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Biology and Management of Giant Ragweed

Bill Johnson, Purdue University
Mark Loux, Ohio State University
Dawn Nordby, University of Illinois
Christy Sprague, Michigan State University
Glenn Nice, Purdue University
Andy Westhoven, Purdue University
Jeff Stachler, Ohio State University

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This publication was reviewed and endorsed by the *Glyphosate, Weeds, and Crops* Group. Members are university weed scientists from major corn and soybean producing states who have been working on weed management in glyphosate-resistant cropping systems.

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Biology and Management of Giant Ragweed

Giant ragweed is one of the most common and problematic weeds in corn and soybean production in the eastern Corn Belt. Giant ragweed management has been complicated by the weed's emergence throughout the growing season and its interference with the growth of many crops. Management is also a challenge because giant ragweed has adapted to an array of environments, including wastelands, roadsides, fencerows, and floodplains. More recently, it has adapted to fertile agricultural soils. With the development of herbicide resistance in many giant ragweed populations, the number of effective management options has declined.

This publication's purpose is two-fold. First, we will discuss the biological characteristics that make giant ragweed troublesome. Second, we will use an understanding of those biological characteristics to provide management guidelines that will minimize yield losses and slow the development of glyphosate-resistant biotypes.

Identification

Giant ragweed seedlings initially emerge in late March in most of the North Central region. They can be identified by their spatulate (spoon-shaped) cotyledons, which are fairly large, ranging from 6/16 to 10/16 inch wide, 1 to 1 11/16 inches long, and up to 1/16 inch thick (Figure 1). Cotyledons unfold from a hairless hypocotyl and have an indentation at the base of the cotyledons. The first true leaves are entire and ovate with lobulate margins.

Figure 1. *Giant ragweed seedlings can be identified by their fairly large, spatulate (spoon-shaped) cotyledons.*

Leaves have stiff hairs that point toward the tip. Only after the second pair of true leaves appear do the leaves show the lobes that are a typical, familiar characteristic of giant ragweed. In most cases, leaves are opposite and always simple. Giant ragweed leaves generally have three distinct lobes, but can have as many as five (Figure 2).

Figure 2. *Giant ragweed leaves generally have three distinct lobes, but can have as many as five. Leaves are typically opposite and always simple.*

When mature, giant ragweed can reach up to 17 feet tall, but height often depends on whether giant ragweed must compete with other plants for sunlight. Giant ragweed in the field is often 1 to 5 feet taller than the crop with which it is competing (Figure 3). For example, in an Illinois study where giant ragweed emerged with corn and soybeans planted on the same day, giant ragweed reached a height of 9 feet in corn and 6 feet in soybeans.

Figure 3. *Giant ragweed plants can be up to 17 feet tall and are often 1 to 5 feet taller than the crops with which they are competing.*

Giant ragweed plants can bloom from July through October. Its flowers are monoecious, meaning that both male and female flowers are found on the same plant. The male flowers are in terminal racemes at the top of the plants and the female flowers are found in clusters at the axils below the male flowers.

Giant ragweed pollen is a major trigger for allergies. The male flower produces considerably more pollen grains than the female flowers need to pollinate on a single plant. A single plant can produce an estimated 10 million pollen grains daily and more than a billion pollen grains during its life cycle. By comparison, a single corn plant produces approximately 4.5 million pollen grains during its life cycle. This excessive pollen production allows giant ragweed plants to cross-pollinate, leading to much variation in its physical appearance and genetic diversity (and consequently, herbicide resistance).

A single giant ragweed plant in a soybean field can produce up to 5,100 seeds, or up to 3,500 seeds per square yard when growing in competition with corn. The seeds are encased in a woody hull (involucre) and are quite large compared to those of other Midwest weeds. The seeds vary from 3/16 to 7/16 inch long and 2/16 to 4/16 inch wide (Figure 4). They have often been described as crown-shaped, with a point at the top and a series of smaller points or ridges circled around the center point.

