Integrated
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Management

WEED MANAGEMENT SYSTEMS for ENVIRONMENTALLY SENSITIVE AREAS

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WEED MANAGEMENT SYSTEMS for ENVIRONMENTALLY SENSITIVE AREAS

Environmentally sensitive areas are characterized by their susceptibility to the effects of agricultural practices and require special consideration when selecting a weed management program. These areas are often associated with watersheds that feed into sources of public drinking water, such as the Salt River watershed in northeast Missouri, which includes Mark Twain Lake and several other bodies of water. Water quality is of particular interest in rural areas with intensive row-crop production because of runoff, the potential for increased erosion of soil particles, or leaching of inputs such as fertilizers or pesticides into surface water. This publication examines four aspects of corn production in environmentally sensitive areas:

1. Influence of management practices on weed control with atrazine.
2. Weed control in no-till, herbicide-resistant corn.
3. Herbicide activity in corn using a cover crop.
4. Weed interference and nitrogen accumulation by grass weeds in corn.

Atrazine is an important herbicide for broadleaf weed control in Missouri corn and grain sorghum production. It is applied to 80–100 percent of corn and grain sorghum acres annually at a rate of about 1.4 pounds of active ingredient per acre (lb ai/acre). More than 18 herbicides and tank mixes containing atrazine are available for preemergence and postemergence application in corn. However, atrazine use has been scrutinized for more than 10 years because of its occasional detection in surface and groundwater. In 1994 the U.S. Environmental Protection Agency (EPA) established a maximum contaminant level of 3 parts per billion of atrazine in drinking water supplies in Missouri, and 10 drinking water supplies received notices of violation (NOV) for exceeding acceptable levels of contamination. No NOVs were issued in 1995, 1996 or 1997; two NOVs were issued in 1998.

EFFECT OF MANAGEMENT PRACTICES ON WEED CONTROL WITH ATRAZINE

These concerns may lead to the restriction of atrazine use if ways are not found to reduce the amount of atrazine detected in surface and groundwater. Because atrazine is a key component of weed management programs throughout the Corn Belt, it is necessary to use it wisely. Research conducted at the University of Missouri over a 12-year period (1990–2001) explored how atrazine rates, application timing, and tillage practices have influenced weed control and grain yield in field corn.

The information presented in this publication was compiled from the results of field experiments to assess the performance of atrazine and other herbicides in corn. Visual evaluations of weed control were collected in July. The species evaluated included giant foxtail, cocklebur, common ragweed, common sunflower, common waterhemp, ivyleaf morningglory and velvetleaf. Data were sorted by herbicide application timing, atrazine rate and tillage system.

How does application timing affect weed control with atrazine?

In a comparison of one-pass preemergence application of atrazine with postemergence application and preemergence followed by postemergence applications (two-pass), the two-pass application programs provided greater weed control than one-pass programs (Figure 1).

When averaged over 12 years, test results from postemergence programs only once showed control equal to that provided by the two-pass program (Figure 2). This occurred in one of the first years that Roundup Ready and Liberty Link technology was used in the research program.

Two-pass programs provided the best overall control in 11 out of 12 years. Two-pass herbicide applications also provided commercially acceptable control (90% or higher) more often than single-pass programs (Figure 3). Research in no-till corn became more prevalent in the Missouri program in 1997. Figure 3 summarizes information gathered between 1997 and 2001 to evaluate the influence of tillage systems on weed control in corn.

Figure 1. Average weed control (%) in July with 1- and 2-pass weed control programs.

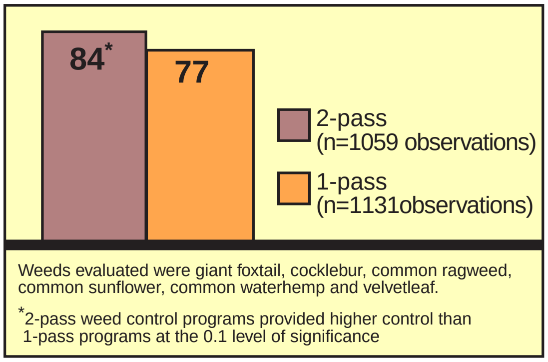


Figure 2. Herbicide programs that provided best overall weed control in July.

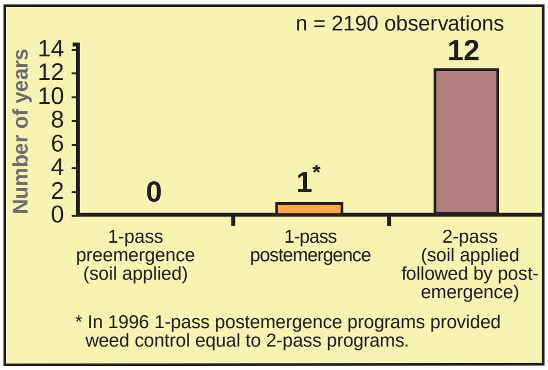
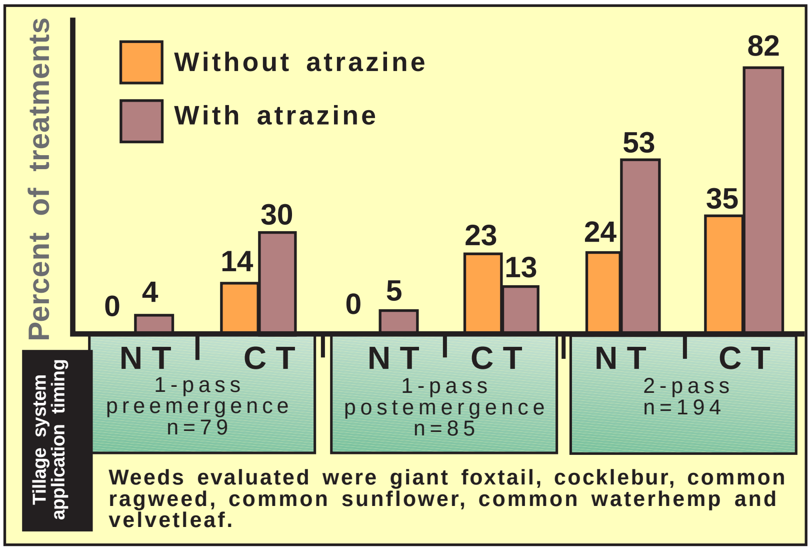


