TIMING POSTEMERGENCE HERBICIDES IN CORN AND SOYBEANS

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Introduction

Total postemergence (post) herbicide programs for corn and soybean weed control have increased dramatically during this past decade. There are several reasons for this shift including the introduction of effective grass and broadleaf post herbicides, restrictions on atrazine, the need to spread the work load, and transgenic crops that allow the use of nonselective post herbicides. However, the increased reliance on post programs can lead to two specific questions. The first question is when to spray the herbicide to maximize crop yield. If the herbicide is sprayed at the wrong time, crop yield could be reduced either from weed competition or from herbicide injury. The second question is when to spray to get the best weed control. This is a question because several post herbicides lack residual activity and weeds may emerge after the herbicide application. Weed competition and seed production from late emerging weeds must be considered.

Advantages. There are several potential advantages to total post herbicide programs. An idealist could say that total post programs allow farmers to assess weed pressure and decide if a herbicide application is required. However, nearly all fields have weed densities that exceed economic thresholds and justify treatment. Still, the best post herbicides can be selected, rates adjusted, and programs customized to match the weed spectrum and density present in each field compared to using preemergence herbicides. Using post herbicides may save precious time in the spring compared to incorporating preplant herbicides or avoid the risk that preemergence herbicides are not fully activated in a dry spring. Post herbicides are sometimes the only practical or effective herbicides to deal with certain problem weeds such as perennials, volunteer corn, or difficult annuals like woolly cupgrass or giant ragweed. Another reason for the development of many of the post herbicides is that they degrade rapidly in the soil and have a low potential to contaminate the ground water. Of course, this lack of residual activity can lead to disadvantages.

Risks. Although total post programs are generally successful, there are several inherent risks associated with these programs and many of the risks relate to timing. Poor weed control can result from poorly timed post herbicide applications that are either too early (with subsequent late flushes of weeds) or too late (when weeds that are too large for control). Wind, rain, and sprayer breakdowns can potentially lead to late applications in addition to customers who simply make late requests for spraying. The advertizing for post herbicides may also lull us into a false sense of security with late applications by stating that the herbicide can be applied to weed "X" up to 12 inches tall (but did weed competition occur by this time?) or that the herbicide can be applied to corn up to 24 inches tall (this doesn't mean that the window for controlling weeds should be until the corn is 24 inches tall).

Post herbicide applications can also increase the risk of crop injury. For certain herbicides, post herbicides are just more risky than their preemergence herbicide counterparts. For instance, preemergence grass herbicides in corn (eg. acetamides) generally have greater crop tolerance than post herbicides with nicosulfuron (eg. Accent, Basis Gold). The opposite is also true with other herbicides where post herbicides are extremely safe such as the ACCase inhibitors and glyphosate and glufosinate on transgenic crops. The risk of injury can be increased greatly if post herbicides are applied at the wrong stage of growth. In certain cases, the herbicide label may

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not accurately describe the risk of injury. The Celebrity Plus label states that applications can be made to corn up to 24 inches tall even though we know that it is not wise to make a broadcast application of one of the ingredients, nicosulfuron (Accent), after the V6 stage. Post herbicide applications also have a greater risk of crop injury from spray tank contamination, which would often go unnoticed with preemergence applications, and spray drift.

Critical Period of Weed Control

The critical period of weed control is a concept that weed scientists use to describe the effect of the length and timing of weed competition on crop yield. Understanding the critical period of weed control is very important when relying on total post herbicide programs because their success depends on timing. In this case, success means maximum crop yield not just dead weeds. The critical period of weed control has two components. The first component is the length of time that a crop can withstand weed competition without losing yield as long as the weeds are controlled after that time. This can be seen as the time of weed removal as shown in Figure 1, where the crop yield is 100% as long as weeds are removed by 4 weeks after planting. If a post herbicide was applied at 6 weeks, 20% of the yield would have been lost from the early season weed competition in this hypothetical example. The second component in the critical period is the length that the crop needs to be weed free before the crop establishes dominance over late emerging weeds. After a certain weed free period, late emerging weeds will be shaded out and will not compete with the crop or reduce yields. In Figure 2, if weeds emerge at 2 weeks after planting and competed for the rest of the season, yield would only be 70% of the maximum potential yield. However, if weeds were controlled by herbicides for 7 weeks after planting, any weeds emerging after that time would non-competitive and yields would not be reduced.

