# A Field Survey of Weed Species Observed in Kentucky Soybeans

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## Introduction

The most recent advances in weed control technology for field crops have been the introduction of soybean varieties and corn hybrids that are genetically tolerant to herbicides to which they were originally susceptible. For example, it has been estimated that approximately 50 percent of the soybeans planted in 1999 were planted with Roundup Ready® technology. Fewer herbicides are needed to combat weed problems, and lower weed control costs are often cited by producers who have adopted this technology. However, the potential exists for a shift in the predominant weed species that occur in field crops when this pest management technology becomes widely used by crop producers.

Therefore, a comprehensive field survey of the most frequently occurring weed species that infest Kentucky soybean fields was conducted. The long-term objective of this project is to assess the impact of herbicide-tolerant crop technology on the occurrence of weed species and to determine if these practices result in a shift in the predominant weed species present.

## Procedures

Soybean fields in six Kentucky counties were surveyed in 1998, and eight counties were chosen in 1999. Four of the 10 counties participated in the survey both years. These counties represent some of the major soybean- and corn-producing areas of the state (Figure 1).

An in-field weed survey method was used to estimate the most frequently occurring weed species present in Kentucky soybean fields. Assistance was obtained from county Extension agents who played a major role in soliciting crop producers and locating field sites used for the survey. Sixty crop producers in the counties represented participated in the survey. When possible, the past field-cropping history was also determined for each field that was surveyed.

Fields were surveyed at three to five weeks after planting. Ideally this would allow time for weeds to emerge but before a field was treated with a postemergence herbicide. The method involved walking in a predetermined pattern and counting steps to help divide a field into 5-acre segments. The presence of all weed species was noted at an arbitrary site within each 5-acre area represented. For example, 10 survey sites were used for a field size of approximately 50 acres. Each site was noted on a map of the field. Some fields were mapped, and specific survey sites were noted by using Global Positioning System technology (Figure 2). The size of fields surveyed ranged from 15 to 160 acres.

**Figure 1.** Counties surveyed (1998—Fulton, Hardin, Henderson, Hickman, Shelby , and Todd; 1999—Hardin, Henderson, Hickman, Hopkins, Shelby, Taylor, and Wayne).

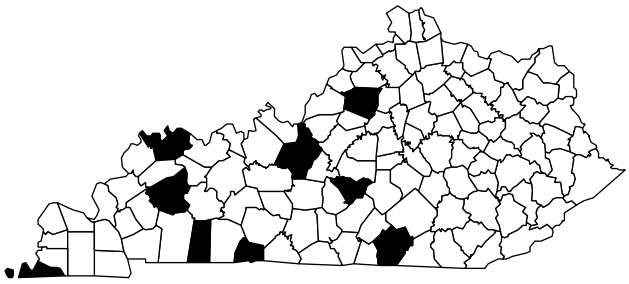

**Figure 2.** Example of field site surveyed.

The survey provided a technique for estimating the frequency of occurrence for each weed species within each field surveyed. Thus, the percent frequency was determined by calculating the number of survey sites it occupied compared to the total number of sites surveyed. Species that did not occur at the survey sites but were observed when walking between sites were also noted. The relative frequency of the predominant weed species within a county or for a statewide summary could also be estimated by using this survey method.

## Results

A total of 64 different soybean fields representing approximately 2,733 acres were surveyed during 1998 and 1999. Most soybean fields were grown as a full-season crop, but some fields had been subjected to double-crop production practices behind wheat. The number of weed species noted during the survey process but not present at a survey site was relatively small; consequently, the data from the survey sites were fairly representative of the species present in the field.

In soybean fields, 97 different weed species were observed (Table 1). Prickly sida, johnsongrass, honeyvine milkweed, wild garlic, and ivyleaf morningglory were among the top five

