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The Glyphosate, Weeds, and Crops Series

Biology and Management of Horseweed

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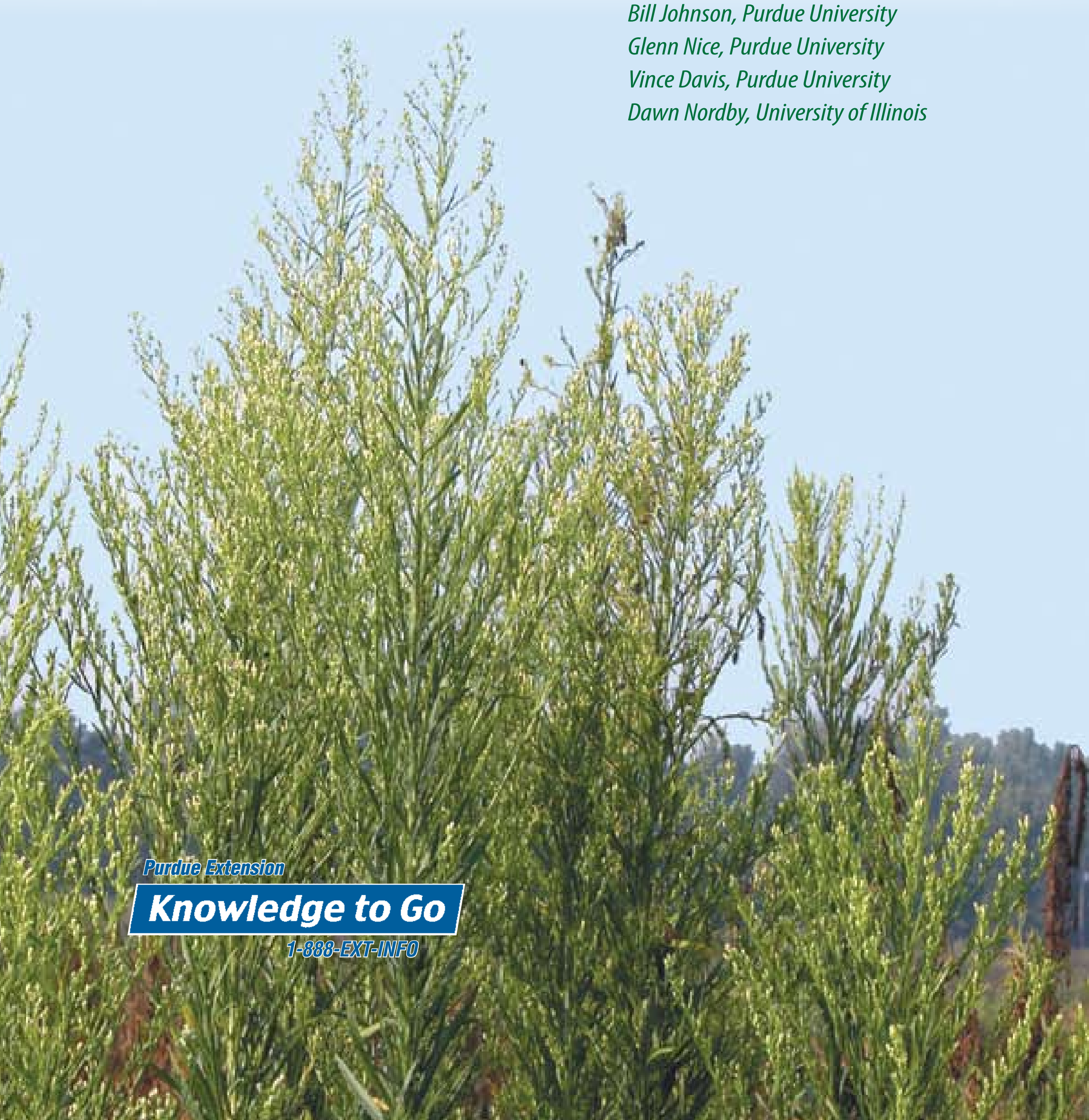

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This publication was reviewed and endorsed by the *Glyphosate, Weeds, and Crops* Group. Members are university weed scientists from major corn and soybean producing states who have been working on weed management in glyphosate-resistant cropping systems.

