FORAGE YIELD OF UNFERTILIZED PERENNIAL CROPS IN SIMPLE AND COMPLEX MIXTURES UNDER TWO MANAGEMENT STRATEGIES IN NORTHEASTERN SASKATCHEWAN

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Abstract

A field experiment was sown on May 27, 2008 at Melfort, Saskatchewan (52^{O}44'N 104^{O}47'W) on a thick Black Chernozem (Udic Boroll) silty clay soil to compare the effects of perennial forage crop monocultures and mixtures on dry matter yield (DMY) under two-cut and three-cut management systems in 2009, 2010 and 2011. The 11 treatments were consisted of monocultures of alfalfa, crested wheatgrass, hybrid bromegrass, intermediate wheatgrass, smooth bromegrass and in mixtures with alfalfa; a more complex mixture of smooth and hybrid bromegrass, intermediate and crested wheatgrass and alfalfa, and finally a very complex mixture consisting of the complex mixture plus orchardgrass, tall fescue, timothy, meadow bromegrass and slender wheatgrass. The alfalfa was inoculated with rhizobium, and no fertilizer was added to any treatment during the course of this study. In 2009, the first cutting year, all treatments produced similar forage DMY, with the monoculture grasses yielding almost as much as that of their mixture with alfalfa. In 2010 and 2011, monoculture alfalfa was the highest yielding treatment under both two and three cut methods. The two cut system yielded higher in all years for both treatments, except alfalfa in 2010. The complex and very complex mixtures yielded higher than the monoculture grass treatments, but did not yield higher than the simple alfalfa grass mixtures or the monoculture alfalfa treatment. In conclusion, the inclusion of alfalfa in unfertilized grass mixtures increased forage yield, especially after the first year.

Rationale and Objective

In Saskatchewan, there are a number of grass and legume species/cultivars available for hay and pasture. Most often one or two grass species are used in a mixture with alfalfa for hay/pasture. Improved forage yield is one of the benefits of sowing a grass-legume mixture, while the mixtures also improve feed quality. Legumes have higher protein content than grasses and as a result the protein requirements of growing animals can be met to a large degree by adequate legumes in the forage mix. Research has shown that mixtures of grasses were more competitive against weed invasion than were monocultures of the same species. Smooth bromegrass is still often seeded with alfalfa for hay/pasture in Northeastern Saskatchewan, but increasing species richness in perennial mixtures can increase productivity and weed suppression. Simple mixtures of two to four species may offer the best means to provide plant diversity and yet limit seedling competition. The objective of this study was to determine the forage yield of unfertilized grass, alfalfa, and a simple and complex grass-alfalfa mixture, when cut either two or three times during the growing season on a Black Chernozem soil at Melfort, Saskatchewan.

Materials and Methods

A 3-year field experiment was seeded on wheat stubble on May 27, 2008 on a thick Black Chernozem (Udic Boroll) silty clay soil at the Agriculture and Agri-Food Canada Research Farm, Melfort, Saskatchewan ($52^{O}44'$N $104^{O}47'$W). Precipitation in the growing season (May to September) was near average in 2009, above average (wet) in 2010 and below average in 2011. Air temperature was slightly cooler in 2009 and 2010 and slightly warmer in 2011 (Environment Canada).

Eleven treatments (in a randomized complete block design, with four replications in 2 m x 10 m plots) of perennial forage crop monocultures and mixtures were consisted of monocultures of alfalfa (AL), crested wheatgrass (CW), hybrid bromegrass (HB), intermediate wheatgrass (IW), smooth bromegrass (SB) and in mixtures with alfalfa; a more complex mixture (CM) of smooth and hybrid bromegrass, Intermediate and crested wheatgrass and alfalfa, and finally a very complex mixture (VCM) consisting of the complex mixture plus orchardgrass, tall fescue, timothy, meadow bromegrass and slender wheatgrass. The alfalfa was inoculated with rhizobium, and no fertilizer was added to any treatment during the course of this experiment. Seeding rates for each perennial crop are presented in Table 1.

Forage was managed as two-cut (clipping in early July and mid September) and three-cut (clipping in mid June, late July and mid September) systems. Forage dry matter yield (FMY) was determined by clipping the centre 1.5 m of each plot to 5 cm height using a sickle type forage harvester. Plant samples were weighed and about 200 g sub-sample from each plot was dried in a forced air oven at 60^{o}C for DMY calculations. The data on forage DMY was subjected to analysis of variance (ANOVA) using GLM procedure in SAS. Least significant difference ($LSD_{0.05}$) was used for mean separation for each parameter.

Summary of Results

In 2009, the first cutting year, all treatments produced similar forage DMY, with the monoculture grasses yielding almost as much as that of their mixture with alfalfa. In 2010 and 2011, monoculture alfalfa was the highest yielding treatment under both two- and three-cut systems. The two-cut system yielded higher than three-cut system in all years, except alfalfa in 2010. The complex and very complex mixtures yielded higher than the monoculture grass treatments, but did not yield higher than the simple alfalfa grass mixtures or the monoculture alfalfa treatment.

