INTERSEEDING COVER CROPS INFLUENCE ON OPTIMAL CORN NITROGEN RATE IN NO-TILL

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ABSTRACT

Moving from conventional to no-till with the inclusion of cover crops may change the amount and timing of nitrogen (N) provided to corn (*Zea mays* L.) from mineralization, which may increase or decrease needed N fertilizer to optimize corn grain yield. This study evaluated the effect of cover crop composition on corn N fertilizer requirement and corn grain yield. The effect of three cover crop treatments (no cover crop, single grass species, and grass/broadleaf mixture) on corn N fertilizer requirement and grain yield were evaluated at Beresford and Brookings, South Dakota (SD). Corn biomass at an early reproductive stage and physiological maturity was similar regardless of cover crop treatment and N fertilizer rate applied. Within each N fertilizer rate, the addition of either cover crop mixture did not influence corn grain yield. The fertilizer-N rate needed to obtain optimal corn grain yield was not influenced by the addition of either cover crop mixture. Results from the first year of this long-term study indicate that a single grass species or grass/broadleaf cover crop mixture can be interseeded into corn without significantly affecting corn biomass, corn grain yield, or N fertilizer requirement for optimal grain yield.

INTRODUCTION

No-till and planting cover crops are recommended practices compared to conventional tillage because of their potential to improve organic matter and soil structure leading to a greater capacity to hold water and nutrients needed for plant growth (Dapaah and Vyn, 1998; Nielsen and Vigil, 2010; Blanco-Canqui et al., 2015; Blanco-Canqui and Jasa, 2019). Cover crops can also take up nutrients and excess water in the fall and spring that may otherwise be lost from the root zone due to erosion, leaching, or volatilization (Tilman et al., 2002; Snapp et al., 2005). Inhibitions to planting cover crops in SD are the short amount of time between harvest and the first killing frost that is available for cover crops to grow and the high seeding rate required to establish an optimal stand when seeds are broadcast planted. Using an interseeder to plant cover crops overcomes these impediments because the seeds are placed in the soil and not on top after corn and soybean are established enough that cover crops will not decrease yield but before a planter cannot get into the field. This innovative method of planting cover crops lowers seeding rate requirements and increases the time cover crops are growing.

The cover crops farmers' plant vary extensively from single grass species to mixtures of multiple grass and broadleaf species, depending on weather conditions and the cover crops intended use. The chosen cover crop can influence N mineralization as cover crops take up water and nutrients and ultimately add organic material to the soil when terminated (McVay et al., 1989; Nielsen and Vigil, 2010; Wortman et al., 2012; Blanco-Canqui et al., 2015). Dominantly grass based cover crop mixtures normally have a greater C:N ratio, which may slow N mineralization initially during the growing season while broadleaf dominant mixes tend to have lower C:N ratios, promoting N mineralization sooner (McVay et al., 1989; Fageria et al., 2005). The amount and timing of N mineralization during the growing season may change based on planted cover crop composition, subsequently influencing the N fertilizer amount required to optimize corn grain yield. The objective of this project was to compare the effect of N fertilizer on corn production with no cover crop versus single- and multiple-species cover crops in SD.

MATERIALS AND METHODS

This study was conducted at the Southeast Research Farm in Beresford, SD and at the USDA-ARS research fields in Brookings, SD. Both study locations have been under no-till management for >5 years and receive an average annual rainfall of 24–26 in. The mean temperature and growing degree-day (GDD) accumulation were greater at the Beresford site (47°F and 2750 GDD) compared to the Brookings site (43°F and 2390 GDD). At each location, a corn and soybean block were planted in adjacent fields to minimize soil variation. The experimental design within each corn and soybean block was a randomized complete block in a split plot arrangement with four replications. The whole plot consisted of one of three cover crop treatments (no cover crop, single grass species, and grass/broadleaf mixture). For the single grass species, annual rye grass (*Lolium spp.*) was interseeded at 20 lbs ac^{-1}. The grass/broadleaf cover crop mixture consisted of annual ryegrass, crimson clover (*Trifolium incarnatum*), turnip (*Brassica rapa*), and radish (*Raphanus sativus*) planted at 5, 3.5, 1, and 2 lbs ac^{-1}, respectively. Cover crops were interseeded into corn at the V6–V7 growth stage and into soybean at the V4–V5 growth stage using a high clearance planter. Subplots consisted of N rates ranging from 0–250 lbs ac^{-1} in 50 lb increments at the Beresford site and ranging from 0–225 lbs ac^{-1} in 75 lb increments at the Brookings site. Ammonium nitrate (34-0-0) was broadcast applied near planting only on the corn plots. All other fertilizers were applied to ensure optimal soil fertility for corn and soybean based on university guidelines (Clark et al., 2019). Corn was planted in 30-in. rows at Beresford and 20-in. rows at Brookings at 31,000-corn seeds ac^{-1} and 130,000-soybean seeds ac^{-1}. Corn was planted on 15 May in Beresford and 23 May in Brookings. Soybean was planted 23 May in Beresford and 14 June in Brookings. Recommended practices were followed for all other weed, pest, and disease control.

