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Growth, Forage Quality, and Economics of Cover Crop Mixes for Grazing

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Growth, Forage Quality, and Economics of Cover Crop Mixes for Grazing

Abstract

Cover crops offer many potential benefits to crop production. They diversify the plant system, increase soil organic matter, and reduce erosion. However, they can be expensive to plant. By grazing the cover crops, farmers can recover some of the expenses associated with growing cover crops. Grazing also increases the nutrients to the field, further enhancing the productive capacity of the soil.

Many cover crop mixtures are currently available on the market. However, it is not clear how useful the multi-species cover crops mixtures are, or their potential impact on economics of production. Moreover, many of the cover crop mixes being sold contain species that are potentially harmful to either humans or cattle. For example, some cattle are sensitive to hairy vetch (Farney et al., 2016). Buckwheat, a valuable and frequently used cover crop, causes serious allergic reactions in some human populations, making it especially unsuitable for growing regions that also produce wheat. To avoid cross-contamination of buckwheat with wheat, the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) requires an exclusion of buckwheat by 30 feet and two years from any commercial wheat production fields. NRCS has restricted the use of buckwheat in cover crop mixes for regions that grow wheat (NRCS, 2016).

Many plants are good for planting as cover crops. There are three general categories of plants that are commonly used as cover crops, each with a unique growth habit and rooting structure. In this study, we chose common plants from each of these major groups: grasses, brassicas, and legumes. The soils in southeast Kansas were developed under the tallgrass prairie. Grasses have a dense, fibrous rooting system that is ideally suited for growth in the claypan soils of this region. Studies of soil microbial activity indicate that grasses may enhance microbial activity at lower soil layers, better using more of the soil profile for extracting nutrients and water (Hsiao et al., 2018). The grasses chosen for this study included winter barley, winter oats, cereal rye, and winter wheat. Brassicas have a taproot that creates large holes in the soil called macropores. These macropores break up the soil structure. As the large taproot decays, it supports microbial activity and further improves the soil structure. Brassicas also release unique compounds into the soil, such as glucosinolates, that have been shown to suppress disease organisms in the soil such as fungi and nematodes. The brassicas used in this study included tillage radish and purple-top turnip. Legumes improve the soil by increasing the soil nitrogen. Most legumes have a fibrous rooting system. The legumes used in this study included berseem clover and Austrian winter pea.

Keywords

Cover crop mixes; grazing; forage quality; economics of cover crops

Cover Page Footnote

The authors would like to thank Lonnie Mengarelli and Garth Blackburn for their assistance in field management and data collection. We gratefully acknowledge the collaboration of Dr. Doohong Min for allowing Cathryn Davis to use forage testing equipment in his laboratory. This work is supported by the USDA National Institute of Food and Agriculture, Hatch project 1003478. Additional funding for this material is based upon work that is supported by the National Institute of Food and Agriculture, USDA, under award number 2013-69002-23146.

Growth, Forage Quality, and Economics of Cover Crop Mixes for Grazing

J.K. Farney, G.F. Sassenrath, C. Davis, D. Presley

Summary
Cover crops can improve soil health by diversifying the cropping system. Integrating grazing with cover crop production can also improve the return on investment and reduce costs of planting cover crops. We examined mixtures of three common cover crops: grasses, brassicas, and legumes. Each mixture contained one cover crop from each of the different plant types. The mixtures varied in total protein and fiber amounts, but all mixes would provide adequate forage and protein amounts for cattle. Key differences were observed between the cost to produce each ton of forage dry matter biomass or protein. Cover crop mixes with oats produced more dry matter and protein at the lowest cost.

Introduction
Cover crops offer many potential benefits to crop production. They diversify the plant system, increase soil organic matter, and reduce erosion. However, they can be expensive to plant. By having cattle graze the cover crops, farmers can recover some of the expenses associated with growing cover crops. Grazing also increases the nutrients to the field, further enhancing the productive capacity of the soil.

Many cover crop mixtures are currently available on the market. However, it is not clear how useful the multi-species cover crop mixtures are, or their potential impact on economics of production. Moreover, many of the cover crop mixes being sold contain species that are potentially harmful to either humans or cattle. For example, some cattle are sensitive to hairy vetch (Farney et al., 2016). Buckwheat, a valuable and frequently used cover crop, causes serious allergic reactions in some human populations, making it especially unsuitable for growing regions that also produce wheat. To avoid cross-contamination of buckwheat with wheat, the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) requires an exclusion of buckwheat by 30 feet and two years from any commercial wheat production fields. NRCS has restricted the use of buckwheat in cover crop mixes for regions that grow wheat (NRCS, 2016).

