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# Previous Crop Impacts on Wheat Variety Performance in Central Kansas During the 2021–2022 Growing Season

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## Summary

The effect of a previous crop and its residue left on the field before the next crop is a consequence of soil water usage and residue quality. We evaluated the grain yield of forty winter wheat varieties, as well as soil bulk density, soil water content, and previous crop's residue C:N ratio in three neighboring fields near Solomon, KS. Wherein these three fields, winter wheat was no-tilled following a previous crop of either 1) soybean; 2) cover crop mix (legume and cereal); or 3) winter wheat. The mix of cover crops consisted of pearl millet, sorghum sudan, and sunn hemp. Soil samples were taken in October during winter wheat sowing. Four replications of soil measurements for bulk density and water content were taken from the 0- to 16-in. depth at 8-in. intervals. Six replications of 10.8-ft$^2$ quadrats of residue biomass were sampled and evaluated for total nitrogen (N) and carbon (C). There were no significant differences in winter wheat grain yield among the varieties nor among the sites, although yield following soybeans was slightly lower than yield following wheat or cover crops (41 vs. 46 bu/a). Soil bulk density and residue C:N ratio were the lowest when following soybean (i.e., greater soil porosity and faster residue decay), although soil water content was also the lowest. Soil water content at sowing was the greatest when following winter wheat, likely as there were no actively growing summer crops to use precipitation water prior to wheat sowing. Soil water content increased at deeper layers (0–8 in. compared to 8–16 in.) when winter wheat was sown following a cover crop mix or a previous winter wheat crop, but it decreased when following soybean. Preliminary results from this on-farm experiment suggest that winter wheat variety performance was similar across previous crops despite measured differences in residue and soil characteristics. These results may help farmers to decide the benefits of each crop residue based on their cropping system needs.

## Introduction

A previous crop can impact the yield of the following crop (Munaro et al., 2020; Jaenisch et al., 2021; Simão et al., 2023). This impact may result from modification of soil characteristics—such as soil bulk density through different root systems, and soil water content by the soil water usage of the previous cash or cover crop—and length of the fallow period preceding wheat sowing (Lollato et al., 2016). Different wheat varieties are adapted to specific environmental conditions (Lollato et al., 2020, 2021). Researching the effects of previous crops to help producers choose wheat varieties improve the yield and reduce yield gaps in the U.S. Great Plains (Lollato et al., 2017, 2019; Jaenisch et al., 2019, 2022).

Decisions at the cropping systems level can impact a number of environmental indicators that later may relate to crop performance. For example, soil bulk density is a crucial factor that impacts soil health and productivity. It refers to the weight of soil per unit volume and is often used as an indicator of soil compaction (NRCS, 2012). When soil is compacted (i.e., greater bulk density), it becomes denser and less porous, which makes it difficult for water and air to penetrate the soil. As a result, plant roots are unable to access the nutrients they need to grow, and the soil becomes less productive. The availability of water in the soil is essential for plant growth, as it is required for the uptake of nutrients and the maintenance of turgor pressure in plant cells (Troch et al., 2009). Thus, soil water content is an important measurement to consider when sowing the next crop. Likewise, the crop residue's C:N ratio is a measure of the relative amounts of carbon and nitrogen in plant material left on the soil surface after a crop is harvested. This ratio is important because it impacts the rate at which plant residues decompose and release nutrients back into the soil. If the C:N ratio is too high (i.e., greater than approximately 25:1), the decomposition process can be slow, and the nitrogen in the residues may not be readily available for plant uptake. In fact, nitrogen can be immobilized if the C:N ratio is too high because bacteria that decompose plant residue also consume nitrogen. If this nitrogen is not available from the residue due to low nitrogen content, the bacteria will use nitrogen from the soil surroundings (Robertson and Groffman, 2007). If the C:N ratio is too low, the carbon in the residues may be rapidly decomposed, which can result in a loss of soil organic matter (Stella et al., 2019). By managing the C:N ratio of crop residues, farmers can improve nutrient cycling, reduce fertilizer costs, and maintain soil health. Our objective was to quantify the grain yield of 40 winter wheat varieties and characterize previous crop residue quality (C:N ratio), soil bulk density, and soil water content after soybean, a cover crops mix, and winter wheat.