Plant Sampling and Analysis

Whole corn plant samples were obtained in the zero, low (75–100 lbs ac^{-1}), and optimal (150–200 lbs ac^{-1}) N fertilizer rate treatments within each cover crop treatment at the R1 and R6 growth stages. Corn samples were collected by clipping six plants at ground level. At R6, corn plant samples were separated into ears (grain and cob) and above ground vegetative matter (stover). Plant materials were dried at 140°F until constant mass. Ears were shelled and then the weights of the whole plants (R1), dried stover, grain, and cob were determined separately. Harvest yields were determined by harvesting the center two rows of each corn plot. The moisture-adjusted grain weight from the R6 corn samples were added to the harvest weight of each plot to determine final corn grain yield. Corn grain yield was adjusted to 15.5% moisture.

Statistical Analysis

Data was analyzed within each site using box and whisker plots in Excel to test for differences among the range and mean among N rate and cover crop treatments.

RESULTS AND DISCUSSION

Corn Biomass and Grain Yield

There were marginal corn biomass differences between sites at each plant sampling but only minor differences among the cover crop treatments within each site (Fig 1 and 2). Corn biomass was on average greater at Beresford compared to Brookings regardless of cover crop treatment likely because the warmer temperatures and longer growing season of the Beresford site. The variability of the effect of cover crop treatments on corn biomass varied between the two sites. However, cover crop treatments did not significantly affect corn biomass within each N fertilizer rate. Further, corn biomass was similar across N fertilizer rates and cover crop treatments. Except for the R6 corn sampling at the Brookings site where N fertilization of 75 and 150 lbs ac^{-1} substantially increased biomass over the zero-N control treatments. The lack of R6 biomass increase with greater N fertilizer rates at the Beresford site is likely due to stalk breakage due to high winds. Overall, these results indicate that cover crops regardless of composition can be interseeded into corn without significantly changing corn biomass.

