DOES INTERSEEDED COVER CROPS COMPOSITION AFFECT CORN N FERTILIZER NEEDS IN CORN AND SOYBEAN YIELDS?

S.Kodali, J.D.Clark, Peter Kovacs, Peter Sexton, Shannon Osborne
South Dakota State University, Brookings, SD
Srinadh.Kodali@sdstate.edu (313)265-9118

ABSTRACT

Cover crops are often recommended as a valuable practice to develop more sustainable cropping systems. However, interseeding cover crops may change the amount and timing of nitrogen (N) provided to the crop from decomposition (mineralization), which may increase or decrease the N fertilizer required to optimize corn grain yield. This study aims at understanding the effect of cover crop composition (single and multispecies) on soil biological measurements, corn N requirements, and corn and soybean yield. A long-term corn-soybean rotation study was established in 2019 in Brookings and Beresford, South Dakota. Treatments consisted of three cover crop treatments (No cover crop, single grass species, and grass/broadleaf mixture) with 4 or 6 N rates for corn ranging from 0-250 lbs. ac^{-1}. Results from 2019 to 2021 indicate that corn with grass cover crop required anywhere from 40 lbs. ac^{-1} less to 25 lbs. ac^{-1} more N compared to when no cover crop was grown. In 2 of 4 N responsive site years including a grass/broadleaf cover crop reduced corn yield at EONR (Economical Optimum Nitrogen Rate) by 15-30 bu. ac^{-1} compared to the grass or no cover crop treatments. In two of three responsive site years. Including a grass cover crop significantly increased corn yield (15-30bu ac^{-1}) at EONR compared to the grass/broadleaf mix and no cover crop and required less N without any significant yield losses. For soybean, interseeding grass or a grass/broadleaf mixture had little to no influence on soybean yield. These results demonstrate that cover crops regardless of composition can be interseeded into soybean without negative yield results, but the effect of cover crop composition on yield and N requirements of corn has been inconsistent in the first three years of this study.

INTRODUCTION

Corn production and productivity have been on a steady rise in South Dakota. However, dependence on a small number of crops can reduce agricultural biodiversity. Rotating diverse crops improves productivity through enhanced soil biodiversity, nutrient availability, resource use efficiency, and increased soil organic matter(McDaniel et al., 2014; Tiemann et al., 2015). The inclusion of cover crops increases the diversity in corn (*Zea mays L.)* and soybean (*Glycine max L. Merr.*) rotations that are common in the US Midwest. The use of cover crops also affects a wide range of ecosystem services viz., improved soil quality, pest suppression, and biological N fixation(Schipanski et al., 2014).

Although the practice of planting cover crops has been around for many years recent gain in popularity can be largely credited to potential soil and water quality improvements (Thompson et al., 2021). Cover crops use in the US has increased by 50 percent between 2012 and 2017. Although this is a significant increase from the previous year's it only accounts for a small fraction of the total cultivated area. Current limitations to cover crop adoption are numerous, but seeding cost, return on investment, as well as a lack of breeding efforts and variety enhancement, were common culprits. Poor cover crop establishment was the most common factor limiting cover crop performance(Wayman et al., 2017). Furthermore, cover crop use tends to be lower in the northern Midwest likely due to the shorter growing season to establish a cover crop. Winter cereals are the only option for seeding a cover crop in northern climates following corn harvest; however, the establishment is still somewhat limited by the length of the growing season (Baker & Griffis, 2009). Currently, grasses are the most popular interseeded species, followed by clovers, and then Brassica species(*USDA ERS - Cover Crops*, n.d.). Researchers have examined interseeding several cover crop species including annual ryegrass (*Lolium multiflorum Lam.*) and crimson clover seeded as a single species and in mixtures.

Crop competition is a major concern associated with interseeding cover crops (Hall et al., 1992). The competitiveness of weeds in corn depends on the weed emergence time in relation to corn emergence, weed species, and weed density. Weeds were not competitive with corn when weeds emerged after V2, V4 (Travlos et al., 2011), and V5 corn stages. These results suggest that cover crops could be interseeded in corn as early as the V2 corn growth stage without reducing corn grain yield, but the competitiveness of cover crops, like weeds, may be dependent on species and density. Although cover crops do not compete with the corn plant after the V5 stage they can still influence the amount of N required to optimize corn yields. It is therefore important to understand the influence of different cove crop composition and their effect on the N rates in corn, and soybean yields. This study aims at understanding the effects of cover crop composition (single and multispecies) on soil biological measurements, corn N requirements, and yields in corn and soybeans.

