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Effects of Spring-Planted Cover Crops on Weed Suppression and Winter Wheat Grain Yield in Western Kansas

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Abstract

Herbicide resistant (HR) weeds pose a major challenge to continuous no-tillage (NT) dryland crop management systems. Integrating cover crop (CCs) in dryland crop rotations could suppress weeds and provide a weed management option for HR weeds in NT systems. Field experiments were conducted to investigate weed suppression potential of spring-planted CCs and their impacts on subsequent winter wheat grain yields. The CCs were oat/triticale, oat/triticale/pea, spring pea, and chem-fallow (standard) over 3 years and 2 locations in western Kansas. A weedy-fallow check was added to compare weed suppression of CCs in 2 out of the 3 years. Results showed CC mixtures of oat/triticale or oat/triticale/pea produced more biomass than spring pea by mid- June. Averaged across years, CC dry matter (DM) produced in Colby was 3560 lb/a with spring pea, 5850 lb/a for oat/triticale, and 5700 lb/a for the 3-way mixture of oat/triticale/pea. Similarly, DM production at HB Ranch (located 5 miles north of Brownell) was 2160 lb/a for spring pea, 4420 lb/a for oat/triticale or 4330 lb/a for oat/ triticale/pea. Regardless of study location, growing a CC resulted in > 95% suppression of total weed biomass relative to the weedy-fallow check. Compared to chem-fallow, growing a CC reduced soil water content at winter wheat planting in 3 out of the 6 site-years (2017 at Colby, 2016 and 2017 at HB Ranch). At Colby, CCs reduced winter wheat grain yields in 2018 but not in 2016 or 2017. Except 2016, growing oat/triticale or oat/triticale/pea CC reduced wheat yields at HB Ranch. When averaged across the 3 years, wheat grain yields were 31 bu/a with chem-fallow, 30 bu/a after spring pea, and 34 bu/a with oat/triticale or oat/triticale/pea CC in Colby. Similarly, at HB Ranch, wheat grain yields averaged 50 bu/a with chem-fallow, 46 bu/a for spring pea, and 40 bu/a with either oat/triticale or oat/triticale/pea CCs.

Keywords

cover crops, weeds, dryland

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Summary

Herbicide resistant (HR) weeds pose a major challenge to continuous no-tillage (NT) dryland crop management systems. Integrating cover crop (CCs) in dryland crop rotations could suppress weeds and provide a weed management option for HR weeds in NT systems. Field experiments were conducted to investigate weed suppression potential of spring-planted CCs and their impacts on subsequent winter wheat grain yields. The CCs were oat/triticale, oat/triticale/pea, spring pea, and chem-fallow (standard) over 3 years and 2 locations in western Kansas. A weedy-fallow check was added to compare weed suppression of CCs in 2 out of the 3 years. Results showed CC mixtures of oat/triticale or oat/triticale/pea produced more biomass than spring pea by mid-June. Averaged across years, CC dry matter (DM) produced in Colby was 3560 lb/a with spring pea, 5850 lb/a for oat/triticale, and 5700 lb/a for the 3-way mixture of oat/triticale/pea. Similarly, DM production at HB Ranch (located 5 miles north of Brownell) was 2160 lb/a for spring pea, 4420 lb/a for oat/triticale or 4330 lb/a for oat/triticale/pea. Regardless of study location, growing a CC resulted in > 95% suppression of total weed biomass relative to the weedy-fallow check. Compared to chem-fallow, growing a CC reduced soil water content at winter wheat planting in 3 out of the 6 site-years (2017 at Colby, 2016 and 2017 at HB Ranch). At Colby, CCs reduced winter wheat grain yields in 2018 but not in 2016 or 2017. Except 2016, growing oat/triticale or oat/triticale/pea CC reduced wheat yields at HB Ranch. When averaged across the 3 years, wheat grain yields were 31 bu/a with chem-fallow, 30 bu/a after spring pea, and 34 bu/a with oat/triticale or oat/triticale/pea CC in Colby. Similarly, at HB Ranch, wheat grain yields averaged 50 bu/a with chem-fallow, 46 bu/a for spring pea, and 40 bu/a with either oat/triticale or oat/triticale/pea CCs.