**Table 1.** Summary of weed species and their frequency observed in 64 soybean fields in Kentucky during 1998 and 1999.[1]

| Weed Species | | Freq[2] | % Total [3] | Weed Species | | Freq[2] | % Total [3] |
|---|---|---|---|---|---|---|---|
| 1 | Prickly Sida | 208 | 36% | 50 | Milkweed, Common | 10 | 2% |
| 2 | Johnsongrass | 191 | 34% | 51 | Passionflower, Maypop | 10 | 2% |
| 3 | Milkweed, Honeyvine | 128 | 22% | 52 | Violet, Wild | 10 | 2% |
| 4 | Garlic, Wild | 124 | 22% | 53 | Volunteer Corn | 10 | 2% |
| 5 | Morningglory, Ivyleaf | 124 | 22% | 54 | Croton, Tropic | 9 | 2% |
| 6 | Pigweed, Smooth | 120 | 21% | 55 | Smartweed (Ladysthumb) | 8 | 1% |
| 7 | Wheat, Volunteer | 112 | 20% | 56 | Bindweed, Hedge | 7 | 1% |
| 8 | Morningglory, Pitted | 101 | 18% | 57 | Morningglory (Annual) | 7 | 1% |
| 9 | Trumpetcreeper | 91 | 16% | 58 | Buttercup spp. | 6 | 1% |
| 10 | Marestail | 89 | 16% | 59 | Bluegrass | 5 | 1% |
| 11 | Nutsedge, Yellow | 85 | 15% | 60 | Brome spp. | 5 | 1% |
| 12 | Panicum, Fall | 82 | 14% | 61 | Clover spp. | 5 | 1% |
| 13 | Horsenettle | 80 | 14% | 62 | Goosegrass | 5 | 1% |
| 14 | Crabgrass, Large | 78 | 14% | 63 | Orchardgrass | 5 | 1% |
| 15 | Spurge, Nodding | 78 | 14% | 64 | Purslane, Common | 5 | 1% |
| 16 | Pokeweed, Common | 73 | 13% | 65 | Sumac | 5 | 1% |
| 17 | Nightshade, E. Black | 70 | 12% | 66 | Woodsorrel, Yellow | 5 | 1% |
| 18 | Copperleaf, Hophornbeam | 69 | 12% | 67 | Groundcherry, Clammy | 4 | 1% |
| 19 | Ragweed, Common | 63 | 11% | 68 | Maple saplings | 4 | 1% |
| 20 | Carpetweed | 62 | 11% | 69 | Morningglory, Tall | 4 | 1% |
| 21 | Dandelion | 62 | 11% | 70 | Smilax spp. | 4 | 1% |
| 22 | Foxtail, Giant | 56 | 10% | 71 | Dayflower | 3 | 1% |
| 23 | Lambsquarters | 51 | 9% | 72 | Foxtails | 3 | 1% |
| 24 | Signalgrass, Broadleaf | 44 | 8% | 73 | Jimsonweed | 3 | 1% |
| 25 | Cocklebur | 43 | 8% | 74 | Mustard spp. | 3 | 1% |
| 26 | Crabgrass, Smooth | 42 | 7% | 75 | Amaranth, Spiny | 2 | <1% |
| 27 | Eclipta | 40 | 7% | 76 | Ammania, Purple | 2 | <1% |
| 28 | Dock, Curly | 37 | 6% | 77 | Burdock, Common | 2 | <1% |
| 29 | Smartweed, Pennsylvania | 34 | 6% | 78 | Multiflora Rose | 2 | <1% |
| 30 | Ragweed, Giant | 31 | 5% | 79 | Pancium, Beaked | 2 | <1% |
| 31 | Groundcherry, Smooth | 27 | 5% | 80 | Plaintain, Broadleaf | 2 | <1% |
| 32 | Waterhemp, Common | 27 | 5% | 81 | Bermudagrass | 1 | <1% |
| 33 | Morningglory, Entireleaf | 23 | 4% | 82 | Bidens spp. | 1 | <1% |
| 34 | Copperleaf, Virginia | 21 | 4% | 83 | Burcucumber | 1 | <1% |
| 35 | Shattercane | 21 | 4% | 84 | Cinquefoil | 1 | <1% |
| 36 | Brambles spp. | 20 | 4% | 85 | Dallisgrass | 1 | <1% |
| 37 | Ironweed, Tall | 20 | 4% | 86 | Geranium, Wild | 1 | <1% |
| 38 | Thistle, Musk | 17 | 3% | 87 | Knotweed, Erect | 1 | <1% |
| 39 | Foxtail, Green | 13 | 2% | 88 | Locust, Black | 1 | <1% |
| 40 | Foxtail, Yellow | 13 | 2% | 89 | Marshelder | 1 | <1% |
| 41 | Spurge spp. | 13 | 2% | 90 | Mulberry sapling | 1 | <1% |
| 42 | Barnyardgrass | 12 | 2% | 91 | Nimblewill | 1 | <1% |
| 43 | Velvetleaf | 12 | 2% | 92 | Plaintain, Buckhorn | 1 | <1% |
| 44 | Dogbane, Hemp | 11 | 2% | 93 | Poison Ivy | 1 | <1% |
| 45 | Fleabane spp. | 11 | 2% | 94 | Purpletop | 1 | <1% |
| 46 | Lettuce, Prickly | 11 | 2% | 95 | Spurred Anoda | 1 | <1% |
| 47 | Morningglory, Bigroot | 11 | 2% | 96 | Thistle, Canada | 1 | <1% |
| 48 | Fescue, Tall | 10 | 2% | 97 | Venice Mallow | 1 | <1% |
| 49 | Indian Tobacco | 10 | 2% | | | | |

