



Palmer amaranth (*Amaranthus palmeri* S. Wats) has moved into the Mid-Atlantic region over the past 10 to 15 years and has been declared a noxious weed in Delaware. It is in the pigweed family, closely related to smooth and redroot pigweed, but with a few key differences related to management:

- The germination period of Palmer amaranth is much longer than other pigweed species;
- It grows much faster under summer conditions (Figure 1); and
- It produces a lot more seeds per area; and it can cause significantly more yield loss.

Effectively controlling Palmer amaranth in soybeans often requires applying postemergence herbicides, three to four weeks after planting. At that time, the soybean canopy may still be a few weeks away from closure (leaves touching between the rows to block sunlight and stop additional seedling emergence). As a result, postemergence applications need to include an additional residual herbicide to provide control until the soybeans form a tight canopy.

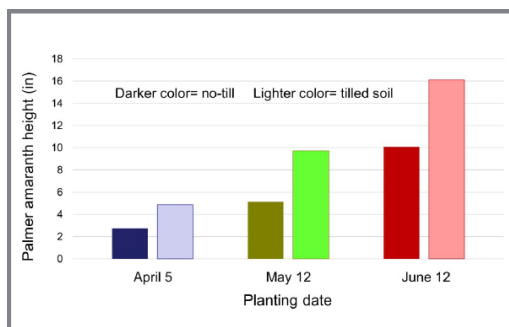


Figure 1. Palmer amaranth height four weeks after emerging in April, May, or June. The later in the season that Palmer amaranth emerges, the faster the plants grow regardless of tillage systems. Source: Unpublished data from University of Delaware in 2019 and 2020.

Fields infested with Palmer amaranth often are not treated in a timely manner due to weather, equipment issues, timing, or desire to reduce the number of applications. As a result, many Palmer amaranth plants are more than 4-inches tall when herbicides are applied. In order to provide advice and suggestions for situations with large plants, University of Delaware and Virginia Tech conducted similar studies of Palmer amaranth control with funding from both the Delaware and Virginia Soybean Boards.

Common treatments applied to tall Palmer amaranth plants (over 16 inches) in soybeans were:

- Dicamba (XtendiMax or Engenia) plus glyphosate
- 2,4-D choline (Enlist One) plus glyphosate
- Glufosinate (Liberty) alone
- Glufosinate plus Enlist One
- Glufosinate plus glyphosate
- Fomesafen plus glyphosate (Flexstar GT)

Comparisons across 10 trials revealed:

- Weeds do not germinate at the same time and growth rates can vary, so treatments typically killed smaller, later-emerging plants, reducing overall density of Palmer amaranth, but did not kill larger, earlier-emerging plants.

- Most treatments caused a lot of damage to large Palmer amaranth plants, even killing some of them, and reduced their competitiveness, often achieved over 70% control.
 - control was slightly higher and more consistent with dicamba- or 2,4-D-based programs compared to glufosinate plus glyphosate;
 - including fomesafen (Reflex or Flexstar GT) or lactofen (Cobra) did not improve control.
- Treatments reduced seed production (Figure 2)
 - **but**, treatments did not eliminate seed production of the surviving plants;
 - **so**, the combine could spread seeds present at harvest within and between fields;
 - and these seeds may contain resistant mutations which confer herbicide resistance due to selection pressure.

Summary of sequential applications.

- Two (sequential) applications of dicamba or 2,4-D, applied at 7- to 10-day intervals, provided at least 99% control of large Palmer amaranth.
- Sequential applications of Liberty were very good, but not as consistent as sequential applications of dicamba or 2,4-D;
 - applying dicamba or 2,4-D followed by glufosinate (7 to 10 days apart) was highly effective and may be necessary due to the June 30th cut-off date for dicamba;
 - glufosinate followed by dicamba or 2,4-D was not as effective.
- Sequential applications were needed to eliminate seed production.

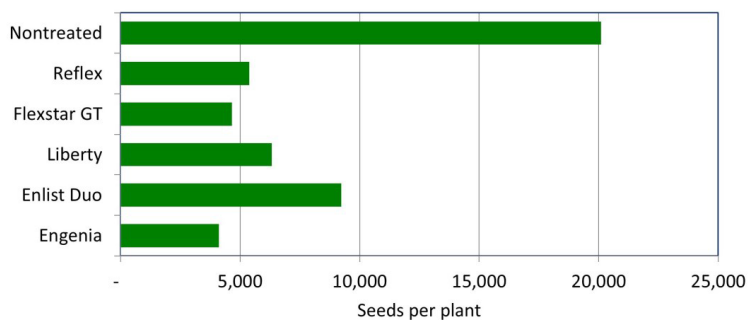


Figure 2. Seeds per plant for Palmer amaranth (over 16 inches at time of application) surviving single herbicide application.

