



## Palmer Amaranth Control in Crop Land



Fig. 55. Palmer amaranth (*Amaranthus palmeri*). Flowering plant and flowering branch. a. Basal leaf. b. Male flower showing stamens. c. Female flower. d. Seed.

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Palmer amaranth (*Amaranthus palmeri* S.Wats.) is a summer annual broadleaf weed. It is native to Sonora Desert in the Southwestern United States. It is also called Palmer pigweed or carelessweed. Mature Palmer amaranth plants are often over 5 feet tall. Palmer amaranth is a very competitive plant, capable of causing dramatic yield losses. Competitiveness of this weed is due to its rapid growth during the seedling stage and its ability to continue growing at temperatures well over 95°F. Research comparing various *Amaranthus* species found Palmer amaranth to be much more competitive than redroot pigweed. Palmer amaranth is closely related to other pigweed species in the mid-Atlantic region, smooth pigweed (*Amaranthus hybridus*), redroot pigweed (*Amaranthus retroflexus*), and spiny amaranth (*Amaranthus spinosus*). Unlike smooth and redroot pigweeds, Palmer amaranth is a dioecious plant which means there are separate male and female plants. The male plants produce pollen that is wind disseminated to female plants.

Palmer amaranth plants look similar to smooth and redroot pigweed. However, Palmer amaranth leaves, stems, and petioles do not have hairs (smooth and redroot pigweed do have fine hairs). Palmer amaranth's leaves have long petioles that are often as long as, or longer, than the leaf blade. As a result, the leaves often droop. Female Palmer amaranth plants have stiff bracts that are sharp and prickly, but these smaller than the spines found on spiny amaranth.

Occasionally, leaves will have a variegated "V" mark or dark red patch. Palmer amaranth is only one of two pigweed species in Delaware with this watermark. Spiny amaranth is the other, but spiny amaranth has a diagnostic pair of ¼ to ½ inch spines at the base of most leaf petioles and along the central stem.

Palmer amaranth's seed heads are very long, ranging from ½ to 1½ feet in length. Only the female plants produce seeds. Seeds are small, shiny black and smooth. A single female plant can produce over 600,000 seeds when grown under optimum conditions.

Most of the Palmer amaranth plants emerge from seeds that are within the top two inches of the

soil surface. It appears that Palmer amaranth seeds are relatively short-lived with only 20% survival after three years in the soil.

Biotypes of Palmer amaranth have become resistant to a wide range of herbicides including dinitroanilines (Group 3), ALS inhibitors (Group 2), photosystem II inhibitors (Group 5), ESPS enzyme inhibitor (glyphosate [Group 9]), PPO inhibitors (Group 14) and HPPD-inhibitors (Group 27).

### **Glyphosate-resistant and ALS-resistant Palmer amaranth is common in Delaware and eastern shore of Maryland.**

In many situations, the genes for herbicide resistance are male-traits that are disseminated in the pollen. Pollen from Palmer amaranth plants can move at least 1000 ft and is believed to be an important factor in the rapid spread of resistant biotypes.

The competitiveness of Palmer amaranth, its likelihood to develop resistance to many mechanisms of action, and the long distance spread of resistance traits through pollen flow are why Palmer amaranth is a species requiring special management for its control.

To preserve the usefulness of herbicides currently effective on Palmer amaranth:

- plant into a clean seedbed;
  - use tillage or an effective burndown herbicide for no-till;
- always use an effective soil-applied herbicide program at planting;
  - applications earlier than 1 to 2 weeks before planting do not provide adequate residual control;
- use multiple effective herbicide mechanism of action;
  - glyphosate and group 2 (ALS) herbicides will not control Palmer amaranth due to resistance; ensure herbicides will effectively control Palmer amaranth plants at the stage they are being treated;
  - it's best to use multiple herbicide mechanism of action as a tankmixture rather than in sequence;
  - consider herbicides sprayed previous year and what will be used in coming years;
- postemergence applications must be made to small (less than 3 inch) plants;
- it is advisable to use PPO-inhibiting herbicides (Group 14) in one year, followed by an HPPD-inhibiting herbicide (Group 27) the following year. For instance, use Group 14