Figure 3. Treatments that provided 90% or greater weed control, NT = no-till CT = conventional till



How do tillage systems affect weed control with atrazine?

Research shows that attaining 90 percent control of all weeds in no-till systems occurs less frequently than in conventional-till systems (Figure 3). Overall weed control greater than 90 percent with two-pass programs occurs more often in conventional-till than in no-till systems. Two-pass programs provide 90 percent or greater control more often than one-pass programs regardless of tillage system. The addition of atrazine increases the frequency of attaining 90 percent control.

How do atrazine rates affect weed control and corn yield?

No matter what weed management program you prefer, the addition of atrazine will increase the level of weed control you can achieve. Including atrazine in a herbicide program increases the frequency of weed control values exceeding 90 percent. Interestingly, Missouri research showed no significant weed control response to atrazine rate, but did observe a significant yield response to rate (Figures 4 and 5).

Average overall weed control ranged from 79 to 85 percent with atrazine rates of 0.5 to 2.5 lb ai/acre. However, corn yields ranged from 101 to 160 bu/acre over the same atrazine range. This difference in response could be due to any of several reasons:

1. Corn yield is extremely sensitive to weed interference. Despite the minimal differences in overall weed control as influenced by atrazine rate, these differences could have been significant enough to cause yield differences.
2. Higher rates of atrazine would provide better late-season weed control, which

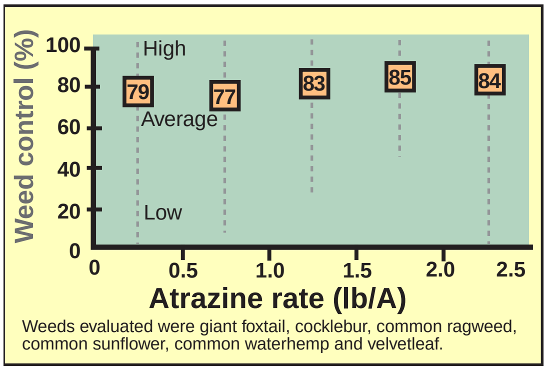


Figure 4. Effects of atrazine rate on high, low and average July weed control in no-till corn.

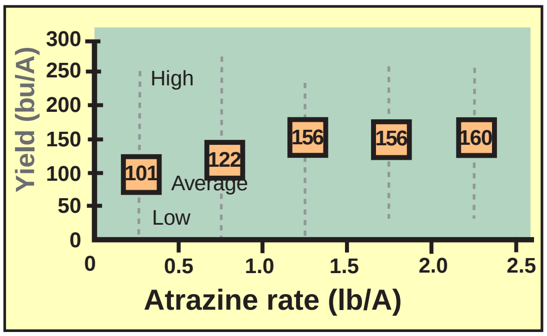


Figure 5. Effects of atrazine rate on high, low and average yield for no-till corn.

would result in less weed biomass at harvest and greater harvest efficiency. Additionally, greater late-season weed control would result in less competition for nutrients and water at a time when these are in high demand by corn for grain fill.

3. In treatments using lower rates of atrazine, there is a higher frequency of other herbicides used to control weeds missed by lower atrazine rates. It is possible that in the Missouri trials, the use of some of these herbicides caused crop injury and yield loss.

Summary

1. Two-pass herbicide programs that include both preemergence and postemergence herbicide applications provide better overall weed control and more frequent occurrence of weed control exceeding 90 percent.
2. No-till or reduced-till production systems provide unique weed management challenges and are more dependent on atrazine use to achieve desired weed control levels.
3. Overall weed control is not very responsive to atrazine rates. However, corn yield increases significantly with higher rates of atrazine application.

WEED CONTROL IN NO-TILL, HERBICIDE-RESISTANT CORN

The popularity of no-till cropping systems and herbicide-resistant corn has grown substantially in recent years. Between 1990 and 2000, the number of acres in no-till corn increased by more than 9 percent. The acceptance of this practice has increased by the availability of improved planting equipment, more selective herbicides, and herbicide-resistant crops. Three of the herbicides for which herbicide-resistant corn has been developed include Roundup (glyphosate) in Roundup Ready corn, Liberty (glufosinate) in Liberty Link corn and Lightning (imazethapyr & imazapyr) in Clearfield corn.

University of Missouri research on the relative efficacy of weed control programs using these three herbicide-resistant corn varieties and their suitability to Missouri evaluated three herbicide strategies:

1. Burndown plus full rates of residual herbicides applied early preplant (EPP), 1 to 2 weeks before planting.
2. Burndown plus a reduced rate of acetochlor applied EPP followed by reduced rates of residual herbicides postemergence (SPLIT).
3. Burndown plus full rate of acetochlor EPP followed by the appropriate postemergence product used in herbicide-resistant corn plus atrazine (EPP gr/at+) and the appropriate postemergence product.

Table 1 shows the products and application rates evaluated in the research.