Conclusions

In 2009, the first cutting year, all treatments produced similar forage DMY, with the monoculture grasses yielding almost as much as that of their mixture with alfalfa. In 2010 and 2011, monoculture alfalfa was the highest yielding treatment under both two- and three-cut systems. The two-cut system yielded higher than three-cut system in all years, except alfalfa in 2010. The complex and very complex mixtures yielded higher than the monoculture grass treatments, but did not yield higher than the simple alfalfa grass mixtures or the monoculture alfalfa treatment.

Acknowledgements: We thank Brett Mollison for technical help.

Table 1. Seeding rates of monocultures and mixtures sown in spring 2008 at Melfort, Saskatchewan

Monocultures and simple mixtures		Complex mixture		Very complex mixture	
Species	Seed rate (kg ha^{-1})	Species	Seed rate (kg ha^{-1})	Species	Seed rate (kg ha^{-1})
Alfalfa	8.96	Alfalfa	3.36	Alfalfa	3.36
Smooth brome	7.84	Smooth brome	2.24	Smooth brome	1.12
Hybrid brome	8.96	Hybrid brome	2.24	Hybrid brome	1.12
Crested wheatgrass	6.72	Crested wheatgrass	2.24	Meadow brome	1.12
Intermediate wheatgrass	11.20	Intermediate wheatgrass	3.36	Crested wheatgrass	1.12
Smooth brome + Alfalfa	6.72 + 3.36			Intermediate wheatgrass	1.12
Hybrid brome + Alfalfa	7.84 + 3.36			Slender wheatgrass	1.12
Crested wheatgrass + Alfalfa	5.60 + 3.36			Tall fescue	1.12
Intermediate wheatgrass + Alfalfa	7.84 + 3.36			Orchard grass	1.12
				Timothy	1.12

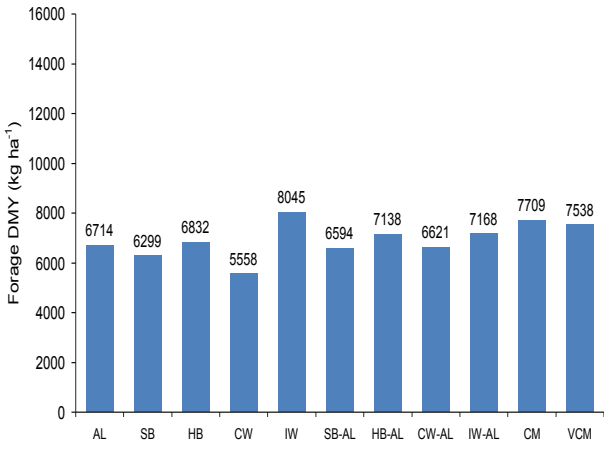

Figure 1. Yield of forage crops and mixtures cut two times/season at Melfort in 2009 (LSD0.05 = 1013).

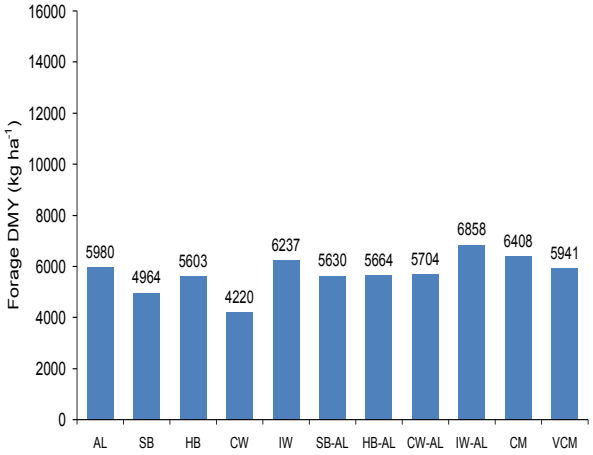

Figure 2. Yield of forage crops and mixtures cut three times/season at Melfort in 2009 (LSD0.05 = 1013).

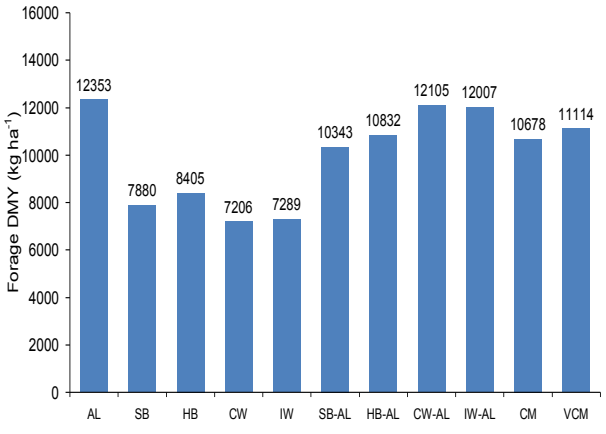

Figure 3. Yield of forage crops and mixtures cut two times/season at Melfort in 2010 (LSD0.05 = 2091).