Introduction

Winter wheat-summer crop-fallow (W-S-F) is a common dryland cropping system in semiarid regions of the central Great Plains (CGP), where soil moisture is often the limiting factor for continuous cropping. The fallow phase of the production system conserves soil water, which could stabilize wheat yields and prevent crop failure in drier years. Weed control during fallow period is accomplished through a combination of tillage and herbicide application in a minimum tillage system or herbicide alone in NT.

Over the years, growers have relied heavily on postemergence herbicides to achieve weed control during the fallow phase in NT. Multiple herbicide applications are generally needed to prevent replenishment of the weed seedbank during the fallow phase of the cropping cycle. Glyphosate is widely used in fallow fields to provide preplant weed control (burndown) and in wheat stubble after harvest. Generally, about three to four applications of glyphosate are applied in NT fallow prior to winter wheat planting. Increased selection pressure imposed by these repeated glyphosate applications has resulted in evolution of glyphosate resistance. For example, glyphosate-resistant (GR) kochia (*Kochia scoparia* L.), Palmer amaranth (*Amaranthus palmeri* S. Watson), horseweed [*Conyza canadensis* (L.)], and Russian-thistle (*Salsola tragus*) biotypes have recently been identified in NT fallow cropping systems across the CGP. The severity of these GR weed problems present a great challenge to NT crop production systems in this region.

Growing CCs during fallow as part of the crop rotation can suppress weeds and provide a significant weed management option for HR weeds in NT systems. This approach of utilizing CCs for weed suppression is gaining popularity among NT dryland producers because of HR weeds. However, CCs utilize soil moisture that could reduce subsequent crop yields particularly in dry years. Therefore, the objectives of this study were to 1) evaluate weed suppression potential of CCs, and 2) quantify CC effects on soil water availability at winter wheat planting and subsequent wheat grain yields in dryland systems.

Procedures

Field experiments were initiated in spring 2015 at the Kansas State University experiment fields at HB Ranch near Brownell, KS, and the experiment field near Colby, KS, to investigate weed suppression potential of CCs in dryland systems. Study design was a split-plot with four replications in randomized complete block. Main plots were three crops in each phase of a winter wheat-sorghum-fallow rotation, and subplots were four CC treatments of chem-fallow, oat/triticale, oat/triticale/pea, and spring pea for grain. In 2016 and 2017 growing seasons, a weedy-fallow check strip was added to quantify weed suppression potential of the CC treatments. The CCs were planted in the spring (by mid-March) of the fallow phase of the rotation. Each phase of the crop rotation was present within each block in each year of the study. The spring pea plots had a preplant herbicide application of Prowl H_2O and Spartan during each year of the study. Three herbicide applications were usually made to control weeds in the fallow plots. The field site at Colby had GR weeds, so paraquat was mostly used for weed control during fallow at this location.

Cover crop biomass, weed biomass, weed density, and weed community diversity were measured on each plot in June 2016 and 2017. At each sampling time, individual weed species were identified and counted within two quadrats (2.7 ft^2) placed randomly in each plot. Total aboveground biomass of weed species and CCs within each quadrat were harvested by clipping at the soil surface, and separated into different sampling bags (weeds or CC). The samples were weighed fresh, oven-dried at 120°F until constant weight, and weighed again for DM determination.

Soil water content at winter wheat planting was determined gravimetrically to 3 ft in 2015 and to 5 ft in 2016 and 2017. Two soil cores were taken from each plot and data averaged for a single soil water content measurement. Winter wheat 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 weed and CC biomass, soil water content, and winter wheat yields as a function of CC treatments.

