



Palmer amaranth (*Amaranthus palmeri*) Control in Soybeans

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Palmer amaranth (*Amaranthus palmeri*) is one of the most troublesome weeds in row crops of the mid-Atlantic region. Palmer amaranth plants germinate throughout the growing season, can grow to over 6 feet in height, and produce up to 600,000 seeds per plant (Keeley et al. 1987, Sauer 1955). Eight Palmer amaranth plants per yard of row can result in soybean yield losses of 79% (Bensch et al. 2006). This publication will discuss Palmer amaranth identification, resistance status as well as integrated weed management tactics and herbicide programs for effective, long term control.

Glyphosate (e.g. Roundup) and ALS-inhibiting (such as Classic, Pursuit, etc.) herbicides have traditionally been used by Virginia soybean growers to control Palmer amaranth. Currently glyphosate (group 9)- and ALS (group 2)-resistant Palmer amaranth occurs throughout the soybean growing regions of Virginia. If herbicide resistance status in a field is unknown, growers should assume resistance to herbicide groups 2 and 9. In soybeans without alternative herbicide tolerance traits, this leaves only PPO-inhibiting herbicides (Flexstar, Reflex, Ultra Blazer, Cobra, etc.; group 14) as an effective postemergence options. Reliance on these herbicides alone is not sustainable, as shown by the 2015 confirmation of PPO-resistant Palmer amaranth populations in North Carolina and Tennessee, among other states. For long-term, effective control of Palmer

amaranth, integrated weed management tactics such as cultural and mechanical control must be utilized in conjunction with multiple, effective herbicide sites of action (SOA).

Identification

Palmer amaranth cotyledons are linear to lanceolate in shape (Figure 1). Palmer amaranth can be differentiated from other pigweed species, such as redroot pigweed and spiny amaranth, by its lack of hair and long petiole length (Figures 2 & 3). Palmer amaranth bears separate female (Figure 4) and male flowers (Figure 5). Female flowers can be distinguished by their sharp bracts.



Figure 1. Palmer amaranth cotyledons. Photo credit: E. Scruggs



Figure 2. Palmer amaranth leaves are ovate to diamond shaped. Photo credit: E. Scruggs



Figure 5. Male Palmer amaranth seed head. Photo credit: S. Askew

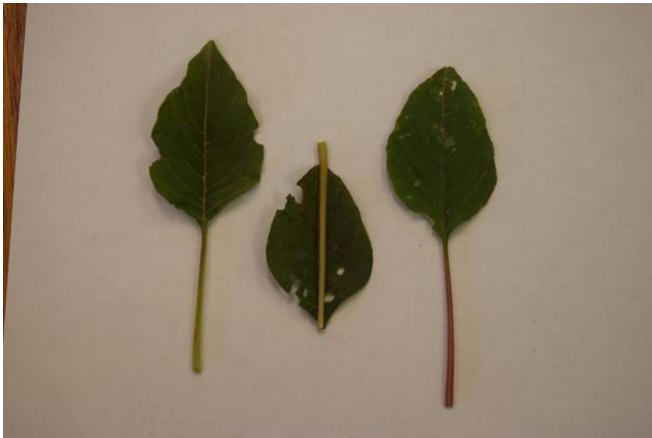


Figure 3. Petioles of Palmer amaranth are typically as long or longer than the leaf itself. Photo credit: E. Scruggs



Figure 4. A female Palmer amaranth seed head. Photo credit: S. Askew

Integrated Weed Management Tactics

Prevention

The prevention of weed infestations is essential to a cost-effective weed management program. Equipment sanitation such as thorough cleaning of harvest and tillage equipment should always be practiced, especially when moving from weed-infested to non-infested fields. It is best to hand pull Palmer amaranth rather than driving a combine through it. If that is not possible, harvest weedy fields last to reduce spread of seed from field to field. In addition, farmers should be cautious when purchasing used combines that have previously harvested Palmer amaranth infested fields. Lastly, ensure weed seed is not introduced through other carriers such as manure and seed.

Cultural

Cultural weed management practices help to increase crop competitiveness against weeds. Such tactics include crop rotation, maintaining optimum fertility, utilizing narrow row spacing (15-inch rows or less), recommended seeding rates, and ensuring a weed-free field at planting.

Cover crops are most effective for weed suppression (Figure 6) when high biomass levels (>7500 lbs dry biomass per acre) are achieved (Mirsky et al. 2011). To ensure high biomass levels, early planting of fall cover crops is crucial. Delayed cover crop termination can also help to increase biomass levels. Termination of cereal rye cover crop about May 1 typically maximizes biomass production. Greenhouse studies in Virginia have shown a 77% Palmer amaranth stand reduction from 9000 pounds per acre of cereal rye biomass (Rector and Flessner 2018).



