

# Cover Crop Management Effects on Soil Water Content and Winter Wheat Yield in Dryland Systems

*A.K. Obour, J.D. Holman, and J.R. Jaeger*

## Summary

Integrating cover crop (CCs) into dryland crop production in the semiarid central Great Plains (CGP) can provide several ecosystem benefits. However, CC adoption is slow and not widely popular in the CGP because CCs utilize water that otherwise would be available for the subsequent cash crop. Grazing or haying CCs can provide economic benefits to offset revenue loss associated with decreased crop yields when CCs are grown ahead of a cash crop. Objectives of the current research were to 1) determine forage production of CC mixtures, and 2) evaluate the impacts of removing CC for forage on soil water content, subsequent crop yields, and soil health. Cover crop treatments evaluated were single, two-, three-, and six-species mixtures of oat, triticale, peas, radish, turnips, and buckwheat compared to chem-fallow. The study was conducted in a wheat-sorghum-fallow rotation system with all crop phases present in each block and year of the study. Results showed that decreasing the proportion of grass species in a CC mixture tended to reduce the amount of forage dry matter (DM) produced. Across the 3 years, forage DM production ranged from 3000 lb/a for the 2-way oat/triticale mixture to 2200 lb/a for the 6-species mixture. However, forage crude protein concentration and digestibility were greatest when peas were included in the mixture. Growing a CC in place of chem-fallow reduced soil water content at winter wheat planting in 2 of the 3 study years. Averaged across years, growing CC ahead of wheat reduced winter wheat yields compared chem-fallow, ranging from 3 bu/a less with spring peas to 13 bu/a when oat CC was hayed. Over the 3-year study, wheat yields with haying or grazing a CC were similar to yields when CC was left as cover. Cover crop treatments had no effect on grain sorghum yields.

## Introduction

Cropping system diversification with CCs can provide several benefits. These include improving soil quality, nutrient cycling, weed and pest suppression, and reduced wind erosion. Cover crop adoption is not widely popular in water-limited environments because CCs utilize water that otherwise would be available to the subsequent cash crop. Grazing or haying CC as forage can provide economic benefits and help offset loss in revenue associated with decreases in wheat yields when cover crops are grown in place of fallow. This approach could provide an opportunity for dryland producers to build soil health and produce harvestable forage for the region's livestock.

The few growers that have adopted CC in dryland systems are using them not only for soil health improvement but as a supplemental forage resource. Information is limited on best management options for CCs in dryland systems and producers are asking questions on best CC mixtures and planting windows for integrating CCs into cropping systems in dryland environments. Developing climate-specific CC management options for dryland farmers will improve adoption and CC use in the CGP. Our research effort includes investigating a flex-cover cropping option where CCs are grown only in years when there is adequate soil moisture. Flex-fallow is the concept of only planting CC when soil moisture levels are adequate and the precipitation outlook is favorable. Under drought conditions, implementing flex-fallow should help minimize negative impacts in dry years. Research objectives were to 1) determine forage production of CC crop mixtures, and 2) evaluate the impacts of removing cover crops for forage on soil water content, subsequent crop yields, and soil health.

## Procedures

Field experiments were initiated in spring 2015 at the Kansas State University experiment fields at HB Ranch near Brownell, KS, to address the above objectives. Field experiments compared summer-fallow to grazing or haying CC, and growing CC solely for cover in the fallow phase of a wheat-sorghum-fallow crop rotation system. Study design was a split-plot with four replications in randomized complete blocks. Main plots were three crop phases of a wheat-sorghum-fallow, and sub-plots were ten CC treatments of single, two-, three-, and six-species mixtures of oat, triticale, peas, radish, turnips, and buckwheat compared to chemical-fallow. The CCs were planted in the spring of the fallow phase of the rotation. Each phase of the crop rotation was present within each block in each year of the study. In addition, a flex-cover crop treatment was included and planted to CC only when soil moisture levels are adequate and the precipitation outlook is favorable. This treatment was left fallow when available soil water content at CC planting is < 12 in., and summer and fall precipitation outlook is not favorable. The CC treatments were either grazed, hayed, or left as cover. Grazing and haying of CCs was done at heading, and CCs were all terminated by the second week in June with glyphosate and 2,4-D in 2015. Paraquat and Aim EC were used to terminate CCs in 2016 and 2017.