## Procedures

On-farm data collection was done in October of 2021 at winter wheat sowing at three different neighboring fields near Solomon, KS. Each field had a different previous crop, including: 1) soybean; 2) cover crop mix; or 3) winter wheat. In each site, forty winter wheat varieties were sown in four replications at a 105 lb/a seeding rate, using 6- × 30-ft plots with rows spaced 7.5 in. apart. Winter wheat was sown on October 19 when following a previous wheat crop or cover crops, and on October 21 when following soybeans. The site with previous crops of wheat and cover crops had Irwin silty clay loam soil. The site with a previous crop of soybeans had Solomon silty clay soil. The previous wheat and soybean crops consisted of commercially available varieties, while the cover crop mix consisted of 9 lb/a of pearl millet, 4 lb/a of sorghum sudan, and 2 lb/a of sunn hemp, chemically terminated a few days prior to wheat planting. All trials received 50 pounds of DAP (18-46-0) per acre in furrow at planting, and fertilizer management was done by the cooperator. Grain yield and moisture content were measured at physiological maturity by harvesting the entire plot area using a self-propelled small plot combine (Massey Ferguson XP8).

Each soil measurement had four replications in each site. Soil bulk density was measured using the cylindrical core method, and soil water content was measured as gravimetric water content (mass of water per mass of dry soil). Six random and representative 10.8 $ft^2$ areas were selected in each site for aboveground residue biomass collection. Biomass was weighed, ground, and sent to the Kansas State University Soil Fertility Laboratory for a dry combustion with a Perkin-Elmer CHNS/O Analyser 2400 for nitrogen and carbon quantification. Two-way analysis of variance (ANOVA) at the alpha = 0.05 significance level for grain yield response was performed with winter wheat variety, site, and their interaction as the fixed effects and replication within site as random effect.

# Results

## *Yield*

Winter wheat grain yield ranged from 39–51 bu/a across all sites (Figure 1A). There was no significant effect of winter wheat variety, site, or their interaction on grain yield. Winter wheat varieties showed similar grain yield, regardless of the site (i.e., previous crop). Winter wheat grain yield average across varieties was greater following the cover crop mix and winter wheat (approximately 45–46 bu/a) than when following soybean (41 bu/a).

## *Soil*

Figure 2 shows soil bulk density and soil water content for each site. Soil bulk density was lower after soybean (average 1.31 g $cm^{-3}$) than after the cover crop mix (average 1.41 g $cm^{-3}$) and winter wheat (average 1.52 g $cm^{-3}$) at both depths (0–8 and 8–16 in.), with the greatest value for winter wheat in both depths. Soil water content was greater after winter wheat (average of 25.7%) than after the cover crop mix (average 18.2%) and soybean (average 12.8%) at both depths, with the lowest value for soybean at both depths.

## *Residue*

Figure 3 depicts residue characteristics for each site. Soybean had the greatest aboveground biomass production (8407 lb/a), followed by cover crop mix (7110 lb/a) and winter wheat (2775 lb/a). It is important to highlight that winter wheat residue data was collected after 3 months of winter wheat harvest, whereas soybean biomass was collected as soon as soybean was harvested, and cover crop mix biomass was collected a few days after cover crop termination. The different time intervals between crop harvest and leftover residue sampling at wheat planting could explain some of these differences. The C:N ratio was lowest for soybean (27:1) followed by cover crop mix (50:1) and winter wheat (60:1), suggesting that while soybeans had the highest residue, it would also likely decompose faster. Soybean also left higher amount of nitrogen in the residue compared to cover crop mix and winter wheat, likely due to greater amount of biomass present and nitrogen concentration in the residue.

## *Preliminary Conclusions*

Overall, winter wheat varieties showed similar grain yield response to location and, in this case, a confounded effect of previous crop. Ideally, future work would test winter wheat varieties in a research trial explicitly designed to test the effects of a previous crop on wheat variety performance, thus overcoming the confounding effects of location on the results. Previous soybean crop resulted in lower soil bulk density (though this may be a function of the soil type at the experimental location) and lower residue

C:N ratio than cover crop mix; however, it depleted more soil water. Average grain yield was lower after soybean than after cover crop mix and winter wheat; therefore, soil water content at sowing may have limited the subsequent winter wheat grain yield after soybean. Winter wheat as previous crop resulted in the greatest soil water content at sowing, likely due to the 3-month fallow period preceding wheat sowing. Thus, for the circumstances of this study, a previous crop of soybean was a better option than the evaluated cover crop mix when considering residual nitrogen in the field and soil bulk density. When water availability was the most limiting issue, a previous winter wheat crop followed by a short summer fallow provided greater soil moisture at sowing to the following crop.

