RESPONSE OF CORN TO PLANTING METHODS OF COVER CROP SPECIES AND NITROGEN RATE IN SOUTHERN ILLINOIS

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ABSTRACT

It is well established that planting cover crops prior to corn (*Zea mays* L.) can influence soil temperature, volumetric water content (VWC), and nitrogen (N) dynamics. These changes in soil along with the effects of cover crop on corn plant population can influence corn grain yield and N requirement. Two strategies to facilitate corn establishment and avoid N immobilization especially in winter cereal cover crops is by mixing legumes with winter cereals or skipping the corn row (precision planting). A randomized complete block design trial with split plot arrangement was conducted in 2020-2021 and replicated in the 2021-2022 growing season. The main plots were cover crop treatments including winter rye (*Secale cereale*), crimson clover (*Trifolium incarnatum*), their mixture, precision planted crimson clover, and precision planted crimson clover and winter rye in mixture. The subplot were six N rates (0 – 320 lbs N ac^{-1}). We measured cover crop performance, corn morphology and physiology, grain yield, N removal, N balance, and N use efficiency. In 2021 among cover crops, the mixture had the largest cover crop biomass with a lower (C:N) at 26:1 compared to 31:1 in winter rye alone. Precision planted clover had similar biomass production to solid planted clover indicating lower clover seeding rate and skipping the corn row had no influence on clover performance but decrease cost of cover crop planting. Corn yield was similar among all cover crop treatments in 2021 and corn economic optimum rate of N (EORN) was 179 lb N ac^{-1}. Data for the year 2022 is continuing to be collected.

INTRODUCTION

In response to the growing algal blooms and eutrophication within the Mississippi River Basin, the state of Illinois is implementing the Nutrient Loss Reduction Strategy[1]. The goal of this strategy is to reduce the impact of N and phosphorus (P) loading in water bodies through the integration of best management practices[1]. Two of the strategies included are the selection of winter cover crops and the optimized use of N fertilizer[1]. It is known that winter rye offers a host of ecosystem services due to its ability to scavenge nutrients, reduce soil erosion, sequester carbon, lessen compaction, and suppress weeds[1,2]. While winter rye provides these benefits, it can negatively influence the following corn cash crop through several mechanisms [1,2]. Winter rye can immobilize N, deplete soil water, interfere with corn establishment, decrease corn stand and therefore, decrease corn yield[2,3]. Solutions that can help alleviate the soil-N immobilization include the termination stage and integration of legumes, such as crimson clover, which can reduce the C:N below 25:1 where immobilization will no longer happen[3]. Previous studies have shown that a mixture of winter rye with crimson clover can decrease the negative effects of winter rye on the subsequent corn[4] and alter its N requirement. It is unclear how precision planting (skipping the corn row) or integrating precision planting into winter rye-crimson clover mixture can affect corn establishment, soil N, corn grain yield and N requirement. Therefore, the objectives were to explore the impact of cover crop selection and planting method on cover crop biomass, weed suppression, corn plant population (stand density), grain yield, and N requirement. We hypothesized that precision planting and including crimson clover could decrease N requirement of corn.

MATERIALS AND METHODS

Trial was conducted at the Agronomy Research Center in Carbondale, IL (37.75◦ N, 89.06◦ W). Experimental design was split plot arranged in a randomized complete block design with four replicates. Main plots were cover crop treatments: no cover crop control (NOCC), crimson clover precision planted (CLPP), crimson clover solid planted (CLNP), crimson clover on corn row winter rye (WCR) on middle rows (CLRMIXPP), crimson clover mixed with WCR (CLRMIX), and solid planted WCR (RNP). Subplots were the fertilizer N treatments: 0, 40, 80, 160, 240, 320 lbs ac^{-1}. All plots except for the zero-N control received a stater fertilizer (2×2×2) at the rate of 40 lbs ac^{-1}. Cover crop seeding rates were: CLPP (18.75 lbs ac^{-1}); CLNP (25 lbs ac^{-1}); CLRMIXPP (CL: 6.25 & WCR: 45 lbs ac^{-1}); CLRMIX (CL: 20 & WCR 30 lbs ac^{-1}); RNP (60 lbs ac^{-1}). Each subplot treatment consisted of four rows totaling ten feet wide and forty feet long with four feet alleys.