Results

Cover Crop and Weed Biomass

Results showed DM production of CCs varied over the two study locations. In general, spring CC biomass at Colby was greater than that at HB Ranch. The differences were mostly because of differences in residual soil nutrients at each location. The Colby location had been in NT corn production for more than 15 years prior to the current study, resulting in significant accumulation of nitrogen, phosphorus, and soil organic matter compared to the HB Ranch location that was in conventional tilled wheat-sorghum fallow production prior to the study in 2015 (data not shown). Irrespective of location, total aboveground biomass produced from oat/triticale or oat/triticale/pea was greater than that of spring pea alone (Figure 1a and Figure 1b). Averaged across the 2 years, total DM production ranged from 3560 lb/a for spring pea to 5850 lb/a for oat/triticale in Colby (Figure 1a). Similarly, total DM produced with spring pea was 2160 lb/a compared to 4420 lb/a with oat/triticale CC at HB Ranch (Figure 1b).

Total weed DM varied over location, with greater weed biomass produced at Colby than HB Ranch. Compared to the uncontrolled weedy-fallow, growing a CC resulted in a significant decrease in weed biomass production. At Colby, weed biomass ranged from 78 lb/a when spring pea was grown to 1760 lb/a for the weedy-fallow (Figure 1a). This represented approximately 96% weed suppression. Weed suppression was 86 and 90% for oat/triticale and oat/triticale/pea CC treatments, respectively, in Colby. The significant weed suppression with spring pea was possibly due to the preplant herbicide use compared to no herbicide application in the other CCs. In addition, spring pea in 2017 at Colby were very competitive and provided complete ground cover while the cereals didn't have complete canopy closure. This allowed light penetration between the rows to help weed growth. Similarly at the HB Ranch, weed biomass ranged from as low as 4 lb/a with oat/triticale or oat/triticale/pea to 680 lb/a for the weedy-fallow (Figure 1b). This corresponds to 99% weed suppression compared to the check treatment. Growing spring peas resulted in 95% weed suppression at HB Ranch. Averaged across sites and years, CCs had a significant effect on weed population density. Weed counts were 27 plants ft^2 for the weedy-fallow, 9 plants ft^2 for spring pea, 12.8 plants ft^2 for oat/triticale, and 6 plants ft^2 for oat/triticale/pea treatments. Kochia was the dominant weed species found in Colby, while kochia and large crabgrass dominated at the HB Ranch. The CCs reduced the ability of many weeds to emerge and grow, with the CCs shading out weeds below the canopy and decreasing their biomass production. The relatively smaller weed biomass under the CC likely enhanced chemical control of these weeds with herbicides at termination of the CCs (data not shown).

Soil Water Content and Wheat Yield

In 2015, growing a CC had no effect on soil water content at winter wheat planting, except the grain pea treatment, at both study locations (Figure 2a). Spring pea yields in 2015 averaged 1600 lb/a in Colby and 850 lb/a at HB Ranch resulting in significant water use. Grain pea yields in 2016 averaged 840 lb/a in Colby and 590 lb/a at HB Ranch. Forage peas were grown in 2017 instead of grain peas (because the wrong pea seed was supplied). Growing a CC or grain pea in 2016 decreased soil water content at winter wheat planting in both Colby and HB Ranch. Growing a CC had no effect on soil water content at wheat planting in 2017 at Colby but did cause a significant decrease in soil water content at HB Ranch (Figure 2a). Differences were due to greater precipitation amounts after termination of CC at Colby (7.7 inches from June to August) compared to HB Ranch (4.9 inches from June to August). This resulted in more soil water replenishment at the Colby site.