Weeds evaluated in the Missouri trials were giant foxtail, common cocklebur, common ragweed and common waterhemp. Weed control ratings taken five weeks after the last herbicide

Table 1. Treatments used in no-till, herbicide-resistant corn.

Treatment description	EPP burndown treatment (Same for all varieties)	Roundup Ready™ corn POST treatment	Liberty Link™ corn POST treatment	Clearfield™ corn POST treatment
EPP[a]	1.5 pt Roundup Ultra[c] 2.5 pt Harness[d] 4 pt Aatrex[e]	none	none	none
SPLIT	0.75 pt Roundup Ultra 1.25 pt Harness 2 pt Aatrex	0.75 pt Roundup Ultra 1.25 pt Harness 1.5 pt Aatrex	28 oz Liberty[f] 1.25 pt Harness 1.5 pt Aatrex	1.44 oz Lightning[g] 1.5 pt Aatrex
EPP gr/at+	1.5 pt Roundup Ultra 2.5 pt Harness	2.0 pt Roundup Ultra 1.5 pt Aatrex	28 oz Liberty 1.5 pt Aatrex	1.44 oz Lightning 1.5 pt Aatrex
MPOST[b]	none	2 pt Roundup Ultra 1.25 pt Harness 1.5 pt Aatrex	28 oz Liberty 1.25 pt Harness 1.5 pt Aatrex	1.44 oz Lightning 1.5 pt Aatrex
EPP/MPOST	2.0 pt Roundup Ultra	2.0 pt Roundup Ultra	28 oz Liberty	1.44 oz Lightning

Notes:
[a] EPP — early preplant
[b] MPOST — midpostemergence; 2- to 4-inch weeds
[c] Roundup Ultra 3.0 lb ai/gal
[d] Harness 7.0 lb ai/gal
[e] Aatrex 4 lb ai/gal
[f] Liberty 1.67 lb ai/gal
[g] Lightning 70% ai

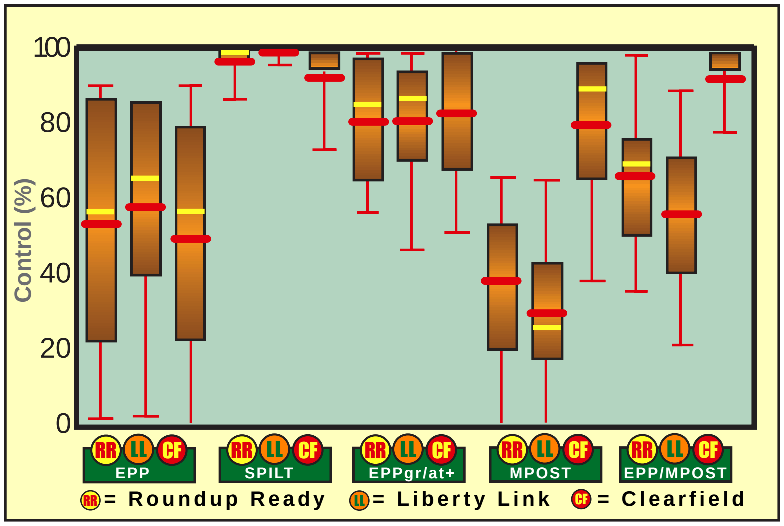


Figure 6. Giant foxtail control in no-till herbicide-resistant corn.

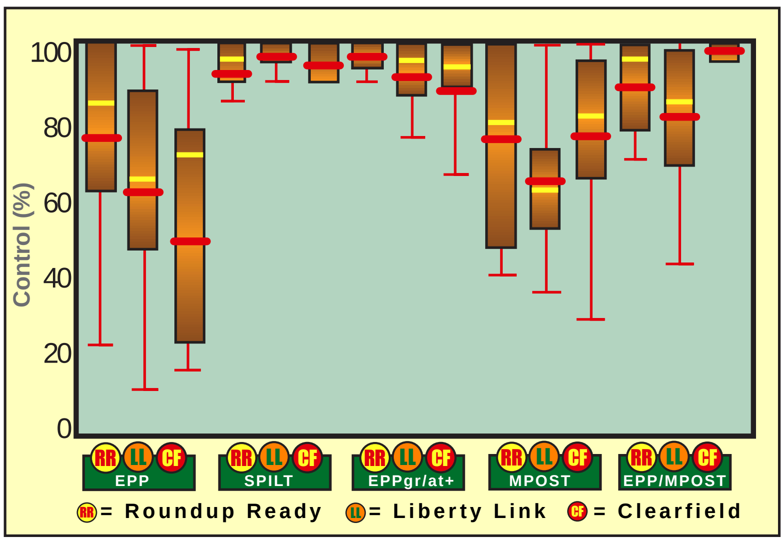


Figure 7. Common cocklebur control in no-till, herbicide-resistant corn.

application in late July are shown as box-and-whisker plots grouped by herbicide strategies (Figures 6–10).

Note: In Figures 6–10, the thick (red) line is the mean, the thin (yellow) line is the median, and the boxes show the 25th and 75th percentiles. The error bars show the 10th and 90th percentiles.

Giant foxtail control

The greatest control of giant foxtail was attained with SPLIT applications in all corn varieties (Figure 6). SPLIT applications provide greater control of giant foxtail because of its long emergence period (8 to 10 weeks). Lightning use in Clearfield corn resulted in more consistent control than other herbicide programs that included postemergence treatments. EPP treatments resulted in more overall variation in control than treatments that included a POST application.