Many plants are good for planting as cover crops. There are three general categories of plants that are commonly used as cover crops, each with a unique growth habit and rooting structure. In this study, we chose common plants from each of these major groups: grasses, brassicas, and legumes. The soils in southeast Kansas were developed under the tallgrass prairie. Grasses have a dense, fibrous rooting system that is ideally suited for growth in the claypan soils of this region. Studies of soil microbial activity indicate that grasses may enhance microbial activity at lower soil layers, better using more of the soil profile for extracting nutrients and water (Hsiao et al., 2018). The grasses chosen for this study included winter barley, winter oats, cereal rye, and winter wheat. Brassicas have a taproot that creates large holes in the soil called macropores. These macropores break up the soil structure. As the large taproot decays, it supports microbial activity and further improves the soil structure. Brassicas also release unique compounds into the soil, such as glucosinolates, that have been shown to suppress disease organisms in the soil such as fungi and nematodes. The brassicas used in this study included tillage radish and purple-top turnip. Legumes improve the soil by increasing the soil nitrogen. Most legumes have a fibrous rooting system. The legumes used in this study included berseem clover and Austrian winter pea.

Experimental Procedures

The sixteen cover crop mixtures were three-way mixes containing one of each of the three plant types. Mixtures were planted at the Kansas State University Southeast Research and Extension Center research field near Columbus, KS, on August 12, 2014, and August 21, 2015, after corn harvest. The planting rates were based on recommendations from the Midwest Cover Crop Selection Tool[1] for Cherokee County, KS, and adjusted to account for multiple species. Seeds were planted with a 10-ft Great Plains no-till drill at the following rates: winter barley, 30 lb/a; winter oats, 37.5 lb/a; cereal rye, 30 lb/a; winter wheat, 30 lb/a; tillage radish, 3 lb/a; purple-top turnip, 2.3 lb/a; berseem clover, 3.7 lb/a; and Austrian winter pea, 19 lb/a.

Total above-ground plant material was collected at three times: 45, 74, and 92 days after planting (DAP) and analyzed for total forage biomass; biomass of each of the cover crop types was analyzed using standard procedures (Farney et al., 2018a). Forage quality was measured as acid detergent fiber (ADF), neutral detergent fiber (NDF), and nitrogen (N). Crude protein (CP) was calculated from total N and total digestible nutrients (TDN) were calculated from ADF. Cost of producing the total dry matter (DM) and percent CP was based on cost of seed for each mixture.

Results and Discussion

Total dry matter biomass production varied by year (Figure 1). The weather was warmer in 2014 than in 2015, and more biomass was produced in 2014 than in 2015. The brassicas had more growth in 2014 that reduced the growth of the grasses. In 2015, more biomass was produced by the grasses than by the brassicas. The grasses continued to grow even as temperatures decreased with later DAP, while the brassica production in 2014 slowed later in the growing period. The legumes contributed very little to the total biomass in either year, but did show slightly more growth in 2015, when the brassica's growth was less.

The barley and oats had the most biomass production in both years of the study (Figure 2). While the radish had more growth than the turnip in both years, only a significant

[1]Midwest Cover Crop Selection Tool at http://mccc.msu.edu/covercroptool/covercroptool.php.

portion of total biomass was produced by radish in 2014. Clover grew well in 2015; pea did not contribute much biomass in either year of the study.

Total dry matter increased as expected with later DAP, reducing cost per ton of dry matter (Figure 3). Interestingly, no difference was observed in either TDN or NDF at any of the sampling DAP. Crude protein decreased with DAP, as the total biomass increased. Cost per ton of protein was optimal at 74 DAP.

Total biomass produced was greatest in the mixes containing oats (Figure 4). Dry matter production was most expensive in the rye/pea/turnip mix, at $59/ton dry matter. The least expensive biomass production was the oats/clover, and either radish ($18) or turnip ($14.20). This was followed closely by the barley/clover, and either radish ($21.40) or turnip ($20.80).

Percent crude protein tended to be higher in the rye and wheat mixes, and less in the oat and barley mixtures. The overall range of crude protein was small; it varied from a low of 18% in the barley/clover/radish mix to a maximum of 24.7% in the rye/clover/turnip mixture. However, the cost per ton of protein was variable, with the most expensive in the rye/turnip/pea mixture at $266.40/ton protein. Crude protein was the least expensive to produce in the oat/turnip/clover mix at $76.60. Overall, the oat/clover and barley/clover mixes were the least expensive mixes to produce both dry matter and protein. The most expensive mixes included rye/pea and wheat/pea.