Winter wheat yields after CCs 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 at HB Ranch (Figure 2b). Relatively drier surface soil (top 2 inches) at winter wheat planting in 2016 and drought in spring 2017 reduced wheat establishment and significantly decreased yields at Colby. Significantly decreased winter wheat yields were observed in 2017 and 2018 when CCs were grown ahead of wheat at HB Ranch (Figure 2b). The lesser water use by spring pea in 2016 (less plant stands) and 2017 (forage pea) resulted in less impact on subsequent wheat yields at this site. Averaged across the 3 years, growing CCs or grain pea ahead of wheat at HB Ranch reduced winter wheat yields compared to chem-fallow. Wheat yields at HB Ranch ranged from 40 bu/a with oat/triticale/pea CC to 50 bu/a with chem-fallow (Figure 3). At Colby, however, CC or grain pea had no effect on wheat yields when averaged across the 3 years (Figure 3). Over the 3-year study, wheat yields with chem-fallow were 31 bu/a, similar to 30 bu/a with grain pea, but 2 or 3 bu/a less than that obtained with oat/triticale and oat/triticale/pea CCs. This observation was possibly due to greater weed pressure in the chem-fallow treatments at the Colby site compared to the HB Ranch site. Averaged across the 3 years and CC treatments, winter wheat yield at HB Ranch was 44.1 bu/a, which was significantly greater than that achieved in Colby (32.1 bu/a). This was mostly because of differences in precipitation amounts received at the locations but also differences in weed pressure.