Figure 6. Comparison of weed control from no-cover (left) vs. fall-planted cereal rye cover (right) on June, 8 weeks after termination with glyphosate. Photo credit: K. Pittman

Mechanical

Mechanical tactics for weed control include tillage, harvest weed seed control, and hand pulling.

Deep tillage with a moldboard plow once every 3-4 years can bury Palmer amaranth seeds to a depth where they are unable to germinate, resulting in up to a 73% reduction in emergence of pigweed (*Amaranthus*) species when compared to no-till production systems (Farmer et al. 2017). Annual use of a moldboard plow reduces tillage's effectiveness since previously buried weed seeds

from earlier passes will be returned to the soil surface. Immediate establishment of a cover crop after fall plowing will provide soil erosion control as well as additional cultural control of seed that were not buried.

Harvest weed seed control has become increasingly popular in Australia where growers are dealing with multiple herbicide resistance issues. Methods of harvest weed seed control include windrow burning, chaff lining, chaff carting, and the Harrington Seed Destructor - an implement which destroys weed seeds exiting the rear of a combine (Walsh et al. 2012). Research in Arkansas has shown up to a 72% reduction in Palmer amaranth using harvest weed seed control alone when compared to conventional harvest (Norsworthy et al. 2016). For more information on harvest weed seed control, see Virginia Cooperative Extension Publication [SPES-135NP, Harvest Weed Seed Control](#).

Hand pulling can be an effective method to remove Palmer amaranth escapes in a field. Do not ignore escapes. When hand pulling, pulled weeds should be removed from the field. Pulled plants left in the field can reestablish roots and still produce seed.

Herbicide Programs

The basis of any weed control program is to start clean and stay clean. This begins with an effective burndown herbicide application. Burndown applications should include at least two effective sites of action for herbicide resistance management.

To stay clean, a pre-emergence application, either applied at planting or with burndown is needed. Application as close to planting as possible is best so that herbicide activity persists for longer into the soybean crop. Postemergence herbicides should be applied with a residual herbicide before weeds reach 4 inches in height. Timing of

application is extremely critical to the success of the herbicide. All applications should include multiple, effective sites of action on Palmer amaranth whenever possible.

All herbicide applications should follow label directions and utilize adjuvants, nozzles, and spray volume listed on the label. Herbicides must be applied at the full labeled rate to ensure control and reduce the possibility of escapes and resistance. The following herbicide programs were developed assuming glyphosate (group 9) and ALS (group 2)-resistant Palmer amaranth, but these herbicides may be utilized for control of other weed species in an herbicide program. Despite a decline in postemergence efficacy, ALS (group 2) herbicides are still useful, preemergence, in controlling Palmer amaranth. Efficacy ratings are based on data from the 2019 Mid-Atlantic Field Crop Weed Management Guide ([456-016](#)).

Pesticide Precautions

Select and use all pesticides carefully. Before using any pesticide, read the instructions printed on the label of its container; follow those instructions, heed all cautions and warnings, and note precautions about residues. Store pesticides in their original containers. Store them where children and animals cannot get to them — away from food, feed, seed, and other materials that could become harmful if contaminated. Dispose of empty pesticide containers in the manner specified on their labels. See your doctor if symptoms of illness occur during or after use of any pesticide.

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Preplant Burndown¹

Apply (SOA #):	With One of the Following (SOA #):	Efficacy Rating:
Gramoxone (22)		9
	2,4-D (4) ²	9
	Xtendimax/Engenia/FeXapan (4) ³	8+
Liberty (10) ⁴		8+
	2,4-D (4) ²	9
	Xtendimax/Engenia/FeXapan (4) ³	8+
Sharpen (14) ⁵		9
	2,4-D (4) ²	9
	Xtendimax/Engenia/FeXapan (4) ³	8+

1. Follow label instructions for rates, adjuvants, timing, soybean size, and rotational restrictions.
2. For full season plantings: Planting intervals for 2,4-D are 1.0 pt/A: 15 days, 1 qt/A: 30 days.
3. For full season plantings: There is no planting interval for Xtend soybeans following applications of new dicamba formulations. For non-Xtend soybeans and other dicamba formulations (Clarity, etc.) planting restriction is 1 inch of rain/irrigation and 14 days at 0.5 pt/A of Clarity.
4. Liberty should be applied 2 hours after sunrise and prior to 2 hours before sunset on hot, humid days. Therefore, Liberty is not typically recommended for use in April.
5. Make no more than two applications of a PPO-inhibiting (group 14) herbicide per season. Do not tank-mix with other group 14 herbicides. Allow 14 days or more between Sharpen and other group 14 herbicide applications.