MATERIALS AND METHODS

A long-term corn-soybean rotation study was established in 2019 in Brookings and Beresford, South Dakota. Treatments were laid out in a split-plot design with three cover crop treatments (No cover crop, single grass species, and grass/broadleaf mixture), and 4 or 6 N rates for corn ranging from 0-250 lbs. N ac^{-1}. Ammonium Nitrate or Super U were used as the N source. Pre-plant soil samples were taken from previous corn going into soybean at two depths (0-6" and 6-24"). Samples collected at 0-6" were analyzed for soil health and fertility and 6-24" samples were analyzed for ammonium, nitrate, and sulfur (Table1). All N rate treatments were applied 7-10 days after planting and cover crops were interseeded at V5 developmental stages in corn and soybean. In-season soil and plant samples were collected at V6, R1, and R6 developmental stages in corn and V5, R1, and R6 developmental stages in soybean. In-season soil samples were analyzed for soil health and fertility, and a complete nutrient analysis was done on plant samples (Table1). Grain samples were collected at harvest and tested for complete nutrient analysis. Post-harvest soil samples were collected at three depths (0-12",12-24", and 24-36"). These samples were analyzed for total nitrate N content remaining in the soil after harvest (Table1).

Table 1. Samples collected and tests run

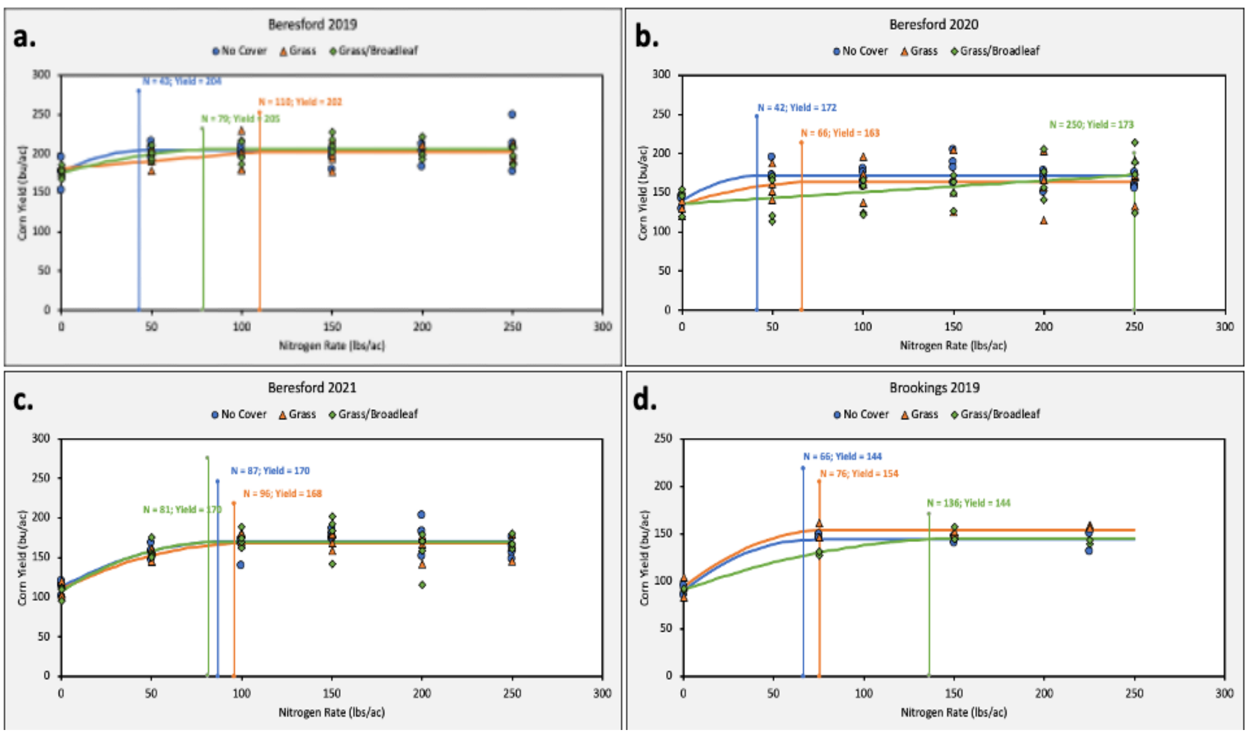
Sample type	Collection time/stage	Sampling depth/type	Tests run
Soil	Pre-plant	0-6”	Nitrate N Ammonium N Soil Organic matter Organic Carbon Active C SHT-Soil health tests (NPK, SOM, CEC & S) PMN (potentially mineralizable nitrogen) Wet aggregate stability
		6-24”	Ammonium N Sub soil nitrate Sub soil S
Soil	In-season	0-6”	Nitrate N Ammonium N Soil Organic matter Organic Carbon Active C PMN (potentially mineralizable nitrogen) Wet aggregate stability
Soil	Post- Harvest	0-12”	Nitrate N
		12-24”	
		24-36”	
Plant	V6,R1,R6	Corn Plant	Full nutrient analysis
Plant	V5,R1,R6	Soybean Plant	Full nutrient analysis
Grain	Harvest	Corn	Full nutrient analysis

RESULTS AND DISCUSSION

Corn yield response

Response in corn yields to N fertilization was observed in four of six site-years (Figure 1). The non-responsiveness of the other site years can be attributed to corn lodging from high winds and drought causing K deficiency in corn. Results from 2019 to 2021 indicate that corn with grass cover crop required anywhere from 40 lbs. ac^{-1} less to 25 lbs. ac^{-1} more N compared to when no cover crop was grown (Figure1a-d). In 2 of 4 N responsive site years, including a grass/broadleaf cover crop reduced corn yield at EONR (Economical Optimum Nitrogen Rate) by 15-30 bu. ac^{-1} compared to the grass or no cover crop treatments (Figure 2d). Including a grass cover crop significantly increased corn yield (15-30bu ac^{-1}) at EONR compared to the grass/broadleaf mix and no cover crop and required less N without any significant yield losses.