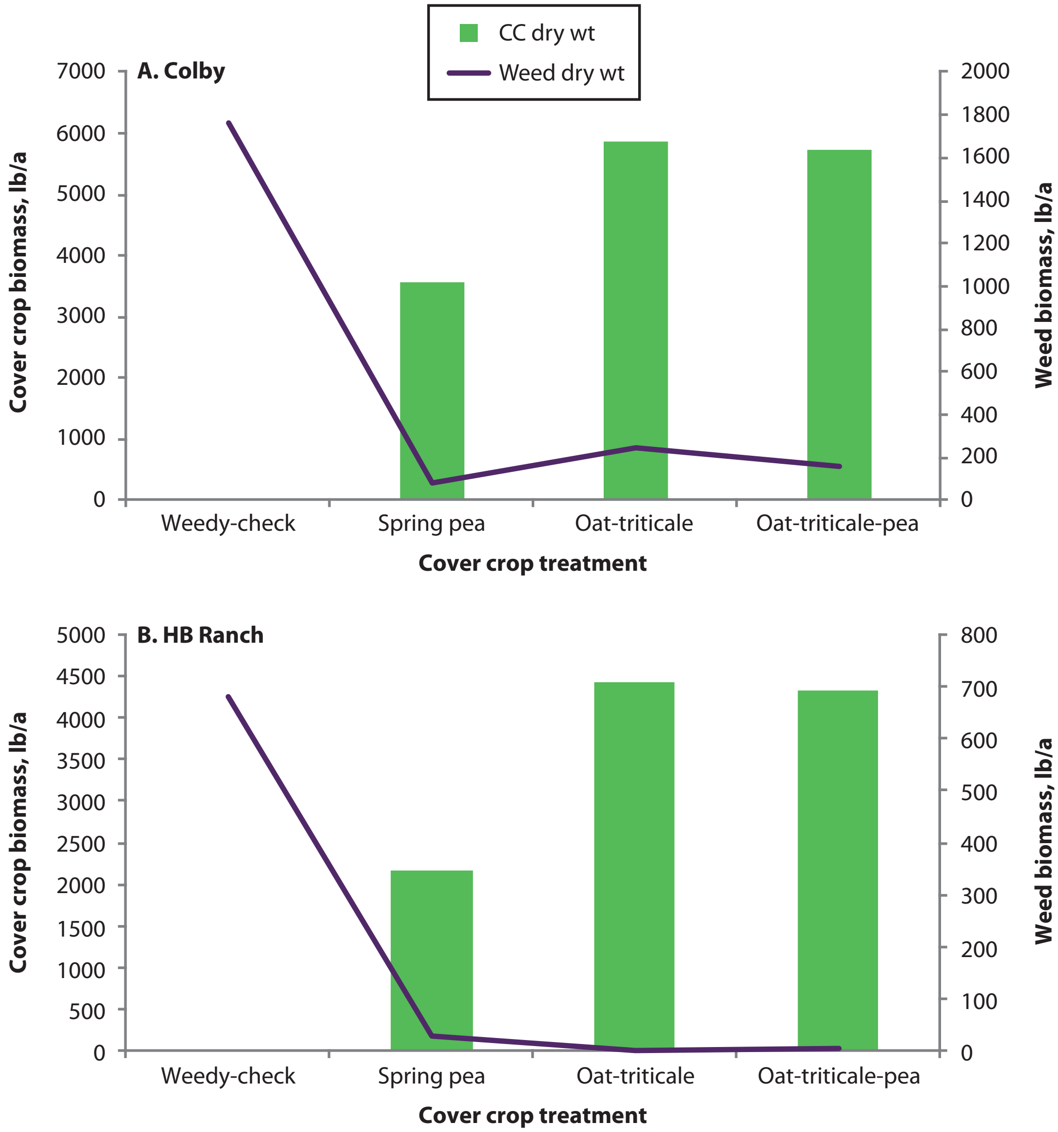

Figure 1. Average cover crop and weed biomass measured in June 2016 and 2017 at Kansas State University experiment fields located at Colby, KS (a), and at the HB Ranch (b) near Brownell, KS (b).