Cover crops were planted on Sept. 23rd, 2020 with a John Deere 450 series grain drill (John Deere, Moline, IL, USA) and terminated via burndown on April 13th, 2021. Prior to termination cover crops were sampled from a 7.2 ft^2 area using grass shears. Cover crops were oven dried at 60 ◦C and then ground for nutrient, carbon, and N analysis using the combustion method with an elemental analyzer.

Corn was planted on May 11th, 2021 and harvested on October 5th, 2021. Dekalb DKC 64-35 RIB corn seed was planted to depths of 1”-1.25” using a no-till drill at 35000 ac^{-1} plant population. 32% urea ammonium nitrate was liquid injected on June 24th, 2021 at V5 stage. Harvest was conducted on the middle two rows of each subplot with a XP Plot Combine (Kincaid, Haven, KS, USA). Weights were corrected to 15.5% moisture content and converted into bu ac^{-1}.

We used several models (linear, quadratic, linear plateau, and quadratic plateau) and to identify the best fit for assessing economic optimum rate of N (EORN). Among those, linear plateau model was the best fit. Statistical analysis for cover crop biomass, percentage of weed biomass, and corn stand density was performed with SAS 9.4 (SAS

Institute Cary, North Carolina) using a one-way ANOVA. Cover crops were considered as the fixed effect and block was the random effect. Statistical analysis for corn grain yield was performed using a two-way ANOVA with SAS 9.4 (SAS Institute Cary, North Carolina) using mixed models with cover crop and fertilizer set as fixed effects and block set as a random effect. When treatments were significant, mean separation was conducted using Least Square Means adjusted for Tukey.

RESULTS and DISCUSSION

Cover Crop Performance

All cover crop treatments decreased weed pressure. In general, WCR was most effective in controlling weeds and the treatments with WCR were either weed free or less weedy (Figure 1). Among cover crop species, WCR biomass was higher than crimson clover and we found that precision planting did not decrease the biomass of crimson clover. This indicates that precision planting could 1) minimize cover crop root interference with corn and also 2) price of planting crimson clover can be decreased because of lower seeding rate used in precision planting. Overall, WCR was the driving factor of total biomass among cover crop treatments leading to high biomass in treatments that included WCR.

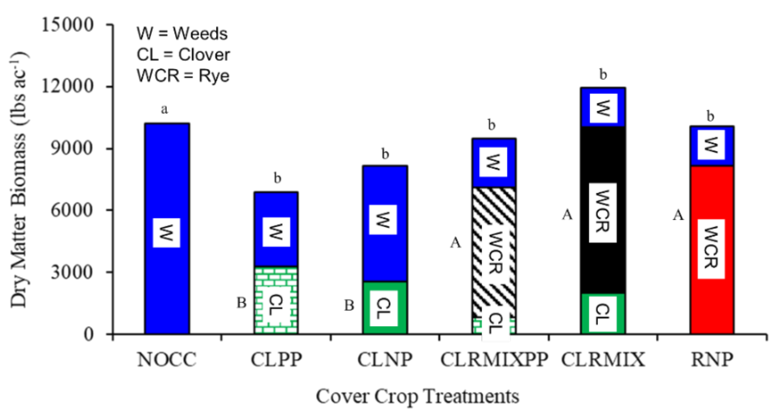

Figure 1. Cover crop (clover and rye) and weed dry matter biomass in each cover crop treatment. (lower case letters compare weed biomass and capital letters compare cover crop biomass) indicate significant difference (<0.05, Tukey). Treatments were no cover crop control (NOCC), crimson clover precision planted (CLPP), crimson clover solid planted (CLNP), crimson clover on corn row winter rye (WCR) on middle rows (CLRMIXPP), crimson clover mixed with WCR (CLRMIX), and solid planted WCR (RNP).

Corn population was only found significant between WCR and the control (NOCC), solid planted clover, PP clover, and PP mixture treatments (Figure 2). This indicated that the WCR had interfered with corn establishment and resulted in corn stand density reduction further emphasizing the importance of precision planting of cover crops.

