Soybean Row Spacing and Planting Rate Effects on Litter Decomposition

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Introduction and Objectives

Cover crops have been rapidly adopted in Delaware, with cereal rye being a popular option for soybean production. The benefits of a rye mulch is weed suppression and soil moisture conservation, but may also cause increased pest presence and disrupt the release of nitrogen (N) to cash crops. While soybeans may not be as affected by the N cycle as corn, the mineralization and release of N in rye may also provide supplemental N to the plant mid-season. These fields may also include corn fodder from the previous cropping year, which will continue to breakdown through the soybean growing season, providing some carbon the soil surface. What is not currently known is now soybean populations and row spacing may affect the decomposition of residues on the soil surface. Earlier canopy may preserve soil moisture, allowing for increased residue decomposition, or may increase evapotranspiration reducing overall soil moisture. This study will take the first steps in measuring decomposition of residues under soybean planting densities.

Methods

Soybeans were planted at the Carvel Research and Education Center in Georgetown, DE into a rye cover crop that had been terminated two week prior. Soybeans were planted at five densities (80, 100, 120, 140, 160 thousand seeds per acre) and two row spacings (15 and 30 inch) and irrigated throughout the season. Prior to biomass termination, ten subsamples were taken to compare to drone imagery for overall field cover crop biomass.

Additional rye biomass was collected after termination from outside the plot boundaries and corn fodder was collected from fields at the research center. Biomass was separated into decomposition bags for each plot (30 rye and 30 corn fodder), weighed, and placed back into the planted plots in the center of a row. Three subsamples of each were be dried and saved to determine the initial carbon (C), N, and moisture content of the biomass. At the end of the season decomposition bags were collected from the plots, dried, weighed, and analyzed for C, N, and the biomass loss. Yields were collected with a plot combine in the late fall. Collected drone imagery was processed in Pix4D, loaded into ArcGIS, and extracted using a polygon plot map of each individual treatment.

Data were analyzed in SAS as a randomized complete block design structured by a factorial including biomass loss, changes in C and N, yield and drone NDVI using Proc Glimmix. Yield and other factors were also correlated using Proc Corr.

Results and Discussion

Plot Yields

Germination and growth across the plots were poor and inconsistent through the season, either due to excess rye biomass causing planting issues, or poor seed germination. All yields averaged below 50 bu acre^{-1}, with no significant differences observed by population or row spacing (Figure 1). The lowest absolute value was for the 60,000 seed acre^{-1} by 30 inch row spacing, with the 15 inch corollary averaging about 10 bushels higher. In a prior study of soybean planting timings in this field, yields averaged closer to 70 bushels acre^{-1}, so it is not a poorly producing field. All plots received irrigation throughout the season.

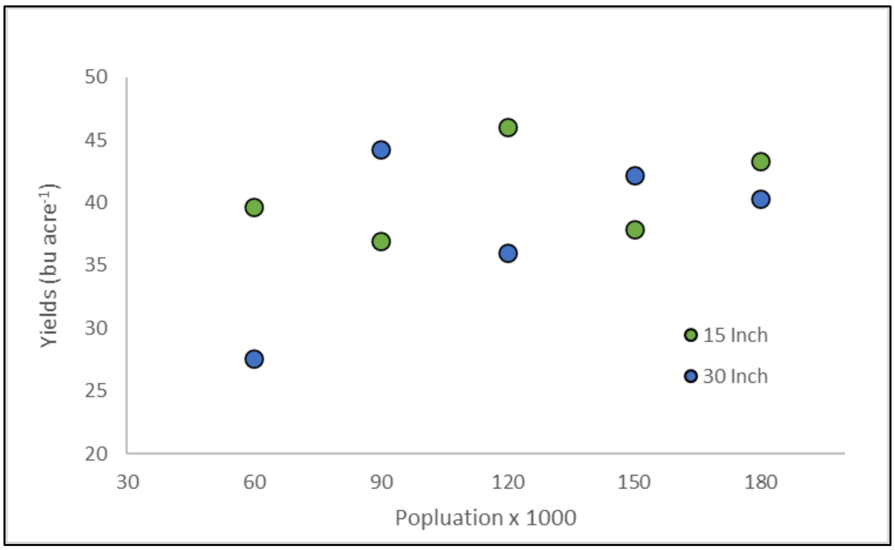


Figure 1: Yields across population and row spacing treatments from the litter bag study at the Carvel Research and Education Center in 2022.

