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# Spring and Summer Cover Crop Effects on Dryland Wheat and Grain Sorghum Yields in Western Kansas

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# Spring and Summer Cover Crop Effects on Dryland Wheat and Grain Sorghum Yields in Western Kansas

## Abstract

Incorporating cover crops (CC) to replace fallow in traditional dryland cropping systems in the semi-arid conditions of western Kansas has the potential to enhance soil health, suppress weeds, and increase precipitation use efficiency. The returns from haying or grazing can help cover costs of CC establishment and any reduction in yield from the subsequent grain crop. Two studies were initiated in 2015 and 2016 near Brownell, KS, to investigate dual-purpose spring and summer CC management effects on subsequent grain yields in a three-year no-till (NT) dryland winter wheat-grain sorghum-fallow cropping system. Cover crops were planted in early spring between grain sorghum and winter wheat or in mid-summer soon after wheat harvest. Cover crops were grazed with yearling heifers, hayed at a six-inch stubble height, or left standing (no forage removal). All CC treatments were compared to NT fallow with no CC. Results showed spring CCs reduced wheat yields between 25 and 31% compared to fallow (59 bu/a) in two of three years, with no difference in the other year. Wheat yields were not different among CC management strategies. Summer CCs reduced grain sorghum yields at rates up to 39% compared to fallow (67 bu/a) in one of three years only when CCs were grazed or left standing but not when CCs were hayed. Sorghum yields were not different in the other two years. Yields of wheat or grain sorghum grown more than one year following CCs in the crop rotation were unaffected by CC treatments. These results showed CCs reduced subsequent crop yields compared to fallow. However, grazed or hayed CCs had no negative effects on dryland wheat and grain sorghum yields compared to standing CCs. Allowing grazing or haying of CCs on land enrolled in Natural Resources Conservation Service cost-share programs could increase producer adoption of CCs in semi-arid western Kansas to enhance regional soil health and increase dryland cropping system profitability.

## Keywords

cover crops, dryland, wheat, grain sorghum



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# Spring and Summer Cover Crop Effects on Dryland Wheat and Grain Sorghum Yields in Western Kansas

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## Summary

Incorporating cover crops (CC) to replace fallow in traditional dryland cropping systems in the semi-arid conditions of western Kansas has the potential to enhance soil health, suppress weeds, and increase precipitation use efficiency. The returns from haying or grazing can help cover costs of CC establishment and any reduction in yield from the subsequent grain crop. Two studies were initiated in 2015 and 2016 near Brownell, KS, to investigate dual-purpose spring and summer CC management effects on subsequent grain yields in a three-year no-till (NT) dryland winter wheat-grain sorghum-fallow cropping system. Cover crops were planted in early spring between grain sorghum and winter wheat or in mid-summer soon after wheat harvest. Cover crops were grazed with yearling heifers, hayed at a six-inch stubble height, or left standing (no forage removal). All CC treatments were compared to NT fallow with no CC. Results showed spring CCs reduced wheat yields between 25 and 31% compared to fallow (59 bu/a) in two of three years, with no difference in the other year. Wheat yields were not different among CC management strategies. Summer CCs reduced grain sorghum yields at rates up to 39% compared to fallow (67 bu/a) in one of three years only when CCs were grazed or left standing but not when CCs were hayed. Sorghum yields were not different in the other two years. Yields of wheat or grain sorghum grown more than one year following CCs in the crop rotation were unaffected by CC treatments. These results showed CCs reduced subsequent crop yields compared to fallow. However, grazed or hayed CCs had no negative effects on dryland wheat and grain sorghum yields compared to standing CCs. Allowing grazing or haying of CCs on land enrolled in Natural Resources Conservation Service cost-share programs could increase producer adoption of CCs in semi-arid western Kansas to enhance regional soil health and increase dryland cropping system profitability.

## Introduction

Cover crops (CCs) have the potential to replace portions of the fallow periods in dryland cropping systems in semi-arid western Kansas to enhance soil health, suppress weeds, and increase precipitation use efficiency. In the dryland winter wheat-summer crop (usually grain sorghum or corn)-fallow crop rotation, two periods exist for growing CCs: 1) fallow ahead of wheat planting and 2) fallow following wheat harvest. Haying or grazing CCs could help to cover the costs of CC establishment and potential reductions in subsequent grain yields. Dual-purpose CCs can provide high-quality forage for livestock, which can offset losses in subsequent grain crop yield and potentially increase system profitability. Adjusting Natural Resources Conservation Service (NRCS) cost-share programs to allow grazing or haying of enrolled CCs could be an effective strategy to increase producer adoption of CCs in semi-arid areas like western Kansas.

