RELATIONSHIP BETWEEN NITROGEN RATE AND WEED REMOVAL TIMING ON CORN YIELD

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Abstract

Weeds actively compete for nitrogen in corn grain production systems. Field studies were conducted in 2009 and 2010 at the Michigan State University Crop and Soils Research Farm in East Lansing, MI to evaluate the effect of N application rate and weed removal timing on grain yield. Treatments included four preplant incorporated rates of urea (0, 67, 134, and 202 kg N ha^{-1}) and four weed removal timings (5, 10, 15, and 20 cm) based on average weed canopy height. An additional season-long weed-free treatment was used as a control. The weed removal timing that significantly reduced grain yield compared to the weed-free treatment was considered to be the critical weed removal timing. The critical weed removal timing was influenced by N application rate in both 2009 and 2010. When 0 kg N ha^{-1} was applied, the critical weed removal timing was 5 cm weed canopy height in both years of the study. At the 67 kg N ha^{-1} application rate, the critical weed removal timing was 5 and 15 cm weed canopy height in 2009 and 2010, respectively. In 2010, when 134 kg N ha^{-1} was applied, the critical weed removal timing was 15 cm. There was no significant grain yield reduction for the weed removal timings at the 134 kg N ha^{-1} application rate in 2009 and with 202 kg N ha^{-1} in 2009 and 2010. These results indicate that when lower preplant N application rates are used, weed removal needs to be timed earlier to avoid any opportunity for a grain yield reduction.

Introduction

In Michigan, nitrogen (N) recommendations for corn are based on the Maximum Return to Nitrogen (MRTN) system. Compared to a yield-based approach, N recommendations are often lower using the MRTN system. Nitrogen is often the yield-limiting nutrient in corn grain production, and weed-corn competition for N can reduce corn grain yield (Gower et al. 2003; Dalley et al. 2006). Due to lower N recommendations as a result of implementing the MRTN system, the critical weed removal timing in Michigan was re-evaluated.

The critical weed removal timing is defined as the point in time where weeds need to be removed to avoid a yield reduction from plant competition (Zimdahl 2004). Several studies in the North Central US, including Michigan, have evaluated the critical weed removal timing in corn grain production. To reduce the chance of grain yield loss from weed competition, weed removal is recommended prior to the V4 to V6 corn growth stage (Gower et al. 2003; Dalley et al. 2006) or prior to an average weed canopy height of 10 to 15 cm (Carey and Kells 1995; Dalley et al. 2004; Gower et al. 2002; Tapia et al. 1997). However, under less competitive conditions (i.e. adequate moisture and moderate weed density), grain yield losses may be avoided until weed height exceeds 30 cm (Dalley et al. 2004).

Most critical weed removal timing studies have been conducted under non-limiting N conditions. However, the critical weed removal timing may be influenced by N application rate (Weaver et al. 1992). In Nebraska, a 5% corn grain yield reduction occurred when 120 kg N ha^{-1} was applied and weeds were controlled at the V6 growth stage. This same study found that when 60 kg N ha^{-1} was applied, weed removal needed to be accomplished by V4 in order to avoid the same percentage yield loss (Evans et al. 2003).

Due to the implementation of the MRTN recommendation system, the critical weed removal timing in Michigan corn grain production systems needed to be re-examined; therefore, the objective of this study was to determine critical weed removal timing based on multiple N application rates.

Approach

The impact of multiple N application rates on the critical weed removal timing in Michigan corn grain production was evaluated in a field study conducted in 2009, 2010, and 2011 at the Michigan State University Crop and Soils Research Farm in East Lansing, MI. Results are given for 2009 and 2010. In 2009, the study was conducted on Aubbeenaubbee sandy loam (fine-loamy, mixed, active, mesic Aeric Epiaqualfs) and Capac loam (fine-loamy, mixed, active, mesic, Aquic Glossudalfs). In 2010, the study was conducted on Capac loam. Treatments included four preplant incorporated rates of urea (0, 67, 134, and 202 kg N ha^{-1}) and four weed removal timings (5, 10, 15, and 20 cm) based on average weed canopy height. A full-season, weed-free treatment was maintained as a comparison control. Weed removal timing was replicated four times and randomized within each N rate block.