Overall Biomass Loss (% Weight Loss) for Rye and Corn Biomass

Although both rye and corn lost about 20-25% of their overall biomass over the growing season, there were no significant differences in biomass loss based on population or row spacing combinations. Due to the difficulty in achieving good stands and canopy closure, this may be why both yields and decomposition of the rye and corn fodder had no differences by treatments. While not statistically significant, the decrease in rye biomass was pretty steady as planting population increased for 15 inch rows, but 30 inch rows bounced around in rye decomposition. Corn was also lowest in value for 15 inch rows at the 180,000 seeding rate.

The C/N of rye biomass at the end of the season was lower than the initial samples, but was not different by soybean management practices (Figure 3). For the C/N of corn fodder at the end of the season, there were significant differences, with the 15-inch 150,000 seeding rate having the highest C/N, but the 90 and 120 population (by 15 inch rows) having the lowest. For most of the corn fodder C/N under 15-inch rows, the

150,000 population having the highest value was out of step. The 30-inch row corn fodder C/N's rose until 150,000, when they dropped close to 40:1 (Figure 3). The 15 and 30-inch rows appear to take opposite directions on corn fodder C/N with rising populations until they become very similar in value at 180,000 seeds per acre. This would warrant additional studies to observe whether this could actually be repeated. It may also be related to the planting and germination issues noted earlier.

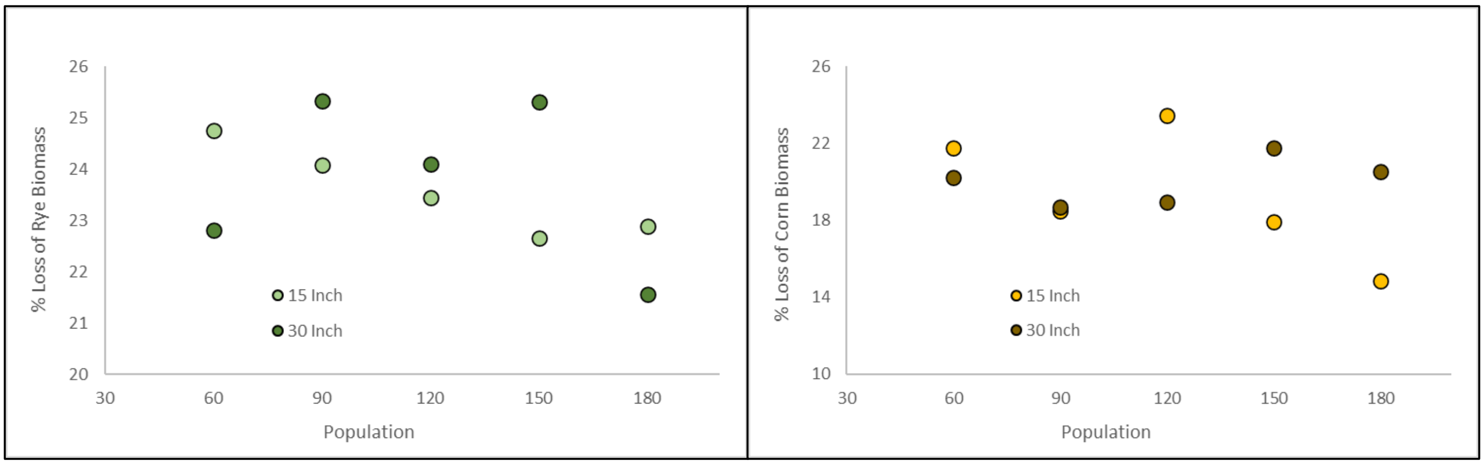


Figure 2: a) Loss in rye biomass (%) by population and row spacing and b) loss in corn biomass (%) by population and row spacing.

