CONSIDER SOIL DRAINAGE CLASS WHEN MAKING NITROGEN APPLICATION TIMING DECISIONS FOR CORN[1]

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Introduction

In-season application on N on sandy soils has been well established as a best management practice to reduce N leaching and increase profitability. Over the past few years, interest in in-season or split N applications has risen because of a desire to increase N use efficiency and profitability of corn production.

A N rate and timing study was conducted from 2014 to 2016 at two locations, one well drained and the other somewhat poorly drained. Treatments included 0 to 200 lb N/a applied at preplant, sidedress (V6), split (40 lb N/a at preplant + sideress), preplant + late (various preplant rates + 40 lb N/a at V13-16), and triple split (40 lb N/a preplant + various sidedress rates + 40 lb N/a late). On the well-drained soil, N application timing did not affect yield at N applications near or greater than the economic optimum N rate (Figure 1) and split applications resulted in lower return on investment (ROI) because of the added cost associated with multiple applications (Figure 2). In two of three years on the somewhat poorly drained soil, sidedress N application resulted in the greatest yield (Figure 3), ROI (Figure 4), and fertilizer N recovery efficiency because of early season N losses associated with preplant application. These sites demonstrate that late application of 40 lb N/a can be an effective rescue treatment, through sidedressing in these situations had the greatest ROI.

Soil drainage class should be considered when making N application decisions. On sand, loamy sand, and sandy loam soils, a majority of the N should be applied in-season to prevent loss. Multiple split applications may be considered on excessively and somewhat excessively drained soils that have the greatest leaching potential. On somewhat poorly, poorly, and very poorly drained soils, a majority of the N should be applied in-season to reduce the potential for denitrification and leaching losses. On moderately well and well drained soils, N application timing less important in most years.

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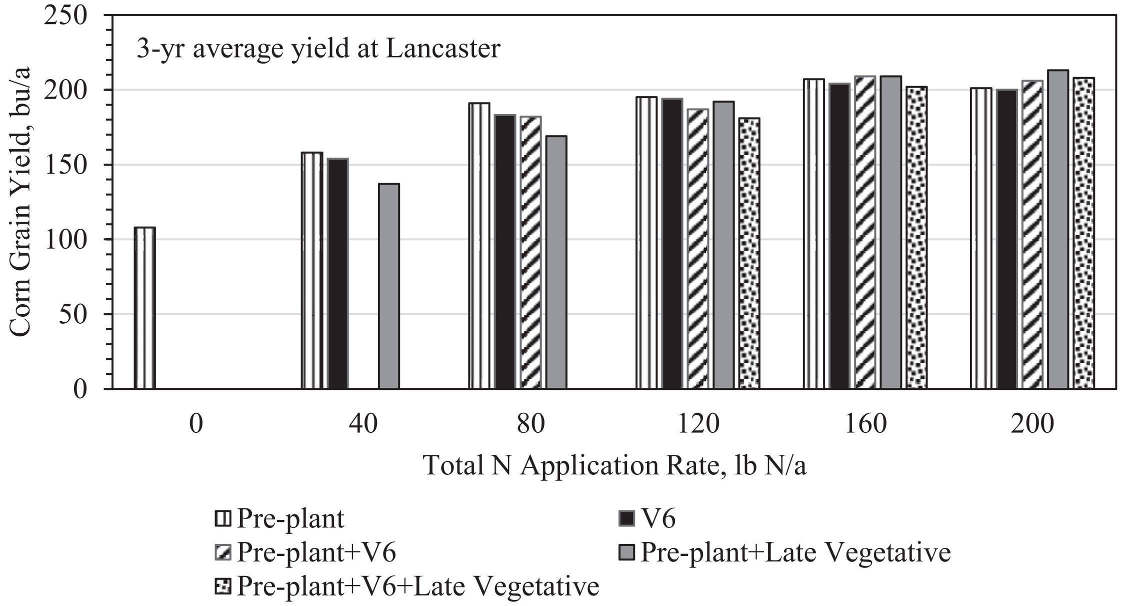

Figure 1. Effect of N application rate and timing on three-year average corn grain yield on a well-drained soil at Lancaster, WI, 2014-2016. When spit applications occurred, 40 lb N/a was applied at pre-plant and/or at late vegetative growth stage. Previous crop was corn.