[1] Summary consisted of 570 survey sites within 64 soybean fields representing 2,733 acres.
[2] Frequency is the number of sites where a weed species was observed.
[3] The percent is based on a total of 570 survey sites.

most frequent species (22 percent or greater of the sites surveyed). The top 10 species also included smooth pigweed, volunteer wheat, pitted morningglory, trumpetcreeper, and marestail. Of all species observed, a high percentage are perennial or biennial species (more than 40 percent of the total number of species).

Current survey results reflect trends in weed management practices during the past 10 years. The high frequency of perennial species could be attributed to the high percentage of no-till and reduced tillage crop production that is practiced in Kentucky. Although several new weed management tools have been available in the past 10 years to combat johnsongrass, it was ranked as the second most frequent species observed. The presence of prickly sida in soybean is possibly linked with the widespread use of imidazolinone and sulfonylurea herbicide chemistry and the trend toward more postemergence herbicide applications.

As indicated in the objectives, a primary focus of this project is to assess the impact of herbicide-tolerant crop technology on the occurrence of weed species. Therefore, we anticipate that many of these same fields will be scouted in the future (within the next five to 10 years) to determine if weed species shifts occur as a result of the use of this new technology.

**Acknowledgments**

The authors acknowledge the cooperation of crop producers and county Extension agents who participated in the survey. This project was funded by the Kentucky Integrated Pest Management program.

## Comparison of Weed Management Strategies with Roundup Ready® Corn

*J.A. Ferrell and W.W. Witt*

### Introduction

Corn weed management during the past several years in Kentucky has centered around two herbicide families, the chloroacetamides (Dual, Frontier, Harness, Micro-Tech, Surpass) and the s-triazines (AAtrex, Bladex, Princep). These products have been used widely because they offer acceptable, full-season control of many common warm-season annual weeds at a reasonable price. This combination has been so popular that several mixtures that contain these types of herbicides (Bicep II, Bullet, Guardsman, Harness Xtra, Surpass 100, FulTime) are commonly used in Kentucky. The key to this efficacious and economic program is atrazine because it controls most annual broadleaf species that exist in Kentucky corn production with minimal economic investment.

Monsanto released Roundup Ready® corn, which is a transgenic crop that is tolerant to glyphosate, in the spring of 1998. Glyphosate is the active ingredient in several products, including Roundup Ultra, and has long been used as a nonselective burndown herbicide for no-till production of grain crops. The Roundup Ready® technology allows corn growers the opportunity to use Roundup Ultra as a tool for managing most annual grass and broadleaf weeds as well as johnsongrass and other perennial species.

**Table 1.** Entireleaf morningglory and common cocklebur control eight weeks after treatment in 1998 and 1999 at Lexington, Kentucky.