Preemergence¹

Choose from the Following (SOA #):	Efficacy Rating:
Dual products/Cinch (15)	8+
Lorox/Linex (7)⁸	7
Outlook (15)	8
Prowl (3)	8
Reflex (14)^{4,6}	9
Spartan (14)	9
Treflan (3)²	9
Valor (14)⁴	9
Warrant (15)	8
Zidua (15)	9
Metribuzin (5)^{5,8} (Consider adding to the products above to increase control)	9
Or Choose a Premix (SOA #):	
Afforia (2/2/14)^{3,4}	9
Anthem (14/15)⁴	9
Anthem Maxx (14/15)⁴	9
Authority Elite (14/15)⁴	9
Authority First (14/2)^{3,4}	9
Authority MTZ (14/5)^{4,5}	9
Authority Supreme (14/15)⁴	9
Authority XL (2/14)^{3,4}	9
Boundary (5/15)⁵	8+
BroadAxe (14/15)⁴	9
Canopy (2/5)^{3,5}	9
Envive (2/2/14)^{3,4}	9
Fierce (14/15)⁴	9
Fierce XLT (2/14/15)^{3,4}	9
Prefix (14/15)^{4,6}	8
Sonic (2/14)^{3,4}	9
Surveil (2/14)^{3,4}	9
Trivence (2/5/14)^{3,4,5}	9
Valor XLT (2/14)^{3,4}	9
Warrant Ultra (14/15)⁴	8
Zidua PRO (2/14/15)^{3,4,7}	9

1. Follow label instructions for rates, adjuvants, timing, soybean size, and rotational restrictions. If weeds were not completely controlled or have emerged since preplant burndown, add Gramoxone (22) or Liberty (10) to the options listed.

2. Treflan must be incorporated.

3. Only one application of an ALS-inhibiting (2) herbicide is allowed per year.

4. Only two applications of PPO-inhibiting (14) herbicides are allowed per year.

5. Product contains metribuzin; some soybean varieties are sensitive to metribuzin.

6. Fomesafen is an active ingredient in Prefix and Reflex. Only one application of fomesafen is allowed every other year.

7. This product should not be applied if Sharpen was applied as a burndown.

8. The combination of Lorox/Linex + Metribuzin increases the potential for soybean injury and is discouraged.

Postemergence¹

	Apply (SOA):	With one of the following (SOA):	Add a Residual Herbicide (SOA):
Conventional	Reflex (14) ²		Dual (15)
	Flexstar (14) ²		Outlook (15)
	Cobra (14)		Warrant (15)
	Ultra Blazer (14)		Zidua (15)
Roundup Ready	Reflex (14) ²		Dual (15)
	Flexstar (14) ²		Outlook (15)
	Flexstar GT (9/14) ²		Warrant (15)
			Zidua (15)
Liberty Link	Liberty (10)	Reflex/Flexstar (14) ²	Dual (15)
		Cobra (14)	Outlook (15)
		Ultra Blazer (14)	Warrant (15)
			Zidua (15)
RR2 Xtend	Xtendimax (4)	Reflex/Flexstar (14) ²	Dual (15)
	or	Flexstar GT (9/14) ²	Outlook (15)
	Engenia (4)	Cobra (14)	Warrant (15)
	or	Ultra Blazer (14)	Zidua (15)
	FeXapan (4)		
LLGT2 7	Liberty (10)	Reflex (14) ²	Dual (15)
		Flexstar GT (9/14) ²	Outlook (15)
		Cobra (14)	Warrant (15)
		Ultra Blazer (14)	Zidua (15)
Enlist E3	Enlist One (4)	Liberty (10)	Dual (15)
	or	Reflex (14) ²	Outlook (15)
	Enlist Duo (4) ³	Flexstar GT (9/14) ²	Warrant (15)
		Cobra (14)	Zidua (15)
		Ultra Blazer (14)	

1. Follow label instructions for rates, adjuvants, timing, soybean size, and rotational restrictions. Make only one application of ALS-inhibiting (2) herbicide and no more than two applications of a PPO-inhibiting (14) herbicide per season.

2. Fomesafen is an active ingredient in Flexstar GT and Reflex. Only one application of fomesafen is allowed every other year. Only two applications of a PPO-inhibiting (14) herbicide are allowed per year.

3. Enlist Duo cannot be tank-mixed with Liberty.

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