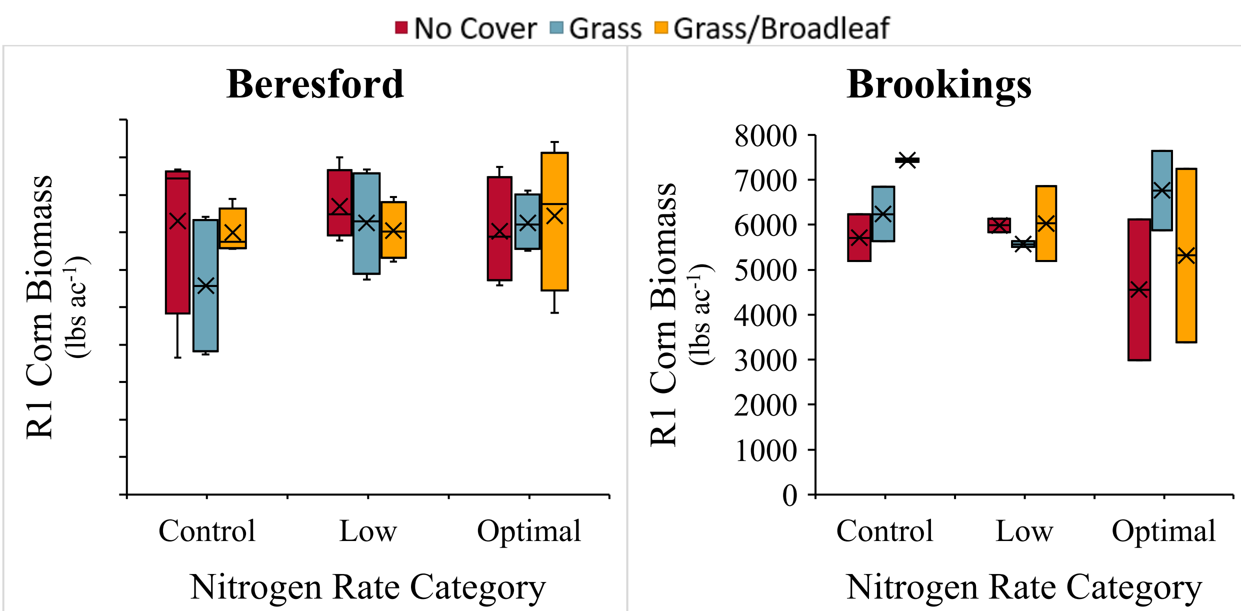

Figure 1. *The influence of three N fertilizer rates within three cover crop treatments (no cover crop, annual rye grass alone, and a grass/broadleaf mixture) on R1 whole corn plant biomass at Beresford and Brookings, SD in 2019. The box midline represents the median, the 'x' marks the mean, the upper and lower edges of the box represent the 25th to 75th percentiles, and the whiskers represent the range.*

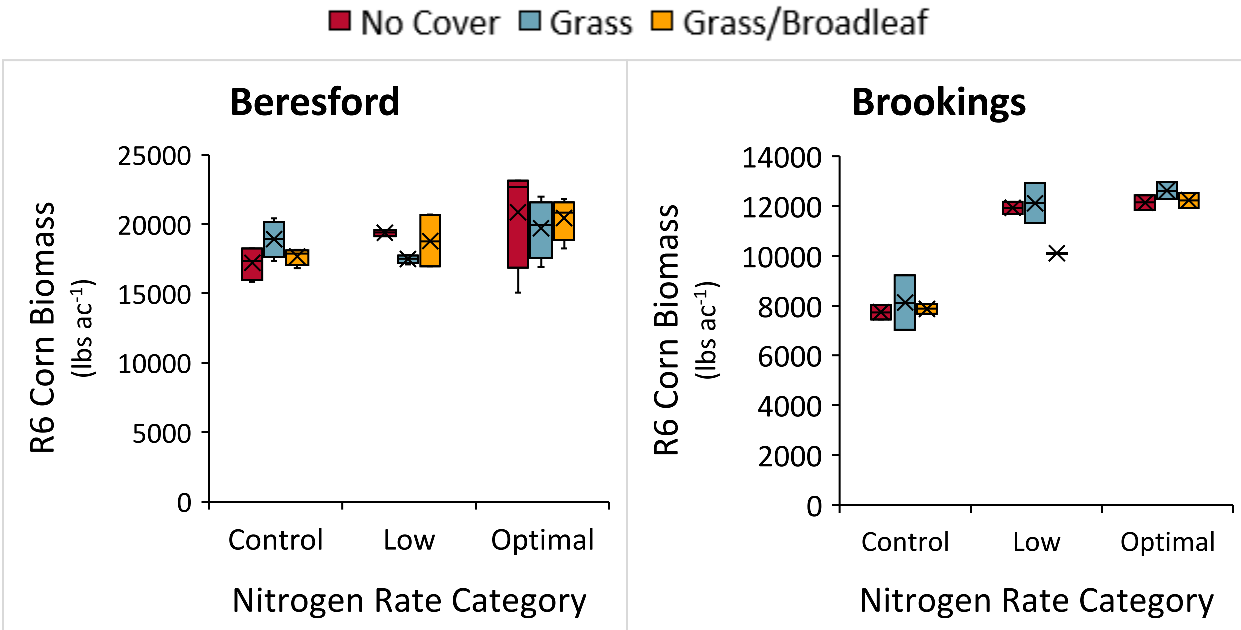

Figure 2. *The influence of three N fertilizer rates within three cover crop treatments (no cover crop, annual rye grass alone, and a grass/broadleaf mixture) on R6 corn biomass at Beresford and Brookings, SD in 2019. The box midline represents the median, the 'x' marks the mean, the upper and lower edges of the box represent the 25^{th} to 75^{th} percentiles, and the whiskers represent the range.*

For the Beresford site, corn grain yield ranged from 142 to 235 bu ac^{-1} with a mean yield of 180 bu ac^{-1} across all treatments (Fig. 3). The zero-N plots grain yield averaged 168 bu ac^{-1} regardless of cover crop treatment. The addition of N fertilizer (50–250 lbs ac^{-1}) increased mean corn grain yield 7–30 bu ac^{-1} for no cover crop, 1–17 bu ac^{-1} for the grass cover crop, and 6–33 bu ac^{-1} for the grass/broadleaf cover crop. Overall, grain yield did not increase substantially with added N fertilizer as it would it most years. Therefore, we were not able to calculate an optimal N rate at this site. This lack of greater increases in yield with more N fertilizer applied may have been due to high winds causing some stalk breakage during the growing season. In addition, within each N fertilizer rate there was no significant difference in grain yield among the three cover crop treatments.

