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Summary

Intensification of no-till dryland cropping systems in western Kansas with cover crops (CCs) may provide important ecosystem services while also supplying annual forage for livestock. Two experiments were initiated in 2015 and 2016 near Brownell, KS, to determine the forage production potential of spring and summer CCs in a winter wheat-grain sorghum-fallow crop rotation. Cover crops were mechanically harvested as hayed forage to a height of 6 inches or mob-grazed with yearling heifers (weighing approximately 1000 lb each) stocked at 3 head/acre/day. Forage accumulation was determined for the hayed treatment using a small plot forage harvester, and samples of the grazed treatment were hand-clipped before and after grazing every year from 2015 to 2020. Results showed forage accumulation of spring CCs grown in place of fallow following grain sorghum averaged 2231 lb/a dry forage mass and ranged from 1427 to 2871 lb/a. Similarly, forage accumulation of summer CCs planted after wheat harvest averaged 2513 lb/a dry forage mass and ranged from 956 to 3718 lb/a. In 2017, summer CCs failed to produce a harvestable yield. Results suggest that CCs may provide desirable annual forage for livestock. However, forage accumulation of both spring and summer CCs was variable in this study. In years that spring CCs were planted early (before March 15), yields tended to be higher (>2200 lb/a) due to less susceptibility to heat and moisture stress. Summer CCs performed best when planted immediately following wheat harvest to take advantage of summer rains and to produce as much forage mass (>3000 lb/a in favorable years) as possible before the first killing frost or about October 15 for most of western Kansas.

Introduction

Conventional dryland crop rotations in western Kansas typically produce either one crop in two years or two crops in three years with long periods of fallow in between the harvest of one crop and the planting of another. As a water conservation practice, fallow has been utilized to store soil moisture and stabilize subsequent crop yields. However, water storage efficiencies are typically low (about 30%), even with reduced or no-till tillage. Some producers have looked to intensify such crop rotations by replacing fallow with cover crops (CCs) or annual forages. As less water is necessary to produce forage compared to grain, such CCs may be successfully integrated into dryland crop rotations for increased soil cover and potentially greater income per acre when hayed or grazed as annual forages.

Two periods that exist for integrating CCs in conventional western Kansas crop rotations include 1) fallow ahead of winter wheat planting, or 2) fallow following winter wheat harvest. Replacement of fallow ahead of wheat planting presents an opportunity to take advantage of spring precipitation and cool temperatures for spring annual forage production. However, there is much greater risk associated with summer CCs following wheat harvest when soil moisture levels are frequently low and summer rainfall is erratic. The objective of this study was to determine the forage accumulation of either spring or summer CCs in place of fallow in a no-till dryland cropping system.

Procedures

Two experiments were initiated in 2015 (spring CCs) and 2016 (summer CCs) at the Kansas State University HB Ranch near Brownell, KS, to investigate CC management strategies for dryland cropping rotations in western Kansas. Cover crops were compared to chemically-controlled no-till fallow in a winter wheat-grain sorghum-fallow crop rotation. Spring CCs were a two-species mixture of oats and triticale at a seeding rate of 32 and 38 lb/a for oats and triticale, respectively. Spring CCs were planted into grain sorghum residues near the third week of March each year as field conditions would allow. Summer CCs were a four-species mixture of forage sorghum, pearl millet, sunn hemp, and cow pea at seeding rates of 7.5, 2.5, 5, and 20 lb/a, respectively. Summer CCs were planted into wheat stubble shortly after harvest as field conditions would allow. Both spring and summer CCs were mechanically harvested to a height of approximately 6 inches or mob-grazed with yearling heifers. Both studies were designed as split-plot randomized complete blocks. Main plots were the three crop phases of the wheat-sorghum-fallow crop rotation, and split-plots included hayed CCs or grazed CCs in place of fallow before or after winter wheat.