***Pursuant to the provisions of Title 3, Chapter 24 of Delaware Code, the Delaware Department of Agriculture under its Rules and Regulations has declared Palmer amaranth a noxious weed. Designation as a noxious weed requires that Palmer amaranth must be controlled.***

A noxious weed is a plant that has adverse effects on or threatens agricultural production. A plant is designated as “noxious” by the U.S. or Delaware Departments of Agriculture. An attribute of a noxious weed is that it is difficult to control with many ‘standard’ weed control programs. Often fields infested with a noxious weed need special attention and require different management than non-infested fields.

Growers who have noxious weeds can call Todd Davis, noxious weed specialist, at Delaware Department of Agriculture to sign a compliance agreement. Failure to control this weed can result in fines of \$25 per acre (\$100 minimum).

Noxious weeds can be reported to Mr. Davis at 1-800-282-8685. He will contact the owner or agency to work on developing a control program. Noxious weeds also must be controlled on right-of-ways, lots and undeveloped lands as well as farmland.

herbicides (Authority, Valor, Sharpen, or Reflex) for soybeans, and Group 27 herbicides (mesotrione, tembotrione, or topramezone) for corn;

- use full-labeled rates of herbicides;
- scout fields after treatment to determine if additional measures are needed; and
- rely on integrated weed management (IWM) strategies;
  - IWM can reduce the number of seedlings and their growth rate which reduces risk of herbicide resistance and improves herbicide effectiveness.

## **INTEGRATED WEED MANAGEMENT**

### **Prevention**

Palmer amaranth is a prolific seed producer and these seeds can be spread by many means. Preventing or limiting seed production is very important. This may require post-harvest mowing, tillage operations or herbicide applications to stop late-season seed production. When using mowing, repeated mowing is necessary to prevent seed production. Of particular importance is the spread of seeds carried with crop harvesting equipment. Infested areas should be harvested separately to minimize the risk of moving seed with equipment. Machinery should be cleaned in the field where Palmer amaranth is present (or suspected), rather than transported to another field prior to cleaning. Clean equipment with an air compressor or pressure hose; letting the equipment run to clean itself out is not adequate.

Prevent Palmer amaranth plants outside the field from producing seeds. Ensure that organic materials such as straw, mulch, manures, and cover crop seeds are not infested with Palmer amaranth or other weed seeds.

### **Tillage and Mechanical Weed Control**

Palmer amaranth densities appear to be lower in no-till than conventional tillage situations. However, altering tillage alone is not adequate for Palmer amaranth control.

Cultivation and tillage can be very effective methods of controlling small Palmer amaranth plants. Roots from larger plants have the ability to re-root or regrow after mechanical disturbances. As a result, cultivation and hoeing are more effective on small plants (3 inches or less). Plants >12" are likely to re-grow if roots or stem remain in contact with the soil.

Hand-removal of escaped female Palmer amaranth plants before seed production will prevent further seed dispersal into a field.

Burying Palmer amaranth seed at least 4" deep in the soil with moldboard plowing will provide a high level of Palmer amaranth control. Plowing is a "last resort" strategy and should only be considered to help manage the most severe situations.

### **Cultural Methods**

Palmer amaranth requires sunlight to thrive, so a dense crop canopy can effectively shade out later emerging Palmer amaranth plants. Use good agronomic practices to ensure the crop develops quickly and forms a dense canopy. Decreasing row widths results in faster canopy

closure and shade formation.

Crop rotations should include crops that allow for excellent Palmer amaranth control and/or do not allow it to produce seed, for instance:

- early-season vegetables that are harvested before seeds are produced;
- field corn provides the best opportunity for chemical control of Palmer amaranth (better than soybeans).

