MANAGING AROUND WATERHEMP RESISTANCE

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Few weed species have gained so much attention over the past decade as waterhemp. Waterhemp has gone from an obscure weed species in the 1980s to a species that has achieved widespread distinction throughout most of the Midwest. This species gained its notoriety in the early 1990s when it began appearing in many corn and soybean fields in Illinois, Iowa, Kansas, and Missouri. In these fields ALS-inhibiting herbicides, like Pursuit, Classic, Pinnacle, and Beacon were no longer controlling this member of the pigweed family. To make matters worse waterhemp was not a species that most of these producers encountered and in many cases waterhemp identification was confused with the closely related species, redroot pigweed and smooth pigweed. Recently waterhemp has spread throughout most parts of the Midwest, including Wisconsin.

Identification

There are actually two species of waterhemp: common (*Amaranthus rudis*) and tall waterhemp (*Amaranthus tuberculatus*). They are distinctly different species, yet it is impossible to differentiate them while in the vegetative stage. Only when plants have produced seed can tall and common waterhemp be differentiated. The question is often asked: "Is there really a need to be able to differentiate between these two species?". At this time there is no data that exists that suggests herbicides respond differently to either of these two species. So management options for both common and tall waterhemp will be similar.

Similar to other pigweeds, waterhemps have notched leaf tips and reddish colored roots. When pigweed species are small, it can be very difficult to identify them. Some ways to identify small waterhemp from other pigweeds is that waterhemp plants generally have no hairs on the stem or leaf surface. Waterhemp leaves are also typically glossy and more elongated or lanceolate compared with redroot or smooth pigweed. Stem color of more mature waterhemp plants varies greatly from shades of green to red.

There is an excellent guide, developed jointly by Kansas State University, USDA/ARS, and the University of Illinois, that distinguishes the different *Amaranthus* species. The guide is *Pigweed Identification: A Pictorial Guide to the Common Pigweeds of the Great Plains.* It is available through the Kansas State University Cooperative Extension Service Distribution Center, 16 Umberger Hall, Kansas State University, Manhattan, Kansas 66506-3406.

Biology

Both common and tall waterhemp are summer annual species that are native to Illinois. One of the most important considerations concerning waterhemp management is the ability of the species to germinate and emerge later in the growing season than most other summer annual weed species. A five-year emergence study that was conducted in Urbana, Illinois has tracked waterhemp emergence well into July. Because of these emergence characteristics, soil-applied herbicides may not have sufficient residual activity to control late-emerging

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flushes of waterhemp. Conversely, postemergence herbicides can control waterhemp that is present at the time of application, however they may not provide sufficient control of plants that emerge following application.

Another factor that makes waterhemp a very successful species is its ability to produce abundant amounts of very small seed. A single female waterhemp plant can produce over 1 million seeds without competition and can produce from 1,000 to 600,000 seeds per plant if grown in corn or soybean. In some recent studies, waterhemp growth and seed production was suppressed significantly as light interception was decreased. This data suggests shade or earlier canopy closure may be beneficial in suppressing waterhemp growth and seed production and may be an integral part in managing waterhemp. The amount of seed produced from a single waterhemp plant leads to tremendous amounts of seed in the soil seed bank for germination in subsequent years. These small seeds are ideally suited for shallow germination and waterhemp emergence is often favored in no-tillage environments the year following seed production. However, in subsequent years germination is either slightly favored or is not different from tilled environments.

Waterhemp is dioecious, meaning plants are either male or female. This biology leads to cross pollination, which increases the genetic diversity of a population. The genetic diversity can be expressed in physical appearance and other biological characteristics, including differential responses to herbicides.

Herbicide Resistance in Waterhemp

Resistance of waterhemp to some herbicides may have been one of the largest factors that has led to the widespread development of this species. Biotypes of waterhemp have been identified in Illinois and in other areas of the Midwest as resistant to herbicides with various modes (sites) of action. In particular, resistance to ALS-inhibiting herbicides seems to be the most common with a large percentage of all waterhemp populations being resistant to these herbicides. In addition, there are waterhemp populations in Illinois that are resistant to triazine herbicides and some that even have multiple resistance to ALS-inhibiting and traizine herbicides. Even though these populations are present they are of less prevalence than the ALS-resistant waterhemp populations.