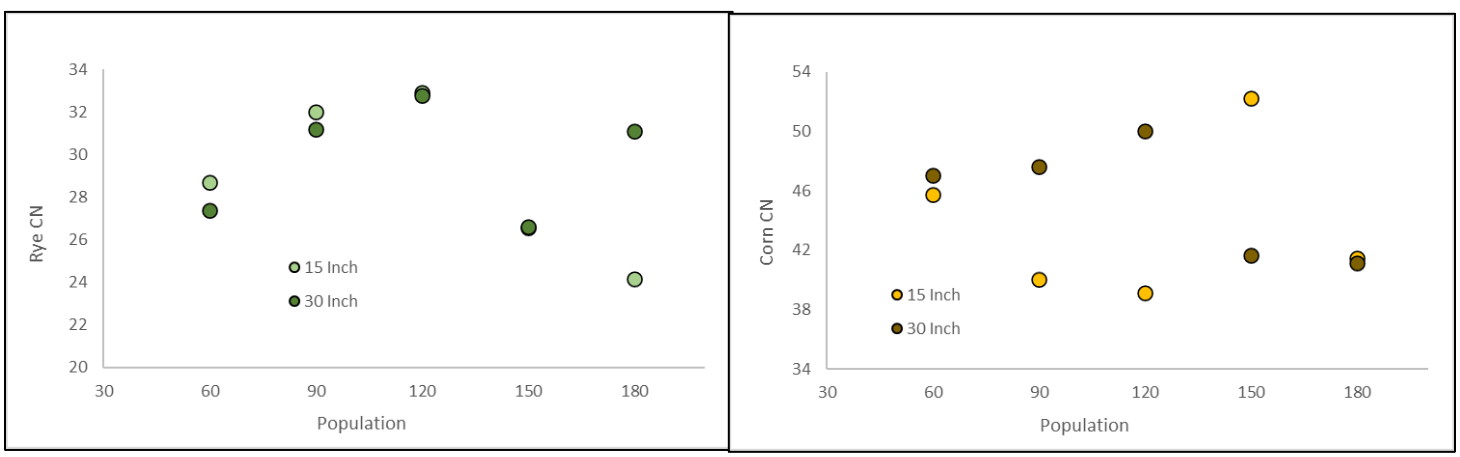


Figure 3: a) Rye CN by population and row spacing and b) and corn CN by population and row spacing.

