Cover crops, weeds and herbicides

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The Iowa Nutrient Reduction Strategy and other factors have increased interest in fitting cover crops into Iowa's cropping systems. The benefits of cover crops are well documented, and include reducing erosion, nutrient losses, and soil compaction. Legume cover crops such as hairy vetch may contribute nitrogen via biological fixation. The extended period of plant growth during times when soil is often left bare also is beneficial for overall soil health. Finally, cover crops can complement weed management programs by suppressing the establishment of weeds. This paper will focus on the interactions between cover crops, weeds and current weed management programs.

Weed suppression

The ability of cover crops to suppress weeds is well documented, with the majority of research using cereal rye as the cover crop. While many people attribute the weed suppression of rye to the release of allelopathic chemicals, research has shown the primary factor affecting weed growth is the physical barrier of rye on the soil surface. In order for cover crops to contribute to weed management, they must be managed in a way that maximizes accumulation of biomass. Iowa's relatively short growing season compared to other areas where cover crops are more commonly used has a major impact on the contribution of cover crops to weed management.

We evaluated the effect of cereal rye planting dates and seeding rates on the ability of rye to suppress lambsquarters and waterhemp. Rye was planted in mid-September and mid-October of 2012 and 2013 at rates ranging from 0.5 to 4 bushel per acre. The rye was terminated the first week of May with glyphosate, and then weed establishment was measured throughout the growing season. Seeding rate did not affect rye biomass at the time of termination in either year; however, planting date had a large effect on biomass levels. Rye biomass from October planting dates was less than 500 lb/A regardless of seeding rate, whereas September planting dates produced approximately 3200 lb/A of rye biomass (Table 1).

Table 1. Effect of cereal rye cover crop biomass on establishment of two summer annual weeds.

Rye seeding date	Avg rye biomass	Lambsquarter	Waterhemp
	lb/A	---------- *% emergence*[1] ----------	
Control	-	7.3	4.4
October	400	9.7	5.8
September	3,200	6.3	10.8

[1]Data are means of 2013 and 2014 emergence counts. The seeding dates are averaged over multiple seeding rates.

High levels of rye associated with the September seeding dates resulted in a 15% reduction in lambsquarters emergence, but more than doubled waterhemp densities (Table 1). In contrast, low levels of rye in the October seeding dates increased emergence of both species, although the effect on waterhemp was much less than seen with high levels of rye residue. The failure of rye to suppress weeds is not surprising based on the quantity of rye biomass produced. Other researchers have reported that at least 9000 lb/A of biomass is needed to consistently reduce weed establishment. Increasing seeding rates to excessive amounts (4 bu/A) failed to increase biomass at termination. This is likely due to tillering of rye compensating for differences in plant stands.

The high levels of rye with September seeding dates caused a small reduction in lambsquarters establishment, but more than doubled the density of waterhemp. This difference between the species is likely due to their respective emergence patterns. Lambsquarters is an early-emerging weed, thus its peak emergence period occurred before or shortly after termination of the rye. Waterhemp is a late-emerging weed, so much of the rye biomass had degraded by the time of waterhemp's peak emergence. The rye that remained at this time apparently created a more favorable

environment for germination and establishment of waterhemp.

The presence of rye residue resulted in prolonged emergence patterns of waterhemp in both years, whereas lambsquarters emergence was extended only in 2014. The high levels of rye associated with September planting dates delayed emergence of waterhemp by two to three weeks, whereas with lambsquarters the time until 50% emergence was delayed by four weeks in 2014. The shift in waterhemp emergence is illustrated in Figure 1. Delayed emergence of weeds reduces their competitiveness, but prolongs the time period in which control efforts need to be implemented.

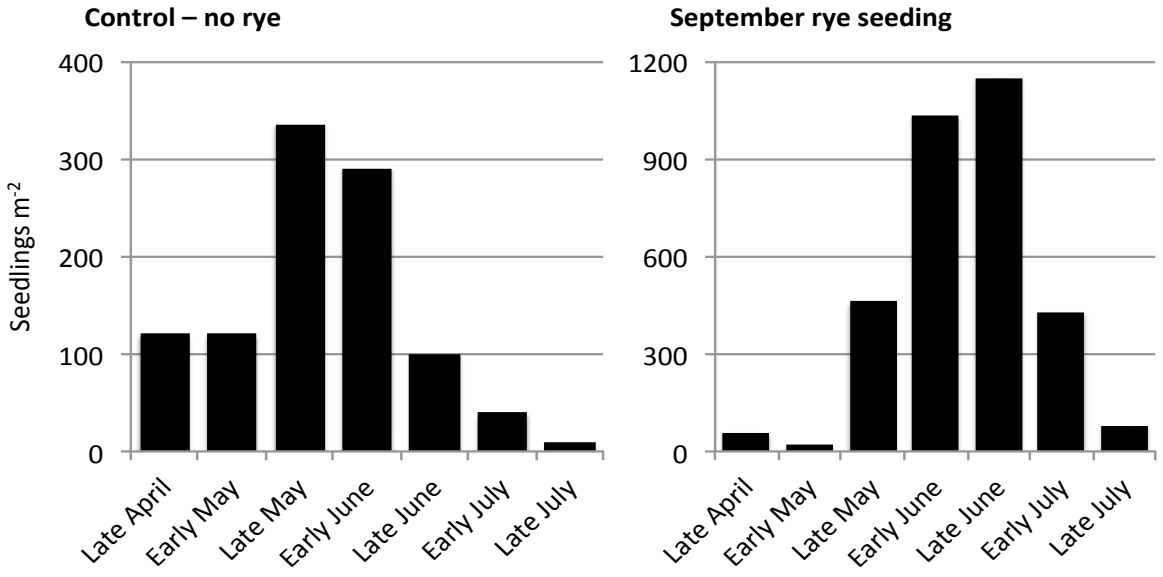

Figure 1. Effect of a cereal rye cover crop on the emergence pattern of waterhemp. 2014. M. Anderson. ISU.