Over a two-year period, researchers at the University of Illinois made approximately 60 waterhemp collections from 30 Illinois counties to examine the extent of herbicide resistance in Illinois waterhemp populations. The progeny of randomly selected waterhemp plants from corn and soybean fields were grown in the greenhouse and were treated with a triazine herbicide (atrazine), an imidazolinone herbicide (Pusuit -imazethapyr), or glyphosate. Results indicated approximately 25% of the samples produced progeny resistant to atrazine, while approximately 90% of the populations demonstrated resistance to ALS-inhibiting herbicides. Within the atrazine-resistant populations, there appears to be different mechanisms of resistance, cross-resistance, and inheritance of the resistance trait. Population responses to glyphosate were more uniform compared with responses to atrazine or imazethapyr, however several populations were identified with reduced sensitivity to glyphosate under greenhouse conditions. These results, coupled with the extensive use of glyphosate for waterhemp control in Roundup Ready soybean, suggest a strong potential for

selection of waterhemp populations that would not effectively be controlled with field use rates of glyphosate.

In addition, researchers at Kansas State University recently have identified waterhemp biotypes that have demonstrated differential responses to acifluorfen (Ultra Blazer) and lactofen (Cobra) (Al-Khatib et al. 2000). Field reports from several areas of Illinois in 2001 have also indicated waterhemp control was much less than expected following applications of Ultra Blazer, Flexstar, or Cobra. While samples from these fields have not yet been confirmed resistant to diphenylether (DPE) herbicides, the reports from Kansas State University suggest selection of DPE resistant waterhemp biotypes can occur.

Waterhemp Management

The most effective waterhemp control programs are those that combine a sequential management approach. As mentioned before, the biology of waterhemp makes consistent control using only one herbicide application extremely difficult to achieve. Sequential programs may consist of a soil-applied herbicide followed by a postemergence herbicide or two postemergence herbicide applications. Including cultivation with herbicides can frequently increase the likelihood of successful management.

Effective soil-applied herbicides in corn include: atrazine, Balance PRO, Callisto, simazine, and many of the chloloracetamide herbicides. Postemergence herbicide options in corn include: atrazine, growth regulator herbicides (2,4-D, and dicamba containing products), glyphosate products (RR-corn), glufosinate (LL-corn), Callisto, and Aim. Effective soil-applied options in soybeans are the dinitroanaline herbicides (Prowl or Treflan), sulfentrazone-containing herbicides (Canopy XL, Authority, Command Xtra, and Guantlet), Valor, chloroacetamide herbicides, and metribuzin (Sencor). Effective postemergence control of waterhemp in soybean can be achieved with fomesafen (Flexstar), acifluorfen (Ultra Blazer), lactofen (Cobra/Phoenix), or glyphosate-containing products.

The available options are for control in these crops are by no means extensive. Loss of effectiveness with one or more of these options will potentially make waterhemp even more problematic. One way to limit the selection of herbicide resistant waterhemp biotypes is the integration of multiple control tactics, such as utilization of soil-applied and postemergence herbicides, mechanical cultivation, or all three. Historically, when weed resistance reduced the effectiveness of a given herbicide, new products were introduced into the marketplace that provided alternatives to producers. With the current trend of increased acres in Roundup Ready soybeans, there is less incentive for herbicide manufacturers to introduce new active ingredients, which increases the need to manage currently available options to reduce the selection for resistant weed populations.

Literature Cited

Al-Khatib, K., N. Hoss, D.E. Peterson, and J.A. Dieleman. 2000. Differential response of common waterhemp biotypes to acifluorfen and lactofen. Proc. North Cent. Weed Sci. Soc. 56:32.