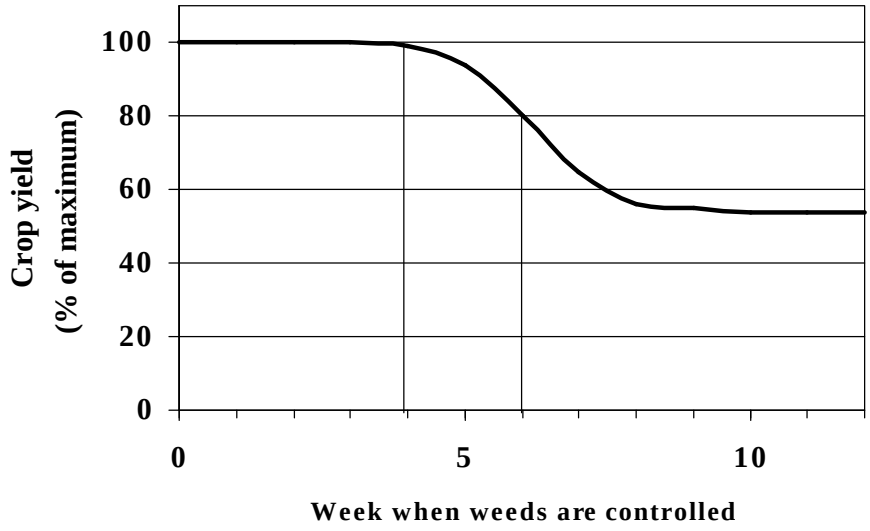
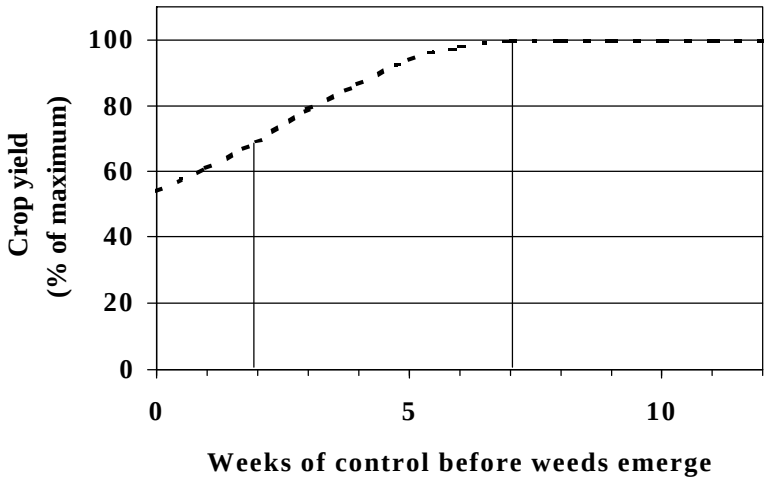


Figure 1. Crop yield decreases as weeds are allowed to compete for longer periods of time. The time when yield loss occurs is known as the critical period of weed removal.

The combination of these two components (knowing when weeds need to be removed and when the crop becomes dominant) defines the critical period of weed control (Figure 3). In this example,

weeds need to be controlled from 4 weeks to 7 weeks after planting to protect crop yield. Since the weed free period and weed removal period don't overlap, a single post, non-residual herbicide cannot protect maximum crop yield no matter when it is applied. If the herbicide was applied at 4 weeks after planting, weeds that emerge over the next 3 weeks would be large enough to compete for the rest of the season and reduce yield 13%. If applied later, some yield would be lost from early weed competition. With a more competitive crop, the crop may be able to withstand early season competition longer or shade out late emerging weeds sooner so that the two time periods overlap (Figure 4). In this case, there is no critical period weed control and a single post application at 5 weeks after planting would protect against both early and late season weed competition.



