Palmer Amaranth Biology and Management

Guide A-617

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INTRODUCTION

Palmer amaranth (*Amaranthus palmeri*), a native North American weed also known as careless weed, is recognized as one of the most troublesome weed species in the southern and southwestern United States (Webster, 2001). Palmer amaranth is a short-lived, summer annual plant that readily invades croplands (Steyermark, 1963). Compared to other *Amaranthus* species, such as redroot pigweed and prostrate pigweed, Palmer amaranth has the most aggressive growth habit and is therefore extremely competitive with crops even at low densities (Massinga et al., 2001; Rowland et al., 1999).

The word amaranth comes from the Greek amarantos, which means the one that does not wither or the never-fading flower. *Amaranthus* is a large genus that includes three recognized subgenera and nearly 75 species. This genus is part of the Amaranthaceae family, and only 10 species in this group are dioecious (separate male and female plants). In contrast to the monoecious *Amaranthus* spp., the dioecious *Amaranthus* spp. are all native to North America, ranging from southern California to Texas and northern Mexico. Palmer amaranth is a very successful invasive species as evidenced by its expansion both in eastern North America and overseas (Mosyakin and Robertson, 2003).

***Figure 1*. Palmer amaranth seedling.**

DESCRIPTION

Palmer amaranth is an erect summer annual plant that germinates from seeds during late winter through fall. Palmer amaranth may reach 1 to 7 feet (0.3 to 2 m) in height.

- **Roots**: Roots are mostly taproot and reddish in color.
- **Seedling**: Cotyledons are 0.3 to 0.4 inch long (0.7 to 1 cm), narrow, and green to reddish in color on the upper surface, with a reddish tint on the lower surfaces (Figure 1).

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Figure 2. **Palmer amaranth plant shape.**

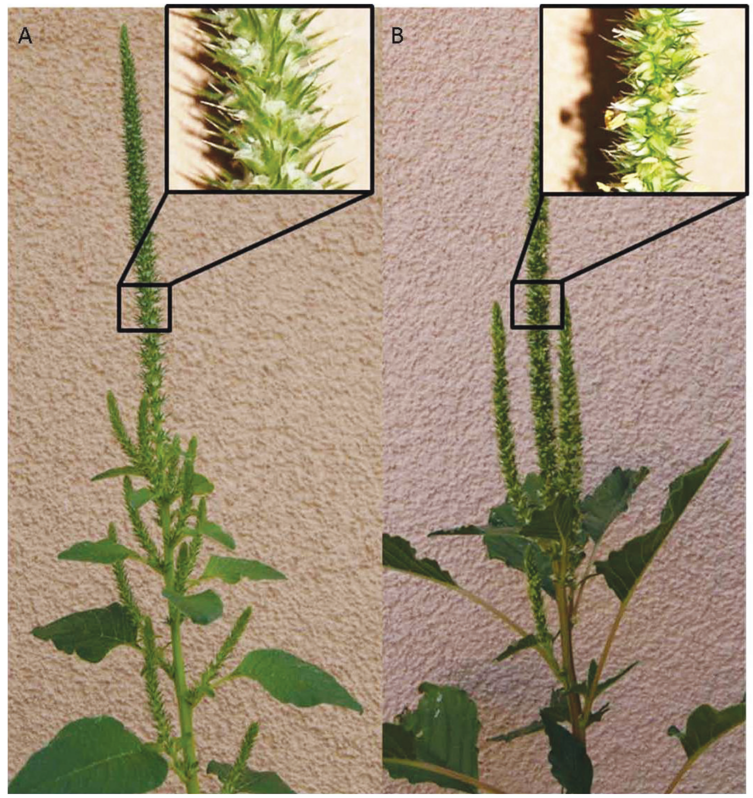

Figure 3. **Palmer amaranth's female (A) and male (B) flowers.**

- **Stem**: Stem is generally coarse with colors varying from green to red to a mix of both colors (Figure 2).

- **Leaves**: Leaves are alternate, ovate, 2 to 8 inches long (5 to 20 cm), and 0.5 to 2.5 inches wide (1.3 to 6 cm) (Figure 2).

