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Productivity, Nutritive Value, and Profitability of Single and Multi-Species Cover Crops in Dryland Environments

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2025 WESTERN KANSAS AGRICULTURAL RESEARCH

Productivity, Nutritive Value, and Profitability of Single and Multi-Species Cover Crops in Dryland Environments

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Summary

Replacing fallow with dual-purpose cover crops (CCs) can increase the profitability of dryland crop rotations in the semi-arid Great Plains. Little research information is available on CC mixtures that optimize productivity and profitability in dryland environments. Field experiments were conducted from 2015 to 2017 at the Kansas State University Hearting Beason (HB) Ranch near Brownell, KS, to quantify forage productivity, nutritive value, and profitability of spring-planted single or mixed species CCs in a winter wheat-grain sorghum-fallow (WSF) crop rotation. The CC treatments were implemented in the fallow phase ahead of winter wheat planting. Treatments were five spring-planted CC treatments: (1) spring oat; (2) spring triticale; (3) oat and triticale mixture (OT, two-species mixture); (3) oat, triticale, and pea (OTP, three-species mixture); and (5) oat, triticale, pea, radish, turnips, and buckwheat (cocktail, six-species mixture), and chemical fallow. Results showed that CC forage accumulation was 33% to 35% greater in sole triticale and OT mixture compared with sole spring oat or cocktail treatments. Multi-species mixtures, cocktail, and OTP had significantly greater available energy, digestibility, and dry matter intake based on measured CP, ADF, NDF, and *in vitro* dry matter digestibility (IVDMD) compared with single CC species (oat or triticale). Net return was directly proportional to CC forage accumulation. Averaged across years, net return was $40/a greater for the OT treatment compared with the multi-species mixtures. Our results suggest that simple CC mixtures with greater forage accumulation (for example, sole triticale and OT mixture) are better dual-purpose CC alternatives for the semi-arid Great Plains.

Introduction

Cropping system diversification with CCs can provide several benefits. These include improving soil quality, nutrient cycling, weed and pest suppression, as well as reduced wind erosion. The primary drawback of CCs in water-limited environments is the water use of CCs, which often affects subsequent cash crop yields. Utilizing CCs as forage can provide economic benefits and help offset loss in revenue associated with decreases in subsequent crop yields when CCs are grown in place of fallow. This approach could provide an opportunity for dryland producers to build soil health and produce forage for the region's livestock industry.

Information is limited regarding the best CC mixtures to optimize productivity, nutritive value, and profitability in water-limited dryland systems. Developing climate-spe-

cific CC management recommendations for dryland farmers will improve adoption in the semi-arid Great Plains. This research reports on the productivity and net returns of CCs in a dryland winter wheat-sorghum-fallow rotation. The research objective was to determine forage productivity and profitability of single and multi-species cover crops when used as a forage resource in dryland systems.

Procedures

This study is a component of a large CC field experiment initiated in spring 2015 at the Kansas State University experiment fields at HB Ranch near Brownell, KS. The overall goal of the CC trials was to develop climate-specific CC management options for integrating CCs into dryland crop production in western Kansas. The experimental design for the current study was a split-plot randomized complete block with four replications. The main plots were three crop phases of the WSF rotation (WSF, SFW, and FWS). The subplots were five spring-planted cover crop (CC) treatments: (1) spring oat; (2) spring triticale; (3) oat and triticale mixture (OT, two-species mixture); (3) oat, triticale, and pea (OTP, three-species mixture); and (5) oat, triticale, pea, radish, turnips, and buckwheat (cocktail, six-species mixture), and chemical fallow. The CCs were planted by March 15 in the fallow period between grain sorghum harvest and planting the next winter wheat crop in the rotation. Seeding rates were: 64 lb/a for spring oat; 76 lb/a for spring triticale; 32 lb/a of oat and 38 lb/a triticale (OT); 21 lb/a oat, 28 lb/a triticale, and 40 lb/a pea (OTP); and 15 lb/a oat, 15 lb/a triticale, 15 lb/a pea, 1 lb/a radish, 1 lb/a turnip and 4 lb/a for buckwheat (cocktail).