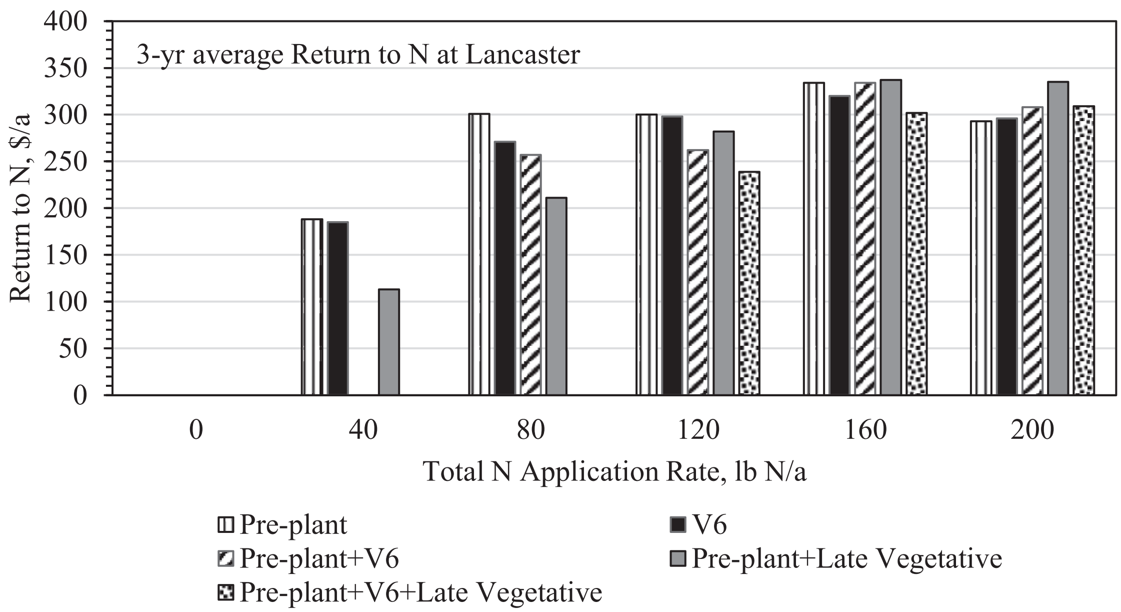

Figure 2. Effect of N application rate and timing on three-year average return to N on a well-drained soil at Lancaster, WI, 2014-2016. When spit applications occurred, 40 lb N/a was applied at pre-plant and/or at late vegetative growth stage. Return to N calculated as $0.44/lb N, $4.00/bu grain, $6/a for each N application additional N application. Previous crop was corn.