For the Brookings site, corn grain yield ranged from 83 to 162 bu ac^{-1} with a mean yield of 132 bu ac^{-1} across all treatments (Fig. 3). The zero-N plots grain yield averaged 92 bu ac^{-1} across cover crop treatments. The addition of N fertilizer (75–225 lbs ac^{-1}) increased mean corn grain yield 49–53 bu ac^{-1} for no cover crop, 60–66 bu ac^{-1} for the grass cover crop, and 38–59 bu ac^{-1} for the grass/broadleaf cover crop. Corn grain yield plateaued near 75 lbs N ac^{-1} for all three cover crop treatments. Further, grain yields were similar among the three cover crop treatments within each N fertilizer rate. These results from the first year of this study indicate that grass or grass/broadleaf cover crop mixtures can be interseeded into corn without reducing yield or affecting N fertilizer required to obtain optimal yield. As this study continues, we will determine whether the cumulative effects of planting cover crops over several years will influence corn grain yield or N fertilizer required to obtain optimal yield.

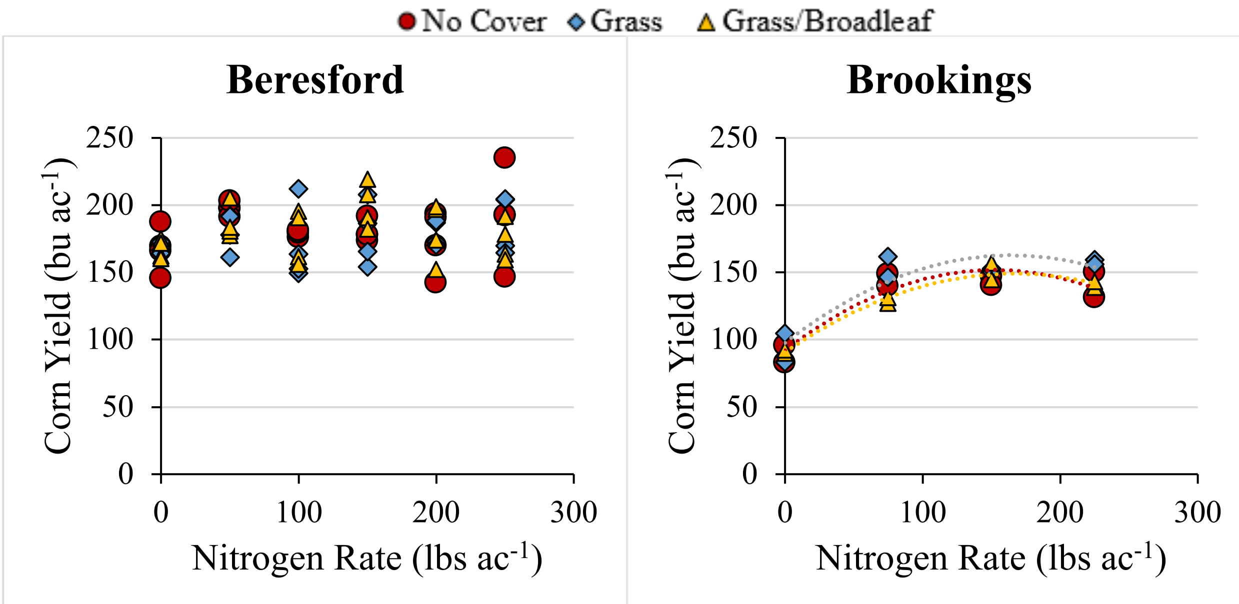

Figure 3. *Corn grain yield response to N fertilizer for three cover crop treatments (no cover crop, annual rye grass alone, and a grass/broadleaf mixture) at Beresford and Brookings, SD in 2019.*

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