## **Cover Crops**

Cover crops that are terminated shortly before planting the cash crop can provide good early-season suppression of Palmer amaranth. Late terminated cover crops allow more lignified tissue to develop. Cereal rye is the most effective cover crop, with winter wheat and barley also quite effective. Crimson clover and hairy vetch are two options prior to corn, but they have a tendency to break down sooner than cereal cover crops.

Terminating cover crops before they reach a late vegetative/reproduction stage allows them to break down quicker and minimizes their effectiveness. Cereal rye terminated four weeks before planting soybeans had very little impact on Palmer amaranth control.

## **CONTROL IN CORN**

Excellent Palmer amaranth control can be achieved in field corn. Corn is typically planted 2 to 4 weeks before soybeans, when Palmer amaranth is not growing as rapidly. Control programs should consist of soil-applied residual herbicides followed with postemergence herbicide applications as needed. Postemergence herbicides should include residual herbicides that will control later germinating emerging plants. Follow all herbicide label precautions.

### **Preplant or Preemergence Control**

The seedbed should be weed-free at planting with either tillage or effective burndown herbicide. Gramoxone is very effective for seedling Palmer amaranth.

Apply an effective preemergence herbicide at labeled rates for the soil type. Preemergence herbicides are critical to delay emergence and slow the growth of Palmer amaranth plants. However, in most situations soil-applied herbicides are not adequate for full-season control and a postemergence herbicide is needed.

Acetochlor, atrazine, isoxaflutole, mesotrione, pyroxasulfone, simazine, and s-metolachlor all provide good to excellent control. Prepackage mixtures containing these active ingredients include Acuron, Anthem ATZ, Balance Flexx, Bicep II Magnum, Degree Xtra, Harness Xtra, Keystone NXT, Lexar EZ, or Lumax EZ.

Palmer amaranth control in corn has been more consistent than for soybeans. So consider planting corn in fields where there has been severe Palmer amaranth infestations. Two to three years of excellent Palmer amaranth control should result in noticeable reduction of Palmer amaranth densities. For severe infestations, a soil-applied herbicide followed by an effective postemergence combination should be used.

## Postemergence Control

The following table lists herbicides that can be used at labeled rates and according to label directions to control emerged Palmer amaranth plants. Due to prolonged germination of Palmer amaranth, consider postemergence treatments that will provide residual control, such as Callisto, Impact/Armezon, or Laudis. Otherwise, subsequent flushes of Palmer amaranth may require multiple applications. Timely cultivation and hand pulling may be equally effective when there are few uncontrolled weeds.

Due to the seriousness of glyphosate-resistance, and the tendency of Palmer amaranth to develop resistance to glyphosate, UD Weed Science recommends:

- **Never apply glyphosate alone**; an additional herbicide should be used as a tank mix partner;
  - due to the presence and the rapid spread of herbicide-resistant Palmer amaranth, tankmixing glyphosate with one of the other herbicides listed in this table is important for resistance management;
- additional mechanism of action must be highly effective on Palmer amaranth;
- avoid use of Group 14 (Valor, Sharpen, etc.) and Group 2 (Basis, Steadfast, etc.) herbicides in corn, except in cases of continuous corn;
- applications should be made to plants less than 3 inches tall (typically 4 to 5 weeks after planting); and
- be sure to scout the field shortly after a postemergence application.