Cover crop grazing and haying generally coincided with grass crop heading stages. Prior to grazing, available forage mass was determined from samples that were hand-clipped to ground level in two areas of 3 ft × 2 ft from each plot. Fresh weights were recorded and samples were oven-dried at 122°F for a minimum of 48 hours or until a constant weight was reached. Grazed CCs were stocked with yearling heifers (weighing approximately 1000 lb each) stocked at 3 head/acre/day, on average, to utilize approximately 30 to 40% of the available forage mass. Following grazing, CC residue retained was measured as previously described. Hayed CC treatments were harvested from a 3 ft × 100 ft strip in the middle of each plot using a Carter small-plot forage harvester (Carter Manufacturing Company, Brookston, IN). Whole plot weights were recorded in the field with sub-samples collected and weighed. Sub-samples were oven-dried at 122°F to determine dry matter (DM) yield. This report summarizes forage accumulation of spring and summer CCs across years and management strategies. Statistical analysis was completed using PROC GLIMMIX of SAS ver. 9.3 (SAS Institute, 2012, Cary, NC) with year and treatment considered fixed and replication considered random. Differences were considered significant at $P \leq 0.05$. Coefficient of variation was determined for spring and summer CCs using PROC MEANS of SAS.

Results

On average, spring CC forage accumulation averaged 2231 lb of DM per acre with a high of 2871 lb/a in 2017 and a low of 1427 lb/a in 2019 (Figure 1a). Substantial variation in forage accumulation occurred across years in this study (coefficient of variation = 41.33), mostly due to differences in CC planting and harvest dates as field conditions would allow. From 2015 to 2018, favorable conditions supported DM production >2200 lb/a each year. However, low yields (<1500 lb/a) were observed in 2019 due to cool, wet conditions that delayed CC planting (Table 1). Further, in 2020, although CCs were planted on time, dry conditions that persisted through late spring limited vegetative growth early in the growing season. Across years, it was observed that once warm summer temperatures developed, spring CCs ceased vegetative growth and began to mature rapidly. On average, hayed CCs yielded 2299 lb/a of dry forage mass (Figure 1b). Following CC grazing, 1861 lb/a of residue was retained. This indicated a forage utilization rate of 26% compared to the 2532 lb/a available forage at the start of grazing.

Post-wheat summer CC forage accumulation averaged 2516 lb/a with substantial variation across years (coefficient of variation = 53.17). A high of 3718 lb/a was observed in 2018 with a low of 956 lb/a in 2019 (Figure 2a). Drought conditions in 2017 (Table 1) severely limited CC establishment and resulted in no harvestable yield. Favorable conditions in 2016 and 2018 supported DM production >3000 lb/a. In this study, timely rainfall in July and August was critical for adequate summer CC establishment following wheat harvest. Averaged across years, hayed CCs yielded 2423 lb/a of dry forage (Figure 2b). Following CC grazing, 1769 lb/a of residue was retained. This indicated a 39% forage utilization rate compared to the 2905 lb/a available at the start of grazing.

Results from this study suggest that spring CCs may produce about 2230 lb/a available forage in similar environments in western Kansas. Early planting dates (March 15 or earlier) will be essential for spring-planted cool-season CCs to take advantage of early spring precipitation as well as to develop as much vegetative growth as possible when temperatures are cooler. When planted post-wheat, successful summer CC establishment will depend upon timely rainfall in July and August. Planted immediately following wheat harvest, summer CCs may take advantage of all mid-summer rainfall and develop as much vegetative growth as possible (>3000 lb/a in favorable years) before the first killing frost, or approximately October 15, for most of western Kansas.

Table 1. Monthly precipitation from 2015 to 2020 near Brownell, KS

	Precipitation						
Month	2015	2016	2017	2018	2019	2020	30-yr avg.
	------------ inches ------------						
January	0.67	0.35	1.14	0.04	0.51	0.98	0.47
February	0.16	0.20	0.08	0.04	0.31	1.57	0.87
March	0.04	0.43	1.30	0.31	0.71	0.43	1.02
April	0.83	6.93	5.31	0.67	0.91	0.47	2.44
May	6.02	2.72	3.94	3.62	7.76	3.19	3.74
June	0.63	3.15	1.57	3.70	1.57	2.40	3.27
July	4.02	3.11	1.54	7.83	0.94	7.01	2.52
August	0.39	4.65	3.23	5.59	12.48	2.44	2.72
September	0.39	1.30	1.85	3.43	1.57	0.94	1.69
October	1.69	0.63	2.01	3.07	1.50	0.08	1.77
November	1.50	1.14	0.08	0.47	0.39	0.94	0.75
December	1.14	0.39	0.00	1.69	2.32	0.31	1.02
Annual	17.52	25.00	22.01	30.51	31.06	20.75	22.28