Figure 4. *The points and ridges along the top of giant ragweed seeds give them a crown-shaped appearance.*

Distribution and Emergence

Giant ragweed is found throughout the entire Midwest and East, but tends to be most problematic in row crop production in the eastern Corn Belt. Historically, giant ragweed was found mostly in undisturbed areas, such as fencerows and drainage ditches, and could occasionally be found in flood plain fields. However, in the past two decades giant ragweed populations have dispersed from their primary habitats into many fertile fields across the Corn Belt. The cause of this spread is unknown, but it is clear that giant ragweed has adapted to survive current agronomic practices, such as earlier planting and less tillage.

One way giant ragweed has adapted to row crop production is changes in its time of emergence. Historically, giant ragweed plants emerged early in the growing season and would pose a problem to agronomic production systems. Results from University of Illinois research in the 1960s and 1970s showed that virtually all giant ragweed plants emerged by the first of May. However, recent research shows that giant ragweed in production fields can begin emerging as early as March. Moreover, emergence can continue through June and sometimes into late-July, especially eastern Corn Belt biotypes. The extended duration of giant ragweed emergence results in a tremendous management challenge.

Late-season surveys in more than 1,300 Indiana fields in 2003, 2004, and 2005, found giant ragweed escapes in 29 percent of the fields. About 20 percent of all fields contained economically important infestations, that is, infestations likely to reduce yield. Late-season Illinois surveys found escapes in 16 percent of the corn and soybean fields sampled.

Interference and Competition

Giant ragweed has an initial competitive advantage over many other weeds and crops due to its early emergence and rapid growth rate. These factors, plus its large leaf area allow giant ragweed to compete with crops and other weeds for water, nutrients, and light throughout the growing season.

Research that examined giant ragweed competition in corn demonstrated that seasonlong competition from just two giant ragweed plants per 110 square feet can reduce corn yield by 13 percent.

Giant ragweed is even more competitive in soybeans than in corn. Just one plant per 110 square feet reduced yields by 50 percent. When giant ragweed plants emerge with the crop and interfere with soybeans for at least four weeks, yields can be reduced more than 25 percent if weather conditions are unfavorable for crop development.

The duration of giant ragweed competition plays a critical role in determining the extent of crop yield loss. With most weeds, soybean yields can typically be protected if there is a four- to six-week weed-free period after planting. However, for fields with giant ragweed, a 10-week weed-free period is usually required to prevent significant yield loss. The highly competitive nature of this plant makes giant ragweed the focus of many weed management programs.

Increased Prevalence

In addition to its seasonlong emergence, three factors are commonly mentioned as causes of increased giant ragweed prevalence:

1. Crop rotation and tillage.
2. The influence of stem-boring insects on herbicide efficacy.
3. Herbicide resistance.

Crop Rotation and Tillage

In late-season Indiana field surveys, giant ragweed was observed more frequently in northern Indiana fields rotated with corn (42 percent) than in continuous soybean (30 percent), but this trend was not observed in southern Indiana. In the same surveys, giant ragweed was found more frequently in mulch-tilled fields (49 percent), than in no-till (37 percent) or conventional-till fields (32 percent).

Using strict no-till practices leaves giant ragweed seed on the soil surface, making it more prone to predation by insects, mice, birds, or soil organisms. Mulch-till and conventional-till systems mix the seed into the soil, prolonging giant ragweed problems because buried seed may escape predation. Additionally, because of giant ragweed's large seed, it is not uncommon for seedlings to emerge from seed buried as deep as 4 inches. While fall chisel or moldboard plowing may bury seeds below this depth, this practice ultimately prolongs the emergence of some of these seeds as they are brought up by additional tillage passes.

Stem-Boring Insects and Control with Glyphosate

Research indicates that stem-boring insects may cause large giant ragweed plants to survive glyphosate applications. After a glyphosate application, many insect-infested plants appear have dead tissue on their upper portions, making it appear the application was effective. However, new growth appeared from the lower parts of the stems, allowing weeds to survive. It appears that insects that bore into the stems or roots injure the vascular system, which may prevent glyphosate from translocating in the plant and working effectively.