| | | | Entireleaf Morningglory | | Common Cocklebur | |
|---|---|---|---|---|---|---|
| | | | 1998 | 1999 | 1998 | 1999 |
| Treatment[1] | Rate/A | Time of Treatment[2] | % Control[3] | | | |
| 1. Roundup Ultra | 2.0 pt | MP | 90 ab | 96 a | 93 a | 100 a |
| + Roundup Ultra | 2.0 pt | REG | | | | |
| 2. Roundup Ultra | 2.0 pt | MP | 90 ab | 98 a | 94 a | 98 a |
| + Roundup Ultra | 2.0 pt | ASN | | | | |
| 3. Harness Xtra | 4.8 pt | PRE | 66 c | 76 b | 70 b | 86 ab |
| 4. Harness Xtra | 3.4pt | PRE | 89 ab | 100 a | 91 a | 100 a |
| + Roundup Ultra | 2.0 pt | MP | | | | |
| 5. Harness Xtra | 3.2 pt | PRE | 79 b | 95 a | 80 ab | 100 a |
| + Roundup Ultra | 2.0 pt | MP | | | | |
| 6. FieldMaster | 8.0 pt | MP | 94 ab | 100 a | 93 a | 100 a |
| 7. Bicep II | 4.8 pt | PRE | 65 c | 71 b | 68 b | 73 bc |
| 8. Bicep II | 4.8 pt | PRE | 97 a | 100 a | 98 a | 100 a |
| + Exceed | 1.0 oz | MP | | | | |
| 9. Aatrex | 2.0 pt | PRE | 96 ab | 100 a | 97 a | 100 a |
| + Princep | 2.0 pt | PRE | | | | |
| + Exceed | 1.0 oz | MP | | | | |
| 10. AAtrex | 2.0 pt | PRE | 90 ab | 100 a | 89 a | 100 a |
| + Princep | 2.0 pt | PRE | | | | |
| + Roundup Ultra | 2.0 pt | MP | | | | |
| 11. AAtrex | 2.0 pt | PRE | 86 ab | 100 a | 89 a | 100 a |
| + Roundup Ultra | 2.0 pt | MP | | | | |
| 12. Guardsman | 4.5 pt | PRE | 81 ab | 71 b | 80 ab | 71 c |
| 13. Guardsman | 4.5 pt | PRE | 93 ab | 100 a | 96 a | 100 a |
| + Banvel | 0.25pt | MP | | | | |

[1] All postemergent treatments contained adjuvants recommended on the label.
[2] PRE = applied day of planting, ASN = as needed, MP = 2- to 4-inch weeds, REG = 2- to 4-inch weed regrowth.
[3] Treatment means with the same letter are not statistically different (P=0.05).

Although Roundup Ultra was known to control a wide range of weedy species, there were questions regarding the economics of this technology relative to traditional standard herbicide programs for controlling warm-season annual weeds. The technology fee of $6 per acre for the Roundup Ready® seed was an expense associated with a Roundup weed control program. Furthermore, it was not known if one or two applications of Roundup Ultra would be needed to provide weed control

comparable to other products.

The objective of this research was to compare the profitability of Roundup Ready® technology with traditional herbicide programs for managing warm-season annual weeds.

## Methods

Experiments were conducted in Princeton and Lexington in 1998 and 1999 to evaluate and compare weed control and net returns that resulted from Roundup Ultra and several commonly used herbicide programs. Herbicide applications were made to the soil surface (PRE) the day of planting, to 2- to 4-inch weeds (MP), to 2- to 4-inch weed regrowth (REG), or as needed (ASN) to late emerging weeds. DeKalb 591RR and DeKalb 626RR were planted in late April or early May for all locations in 1998 and 1999, respectively. Plots were 10 feet wide (4 rows) by 30 feet long with four replications.

Weed control was evaluated visually two, four, and eight weeks after application. The plots were hand harvested by collecting 30 linear feet of row and yields adjusted to 15.5 percent moisture. Return above fixed and variable costs was calculated by the formula: [yield (bu/A)*$2.06] – [herbicide cost + fixed and variable cost]. Herbicide costs included cost of the herbicide(s) plus a $6 technology fee for Roundup Ready® treatments and an application charge of $4/A for each herbicide treatment. A value of $264.54/A, for variable and fixed costs, was obtained from the University of Kentucky Department of Agricultural Economics.

**Table 2.** Corn yield and net return in 1998 and 1999 at Lexington Kentucky. No statistical differences among yield or net return occurred.