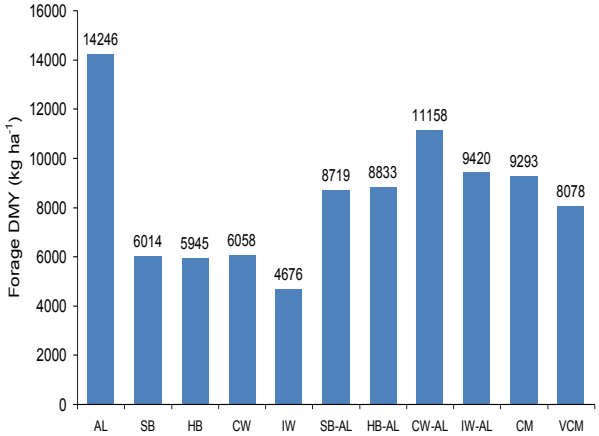

Figure 4. Yield of forage crops and mixtures cut three times/season at Melfort in 2010 (LSD0.05 = 2091).

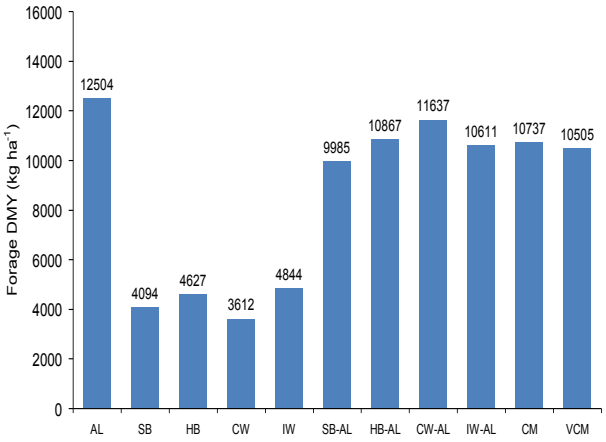

Figure 5. Yield of forage crops and mixtures cut two times/season at Melfort in 2011 ($LSD_{0.05}$ = 1405).

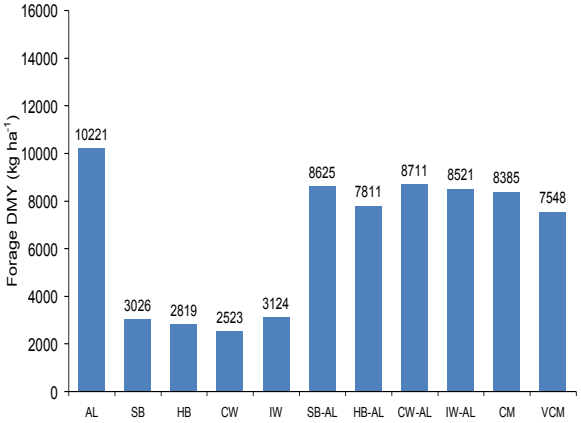

Figure 6. Yield of forage crops and mixtures cut three times/season at Melfort in 2011 ($LSD_{0.05}$ = 1405).

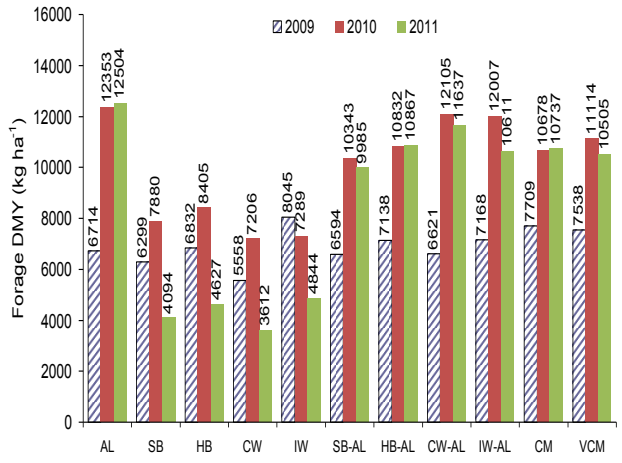

Figure 7. Yield of forage crops and mixtures cut two times/season at Melfort.

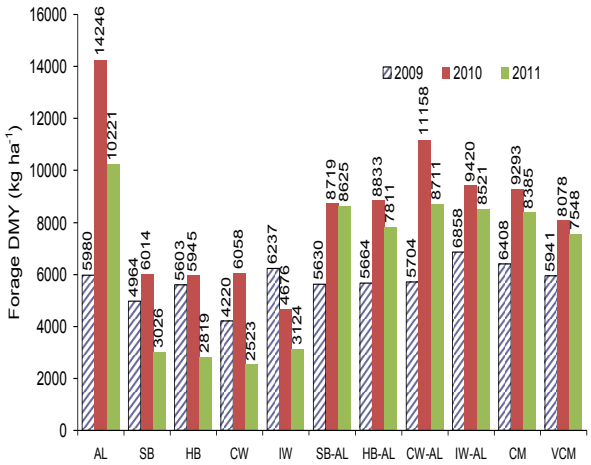

Figure 8. Yield of forage crops and mixtures cut three times/season at Melfort.