Grazing CCs can extend the grazing season, delay grazing of native perennial grasslands, and is the most efficient means of utilizing CCs in years when biomass production is relatively low. Additionally, in years when biomass production is high, CCs can be harvested for hay for future feeding. Hay from CCs can be especially valuable during drought when hay supplies become scarce. More information is needed to understand the effects of such dual-purpose CCs on subsequent grain crop yields in the dryland cropping systems of western Kansas, which necessitates the current research. The objective of this study was to determine the effects of dual-purpose spring and summer CCs on wheat and grain sorghum yields in a three-year no-till (NT) dryland winter wheat-grain sorghum-fallow (WSF) cropping system.

## Procedures

In 2015 and 2016, two studies were initiated at the Kansas State University HB Ranch near Brownell, KS, to investigate CC management options for dryland cropping systems in western Kansas. The climate at the study site is semi-arid and characterized by erratic rainfall amounts and distribution (Figure 1). The 30-year average annual precipitation is 22 inches. In both studies, the experimental design was a split-plot randomized complete block with four replications. Main plots were the three crop phases of the WSF crop rotation and split-plots (600 $ft^2$) were grazed, hayed, and standing (no forage removal) CCs. All CC treatments were compared to NT fallow with no CC. The first study was implemented from 2015 to 2019 and compared spring planted CCs to fallow before subsequent winter wheat (Figure 2a). In this study, CCs were a mixture of oats and triticale at a seeding rate of 32 and 38 lb/a, respectively. Spring CCs were planted with a Great Plains no-till drill (Great Plains Manufacturing Inc., Salina, KS) near the third week of March each year as field conditions would allow and terminated with herbicides [Aim EC (carfentrazone-ethyl) and Gramoxone (paraquat)] near the first week of June. The second study was implemented from 2016 to 2021 and compared summer planted CCs to fallow after wheat harvest before subsequent grain sorghum (Figure 2b). In this study, CCs were a mixture of forage sorghum, pearl millet, sunn hemp, and cowpea at seeding rates of 7.5, 2.5, 5, and 20 lb/a, respectively. Summer CCs were planted with the same drill as used for spring CCs shortly after wheat harvest near the third week of July as field conditions would allow and were terminated by killing frost near the third week of October. No fertilizer was applied to spring or summer CCs in this study.

In both studies, CC grazing and haying coincided with heading of the grass components of the cover crop. Grazed CCs were stocked with yearling heifers (weighing about 1000 lb each) at about three head/acre/day to remove approximately 30 to 40% of the available forage. Hayed CCs were harvested to a six-inch cutting height using a Carter small-plot forage harvester (Carter Manufacturing Company, Brookston, IN) to remove approximately 60 to 70% of the available forage. Some regrowth of CCs following grazing or haying and before termination occurred occasionally but was usually minimal with no significant impact in these studies. Following fallow or spring CCs, winter wheat was planted with the same drill as used for CCs near the first week of October at a seeding rate of 60 lb/a with 7.5-inch row spacing and harvested near the last week of June using a Massey-Ferguson 8XP plot combine (Kincaid Equipment Manufacturing, Haven, KS). Eleven months after wheat harvest and following fallow or summer CCs, grain sorghum was planted near the first week of June at a rate of 35,000 seeds/a with 15-inch row spacings with the same planting equipment as used for wheat. Grain sorghum was harvested near the third week of October using the same harvesting equipment as used for wheat. For both grain crops, 18 lb/a $P_2O_5$ and 5 lb/a N was applied as monoammonium phosphate (11-52-0) with the seed. Additionally, 75 lb/a N was applied as broadcasted urea (46-0-0) for a total of 80 lb/a N for both grain crops. This report summarizes dual-purpose spring and summer CC effects on yields of subsequent winter wheat and grain sorghum as they appeared in the cropping sequence since 2015 and 2016, respectively. Statistical analyses were completed using PROC GLIMMIX of SAS v. 9.3 (SAS Institute, Cary, NC) with year and treatment considered fixed and replication considered random. Treatment differences were considered significant at $P \leq 0.05$.

