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PROTECTING CROP YIELDS WITH POSTEMERGENCE HERBICIDES

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Introduction

Postemergence herbicides are an important component of today's weed management systems. Herbicides introduced in the past 10 years for use in both corn and soybeans are able to kill much larger weeds than earlier products, thus providing farmers with greater flexibility in application timing. However, this benefit may end up costing farmers money if application is delayed too late into the growing season. This article will discuss the importance of application timing in protecting crop yields.

Critical period of competition

Weeds impact yields primarily by competing with the crop for light, water and nutrients. At the start of the growing season the requirement for these resources is small enough that both the crop and weeds can co-exist without significantly affecting each other's growth. As the growing season progresses and plant size increases, weeds begin to compete with the crop for the resources essential for plant growth. Once weeds begin to deprive the crop of these resources the yield potential can be negatively impacted. The time at which competition begins is known as the critical period. Controlling weeds at or before the critical period will protect crop yields from early-season competition, and this should be the goal in systems relying on postemergence herbicides.

While the concept of the critical period is relatively simple, determining when the critical period occurs is difficult due to the many interacting factors involved. The critical period is influenced by the weed community (weed species, number of weeds, emergence date, etc.), cropping practices (cultivar, row spacing, population, tillage, etc.) and environment. Applications of preemergence herbicides generally extend the critical period by reducing and delaying weed establishment. Depending on the situation, the critical period may occur as early as two weeks after planting to as late as eight to ten weeks after planting.

Research at the University of Nebraska found that row spacing had a large impact on the critical period for early-season competition (Figure 1). The critical period for soybeans planted in 7.5", 15" and 30" rows occurred at the V3, V2 and V1 stage, respectively. Soybean planted in narrow rows were more competitive with weeds and able to delay the onset of competition. Fields with high weed populations that emerge at the same time as the crop will have a relatively short critical periods, whereas clean fields or situations when most weeds emerge several weeks after the crop will have longer critical periods.
Figure 1. Influence of soybean row spacing on critical period and yield losses associated with early season weed competition. Adapted from Knezevic et al. 2003. Weed Technol.

Almost all research investing the critical period has been conducted by planting into a weed-free seedbed, therefore providing the crop with an even start with weeds. Skipping the burndown application in no-till when weeds are present at planting provides weeds a competitive advantage with the crop, resulting in a significant reduction in the critical period. The limited application window when burndown applications are omitted greatly increases the risk of reduced profits, and therefore this practice is not recommended except for fields with histories of excellent weed control and low weed pressures.

Determining when to pull the trigger

Due to our inability to accurately predict the critical period, subjective evaluations of crop and weed growth are used to determine when to spray. Several criteria can be used to guide this decision, including days after planting, days after crop emergence, crop stage or height, or weed height. Days after planting probably is the least effective method since crop and weed emergence rates vary widely with the environment. This is especially true when relying on herbicides with little or no residual activity, such as glyphosate.

Weed height is commonly used to determine when to apply herbicides. Basing herbicide application on weed height takes into account both weed susceptibility to the herbicide and the competitiveness of the weed. While height guidelines on labels provide information on the ability to kill weeds at specified heights, they do not take into consideration the potential of a weed to impact crop yields. A 10" weed is much more likely to cause yield losses than a 4" weed. Thus, just because a herbicide label states that 12" foxtail can be controlled doesn’t mean delaying application until the foxtail reaches 10" is a good management decision.

The relationship between weed height at the time of glyphosate application in Roundup Ready corn is shown in Figure 2. The yield response is the mean of 35 experiments conducted across
the Corn Belt. The critical period occurred when weeds reached a height of approximately 3”, and delaying application beyond this weed height resulted in increasing yield losses. Spraying when weeds reached a height of 10” resulted in approximately a 15% yield loss. The critical period and weed competitiveness varied widely in these experiments, with yield losses ranging from 0 to 25% when weeds were controlled at a 6” height.

Figure 2. Relationship between weed size at time of herbicide application and corn yield loss from early-season competition. Line represents mean of 35 experiments. The response in individual fields varies widely depending upon weed infestation, environmental conditions and cultural practices. For example, in this study the yield loss from early-season competition when weeds were controlled at a six inch height ranged from 0 to 25% in individual experiments, whereas the mean yield loss was 6%. Adapted from: Gower et al. 2003. Weed Technol. 17:821-828.