All of the mixtures would provide enough protein and fiber for cattle needs. Given the strong biomass and protein production and least cost, oat and barley are good choices for cover crops for fall grazing. By producing more biomass, these plants would provide more grazing capacity and potentially provide greater revenue per acre. Addition of a brassica is useful for improving soil health, but does add additional expense. Also, note that cattle do not prefer to graze brassicas prior to a frost due to their bitter taste. Legumes, while useful in providing nitrogen, did not add much biomass. The cost per acre of planting the legumes was comparable to that of the grasses, so including legumes in the mix would double the cost of planting the cover crops, without significantly increasing either the protein or the biomass produced (Farney et al., 2018b).

Acknowledgments

The authors would like to thank Lonnie Mengarelli and Garth Blackburn for their assistance in field management and data collection. We gratefully acknowledge the collaboration of Dr. Doohong Min for allowing Cathryn Davis to use forage testing equipment in his laboratory. This work is supported by the USDA National Institute of Food and Agriculture, Hatch project 1003478. Additional funding for this material is based upon work that is supported by the National Institute of Food and Agriculture, USDA, under award number 2013-69002-23146.

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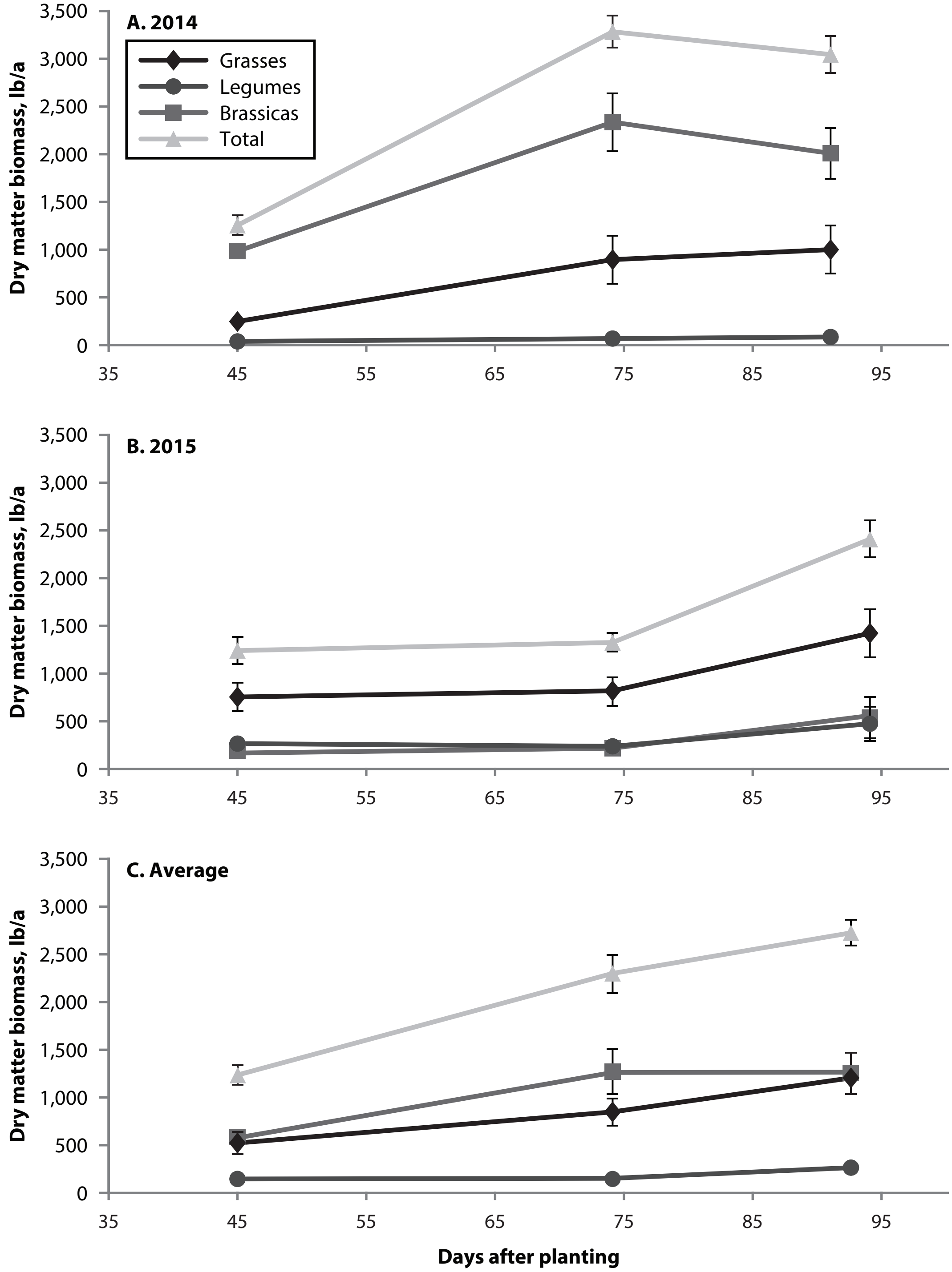

