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J. K. Farney
Kansas State University, jkj@ksu.edu

G. F. Sassenrath
Kansas State University, gsassenrath@ksu.edu

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Evaluating Single and Multi-Species Summer Cover Crops for Biomass Yield

J.K. Farney and G.F. Sassenrath

Summary

Cover crops have multiple benefits to integrated agricultural production systems. However, information is needed on best species and mixes to use. In this one-year study, the single species grass cover crops produced the most biomass. Spring forage peas did not perform well as a summer cover crop, yielding the same biomass as the fallow areas. Adding collards to the mixtures generally reduced total biomass production compared to single species of grasses alone. Total biomass production was affected by the number of plants in the mixture. Yields of grass-only plots were ~868 lb of dry matter (DM) per acre more than cover crop mixtures composed of two or three plant species. Plots with cover crop mixes yielded on average 1,348 lb DM/acre more than single species plots with legumes or collards. Grasses composed the greatest proportion of the total biomass (> 77% of total DM biomass was from grass species in mixtures).

Introduction

Maintaining productivity, improving quality, and providing an economic return are persistent challenges to agricultural production systems. Conservation agriculture and sustainable agriculture are ideologies and management practices in modern agriculture that are being highlighted as important by both producer and consumer groups. Sustainable agriculture has become increasingly important for agricultural commodity groups. Consumers, especially in developed countries, actively apply pressure to agricultural producers to confirm that they manage resources (land, livestock, water, etc.) to promote future commodity production and to minimize environmental contamination. Many agricultural producers rely on sustainable management practices. These practices are suitable for continued use, maintain and/or improve current natural resources, and are financially efficient.

Agricultural production systems in the United States are dictated by the productive capacity of the soil. Fields with better soils are used for crop production, while fields with poor soil quality (limited topsoil depth, rocky, or “worn out”) are commonly used for pasture. Most farming operations in central Great Plains include both crop and animal production to diversify the operation, capture return on investment in highly dynamic markets, and capitalize on the highly variable soil conditions. One method of conservation agriculture includes cover cropping. Cover crops offer multiple benefits to producers, including long-term improvements in soil quality, improved soil structure

and water holding capacity, and reduced erosion. The quickest method to recover the cost associated with planting cover crops is to utilize the cover as a forage for livestock. Moreover, integrating livestock into crop production through grazing further diversifies the cropping system and can provide important improvements to the soil health, including additional nutrients.

There is an extensive list of cover crop plants available for producers. Understanding the purpose of the plant and the objective of the cover crop can help producers make decisions about plant selection. For many of the cover crops, maximizing biomass production provides the greatest benefits as a cover crop and for cattle grazing. Previous research has reported conflicting results about biomass production in multiple species mixtures versus single species. The objective of this study is to determine biomass production of summer cover crops based on the number and type of cover crops in the planting mixture.

Experimental Procedures

Sixteen cover crop treatments were planted on June 6, 2018, in 10- × 40-ft. replicated plots at the Southeast Research and Extension Center (SEREC) research station near Columbus, KS (Table 1). Treatments consisted of single species cover crops of brown midrib (BMR) sorghum, forage sorghum, pearl millet, sunn hemp, spring forage pea, and collards. The two-species mixtures consisted of each of the grass species with spring pea and each of the grass species with collards. The three-species mixtures included one of the grasses plus spring pea and collards. The cover crops were chosen for the safety and palatability for cattle grazing, as well as their potential contributions to soil health.

Total plant biomass from one 3- × 3-ft. area of each plot was clipped to a 2-inch stubble height using a sickle bar mower on July 17, 2018. The clipped biomass was immediately weighed for total wet biomass, then the samples were taken to the SEREC and separated by plant type. Each plant type (including weeds) was weighed separately and then completely dried to determine dry matter biomass of each species.