Surveys in Illinois, Indiana, and Michigan examined the frequency of insects in giant ragweed. Early in the season (June), the Indiana and Michigan surveys found that 18 to 30 percent of all giant ragweed plants containing stalk boring insects or insect tunnels were not controlled with glyphosate. In August, 28 to 62 percent of all giant ragweed plants showing evidence of stalk boring insects were not controlled by postemergence herbicide applications.

In greenhouse studies, the presence of stalk-boring insects enhanced glyphosate efficacy on 6-inch giant ragweed plants, but reduced the efficacy on 18-inch plants. This shows that stalk boring insects may have the potential to reduce giant ragweed control with glyphosate under certain conditions.

Herbicide Resistance

Before Roundup Ready® soybeans were widely available; ALS inhibitors such as Classic® and FirstRate® were a primary tool for giant ragweed control. Not surprisingly, extensive ALS inhibitor use resulted in the development of ALS-resistant giant ragweed populations by 1996. ALS resistance has been confirmed in a number of Indiana, Illinois, and Iowa fields. While widespread adoption of Roundup Ready® soybeans slowed the overall increase in ALS resistance in giant ragweed, it has continued to develop in fields where non-Roundup Ready® soybeans are grown.

More recently, research in Indiana and Ohio has confirmed what appears to be a low level of glyphosate resistance in several giant ragweed populations (Figure 5). Plants from these populations have survived glyphosate applications of up to 3 lbs. ae/A in field studies (Figure 6).

Figure 5. *Three weeks after application, these giant ragweed plants have survived a POST application of glyphosate at a rate of 2.25 lbs. ae/A, suggesting a low level of glyphosate resistance.*

Figure 6. *Giant ragweed control was inadequate in a number of fields across Ohio and Indiana even where glyphosate was applied three or four times, which may indicate a loss of sensitivity to glyphosate.*

Management Strategies

Giant ragweed's characteristics make it difficult to consistently control with single applications of PRE or POST herbicides, or multiple applications of herbicides with the same mode of action. The most effective herbicide programs combine PRE and POST herbicide treatments, and two or more herbicide modes of action.

Although it is still possible to obtain effective control in some Roundup Ready® soybean fields with multiple POST glyphosate applications (especially where the soybeans are grown in rotation with non-Roundup Ready® crops), this approach results in maximum selection pressure for glyphosate-resistant weeds.

The goals of an effective giant ragweed management program should be to ensure consistently effective control, minimize interference with crops early in the growing season, minimize further selection for herbicide resistance, and prevent further increases in the soil seedbank of giant ragweed. The most effective giant ragweed management programs include the following steps:

- Control weeds that emerge prior to planting with tillage or preplant burndown herbicide applications.
- Apply preemergence herbicides with activity on giant ragweed to reduce competition with crops, provide flexibility in the timing of POST herbicides, and minimize the need for a second POST glyphosate application.
- Apply POST herbicides before plants are more than 6 to 10 inches tall. Where PRE herbicides are not used, control giant ragweed with POST herbicides when weeds are less than 6 inches tall.
- Scout fields two weeks after the first POST application. Control escapes or plants that emerge after the initial POST application with a second POST application. Where needed, make the second POST application three to four weeks after the first, before plants regrow to a larger size.

Herbicide Programs for Corn

Control of Emerged Weeds at Planting

To effectively control emerged giant ragweed with herbicides before corn emergence:

- Combine atrazine with either dicamba, 2,4-D ester, glyphosate, or Gramoxone Inteon®.
- Apply Lumax® or Lexar®.
- Combine 2,4-D ester or dicamba with either glyphosate (at least 0.75 lb. ae/A) or Gramoxone Inteon®.
- Avoid using 2,4-D, glyphosate, or Gramoxone Inteon® alone since control will likely be more variable.

When applying glyphosate alone, use a rate of 1.1 lbs. ae/A. Increase the rate to 1.5 lbs. ae/A where plants are more than 6 inches tall. Gramoxone Inteon® rates also need to increase with weed size. See product labels for details.