Figure 1. Forage dry matter biomass production, lb dry matter/acre, in the cover crop mixtures for days after planting for (A) 2014, (B) 2015, and (C) the two-year average.

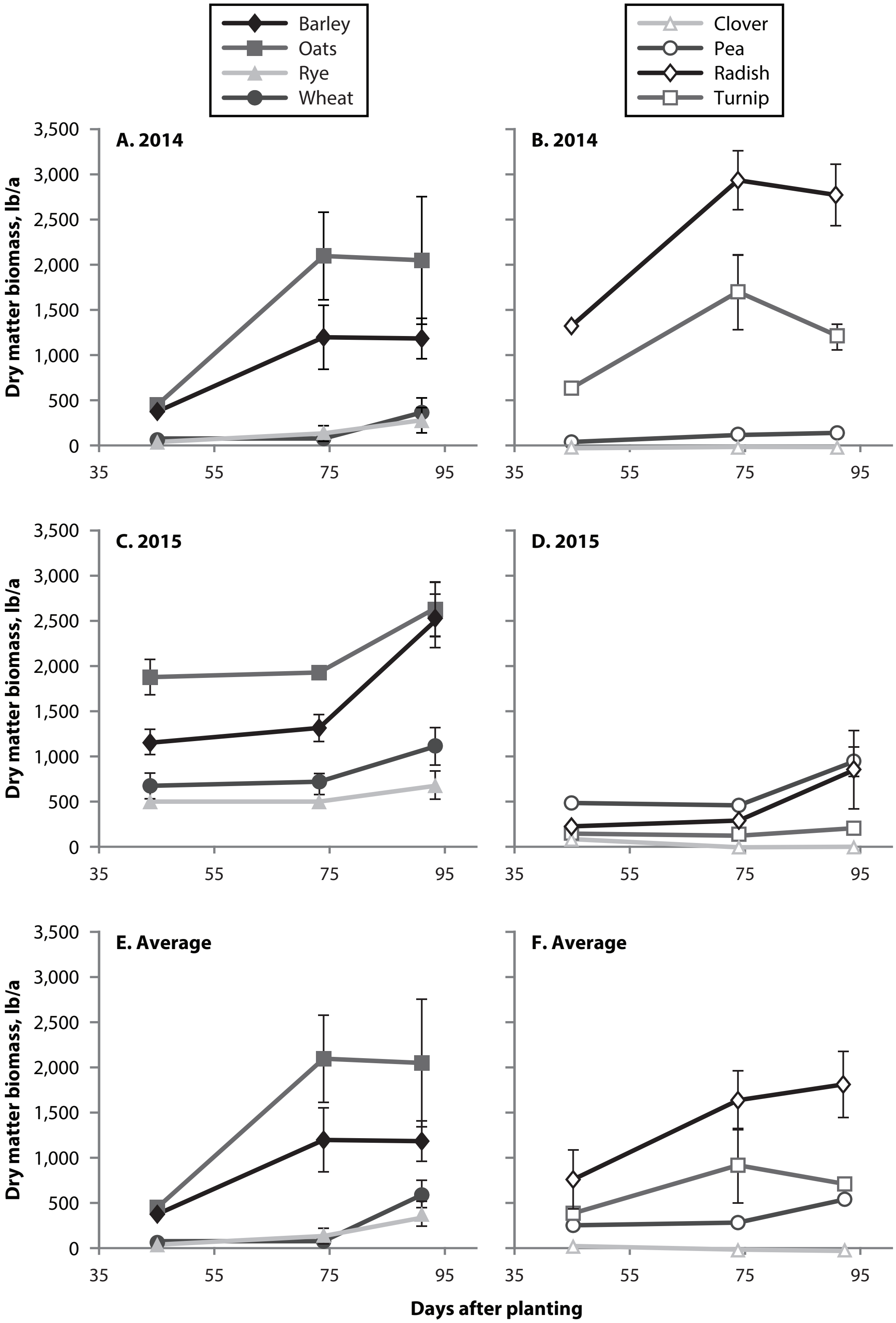

Figure 2. Forage dry matter biomass production, lb dry matter/acre, for each of the cover crops in the mixtures for days after planting for 2014 (A, B); 2015 (C, D) and the two-year average (E, F) for grasses (A, C, E); and brassicas and legumes (B, D, F).