Cover crops were harvested at heading to determine forage DM production and nutritive value. Forage harvests were performed the last week in May 2016 and first week in June 2016 and 2017. During each harvest, a 3-ft × 30-ft forage strip was harvested from each plot using a Carter plot forage harvester (Carter Manufacturing Company, Inc.) to a 6-inch stubble height. Fresh weights of samples were recorded, sub-samples were weighed, and oven dried at 50°C for at least 48 hours in a forced-air oven for DM determination. Oven-dried samples were ground to pass through a 1-mm mesh screen in a Wiley Mill (Thomas Scientific, Swedesboro, NJ). The ground samples were then analyzed for forage nutritive value [crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), *in vitro* dry matter digestibility (IVDMD)], and tissue nutrient concentrations (Ward Laboratories, Inc., Kearney, NE) using Foss 6500 near infrared spectroscopy (NIRS).

Soil water content at winter wheat planting was measured at 3 ft in 2015, and at 5 ft in 2016 and 2017. Two soil cores were collected from each plot and data averaged for

a single soil water content measurement. Winter wheat and sorghum grain yields were determined by harvesting a 5-ft × 100-ft area from the center of each plot using a small plot combine. Statistical analysis with the PROC MIXED procedure in SAS version 9.4 (SAS Inst., Cary, NC) was used to examine forage production, soil water content, and winter wheat and grain sorghum yields as a function of cover crop management options.

## Results

### *Forage Dry Matter and Nutritive Value*

Results over three growing seasons showed CC species or mixtures planted had good forage production potential. Forage DM produced varied over the three years because of variations in soil water availability and air temperature in the spring. Averaged across the 3 years, forage DM ranged from 2225 lb/a for the cocktail treatment to 3026 lb/a for oat/triticale mixture or spring triticale alone. This result suggests decreasing the proportion of grass species in the mixture tends to reduce the amount of forage biomass produced (Table 1).

Forage CP concentration and IVDMD were greater when peas were included in the mixture compared to mixtures with only grass species (Table 1). Similarly, ADF and NDF concentrations were lower for the three-way (oat/triticale/pea) and cocktail compared to oat or triticale alone, and oat/triticale mixture. The CP requirement for growing replacement heifers with body weight (BW) of 1200 lb at maturity ranged from 8.1% (with growing BW of 960 lb) to 10.2% (with growing BW of 660 lb) assuming the forage contains ≥ 60% total digestible nutrients (NRC, 2000). Therefore, average CP concentration of the CCs species and mixtures in this study were greater than the minimum CP requirement for growth or maintenance of grazing beef cattle.

### *Soil Water Content and Wheat Yield*

In 2016, except for the grain pea treatment, growing a CC had no effect on soil water content at winter wheat planting. Spring pea yields averaged 850 lb/a in 2015, resulting in significantly greater water use. Growing a CC in 2016 and 2017 resulted in a significant decrease in soil water content at winter wheat planting (Figures 2a and 3a). Poor pea stands and less grain pea production in 2016 resulted in less water use compared to other CC treatments.

Winter wheat yields after CC corresponded well with soil water content at winter wheat planting. Wheat yields after CCs were not affected in 2016 except when peas were grown for grain (Figure 1b). However, a significant decrease in winter wheat yields was observed in 2017 when CCs were grown ahead of wheat (Figure 2b). The lesser water use by peas in 2016 resulted in less impact on subsequent wheat yields. Winter wheat yields with triticale alone or a pea CC (forage peas were grown in 2017 instead of grain peas because the wrong pea seed was supplied) were similar to the fallow treatment in 2018. Yields from the remaining CC treatments were less than that of fallow. Averaged across the 3 years, growing a CC ahead of wheat reduced winter wheat yields compared to chem-fallow. Wheat yields ranged from 36.6 bu/a when oat CC was hayed to 49.4 bu/a with fallow (Figure 4). Over the 3-year study, haying or grazing a CC had no significant effect on wheat yields compared to yields when CC was left as cover (Figures 1b, 2b, and 3b). Similarly, soil moisture at winter wheat planting was

not different among CC treatments or management options (Figure 4a). This finding suggests CC could be utilized for forage with similar impact on subsequent crop yields compared to when grown as a true CC. Though not shown in this report, CC management had no effect on sorghum grain yield in this study.

## Reference

National Research Council. 2000. *Nutrient Requirements of Beef Cattle: Seventh Revised Edition: Update 2000*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/9791>.