Results and Discussion

Total Biomass Production

Total biomass was different for each of the cover crops planted. Pearl millet, BMR sorghum, and forage sorghum yielded the most biomass, with mixtures of these grasses yielding intermediate levels. The lowest biomass was measured in the spring forage pea and fallow treatments (Figure 1). Grass was the predominant component of the biomass in the mixtures that included grasses. Overall, weeds were fairly low in the treatment mixtures (ranging from 1% to 23% of the mixtures), except for spring peas which contained 77% weed biomass. A lower weed amount in the cover crop mixture indicates a high biomass that out-competed the weed population at the sampling time.

To further illustrate the differences observed in biomass production based on the number of plant species in the mixture, we found that single grass species yielded the most biomass. This was followed by two- and three-species mixtures, which produced more biomass than the single species of legumes and collards (Figure 2). This is not an uncom-

mon result as many other researchers have found that grass species yield the most biomass, with mixtures of grasses and non-grass species producing intermediate amounts of biomass, and legumes producing the least biomass. This is illustrated in Figure 3 where single species of grasses had the highest biomass and the collard (broadleaf) and legumes were substantially lower in production. When adding the lower-producing species such as broadleaves and legumes to grass cover crop mixtures, the total grass biomass production is reduced, indicating a competitive effect of the other cover crop species.

Production Difference Between Two-Species and Three-Species Cover Crop Mixtures

The two-species mixtures showed no difference in biomass production when either pearl millet or BMR sorghum was the grass, regardless of whether a pea or collard was included. For the forage sorghum mixtures there was greater biomass with the spring pea in the mixture as compared to the collard (Figure 4).

In the three-species mixtures, there was no difference in biomass production regardless of grass type included (Figure 5). In this comparison all mixtures had spring forage pea and collards, the only difference was the type of grass.

Based on one year of data, if biomass is the driver for forage production and as the function for cover crop benefits, a single species cover crop of grass yields the greatest biomass production. We observed no difference in biomass production between the three grasses used: BMR sorghum, forage sorghum, or pearl millet. Spring forage pea was not a viable option for a summer cover crop. Single mixtures of sunn hemp and collards yielded similar total biomass, but had some of the lowest biomass production between all treatments. The plant species selected for this study were chosen as they have been promoted as high-quality grazing forages. Quantity and quality are the measurements needed to identify whether the forage is a wise choice for cattle feed. The quality components of these mixtures have not been analyzed at the time of the publication, but based on knowledge of previous research, the grasses utilized offer a quality feed for cattle. For the legumes, sunn hemp can be a good feed for cattle at specific times. To our knowledge, little information is available about spring forage peas in this area as a cattle feed. Collards have primarily been used in winter feeding mixtures and are a high protein, high energy feedstuff. To further determine if the species discussed in this publication are a feed that cattle will consume (Farney, 2019).

Acknowledgments

This work is supported by the U.S. Department of Agriculture National Institute of Food and Agriculture, Hatch project 1003478, with partial funding from the Kansas Conservation Innovation Grant. We also appreciate the work of Lonnie Mengarelli and Dekon Stickland.

Reference

Farney, J.K. (2019) "Cattle Preference for Annual Forages," Kansas Agricultural Experiment Station Research Reports: Vol. 5: Iss. 2.

Table 1. Cover crop mixtures and seeding rates

Mixture	Grass, lb/a	Collard, lb/a	Legume, lb/a
BMR sorghum	20		
BRM sorghum + spring pea	10		25
BMR sorghum + collard	10	4	
BMR sorghum + spring pea + collard	7	2.7	17
Collard	8		
Forage sorghum	20		
Forage sorghum + spring pea	10		25
Forage sorghum + collard	10	4	
Forage sorghum + spring pea + collard	7	2.7	17
Pearl millet	20		
Pearl millet + spring pea	10		25
Pearl millet + collard	10	4	
Pearl millet + spring pea + collard	7	2.7	17
Spring forage pea	50		
Sunn hemp	15		

Variety names:

Brown midrib (BMR) sorghum: 400 brown mid-rib forage sorghum

Collard: Impact forage

Forage sorghum: Sorgrow 80

Pearl millet: pearl millet

Spring forage pea: 4010

Sunn hemp: sunn hemp

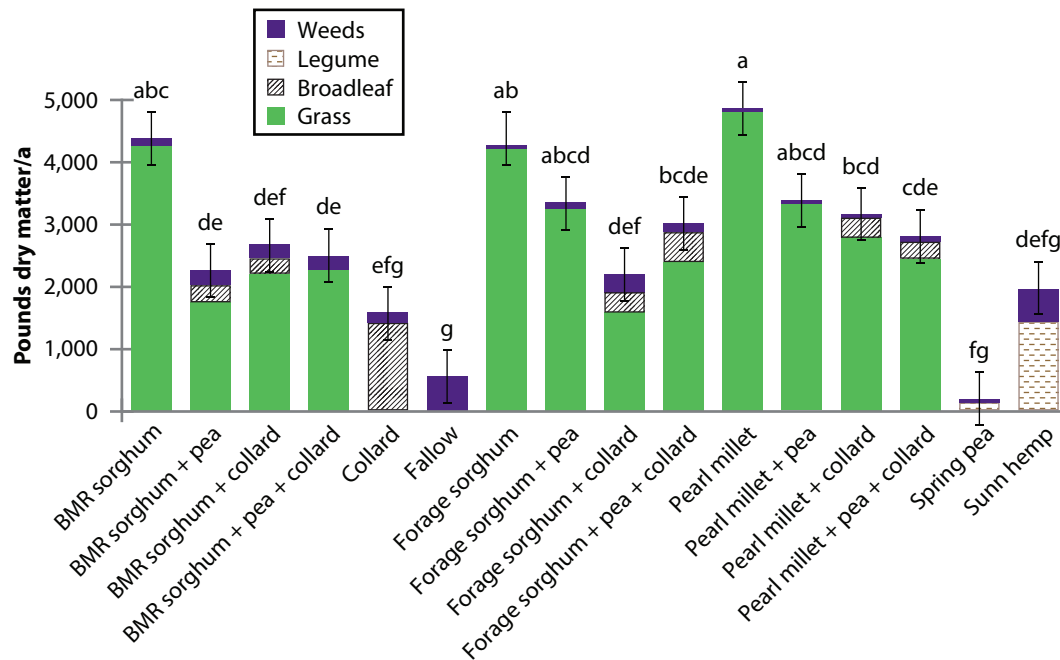


Figure 1. Total biomass production of each summer cover crop mixture including biomass of each component of the mixtures.

^{abcde} Different superscripts indicate differences in treatment at $P < 0.05$. Values are averages with standard error bars.

The grass component of the biomass production is represented by solid green and includes brown midrib (BMR) sorghum, forage sorghum, or pearl millet.

The broadleaf component of the biomass production is represented by black diagonal lines with check over-pattern lines and is the collard plant.

The legume component of biomass production is represented by white with purple dashes and is either spring forage pea or sunn hemp.

The biomass of the weeds in the mixtures is represented by the solid purple portion of the column.

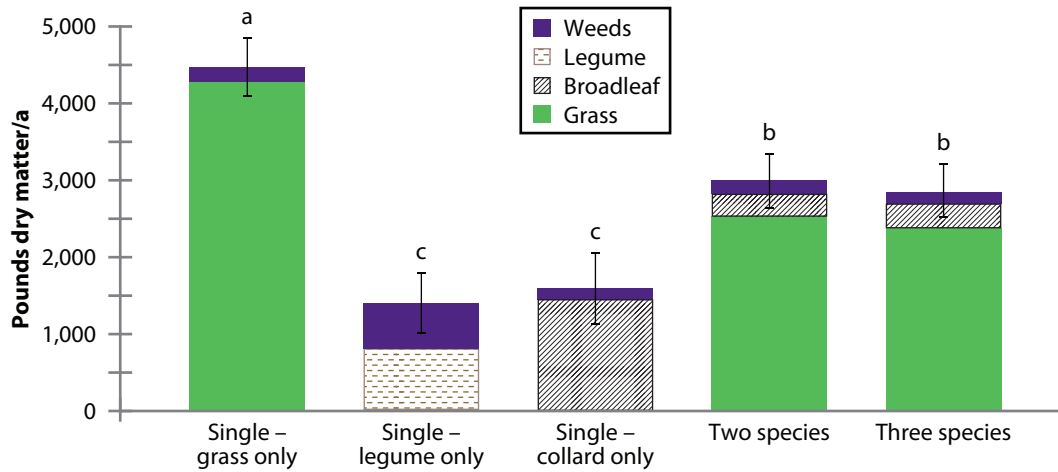


Figure 2. Biomass production based on the number of plant species in the cover crop mixture as well as the biomass type.