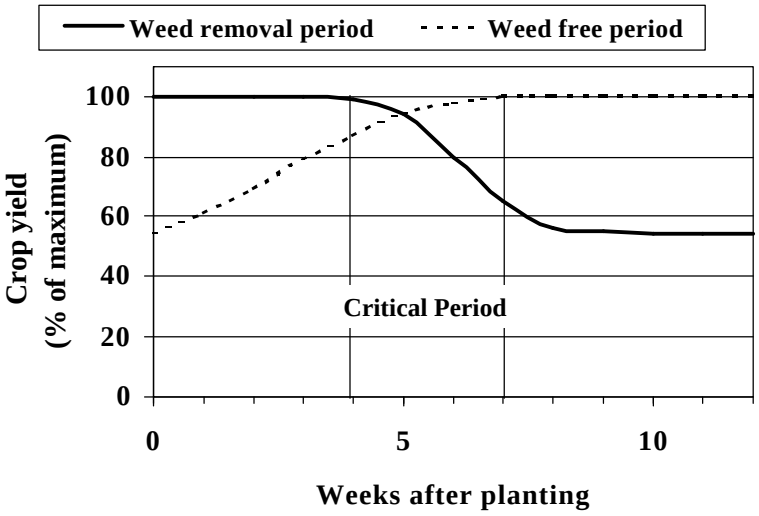


Figure 2. Crop yield increases with longer weed free periods. The length of weed control required to give maximum yield is known as the critical weed free period.

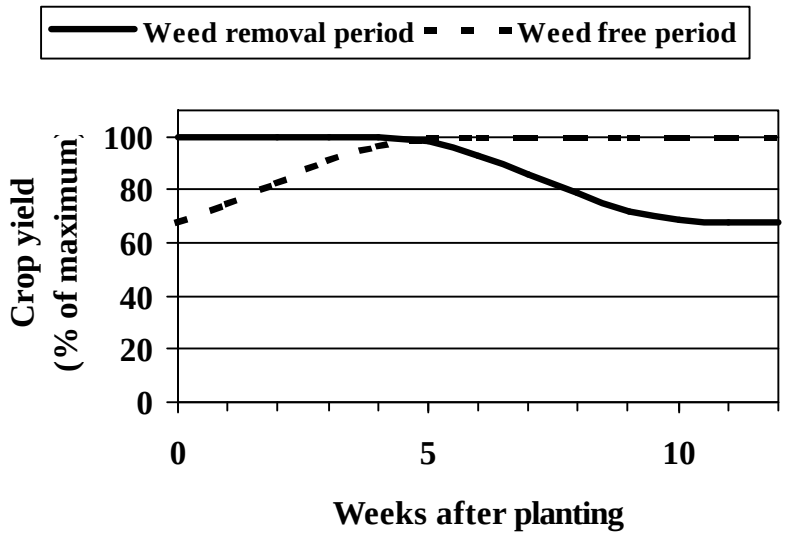


Figure 3. The critical period of weed control is the interval when control is required to provide maximum yield. Weed competition before this period will not affect yield if weeds are controlled by the start of the critical period. Weed competition after the critical period will not affect yield.

Predicting the exact beginning and end of the critical period of weed control is difficult to do because of the many variables that can affect it. The critical period depends upon the weeds (how competitive the different weed species are, their density, when they emerge), the crop (corn vs soybeans, row spacing, and density), and environment (soil moisture and nitrogen). Despite all of these variables and their effects, several generalities can be concluded from numerous field studies on the critical periods of weed control.

Figure 4. This hypothetical example does not have a critical period of weed control because the critical weed free period and critical weed removal periods overlap.

Critical Periods in Corn and Soybeans

In corn, several studies have shown that weeds, especially annual grasses, competing beyond the 4 inch height can reduce corn yields (Carey and Kells 1995, Tapia et al. 1997). However, the exact results can be variable. Hall (1992) found that the beginning of the critical period in corn ranged from the 2 to 12 visible leaf stage and the end ranged from the 6 to 14 visible leaf stage depending on year, location, and weed density. Corrigan et al. (1998) reported the beginning of the critical period was the V4 stage when corn was competing with wild-proso millet, but ranged from the V1 to V12 stage with low and high densities of woolly cupgrass. The end of the weed free period was generally earlier in Corrigan's studies than Hall's studies and wild-proso millet or woolly cupgrass emerging after the V1 to V5 stage, depending on the study, did not reduce corn yield. In general, these results suggest 1) that corn may require an early post treatment to prevent excessive early season weed competition, 2) that a critical period of weed control may exist in corn, in which a single post, non-residual herbicide would not fully protect corn yield, or 3) that a single post, non-residual herbicide could fully protect corn yield, but the window for application is small and the timing is difficult to predict.