The CCs were harvested at heading to determine DM production and nutritive value. Forage harvests were performed in the last week in May 2015 and the first week in June 2016 and 2017. During each harvest, a 3-ft × 100-ft forage strip was harvested from each plot using a Carter plot forage harvester (Carter Manufacturing Company, Inc.) to a 6-inch stubble height. Whole plot sample weights were recorded, sub-samples were weighed, and oven dried for DM. 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).

Economic profitability (net return) was calculated as total revenue minus total costs for each treatment in each year. Total revenue was calculated as forage mass multiplied by price of hay. Field operations and input costs were estimated using 5-year average custom rate values published by Kansas State University Land Use Survey Program and the Kansas Department of Agriculture (AgManager, 2021). Cover crop hay prices were taken from the USDA Economic Research Service's market reports (USDA-ERS, 2021). Prices for hay were calculated on a per ton basis and averaged $130/ton over the study period. Total variable costs were calculated as the sum of the expenses for CC seed, planting, harvesting, hay swathing, and baling.

Results

Forage Mass, Nutritive Value, and Net Returns

Forage accumulation differed among CCs in 2015 and 2016 but not in 2017 (Table 1). In 2015, forage accumulation of the OT mixture was significantly greater than the

cocktail treatment. There were no significant differences among other CC treatments. In 2016, triticale forage accumulation was greater than oat alone and the OTP mixture. Forage accumulation of the OTP and cocktail treatments were not significantly different in 2016 (Table 1). Across years, CC forage accumulation was 33% to 35% greater in triticale alone and the OT mixture compared with oat alone or the cocktail treatment. This result suggests triticale or triticale-dominated mixture productivity was greater compared with the oat alone or the cocktail and OTP treatments where the proportion of triticale in the mixture was less.

The multi-species mixtures (i.e., cocktail and OTP) had greater CP compared with oat alone in two of the three years, and IVDMD with these treatments was greater than triticale. Triticale had moderate concentrations of CP, the greatest ADF and NDF, and the least IVDMD compared with the cocktail, and OTP CC treatments (Table 2). Therefore, the cocktail and OTP treatments had greater available energy, digestibility, and greater dry matter intake compared to triticale alone or the OT treatment. Due to relatively higher ADF, NDF, and lower IVDMD concentrations, triticale intake and digestibility could be less than the other treatments. Complementarity from the component crops in multi-species mixtures often increased nutritive value.

Gross return was greatest for triticale alone and triticale-dominated mixtures compared with the cocktail and oat alone treatments (Table 1). Gross return was not significantly different over the three years. Net return was greatest for the OT treatment compared with the OTP and cocktail treatments (Table 1). There was a significant linear relationship between forage accumulation and net return for all treatments (Fig. 1). Net return increased by $0.05 for each lb/a increase in forage accumulation. Crude protein yield, a function of CP concentration and forage accumulation, was greater for triticale and OT treatments compared with oat or the cocktail treatment. Crude protein yield ranged from 274 lb/a for oat alone to 362 lb/a for the OT treatment.

Conclusions

Our results showed CC forage accumulation was greater in the triticale alone and OT mixture compared with the oat alone or cocktail treatments. Multi-species CCs mixtures (i.e., cocktail and OTP) had significantly greater available energy, digestibility, and greater dry matter intake compared with single species (i.e., oat or triticale alone). Net returns for the OT or triticale alone treatments were greater compared with the multi-species mixtures (i.e., cocktail and OTP). Our results suggest that simple CC mixtures with greater forage accumulation (e.g., triticale alone and OT mixture) are better dual-purpose CC alternatives for the semi-arid Great Plains.

Acknowledgements

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References

AgManager. (2021). Kansas custom rates 2020. Kansas Department of Agriculture and Kansas State University Land Use Survey Program. *https://www.agmanager.info/machinery/papers/custom-rates-survey*.

USDA-ERS. (2021). Commodity cost and returns. Economic Research Service. *https://www.ers.usda.gov/data-products*.