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Financial support for developing, printing, and distributing this publication was provided by BASF, Bayer Crop Science, Dow AgroSciences, Dupont, Indiana Soybean Board, Illinois Soybean Association/Illinois Soybean Checkoff Board, Syngenta, Valent USA, USDA Critical and Emerging Pest Competitive Grants Program, and USDA North Central IPM Competitive Grants Program.

Biology and Management of Horseweed

Heavy reliance on glyphosate for weed control in soybeans has resulted in a serious concern for the long-term viability of this valuable weed management tool. Weed resistance to glyphosate is not a new phenomenon. Glyphosate-resistant field bindweed was reported in Indiana during the mid-1980s in areas that had received repeated glyphosate applications (Degennaro and Weller, 1984). But, weed resistance to glyphosate did not become a major issue in U.S. agronomic crops until several years after the 1996 release of Roundup Ready® soybeans.

__Figure 1.__ This photo shows the flower structure of a mature horseweed plant.

Of greatest concern recently has been horseweed. Since the initial report of glyphosate-resistant horseweed in 2000 (VanGessel, 2001), this weed management issue has been reported in over 10 states. Common to all known cases of glyphosate-resistant horseweed is the frequent use of glyphosate for control of all weeds, little or no use of alternative herbicides that control horseweed, and long-term no-tillage crop production practices.

The purpose of this publication is two-fold. First, we will discuss some of the biological characteristics that make horseweed particularly troublesome to control in agronomic crops. Second, we will provide management strategies, using technologies now available, that will allow growers to control herbicide-resistant horseweed and hopefully slow the spread of glyphosate resistance.

Identification

Horseweed, also known as marestail and Canada fleabane, is native to North America. This annual weed can follow a winter or summer annual life cycle. After emergence in the fall, horseweed forms a basal rosette for winter survival. In a winter annual life cycle, the rosette bolts in the spring, growing to a height of 1.5 to 6 feet. Horseweed leaves are alternate, linear, and simple with entirely or slightly toothed margins. Mature plants have leaves with no petioles (sessile). Leaves get progressively smaller in size toward the top of the plant. Stems are erect and tend to be unbranched at the base of the plant unless damaged by herbicides, mowing, or animal or insect feeding. Flowers are arranged in a panicle with numerous white ray flowers (1/16 to 2/16 inches long) and 20 to 40 yellow disk flowers (see Figure 1). The seeds are small achenes (1/16 to 1/4 inches long), with a pappus of tan to white bristles. A pappus is a structure that allows the seed to be dispersed by the wind, similar to that of common dandelion.

Horseweed (see Figure 2) is often misidentified as whitlowgrass, mouseear chickweed, corn or Persian speedwell, shepherd's-purse, or several of the fleabane species, especially annual fleabane (see Figure 3). The two most common misidentifications are whitlowgrass and fleabane species. Whitlowgrass has shorter

Figure 2. *This photo shows a horseweed seedling in rosette stage, just beginning to bolt.*

Figure 3. *The photos above show weeds commonly confused with horseweed: whitlowgrass (top left), mouseear chickweed (middle left), annual fleabane (bottom left) corn or Persian speedwell (top right), and shepherd's-purse (bottom right).*

and narrower leaves than horseweed, and a smooth to very slightly notched margin. Around the leaf margin, annual fleabane tends to have purple spots at the tip of each tooth while horseweed does not have these spots. Also, the distance between nodes on all fleabane species after bolting are greater than the internode distance on horseweed. Fleabanes will produce more branches than horseweed at the base of the plant. Mouseear chickweed, and corn and Persian speedwell have opposite leaves at all early stage nodes, and can easily be separated from horseweed, which has alternating leaves at all nodes. The first node of shepherd's-purse tends to have opposite leaves while subsequent nodes have alternate leaves, although leaves at all nodes may be alternating. The hairs on shepherd's-purse leaves are shorter and tend to stay on the upper leaf surface compared to horseweed leaf hairs, which are larger and usually present on leaf margins. In later development stages, shepherd's-purse leaves will be deeply lobed compared to the toothed or slightly lobed leaves of horseweed.