Common cocklebur control

The most effective control of common cocklebur occurred with treatments that included both preemergence and postemergence application of residual herbicides (SPLIT or EPP gr/at+) (Figure 7). Treatments in which the residual herbicide was applied at a single time (EPP or MPOST) provided less control and more variation in control. Residual herbicides applied once are not active long enough to control late-emerging common cocklebur.

Common ragweed control

As in the control of common cocklebur, treatments that included both preemergence and postemergence application of residual herbicides provided the most effective control of common ragweed (Figure 8). However, any treatment that included a POST application of Lightning tended to produce a lower level of control than the corresponding Roundup or Liberty treatment within the herbicide strategy. In the strategies that rely on single applications (EPP, MPOST), better control was achieved with earlier applications (EPP) than with late applications (MPOST) because the common ragweed is smaller and easier to control and does not emerge later in the growing season.

Common waterhemp control

Of the weed-control strategies evaluated in the Missouri studies, the greatest variability occured in control of common waterhemp (Figure 9). SPLIT treatment in Roundup Ready and Liberty Link varieties, as well as the use of Roundup in the EPP gr/at+ program, provided 100 percent control of common waterhemp. Clearfield programs tended to provide lower control than the other programs. Roundup Ready programs tended to provide the highest control of this weed. Because common waterhemp germinates throughout the growing season, use of residual herbicides before and after planting, in addition to POST herbicides with efficacy on waterhemp, were needed to provide effective season-long control.

Corn yield

Corn yields tend to follow a trend similar to that for weed control (Figure 10). Weed control programs using SPLIT and EPPgr/at+ applications resulted in the highest yields of the treatments in the study, at 94 percent and 90 percent of the weed-free control, respectively. Postemergence treatments alone without accompanying preemergence treatments resulted in yields that were less than or equal to 65 percent of the weed-free checks.

Summary

In no-till, herbicide-resistant corn, herbicide programs using both pre- and postemergence applications of a residual herbicide consistently provided effective weed control with lower amounts of variability. These programs also provided the highest yield. Use of residual herbicides in programs with both pre- and postemergence applications resulted in the best yield.

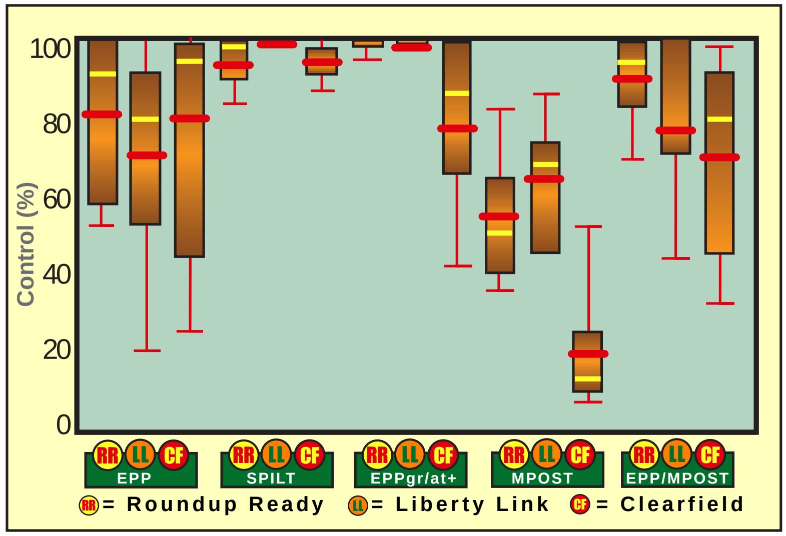


Figure 8. Common ragweed control in no-till, herbicide-resistant corn.

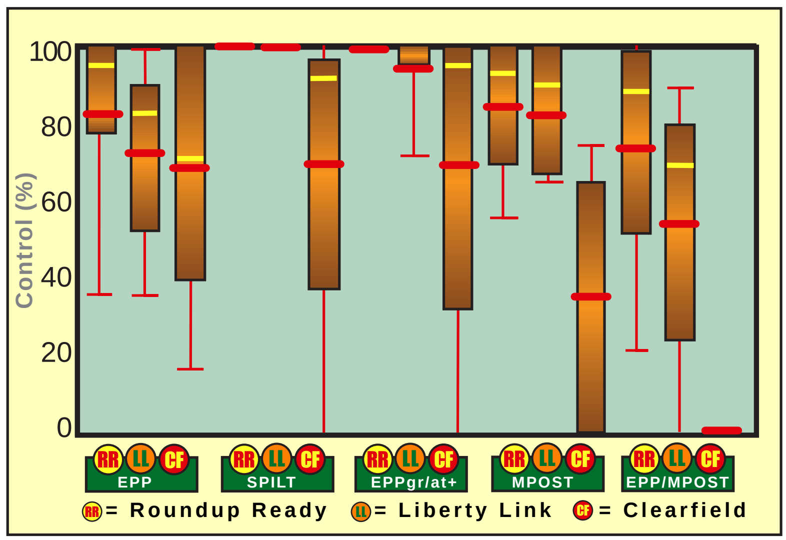


Figure 9. Common waterhemp control in no-till, herbicide-resistant corn.

