COMPARISON OF WHEAT AND BARLEY TO RYE AS A COVER CROP FOR MAIZE

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ABSTRACT

Winter cereal cover crops have become an essential management practice for sustainable corn production. Rye (*Secale cereale* L.) is the most popular winter cereal cover crop, but wheat (*Triticum aestivum* L.) and barley (*Hordeum vulgare* L.) may provide a comparable value due to their similar fibrous root systems. Winter cereals provide organic matter, scavenge residual nutrients, and protect the soil from erosion. Winter cereals can immobilize nutrients for the corn crop and can reduce corn stands in some situations, reducing corn yield. This study's main objective was to determine if wheat and barley cover crops have fewer corn yield penalties than rye. Three site-years included Lexington, KY, 2022, Lexington 2023, and Glendale, KY, 2023. The study consisted of four cover crop treatments, five nitrogen rates, and two nitrogen timings. The cover crop treatments were 'Somerset' barley, 'Pembroke' wheat, 'Aventino' rye, and a no cover crop control. Five nitrogen rates were 40, 110, 210, 310, and 410 lb N/acre. Liquid UAN (32-0-0) was surface applied at 40 lb N/acre to all plots at planting; the remaining nitrogen was applied at planting or side dress (V3 growth stage) as Urea (46-0-0). Cover crop biomass accumulation in 2022 was a fraction of the 2023 biomass resulting from a longer growing period. Wheat produced significantly more biomass than rye in Lexington 2023 and the most average biomass in all site-years. Barley produced the least biomass of the winter cereals. There were no significant N or P interactions from the 2022 VT ear leaf tissue sample analysis. There was no significant effect from cover crops on yield in 2022. Sidedress N at 310 lb N/acre yielded significantly higher than 210 lb N/acre applied all at-planting but there were no effects of fertilization timing at the same N rate. 2023 yield data will be presented at conference.

INTRODUCTION

Cereal rye is the most popular cover crop utilized by farmers before corn in the United States. A 2022-2023 SARE survey of 575 cover crop growers found that of those growers 134,000 acres of cereal rye cover crops were planted with the next closest cover being radishes with around 43,000 acres (SARE, 2023). There are numerous benefits associated with a rye cover crop such as reduced nitrate runoff (Kaspar et al, 2012), weed suppression (Haramoto, 2019), and erosion control (Kaspar et al, 2001) in both the fall and spring since rye will not winterkill. The erosion benefits of a winter cereal are especially important since 75% of all farmlands in Kentucky have significant erosion potential (Wells, 1982). Rye unfortunately has some potential drawbacks that could affect the subsequent corn crop. A prior study in Kentucky found that a late terminated rye cover crop could reduce plant stand by as much as 35% and decrease yield by up to 24% (Quinn, 2021). The risk of a yield penalty associated with winter cereals can be diminished with an earlier cover crop termination, but the risk is still present (Otte et al., 2019). Wheat and barley are other winter cereals with similar fibrous roots systems as rye. Wheat already performs well in Kentucky when cultivated for grain and barley is a new addition to current rotations. The potential drawback persists beyond rye since winter cereals such as wheat have the potential to decrease corn yields (Kaspar & Bakker, 2015). Splitting nitrogen fertilizer applications to later in vegetative corn growth stages could potentially alleviate potential yield penalties from winter cereals. Sidedress nitrogen can improve corn yields regardless of cover crop (Quinn, 2020). The objective of this study was to compare wheat and barley to rye as cover crops to see if they provide comparable benefits for the subsequent corn crop.

METHODS AND MATERIALS

Study Site and Dates

This experiment was conducted at the University of Kentucky North Farm in Lexington and an on-farm site in Glendale, Kentucky for a total of Three-site years including: Lexington 2022, Lexington 2023, and Glendale 2023. The soil textures for Lexington 2022/2023 were predominately a Lowell-Bluegrass Slit Loam, Glendale 2023 was mainly a Pembroke Silt Loam. Soil cores were collected at a 6-in depth at cover crop termination and after harvest to quantify soil nutrient contents. Soil samples were analyzed at the University of Kentucky Regulatory Services using Mehlich 3 extractant. Table 1 details important planting and termination dates from the study. Wet field conditions in the fall of 2022 delayed cover crop planting until December and a wet spring delayed Glendale corn planting until May 31st. Lexington 2023 corn was initially planted May 11th but pest pressure in the cover crop residues severely decreased plant stands requiring replanting. Replant occurred on June the 1, 2023 6 weeks post cover crop termination.