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**Table 1. Forage yield and nutritive content<sup>1</sup> at heading, before grain fill of various cover crops and mixtures averaged over 3 years at the Kansas State University experiment fields at HB Ranch near Brownell, KS**

| Treatment                         | Yield               | CP            | ADF     | NDF     | IVDMD   |
|-----------------------------------|---------------------|---------------|---------|---------|---------|
|                                   | lb/a                | ----- % ----- |         |         |         |
| Oat-triticale (flex) <sup>2</sup> | 3014 a <sup>4</sup> | 11.6 c        | 37.1 b  | 62.9 bc | 72.7 ab |
| Oat-triticale                     | 3026 a              | 11.6 c        | 38.3 ab | 64.8 ab | 71.2 bc |
| Oat                               | 2383 ab             | 11.9 bc       | 37.1 b  | 62.1 c  | 73.8 a  |
| Triticale                         | 2981 a              | 12.1 bc       | 38.8 a  | 65.3 a  | 69.7 c  |
| Oat-triticale-pea                 | 2440 ab             | 14.4 a        | 37.1 b  | 61.5 c  | 73.6 a  |
| Cocktail <sup>3</sup>             | 2225 b              | 13.0 ab       | 37.2 b  | 61.8 c  | 73.8 a  |

<sup>1</sup>CP = crude protein. ADF = acid detergent fiber (higher values reflect lower digestibility). NDF = neutral detergent fiber (higher values reflect lower animal intake). IVDMD = *in vitro* dry matter digestibility (reflects relative energy differences).

<sup>2</sup>Only planted when there was adequate moisture.

<sup>3</sup>Species were spring oat, triticale, forage pea, buckwheat, turnip, and radish.

<sup>4</sup>Values within a column followed by the same letter (s) are not significantly different ( $P < 0.05$ ).