- **Flowers**: Flowers are small and green and are produced in dense, compact, terminal panicles that range from 4 to 20 inches in length (10 to 50 cm), with smaller axillary spikes at the base. Male and female flowers are on separate plants. Inner female sepals are spoon-shaped and only 0.08 to 0.16 inch long (2 to 4 mm). Male flower inner sepals are 0.09 to 0.2 inch in length (2.3 to 5 mm) and tapered to a point (Figure 3).

- **Fruit**: Fruit are single-seeded utricles that reach 0.06 to 0.08 inch in length (1.5 to 2 mm) and become wrinkled when dry. The utricles open like a lid to expose the seed.

- **Seeds**: Seeds are dark reddish-brown to black, lens-shaped, and 0.04 to 0.05 inch long (1 to 1.3 mm) (Figure 4) (DiTomaso and Healy, 2007).

USES AND TOXICITY

People around the world have valued *Amaranthus* spp. as a leafy vegetable, cereal, and ornamental. Different Native American tribes used *Amaranthus* spp. extensively as a source of food. The Cocopa, Mohave, and Pima tribes would bake and eat Palmer amaranth leaves. Seeds of Palmer amaranth were also ground into meal and used for food by the Navajo and Yuma tribes (Sauer, 1957). Nevertheless, Palmer amaranth also possesses some toxic properties. Under favorable growth conditions and prior to flowering, Palmer amaranth plants store high concentrations of nitrates that, upon conversion to nitrite during digestion, can be poisonous to livestock (Schmutz et al., 1974). Also, the presence of oxalate in Palmer amaranth can be harmful

Figure 4. **Palmer amaranth seeds.**

under a wide range of temperatures, from as low as 61/50°F (day/night; 16/10°C) with a low germination rate (Keeley et al., 1987) to peak germination at 95/86°F (35/30°C) (Guo and Al-Khatib, 2003). As a result, seeds can germinate from late winter through fall depending on the region in the state.

Other characteristics that make Palmer amaranth a competitive weed include C4 photosynthetic mechanism, aggressive growth at higher temperatures, and high water-use efficiency (Guo and Al-Khatib, 2003; Horak and Loughlin, 2000; Keeley et al., 1987). These characteristics contribute to Palmer amaranth's aggressive growth of more than 2 inches/day under full light (Horak and Lougbin, 2000).

Many studies have documented the negative effects of Palmer amaranth on crop yield. Rowland et al. (1999) reported a 10% decrease in cotton lint yield for every additional Palmer amaranth plant per 32 feet of row. There are also reports of some allelopathic effects associated with Palmer amaranth. Megnes (1987) also showed that the incorporation of Palmer amaranth residues into soil 7 weeks before planting reduced the growth of carrot and onion by 49% and 68%, respectively.

to livestock (Saunders and Becker, 1984). Because of these toxic properties, it is not advisable to graze livestock in areas predominantly infested with Palmer amaranth.

SEED BANK

Palmer amaranth is capable of producing up to 600,000 seeds per female plant (Kneely, 1987). Research has shown that its seeds usually degrade after three years in the soil (Langcuster, 2008). The prolific seed production along with small seed size of this weed facilitate rapid seed dispersal and restocking of soil seed banks (Morgan et al., 2001). Palmer amaranth seeds are generally distributed through irrigation waters (Wilson, 1980), wind (Menges, 1987), and human activities such as movement of field and harvest equipment (Sauer, 1957; Norsworthy et al., 2008).

WEEDY ATTRIBUTES

Palmer amaranth has many characteristics that make it a competitive weed. Its seeds can germinate

MANAGEMENT

The most effective management method for Palmer amaranth is a combination of preventive, cultural, mechanical, and chemical methods. To obtain long-term management of Palmer amaranth, a multiple-tactic approach is necessary. Integrating crop and herbicide rotation, diversifying in-season herbicides, closely monitoring fields, completely controlling the weed in rotational crops, using cover crops, cleaning harvest and tillage equipment, and removing escapees before seed production can all be used to achieve acceptable season-long control of Palmer amaranth (Holshouser, 2008). Our observations have indicated that, depending on the environmental conditions, Palmer amaranth can set seeds between approximately 3 (under stress conditions) and 8 (under optimal conditions) weeks after germination. It is of utmost importance to monitor fields and control Palmer amaranth in its early stages of development to prevent seed production.