| | | | Yield | | Return[3] | |
|---|---|---|---|---|---|---|
| | | | 1998 | 1999 | 1998 | 1999 |
| Treatment[1] | Rate/A | Time of Treatment[2] | Bu/A | | $/A | |
| 1. Roundup Ultra | 2.0 pt | MP | 195 | 66 | $104.84 | $-159.42 |
| + Roundup Ultra | 2.0 pt | MPR | | | | |
| 2. Roundup Ultra | 2.0 pt | MP | 225 | 61 | 166.43 | -169.63 |
| + Roundup Ultra | 2.0 pt | ASN | | | | |
| 3. Harness Xtra | 4.8 pt | PRE | 180 | 60 | 78.66 | -168.79 |
| 4. Harness Xtra | 3.4pt | PRE | 206 | 64 | 133.99 | -158.44 |
| + Roundup Ultra | 2.0 pt | MP | | | | |
| 5. Harness Xtra | 3.2 pt | PRE | 217 | 72 | 143.36 | -155.63 |
| + Roundup Ultra | 2.0 pt | MP | | | | |
| 6. FieldMaster | 8.0 pt | MP | 198 | 84 | 112.06 | -124.17 |
| 7. Bicep II | 4.8 pt | PRE | 188 | 61 | 99.46 | -163.36 |
| 8. Bicep II | 4.8 pt | PRE | 226 | 59 | 160.19 | -183.61 |
| + Exceed | 1.0 oz | MP | | | | |
| 9. AAtrex | 2.0 pt | PRE | 210 | 56 | 139.73 | -175.75 |
| + Princep | 2.0 pt | PRE | | | | |
| + Exceed | 1.0 oz | MP | | | | |
| 10. AAtrex | 2.0 pt | PRE | 218 | 66 | 154.13 | -158.90 |
| + Princep | 2.0 pt | PRE | | | | |
| + Roundup Ultra | 2.0 pt | MP | | | | |
| 11. AAtrex | 2.0 pt | PRE | 202 | 66 | 124.65 | -154.95 |
| + Roundup Ultra | 2.0 pt | MP | | | | |
| 12. Guardsman | 4.5 pt | PRE | 192 | 48 | 107.45 | -188.63 |
| 13. Guardsman | 4.5 pt | PRE | 213 | 57 | 144.65 | -177.28 |
| + Banvel | 0.25 pt | MP | | | | |
| LSD (P=0.05) | | | NS | NS | NS | NS |

[1] All postemergent treatments contained adjuvants recommended on the label.
[2] PRE = applied day of planting, ASN = as needed, MP = 2- to 4-inch weeds, REG = 2- to 4-inch weed regrowth.
[3] Return above fixed and variable costs = [yield(bu/A)*$2.06] – [herbicide cost + fixed and variable cost].

## Results and Discussion

Several weeds were evaluated at the various study locations including giant foxtail, common lambsquarters, and giant ragweed. Control of these three species exceeded 90 percent for all treatments in both 1998 and 1999 (data not shown). In Lexington, the dominant weeds were entireleaf morningglory and common cocklebur. Data are presented for these weed species due to their common occurrence in Kentucky corn production and because they are difficult to control. For entireleaf morningglory and common cocklebur, control ranged between 66 and 100 percent during both years (Table 1). Sequential Roundup Ultra treatments were highly effective and were not significantly different from the highest control treatment in either year. The choloracetamide + atrazine treatments, not followed by postemergence applications (treatments 3, 7, 12), usually had the least control. Treatments consisting of PRE followed by MP combinations consistently were the most efficacious. For all locations and both years, the ASN treatment was required in the form of a single application to 2- to 4-inch weed regrowth. These data indicate that a single Roundup Ultra application will rarely be sufficient; however, a third application will not be required.

Although significant differences in weed control were detected between treatments, no significant differences were observed in yield or return above fixed and variable costs for any treatment (Table 2). These data clearly demonstrate that 100 percent weed control was not necessary to obtain top yields. It was also readily noticed that a great disparity between yield and net return existed between 1998 and 1999 (Table 2). This was due to the lack of rainfall during the growing season of 1999 that led to low corn yields and negative net return values.

## Summary

These results demonstrated that Roundup Ultra could be used alone, or sequentially with other products, to deliver effective and consistent weed control over a range of weed species and environmental conditions. There were no differences in return above fixed and variable costs between Roundup Ultra and any of the other herbicide programs compared in this study. Roundup Ready® technology provides another weed management alternative for Kentucky corn growers.

The two years in which these studies were conducted were very different. Growing conditions in 1998 were excellent for corn production resulting in excellent yields in Lexington and Princeton, while rainfall was lacking at both locations in 1999 and corn yield was reduced greatly. The extremes in growing conditions provided an opportunity to evaluate Roundup Ready® technology under the "best" and "worst" cases that will be encountered in Kentucky. Consistent weed control was obtained with all herbicide treatments in both years.

**Acknowledgments**

The Kentucky Corn Growers Association provided partial funding of this research.

