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Summary

Cover crops offer potential benefits for improving soil health, but establishment and management costs can be expensive. One way for farmers to recover these costs is to graze the forage, which benefits producers by integrating crop and animal production. More information is needed on the potential forage quantity and quality for grazing livestock of cover crops and mixed species of cover crops. Researchers have suggested that different plant species complement each other, but additional work is needed to determine how best to balance forage production and how competitive the various species are when added to a mix. Sixteen treatments were drill-seeded at the Southeast Research and Extension Center near Columbus, Kansas, in August 2014 and 2015. Each treatment consisted of a three-way mix representing popular cover crops from the plant families Brassicaceae (brassicas), Poaceae (grasses), and Fabaceae (legumes). Eight species were planted, including forage radish (*Raphanus sativus*), purple-top turnip (*Brassica rapa*), oat (*Avena sativa*), rye (*Secale cereale*), barley (*Hordeum vulgare*), wheat (*Triticum aestivum*), Austrian winter pea (*Pisum sativum* subsp. *arvense*), and berseem clover (*Trifolium alexandrinum*). Small areas of each plot were clipped at 45-, 74-, and 91-day intervals each year. The clipped biomass was then weighed, sorted, and dried to determine biomass as well as species composition. In 2014 the average biomass produced at 45, 74, and 91 days was 1,250, 3,290, and 3,050 lb/ac, respectively. These range from 470–1,940 lb/ac 45 days after planting to 1,790–4,440 lb/ac at 91 days after planting, depending on the cover crop mix. In 2015, the average biomass at 45, 74, and 91 days was 1,120, 1,604, and 2,273 lb/ac, respectively. These range from 557–1,876 lb/ac 45 days after planting to 1,100–4,127 lb/ac at 91 days after planting, depending on the cover crop mix.

Introduction

Interest in the potential for a multi-species cover crop blend that also provides benefits as forage to supplement fall livestock grazing has been growing among farmers. Although the idea of cover crops is certainly not new, the concept of a cover crop mixture is an area where more research is needed. Information on the quantity of forage produced by a mixture of species, specifically with respect to individual species' contribution to total biomass, is minimal. Legumes increase forage value through nitrogen (N) fixation and add nutrition to forage in the form of protein. Animals need a balanced diet with fiber, which can be obtained through grass, and annual cereal grasses provide a fibrous root system and high biomass production. Brassicas have a taproot structure for

creating macropores and are excellent N scavengers. Both brassicas and grasses such as cereal rye have been shown to take up soil N as they grow and then release it back to the soil as they decompose. Farmers can use mixtures of multiple species to gain both grazing and soil health benefits.

Experimental Procedures

A randomized complete block design with 16 treatments in triplicate was laid out in approximately 120- × 10-ft plots. The 16 treatments each consisted of a three-way mix with combinations of popular cover crops from each of the three plant families (Brassicaceae, Poaceae, and Fabaceae), as illustrated in Table 1. The plots were planted August 12, 2014, and August 21, 2015, with a 10-ft Great Plains (Salina, KS) no-till drill with two seed boxes. Seeds of similar size were mixed and planted using one seed box; the other seed was placed in the second box. For example, in treatment 1, the berseem clover and turnip seeds were placed in the small box and the wheat was placed in the larger box. The plots were clipped on September 26, 2014; October 25, 2014; and November 11, 2014. The second year of the study, the plots were clipped on October 6, November 3, and November 23, 2015. For both years, these dates correspond to 45, 74, and 91 days after planting.

The area clipped was 3.75 ft². The forage samples were then placed in plastic bags and transported to the lab in Manhattan, KS, where they will be analyzed for species composition, total biomass, and dry matter. Nutritional components such as acid detergent fiber (ADF), neutral detergent fiber (NDF), and crude protein (CP) are currently being evaluated and will be reported as the procedures are completed.

Results and Discussion

2014 Biomass

The total biomass produced by the 16 treatments and the pounds that each species contributed to the total are illustrated in Figure 1. In 2014 the 74-day clipping in a majority (11 of 16) of the treatments yielded the highest dry matter biomass production. In some treatments, including treatment 1 (wheat, clover, turnip), treatment 4 (oat, clover, turnip), treatment 7 (barley, pea, turnip), treatment 10 (rye, clover, radish), and treatment 16 (oat, pea, radish), the 91-day clipping yielded the highest biomass (DM basis). It is important to note that by the 91-day clipping, a killing freeze occurred that resulted in wilting of the brassicas. This might have led to the reduction in biomass yield for a majority of the mixtures, especially if the aboveground portion of the mixtures was predominantly composed of brassicas. Preliminary data indicated that the optimal time to turn cattle out onto these mixtures might be sometime between days 45 and 74 so the cattle graze during the maximal biomass production period and have sufficient forage to meet their nutritional requirements.