Corn (‘Pioneer 37Y14’) was planted at 71,700 seeds ha^{-1} in 75 cm rows on May 5, 2009 and May 9, 2010. Plots were 3 by 11 m in 2009 and 3 by 8 m in 2010 and consisted of four rows of corn. The study site was tilled in the autumn prior to establishment and cultivated twice in the spring. Urea was applied in four blocks at rates of 0, 67, 134, and 202 kg N ha^{-1} and incorporated prior to planting. With the exception of the weed-free treatment, the natural, mixed-population of weeds was allowed to emerge with the corn. The natural weed population consisted primarily of common lambsquarters (*Chenopodium album* L.), common ragweed (*Ambrosia artemisiifolia* L.), and giant foxtail (*Setaria faberi* Herrm.). At each weed removal timing, weeds were sprayed with glyphosate at 0.84 lb ae ha^{-1} and ammonium sulfate at 2% (wt/wt). Plots were maintained weed-free subsequent to weed removal timing with additional glyphosate applications and/or by hand weeding. The center two rows were harvested and grain yield was determined at 15.5% moisture.

Data were analyzed separately for each year. Analysis of variance at $\alpha = 0.05$ was used to determine if there was a significant effect of weed removal timing on corn gran yield within each N application rate. All statistical procedures were conducted in SAS using the Proc Mixed procedure (SAS Institute 2001).

Results

Across all N application rates, corn grain yield was greater in 2010 than in 2009. More frequent spring precipitation events and fewer growing degree days in 2009 may have lead to greater rates of early season N loss and decreased corn grain yield in 2009 compared to 2010.

When N application rate was 0 kg N ha^{-1}, the critical weed removal timing was at an average weed canopy height of 5 cm in 2009 and 2010 (Fig. 1). At the 67 kg N ha^{-1} application rate, the critical weed removal timing was at an average weed canopy height of 5 cm in 2009 and 15 cm in 2010 (Fig. 2). When 134 kg N ha^{-1} was applied in 2009, no significant grain yield differences occured between any of the weed removal timings (Fig. 3). In 2010, the critical weed removal timing for the 134 kg N ha^{-1} treatment was at an average weed canopy height of 15 cm. At the highest N application rate of 202 kg N ha^{-1}, there were no grain yield differences between any of the weed removal timings over both study years (Fig. 4).

Summary

The critical weed removal timing was influenced by N application in 2009 and 2010. At 0 and 67 kg N ha^{-1} application rates, weed removal needed to occur earlier to avoid any grain yield loss. The 134 and 202 kg N ha^{-1} treatments in 2009 and the 202 kg N ha^{-1} treatment in 2010 resulted in no significant grain yield reductions at any weed removal height. Sufficient N may exist at the high N application rates to discourage plant competition between the corn plants and weed species.

As a result of changing to the MRTN approach, N recommendations for Michigan corn grain production have decreased compared to the prior yield-based recommendation system. Based on the results of this study, decreased N application rates required earlier weed removal to avoid any percentage loss of yield. These findings may warrant a further review of weed removal best management practices to maximize both the economic and nutrient use efficiencies of Michigan agricultural systems.

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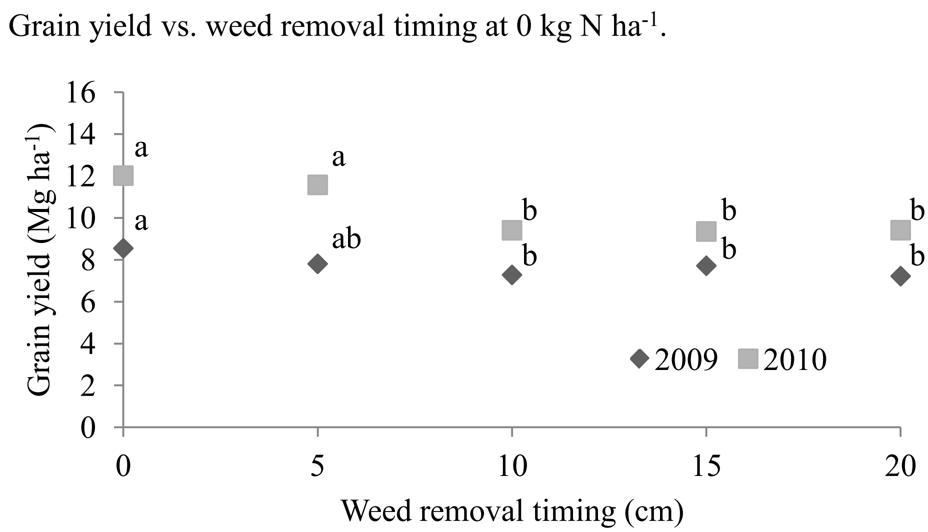

Figure 1. Corn grain yield by weed removal timing at the 0 kg N ha^{-1} application rate.