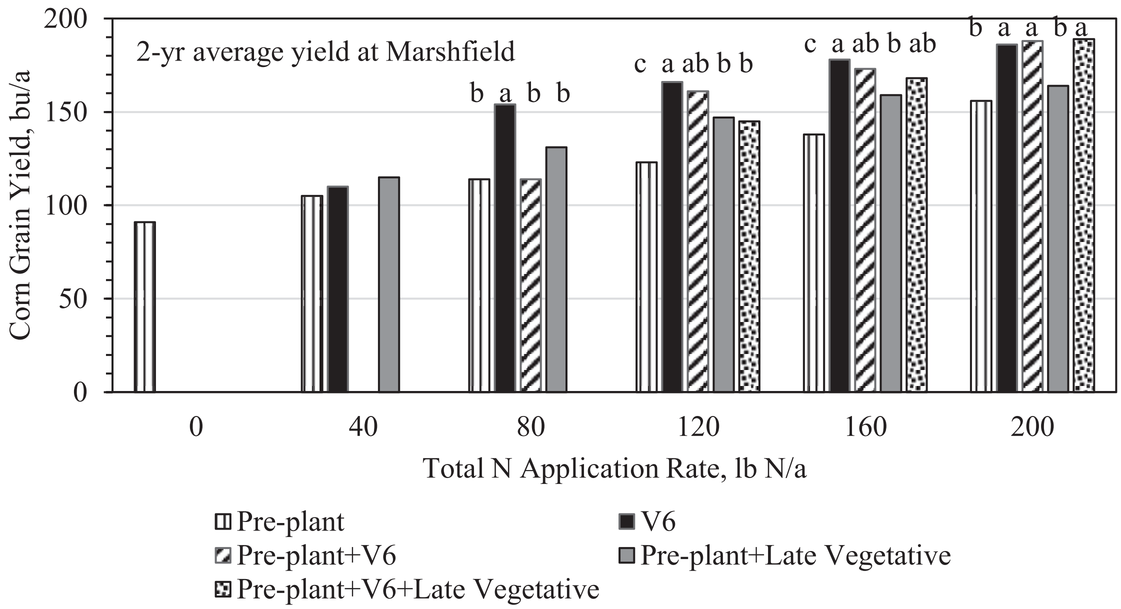

Figure 3. Effect of N application rate and timing on three-year average corn grain yield on a somewhat poorly-drained soil at Marshfield, WI, 2014-2016. When spit applications occurred, 40 lb N/a was applied at pre-plant and/or at late vegetative growth stage. Previous crop was corn. For a given N rate, N application timings with different letters are significantly different ($p<0.10$).

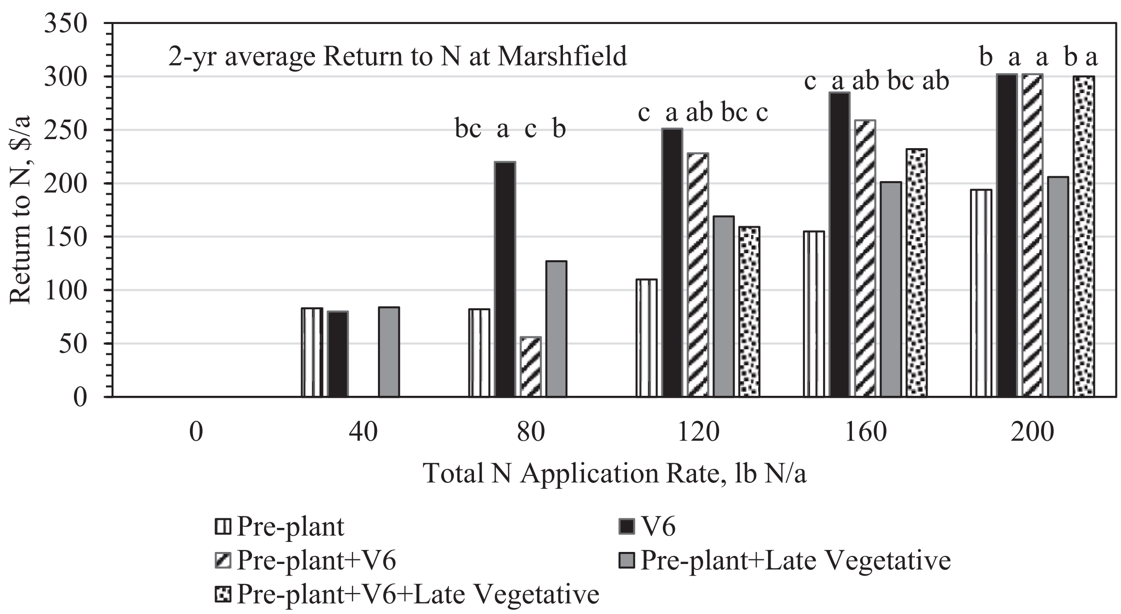

Figure 4. Effect of N application rate and timing on three-year average return to N on a somewhat poorly-drained soil at Marshfield, WI, 2014-2016. When spit applications occurred, 40 lb N/a was applied at pre-plant and/or at late vegetative growth stage. Return to N calculated as \$0.44/lb N, \$4.00/bu grain, \$6/a for each N application additional N application. Previous crop was corn. For a given N rate, N application timings with different letters are significantly different ($p<0.10$).

