Barley After Hay: Grass Matters!

P.G. Jefferson[1], R. Lemke[1], R.P. Zentner[1] and F. Selles[1]

[1] Agriculture and Agri-Food Canada, Semiarid Prairie Agricultural Research Centre, Box 1030, Swift Current, SK, S9H 3X2

Key Words: forage, crop rotation, nitrogen

Abstract

Perennial forage crops are not traditionally grown in crop rotations in the Brown soil zone for several reasons: i) they are slow to establish; ii) they require intensive tillage to terminate; and iii) they reduce yield of subsequent crops. Short-lived perennial forages that possess rapid establishment characteristics could be used for 3 years of hay production with easier rotation to an annual crop. An experiment seeded in 1998 at the Semiarid Prairie Agricultural Research Centre with three short-lived grasses grown in monoculture or with two alfalfa cultivars was terminated by herbicide or tillage in May 2002, and subsequently seeded to barley. Visual observations prior to stand termination indicated that slender wheatgrass (SWG) and Dahurian wildrye (DWR) ground cover had declined but intermediate wheatgrass (IWG) was generally over 90% of the original. Barley yield was 17 bu/ac on plots previously in IWG compared to 26 and 28 bu/ac on plots previously in DWR and SWG, respectively. IWG reduced straw yield, harvest index, and test weight compared to SWG and DWG. Grass mixtures with Beaver alfalfa yielded 30 bu/ac compared to 21 and 19 bu/ac for Nitro alfalfa and grass monocultures. Barley grown on previously Beaver alfalfa mixtures also had higher straw yield, harvest index, and test weight compared to that grown on plots from the other two mixtures. These preliminary results suggest that short-lived grasses (DWR and SWG) may fit in crop rotations better than longer lived species (IWG) and that inclusion of alfalfa may, in fact, increase subsequent barley yields in this semiarid region.

Introduction

Shortly after the introduction of annual cropping to the semiarid Brown soil zone, concerns were raised about the inclusion of perennial forages in crop rotation. The advantages of forages in building soil organic matter, breaking disease and pest cycles, and providing feed for ruminant livestock production was well-known for humid and sub-humid environments. However, by 1935 Clarke concluded that "*no attempt should be made to fit these grass crops into a short rotation. They should be left for 8 or 10 years or more...*" based on his observations at the Dominion Experimental Farm at Swift Current and the Range Station at Manyberries, Alberta (Clarke 1935). Wheat grain yield on fallow after 'breaking' crested wheatgrass was 25% lower than that in a conventional wheat-fallow rotation (Kilcher and Anderson 1963). It took 3 cycles of wheat-fallow (i.e. six years) after the crested wheatgrass was terminated for the wheat yields

to equal those from wheat-fallow. As a result of these observations and recommendations, grain producers in the Brown soil zone have not included perennial forages in their crop rotations. Local or short-term demands for forage production have been addressed with "Green Feed" production using wheat, oats, fall rye, and triticale.

Producers frequently comment that perennial grasses, such as crested wheatgrass, require a year or more to become established in new stands. Short-lived perennial grass species, such as Dahurian wildrye (DWR) and slender wheatgrass (SWG) exhibit improved seedling vigour and can be established with annual companion crops or nurse crops that avoid a loss of cash crop production during the forage establishment year (Jefferson et al. 2002). Including alfalfa in mixture with these grasses increases forage yield over grass alone (Jefferson et al. 2002). Results from Manitoba suggest that yield and N content of cereal crops could be enhanced following forage legumes (Bullied et al. 2002). If annual crops could be seeded following short-lived grasses, then "short rotation" forage production might yet be feasible in the Brown soil zone.

The objective of our research was to determine barley grain yield and protein concentration following three years of forage production from DWR, Intermediate wheatgrass (IWG), or SWG grown alone or in mixture with alfalfa cv. Beaver or Nitro.

Materials and Methods

The site at Swift Current was a Swinton silt loam soil that had been seeded to Short Rotation forage mixtures in 1998 (Jefferson et al. 2002). The original experimental design was a split-split-plot with companion crops as the main effect, grass species as the subplot effect, and alfalfa mixture as the sub-subplot. Forage yields were harvested from 1999 to 2001. Due to very dry conditions in April and May 2002, spraying and seeding was delayed. On 04 June 2002, the plot area was sprayed with Roundup at 1 L/ac followed by a second treatment of Rustler at 1 L/ac on 07 June. On 17 June, 2002 two replications (½ of the original experiment) was rototilled, cultivated, and harrow-packed to create a tillage treatment. The other two replications were not tilled. The experiment was seeded on 17 June to barley, cv. Harrington, at 80 lbs/ac using an zero-till air drill with 9 inch row spacing. No fertilizer was applied in order to determine if N benefits could be obtained from the previous alfalfa. Broadleaf weeds including alfalfa escapes were observed so the experiment was sprayed with 2,4-D/Banvel at the recommended rate on 07 July 2002.