PRE (Residual) Herbicides

Adequate control of light giant ragweed populations is possible with PRE herbicide applications, but moderate to high populations require combining

PRE and POST applications. When trying to get by with just PRE herbicide applications:

- Combine atrazine-containing products with Hornet®, Balance® (not labeled for use in Michigan, Minnesota, or Wisconsin), or Callisto®.
- Apply Lumax® or Lexar®.

Include additional atrazine in any of these treatments to improve control, but do not exceed the maximum atrazine rates allowed for the soil type. Lower rates of these PRE herbicides can be used in a planned program of PRE followed by POST herbicides, but use rates that provide at least several weeks of giant ragweed control. It is also possible to use atrazine or an atrazine-containing product alone, as long as the atrazine rate is no less than about 1.5 lbs. ai/A.

POST Herbicides

Many POST broadleaf herbicides effectively control emerged giant ragweed in corn. In areas where there are known ALS-resistant populations, be sure to combine ALS-inhibitor herbicides with an herbicide with another mode of action, such as 4 oz. of Distinct® or 6 oz. of dicamba. When applying in a program following PRE applications, apply:

- Dicamba or Distinct®.
- 2,4-D amine.
- Hornet®, Stinger®, or WideMatch®.
- Atrazine plus either Callisto® or Buctril®.
- Steadfast ATZ® or Equip® plus either Distinct®, dicamba, or Callisto®.
- Northstar® or Yukon®.
- Beacon® or Spirit® (except in ALS-resistant populations).
- Lightning® plus either dicamba or Distinct® (in Clearfield® corn only).
- Liberty® or Liberty plus atrazine® (in Liberty Link® corn only).
- Glyphosate (in Roundup Ready® corn only).

In a total POST herbicide program in corn, it is essential to apply herbicides when weeds are less than about 4 inches tall. Such applications are usually early in the season, so use herbicides with substantial residual activity to control later-emerging plants. This usually involves adding atrazine to the POST treatment. When applying in a total POST approach, apply:

- Glyphosate plus atrazine or an atrazine premix product (in Roundup Ready® corn only).
- Glyphosate plus either Lumax® or Lexar® (in Roundup Ready® corn only).
- Liberty plus atrazine® or an atrazine premix product (in Liberty Link® corn only).
- Lightning plus atrazine® (in Clearfield® corn only).
- Steadfast ATZ® plus Callisto®, or Option plus atrazine® plus Callisto®, or Equip plus atrazine® plus Callisto®.

In the treatments above, use an atrazine rate of at least 1 lb. ai/A. Remember, the total POST approach is far less effective for dense infestations than programs where PRE herbicides are followed by POST herbicides.

Herbicide Programs for Soybeans

Control of Emerged Weeds at Planting

For the most consistent control of emerged plants:

- Combine 2,4-D ester with either glyphosate or Gramoxone Inteon®. Adding a product containing chlorimuron (Canopy® or Synchrony®) or

cloransulam (Authority First®, FirstRate®, Gangster®, Sonic®, or Valor XLT®), or adding Scepter® can improve control if the population is not ALS-resistant, especially when soybean planting prevents using 2,4-D ester (less than seven days for 0.5 lb. ai/A of 2,4-D ester).

- Avoid using 2,4-D, glyphosate, or Gramoxone Inteon® alone, since control is likely to be more variable compared to combinations.

When applying glyphosate, use a rate of 1.1 lbs. ae/A. Increase the rate to 1.5 lbs. ae/A where plants are more than 6 inches tall. Gramoxone Inteon® rates also need to increase with weed size. See product labels for details.

PRE (Residual) Herbicides

Preplant or preemergence applications of Authority First®, Canopy®, Valor XLT®, Synchrony XP®, FirstRate®, Gangster®, Sonic®, or Scepter® can provide limited residual giant ragweed control, but none of these will likely provide adequate seasonlong control except in very light infestations. These products will not control ALS-resistant populations.