Herbicide	Corn growth stage - maximum size or range		Maximum Palmer amaranth size	Rate/Acre	Efficacy for seedlings <sup>a</sup>	Herbicide group
	Broadcast	Directed				
2,4-D	8 in	pre-tassel	* <sup>b</sup>	0.5-1 pt	E	4
Atrazine	12 in	n/a	** <sup>b</sup>	2.4 pt	E	5
Banvel / Clarity	16 oz: 5 lvs or 8 in <8 oz: 36 in or 15 day pre-tassel	n/a	** <sup>b</sup>	8-16 oz	E	4
Status	6 oz: 4 to 10 in 4 oz: up to 24 in	4 oz: up to 36 in	*	4-6 oz	E	4 + 4
Callisto <sup>c</sup>	V8 or 30 in	n/a	5 in	3 oz	G-E <sup>f</sup>	27
Capreno	V6	V6-V7	6 in	3 oz	G-E <sup>f</sup>	2 + 27
<i>Glyphosate products<sup>d</sup></i>	V8 or 30 in	V8 or 30 in	18 in	1 qt <sup>e</sup>	--	9
Impact or Armezon	up to 45 days pre-harvest	as needed	6 in	0.75-1 oz	G-E <sup>f</sup>	27
Halex	V8 or 30 in	n/a	4 in	3.6-4 pt	G-E <sup>f</sup>	9 + 15 + 27
Laudis	up to V8	n/a	6 in	3 oz	G-E <sup>f</sup>	27
Liberty <sup>e</sup>	through V5	n/a	4 in	22 oz	G	10

Palmer amaranth biotypes resistant to Group 2 herbicides (ALS-inhibiting herbicides) are wide-spread in DE. Group 2 herbicides include Accent, Permit Plus, Resolve, and Steadfast; and while they are labeled for corn they should not be used due to resistance management.

\* Indicates Palmer amaranth is listed on the label, but no size information is given.

\*\* Experience in the Mid-Atlantic region indicates activity with this herbicide, although Palmer amaranth is

not listed on the label. Treatment should be made before Palmer amaranth is 3 inches tall.

<sup>a</sup>E = Excellent (>90% control) G-E = Good to Excellent G = Good (80-90% control)

<sup>b</sup>Only pigweed species are listed on the label, individual species are not listed.

<sup>c</sup>Callisto and other herbicides with mesotrione have restrictions concerning soil insecticide use. Follow label carefully or serious crop injury may occur.

<sup>d</sup>Glyphosate is the active ingredient in all Roundup formulations. Glyphosate is also available under many other names and as part of numerous prepackaged mixtures. The rate given in the table is for glyphosate with a formulation of 4 lb ai (3 lb ae) per gallon. Adjust the rate for other formulations. All glyphosate products require the use of glyphosate-resistant corn hybrids (i.e. Roundup Ready). Using these products on corn hybrids that are not glyphosate resistant will seriously injure or kill the crop.

<sup>e</sup>Liberty requires the use of glufosinate-resistant corn hybrids (Liberty Link). Using this product on corn hybrids that are not glufosinate resistant will seriously injure or kill the corn crop.

<sup>f</sup>Control is improved if atrazine at 0.5 lb ai/A or higher is included as a tankmix partner.

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Always consult herbicide labels for proper adjuvant use. Required or recommended adjuvants can vary when tankmixing different herbicides. Other important considerations are crop variety, soil insecticide interactions, environmental conditions, herbicide volatility or drift to sensitive crops, crop health and stage, and crop rotations. This information is available on herbicide labels.

## **Post-harvest Management**

Mowing, disking, or a broadcast herbicide application after harvest can reduce seed production and are very important for improving long-term management. This is particularly important with early-harvested corn.

## **CONTROL IN SOYBEANS**

Control of Palmer amaranth in soybeans requires additional management because it continues to germinate and grow throughout the summer and early fall. Soybeans are planted in early summer when daytime temperatures are in the mid-80's or higher. These higher temperatures result in rapid growth of Palmer amaranth.

Satisfactory control is possible with an herbicide-based control program that includes a preplant or preemergence herbicide plus timely application of postemergence herbicides.