QUANTIFYING THE BENEFITS OF LEGUME COVER CROPS

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Introduction

Red clover, when interseeded (or frost-seeded) with winter wheat offers potential for economic return in the form of N credits, rotational yield bump and the potential for harvest as forage, all without idling cropland for the sake of cover cropping (Gaudin et al., 2014; Stute and Posner, 1995). Current UW-Extension N credits for red clover are based on the height of above ground growth: 50 to 80 lb-N ac^{-1} if greater than 6 inches tall and 40 lb-N ac^{-1} if less than 6 inches tall (Laboski and Peters, 2012). But, it is not clear what data this N credit is based on; there is no published data from Wisconsin studies that have calculated an N credit from red clover. Previous work in the early to mid-1990s (e.g., Stute and Posner, 1995) only evaluate the feasibility of frost-seeding legumes and potential yield benefit, but were not designed to determine an N credit. Other Midwestern states and corresponding land grant institutions do not provide a red clover specific credit, but rather provide a generic annual legume credit, which ranges from 30 to 80 lb-N ac^{-1} (Ohio and Michigan, respectively). In contrast, recently published studies have reported red clover N credits that are lower than those recommended by these states for unharvested red clover. In Michigan, Gentry et al. (2013) found reportable credits of 27 and 43 lb-N ac^{-1} in 2006 and 2007 and in Ohio, Henry et al. (2010) found no credit in 3 of 4 site-years, although they did find that corn yields increased 14.5% when following red clover. Vyn et al. (2000) also found a significant yield increase in corn following red clover compared to no cover in two tillage systems in 3 of 4 site years, but only when no additional fertilizer was added; yield differences were negated by the addition of 130 lb-N ac^{-1}.

Red clover can also be established in a standing corn crop. Previous research on interseeding red clover into corn in Wisconsin has shown that it is a viable system. Trials at the Arlington Agricultural Research Station in 2014 and 2015, conducted by Dan Smith with the University of Wisconsin Nutrient and Pest Management Program, have shown that red clover grows well when interseeded into corn at the V4-V5 growth stage. These trials also determined that interseeding clover did not reduce corn grain yields in the same year. However, similar research by Grabber et al. 2014, determined greater corn yields when red clover was interseeded compared to a no cover control. What remains to be studied is the effect of interseeding red clover on subsequent years corn yields and response to N. The potential N credit has not been determined. Another aspect to this research is that there is a clear yield drag when corn is grown in continuous rotation without tillage. If red clover provides a yield increase, interseeding red clover into continuous corn could serve to eliminate this yield drag. The other issue not yet addressed by current research is if the N credit from red clover in this system comes from fixed-N or from fertilizer N.

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The goals of previous research have been to quantify the N benefit (to corn) of legume cover crops either frost-seeded into winter wheat, planted after winter wheat, or interseeded into corn. Preliminary results here demonstrate the potential benefit of red clover.

Frost-Seeding Study

Experimental Design

This study was conducted during the 2017-2018 and the 2018-2019 growing seasons, with red clover being frost-seeded into winter wheat the first year and corn yields being evaluated in the second year. The study was conducted at the Arlington Agricultural Research Station. The study design was a randomized, complete block split-split plot design with four replications. The whole plot treatments were no cover crop, red clover cover crop terminated in the fall, and red clover cover crop harvested in the fall. The split plot treatments were tillage and no tillage and the split-split plot treatments were six rates of N fertilizer (0, 50, 100, 150, 200, 250 lb-N ac^{-1}). The split-split plot size will be 15 × 40 ft (144 plots). The red clover cover crop was frost seeded into winter wheat in March. Wheat grain and straw yield were measured in August by hand from a 2 × 2 m area, then mechanically harvested from the entire plot area. In November of each year, the red clover was killed chemically or harvested as a silage crop at bud stage. Both red clover as cover and for forage was be sampled prior to termination or harvest and analyzed for dry matter (DM) content and C and N concentration. The red clover for silage will also be analyzed for forage quality [hay/haylage analysis, University of Wisconsin Soil and Plant Analysis Laboratory (UW-SPAL)], which includes DM, crude protein (CP), acid detergent fiber (ADF), ADF-CP, neutral detergent fiber (NDF), NDF-CP, ash, fat, NDF digestibility (NDFD), and relative forage quality (RFQ). Soil samples (0-1 and 1-2 ft) will be taken at the time of red clover harvest and analyzed for nitrate-N. The tillage treatment (chisel plow) will be conducted after soil sampling (this treatment may require a soil finisher in the spring as well).