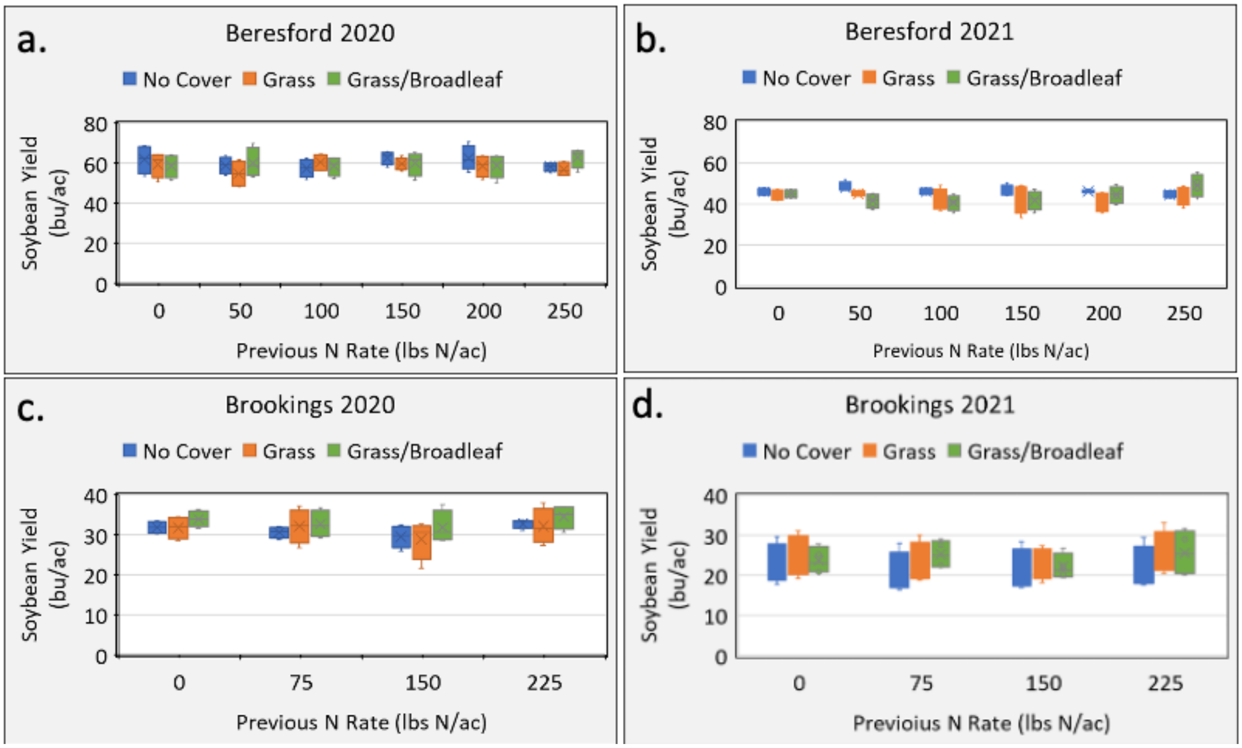
Figure 1. Corn responsive site years - yield vs. nitrogen rate



Soybean yield response

Regardless of the previous N rate applied, no significant difference was observed in mean soybean yields among the cover crop treatments with an exception at the Beresford site in 2021 (Figure2a-d). These results indicate that for soybean, interseeding grass or a grass/broadleaf mixture had little to no influence on soybean yield. Therefore, cover crops regardless of composition can be interseeded into soybean without impacting yield. In the Beresford 2021 site year, interseeded single or cover crop mixtures trended to reduce yield at the previous year's 50 and 100 lbs. N ac^{-1} rates (Figure2b). The drought conditions during 2021 may have contributed to this trend toward reduced yields where cover crops were planted. However, the 2021 Brookings site was also under drought conditions and cover crop inclusion did not influence soybean yield. As we get more site-years of data under various moisture conditions, our understanding of interseeded cover crop's effect on soybean yield will increase.

Figure 2. Soybean responsive site years – yield vs. previous N rate



CONCLUSIONS

Interseeding cover crops in the corn-soybean rotation can have several direct and indirect impacts on overall soil health and fertility without compromising yields. Single or multiple cover crop mixtures can be interseeded into soybean without negative yield. The effect of cover crop composition on yield and N requirements of corn has been inconsistent in the first three years of this study. Therefore, further data is required before solid conclusions about the effect of cover crop composition on N requirements and yield in corn can be determined.

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