PREDICTED YIELD LOSSES WITH POSTEMERGENCE HERBICIDES

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Introduction

In a postemergence herbicide program, the application of the herbicide can easily be delayed by weather, time constraints, equipment availability, and other such causes. However, if weeds are not controlled early enough, there is potential for yield loss from early season weed competition. This is true even when herbicides provide high levels of efficacy.

It has been observed that a large number of corn and soybean fields in Wisconsin are currently being managed with postemergence programs. Thus, the potential for significant yield loss due to early-season weed competition exists. This became more evident after an initial survey of grower's fields was taken in 2008. In this survey, weeds were controlled at an average height of 2 inches taller than the recommended critical heights for weed removal (4-inch weed height in corn and 6-inch weed height in soybean).

In order to better understand the potential for yield loss from early season weed competition in Wisconsin corn and soybean fields managed with postemergence herbicide programs, in-field surveys of weed populations were conducted in 2008 and 2009. Individual field data from these surveys was used to estimate yield loss using a computer program called WeedSOFT®. A possible solution in soybean was also evaluated using on-farm trials comparing a single pass glyphosate program with a half rate of a preemergence broadleaf herbicide followed by glyphosate.

Methods

Field Surveys. In the summers of 2008 and 2009, surveys were conducted every 3 to 4 days until postemergence herbicide applications in 48 and 45 corn fields and 30 and 40 soybean fields, respectively. The fields were selected randomly from fields likely to be managed postemergence without a preemergence treatment. Approximately five fields per crop were surveyed per county per year, and surveyed fields were spaced at least 3 miles apart to increase the likelihood that the fields were managed by different growers.

For each field, a surveyor walked a horseshoe pattern through the field starting and ending at the field's edge. Heights and densities of predominant weed species in the field were estimated in 10 1-m^2 quadrats per field spaced at intervals of 30 paces. Weed heights were recorded in 2-inch increments ranging from less than 2 inches tall to less than 12 inches tall. Estimated heights of any weeds over 12 inches tall were also recorded. Weed densities were recorded within ranges of 1-5, 6-10, 11-50, 51-100, 101-500, and greater than 500 plants/m^2. Estimations were used to speed the survey procedure in order to increase the number of fields sampled. The average crop height, crop growth stage, and row spacing were recorded for each field. Also, leaf samples were taken from each field and were tested for the glyphosate-resistant trait using an Elisa-test.

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In summarizing the weed population data, the average of a given density range was used as the weed density. The average height of a weed species within a field was calculated using its height within a quadrat weighted by the respective densities in the different quadrats. This helped to account for the variance between height and density in the different quadrats. The data are summarized in tables listing the minimum and maximum values for individual fields, the median (value where 50% of fields have more than this number), and the overall average among fields.

Yield Loss Estimates. Yield loss estimates were based on the weed population characteristics and calculated using a modified version of WeedSOFT®. The modification was adding weed species to WeedSOFT®, which were not already in its database. For calculations, WeedSOFT® first estimates a competitive load for each weed species based on the species competitive index and is modified by weed height, weed density, crop growth stage, and crop row spacing. These characteristics had been collected in the field survey. Yield loss is then estimated with a crop specific yield loss function based on the total competitive load, which is a summation of the individual competitive loads from each weed. The data are summarized in tables listing the minimum and maximum values for individual fields, the median (value where 50% of fields have more than this number), and the overall average among fields.

On-Farm Trials. In 2009, 12 on-farm trials were coordinated through the help of Richard Proost and UW Extension county agents. Growers split about 15 acres of a soybean field into 6 strips with two treatments. On three of the strips the growers applied preemergence FirstRate or Sonic (both contain the same premix of sulfentrazone plus cloransulam) at 3 oz/a, which is a half rate intended for early season weed suppression prior to a glyphosate application. Later, the entire field was sprayed with glyphosate. Right before the glyphosate treatment, three quadrats per strip were surveyed in the same fashion as the field survey. This was done to test the efficacy of the half rate of the preemergence broadleaf herbicide.

The weed populations were summarized similar to the field survey. The average density within a given range was used as the weed density. The average height of a weed species within a field was calculated using the weed's height in a quadrat weighted by their respective densities. The data is summarized by broadleaf and grass species separately because a broadleaf herbicide was used.

Results and Discussion

Field Surveys. The field survey gave interesting results characterizing weed populations in Wisconsin corn and soybean fields managed with postemergence programs. The average density was fairly similar across both years and crops at about 100 plants/m^2. In 2008 and 2009, the average density in corn was 102 and 93 plants/m^2 and the average density in soybean was 107 and 98 plants/m^2, respectively (Table 1). Some individual fields had high weed densities. The maximum density in corn was 582 and 460 plants/m^2 and the maximum density in soybean was 526 and 551 plants/m^2 in 2008 and 2009, respectively (Table 1).