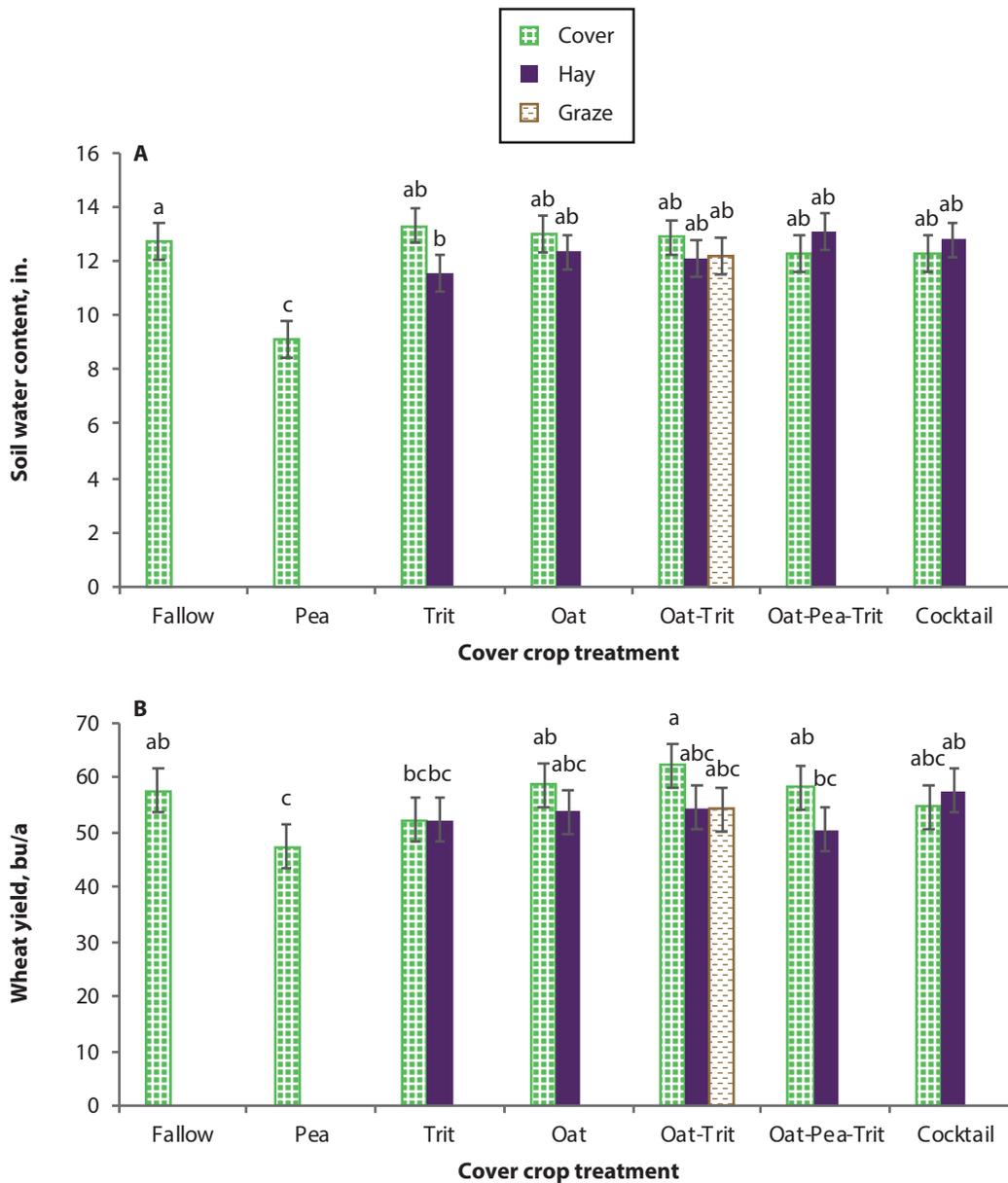


Figure 1. Cover crop management effect on soil water content (a) measured in fall 2015 and subsequent winter wheat yield (b) in 2016 at the Kansas State University experiment fields at HB Ranch near Brownell, KS.