For immediate control of infestations, Palmer amaranth plants are vulnerable to cultivation, herbicides, and flaming during the seedling stage of development. But because of rapid early development, the opportunity period for control is brief, and thus diligent monitoring and timely interventions are critical (Langcuster, 2008). Mowing alone is not as effective as cultivation because Palmer amaranth plants are usually not killed by mowing, and the regrowth may still set a limited number of seeds close to the ground. Therefore, mowing must be done in conjunction with other tactics to provide acceptable control of Palmer amaranth plants.

Both pre- and postemergence herbicides have been effective in controlling Palmer amaranth. There are many active ingredients that provide effective control and have been registered in different cropping systems. A list of effective herbicides for controlling Palmer amaranth in different crops/sites and some information regarding their usage is given in Table 1. When considering the use of an herbicide, read the label and follow the instructions and precautions carefully. Nothing can take the place of reading the label and making applications according to label directions. An herbicide's poor performance can often be traced to improper use and failure to follow label directions.

HERBICIDE RESISTANCE IN PALMER AMARANTH

As a result of high genetic diversity among Palmer amaranth plants and high selection pressure from certain herbicides (caused by repeated use of those herbicides), several populations of Palmer amaranth in the U.S. have evolved resistance to herbicides with different mechanisms of action (Heap, 2012). Resistance to dinitroanilines (i.e., trifluralin) in Palmer amaranth was first reported in South Carolina and Tennessee in 1989 (Gossett et al., 1992). Since then, Palmer amaranth populations have also evolved resistance to acetolactate synthase (ALS) inhibiting herbicides (i.e., imazaquin, imazethapyr, thifensulfuron), photosystem II inhibitor herbicides (i.e., atrazine), and 5-enolpyruvylshikimate-3-phosphate (EPSP) synthase inhibitor herbicides (i.e., glyphosate) in different regions of the U.S. Palmer amaranth was first reported to have evolved resistance to glyphosate in Georgia (Culpepper et al., 2006). Since then, resistance to glyphosate in Palmer amaranth has been reported in Tennessee, North Carolina, South Carolina, Alabama, Mississippi, Missouri, Louisiana, Arkansas, and New Mexico (Heap, 2012).

The evolution of herbicide resistance in Palmer amaranth populations has threatened the ongoing sustainability of herbicides as important resources for weed management. Proactive adoptions of resistance management practices are required to maintain the benefits of using chemicals in our management practices.

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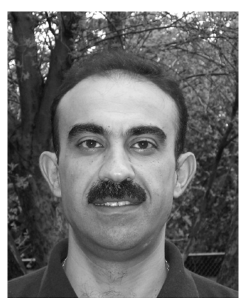

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Table 1. Herbicide Options for the Control/Suppression of Palmer Amaranth in Different Crops/Sites[a]