## Acknowledgments

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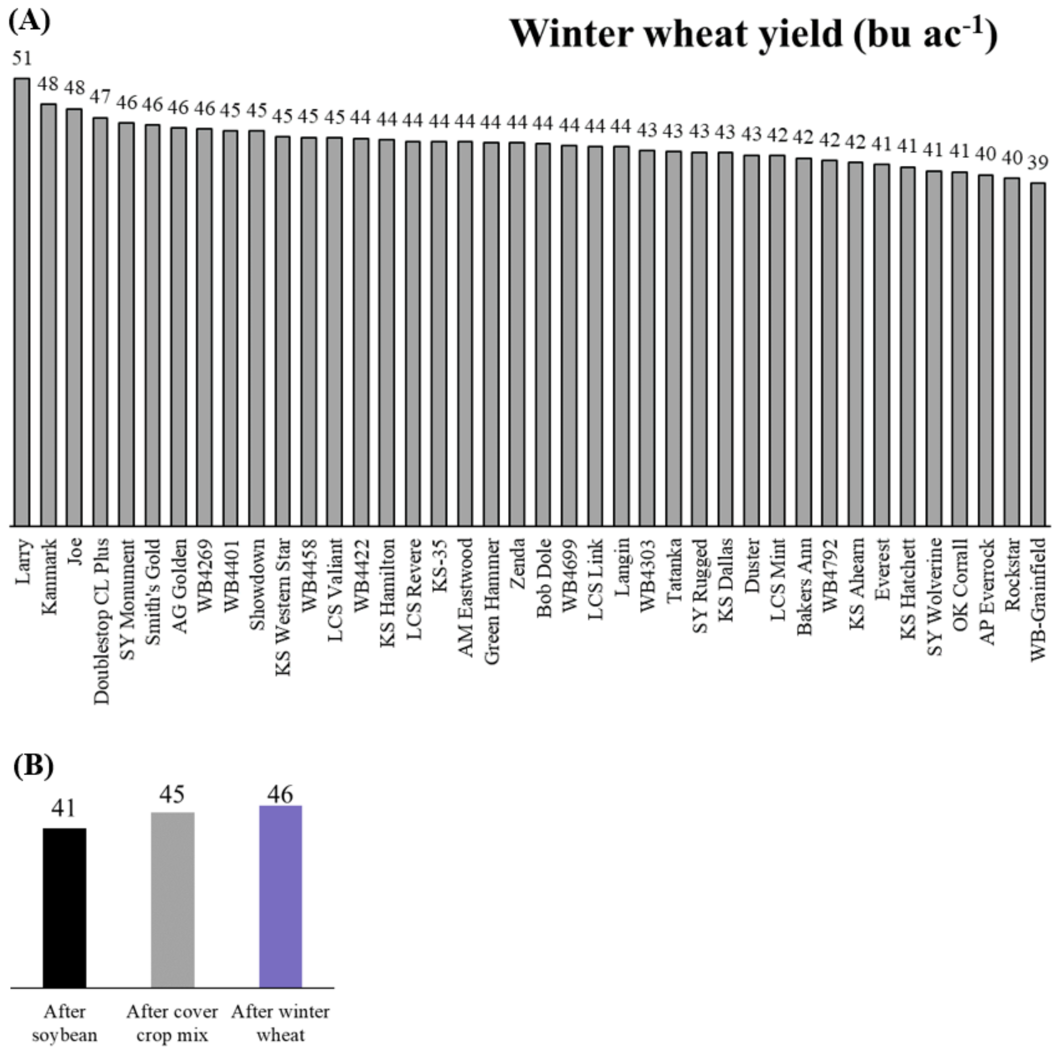


**Figure 1. Winter wheat grain yield by variety (A) and by site (B) (i.e., after soybean, cover crop mix (legume + cereal), or winter wheat) in an on-farm experiment near Solomon, KS.**