^{abc}Different superscripts indicate differences in treatment at $P < 0.05$. Values are averages with standard error bars.

Single – grass only is the average production from the brown midrib (BMR) sorghum, forage sorghum, and pearl millet treatment.

Single – legume only is the average of the sunn hemp and spring forage pea treatments.

Two-species are the averages of each grass type that was planted with either a collard or the spring forage pea.

Three-species are the average of each grass type that was planted with both the collard and the spring forage pea.

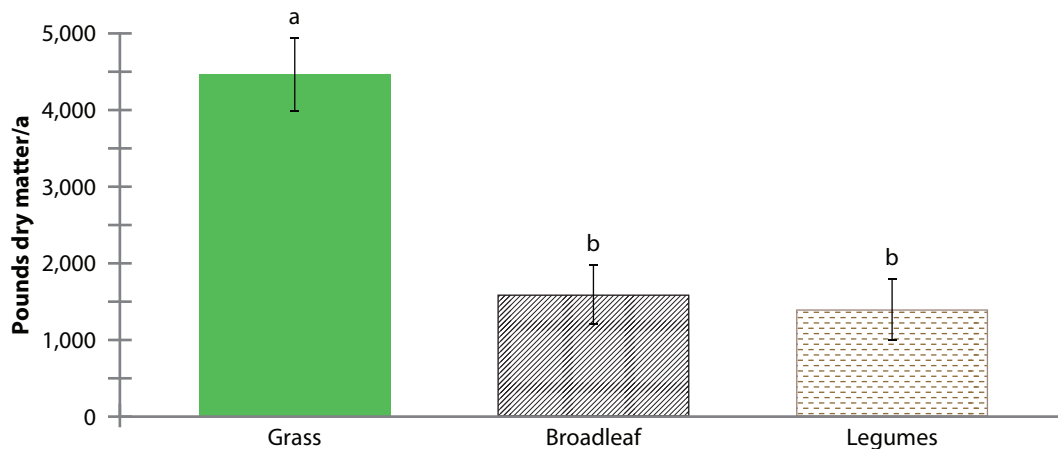


Figure 3. Biomass production of single species mixtures based on plant category (grass, broadleaf, and legume).

^{ab}Different superscripts indicate differences in treatment at $P < 0.05$. Values are averages with standard error bars.

Grass is the average production from the brown midrib (BMR) sorghum, forage sorghum, and pearl millet treatments.

Broadleaf is the collard treatment biomass production.

Legume is the average of the sunn hemp and spring forage pea treatments.