Preliminary Results

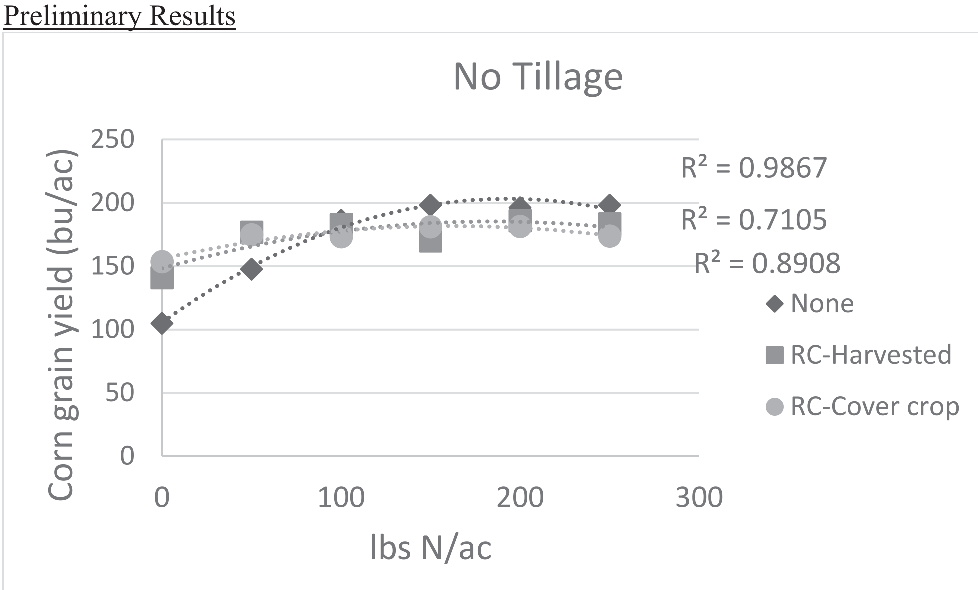

Figure 1. Corn yield following no cover crop, red clover as a cover crop, or red clover harvested as a silage crop in 2018 at the Arlington research station. Clear yield benefit from red clover at lower N rates, but greater yields were achieved without a cover crop at higher N rates.

Experimental design

Research was conducted at the Arlington Agricultural Research Station in 2017 and 2018, and will be continued in 2019. Continuous corn was grown in a no-till system. The experimental design was a randomized, complete block-split plot design, with four replications. The whole plot treatments were with or without interseeding of red clover and the split plot treatments will be eight rates of N fertilizer (0 to 280 lb-N/ac in 40 lb-N/ac increments). Based on the experimental design proposed, we evaluate dthe effect of corn yield on the interseeding year in 2017 and 2018, the effect on the subsequent corn years in 2018 and 2019. The effect of interseeding red clover on subsequent corn yields was evaluated when red clover is continually interseeded or not-interseeded to evaluate if the continual presence of red clover has an effect on the N credit. Red clover was drill seeded at the V4-V5 growth stage at a rate of 12 lb/ac with a modified grain drill operated by Dan Smith (UW-Nutrient and Pest Management Program). The drill can interseed three rows at a time, so each plot was six rows wide, with each plot being slightly offset. Nitrogen fertilizer was surface applied at sidedress near the time of red clover seeding, applied as urea coated with Agrotain®. Red clover was terminated chemically in the spring with 1 pint of dicamba and 32 oz of glyphosate. For post planting weed control, we applied 32 oz of glyphosate at V5 right before interseeding of red clover.

