it is applied with adequate water and spray coverage is adequate. Other options include products like 2,4-D, saflufenacil (Sharpen®), or dicamba. Each of these products have plant-back restrictions. Glyphosate, while not effective on Palmer amaranth, can still be added to control other weeds present.

- **Use an effective residual herbicide with at least two effective modes of action as close to planting as possible.** The best residual herbicides will provide 3-4 weeks of control in most cases. While this added control might not seem like a lot, but it gives the soybeans more time to establish a closed canopy and provides added time to apply post-emergent controls. You should apply residual herbicides as close to planting as possible to extend the period of control as far into the growing season as possible.

Results from trials conducted in Maryland indicate significantly better control of Palmer amaranth with the use of any residual product when compared to a non-treated control. Products with flumioxazin (Valor®) including premixes of Fierce® or Fierce XLT® or products with sulfentrazone (Authority®) including premixes Broadaxe®, Authority Elite®, or Authority MTZ® provided the most consistent control.

Tank-mixing products with different modes of action often result in better control than either product applied alone. Dual®, Prowl®, Zidua®, and Metribuzin® are good examples of tank-mix partners for many residual products. Tank mixing is also important to help delay additional herbicide resistance, especially to group 14 (PPO inhibiting) products. The use of a residual herbicides also results in significant differences in weed height over the length of the season. This reduction is especially advantageous in that it provides a longer period for the timely and thus effective application of post-emergent herbicides. Be sure to read labels carefully for factors such as application rates and plant-back restrictions.

- **Apply an effective post-emergent herbicide before Palmer amaranth plants reach 3-4 inches in height.** In Maryland trials, this occurred approximately 24 days after planting with a residual herbicide application. In many cases, the average height will significantly exceed 4 inches by 32 days. The tight application window means having a sprayer and operator ready to go when needed. In conventional or Roundup Ready beans, the post-emergent choices are limited to diphenylether herbicides such as Reflex®, Cobra® or Ultra-Blazer®. In Maryland, Reflex® (fomesafen) can only be used once every two years. These products require good coverage with at least 20 gallons of water and the proper adjuvant for effective weed control. Growers may consider the use of a post-emergent delayed residual product, like Dual®, Warrant® or Zidua® to extend the length of residual control.

- **Consider Liberty-Link® Soybeans.** Liberty-Link® soybeans are tolerant of the herbicide glufosinate, sold under the brandname Liberty®. Glufosinate is a contact herbicide, so good coverage is important to achieve weed control (at least 20 gallons of spray volume). It provides effective control of emerged Palmer amaranth plants if applied when the plants are still small-- up to 3-4 inches. Liberty® is weaker on grasses and perennial broadleaves than Roundup. Liberty-Link® beans are **not** tolerant to glyphosate, the active ingredient in Roundup®. A residual program is still recommended when using the LibertyLink® program. Bayer anticipates that there will be a limited release of soybeans during the 2019 growing season with tolerance to glufosinate and glyphosate, sold under the brand name LibertyLink GT27®. These soybeans will provide another option for growers, allowing post-emergent applications of both glufosinate and glyphosate.
- **Consider Roundup Ready Xtend® Soybeans.** RRXtend® soybeans are tolerant to dicamba and glyphosate. Growers may only use dicamba formulations approved for use on RRXtend® soybeans in their state. In Maryland the only dicamba formulations that have received approval are Xtendimax®, Fexapan® and Engenia®. These products contain improved anti-volatilization chemistry, which reduces vapor drift from treated fields. The approved dicamba formulations provide effective control of emerged Palmer amaranth plants up to 4 inches tall. They may be used as a pre-plant burndown or for in-season, post-emergent applications. There are a number of label restrictions such as buffer requirements, tank-mix limitations, tank clean-out requirements, specific nozzle requirements, and wind speed restrictions.
- **Each applicator must compete an annual training certification program approved by their state before using Xtendimax®, Fexapan® or Engenia®.** Dicamba will severely injure most vegetable crops, non- Xtend soybeans, tobacco, fruits crops, landscape plantings and other sensitive plants. Growers are cautioned to only use these products according to label directions and to use due diligence to avoid off-target movement of dicamba. You should not use non-approved dicamba products cannot be used on RRXtend soybeans. A residual program is still recommended when using the Xtend program.
- **Manage escapes.** Hand pull any escaped plants before they go to seed. If escapes cannot be destroyed and Palmer amaranth is not present on other parts of the farm consider tillage to kill all plants and minimize the seed bank. Palmer amaranth seeds are relatively short-lived. If you are able to avoid new seed production for a few years, the seed bank will be dramatically reduced.
- **Isolate infested fields and harvest last.** For any Palmer amaranth that do go to seed, be sure to harvest infested fields or areas last during the harvest season. This step will prevent machinery from spreading seed to new fields. If the area is small, it may be better in the long run to avoid harvesting that area entirely and destroy the crop and weeds in that spot. The key to controlling Palmer is to prevent its spread.

**Managing Palmer Amaranth in Corn can be Less Challenging than in Soybeans but Careful Management is Still Required**

Generally, herbicide modes of action used for corn are different from those for soybeans, providing a level of herbicide rotation. Effective pre-emergence options in corn include the Atazine, Dual® or Harness®, Prowl®, and HPPD inhibitors and others. Additionally, there are more effective post-emergence options available for Palmer amaranth control in corn. Growers must make post-emergence applications with effective modes of actions to weeds three inches or less. These herbicides include Callisto®, dicamba, atrazine, and Liberty (Liberty-Link® corn only). Callisto® and generic HPPD herbicides should be tank-mixed with atrazine for optimum control. It is also important to remember that dicamba and Liberty provide no residual so they should be tank-mixed with a residual herbicide.

Pesticide Disclosure: **Be sure to read and follow all pesticide label directions.**

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