### **Preplant or Preemergence Control**

The seedbed should be weed-free at planting. No-till fields should be treated with Gramoxone or Liberty if emerge Palmer amaranth plants are present at planting. The herbicides listed below can be used at labeled rates and according to label directions. Be aware that Palmer amaranth has developed resistance to Group 2 herbicides (ALS-inhibiting herbicides) in many states. Also, Prefix contains fomesafen, which can only be used on a given field once in alternate years in DE. So, if the field will be treated with Flexstar GT or Reflex, do not use Prefix or Reflex at planting. UD research recommends soil-applied herbicides with two effective mechanisms of action over a single effective mechanism of action.

Herbicide	Application	Rate/A	Efficacy rating <sup>a</sup>	Herbicide group
Anthem Maxx	PPI or PRE	2-5.5 fl oz	G	14 + 15
Authority First / Sonic	PPI or PRE	6.5-8 oz	G	2 + 14
Authority MTZ	PPI or PRE	12-16 oz	G	5 + 14
Authority XL	PPI or PRE	5-8 oz	G	2 + 14
Boundary	PRE	1.2-3 pt	E	5 + 15
BroadAxe / Authority Elite	PPI or PRE	19-38.7 fl oz	E	14 + 15
Canopy	PPI or PRE	4-7 oz	E	2 + 5
Dual	PPI or PRE	1.3-1.7 pt	G	15
Envive	PRE	5 oz	G	2 + 2 + 14
Fierce	PRE	3-3.75 oz	E	14 + 15
Fierce XLT	PRE	3.75-5.25 oz	E	2 + 14 + 15
Gangster / Surveil	PRE	3.6 oz <sup>b</sup>	G	2 + 14
metribuzin	PRE	3-4 oz	G	5
Prefix	PPI or PRE	2-2.75 pt	G-E	14 + 15
Trivence	PRE	6-10 oz	G	2 + 5 + 14
Valor SX	PRE	2-3 oz	G	14
Valor XLT	PRE	4 oz	G	2 + 14
Zidua SC	PPI or PRE	2.5-5.75 fl oz	G	15

Populations of Group 2 resistant Palmer amaranth are common, as a result do not rely on Group 2 herbicide

<sup>a</sup>E = Excellent (>90% control); G-E = Good to Excellent G = Good (80-90% control)

<sup>b</sup>equivalent to 3 oz of Valor and 0.6 oz of FirstRate

## Postemergence Control

The following herbicides can be used at labeled rates and according to label directions to control emerged Palmer amaranth plants. Due to subsequent flushes of Palmer amaranth consider a product that can provide residual control such as fomesafen (Reflex or Flexstar GT) or a soil-applied herbicides labeled for applications to emerged soybeans (see APPLICATIONS OF RESIDUAL HERBICIDES TO EMERGED CROPS in later section).

Due to the seriousness of glyphosate-resistance and the tendency of Palmer amaranth to develop resistance to glyphosate and other herbicide mechanisms of action, UD Weed Science recommends:

- **Never apply glyphosate alone**; an additional herbicide should be used as a tank mix partner;
  - due to the presence and the rapid spread of glyphosate-resistant Palmer amaranth, tankmixing glyphosate with one of the other herbicides listed below is important for resistance management;
- additional modes of action must be highly effective on Palmer amaranth;
  - do not use Group 2 herbicides due to the wide-spread presence of ALS-resistant Palmer amaranth;
- due to presence of PPO-resistant (Group 14) Palmer amaranth in other regions, be sure to rotate herbicides to reduce the risk of selecting for resistant biotypes;
- applications should be made to plants less than 3 inches tall;

- plan on applying postemergence herbicides within 4 weeks after the residual herbicide application was made;
- plants will reach 3 inches within 4 weeks, even if a soil-applied herbicide is used;
- when soybeans are planted two or more years in a row, extra precautions are needed to avoid resistance.