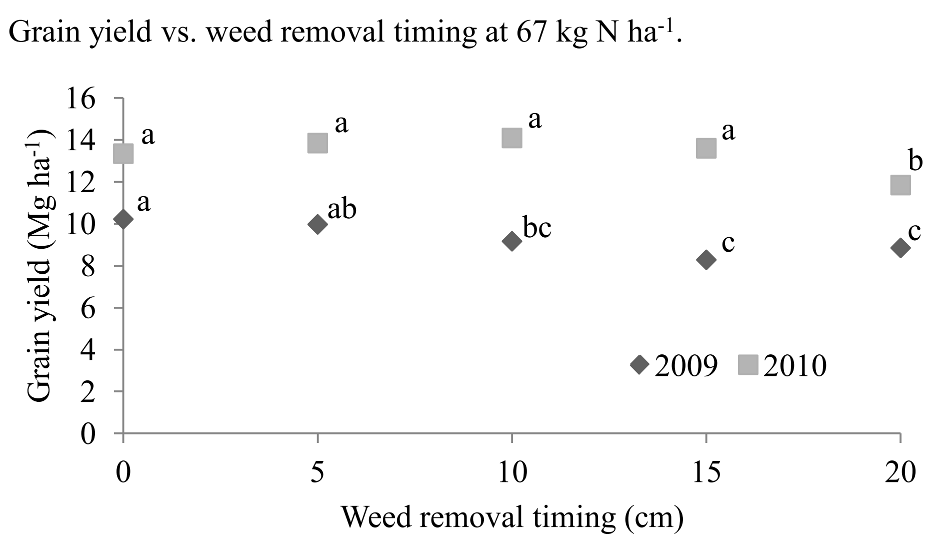

Figure 2. Corn grain yield by weed removal timing at the 67 kg N ha^{-1} application rate.

Grain yield vs. weed removal timing at 134 kg N ha^{-1}.

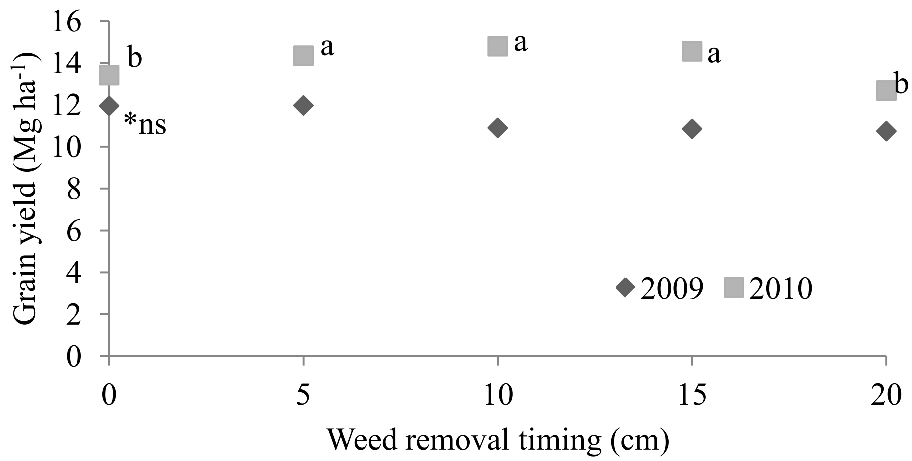

Figure 3. Corn grain yield by weed removal timing at the 134 kg N ha^{-1} application rate.

Grain yield vs. weed removal timing at 202 kg N ha^{-1}.

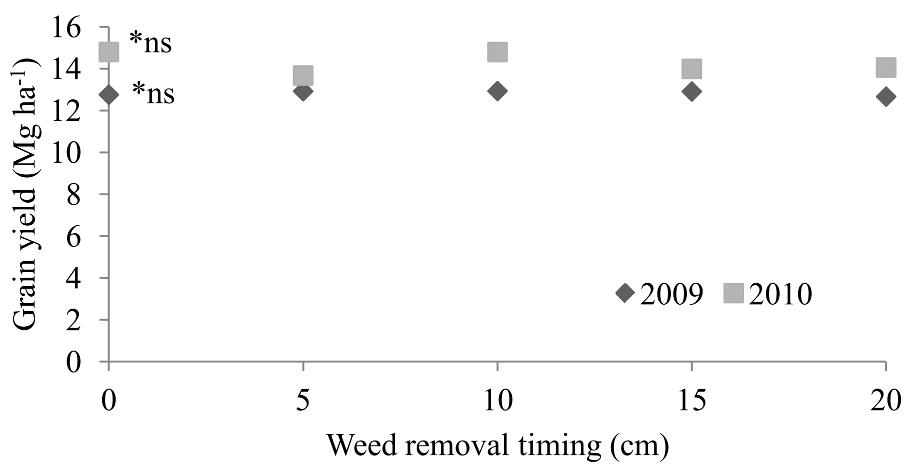

Figure 4. Corn grain yield by weed removal timing at the 202 kg N ha^{-1} application rate.

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