## Results

Wheat yields in the three-year NT winter wheat-grain sorghum-CC system (Figure 2a) were reduced following CCs compared to fallow in two of three years. In 2016, wheat yields following spring CCs were similar to yields following fallow (59 bu/a) (Table 1). However, wheat yields were 31 and 25% less following CCs compared to fallow in 2017 (49 bu/a) and 2018 (42 bu/a), respectively. In all years, wheat yields were not different among CC management strategies (grazed, hayed, or standing). Grain sorghum yields were not different across treatments in all years of this study and averaged 55, 84, and 83 bu/a in 2017, 2018, and 2019, respectively.

Sorghum yields in the three-year NT winter wheat/CC-grain sorghum-fallow system (Figure 2b) were reduced following grazed or standing CCs in one of three years. In 2017, grain sorghum yields following summer CCs were 39% less compared to fallow (67 bu/a) when CCs were grazed or standing (Table 2). However, yields following hayed CCs (59 bu/a) were not significantly different from fallow. Grain sorghum in 2018 followed a failed CC in 2017. As expected, grain sorghum yields were not different across treatments in 2018 and averaged 87 bu/a. In 2019, grain sorghum yields were not different across treatments following a successful CC in 2018 and averaged 75 bu/a. Although grain sorghum yield after hayed CCs was greater compared to standing or grazed CCs in 2017, yields in 2018 and 2019 were not different among CC management strategies. Wheat yields were not different across treatments in any year of this study and averaged 45, 42, and 50 bu/a in 2019, 2020, and 2021, respectively.

In this study, spring CCs reduced subsequent winter wheat yields compared to fallow in two of three years with no differences among CC management strategies (grazed, hayed, or standing).

Summer CCs reduced subsequent grain sorghum yields compared to fallow in one of three years only when CCs were grazed or standing but not when CCs were hayed.

Yields of wheat or grain sorghum grown more than one year following CCs in the crop rotation were not different across treatments. These results show CCs can reduce subsequent dryland grain yields, though crops following grazed or hayed CCs yield similarly to when CCs are left standing (no forage removal). Grazing and haying of CCs could be effective practices in semi-arid western Kansas to generate income to offset losses when grain yields are reduced, which could increase producer adoption of CCs, enhance regional soil health, and increase dryland cropping system profitability.



**Table 1. Cover crop (CC) management effects on winter wheat and grain sorghum yields in a three-year no-till winter wheat-grain sorghum-CC system near Brownell, KS**

| Treatment | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|
| | ------------------- bu/a ------------------- | | | |
| | ------------------- Winter wheat yield ------------------- | | | |
| Fallow | 59a[†] | 49a | 42a | --- |
| Standing CCs | 57a | 35b | 36b | --- |
| Hayed CCs | 53a | 34b | 35b | --- |
| Grazed CCs | 58a | 32b | 34b | --- |
| Average | 57A | 38B | 37B | --- |
| | ------------------- Grain sorghum yield ------------------- | | | |
| Fallow | --- | 55a | 89a | 81a |
| Standing CCs | --- | 55a | 80a | 87a |
| Hayed CCs | --- | 55a | 78a | 78a |
| Grazed CCs | --- | 56a | 89a | 86a |
| Average | --- | 55B | 84A | 83A |

[†]Means followed by the same lower-case letter are not different ($\alpha = 0.05$) across treatments within the same column and means followed by the same upper-case letter are not different ($\alpha = 0.05$) across years within the same row.

**Table 2. Cover crop (CC) management effects on grain sorghum and wheat yields in a three-year no-till winter wheat/CC-grain sorghum-fallow system near Brownell, KS**

| Treatment | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|
| | bu/a | | | | |
| | Grain sorghum yield | | | | |
| Fallow | 67a† | 85a | 75a | --- | --- |
| Standing CCs | 38b | 87a | 78a | --- | --- |
| Hayed CCs | 59a | 89a | 72a | --- | --- |
| Grazed CCs | 44b | 85a | 76a | --- | --- |
| Average | 52C | 87A | 75B | --- | --- |
| | Winter wheat yield | | | | |
| Fallow | --- | --- | 48a | 41a | 49a |
| Standing CCs | --- | --- | 48a | 41a | 50a |
| Hayed CCs | --- | --- | 43a | 40a | 49a |
| Grazed CCs | --- | --- | 46a | 44a | 51a |
| Average | --- | --- | 45B | 42B | 50A |

†Means followed by the same lower-case letter are not different ($\alpha = 0.05$) across treatments within the same column and means followed by the same upper-case letter are not different ($\alpha = 0.05$) across years within the same row.