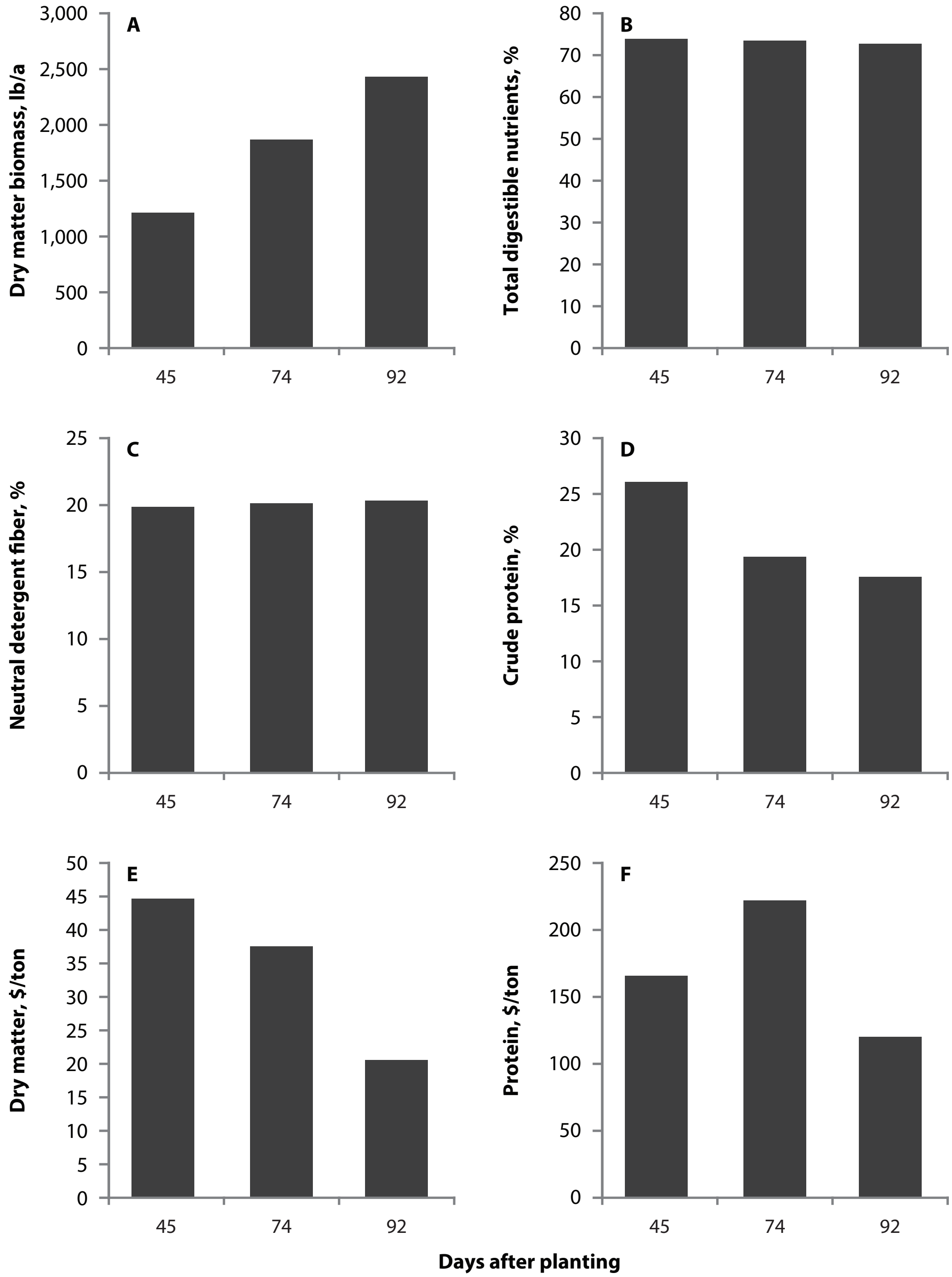

Figure 3. Change in forage biomass, quality, and cost for days after planting for (A) total forage dry matter biomass, lb dry matter/acre; (B) total digestible nutrients, %; (C) neutral detergent fiber, %; (D) crude protein, %; (E) cost per ton of dry matter produced, $/ton; and (F) cost per ton of protein produced, $/ton.