## Italian Ryegrass Control in No-Till Corn

*J.R. Martin*

Italian ryegrass (*Lolium multiflorum*) is a cool-season grass that is commonly referred to as annual ryegrass. Grass waterways and field borders are often sown with a seed mixture of Italian ryegrass and tall fescue; consequently, these areas may be a potential source of spreading this weed into grain crop fields, particularly those planted to no-tillage corn. As Italian ryegrass continues to spread, the numbers of complaints about controlling it with burndown herbicides in no-tillage corn increase.

Field trials were conducted in 1997 and 1998 to evaluate and compare the efficacy of different combinations and timings of Gramoxone Extra (paraquat) and Roundup Ultra (glyphosate) applied as burndown herbicide treatments in no-tillage corn. Herbicide treatments included in these studies are listed in Table 1.

**Table 1.** Italian ryegrass control and corn grain yield following preplant-foliar applications of Gramoxone Extra and Roundup Ultra (Princeton, Kentucky, 1997 and 1998).

| | | | 1997 | | 1998 | |
|---|---|---|---|---|---|---|
| **Chemicals** | **Rate/A** | **Timing[a]** | **Ryegrass Control[b] %** | **Corn Yield (bu/A)** | **Ryegrass Control[b] %** | **Corn Yield (bu/A)** |
| Gramoxone Extra | 1.5 pt/A | PRE | 18 | 80.4 | 67 | 123.8 |
| Non Ionic Surfactant | 0.25% | | | | | |
| Gramoxone Extra | 1.5 pt/A | PRE | 48 | 126.1 | 97 | 126.2 |
| Non Ionic Surfactant | 0.25% | | | | | |
| Atrazine | 3 pt/A | | | | | |
| Roundup Ultra | 2 pt/A | PRE | 63 | 99.4 | 93 | 113 |
| Roundup Ultra | 2 pt/A | PRE | 68 | 141.3 | 90 | 124.6 |
| Atrazine | 3 pt/A | | | | | |
| Roundup Ultra | 3 pt/A | PRE | 88 | 129.6 | 100 | 123.7 |
| Atrazine | 3 pt/A | | | | | |
| Gramoxone Extra | 1.5 pt/A | EPP | 90 | 141.6 | 100 | 134.9 |
| Non Ionic Surfactant | 0.25% | | | | | |
| Gramoxone Extra | 1.5 pt/A | PRE | | | | |
| Non Ionic Surfactant | 0.25% | | | | | |
| Atrazine | 3 pt/A | | | | | |
| Roundup Ultra | 2 pt/A | EPP | 90 | 138.8 | 100 | 120.8 |
| Gramoxone Extra | 1.5 pt/A | PRE | | | | |
| Non Ionic Surfactant | 0.25% | | | | | |
| Atrazine | 3 pt/A | | | | | |
| Non-treated check | | | ---------- | ---------- | 0 | 98.2 |
| LSD (0.05) | | | 38 | NS | 18 | 25.6 |

[a] Early preplant treatments were applied during mid-April when ryegrass plants were 14 to 22 inches in height. Preemergence treatments were applied approximately three weeks later when ryegrass plants were about 26 to 33 inches tall. Banvel (dicamba) was applied postemergence to all plots for broadleaf weed control.
[b] Visual ratings of Italian ryegrass control were made in mid-June.

Gramoxone Extra applied alone as a single spray at planting provided less than 70 percent control of Italian ryegrass both years. Including atrazine with Gramoxone Extra enhanced control in one out of two years. The results from PRE applications of Roundup Ultra at 2 pt/A, either alone or with atrazine at 3 pt/A, were similar to those observed with PRE applications of Gramoxone Extra. However, increasing the Roundup Ultra rate to 3 pt/A in the mixture with atrazine tended to improve Italian ryegrass control. The use of Gramoxone Extra at 1.5 pt/A or Roundup Ultra at 2 pt/A as an EPP treatment followed by the PRE treatment of Gramoxone Extra at 1.5 pt/A plus atrazine at 3 pt/A provided at least 90 percent control of Italian ryegrass both years.

The fact that no significant differences in corn yield were observed among herbicide treatments indicates that total season-long control of Italian ryegrass is not always crucial to achieving high yields. However, corn stands and yields can be greatly affected if no control measures are implemented.