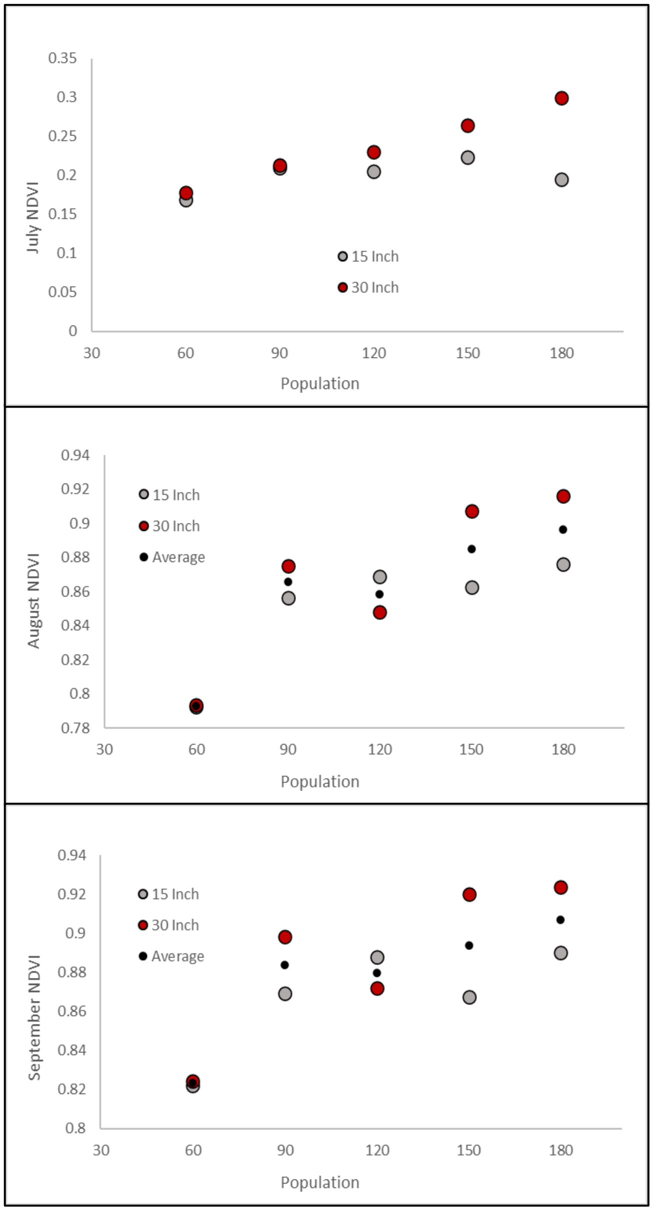


Figure 4: Drone measured NDVI for a) July 2022, b) August 2022, and c) September 2022.

Drone Measured NDVI Over the Growing Season

In July, drone measured NDVI had an interaction between population and row spacing, with a steady increase in NDVI with population in the 30-inch rows, but a decrease above 150k in the 15-inch rows. This may indicate that the issues here existed in the higher populations of the 15-inch plots. The lowest absolute value was in the 15-inch 60,000 seeding rate plots.

In August, there ceased being an interaction with row spacing, but populations averaged by both were significantly different in their NDVI. Populations between 90-180,000 seeds per acre were similar, while 60,000 had the lowest NDVI. This may explain why yields were not different, with most treatments having similar canopy cover at this stage.

The results were similar in September, with very little change.

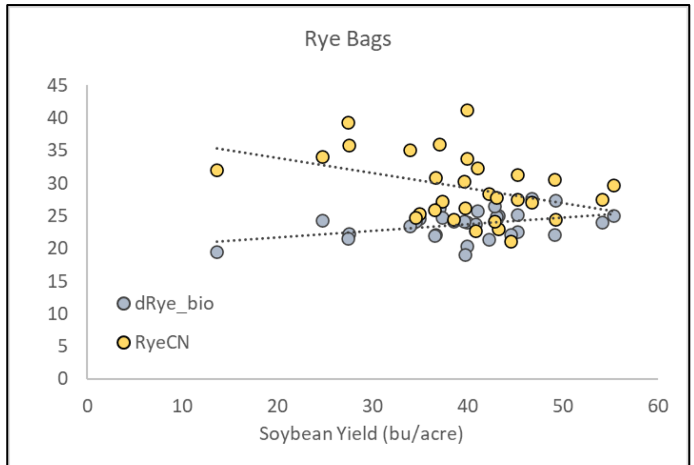
Relationships Between Biomass, NDVI and Yield