Herbicide	Soybean growth stage maximum size or range	Maximum Palmer amaranth size	Rate/Acre	Efficacy rating <sup>a</sup>	Herbicide group
Ultra Blazer	50 days before harvest	4 in	1.25-1.5 pt	G-E	14
Flexstar GT <sup>b,e</sup>	45 days before harvest	4 in <sup>c</sup>	4.5 pt	E	9 + 14
Cobra	45 days before harvest	6 lvs	12.5 fl oz	G-E	14
Liberty <sup>d</sup>	70 days before harvest	4 in	29-36 fl oz	G	10
Reflex/Flexstar <sup>e</sup>	pre-bloom	4-6 lvs <sup>c</sup>	1.25-1.5 pt	E	14
Engenia/XtendiMax FeXapan <sup>f</sup>	45 days before harvest (pre-bloom)	4 in	12.8 / 22 fl oz	G	4

<sup>a</sup>E = Excellent (>90% control) G-E = Good to Excellent G = Good (80-90% control)

<sup>b</sup>Product contains glyphosate and requires the use of glyphosate-resistant soybeans.

<sup>c</sup>Indicates the maximum weed size is rate dependent; consult label for details.

<sup>d</sup>Liberty requires the use of glufosinate-resistant soybeans. Two postemergence applications of Liberty can be used; max rate per application is 36 fl oz and total application cannot exceed 65 fl oz.

<sup>e</sup>Contains fomesafen, which can only be used on a given field once in alternate years in DE.

<sup>f</sup>Engenia, XtendiMax, FeXapan all contain dicamba and must be used only with dicamba-resistant soybeans. Only approved formulations of dicamba are allowed to be applied to dicamba-resistant soybeans. Refer to product label for application requirement, restrictions, and precautions, including allowed tankmix partners.

Always consult herbicide labels for the proper adjuvants to use. Different adjuvants may be required or recommended when tankmixing more than one herbicide.

## CONTROL IN GRAIN SORGHUM

Palmer amaranth control in grain sorghum should consist of soil-applied atrazine plus s-metolachlor followed with a postemergence herbicide program. Atrazine rate restrictions must be considered when planning herbicide programs that include atrazine and/or atrazine premixes.

### Preplant or Preemergence Control

Apply atrazine preplant incorporated or preemergence at labeled rates for the soil type. A postemergence herbicide will be needed to control escaped plants. Hand pulling may be equally effective when there are few uncontrolled plants. Follow all herbicide label precautions.

Prepackage mixtures containing atrazine such as Bicep II Magnum or Lumax/Lexar EZ are available for soil-applied use. Sorghum seed must be protected with seed treatments of Concep or



Screen when using Dual (metolachlor, s-metolachlor) or premix products containing them.

## **Postemergence Control**

Control of emerged Palmer amaranth plants can be obtained with Huskie (12.8 to 16 fl oz) plus atrazine, dicamba (8 oz/A Banvel or Clarity), Marksman (2 pt/A), or Yukon (4 to 6 oz/A). Consult the labels (or corn section of this sheet) for weed sizes that can be treated with these products.

Always consult herbicide labels for the proper adjuvants to use. This information is available on herbicide labels.

## **CONTROL IN PASTURE AND FORAGE**

### **Establishment or Renovation**

Control Palmer amaranth during grass or legume forage establishment or renovation with Gramoxone 2SL at 2 to 4 pts/A. Thorough coverage of foliage is essential. Higher rates or additional herbicides may be needed to control other weeds or sod.

### **Grass Forage**

Postemergence control of Palmer amaranth in permanent pasture or hay is possible with 2,4-D (1 qt/A), dicamba (1 pt/A Banvel or Clarity), PastureGard HL (1-1.5 pt/A), or Crossbow (2-3 qt/A). These products will injure or kill desirable legumes.

Mowing may be an appropriate alternative to chemical control. Mowing should take place before the plants produce seed and multiple mowings will be necessary.