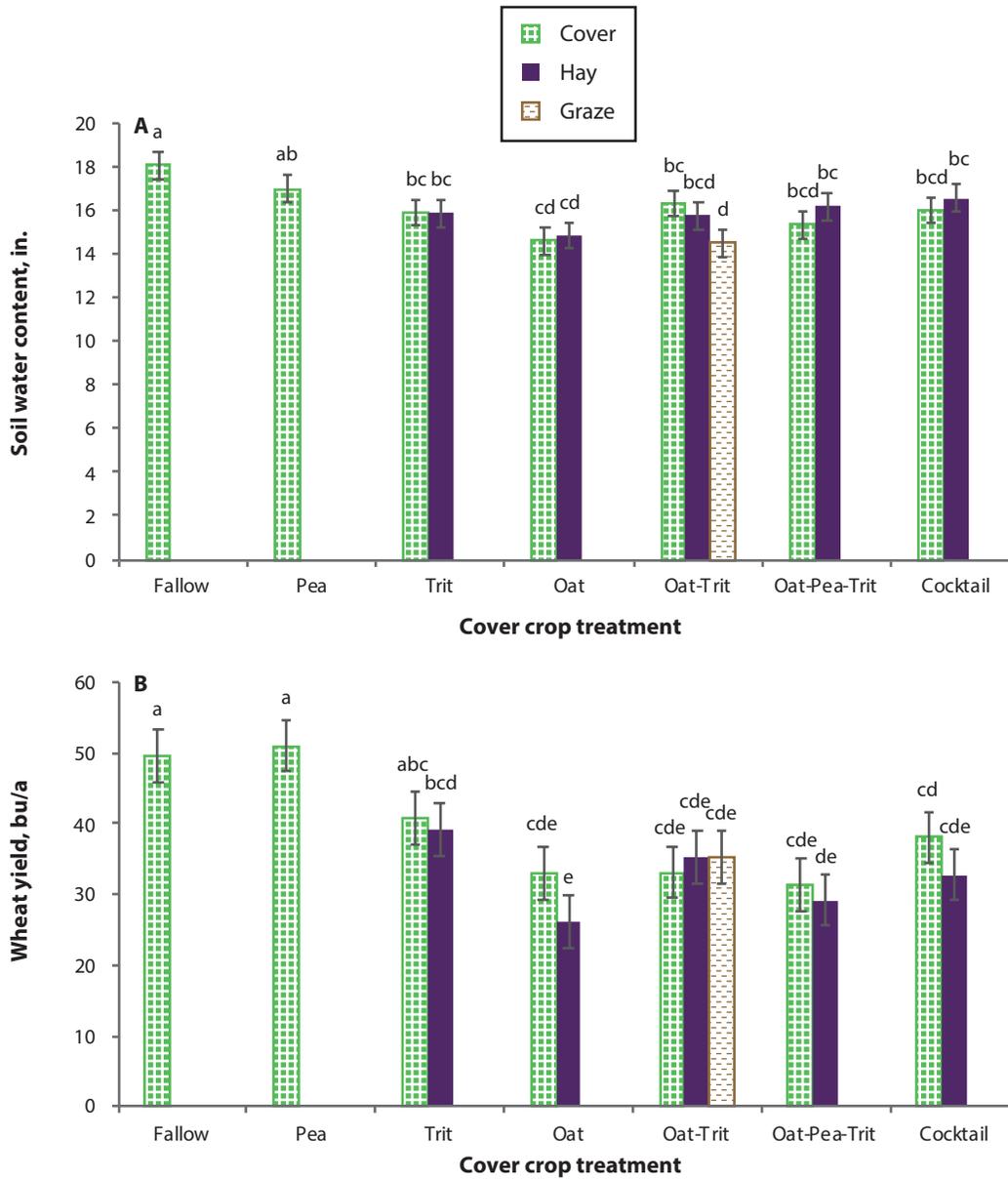


Figure 2. Cover crop management effect on soil water content (a) measured in fall 2016 and subsequent winter wheat yield (b) in 2017 at the Kansas State University experiment fields at HB Ranch near Brownell, KS.

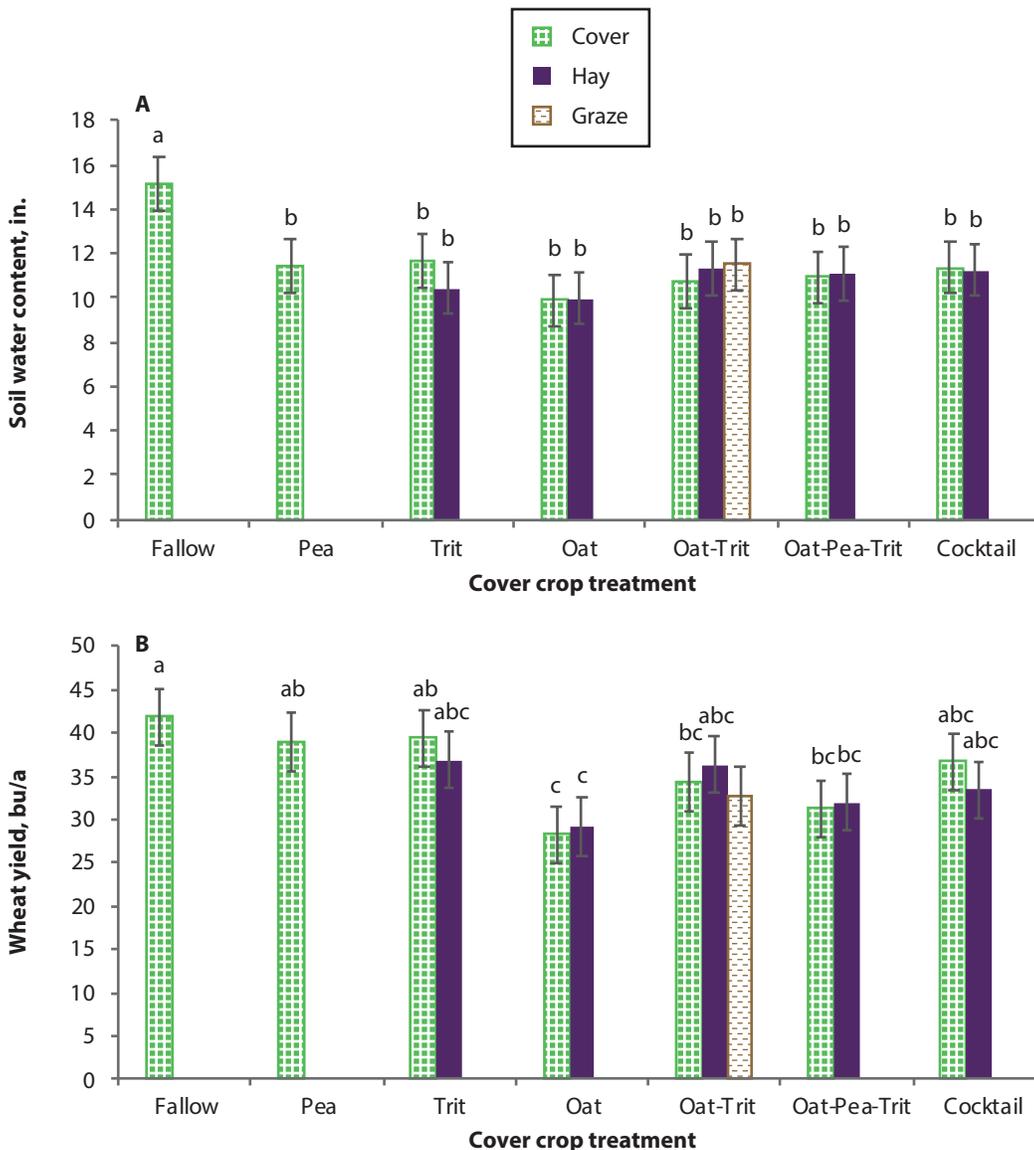


Figure 3. Cover crop management effect on soil water content (a) measured in fall 2017 and subsequent winter wheat yield (b) in 2018 at the Kansas State University experiment fields at HB Ranch near Brownell, KS.