**Summary**

These results confirm that achieving control of Italian ryegrass with burndown herbicides can be difficult. Obtaining maximum burndown control of Italian ryegrass in no-tillage corn may require a single spray of Roundup Ultra applied at a minimum rate of 3 pt/A in combination with atrazine or a sequential program of burndown herbicides applied as an early preplant treatment followed by a preemergence treatment.

# Impact of Wheat Herbicides on Double-Cropped Soybeans

*J.M. Ewing, W.W. Witt, and J.R. Martin*

## Introduction

Numerous weed species can infest wheat in Kentucky, and several of these are particularly troublesome and can decrease wheat yield. Cheat, hairy chess, and Italian ryegrass are especially troublesome and difficult to control with currently available herbicides. Chickweed, purple deadnettle, henbit, and several mustard species are also problems. Because of the occurrence of these weeds, wheat growers are interested in the evaluation of herbicides labeled for use in wheat. There are several herbicides labeled for wheat in states other than Kentucky, primarily in continuous wheat. Double-cropped soybeans follow essentially all of the wheat grown in Kentucky, and herbicides used for wheat weed control must not persist in soil and cause injury to soybeans.

## Objective

Determine if wheat herbicides applied in the fall or spring cause injury to double-cropped soybeans.

## Methods

Wheat was planted in October of 1997 and 1998 at Princeton and 1998 at Lexington. After wheat harvest in June of 1998 and 1999, soybeans were planted no-till into the standing wheat stubble. Two soybean varieties were evaluated: AG 4501, an sulfonylurea-tolerant soybean (STS) and AG 4702, a non-STS. Several of the wheat herbicides discussed in this report kill weeds (and crops) by inhibiting the acetolactate synthase enzyme (ALS). STS soybeans were developed because of their tolerance to ALS-inhibiting herbicides, and we were interested in knowing if STS soybeans would be tolerant to these wheat herbicides.

Wheat herbicides were evaluated for double-crop soybean injury at Princeton in 1998 and 1999 and Lexington in 1999. Treatments were applied to actively growing wheat in late November and in mid-March. Soybean injury was evaluated in mid-August, eight weeks after soybean planting. Listed in the following table are products evaluated in these studies:

| Herbicide | Rate | Active Ingredients |
|---|---|---|
| Harmony Extra75 DF | 0.6 oz/A | *thfensulfuron & *tribenuron |
| Peak 57 WDG | 0.75 oz/A | *prosulfuron |
| Ally 60 DF | 0.1 oz/A | *metsulfuron |
| Maverick 75 WSG | 0.5 oz/A | *sulfosulfuron |
| Assert 2.5 E | 1.5 pt/A | *imazamethabenz |
| Sencor 75 DF | 3 oz/A | metribuzin |
| Curtail 2.38 E | 2.5 pt/A | clopyralid + 2,4-D |

* ALS-inhibiting herbicides

## Results

**Soybean Injury.** No injury was noted in 1998 to either soybean variety from fall or spring applications of the herbicides (Table 1). Rainfall was below normal from the time of wheat planting and fall herbicide applications, until the spring herbicide applications in 1998. However, 22 inches of rainfall were received on the plots in April, May, and June. This excessive rainfall probably contributed to a more rapid herbicide loss in the spring. Substantial soybean injury was noted in 1999 at Princeton and Lexington (Table 1). Rainfall from the time of wheat planting until the spring herbicide treatments was near normal at Princeton and slightly below normal at Lexington.

Peak and Maverick caused the greatest injury in Princeton with fall and spring treatments on the non-STS variety, with the spring treatment having greater injury. However, the STS variety exhibited much less injury from Peak and Maverick. Ally applied in the fall caused 10 percent injury to the non-STS and 3 percent injury to the STS variety at Princeton. A similar response was noted with the fall treatment of Maverick to the STS variety. Assert , Harmony Extra, and Sencor caused little, if any, injury at Princeton. The spring treatment of Peak produced the greatest injury to the non-STS variety at Lexington. Maverick injury was less at Lexington compared to Princeton for the non-STS variety. Less injury was noted at both locations with the STS variety for Harmony Extra, Peak, Ally, Maverick, and Assert.

Although Curtail is not an ALS-inhibiting herbicide, it did cause injury to double-cropped soybeans at Princeton with the spring treatment and the fall and spring treatment at Lexington. The clopyralid component of Curtail is believed to have persisted in soil and caused injury to the double-cropped soybeans.