Precipitation was 150 mm above average from June through September so crop maturity was delayed until late September. Aboveground biomass was determined on 2 sub-samples (0.25 m quadrats) per plot by hand harvesting on 27 September 2002. Grain yield was determined by combining 20 foot strip from the center of each sub-subplot on 09 October 2002. Grain and straw protein was determined by micro-Kjeldahl. Bushel weight was determined by standard techniques. Harvest index was calculated from biomass and grain yield estimates. Nitrogen uptake was determined from straw and grain N concentrations and biomass production.

Data were analyzed using JMP software (SAS Institute Inc. Cary, NC, USA). Mean separation was determined by Fisher's Protected LSD with 0.05 probability of type I error. For the purposes

of this presentation, tillage effects are not reported.

Results and Discussion

Intermediate wheatgrass produced more forage in the first year and over three years of the forage stand than DWR or SWG (Table 1.) It was observed in the spring of 2002 that ground cover of DWR or SWG had declined sharply from the previous year. This is consistent with the reported short-lived perennial nature of these species. It also appeared that emergence and stand density of the barley crop were superior following these two grasses.

Barley biomass yield was largest following SWG and least following IWG stands in 2002. Barley grain production, bushel weight, and harvest index were significantly lower following IWG compared to DWR or SWG stands. Barley grain production was 40% less following IWG compared to SWG. This is similar to the wheat yield reduction following crested wheatgrass breaking observed by Kilcher and Anderson (1963). Barley grain protein was not affected by the prior grass species but straw protein was higher following IWG.

Table 1. Forage yield of three grasses in 1998 and mean over 3 years, barley yield, harvest index, and barley quality in 2003 following three grasses.

Variable	Grass Species			
Forage production	DWR	IWG	SWG	LSD
DM yield 1999 (t ac^{-1})	0.29	0.57	0.38	0.06
Mean DM yield 99-01 (t ac^{-1})	1.14	1.26	1.12	0.09
Barley production				
Biomass yield (t ac^{-1})	1.67	1.21	1.84	0.09
Grain yield (bu ac^{-1})	25.6	16.8	27.7	1.4
Bushel weight (lb bu^{-1})	43.1	37.2	42.5	1.0
Harvest Index	0.34	0.23	0.32	0.01
Grain protein (%)	9.2	9.1	9.2	NS
Straw protein (%)	3.2	4.1	3.4	0.2

Beaver alfalfa mixtures produced more forage in the first year of forage production and over the three years of the forage stand. Nitro alfalfa did not persist after 1999 which is consistent with it's non-winterhardy rating. Forage production from the DWR/Beaver or SWG/Beaver plots was

mostly alfalfa by 2001 as the grass contribution to forage yield was less than 30% (data not shown).

Barley grain yield, biomass yield, bushel weight and harvest index in 2002 were greater following Beaver alfalfa mixtures than following Nitro mixtures or grass alone (Table 2). There was no difference in grain protein but straw protein concentration was lower in barley following Beaver mixtures. This appears to be the result of dilution with the larger biomass production as suggested by the larger N uptake observed following Beaver alfalfa mixtures compared to Nitro mixtures or grass alone.

Table 2. Forage yield of three alfalfa mixtures with grasses in 1998 and mean over 3 years, barley yield, harvest index, and barley quality in 2003 following three mixtures.

Variable	Alfalfa cultivar			
Forage production	Beaver	Nitro	None	LSD
DM yield 1999 (t ac^{-1})	0.58	0.28	0.37	0.06
Mean DM yield 99-01 (t ac^{-1})	1.56	0.98	0.98	0.13
Barley production				
Biomass yield (t ac^{-1})	1.97	1.47	1.28	0.09
Grain yield (bu ac^{-1})	29.8	21.1	19.2	1.4
Bushel weight (lb bu^{-1})	42.3	40.8	39.7	0.8
Harvest Index	0.33	0.28	0.28	0.02
Grain protein (%)	9.3	9.1	9.1	NS
Straw protein (%)	3.4	3.7	3.6	0.2
N uptake (lb ac^{-1})	33.3	24.5	21.0	1.9

Barley grain yields and bushel weights were lower than expected in this experiment especially in light of higher than average rainfall during the growing season. However, this was consistent with producers observations for barley crops in 2002. While preliminary, these results support our hypothesis that short-lived forage species, such as DWR or SWG, in combination with a winter-hardy alfalfa could be successfully utilized for "Short Rotation" hay production in the semiarid Brown soil zone of Saskatchewan.

References

Bullied, W.J., Entz, M.H., Smith, S.R.Jr. and Bamford, K.C. 2002. Grain yield and N

benefits to sequential wheat and barley crops from single-year alfalfa, berseem and red clover, chickling vetch and lentil. Can. J. Plant Sci. **82**:53-65.

Clarke, S.E. 1935. Forage crop production in a dry farming programme. Sci. Agric. **16**:161-164.

Jefferson, P., Pearse, G., Pastl, R. and Lyon, G. 2002. Establishment of Short Rotation Forage Crops. Proceedings of Soils and Crops Workshop. University of Saskatchewan. 4 pp.

Kilcher, M.R. and Anderson, L.J. 1963. Wheat yields and soil aggregation after perennial grasses in a semi-arid environment. Can. J. Plant Sci. **43**:289-294.