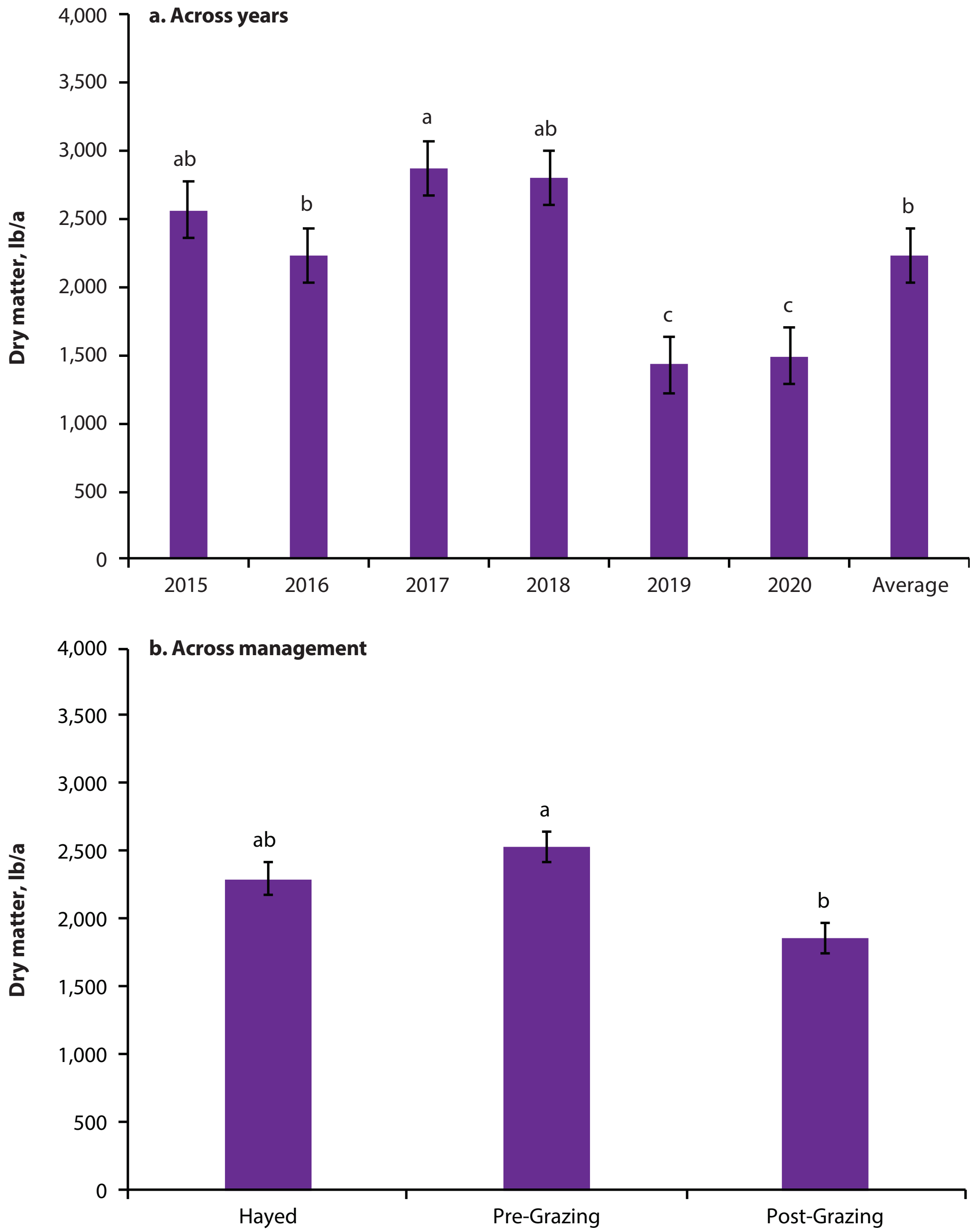

Figure 1. Spring cover crop forage accumulation across years (a) and management strategy (b) near Brownell, KS. Error bars indicate standard error ($\alpha = 0.05$) and bars with the same letter are not significantly different ($\alpha = 0.05$).