### **Legume Forage**

Gramoxone 2SL will control emerged Palmer amaranth as post-cutting application. Apply 1 pt/A within 5 days of cutting. Prowl H2O or Chateau are labeled for alfalfa as a post-cutting application. However, Prowl H2O or Chateau will not control emerged plants, only those that germinate after application.

Always consult herbicide labels for surfactants to use, appropriate weed and crop stages, grazing, feeding, haying, and slaughter intervals, and other restrictions.

## **CONTROL IN VEGETABLES**

### **Chemical Control**

Herbicide options for Palmer amaranth control in most vegetable crops are limited. Residual herbicides for grasses and small-seeded broadleaves such as Dual or Curbit will provide some control of Palmer amaranth, but often not enough for full-season control. Sweet corn fields can be treated at planting with Bicep II Magnum, Lumax EZ, or Lexar EZ and/or postemergence applications of Callisto, Impact/Armezon, or Laudis. Reflex or Chateau are options for some

vegetables; check the label for timing and rates.

Reflex (fomesafen) will control Palmer amaranth, but in DE Reflex can only be used in a given field once every two years. Be sure to plan the herbicide rotation to allow use of fomesafen-containing herbicides in vegetables.

Many Group 2 herbicides (Sandea, Pursuit, Raptor, Matrix, and Accent) are labeled for vegetables. Palmer amaranth has developed resistance to this herbicide mechanism of action in numerous states, including Delaware.

## Cultivation

Cultivation in combination with herbicide application can increase the overall level of control. When cultivating, care must be taken to avoid bringing soil not treated with an herbicide near the soil surface, thereby reducing the opportunity for seeds to germinate and seedlings to emerge. Cultivation should be done before Palmer amaranth is 3 inches tall because of the likelihood of larger plants re-rooting.

## SPOT-SPRAY CONTROL (Crop and Non-crop)

Spot treatment can be made in corn, soybeans, wheat, barley, oats, sorghum, forage, pasture, and non-crop areas. For small or localized areas, use the chart below and apply the recommended concentration on a spray-to-wet basis (1 gal/1000 ft<sup>2</sup>) to provide thorough coverage. For larger areas, refer to the herbicide label for rates to apply on a per-acre basis. Mowing may be used as an alternative to chemical control, particularly in pastures and non-crop areas. However, Palmer amaranth will regrow after mowing, so repeated mowing will be necessary. Mowing should take place before the plants produce seed. Several other products are labeled for spot-spray applications in grass forage.

Amount of herbicide to mix with various volumes of water**		
Gallons of water	2,4-D <sup>a</sup>	Gramoxone 2SL <sup>b</sup>
100	2.5 gal	3.8 qt
25	20 fl oz	30 fl oz
1	0.8 oz (1.6 Tbsp)	1.2 oz (2.4 Tbsp)

\*\*Spot applications are based on spraying to wet leaves but not to the point of spray running off the leaves (estimated at 40 gal/A of spray volume).

<sup>a</sup>2,4-D can be used in non-cropland and in crops labeled for postemergence 2,4-D application. Amount is based on 1 qt/A of a 3.8 lb/gal formulation of 2,4-D.

<sup>b</sup>Gramoxone 2SL rate is based on 3 pts/A. Always add 1/3 to 1/2 fl oz of a non-ionic surfactant for each gallon of spray. When spot spraying, spray to thoroughly wet, but not to the point of runoff.

**NOTE:** Gramoxone will kill most vegetation. Take care to avoid drift outside the target area. Neither Gramoxone nor 2,4-D provide residual control; therefore, Palmer amaranth seedlings that germinate after application will not be controlled.

2,4-D can volatilize or drift to sensitive crops or plants and cause serious injury. Consult herbicide labels for precautions and application procedures that will minimize the potential for volatility or drift. Alternatives to 2,4-D are preferred when high value and/or sensitive plants such as ornamentals, fruit trees, vines, or flowers are nearby.