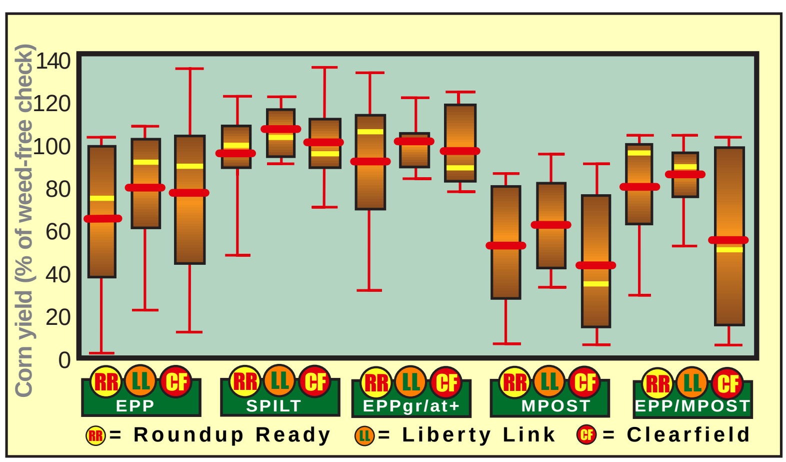


Figure 10. Corn grain yield in no-till, herbicide-resistant corn.

HERBICIDE ACTIVITY IN CORN WITH A COVER CROP

Because of the low cost and reliability of atrazine, alternative corn production practices that would ensure continued use of atrazine are necessary. One such option is increasing the presence of surface crop residues in early spring, a time when atrazine is most likely to move away from target sites (Figure 11). In a typical corn-soybean rotation, the standard level of soybean residue is 30 percent under no-till conditions at the time when atrazine in applied. This level of residue may not be enough to prevent atrazine movement in periods of moderate to heavy rainfall.

Figure 11. Corn emerging through the residue of a rye cover crop.

Alternatively, planting a cover crop after soybean harvest would increase plant residue to sufficient levels before corn planting. Elevated plant residue levels may reduce the movement of atrazine off-site. The use of a cover crop would require additional management, but the option to continue use of an efficacious and cost-effective herbicide such as atrazine may offset this cost.

Studies were conducted at the University of Missouri Agronomy Research Center in 1999, 2000 and 2001 to evaluate the use of cover crops in corn production. All treatments received a labeled rate application of Roundup Ultra (26 oz/acre) 14 days before planting. Treatments included a preemergence application of Bicep II Magnum or Dual II Magnum and postemergence application of Marksman or Clarity. Treatments were ranked according to the amount of atrazine applied. All treatments were repeated on bare ground and on a rye cover crop. Treatments were as follows:

High rate — Bicep II Magnum followed by Marksman; 2.5 lb atrazine/acre

Medium rate — Bicep II Magnum followed by Clarity; 1.6 lb atrazine/acre

Low rate — Dual II Magnum followed by Marksman; 0.79 lb atrazine/acre

None — Dual II Magnum followed by Clarity; 0 lb atrazine/acre

Giant foxtail and waterhemp control was rated two weeks after the postemergence applications.

What is the cost of implementing a cover crop in corn production?

Many costs of introducing a cover crop into a conventional corn production system are related to establishment of the cover crop. This includes the cost of the cover crop seed. One to two bushels of seed per acre is the rate necessary to establish a suitable rye cover crop stand. Another input is the application of nitrogen (30 to 50 lb/acre in early spring), which is needed to optimize cover crop growth. There are also some in-season costs that are associated with interactions within the cropping system. These include, subsoil moisture depletion during the growing season of the corn crop, potential immobilization of nutrients required for corn (specifically nitrogen), and greater pressure of insect pests that may use the cover crop as a host.

What are the benefits of using a cover crop?

Cover crops provide both short- and long-term benefits. Short-term benefits include continued use of atrazine in areas prone to watershed contamination, weed suppression by the cover crop residues, and reduced soil erosion and runoff of nutrients and pesticides. Long-term benefits include improvement in soil organic matter and uniform establishment of plant species relatively sensitive to a burndown herbicide in the spring.

What special considerations are involved in adopting a cover crop?

Many of the keys to successfully adopting a cover crop are related to good management of the field. These and other considerations require special planning for the cover crop:

- Timely harvesting of the crop in the fall.
- Establishment of a cover crop when soil temperature is suitable for emergence and growth.
- Timely application of herbicides in early spring to terminate cover crop growth.
- Proper rate and timing of nitrogen application.
- Use of an effective no-till planter for establishing corn.
- Proper use of in-furrow insecticide or treated seed.
- Minimizing light interference due to the cover crop by rolling down the cover crop shortly before or after corn planting.

How effective are herbicide applications in cover crops?

In the Missouri research, weed control was not reduced by the presence of a rye cover crop at any rate of atrazine application (Figures 12 and 13). However, increased rates of atrazine application did result in increased control of giant foxtail and common waterhemp. At the high and medium application rates (2.5 and 1.6 lb/acre), giant foxtail control was excellent (98 to 100%) for the bare ground and the cover crop treatments. Giant foxtail control decreased at the low atrazine application rate and without atrazine, with a similar level of control in the rye cover crop and on bare ground (Figure 12).

The amount of atrazine in postemergence applications clearly influenced the level of control of common waterhemp (Figure 13). High and medium rates of application (2.5 and 1.6 lb/acre) resulted in 85 to 92 percent control of common waterhemp, a lower level of control than that for giant foxtail. Low rates of application (0.79 lb/acre) resulted in less than 75 percent control of waterhemp and similar levels in both the rye cover crop and bare ground areas. Without atrazine, waterhemp control dropped to 65 percent in the cover crop areas but was significantly greater than in bare ground areas (46%).

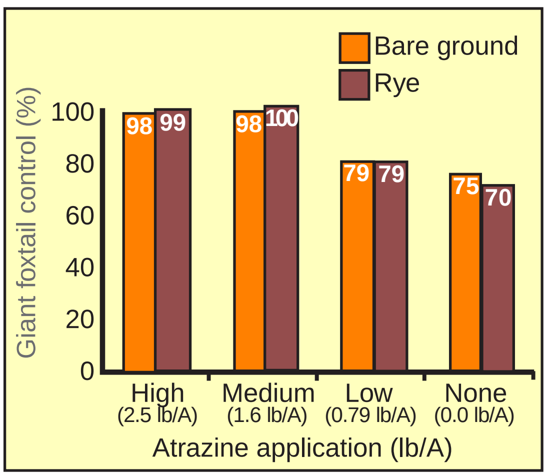


Figure 12. Giant foxtail control 2 weeks after postemergence application as influenced by cover crop and atrazine rate.