Preliminary Results

Table 1. Preplant sampling for nitrate and ammonium (ppm) in May 2018 (reflecting effect of 2017 treatments). No significant differences among treatments.

Preplant sampling (ppm) May 2018					
Cover crop treatment	2017 N rate	0-1 ft		1-2 ft	
		NO_3	NH_4	NO_3	NH_4
No RC	160	5.6	6.6	7.8	4.5
No RC	0	4.0	4.4	4.2	4.0
Always RC	160	4.8	5.1	6.3	4.1
Always RC	0	3.6	4.7	3.5	4.0

Table 2. Presidedress sampling for nitrate and ammonium (ppm) in 2018 reflecting the effect of the 2017 treatment. No significant difference among treatments. These results would indicate that the red clover did not increase the amount of plant available N in the soil.

Presidedress sampling (ppm) 6/28/18			
Cover crop treatments	N rate	0-1 ft	
		NO_3	NH_4
No RC	Bulk	5.5	6.0
No RC	0	4.7	6.1
Always RC	Bulk	5.9	5.4
Always RC	0	5.5	5.4

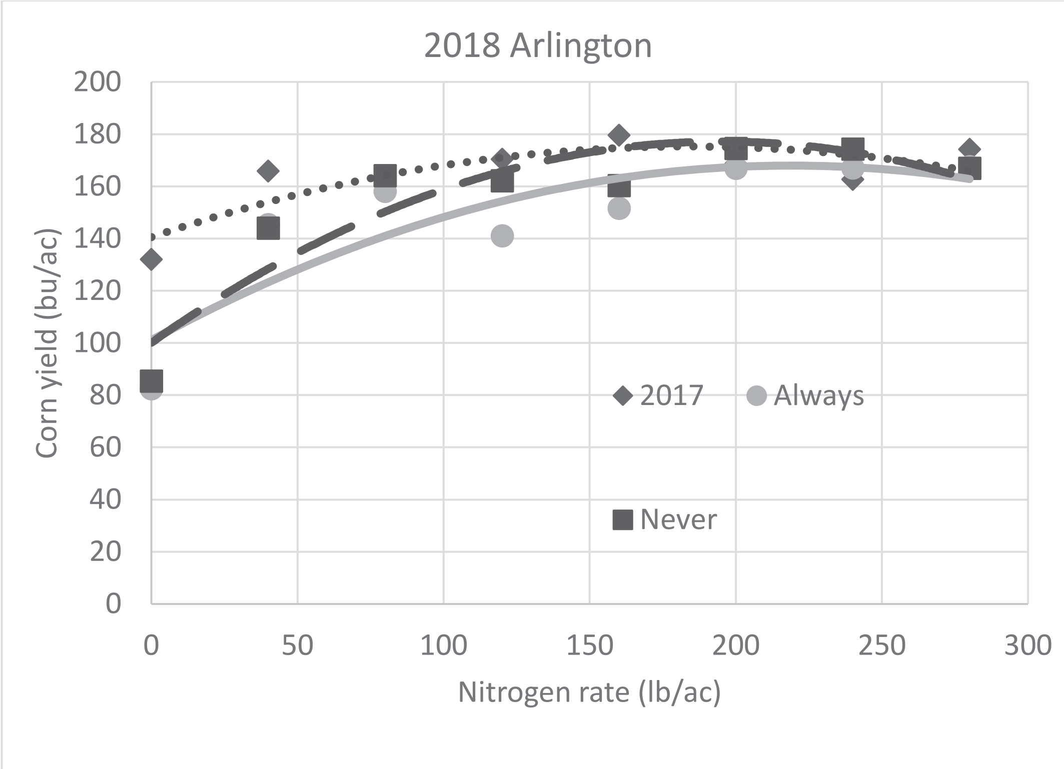

Figure 2. 2018 corn yields vs. N rates following a 2017 interseeded cover crop (2017) (dotted line), a cover crop in both 2017 and 2018 (always) (solid line), or no cover crop (Never) (long-dashed line). Results indicate yield benefit if red clover was interseeded the year prior, but not if interseeded every year.

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