## APPLICATIONS OF RESIDUAL HERBICIDES TO EMERGED CROPS

Due to Palmer amaranth, many companies have expanded their residual herbicide labels as tank-mix partners with glyphosate, Liberty and/or dicamba products. The herbicides below will not control emerged Palmer amaranth seedlings, but can provide an additional 2 to 3 weeks of residual control.

Herbicide	Corn	Soybean
Anthem Maxx	emergence through V4	emergence through 3 <sup>rd</sup> trifol
Dual Magnum <sup>c</sup>	emergence to 40"	emergence through 3 <sup>rd</sup> trifol
Outlook	emergence to 30" tall <sup>a</sup>	cracking to 5 <sup>th</sup> trifoliolate
Pendimethalin	30" or V8 <sup>b</sup>	not labeled for this use
Prowl H20	30" or V8 <sup>b</sup>	not labeled for this use
Warrant	emergence to 30" tall	full emergence to R2
Zidua SC	spike to V4	cracking to 3 <sup>rd</sup> trifol

<sup>a</sup>applications can be made from 30- to 36-inch corn if drop nozzles are used.

<sup>b</sup>whichever is more restrictive.

<sup>c</sup>not all generic versions of Dual address tankmixtures with POST applications to Roundup Ready or Liberty Link crops. Refer to specific labels.

Herbicide rates when the following products are used in combination with glyphosate (Roundup Ready crops) or Liberty (Liberty Link crops). These rates often differ from preemergence application rates. Refer to specific labels for other details.

Herbicides (rate unit)	Crop <sup>xx</sup>	Max use rate/season	Soil texture		
			Coarse	Medium	Fine
Anthem Maxx (fl oz/A)	Corn	2 to 6 <sup>a</sup>	2 to 3.5	2.5 to 4.5	3.5 to 6
	Soybean	3.4 to 5.7 <sup>a</sup>	2 to 3.25	2.5 to 4.5	3.25 to 5.7
Dual Magnum (pts/A)	Corn	3.9	1/1.33 <sup>b</sup>	1.33/1.33 <sup>b</sup>	1.33/1.67 <sup>b</sup>
	Soybean	2.6	1 to 1.33	1 to 1.33	1 to 1.33
Outlook (fl oz/A)	Corn	21	10 to 12	12 to 14	12 to 16
	Soybean	24	12 to 18	14 to 21	14 to 21
Prowl H20 (pts/A)	Corn	##	2 to 3	3 to 4	3 to 4
	Soybean	n/a	not labeled	not labeled	not labeled
Warrant (qts/A)	Corn	4	1.5 to 2	1.5 to 2.75	1.5 to 3
	Soybean	4	1.25 to 1.7	1.25 to 1.9	1.25 to 2
Zidua SC (fl oz/A)	Corn	4.5 to 8.25 <sup>c</sup>	1.75 to 4.5	2.5 to 5	3.25 to 6.5
	Soybean	2.1 to 3.5 <sup>c</sup>	1.75 to 3.5	2.5 to 5	3.25 to 5.75

##maximum rate should not exceed the rates given in the table for the various soil types

<sup>xx</sup>For specific crop stage that can be treated, see table above.

<sup>a</sup>maximum allowable amount for Anthem Maxx is dependent on soil texture (Corn: coarse-textured soils is 4.5 fl oz and medium- and fine-textured soils is 8.15 fl oz; Soybean: coarse-textured soils is 3.4 fl oz and medium- and fine-textured soils is 5.7 fl oz).

<sup>b</sup>the first value for Dual Magnum is rate if organic matter is less than 3% and second number is rate for soils with organic matter greater than 3%.

<sup>c</sup>maximum allowable amount for Zidua SC is dependent on soil texture (Corn: coarse-textured soils is 4.5 fl

oz and medium- and fine-textured soils is 8.25 fl oz; Soybean: coarse-textured soils is 3.5 fl oz and medium- and fine-textured soils is 5.75 fl oz).

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