Distribution and Emergence

Horseweed seed germinates readily as soon as it falls off a mature plant. Horseweed plants usually germinate in the fall or spring, but they also can germinate in midsummer if growing conditions are adequate. In northern regions of Indiana, Illinois, and Ohio most horseweed emerges in the fall, overwinters as a rosette, and begins to bolt in the spring. Typically, up to 91 percent of fall-emerging plants survive until spring. This broad survival range can be attributed to weather conditions and the size of the horseweed rosette. The larger the rosette is prior to winter, the greater the chance of survival into the spring (Buhler and Owen 1997). Horseweed emerges predominately in the spring in the southern regions of Indiana, Illinois, and Ohio. In southeast Indiana and southwest Ohio, spring germinating horseweed is one of the most problematic summer annual weeds. Spring horseweed generally remains a rosette for a relatively short period prior to bolting. Horseweeds germinating in July and August tend to remain as rosettes until the following spring, with only a few plants bolting and producing flowers in the fall.

Growth and Development

Following rosette formation, horseweed plants begin bolting in mid-April and start flowering at the end of July. Horseweed is self-compatible and releases pollen before the captula are fully opened, supporting the idea that horseweed is primarily self-pollinating; however, outcrossing within a population has been observed to range from 1.2 to 14.5 percent. Horseweed's wind dissemination and relatively abundant seed production suggests that the dispersal of resistant horseweed plants across an agricultural landscape could be very rapid. Regehr and Bazzaz (1979) reported that horseweed seed movement in a corn field ranged from 12,500 seeds per square yard at 20 feet from the seed source, to more than 125 seeds per square yard at 400 feet from the seed source. Taller plants produce more seed than shorter plants, suggesting that seed height on plants might influence both the distance wind can transport seed and the total number of seeds that are transported.

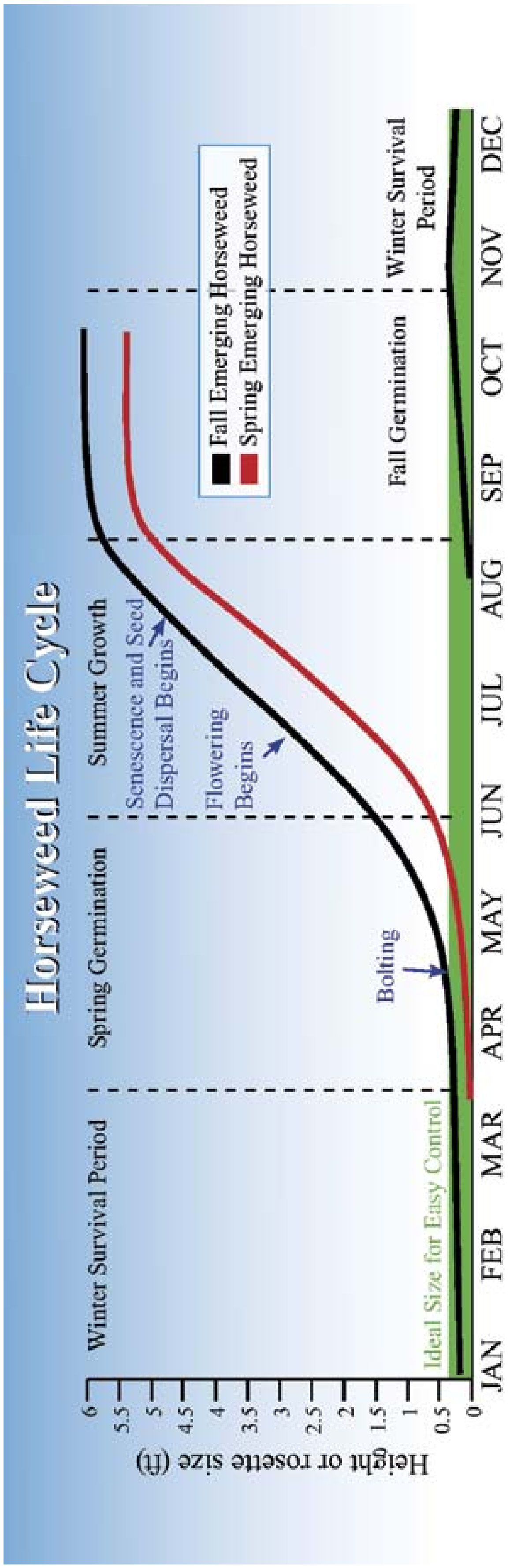

Figure 4. *This graph shows the relative life cycles of horseweed throughout the year for plants that emerge in the spring and fall.*