Active Ingredient	Herbicide Trade Name[b]	Application	Mode of Action (WSSA Groupings)[c]	Examples of Site Registrations[d]
Acifluorfen-sodium	ULTRA BLAZER	POST	Inhibition of protoporphyrinogen oxidase (14)	Peanuts, strawberries, rice
Carfentrazone-ethyl	AIM EC	POST	Inhibition of protoporphyrinogen oxidase (14)	Tomatoes, chile, eggplants
Dicamba	VISION	POST	Action like indole acetic acid (synthetic auxins) (4)	Corn, cotton, sorghum, rangeland
Dimethenamid	SORTIE	PRE	Inhibition of very-long-chain fatty acids (VLCFAs) (15)	Corn, garlic, potato, onion
Ethalfluralin	SONALAN HFP	PRE	Microtubule assembly inhibition (3)	Peanuts, sunflower, canola
Flumiclorac pentyl ester	RESOURCE	POST	Inhibition of protoporphyrinogen oxidase (14)	Corn, cotton
Flumioxazin	CHATEAU WDG	PRE and POST	Inhibition of protoporphyrinogen oxidase (14)	Sugarcane, pecan, alfalfa, peanuts
Glufosinate-ammonium	IGNITE	POST	Inhibition of glutamine synthetase (10)	Cotton
Glyphosate	ROUNDUP	POST	Inhibition of EPSP synthase (9)	Pecan, cotton, alfalfa, pasture grasses, rangeland
Imazamox	RAPTOR	POST	Inhibition of acetolactate synthase (ALS) (2)	Chicory, alfalfa
Imazapic	CADRE	POST	Inhibition of ALS (2)	Peanuts
Indaziflam	ALION	PRE	Inhibition of cellulose biosynthesis (29)	Pecan
Isoxaflutole	BALANCE FLEXX	PRE and POST	Inhibition of 4-hydroxyphenyl-pyruvate-dioxygenase (27)	Corn
Lactofen	COBRA	PRE and POST	Inhibition of protoporphyrinogen oxidase (14)	Cotton, peanuts
Mesotrione	CALLISTO	PRE and POST	Inhibition of 4-hydroxyphenyl-pyruvate-dioxygenase (27)	Corn
Metribuzin	DIMETRIC DF 75%	PRE and POST	Photosystem II inhibitors (5)	Corn
Paraquat dichloride	PARAZONE 3SL	POST	Photosystem I inhibitors (22)	Alfalfa, corn, cotton, grapes, sorghum
Pendimethalin	PROWL H_2O	PRE	Microtubule assembly inhibition (3)	Corn, peanuts, pecan, alfalfa, cotton
Prosulfuron	PEAK	POST	ALS inhibitor (2)	Barley, oats, wheat, corn
Pyraflufen-ethyl	ET HERBICIDE	POST	Inhibition of protoporphyrinogen oxidase (14)	Cucurbits, fruiting vegetables
Pyrithiobac-sodium	STAPLE	POST	ALS inhibitor (2)	Cotton
Rimsulfuron	RESOLVE DF[e]	PRE and POST	Inhibition of acetolactate synthase (ALS) (2)	Corn, cotton, sorghum
S-metolachlor	DUAL MAGNUM	PRE	Inhibition of very-long-chain fatty acids (VLCFAs) (15)	Corn, cotton
Saflufenacil	SHARPEN	PRE and POST	Inhibition of protoporphyrinogen oxidase (14)	Corn, cotton, sorghum
Sulfentrazone	SPARTAN 4F	PRE	Inhibition of protoporphyrinogen oxidase (14)	Sugarcane
Tembotrione	LAUDIS	POST	Inhibition of 4-hydroxyphenyl-pyruvate-dioxygenase (27)	Corn
Topramezone	ARMEZON	POST	Inhibition of 4-hydroxyphenyl-pyruvate-dioxygenase (27)	Corn
Trifluralin	TREFLAN 4 EC	PRE	Microtubule assembly inhibition (3)	Pecan, alfalfa, corn, sunflower

[a]The list is current as of August 2012; however, labels change frequently, and the herbicide's current label should be reviewed for the most recent conditions or restrictions before use. Read all labels carefully and comply with their site-use directions (e.g., pre-harvest interval, restricted-entry interval, registration). For the very latest label information on a given herbicide, contact the manufacturer, Extension services in your area, or the company or distributor that sells the product.

[b]Other trade names of mentioned active ingredients alone or in combination may be available in the market.

[c]Herbicide groupings follow the Weed Science Society of America's (WSSA) nationally accepted grouping. The grouping is based on the modes of action of herbicides. For effective herbicide resistance management it is imperative to rotate or mix the herbicides from different groups.

[d]For the complete list of crops/sites registrations, please see the label of each herbicide.

[e]Suppresses the growth of Palmer amaranth.

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NOTES

Brand names appearing in publications are for product identification purposes only. No endorsement is intended, nor is criticism implied of similar products not mentioned. Persons using such products assume responsibility for their use in accordance with current label directions of the manufacturer.

The pesticide recommendations in this publication are provided only as a guide. The authors and New Mexico State University assume no liability resulting from their use. Please be aware that pesticide labels and registration can change at any time; by law, it is the applicator's responsibility to use pesticides ONLY according to the directions on the current label. Use pesticides selectively and carefully and follow recommended procedures for the safe storage and disposal of surplus pesticides and containers.

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