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Identification, Biology and Control of Palmer Amaranth and Waterhemp in North Dakota

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Waterhemp and Palmer amaranth are two pigweed species that now are found in North Dakota and pose a serious threat to crop production. Both of these weeds have populations in other parts of the U.S. that have become resistant to nearly every herbicide mode of action used in crop production.

This publication will explain how the biology of waterhemp and Palmer amaranth, in addition to herbicide resistance, make them more difficult to control than redroot pigweed or Powell amaranth.

North Dakota farmers have dealt with pigweed (*Amaranthus*) for most of our farming history. Recent research has found that some populations of redroot pigweed are resistant to acetolactate synthase (ALS)-inhibiting (Group 2) herbicides in the state.

In the 1990s, waterhemp (*Amaranthus tuberculatus*) was identified in fields in the Red River Valley, and it has been rapidly spreading in the eastern half of North Dakota over the last decade.

Palmer amaranth (*Amaranthus palmeri*) was first identified in North Dakota in 2018. This weed has been one of the most difficult to control weeds in the southern United States for more than two decades. Populations found in North Dakota suggest that this plant can adapt and become competitive in the northern Great Plains as well.

Identification of Palmer amaranth and waterhemp

Proper identification is an important component of managing Palmer amaranth and waterhemp. Two common weeds that are mistaken for Palmer amaranth and waterhemp are redroot pigweed and Powell amaranth. Here are some tips to identify these four weeds from the seedling stage through plant maturity.

	Palmer amaranth (*Amaranthus palmeri*)	Waterhemp (*Amaranthus tuberculatus*)	Redroot pigweed (*Amaranthus retroflexus*)	Powell amaranth (*Amaranthus powellii*)
Stems	Smooth, no hair	Smooth, no hair	Short, dense hairs	Short, dense to sparse hairs
Petiole length	Long, as long or longer than leaf blade	Short	Typically short, can be long on mature plants	Typically short, can be long on mature plants
Inflorescence (Seed head)	Open, unbranched, very long Male are smooth, female are prickly	Open, unbranched Male and female are smooth	Compact, branched, 1-2" Smooth to rough, but not prickly	Compact, branched, 4-8" Smooth to rough, but not prickly
Bracts	Spiny bracts on female plants	No spiny bracts	No spiny bracts	No spiny bracts
Reproductive	Dioecious (separate male and female plants)	Dioecious (separate male and female plants)	Monoecious (male and female flowers on same plant)	Monoecious (male and female flowers on same plant)

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Palmer amaranth (Figure 1) and waterhemp (Figure 5) do not have hairs on the stems. Redroot pigweed (Figure 9) has short, dense hairs, while Powell amaranth (Figure 12) can be sparsely to densely hairy. Always look for hairs at the top of the plant near the newest growth.

Pull older, more mature leaves of suspected Palmer amaranth or waterhemp plants to examine petiole length. Palmer amaranth (Figure 4) has petioles as long as or longer than the leaf blade. Waterhemp (Figure 8) petioles are shorter than the leaf blades.

Palmer amaranth female plants are easily distinguished at maturity from other pigweeds. There are spiny bracts (Figure 15) at each leaf axil, and the seed head (Figure 16) is prickly and rough to handle. Male plants have smooth inflorescence that can be confused with other pigweeds.

Palmer amaranth and waterhemp have smooth stems at maturity. Palmer amaranth (Figure 2, Figure 3) has the longest inflorescence/seed heads of the pigweeds. The long terminal seed head often can reach 2 to 3 feet long by late summer.

Waterhemp (Figure 6, Figure 7) tends to have thin inflorescence/seed heads compared to the other pigweeds.

Redroot pigweed and Powell amaranth have hairy stems near the inflorescence/seed heads. The seed heads of redroot pigweed and Powell amaranth are compact and branched. Redroot pigweed (Figure 10, Figure 11) has short branches, while Powell amaranth (Figure 13, Figure 14) has longer branches.