POST Herbicides

POST herbicides are most effective when part of a program with PRE herbicides. Applying POST herbicides when giant ragweed plants are less than 6 inches tall minimizes early-season interference with the crop and can provide the most effective control of existing weeds. However, early POST applications often must be followed with a second POST application several weeks later to control late-emerging plants.

When using glyphosate or FirstRate®, a slightly later initial application may reduce the need for a second POST treatment, but be sure to apply before giant ragweed plants exceed about 10 inches tall. Allowing weeds to reach this size before treatment can affect yield.

Glyphosate and FirstRate® are generally the most effective POST herbicide treatments, except where populations are ALS- or glyphosate-resistant. For POST herbicide treatments in soybeans, apply:

- Glyphosate at 1.1 lbs. ae/A on plants less than 6 inches tall; 1.5 lbs. ae/A on larger plants (for Roundup Ready® soybeans only).
- FirstRate® or Classic® (except ALS-resistant giant ragweed populations).
- FirstRate® plus Flexstar®.
- Synchrony XP® applied at the STS soybean rate (except ALS-resistant populations).
- Flexstar®, Cobra®, or Phoenix® can be used if the population is ALS- or glyphosate-resistant.
- Basagran® plus Reflex® or Cobra®.
- Pursuit® plus Cobra® (do not use in ALS-resistant populations).

Control in Fields with Poor Glyphosate Performance

Based on recent research from Purdue University and The Ohio State University, giant ragweed control is still possible with glyphosate-based herbicide programs in fields where use of glyphosate alone has resulted in a low level of resistance to glyphosate and poor control. In such fields, we recommend the following strategy exactly as shown here and in Table 1:

1. Apply a preplant herbicide treatment consisting of 2,4-D ester plus either glyphosate or Gramoxone®, plus a preemergence herbicide with residual

activity on giant ragweed (Canopy®, Valor XLT®, Scepter®, Gangster®, Authority First®, Sonic®, or FirstRate®).

2. Apply one of the following POST treatments when giant ragweed plants are no more than 6 to 10 inches tall: glyphosate at 1.5 lbs. ae/A; or Flexstar® at 1.3 pints/A plus a POST grass herbicide treatment, such as clethodim or Fusion®. Cobra® or Phoenix® (at 12.5 oz/A) can be substituted for Flexstar®.
3. Make a second POST application of glyphosate (at 0.75 lbs. ae/A) approximately three weeks after the first POST treatment. Proper timing of this application is essential to obtain control. Do not delay application until giant ragweed plants are evident above the soybean canopy, or control will be reduced.

Table 1. *Control of giant ragweed in fields with a history of glyphosate performance problems. The results shown are the average of four field studies conducted by The Ohio State University and Purdue University in 2006. Glyphosate rates in parentheses are lbs. ae/A.*

Treatment	Control – at Harvest (percent)
No Preplant Herbicide	
POST glyphosate (1.5)	39
POST glyphosate (1.5) + Late POST glyphosate (0.75)	78
Preplant Herbicides = glyphosate + 2,4-D ester	
POST glyphosate (0.75)	55
POST glyphosate (0.75) + Late POST glyphosate (0.75)	88
POST glyphosate (1.5)	61
POST glyphosate (1.5) + Late POST glyphosate (0.75)	96
POST Flexstar® (1.3 pts/A) + Late POST glyphosate (0.75)	99
Preplant Herbicides = glyphosate + 2,4-D ester + Gangster®	
POST glyphosate (0.75)	70
POST glyphosate (0.75) + Late POST glyphosate (0.75)	97
POST glyphosate (1.5)	71
POST glyphosate (1.5) + Late POST glyphosate (0.75)	97

ALS-Resistant Giant Ragweed Control in Non-GMO Fields

Fields with ALS-resistant giant ragweed should be rotated to corn and wheat where possible. Control weeds in those crops to prevent further increases in the soil seedbank. Another useful strategy in these fields is to delay soybean planting, so the preplant tillage or burndown herbicide treatment controls more of the total giant ragweed population that season.