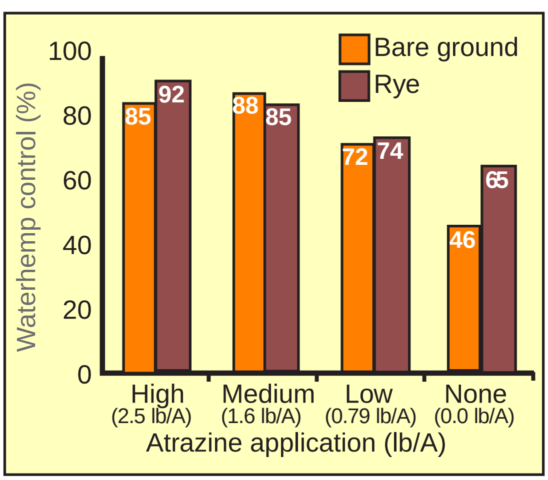


Figure 13. Common waterhemp control 2 weeks after postemergence application as affected by cover crop and atrazine rate.

How does a cover crop effect corn yield?

Significant year-to-year differences in grain yield in the Missouri research (Figures 14, 15 and 16) reflect differences in environment and weed pressure. Soil conditions in 1999 were extremely dry, but there was average or above average rainfall in 2000 and 2001. For each atrazine application level in the experiment, corn yield in fields with rye residues were reduced by an average of 6.8 bu/acre in 1999, 2.2 bu/acre in 2000, and 44.2 bu/acre in 2001. The loss in grain yield may be due to differences in corn plant populations between the fields with and without a rye cover

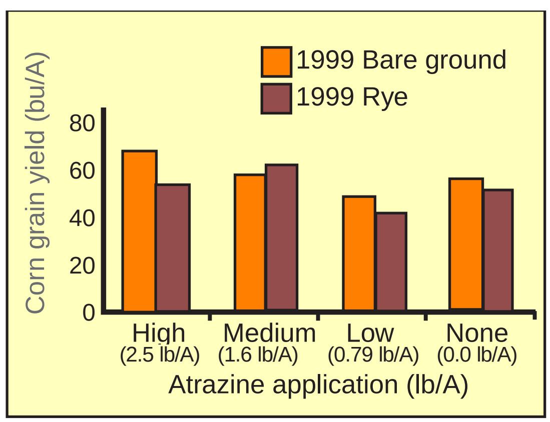


Figure 14. 1999 corn grain yield as affected by cover crop and atrazine use.

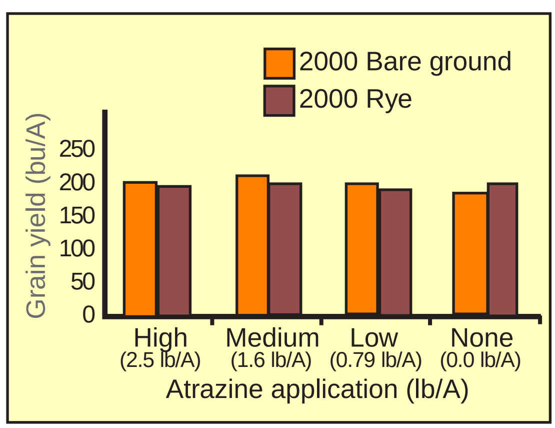


Figure 15. 2000 corn grain yield as affected by cover crop and atrazine use.

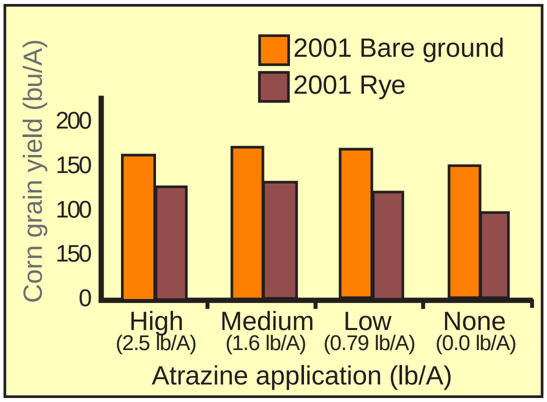


Figure 16. 2001 corn grain yield as affected by cover crop and atrazine use.

crop, or possibly immobilization of nitrogen in the rye, limiting availability to corn. Leaves of corn plants in cover crop areas were yellower than those in bare ground areas in 2001.

Summary

The use of cover crops such as rye can contribute to effective weed control, especially when the cover crop is accompanied by the use of preemergence or postemergence herbicides. This practice may allow continued use of atrazine in sensitive watersheds, because cover crop residues would minimize soil and herbicide movement at a time of year when little crop residue is typically present. However, other factors, such as nitrogen availability need to be addressed to optimize corn production in a cover crop system.

WEED INTERFERENCE AND NITROGEN ACCUMULATION BY GRASS WEEDS IN CORN

Nitrogen is a major economic input for corn production; with application rates of 100 to 200 lb/acre are recommended to optimize corn yield. Nitrogen deficiencies during the growing season result in stunted, yellow corn and can lead to yield loss (Figure 17). The effects of nitrogen deficiencies in the soil can be intensified in the crop by the presence of weeds in the field (Figure 18).