Biology of Palmer amaranth and waterhemp

Genetic Diversity

Both Palmer amaranth and waterhemp easily adapt to new locations. These weeds are both dioecious, meaning they have separate male and female plants. This means that plants must outcross to pollinate and produce seed, which leads to increased genetic diversity. Research has shown that herbicide-resistance traits can transfer on pollen, which quickly can expand geographic areas of resistant populations.

Prolific Seed Production

Both Palmer amaranth and waterhemp can produce up to 100,000 seeds per female plant in direct competition with crops. In the absence of competition, plants can produce more than 1 million seeds per plant. This prolific seed production allows for populations to quickly take over fields if plants are not controlled and are allowed to produce seed.

Small Seed Size

The seeds of all pigweed species are very small, which allows seed to be easily transported through various means. Palmer amaranth and waterhemp have been introduced to new areas through contaminated straw, hay and other animal feed. Equipment, especially combines, can carry seed long distances. Contamination of Conservation Reserve Program seed and cover crop seed have led to new introductions in the Corn Belt. Wildlife and migratory birds also can spread seed.

Extended Germination Period

Both Palmer amaranth and waterhemp can germinate throughout the growing season. Germination typically begins mid-May in North Dakota, but can continue throughout the summer into September. This leads to management challenges in crops that struggle to canopy and could be a challenge after harvesting early maturing crops.

Competitiveness

Palmer amaranth and waterhemp can be aggressive competitors under ideal growth conditions. These plants can grow 2 to 3 inches per day if conditions are favorable. Postemergence herbicides are most effective when the plants are smaller than 4 inches. Their rapid growth can lead to compressed spray application windows for optimal control. Weeds larger than 4 inches likely cannot be controlled by any post-emergent herbicide, including dicamba or 2,4-D.

Herbicide Resistance

Resistance to the ALS-inhibiting (Group 2) herbicides and glyphosate (Group 9) is so widespread in both plants that it is safe to assume resistance to both modes of action. Protoporphyrinogen oxidase (PPO)-inhibiting (Group 14) herbicide resistance is becoming more common. Populations also have been identified with resistance to dinitroanilines (Group 3), growth regulators (Group 4), triazines (Group 5), chloroacetamides (Group 15), and 4-Hydroxyphenylpyruvate dioxygenase (HPPD)-inhibitors (Group 27).

Figure 1. Palmer amaranth stem

Figure 2. Palmer amaranth seed head

Figure 3. Palmer amaranth seed head

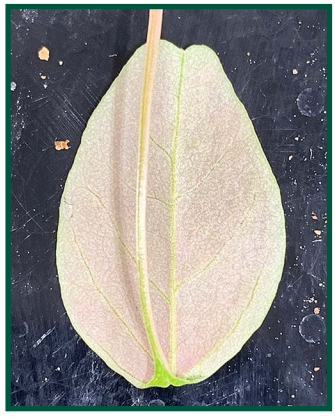

Figure 4. Palmer amaranth petiole

Figure 5. Waterhemp stem

Figure 6. Waterhemp seed head

Figure 7. Waterhemp seed head

Figure 8. Waterhemp petiole

Figure 9. Redroot pigweed stem

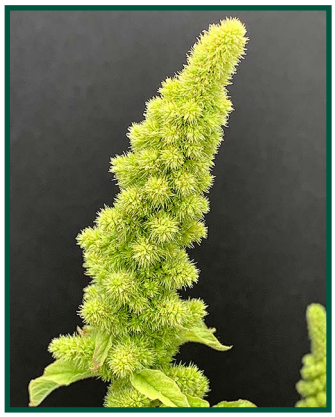

Figure 10. Redroot pigweed seed head

Figure 11. Redroot pigweed seed head

Figure 12. Powell amaranth stem

Figure 13. Powell amaranth seed head

Figure 14. Powell amaranth seed head

Figure 15. Palmer amaranth spiny bracts

Figure 16. Palmer amaranth seed head

Management of Palmer amaranth and waterhemp

Crop Rotation

Palmer amaranth and waterhemp are very competitive against most summer annual crops, but the availability of effective herbicides for corn and soybeans provide more options for chemical weed control. Small grains offer a competetive advantage compared to row crops due to early row closure that helps prevent late-season germination. Limited post-emergent herbicides for pulse crops, flax, canola, sunflowers and other minor crops make Palmer amaranth and waterhemp control almost a no-win situation in these crops.