Table 1: Cover Crop/Corn Planting & Cover Crop Termination

Site-Year	Cover Crop Planting	Cover Crop Termination	Corn Planting
Lexington 2022	12/4/2021	4/27/2022	5/11/2022
Lexington 2022	10/24/2022	4/20/2023	6/1/2023*
Glendale 2023	10/20/2022	4/19/2023	5/31/2023

*****Corn was replanted because pests destroyed the first planting. The replanting occurred 6 weeks after termination.

Experimental Design

The Lexington research design was a split-plot, randomized complete block with 3 replications. There were 4 cover crop treatments planted in the fall following a soybean crop, which is a regular rotation in Kentucky. The cover crop treatments include ‘Somerset’ barley, ‘Pembroke’ wheat, ‘Aventino’ rye, and a no cover crop control. In the spring, two weeks before targeted corn planting, cover crops were terminated with 40 oz/ac of glyphosate (Round-up Brand). Cover crop biomass at each site was collected within a day of the termination timing. Once the corn was planted, the study implemented two fertilization timings with five nitrogen treatments. All plots received 40 pounds of urea ammonium nitrate (32-0-0) per acre at planting. Both nitrogen timings used the same 40 lb/acre control. The five nitrogen rates of 0, 70, 170, 270, and 370 lb/acre were applied at planting or sidedress at the V3 growth stage with urea (46-0-0) surface broadcast by hand. Total N applied was 40, 110, 210, 310, and 410 lb N/acre. Glendale 2023 was arranged as a factorial design with all the same treatments but with the addition of 2 sulfur treatments and was replicated 3 times. The 2 sulfur treatments were 30 lb S/acre applied as gypsum (0-0-0-16) and a no-sulfur control applied to each nitrogen rate/timing. In Lexington, in both site years, drip irrigation was installed at the V6 growth stage to limit drought stress. At the V10 and VT growth stages, 5 SPAD readings per plot were collected to assess chlorophyll content. The highest developed leaf was used at V10, and the ear leaf at VT. Also, at VT 5 ear leaves per plot were collected for nutrient analysis. Pest presence was evaluated weekly throughout the corn growing season, and pesticides were applied as needed to eliminate any effect on corn. Lexington 2022 corn was harvested with a Wintersteiger Delta combine with a 2-row Geringhoff corn head and Juniper Weighing Systems HarvestMaster weigh bucket on October 3, 2022. Data were analyzed with an ANOVA linear mixed effect model lme4 in R. Cover crop, Nitrogen Timing, Nitrogen Rate, and Sulfur Rate were the fixed effects, and replication was the random effect. Locations were analyzed separately to account for environmental and irrigation differences.