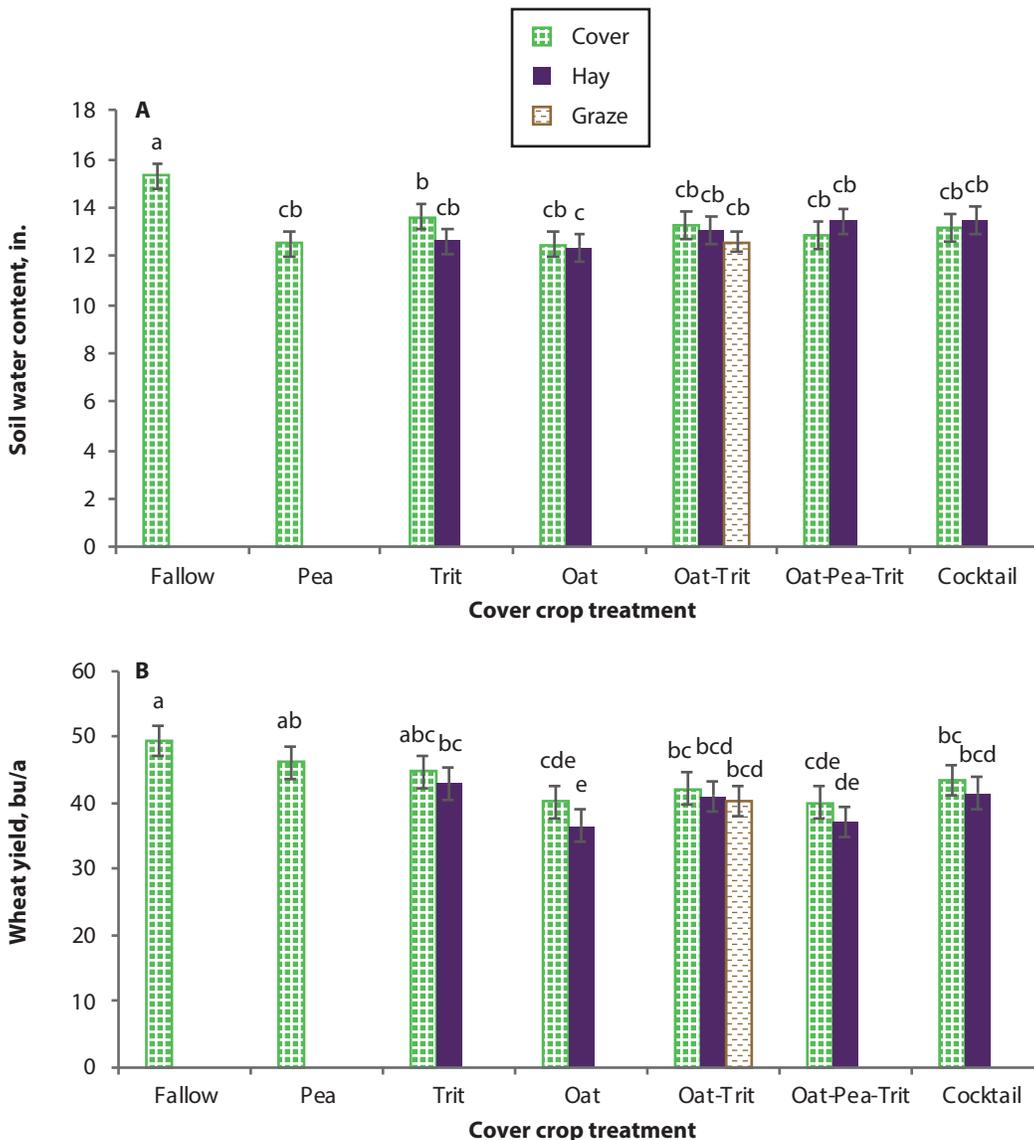


Figure 4. Soil water content (a) and winter wheat grain yield (b) as influenced by cover crop management averaged across three growing seasons (2015-2018) at the Kansas State University experiment fields at HB Ranch near Brownell, KS.