Source: Delaware Soybean Board project in 2018 and 2019.

Stop Seed Production to Control Weeds

Species prone to developing resistance, such as Palmer amaranth, need special attention to limit their spread and avoid the potential of selecting for additional resistance. Zero seed production is the best method. A single herbicide application to large plants likely results in many plants surviving and producing seeds (Figure 2). It is best to plan and treat fields with Palmer amaranth with a soil-applied herbicide and spray a postemergence herbicide before seedlings reach 3 to 4 inches in height (four weeks after planting) and include a residual herbicide to control later flushes. Remove any plants that escape control before seedheads appear.

Table 1. Considerations for postemergence herbicide applications to manage large weeds in soybeans.

CONSIDERATIONS	LIBERTY	ENLIST ONE ^a	ENLIST DUO ^a	XTENDIMAX ^a	ENGENIA ^a
Cutoff date	No	No	No	June 30	June 30
Crop stage cutoff	R1	through R1	through R1	through R1	ns ^b
Pre-harvest interval	70 days	30 days	30 days	7 days	ns
Interval between applications	10 days	12 days	12 days	7 days	7 days
Droplet size	medium to coarse	VC ^b and XC	XC and UC	XC and UC	XC and UC
Technology trait	Liberty Link Enlist E3 XtendFlex	Enlist E3	Enlist E3	Xtend XtendFlex	Xtend XtendFlex

a. Be sure to review manufacturer's website for current recommendations and restrictions related to specific nozzles, tank mixes and adjuvants for Enlist and Enlist Duo, Xtendimax, and Engenia.

b. Abbreviations: VC, very coarse; XC, extra coarse; UC, ultra-coarse; ns, not specified.

Incorporate non-chemical approaches as well such as crop rotation, late-terminated cover crops, narrow row spacing, tillage, or hand removal. Visit GrowIWM.org for more in-depth information.

Other considerations when spraying large weeds:

- Good spray coverage will be difficult; select higher spray volume (> 15 GPA) and appropriate spray tips to maximize coverage (Table 1);
- Yield loss may result from sprayer wheel tracks; larger crop plants are less likely to recover from sprayer traffic damage;
- Even if large Palmer amaranth plants are severely injured, weed competition before the 6th trifoliolate soybean stage often results in yield loss;
- Timely applications will reduce overall costs as well as prevent yield loss (Table 2).

Table 2. Comparison of herbicide costs and timings if applied to 4-inch tall Palmer amaranth (POST1) or applications to manage larger plants with single (POST2) or sequential applications (POST3). Costs are based on using an Enlist E3 variety and herbicide and applications costs are estimates from UMD Extension Soybean Budget Tool (https://awleslie.shinyapps.io/budget_4) and online retail prices.

	Option for 4-inch tall Palmer amaranth	Costs \$	Option for Palmer amaranth over 8 inches tall	Costs \$	Most effective option for Palmer amaranth over 8 inches tall	Costs \$
PRE ^a	Valor EZ (2.5 oz)	10.15	Valor EZ (2.5 oz)	10.15	Valor EZ (2.5 oz)	10.15
PRE ^a	metribuzin (4 oz)	5.00	metribuzin (4 oz)	5.00	metribuzin (4 oz)	5.00
POST1 ^b	Liberty (1 qt)	17.50	n/a		n/a	
POST1 ^b	Reflex ^c (1.5 pt)	10.60	n/a		n/a	
POST2 ^b	n/a		Liberty (1 qt)	17.50	Enlist One (1 qt)	16.00
POST2 ^b	n/a		Enlist One (1 qt)	16.00	n/a	
POST3 ^b	n/a		n/a		Enlist One (1 qt)	16.00
Applications (\$10.25)	two	20.50	two	20.50	three	30.75
Total costs		\$63.75		\$69.15		\$77.90

a. Preemergence herbicides can be substituted for other products; Valor EZ plus metribuzin is often recommended for Palmer amaranth control.

b. Note: POST1= weeds less than 4 inches tall; POST2= larger weeds, often over 8 inches tall; POST3= application 7 to 12 days after POST2.

c. Reflex is often used for postemergence Palmer amaranth control because it provides both postemergence and residual control.

Accreditations

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To learn more, visit <https://bit.ly/3K96s1J>.

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