Increased regulation of nitrogen fertilizer use will require greater efficiency of nitrogen use by producers. These regulations may come from increased awareness of the environmental implications of nitrogen runoff from crop fields. Runoff from overapplication of nitrogen can result in high nitrate levels in wells and streams. At a larger scale, elevated nitrogen levels are linked to a hypoxic zone in the Gulf of Mexico with decreased oxygen available for marine life.

Figure 17. Nitrogen deficiency in corn causes pale green to yellow leaves and yellow or brown midribs.

Figure 18. Season-long interference from shattercane (right) retards corn growth and yield.

By determining when weed competition for nitrogen is greatest, it may be possible to determine an optimal time for removing grassy weeds to reduce the amount of nitrogen tied up by these weeds. Recent introduction of herbicide-resistant corn varieties such as Clearfield, Liberty Link, and Roundup Ready has provided growers with powerful tools for removing weeds after crop and weed emergence. These tools have the potential to reduce reliance on soil-applied herbicides such as atrazine. However, corn is sensitive to early-season weed interference, which occurs before postemergence herbicide applications.

In the first of two separate studies conducted at the University of Missouri with Roundup Ready corn, broadleaf weeds were controlled with a soil-applied herbicide, and annual grass weeds (giant foxtail, large crabgrass and barnyardgrass) were allowed to infest the corn. When the weeds reached a specified height, they were sprayed with Roundup and the corn was kept weed-free until harvest.

In a second experiment, Roundup Ready corn was treated with soil-applied and post-emergence applications of atrazine to control all weeds except shattercane. After reaching a specified height, the shattercane was removed with Roundup. The corn was kept weed-free for the remainder of the growing season after herbicide treatment.

How much nitrogen do grass weeds accumulate in aboveground biomass early in the season?

Early-season accumulation of nitrogen by grass weeds ranged from 1 to 34 lb/acre (Figure 19). On a per acre basis, corn and grass weeds accumulate similar amounts of nitrogen (Figure 20). By the end of the growing season (crop harvest) there is less nitrogen in the aboveground weed biomass than there was at midseason. This difference is due to the loss of seeds and seed nitrogen before the weed plants were removed for testing. In addition, corn contains at least three times more nitrogen (mostly in the grain) at harvest than at midseason.

How do grass species differ in ability to accumulate nitrogen?

In experiments with annual grass weeds, corn accumulates more nitrogen on a per acre basis until the grasses reach a height of about 9 inches. When the grasses reach that height, their growth rate increases rapidly, and nitrogen accumulation rates increase as well. Research shows that the corn and the grass weeds have accumulated equal amounts of nitrogen by the time the grasses are 12 inches tall.

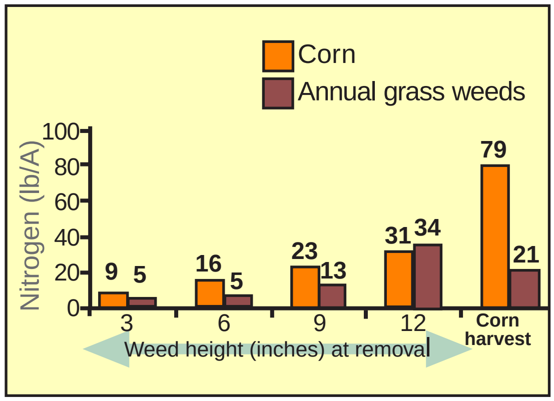


Figure 19. Early-season nitrogen accumulation in corn, giant foxtail, large crabgrass and barnyardgrass.

Figure 20. Early-season nitrogen accumulation in corn and shattercane.

The shattercane experiment showed that nitrogen accumulation by shattercane equals or surpasses that by corn. Shattercane plants that were removed and tested at heights of 15 inches and 18 inches had entered their rapid growth stage and had accumulated more nitrogen than the corn.

The experiments showed that both shattercane and annual grass weeds compete successfully with corn to absorb nitrogen from the soil. Of the two types of weeds, shattercane absorbs nitrogen more aggressively.

Table 2. Grass weed height at each removal timing and corresponding corn growth stage and yield.

Grass height (cm)	1999		2000		Yield (% of weed-free control)
	Days after planting	Corn growth stage	Days after planting	Corn growth stage	
Weed free	—	—	—	—	100
3	28	V4	42	V5	97
6	34	V5	45	V6	99
9	37	V6	51	V8	87
12	44	V8	63	V11	84
Weedy check	—	—	—	—	74
LSD (0.05)	—	—	—	—	13

Notes:
Grass weeds controlled were giant foxtail, large crabgrass and barnyardgrass.
Corn was planted on May 3, 1999, and on April 25, 2000.

Table 3. Shattercane height at each removal timing and corresponding corn growth stage and yield.

Grass height (cm)	1999			2000		
	Days after planting	Corn growth stage	Yield (% weed-free control)	Days after planting	Corn growth stage	Yield (% weed-free control)
Weed free	—	—	100	—	—	100
3	24	V3	93	28	V2	91
6	36	V6	91	37	V4	83
9	39	V7	85	42	V5	81
12	46	V8	77	46	V6	76
15	45	V8	59	50	V6	70
180	49	V9	59	52	V7	70
Weedy check	—	—	15	—	—	57
LSD (0.05)	—	—	20	—	—	22

Note: Corn was planted on May 3, 1999, and April 17, 2000.