RESULTS AND DISCUSSION

Cover Crop Biomass

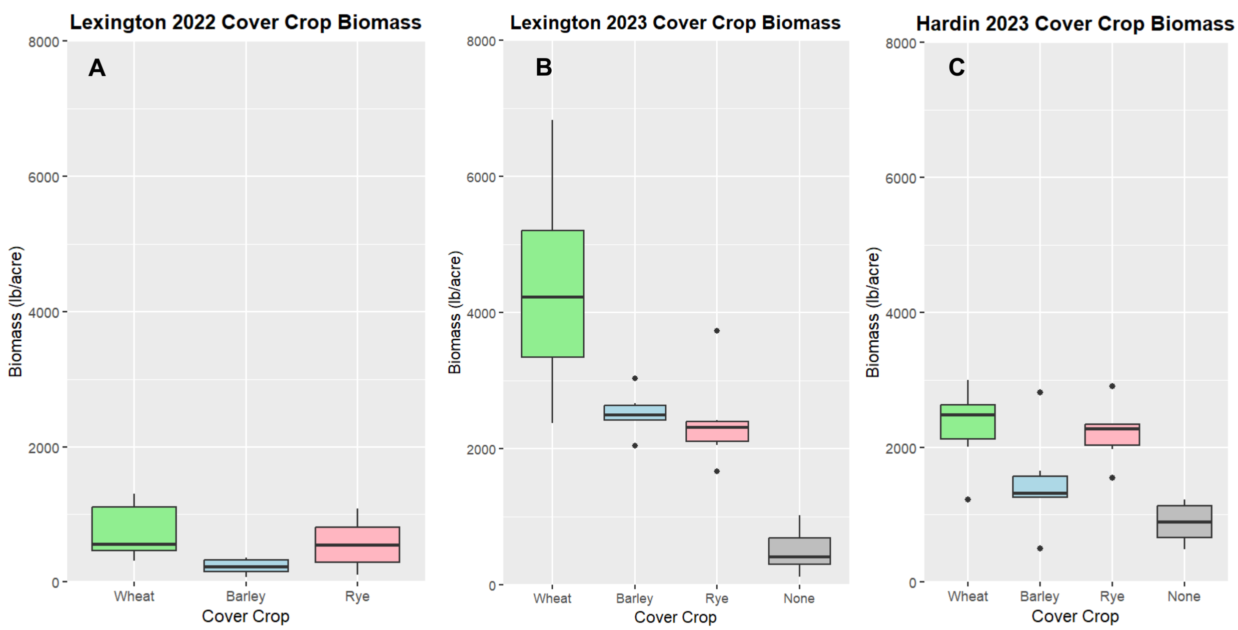


Figure 1: Average Cover Crop Biomass In Pounds Per Acre In Each Site-Year

There were significant cover crop biomass effects in every site-year. Lexington 2022 (A) had very little biomass accumulation compared to other site-years (B, C) due to a delayed cover crop planting. Even with low biomass production, wheat produced significantly more biomass than barley but not more than rye. Lexington 2023 had a more "normal" growing season, with biomass growth and ground cover in fall and spring—wheat produced significantly more biomass than all other cover crop treatments. Barley and rye produced the same biomass level but still significantly more than the no-cover crop control. Glendale 2023 had similar planting/termination dates as Lexington 2023 but produced different rates of biomass. Wheat and rye produced more biomass than barley and fallow. Barley and fallow biomass were not significantly different from each other.

VT Tissue Sample (Lexington 2022)

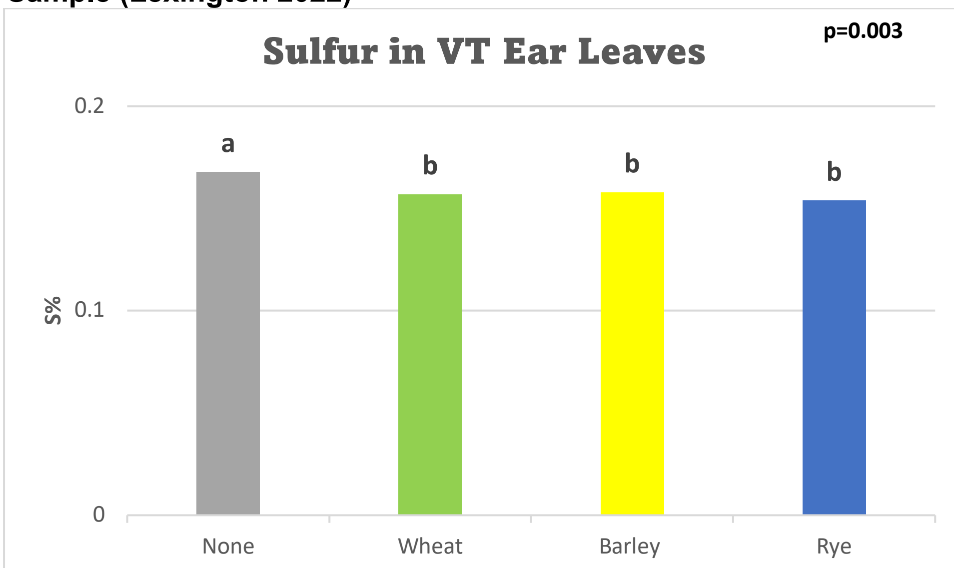


Figure 2: Cover Crop Effect on Sulfur Content in Ear Leaves at the VT Corn Growth Stage. Different letters are significant different at P≤0.1

Wheat, barley, and rye cover crops resulted in roughly 9% less S on VT corn ear leaves than the no cover crop control. There was no cover crop effect on any other primary/secondary macronutrients analyzed.