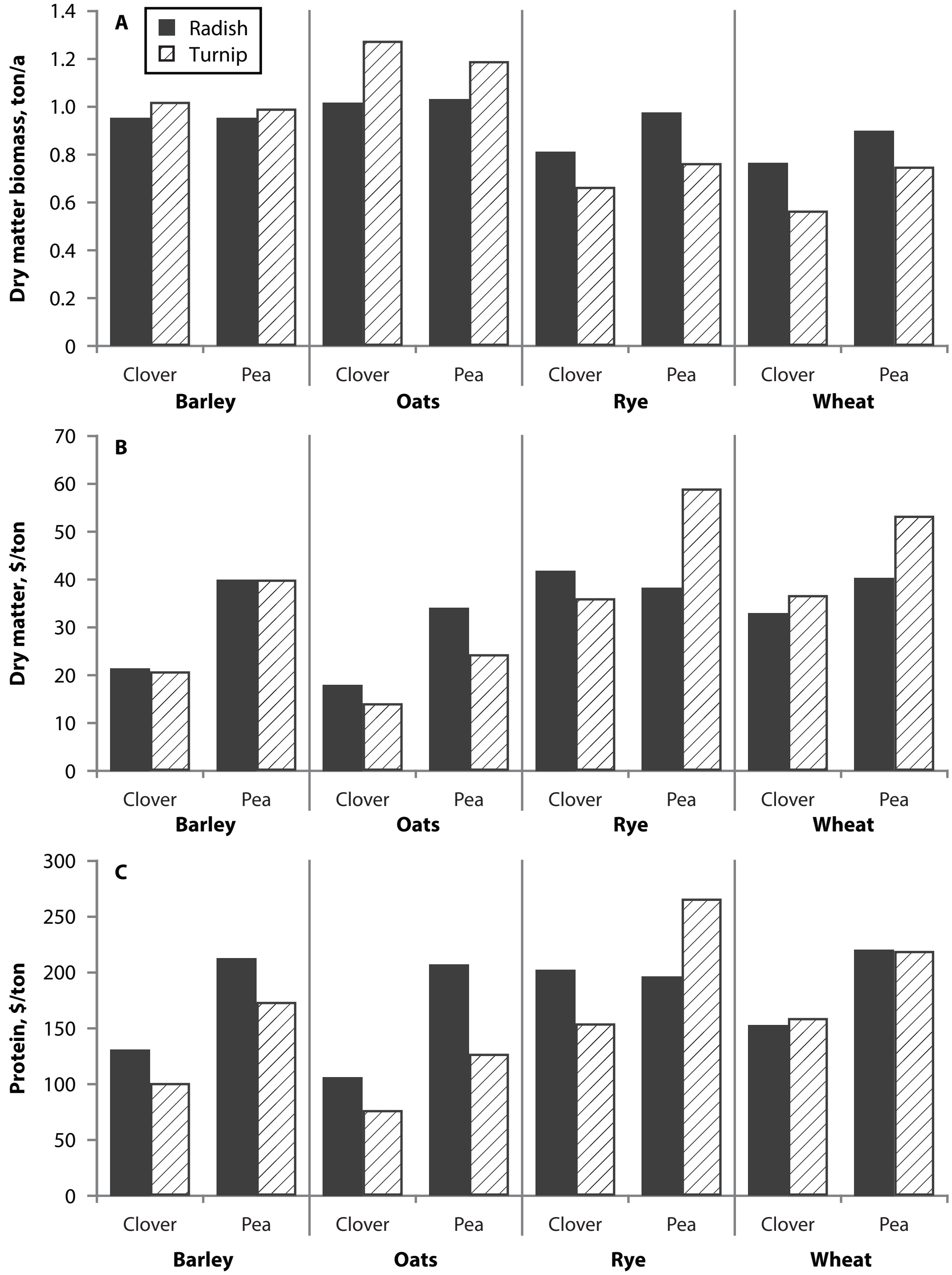

Figure 4. Forage biomass production and cost of cover crop mixes, averaged across both years. (A) Forage biomass dry matter production, lb dry matter/acre; (B) cost per ton of dry matter, $/ton; and (C) cost per ton of protein, $/ton.