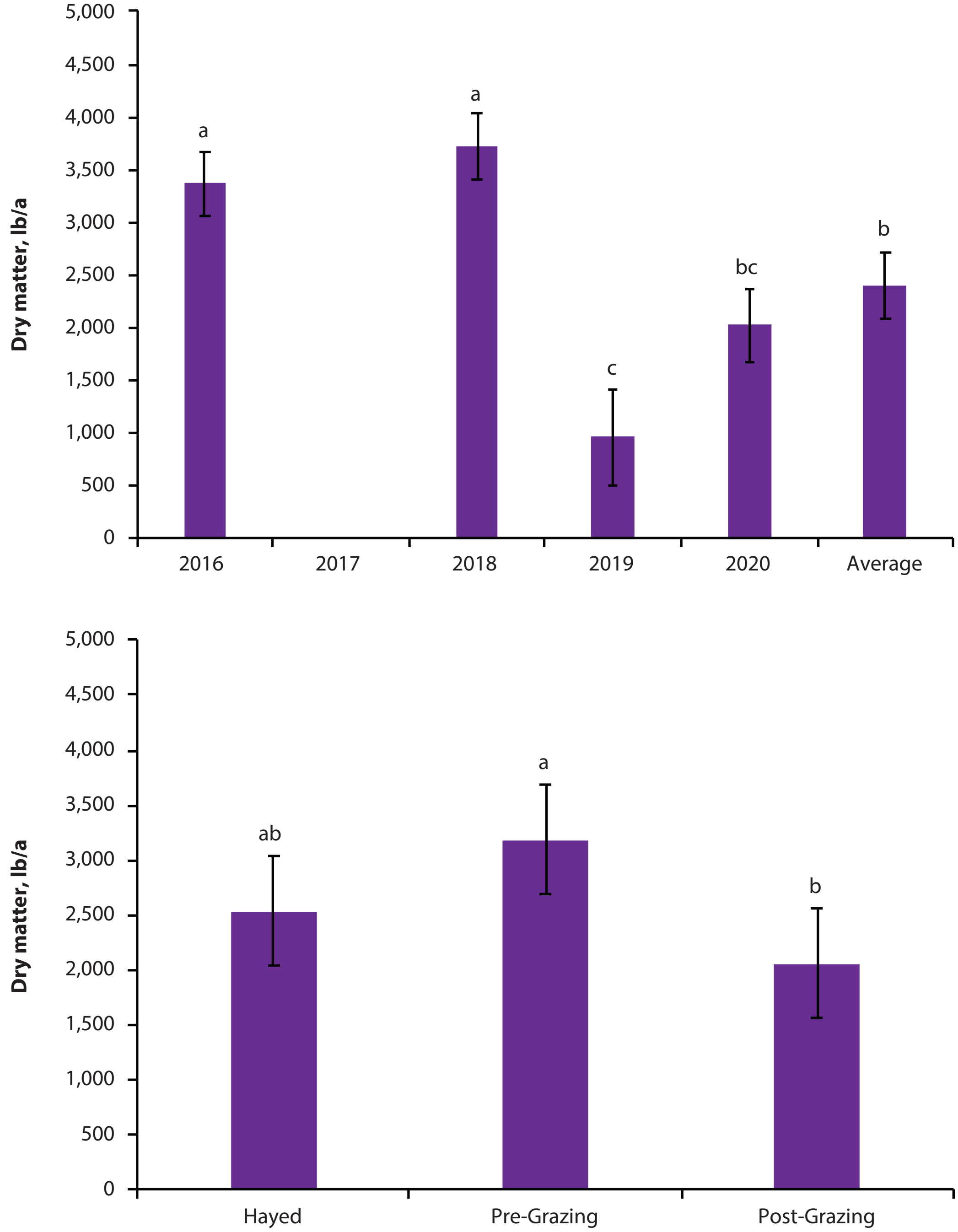

Figure 2. Summer cover crop forage accumulation across years (a) and management strategy (b) near Brownell, KS. Error bars indicate standard error ($\alpha = 0.05$) and bars with the same letter are not significantly different ($\alpha = 0.05$).