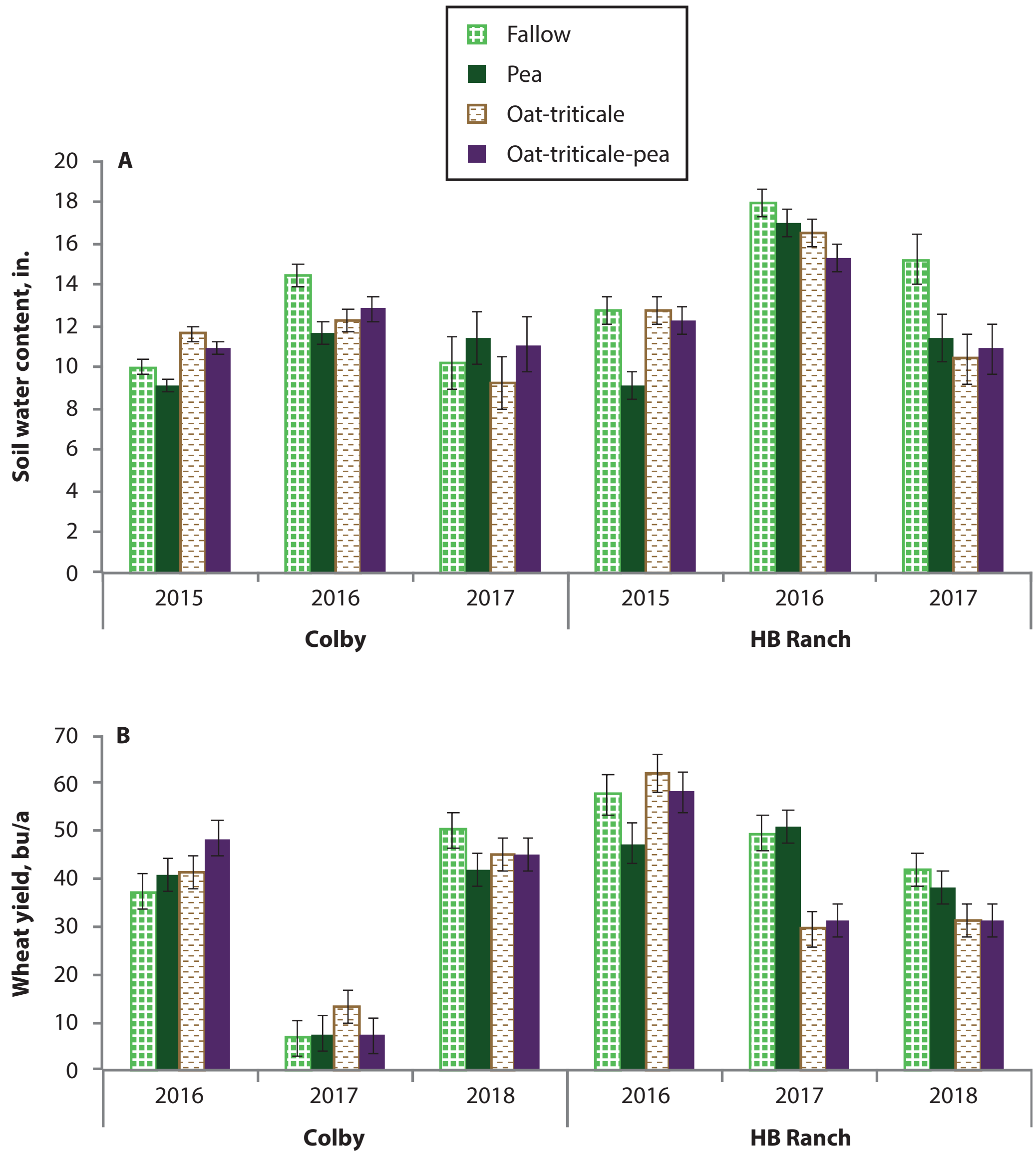

Figure 2. Soil water content at wheat planting (a) and winter wheat yield (b) as affected by cover crops grown over three years at Kansas State University experiment fields located at Colby, KS, and the HB Ranch near Brownell, KS.

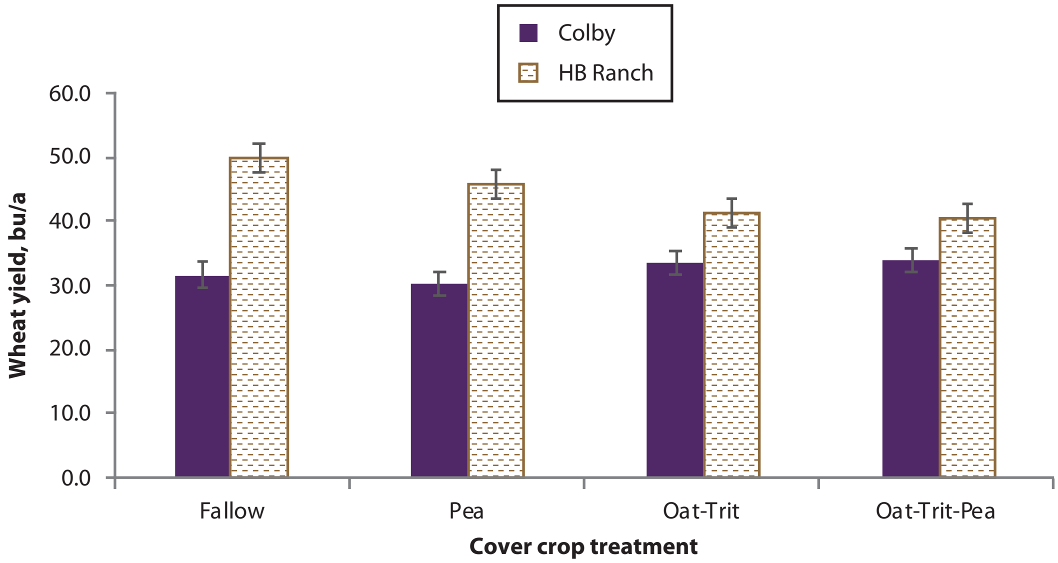

Figure 3. Cover crop effect on winter wheat grain yield averaged across three growing seasons at Kansas State University experiment fields located at Colby, KS, and the HB Ranch near Brownell, KS.