Interference and Competition

In southeast Indiana and southwest Ohio, horseweed often behaves like a summer annual. In these situations, horseweed begins to emerge from late March into late June. Southeast Indiana soils characteristically have a shallow layer of silt over a thick clay layer. These soils have relatively poor internal drainage and water holding capacity and require frequent light rains to maintain optimal crop growth. Horseweed tolerates drought conditions well and continues to grow and produce biomass and seed under conditions stressful for crop growth. Horseweed can produce up to 200,000 seeds per plant, and approximately 80 percent of the seed will germinate right off the plant. Because of the unique soils in this region and widespread adoption of no-till practices, horseweed has emerged as the number one weed problem in this area.

Bruce and Kells (1990) showed in management studies conducted in Michigan that soybean yields could be reduced up to 83 percent by horseweed in untreated check treatments. In general, we feel horseweed is much less competitive than most of the other summer annual weeds. However, no traditional competition studies have been published that have evaluated the effect of density or emergence time on its capability to reduce soybean and corn yields. We do know that horseweed can affect crop production in ways besides direct competition for light, water, and nutrients. Horseweed can be a host for the tarnished plant bug, an alfalfa pest. It can also be a host for aster yellows, a viral disease transmitted by aster leafhoppers to a wide variety of plants.

Increased Prevalence

Three factors are commonly mentioned as the causes of increased horseweed prevalence: lack of diversity in crop rotation, reduced tillage, and herbicide resistance.

Crop Rotation

Crop rotation appears to have a minimal impact on horseweed prevalence. In field surveys conducted in areas where horseweed was most problematic in Indiana, horseweed was found in 63 percent of double crop soybean fields, compared to 51 percent in continuous soybean fields, and 47 percent in fields in a corn-soybean rotation.

Tillage

In the same survey mentioned above, increases in tillage intensity reduced horseweed prevalence by 50 percent or more. Horseweed was found in 61 percent of the no-till fields compared to 24 percent in reduced tillage and 8 percent in conventional tillage fields.

Herbicide Resistance

Japanese researchers reported the first case of horseweed herbicide resistance in 1980, describing biotypes resistant to Gramoxone® (paraquat). More Gramoxone®-resistant biotypes have since been found in Mississippi. The second case of resistance was reported in 1989 by researchers in Belgium, who found biotypes resistant to atrazine in corn, nurseries, and roadsides. Additional atrazine-resistant biotypes have since been found in Michigan. ALS-resistant horseweed biotypes were first found in the United

States in Indiana and Ohio during the 1999 growing season, and today are believed to be present in all Ohio counties west of Interstate 71 and U.S. Route 23.

Biotypes resistant to glyphosate (which is sold under the trade names Roundup®, Touchdown®, and others) were first reported in Delaware in 2000. Since 2000, glyphosate-resistant biotypes have been found in several additional states. In Indiana, glyphosate-resistant biotypes have been found in 29 counties, mostly in the southeast. However, glyphosate-resistant horseweed has been found as far north as Kosciusko County in northern Indiana and Montgomery County in the west-central area. In Ohio, glyphosate-resistant biotypes have been found in 20 counties, mostly in southwestern Ohio but now stretching to northwest and central Ohio.

Glyphosate-resistant horseweed populations in Ohio and Indiana were first reported in areas where the following production practices are common: soybeans grown in the same field for consecutive years (up to 14 years in some fields), use of only glyphosate for weed control, and little or no tillage.

In horseweed, resistance to more than one herbicide has been reported in Israel with a biotype resistant to atrazine and Glean® (an ALS inhibitor); in Michigan with a biotype resistant to atrazine, simazine, and diuron; and in Ohio with a biotype resistant to glyphosate and FirstRate® (an ALS inhibitor) in 2003. The glyphosate and FirstRate® resistant biotype in Ohio has been confirmed in at least two fields (one each in Montgomery and Miami counties) and appears to be spreading. We assume that these biotypes are also resistant to other ALS inhibitors, such as chlorimuron (Classic®, Canopy®, Synchrony®).

In Indiana, horseweed populations resistant to glyphosate and FirstRate® have been found in Bartholomew, Jefferson, Scott, and Washington counties; populations resistant to glyphosate and Classic® have been found in Bartholomew, Scott, and Wells counties; and populations resistant to glyphosate, FirstRate®, and Classic® have been found in Bartholomew and Scott counties.