**Soybean Yield.** Over all locations, soybean yield was low (Table 2). Rainfall at Princeton in 1998 was very limiting during the soybean growing season, although soil moisture was excellent at the time of planting. Soybean yield in 1999 at Princeton was low and averaged about 12 bushels per acre and was attributed to the low rainfall received during the soybean growing season. The plots at Lexington were not harvested. These soybeans never produced pods with seeds, due to the severe lack of water at this location. It was difficult to draw conclusions from these yield data because of the relatively low, to very low, yields; however, the greatest soybean injury was noted in 1999 with a spring treatment of Maverick, and this treatment produced the lowest yield (Table 2). Curtail injury also reduced yield in 1999. Yield was generally greater with the STS variety compared to the non-STS variety in 1999.

## Summary

This research shows the importance of following label restrictions regarding rotational crops. Some of the wheat herbicides in these studies persisted in the soil and caused injury to double-cropped soybeans during a year when the amount of rainfall was below normal. The magnitude and risk of soybean injury from

most ALS-inhibiting herbicides in this study tended to be greater for spring applications compared with fall applications. The STS variety used in these studies exhibited less soybean injury than the non-STS variety. This response is encouraging because it might allow for the use of some herbicides for wheat weed control that could not be used. However, additional research under more "normal" climatic conditions is needed.

**Table 1.** Soybean injury of non-STS and STS varieties at Princeton in 1998 and 1999 and Lexington in 1999. Soybean injury was evaluated in mid-August of each year.

| | | Percent Soybean Injury | | | | | |
|---|---|---|---|---|---|---|---|
| | | Princeton 98 | | Princeton 99 | | Lexington 99 | |
| Herbicide | Timing | Non-STS | STS | Non-STS | STS | Non-STS | STS |
| Harmony Extra | Fall | 0 | 0 | 3 | 0 | 0 | 0 |
| Harmony Extra | Spring | 0 | 0 | 0 | 0 | 0 | 0 |
| Peak | Fall | 0 | 0 | 10 | 0 | 7 | 0 |
| Peak | Spring | 0 | 0 | 23 | 3 | 40 | 0 |
| Ally | Fall | 0 | 0 | 10 | 3 | 0 | 0 |
| Ally | Spring | 0 | 0 | 3 | 0 | 3 | 0 |
| Maverick | Fall | 0 | 0 | 13 | 7 | 0 | 0 |
| Maverick | Spring | 0 | 0 | 47 | 0 | 13 | 0 |
| Assert | Fall | 0 | 0 | 0 | 0 | 10 | 0 |
| Assert | Spring | 0 | 0 | 3 | 3 | 7 | 7 |
| Sencor | Fall | 0 | 0 | 0 | 0 | 0 | 0 |
| Sencor | Spring | 0 | 0 | 0 | 0 | 13 | 0 |
| Curtail | Fall | 0 | 0 | 0 | 0 | 10 | 0 |
| Curtail | Spring | 0 | 0 | 23 | 10 | 13 | 3 |
| | LSD (0.05) | NS | NS | 22 | 8 | 15 | 6 |

**Table 2.** Soybean yield of non-STS and STS varieties at Princeton in 1998 and 1999.

| | | Soybean Yield (bu/A) | | | |
|---|---|---|---|---|---|
| | | Princeton 98 | | Princeton 99 | |
| Herbicide | Timing | Non-STS | STS | Non-STS | STS |
| Harmony Extra | Fall | 15 | 19 | 12 | 13 |
| Harmony Extra | Spring | 18 | 17 | 13 | 13 |
| Peak | Fall | 18 | 18 | 12 | 18 |
| Peak | Spring | 13 | 26 | 13 | 16 |
| Ally | Fall | 16 | 18 | 12 | 13 |
| Ally | Spring | 26 | 21 | 10 | 12 |
| Maverick | Fall | 28 | 22 | 14 | 14 |
| Maverick | Spring | 17 | 23 | 7 | 12 |
| Assert | Fall | 18 | 15 | 14 | 12 |
| Assert | Spring | 17 | 15 | 11 | 13 |
| Sencor | Fall | 25 | 19 | 15 | 15 |
| Sencor | Spring | 25 | 23 | 13 | 15 |
| Curtail | Fall | 24 | 24 | 13 | 14 |
| Curtail | Spring | 26 | 22 | 9 | 14 |
| | LSD (0.05) | NS | NS | NS | NS |