The cover crop mixes used in this experiment were established successfully, but certain species did not emerge with this planting method and/or combination of plants. In the first 45 days, the brassicas in all mixes contributed more than 50% of the total dry matter biomass. At the 74-day clipping, turnips were still the predominant species in the mixtures, except for the combinations that included barley and oats (treatments 3, 4, 7,

and 8), and this trend continued at the 91-day clipping. This was not observed with the radish mix, where radishes contributed more than 50% of the total biomass at the 74-day clipping for all mixtures. Radishes were also the predominant species at the 91-day clipping, except in treatments 11 and 16 (radish mix with barley and oats, respectively).

The legumes (berseem clover and Austrian winter pea) were a very small component of the mixture, if they even emerged. Austrian winter pea was a better legume in these mixes than berseem clover. No clover was found in the clipped samples. The lack of a substantial biomass contribution from legumes might have been caused by issues with planting depth. Although the planter box had separate seed boxes, the drill would only plant at one depth. The entire mixture was therefore drilled at 0.5 in., which is deeper than the recommended planting depth for legumes. In addition, poor emergence of the legumes could have been caused by rapid growth of the brassicas within the first 45 days after planting. The brassicas appeared to out-compete and “choke out” the legumes in these mixtures. This might be a great benefit for fall weed control, but limits cover crop mixes.

2015 Biomass

The total biomass produced by the 16 treatments and the pounds that each species contributed to the total are illustrated in Figure 2. In 2015, planting was delayed slightly due to weather and then after planting, the ground was very dry. This resulted in delayed and uneven emergence. The lack of early growth and quick canopy cover likely contributed to higher weed pressure than the previous year.

The legumes played a much larger role in 2015. All treatments planted to winter pea showed a greater legume component as compared to the previous year, where only a single treatment and sampling period (45-day barley, turnip, clover) showed a significant proportion of legume.

Summary

Overall, the biomass produced in 2015 was noticeably lower than 2014. The most obvious difference from the graph is the drastic reduction in the 2015 brassica composition. In 2014, the brassica species emerged quickly which provided a good canopy cover. This appears to have aided in competition with weeds but may have also contributed to competition with legumes and grasses. In all treatments in 2014, the brassicas made up the majority when mixed with wheat, rye, and clover. This is particularly noticeable in treatments 9, 10, 13, and 14, which suggests that radishes may dominate a mix when combined with less aggressive species.

In both years, the grass component of oat and barley averaged more biomass than wheat and rye treatments. The rye did not establish as well in part because the typical planting date is later in the fall when the weather is cooler. Wheat biomass was also generally reduced as it was planted earlier than normal.

It is interesting that the 90-day treatment 10 (rye, clover, radish) had greater biomass in 2015. At the time of clipping in 2015, we had not yet had a killing frost so the plants were still actively growing.

Depending on forage quality results, multi-species cover crop mixes can generate a significant amount of dry matter to meet cattle nutritional requirements (the nutritional analyses for the samples collected during this project are in progress). More information is needed to determine cattle preference for these forages and the appropriate amount of crop biomass to leave in the field to maximize soil and crop potential. Since weather is different each year, the planting and grazing of cover crops will always vary. Species composition and recommended planting date should be taken into account when choosing a mix. Brassicas have the potential to out-compete less aggressive species when conditions are favorable.

Table 1. Cover crop mixtures and seeding rates

Treatment number	Poaceae ¹		Fabaceae ²		Brassicaceae ³	
	Species planted ⁴	Seeding rate, lb/a	Species planted ⁴	Seeding rate, lb/a	Species planted ⁴	Seeding rate, lb/a
1	Wheat	30	Clover	3.7	Turnip	2.3
2	Rye	30	Clover	3.7	Turnip	2.3
3	Barley	30	Clover	3.7	Turnip	2.3
4	Oat	37.5	Clover	3.7	Turnip	2.3
5	Wheat	30	Pea	19	Turnip	2.3
6	Rye	30	Pea	19	Turnip	2.3
7	Barley	30	Pea	19	Turnip	2.3
8	Oat	37.5	Pea	19	Turnip	2.3
9	Wheat	30	Clover	3.7	Radish	3
10	Rye	30	Clover	3.7	Radish	3
11	Barley	30	Clover	3.7	Radish	3
12	Oat	37.5	Clover	3.7	Radish	3
13	Wheat	30	Pea	19	Radish	3
14	Rye	30	Pea	19	Radish	3
15	Barley	30	Pea	19	Radish	3
16	Oat	37.5	Pea	19	Radish	3

¹ Poaceae is the grass component in these mixtures.