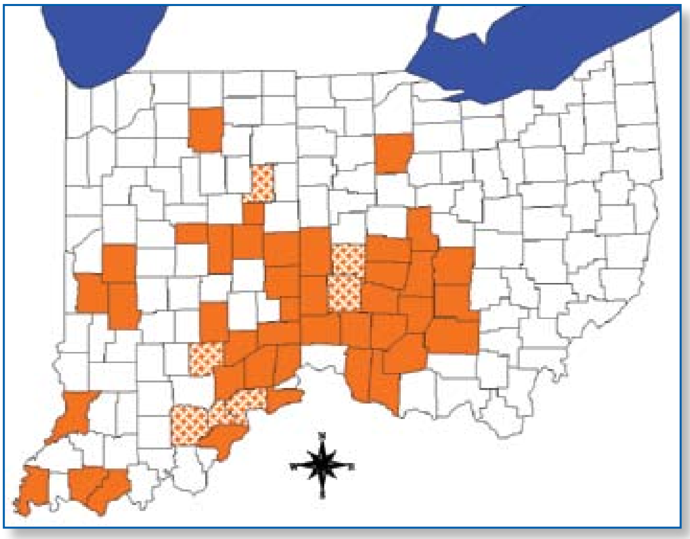

Figure 5. *Glyphosate-resistant horseweed has been identified in at least one field in the counties marked with solid orange. A few fields contain horseweed populations resistant to glyphosate and either chlorimuron or loransulam — these counties are indicated with the crosshatch pattern.*

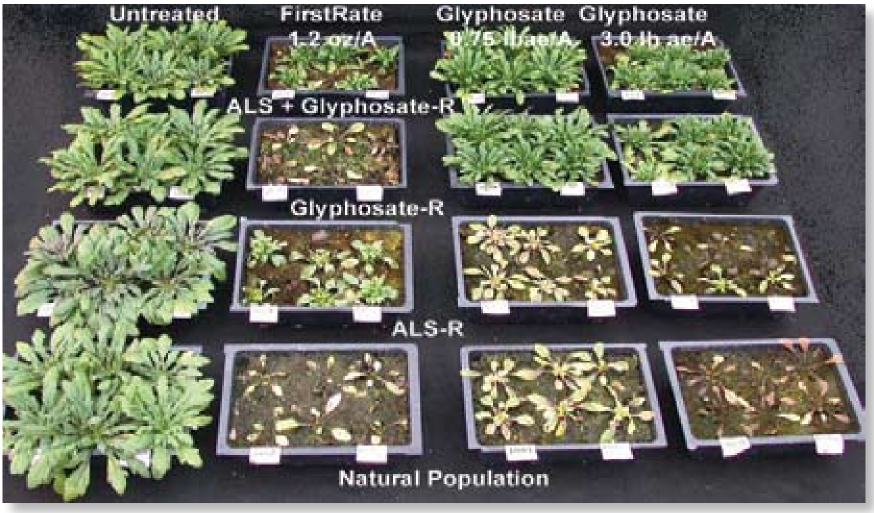

Figure 6. *Ohio horseweed populations showing resistance to ALS and glyphosate herbicides (top row), resistance to glyphosate herbicides only (second row from top), resistance to ALS herbicides only (third row from top), and no herbicide resistance (bottom row).*

Control

The primary goal of a horseweed management program in no-till soybeans should be effective control of emerged horseweed plants prior to planting. Soybeans planted before early to mid-May also will require a residual herbicide to control later emerging plants. This strategy will reduce the need for postemergence herbicide treatments, which can be limited in effectiveness and exert further selection for herbicide resistance in the population. The following principles are important in horseweed control programs:

- 2,4-D ester should be included in preplant herbicide treatments when possible
- Herbicides should be applied before horseweed plants are 4 to 6 inches tall
- Herbicides applied in the fall will control emerged horseweed, but may not adequately control spring-emerging plants
- Spring applications prior to early May should include a residual herbicide to control later-emerging plants

Control of Emerged Plants Before Planting

Treatments containing fewer than three herbicides may be less effective on an ALS-, glyphosate-, or multiple-resistant population. Chlorimuron is a component of Canopy EX®, Canopy®, and Synchrony XP®; and cloransulam is a component of FirstRate®, Amplify®, and Gangster®. The most effective treatments for controlling horseweed plants up to about 6 inches tall are roughly ranked in order of effectiveness:

- A combination of glyphosate and 2,4-D ester; plus chlorimuron or cloransulam
- A combination of glyphosate and 2,4-D ester
- A combination of Sencor®, Gramoxone®, and 2,4-D ester
- A combination of glyphosate plus chlorimuron or cloransulam

Several other treatments can be effective when plants are less than two inches tall, including: Sencor® plus 2,4-D ester; Sencor® plus Gramoxone®; and 2,4-D ester alone. A combination of 2,4-D ester plus chlorimuron or cloransulam can also be used on small plants, but effectiveness will be reduced in ALS-resistant populations. The minimum glyphosate rate should be 1.1 lbs. ae/A for all biotypes. Dicamba is better suited to southern areas of the country because warmer weather will speed the degradation of the herbicide so it is less likely to injure soybeans. It is important to remember that when dicamba is applied at 0.25 lb. ai/A, growers must wait 14 days after application and receive at least one inch of rain before planting soybeans.

Residual Horseweed Control (Spring Application)

In fields where horseweed may be ALS-resistant, the most effective herbicides include Gangster®, metribuzin (at least 0.4 lb ai/A), sulfentrazone, and Valor®. Canopy®, FirstRate®/Amplify® or Gangster®, or Python® can be used for residual control in fields where the horseweed is not ALS-resistant.

Spring Herbicide Recommendations Based on Horseweed Size

Fields Treated With Herbicide the Previous Fall

Fields should be free of overwintering horseweed in the spring, as long as 2,4-D ester was a component of the fall treatment, but additional horseweed emergence is likely. It is possible that residual herbicides applied in the fall, such as Canopy EX®, Valor®, and Sencor®, can control horseweed through early June. This is most likely to occur in sparser populations that are not ALS-resistant. Regardless of the herbicide(s) applied in fall, fields should be scouted before planting. Apply herbicide as needed prior to soybean planting to control emerged horseweed, and include residual herbicides if the field is planted before mid-May.

Horseweed in the Seedling or Rosette Stage (April)

Controlling horseweed in the seedling or rosette stage can be extremely effective, since small plants are easily controlled and residual herbicides applied at these stages can provide control through early June. Emerged plants should be adequately controlled by 2,4-D ester (1 lb. ai/A). When the 2,4-D rate is limited to 0.5 lb. ai/A, combine with glyphosate, Sencor®,

Figure 7. *Horseweed plants protruding through soybean canopy in late summer.*

or Sencor® plus Gramoxone®. Sencor® plus Gramoxone® (without 2,4-D) can effectively control seedlings or small rosettes.

Horseweed Stem Elongated But Not More Than 4 to 6 Inches Tall (May)

During this stage, the most effective treatment is glyphosate, plus 2,4-D ester, plus chlorimuron or cloransulam. Glyphosate plus 2,4-D ester is effective where glyphosate resistance is not an issue; and glyphosate, plus either chlorimuron or cloransulam is effective where ALS resistance and ALS plus glyphosate resistance is not an issue. Use a glyphosate rate of at least 1.1 lb. ae/A, unless ALS and glyphosate resistance is present, then use a minimum rate of 1.5 lbs. ae/A. Somewhat more variable, but generally effective on this size plant, is the combination of Sencor® plus Gramoxone® (minimum of 1.7 pt./A) plus 2,4-D ester.

Horseweed More Than 6 Inches Tall (Mid- to Late May)

Horseweed of this size will likely be difficult to control. Anything less than a three-way mixture of glyphosate, plus 2,4-D ester, plus chlorimuron or cloransulam, is not recommended. Use a glyphosate rate of at least 1.5 lbs. ae/A. Resistance to glyphosate and/or ALS inhibitors can result in situations where effective control is not possible.

Conclusion

Weed resistance is not new to agriculture; we have been dealing with it for some time. Awareness and prevention are the first steps to dealing with this problem. As with other weed resistance issues, dealing with resistant horseweed requires adjusting management strategies. Having knowledge of herbicide groups and using combinations of herbicides with different modes of action will help decrease additional resistance problems from arising.

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The first edition of this publication was released as Purdue Extension publication number ID-323.

4/06

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