An important consideration when using weed height to determine herbicide application is the weed growth rate. Weeds grow relatively slow during the first two weeks after emergence, but as leaf area expands they enter a phase of logarithmic growth (Figure 3). Giant foxtail and waterhemp were approximately 2” tall 14 days after emergence, but reached a height of 5” in an additional 7 days. Velvetleaf was slower at entering the rapid growth phase than the other species.
Because of the rapid growth rates of weeds, timing of herbicide application should be set conservatively due to risks associated with application delays. For example, a farmer might decide to target 4" giant foxtail for an application of Steadfast based on the label recommendations. However, if weather delays keep the sprayer out of the field for five days the foxtail could be 8" tall before the conditions allowed the herbicide to be applied.

Crop stage or height can also be used to determine timing of post applications. This approach is most appropriate in situations when crop tolerance to the herbicide is influenced by stage of development (Clarity or Steadfast on corn) or with herbicides that have significant residual activity (Pursuit in soybean, Callisto in corn). The limitation to this method is that it fails to consider the status of the weed infestation (size, density), and therefore ignores emergence time of the weeds in relation to the crop. Weeds frequently emerge significantly before or after the crop, resulting in the growth of the crop and weeds being out of synch. If the weeds emerge ahead of the crop they may reduce yields significantly by the time the crop reaches the stage used to trigger herbicide application. In situations with delayed weed emergence, applications based on crop stage alone may result in the herbicide being applied prior to most weeds emerging. This could result in problems with late-emerging weeds if the herbicide used has little or no residual activity, such as glyphosate. While crop stage can be used to guide herbicide application timing, in most situations it is also important to take into consideration the development of weeds.

With today's effective herbicides, application timings should be based not only on the ability of a herbicide to kill weeds but also on the weeds' potential to impact yields early in the growing season. Many factors influence the critical period, making precise predictions of when weeds
begin to impact crop yields difficult. However, when weeds emerge with the crop and are present at moderate to high densities (>5 ft²) delaying application to when weeds reach a height of 4 inches or taller may result in significant yield losses. Yield losses accumulate rapidly once the critical period is reached, and losses up to a bushel per acre for each day application is delayed may occur. Because of the risks of reduced yield and profits, farmers should be conservative in determining when to spray fields.

What about late-emerging weeds?

A primary reason delaying postemergence applications is the desire to minimize the establishment of weeds that emerge after application. Most weeds emerge over a prolonged period and significant numbers can emerge after postemergence treatments. Delaying application allows the crop canopy to develop sufficiently to allow it to smother late-emerging weeds. While there are costs associated with weeds that emerge after early postemergence applications, the competitiveness of these weeds is greatly diminished due to the head start provided the crop.

A competitive crop canopy is one of the most effective weed management tools available. In a competitive situation, the plant that initially captures a resource normally will maintain the competitive edge for the remainder of the growing season. This is why late-emerging weeds are much less injurious to yields than weeds that emerge with the crop. Research at ISU found that the majority of waterhemp plants the emerged at the V4 stage of soybean or corn failed to survive to reproduce (Table 1). Biomass of plants that emerged at the V2 stage of soybean was reduced by nearly 80% compared to plants emerging with the crop.

Table 1. Influence of corn and soybean competition on waterhemp emerging at different times in relation to the crop.¹

<table>
<thead>
<tr>
<th>Emergence Time (Crop stage)</th>
<th>Soybean</th>
<th>Corn</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% Survival</td>
<td>Biomass (%)²</td>
</tr>
<tr>
<td>VE</td>
<td>90</td>
<td>100</td>
</tr>
<tr>
<td>V2</td>
<td>70</td>
<td>21</td>
</tr>
<tr>
<td>V4</td>
<td>50</td>
<td>7</td>
</tr>
<tr>
<td>V6</td>
<td>20</td>
<td>1</td>
</tr>
</tbody>
</table>

²Biomass is reported as percentage of dry weight produced by plants emerging at the same time as the crop.

Weeds that emerge at least three weeks after the crop are unlikely to impact yields unless they are present at very high densities. While late-emerging weeds should not be ignored since they are capable of producing significant quantity of seeds, protecting yields from weeds that emerge with the crop should take priority in most fields. The yield saved by preventing early season competition by spraying prior to the critical period can cover the cost of a second post application in most situations.

Summary

Weeds impact crop production in many ways, including reducing yields, interfering with harvest
efficiency, contributing to future weed problems through seed production, and detracting from field appearance. Weed management systems relying solely on postemergence herbicides can produce clean fields at season’s end, yet not produce full yield potential due to competition between the crop and weeds prior to herbicide application. The critical period is the point of time when weeds that emerge with the crop first begin to impact yields. Depending upon the situation, the critical period may occur when weeds reach a height of two to ten inches in height. Our inability to precisely predict the critical period requires that conservative judgment be used in determining when to apply postemergence herbicides in order to consistently produce maximum yields.

References