While it is well documented that rye cover crops can suppress weeds, Iowa's relatively short growing season is likely to minimize the contribution of cover crops to weed management. Allowing a rye cover crop to accumulate sufficient biomass to consistently suppress weeds would require planting dates for corn and soybean to be delayed until mid- to late-May. Although cover crops may not reduce weed populations when managed in a manner that allows maximum corn and soybean yield potential, there are many other benefits associated with their inclusion in corn and soybean production.

Terminating cover crops

Successful management of cover crops requires that they be killed prior to or at the time of planting the primary crops. The primary means of termination are winterkill, mowing, tillage and herbicides. Oats and radish are two cover crops that are killed by freezing temperatures and do not require management in the spring. Cereal rye is the most commonly planted cover crop in Iowa because of its consistent establishment and rapid growth. Glyphosate is the primary herbicide used to kill rye. Problems with terminating rye are usually associated with the cool temperatures that occur in early spring or the advanced stage of rye development when termination. Both issues are difficult to manage, but using full rates of glyphosate, increasing spray volume to improve coverage and including appropriate spray additives can minimize problems associated with the performance of glyphosate. Tank mixing other herbicides with glyphosate can reduce glyphosate effectiveness, especially if the tank-mix partner has significant foliar activity.

Effect of residual herbicides on cover crop establishment

The use of preemergence herbicides has increased in recent years due to the spread of herbicide resistant weeds. Many of these products are persistent in the environment, and toxic concentrations may remain in the soil at the time of cover crop establishment in the fall. While herbicide labels provide information on restrictions regarding rotational crops, these recommendations generally are not written with cover crops in mind.

The first thing to consider when evaluating the effect of herbicides on cover crops is the potential use of the cover crop. If there is any possibility that the cover crop will be grazed or harvested for forage, all restrictions regarding rotational crops must be followed. If a cover crop is only being used for conservation purposes, then the grower can choose to plant a cover crop that is prohibited on the label. However, the grower accepts all responsibility if the herbicide interferes with establishment of the cover crop in this situation.

The potential for herbicides used earlier in the season to prevent successful establishment of cover crops is an important consideration. The threat posed by a herbicide is determined by sensitivity of the cover crop species, rate of herbicide applied, date of application and environmental conditions throughout the growing season and during cover crop establishment. Late herbicide applications and dry growing seasons will increase the potential for crop injury. The relatively short time period for establishment of cover crops prior to the onset of cool fall temperatures and dormancy increases the risk that herbicides pose to these plants.

We evaluated the response of five cover crop species to several persistent herbicides commonly used in Iowa corn and soybean production. All experiments were conducted in the greenhouse, so the studies provide information on the relative tolerance of the cover crops to the herbicides rather than an assessment of actual risk to cover crop establishment under field conditions. Herbicides were sprayed at rates from 1/8 to 1/2 of the label rate, incorporated into the soil, cover crops were seeded and then injury was evaluated for four weeks.

Results of the greenhouse trials are summarized in Table 2. The ratings are based on visual injury and cover crop dry weights. Radish was the most sensitive of the cover crops evaluated, with significant injury occurring with all herbicides except Dual II Magnum. Cereal rye was the most tolerant of the cover crops, with injury observed with atrazine, Corvus and Prowl H_2O. Hornet caused serious injury to plant death on the three broadleaf species, whereas Corvus affected the growth and vigor of all species.

Table 2. Relative tolerance of several cover crop species to herbicides commonly used in corn and soybean production. Injury potential ratings are based on greenhouse trial.

Herbicide	Group No.	1X Rate	Cereal rye	Oat	Hairy vetch	Lentil	Radish
			——————— Injury Potential[1] ———————				
Corn products							
Atrazine 90DF	5	1.1 lb	2	2	2	2	2
Dual II Magnum	15	1.5 pt	1	1	1	1	1
Balance Flexx	27	5 fl oz	1	1	2	2	3
Callisto	27	3 fl oz	1	1	1	2	2
Laudis	27	3 fl oz	1	1	2	2	2
Corvus	2, 27	5.6 fl oz	2	2	2	2	3
Hornet WDG	2, 4	5 oz	1	1	3	3	3
Soybean products							
Classic	2	1 oz	1	1	1	1	2
Pursuit	2	4 fl oz	1	1	1	1	2
Prowl H_2O	3	3 pt	2	2	1	1	1
Reflex	14	1.25 pt	1	1	1	1	2

[1]Injury Potential: 1 = little or no risk; 2 = some risk depending upon herbicide rate and environmental factors; 3 = high potential for injury affecting cover crop establishment.

Summary

There are many benefits associated with inclusion of cover crops into the corn/soybean cropping systems that dominate the Iowa landscape. The limited period of active growth in the fall following crop harvest and in the spring prior to planting reduces the amount of biomass the cover crop accumulates compared to other areas of the country where cover crops have been used more frequently. The low levels of biomass will reduce the contribution of cover crops to weed management, but other beneficial contributions of cover crops are still achieved. Cereal rye has a relatively high tolerance to the herbicides commonly used in corn and soybean, and under most situations its establishment should not be affected by the herbicides used earlier in the growing season. Other cover crop species are more sensitive to herbicides, and the potential impacts of herbicides on their establishment should be considered. Finally, if cover crops may be harvested for forage or grazed, all restrictions regarding rotational crops must be followed.