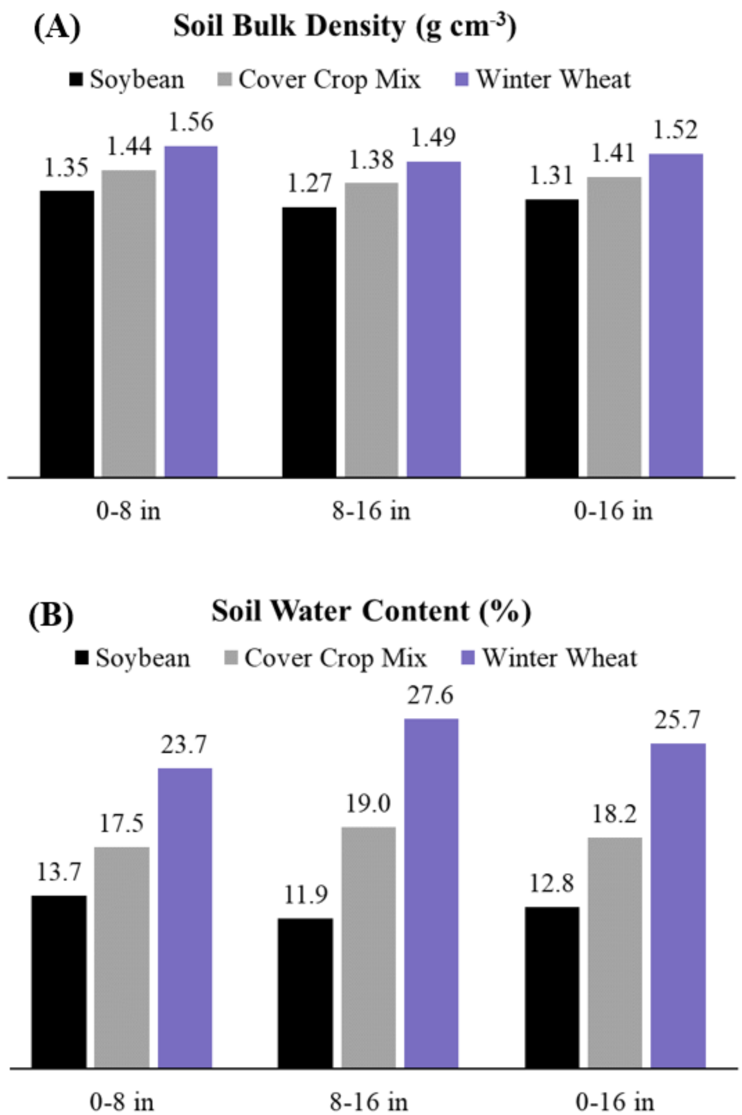


**Figure 2. Soil bulk density (A) and soil water content (B) at two depths (0–8 in. and 8–16 in.) and average between depths (0–16 in.) after soybean, cover crop mix (legume + cereal), and winter wheat in an on-farm experiment near Solomon, KS.**

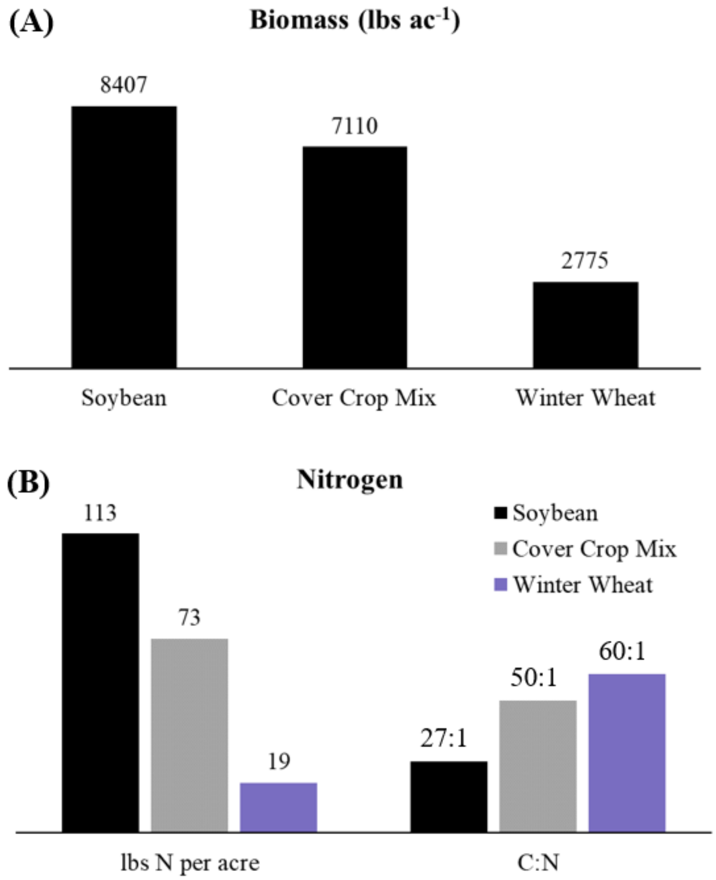


**Figure 3. Aboveground biomass (A); total nitrogen (B, left); and C:N ratio (B, right) of soybean, cover crop mix (legume + cereal), and winter wheat residue in an on-farm experiment near Solomon, KS.**