² Fabaceae is the legume component of the mixtures.

³ Brassicaceae is commonly known as brassicas.

⁴ Common names of the species planted in the mixture are used in the table. Scientific names are: Brassicaceae: forage radish (*Raphanus sativus*) or purple-top turnip (*Brassica rapa*); Poaceae: oat (*Avena sativa*), rye (*Secale cereale*), barley (*Hordeum vulgare*), or wheat (*Triticum aestivum*); Fabaceae: Austrian winter pea (*Pisum sativum* subsp. *arvense*) or berseem clover (*Trifolium alexandrinum*).

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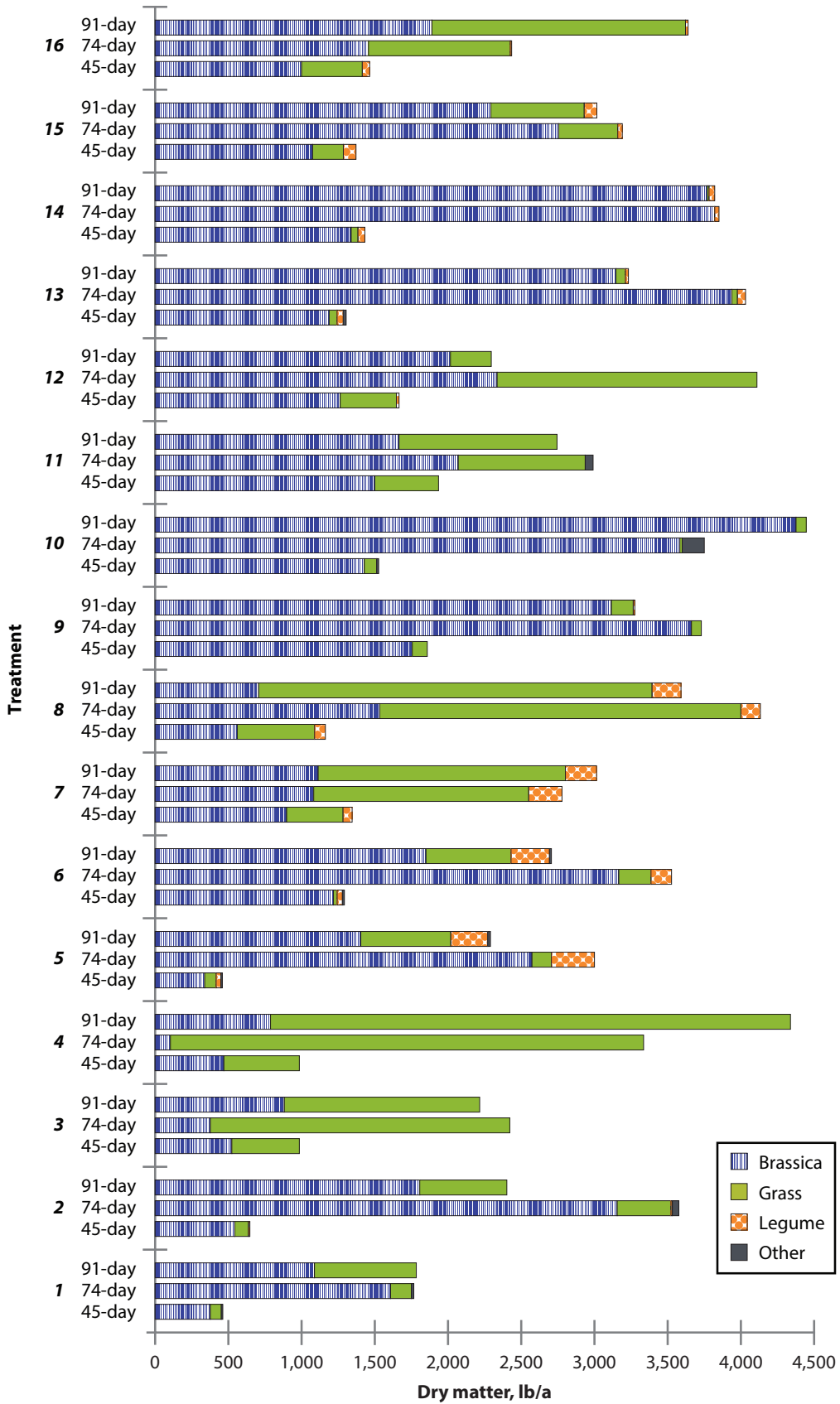


Figure 1. 2014 Total biomass yield (on a dry matter basis) by clipping date and species composition. Reported values are averages. Refer to Table 1 for plant composition of each treatment (1–16).