Effective crop and chemical rotation can help preserve effective herbicides and reduce the chances of Palmer amaranth and waterhemp developing resistance to herbicides. Due to constantly evolving herbicide products and the wide variety of crops across the state, specific herbicide programs are updated regularly at https://www.ag.ndsu.edu/weeds.

Overlapping Residual Herbicides

The extended germination period of Palmer amaranth and waterhemp make these two weeds more difficult to control than traditional pigweeds. In addition to the use of multiple effective modes of action, multiple applications of residual herbicides should be the foundation of a herbicide program focused on Palmer amaranth or waterhemp control.

Research has shown that effective herbicide programs include multiple applications of residual herbicides. Apply residual herbicides at planting to control early emerging weeds. An in-crop application of effective post emergence herbicide, plus an additional residual herbicide about 28 days after planting, can help reduce weed pressure until the crop can canopy.

For most crops, the most effective residual herbicides are the Group 15 herbicides, which help control the later-emerging plants.

Good Agronomic Practices

Season-long control of Palmer amaranth and waterhemp relies on the ability to get a crop canopy. This means that good agronomic practices are an important component of a management program. Problems such as soybean cyst nematode (SCN) and iron-deficiency chlorosis (IDC) should be addressed because these problems can delay or prevent the formation of a full crop canopy.

Tillage

Thorough tillage controls emerged plants prior to planting. Inter-row cultivation also can control emerged plants in-crop. Deep tillage can help control areas with a large population of emerged plants.

The small seed size of Palmer amaranth and waterhemp restricts germination to the top one-half inch of the soil profile. If seed is buried deeper than a few inches, Palmer and waterhemp cannot emerge. Deep tillage should be a one-time event to avoid bringing buried seed back near the surface. Pigweed seed can be expected to remain viable at least 3 to 5 years on the soil surface. Research has shown that buried seed can remain viable for up to 16 years.

Cereal Rye Cover Crop

Research in southern areas of the U.S. has shown promise with using a cereal rye cover crop to suppress Palmer amaranth and waterhemp. About 1,500 pounds of cereal rye biomass per acre at termination can delay the time it takes Palmer amaranth to grow to 4 inches, by about 2 weeks. Producing enough biomass for complete weed control in North Dakota is unlikely, but it can help widen the window to make a post emergence herbicide application.

Hand Weed

Hand weeding is time and labor intensive, but it can be very effective in a total weed management program. A zero-tolerance policy for seed production can help with management of Palmer amaranth and waterhemp due to their abundant seed production. If you suspect a pigweed is Palmer amaranth or waterhemp, pull the plants to help prevent a seed rain and avoid major issues in future years.

Field Edges, Borders, Ditches and Fence Rows

Palmer amaranth and waterhemp can live and produce seed in areas beyond crop fields. Field edges and borders between fields are important areas to monitor for weeds. Pigweeds in these areas can contribute to spreading resistant populations since herbicide resistance can spread via pollen.

Communication with neighbors helps prevent pollen shed and seed production in these areas. Weeds also can thrive in ditches and fencerows. Pasture and right-of-way herbicides can be effective against Palmer amaranth and waterhemp.

Sanitation

Equipment is one of the easiest ways to move pigweed seed from one area to another. If you have infested fields, farm these fields last. Combines are especially capable of spreading seed, so harvest infested fields last. If you run a combine through a patch of Palmer amaranth or waterhemp, you will spread the seed to other fields. Since the seed size is very small, thoroughly clean equipment to ensure seed is not spread to additional fields.

All photos by Joseph Ikley, Brian Jenks and Tom Peters, North Dakota State University

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