Soybeans seem to withstand early season weed competition longer than corn and their canopy closes earlier than corn. As a result, soybeans often lack a critical period of weed control or the critical period is short. In our studies with drilled soybeans, we did not measure a yield loss from weeds competing prior to the V4 stage, but yields declined rapidly if allowed to compete beyond that stage (Mulugeta and Boerboom 2000). Corrigan (1999) also found similar results in drilled, no-till soybeans. However, soybeans in 30 inch rows were more sensitive to early season weed competition and weeds needed to be removed by the V2 to V4 stage to protect yield (Mulugeta and Boerboom 2000). Van Acker et al. (1993) found similar results in 20 inch row soybeans in that the critical period was very short or lacking and that weeds emerging after the V3 to R1 stage did not affect yield. These results suggest that a single post, non-residual herbicide applied from the V2 to V4 stage in drilled soybeans can be used to prevent yield loss. The potential for a critical period of weed control appears more likely in row soybeans than in drilled soybeans, but the length of this critical period appears to be shorter than in corn.

There have also been a few studies on the effect of weed control timing on weed seed production. Mickelson (1999) studied woolly cupgrass seed production in corn and found that if woolly cupgrass is controlled through the V5 corn stage, the woolly cupgrass seed bank should not increase in the following year. Swanton et al. (1999) found similar results in corn with a mixture of weeds. The weed seed bank was similar to the weed free check if weeds were controlled up to the 5 to 7 leaf stage (approximately V3 to V5 stage) in three of four years and was similar to the weed free check if weeds were controlled up to the 8 to 11 leaf stage (approximately V6 to V9 stage) in four of four years. The results of both of these studies illustrate that weeds emerging late in the season are not major seed producers.

Managing Risks with Postemergence Herbicides

Post herbicides are important and valuable tools in corn and soybean production and their use should be determined on a field by field basis as with preemergence herbicides. From the herbicide aspect, weed spectrum, sizes of weeds to be controlled, crop safety, residual activity, and cost need to be considered. From the timing aspect, the critical period of weed control, need for residual control, and the likelihood of getting a timely application also need to be considered. There ways

to lessen the risks of poorly timed post applications although some will increase the cost of weed control. This additional cost needs to be weighed against the risk of crop yield loss either from weed competition or crop injury.

Assess fields. Determine which fields have the least risk when using total post programs and fields where preemergence or sequential herbicide programs may be justified. For instance, fields of drilled soybeans with low or moderate weed densities have less risk than corn fields with heavy weed densities. Also determine which fields have weeds that will likely benefit from a post herbicide such as for perennials or where a sequential application is frequently needed as with woolly cupgrass control.

Use a reduced preemergence herbicide. Use a reduced rate of a residual preemergence herbicide on a portion of the acres or on fields with the highest weed densities. Just a grass or broadleaf herbicide could be used rather than both to lower costs (eg. only use a grass herbicide if broadleaf density is low). This will increase the overall cost of the program, but will provide a longer critical period of weed control and greater flexibility in applying post herbicides. This tactic is also recommended to improve the timing of post glyphosate applications on perennial weeds without sacrificing early season weed control. The preemergence herbicide will reduce much of the annual weed competition and the subsequent glyphosate application can be delayed to maximize activity on the perennial and control the remaining annual weeds.

Use a residual tank mix partner. For post herbicides that lack residual, they need to be applied before weed competition occurs. With an early post application, especially in corn with heavier weed densities, later emerging weeds can be controlled by tank mixing a reduced rate of residual herbicide with the post herbicide. Select the residual herbicide to match the predominant weeds, either a herbicide with grass or broadleaf activity.

Cultivate. The risk of weed competition from late flushes of weeds after early post herbicide applications do not need to be a concern if the corn or soybean fields are going to be cultivated in a timely manner.

Application flexibility. Farmers should consider having their own sprayer to ensure that weeds are sprayed on time if custom applicators get back logged. Owning your own sprayer can also pay off when certain weed patches may need spot treatments or if field edges need follow up treatments.

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