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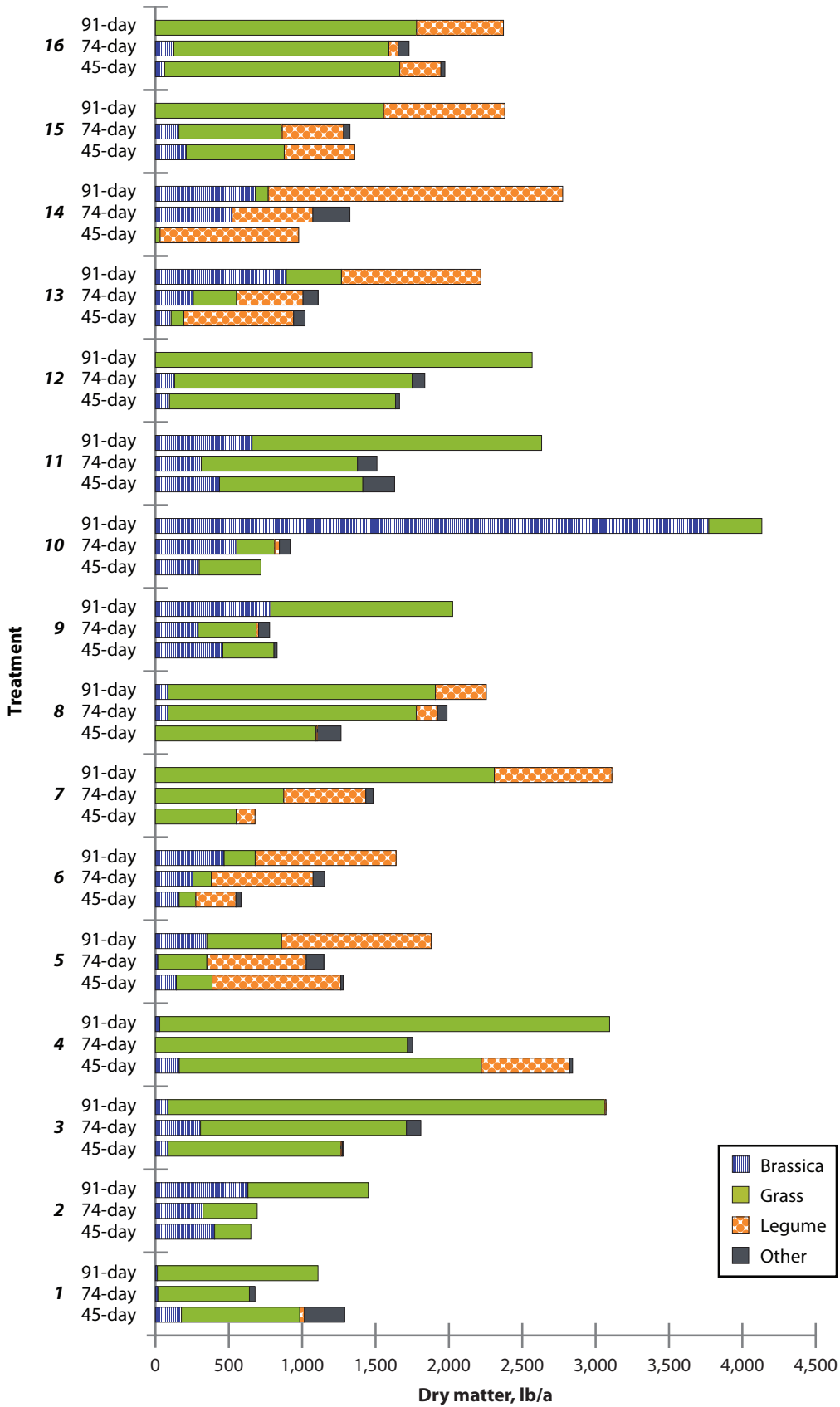


Figure 2. 2015 Total biomass yield (on a dry matter basis) by clipping date and species composition. Reported values are averages. Refer to Table 1 for the plant composition of each treatment (1–16).