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Table 1. Cover crop forage accumulation for the years 2015-2017, average across years, net returns and type 3 test of fixed effects

	Forage accumulation				Gross return	Net return
	2015	2016	2017	Average		
	---------- lb/lbs./a ----------				--------- $/a ---------	
Cover crop treatment						
Spring oat	32741ab†	1885b	2079	2235c	149b	55ab
Spring triticale	3952ab	3330a	2559	2980ab	199a	82ab
Spring oat-triticale mixture	357a	2575ab	2909	3013a	201a	87a
Spring oat-triticale-pea mixture	2521ab	2044b	2756	2440bc	163ab	48b
Cocktail	2241b	2364ab	2068	2225c	148b	46b
HSD	1232	1251	NS	573	49	36
Year						
2015				2822	188	75
2016				2439	163	57
2017				2474	165	59
HSD				NS	NS	NS
Type three test of fixed effects						
Treatment (T)	0.0429	0.0242	0.1715	0.0107		
Year (Y)	-	-	-	0.1735		
Y × T	-	-	-	0.3913		

†Means within a column followed by different letters indicate significant differences among cover crop treatments at $\alpha < 0.05$.

Table 2. Cover crop nutritive value, i.e., crude protein (CP), acid detergent fiber, neutral detergent fiber (NDF), in vitro dry matter (IVDMD) concentration by treatment and year, and type 3 test of fixed effects

	Concentration			
	CP	ADF	NDF	IVDMD
	%			
Cover crop treatment				
Spring oat	11.9ab†	37.1b	62.1b	73.8a
Spring triticale	12.1ab	38.8a	65.3a	69.7b
Spring oat-triticale mixture	11.6b	37.1b	62.9ab	72.7a
Spring oat-triticale-pea mixture	13.4a	37.1b	61.5b	73.7a
Cocktail	13.0ab	37.2ab	61.8b	73.8a
HSD	1.5	1.6	3.1	2.7
Year				
2015	17.7a	36.6b	56.8c	82.4a
2016	9.1c	38.6a	64.1b	67.8b
2017	10.3b	37.1b	67.3a	68.1b
HSD	1.0	1.1	2.0	1.8
Type three test of fixed effects				
Treatment (T)	0.0046	0.0311	0.0065	0.0002
Year (Y)	<.0001	0.0003	<.0001	<.0001
Y × T	0.0117	0.5292	0.3388	0.4886

†Means within a column followed by different letters indicate significant differences among cover crop treatments or years at $\alpha < 0.05$.

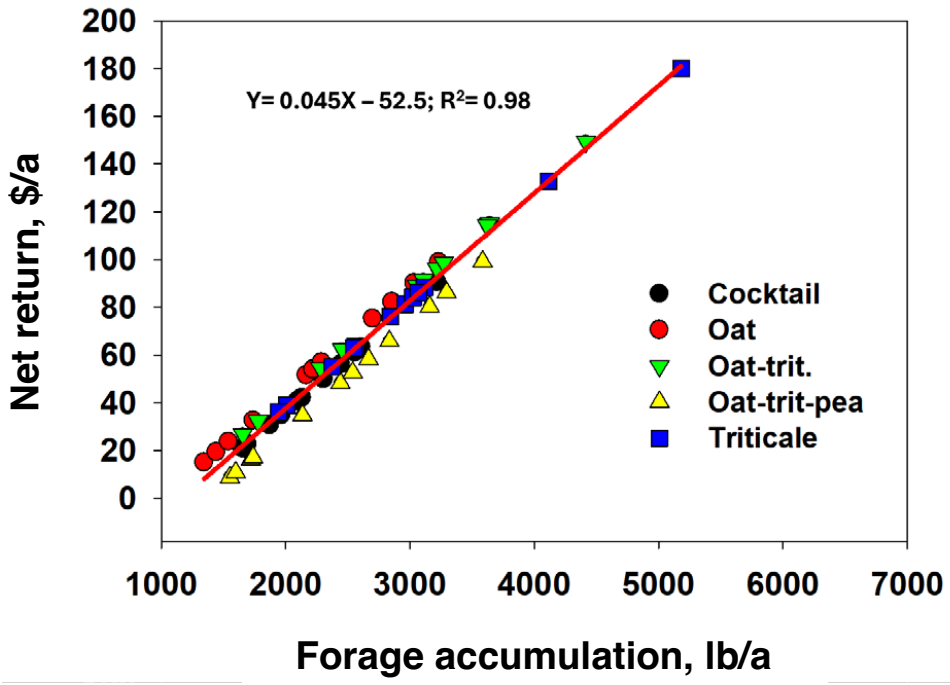

Figure 1. Forage accumulation and net revenue relations of spring cover crops from 2015 through 2017 at Hays, KS.