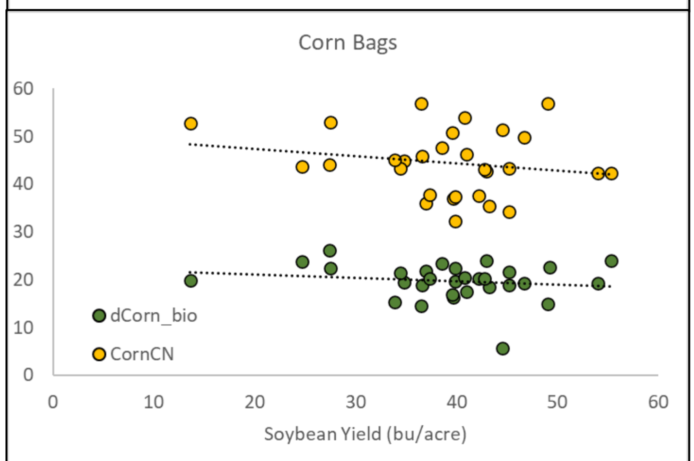
Yields had positive correlations with NDVI in August and September, meaning that more biomass indicated greater yields. However, NDVI did not have any relationship with any of the rye or corn biomass measurements, including biomass loss or final C/N ratio. The plot estimated biomass at planting did have negative correlations (weaker) with NDVI in July, August, and September. This may support that biomass impacted planting in some of the plots.

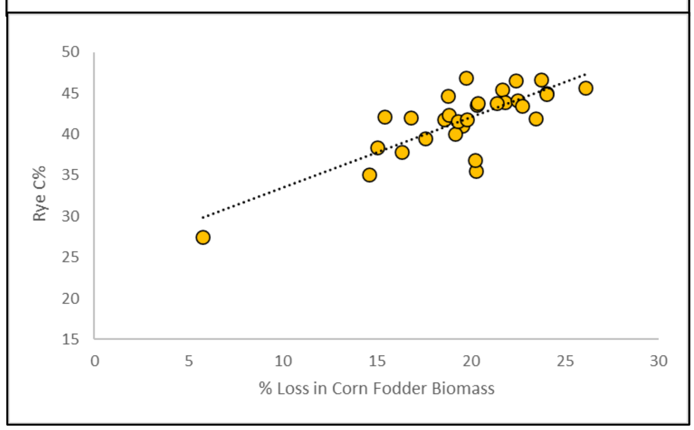
The loss in rye biomass and the rye C/N ratio both had relationships with soybean yield (Figure 5a), where higher yielding plots also had greater biomass loss and lower C/N ratios. With the combination of higher NDVI predicting yields, and yields associated with greater rye breakdown, there is an interesting relationship that could be uncovered. For some reason C/N ratios or rye biomass also ended lower in plots with higher yields, which could be due to canopy cover, but cannot be proven from the data in this study.

The same relationship did not occur with corn, where biomass loss and C/N ratio were not related to higher soybean yields. However, the loss in corn biomass was related to properties of rye biomass, where plots with higher remaining Rye C% also had greater breakdown in corn biomass. Whether this is a biological factor we can't account for in the soils, or an effect the rye cover crop has on corn biomass, it will need further controlled studies to determine.

Conclusions







Compared to the companion study on population and row spacing performed at Warrington in 2022, no differences in yield were observed. Some of this can be related to issues at planting, which included planter by rye biomass as well as potential seed germination. The NDVI values show that the errors mostly reside in the 15-inch 150,000 and 180,000 seeding treatments.

While yields and biomass decomposition could not be related to population and row spacing, and therefore canopy cover, some differences did arise related to overall soybean yields.

The 15-inch row spacing mostly caused decreases in corn C/N ratios by the end of the season, which may have been more consistent had the correct canopy cover occurred. That rye breakdown was greater in higher yielding plots, where yields were also related to higher NDVI (canopy cover) in August could still support the original hypothesis. Still, the study needs better controls on actual growth by treatments to observe if these are related.

Additionally, there is a relationship with corn fodder decomposition and the rye that is present. Where more C was remaining in the rye biomass, the corn fodder decomposition was higher. This study cannot show the mechanism that drove this result, which could be related to biological activity that preferred corn decomposition over rye, or could point to an interaction of fresh rye biomass with corn fodder. The bags are not conducive to larger detritovores which could have also helped with fodder breakdown. As rye decomposition leads to lower C/N ratios, and is related to higher soybean yields, corn fodder appears to prefer the opposite environment, at least during the period of this study. A repeat of this study in 2023 may help further elucidate the relationship.