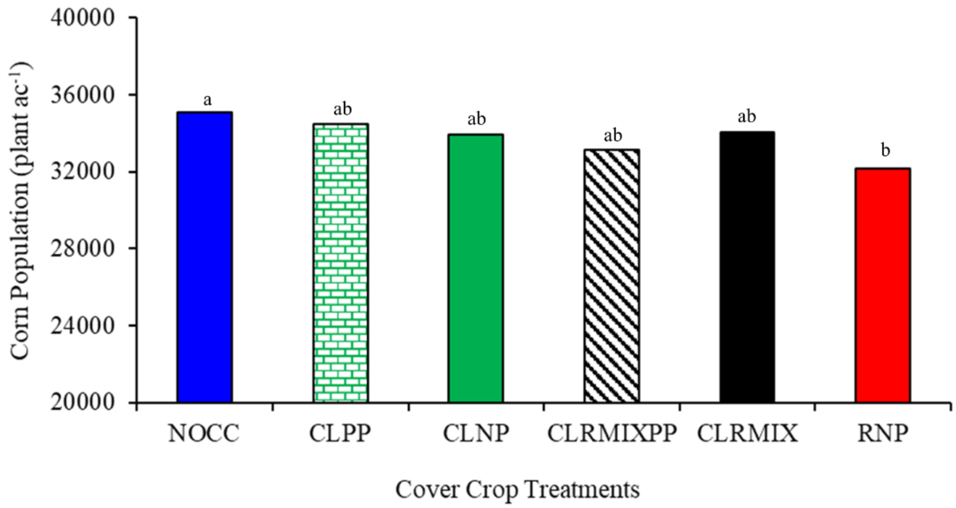

Figure 2. Corn plant population as influenced by cover crop treatments. (a, ab, b) indicate significant difference (<0.05, Tukey). Treatments were no cover crop control (NOCC), crimson clover precision planted (CLPP), crimson clover solid planted (CLNP), crimson clover on corn row winter rye (WCR) on middle rows (CLRMIXPP), crimson clover mixed with WCR (CLRMIX), and solid planted WCR (RNP).

Corn grain yield was not affected by cover crop or cover crop by N fertilizer interaction. This indicates, at this site-yr, reduction in corn stand density by WCR did not translate into yield penalty. Nitrogen fertilization influenced the corn grain yield and corn N requirement. Linear plateau model explained corn grain yield response to N rate the best (Figure 3). Corn grain yield was 11,021 lbs ac^{-1} at the EORN of 179 lbs ac^{-1}. This indicates that N addition beyond 179 lbs ac^{-1} can lead to N surplus and thus potential environmental N losses.

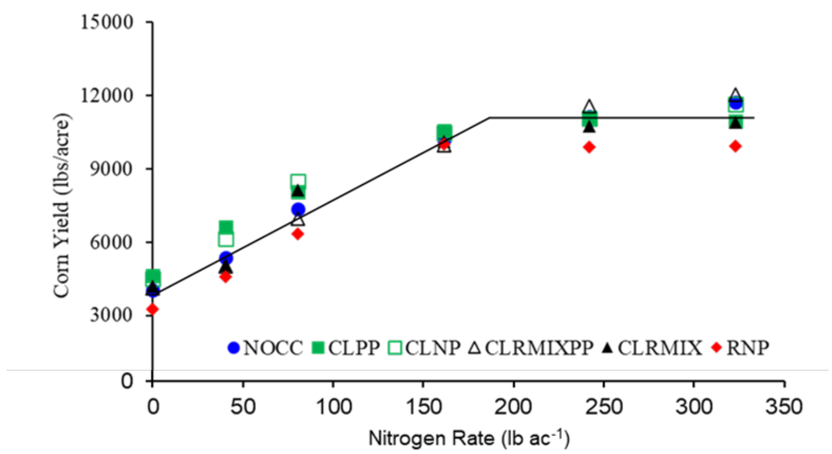

Figure 3. Response of corn grain yield to N fertilization rates and EORN for corn in 2021. Treatments were no cover crop control (NOCC), crimson clover precision planted (CLPP), crimson clover solid planted (CLNP), crimson clover on corn row winter rye (WCR) on middle rows (CLRMIXPP), crimson clover mixed with WCR (CLRMIX), and solid planted WCR (RNP).

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