Table 1. The minimum, maximum, median, and average weed density and weed height across 48 and 45 corn fields and 30 and 40 soybean fields in 2008 and 2009.

	Year	Crop	Minimum	Median	Average	Maximum
			Number per m^2			
Weed density	2008	Corn	8	47	102	582
		Soybean	3	33	107	526
	2009	Corn	4	70	93	460
		Soybean	5	46	98	551
			Inches			
Weed height	2008	Corn	2.0	5.6	5.9	11.6
		Soybean	3.0	7.5	8.5	26.7
	2009	Corn	2.0	5.0	5.5	14.0
		Soybean	2.1	5.8	7.0	23.9

The weed heights were taller than would be desired to avoid the risk of yield loss from weed competition. Across both year and crop, the average weed height was about 2 inches taller than the critical height when weeds start to affect crop yield. Based on research across the upper Midwest, corn should typically be managed before weeds reach 4 inches tall. In both 2008 and 2009, 75% of the corn fields were managed after weeds exceeded this height (data not shown). The average weed height in corn fields was 5.9 and 5.5 inches in 2008 and 2009, respectively (Table 1). Extension specialists typically recommend that soybean should be managed before weeds reach 6 inches tall. In 2008 and 2009, respectively, 75% and 50% of the soybean fields were managed after weeds exceeded this height (data not all shown). The average weed height in soybean fields was 8.5 and 7.0 inches in 2008 and 2009, respectively (Table 1).

With reasonably high densities and weeds more often than not being sprayed after their critical heights, the field survey found there was a significant potential for yield loss to be occurring in Wisconsin corn and soybean fields managed with postemergence programs. Consequently, we wanted to estimate the yield loss using the software program WeedSOFT®.

Yield Loss Estimates. WeedSOFT® is good in estimating average yield loss across multiple fields, and satisfactory in estimating average yield loss in individual fields. In this study, WeedSOFT® was primarily used for estimates across multiple fields, so results are expect to be reasonably accurate. As expected from the field surveys, yield loss was predicted in most of the fields. The average estimated yield loss across all corn fields was 4.4 and 4.8% in 2008 and 2009, respectively (Table 2). The average estimated yield loss across all soybean fields was 9.3 and 3.1% in 2008 and 2009, respectively (Table 2). Also, in corn in both years and soybean in 2008, about 50% of the fields had estimated yield losses greater than 4% (Table 2). Some fields had substantial estimated losses with one soybean field in 2008 reaching 54% (Table 2).

Table 2. The minimum, maximum, median, and average estimated yield loss across 48 and 45 corn fields and 30 and 40 soybean fields in 2008 and 2009.

	Year	Crop	Minimum	Median	Average	Maximum
			Percent of total yield			
Estimated yield loss	2008	Corn	0.6	3.7	4.4	13.4
		Soybean	0.3	4.4	9.3	53.9
	2009	Corn	0.3	4.0	4.8	26.2
		Soybean	0.2	1.4	3.1	20.8

Yield loss at this rate can cause significant economic loss. For example, in 2008 corn sold for $4.59 per bushel on average and soybean sold for $11.15 per bushel on average. The average corn grower produced 137 bushels per acre and the average soybean grower produced 35 bushels per acre. If estimates of 4.6 and 6.2% yield losses in corn and soybean are used, the total economic loss average $28.93 per acre in corn and $24.20 per acre in soybean, respectively. Fields with higher yields would expect even higher losses.

Expected yield losses were fairly high in corn and soybean in both 2008 and 2009. To study one possible solution in soybean, on-farm trials were conducted comparing a postemergence glyphosate program with a half rate of a preemergence broadleaf herbicide followed by postemergence glyphosate program.

On-Farm Trials. Results from the on-farm trials showed a reduction in both weed density and weed height with the use of a half rate of a preemergence broadleaf herbicide. Overall, the average density of broadleaf and grass weeds was reduced by 66 and 50% and heights were reduced by 20 and 30%, respectively. The reduction in density means there would be a reduction in early-season weed competition. The reduction in height means the weeds would not reach their critical height as quickly, giving the grower more time to spray their field.

Recommendations

This research shows there was a significant predicted yield loss in many Wisconsin corn and soybean fields that are managed with postemergence herbicide programs. The field surveys showed that fields were being sprayed about 2 inches after the critical height. This resulted in estimated yield losses on averaged of 4.4 and 4.8% in corn and 9.3 and 3.1% in soybean in 2008 and 2009, respectively. A further study showed a half rate of preemergence herbicide can successfully reduce both weed density and height. Based on this information, it would be suggested that growers whose fields are at risk of yield loss from high weed densities or delayed application should consider using a preemergence herbicide even at a half rate. In a burndown situation, this can often be combined with the burndown herbicide to reduce application costs.