The following strategy is recommended in fields where ALS resistance is suspected or confirmed, or in fields with a history of reliance on ALS inhibitors for giant ragweed control:

- Apply a preplant herbicide consisting of 2,4-D ester plus either glyphosate or Gramoxone®. Preemergence soybean herbicides that have residual activity on giant ragweed are ALS inhibitors (Canopy®, Scepter®, Gangster®, Authority First®, Sonic®, Valor XLT®, or FirstRate®), so will not control ALS-resistant plants. However, these products can help control the giant ragweed plants that are not ALS-resistant. Expect little or no control of giant ragweed from other preemergence soybean herbicides.
- Apply one of the following POST treatments when giant ragweed plants are no more than 8 inches tall: Cobra® or Phoenix® (at 12.5 oz./A), or Flexstar® (at 1.3 pints/A; or 1 pint/A in alternative years in Kansas, Michigan, Minnesota, Nebraska, South Dakota, and parts of Wisconsin). Combinations of one of these herbicides with FirstRate®, Classic®, or Synchrony® can improve control of non-ALS-resistant plants. Do not reduce the rate of Flexstar®, Cobra®, or Phoenix® in these combinations, or ALS-resistant plant control will be reduced.
- Scout fields several weeks after the first POST treatment and make a second POST application of Cobra® or Phoenix® as needed to control later-emerging plants. Proper timing of this application is essential to obtain control. Do not delay application until giant ragweed plants are evident above the soybean canopy or control will be reduced.

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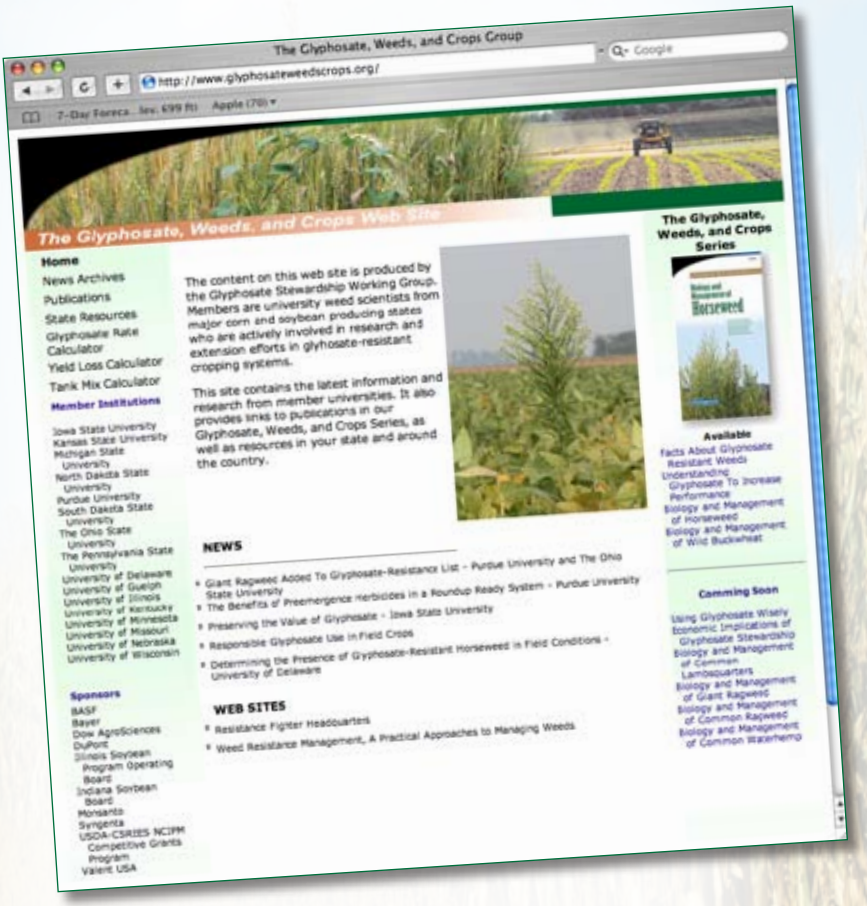

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