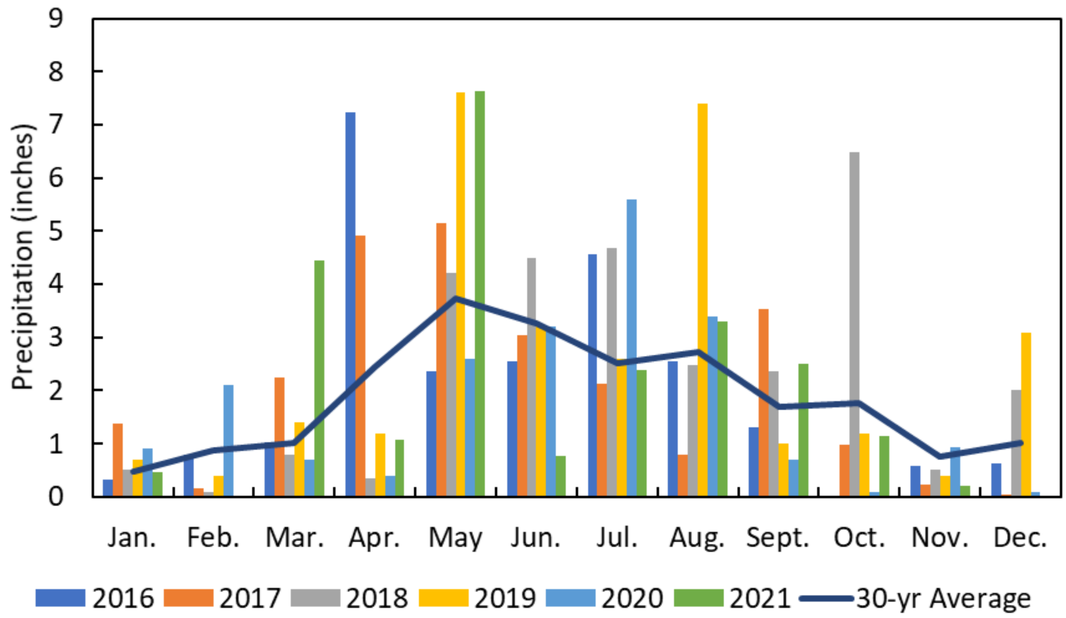


**Figure 1. Monthly precipitation from 2016 to 2021 near Brownell, KS.**

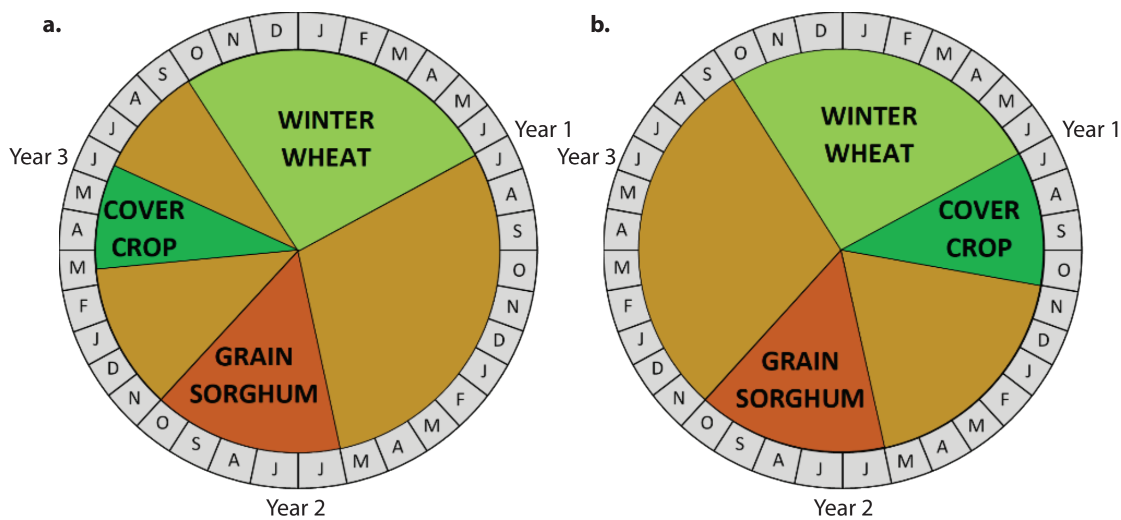


**Figure 2. Cropping sequence of the (a.) winter wheat-grain sorghum-cover crop rotation and (b.) winter wheat/cover crop-grain sorghum fallow rotation. Brown areas indicate periods of no-till fallow between crops.**