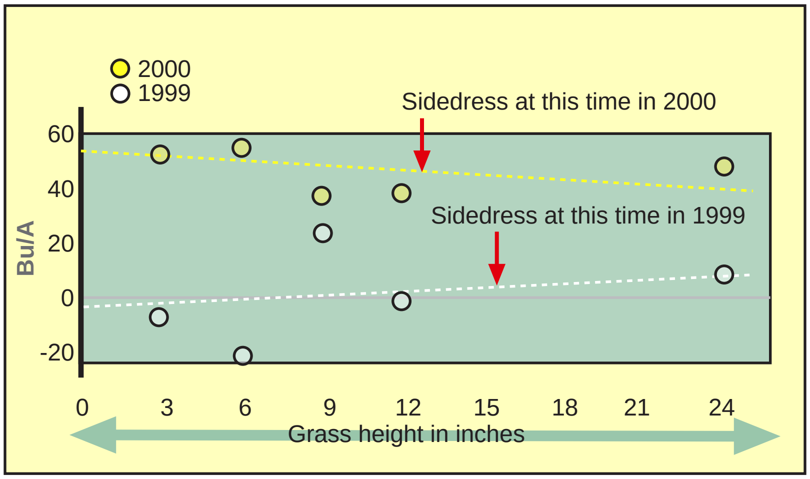


Figure 21. Change in corn yield as a result of sidedress nitrogen application.

When should grass weeds be sprayed to avoid yield losses due to weed competition?

Yield losses in corn were observed when weeds in the annual grass complex of giant foxtail, barnyardgrass and large crabgrass were allowed to reach a height of 9 inches. The grasses reached this height about 37 days after planting in 1999 and 51 days after planting in 2000 (Table 2).

Interference from shattercane caused significant yield losses when the weed was allowed to reach 12 inches in height before removal, about 46 days after planting in both years (Table 3).

In each study, corn was in the V6 to V8 stage of growth when yield reductions were first observed. Control of grass weeds before this stage of corn development is necessary to minimize yield loss due to weed interference.

Can sidedress nitrogen be used to overcome the effects of early-season grass interference?

A sidedress surface application of ammonium nitrate did not overcome the competitive effects of early-season weed interference in the Missouri research (Figure 21). In 1999, a drought year, sidedress nitrogen did not improve corn yields, regardless of the stage at which weeds were removed. In 2000, a year with optimal moisture, corn yields improved with sidedress nitrogen, regardless of when weeds were removed. It is highly likely that the surface-applied nitrogen is tied up by soil microbes as they decompose the weed residue. If so, knifing in sidedress nitrogen would improve the opportunity for yield recovery from early-season weed interference.

How does nitrogen accumulation by grass weeds affect corn yield?

Nitrogen accumulation by weeds does correspond to a reduction in corn yield (Figures 22 and 23). Corn yield was reduced by about 0.55 bu for each pound-per-acre increase in aboveground nitrogen (N) accumulated by the annual grass complex of giant foxtail, large crabgrass and barnyardgrass. For shattercane, corn yield was reduced 0.26 bu/lb N in 1999 and 1.86 bu/lb N in 2000. Yield determination involves complex interactions that extend well beyond nitrogen or moisture. Interactions between various yield factors are often regulated by the most limiting factor in a particular environment. Additionally, each species has a unique response to environmental stresses. In the Missouri studies, environmental conditions had a greater effect on corn yield loss

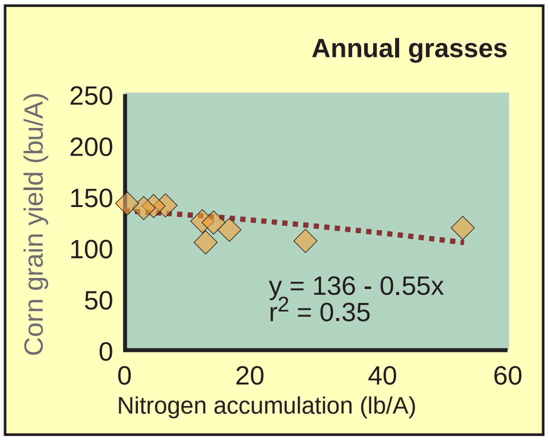


Figure 22. Influence of nitrogen accumulation by grass weeds on corn grain yield.

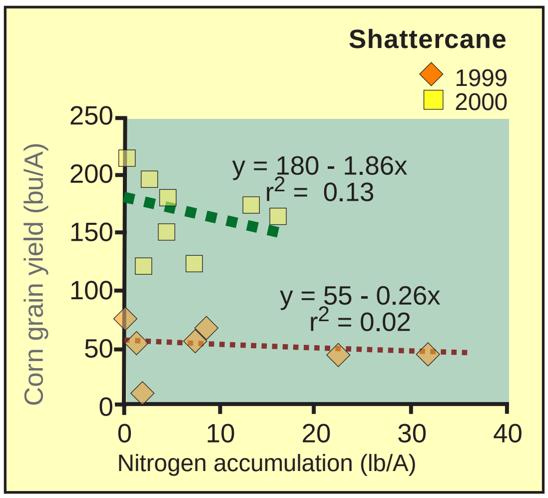


Figure 23. Influence of nitrogen accumulation by shattercane on corn grain yield.

due to shattercane interference than on yield loss due to interference from the other species of grass weeds.

Summary

1. Nitrogen content in corn and grass weeds is influenced by available moisture.
2. Corn yield losses due to weed interference cannot be detected by monitoring corn for visual signs of nitrogen stress.
3. Annual grasses (giant foxtail, large crabgrass and barnyardgrass) should be controlled before they reach a height of 9 inches and shattercane before it is 12 inches tall to avoid yield losses and reductions in the nitrogen content of corn at harvest.
4. Weed size, rather than corn growth stage or days after planting, should be used to target control tactics to avoid yield loss.

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