Corn Yield (Lexington 2022)

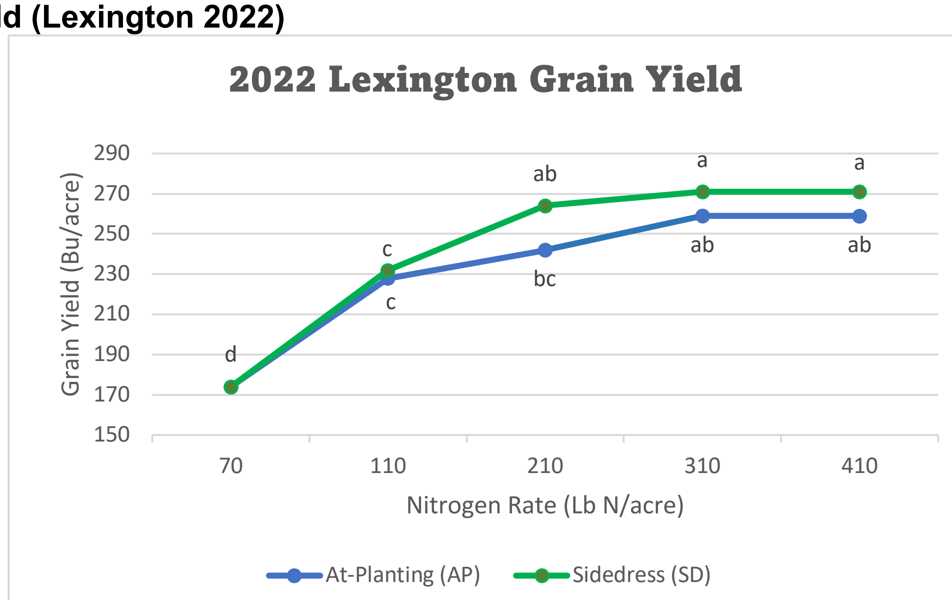
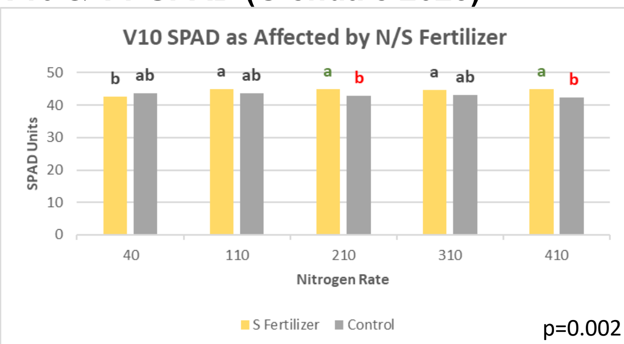
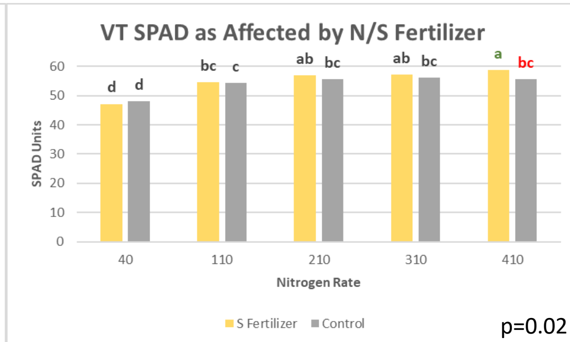


Figure 3: Line Graph of Corn Yields Averaged Across Cover Crops Response to Timing X Nitrogen Rate, Lexington, KY. Different letters are significant different at P≤0.1

The main significant interaction was Timing X Nitrogen Rate. There was no effect from cover crop on yield and all cover crop treatments only varied by 5 bu/acre. Corn treated with 40 and 110 lb N/acre yielded significantly less than corn at the higher nitrogen rates (Figure 3). Sidedress N rates trended higher yields than the At-Planting timings but were not significantly different at the same N rate. Sidedress N at 310 lb N/acre (40 At-planting + 270 at Sidedress) yielded significantly higher than 210 lb N/acre applied all at-planting

V10 & VT SPAD (Glendale 2023)





Figures 5-6: Effect of Sulfur Fertilizer on SPAD Readings at the V10 and VT Corn Growth Stage Across Nitrogen Rates. Different letters are significant different at P≤0.1

A significant interaction was found in Glendale 2023 from the sulfur fertilizer treatments. Sulfur treatments with 210 and 410 total N applied at V10 had significantly higher SPAD readings than the no-sulfur control. The 110 and 310 total N with a sulfur treatment had higher average SPAD readings by approximately 2 SPAD units but this difference was not significant. At the VT growth stage only the highest N rate+sulfur had a significantly higher SPAD than the control. Future analysis of VT ear leaf tissue samples will further investigate these differences.

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