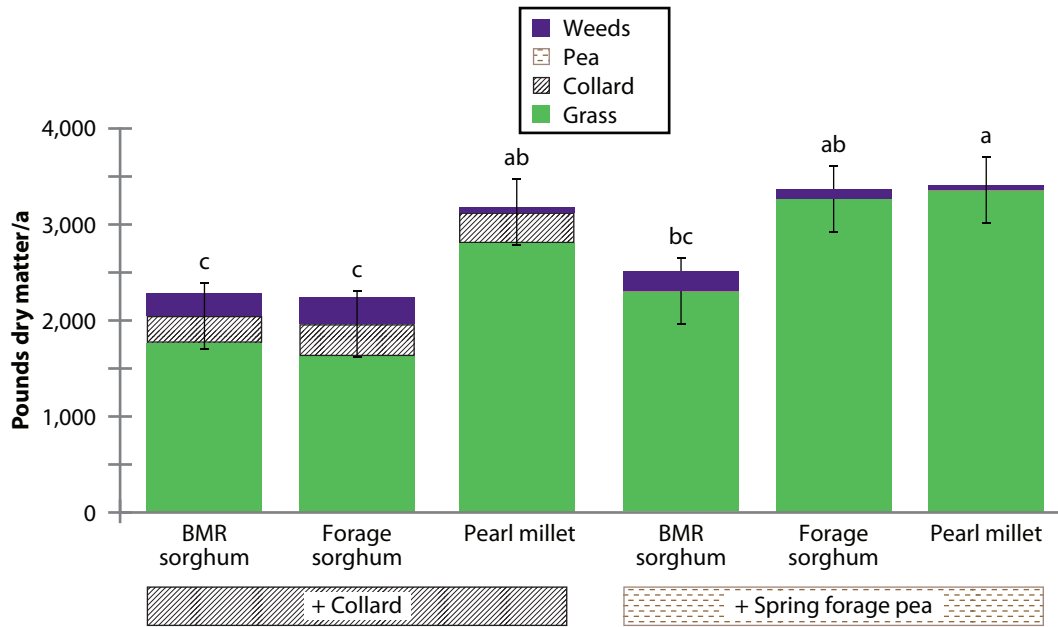


Figure 4. Biomass production of two-species mixtures including plant type biomass within treatment. The two-species include a grass species and spring forage pea, or a grass species and a collard.

^{ab}Different superscripts indicate differences in treatment at $P < 0.05$. Values are averages with standard error bars.

Treatments include brown midrib (BMR) sorghum + spring forage pea; forage sorghum + spring forage pea; pearl millet + spring forage pea; BMR sorghum + collard; forage sorghum + collard; and pearl millet + collard.

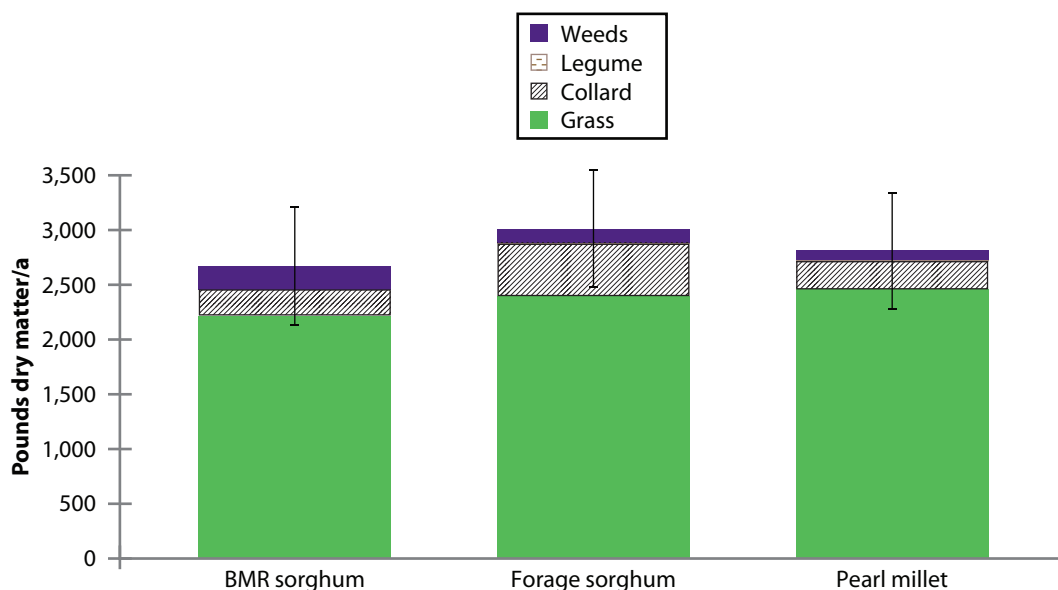


Figure 5. Biomass production of three-species mixtures including plant type biomass within treatment groups. The comparison is between grasses that are planted with both spring forage pea and collards.

Treatment comparisons are for brown midrib (BMR) sorghum + spring forage pea + collard; forage sorghum + spring forage pea + collard; and pearl millet + spring forage pea + collard. No differences were determined (non-significant).