Improving the feeding value of dryland lucerne in Australia

HC Norman [A], SJ Hughes [B], E Hulm [A], AW Humphries [B], K Oldach [B], DK Revell [A], Z Durmic [C], J Vadhanabhuti [C] and PE Vercoe [CD]

[A] CSIRO Animal, Food and Health Sciences, Private Bag 5, Wembley WA 6913 Australia
[B] SARDI Livestock Feed & Forage, GPO Box 397 Adelaide SA 5001 Australia
[C] School of Animal Biology, University of Western Australia, 35 Stirling Highway, Crawley, WA, 6009 Australia
[D] Institute of Agriculture, University of Western Australia, 35 Stirling Highway, Crawley, WA, 6009 Australia
Contact email: Hayley.Norman@csiro.au

Keywords: Lucerne, feeding value, plant improvement.

Introduction

Lucerne (*Medicago sativa* L.) is the most widely grown perennial legume species in southern Australia. Within Australian farming systems it plays an important role in the provision of high-quality feed for livestock, nitrogen fixation and dewatering soils to reduce watertable recharge and dryland salinity (Cocks 2001). The majority of lucerne varieties have been developed for the areas with high rainfall or supplementary irrigation. The new challenge is to develop lucerne cultivars specifically for dryland mixed farming systems in temperate and mediterranean climate zones (Humphries and Auricht, 2001). Persistence in these environments and feeding value to sheep are critical selection traits. In this paper we compare nutritive traits of 35 commercial and experimental accessions of lucerne, sampled during the vegetative phase, and test the hypothesis that there will be significant differences between the accessions for *in vitro* dry matter digestibility (DMD), crude protein (CP), acid detergent fibre (ADF), neutral detergent fibre (NDF) and hemicellulose.

Methods

Plant growth and sampling

The field work was located in the SARDI Genetic Resources field nursery, at the Waite Institute, Urrbrae, South Australia. Three hundred seeds of each of accession were scarified, inoculated and sown into Petri dishes between the 10th and 27th of June 2011. After 3-5 days up to 200 viable seedlings were transferred into seedling trays and grown in a glasshouse. Seedlings were planted by hand on 24th August 2011 into an experimental field following a randomised block design with 3 plot replicates of each accession. Plots were 1.8 m x 0.8 m in size and each plot contained 50 plants spaced in a 20 x 20 cm grid formation. Soil test levels of P, K and S were at recommended levels and weed & insect control was preformed prior to planting. A cleaning cut on each lucerne plot was carried out on the 20th November 2011, using a sickle bar mower. No measurements were taken and the objective was to normalise all plots to minimise any potential differences in seed health, establishment and recovery. Primary vegetative regrowth was measured four weeks after the cleaning cut, when there was sufficient biomass and all plants were in a vegetative physiological state. The central 15 plants of each plot were cut at 3 cm height above the ground. Herbage from the 15 plants per plot was pooled, freeze-dried, weighed and ground to pass 1 mm screen.

Nutritive value and statistical analyses

DMD was estimated using the pepsin-cellulase digestion method based on Klein and Baker (1993). Samples were run in duplicate with a subset of 7 Australian Fodder Industry Association standards (consisting of lucerne and annual legumes) with known *in vivo* DMD (AFIA, 2007). Using these standards, the pepsin-cellulase DMD was linearly adjusted to predict *in vivo* DMD. The energy value of the sample was estimated by the equation: M/D = (0.172*DMD) - 1.707 (SCA, 2007). Total nitrogen was determined by combustion using a Leco FP-428 N Analyser (Sweeney and Rexroad, 1987). CP was estimated by multiplying total N by 6.25. Concentrations of NDF and ADF were measured sequentially, according to operating instructions, using an Ankom 200/220 Fibre analyser (Ankom® Tech. Co., Fairport, NY, USA). Hemicellulose was calculated by NDF minus ADF. The concentrations of organic matter (OM) were determined according to the methods of Faichney and White (1983).

Results

Of the nutritive traits, there was significant variation between lucerne accessions for *in vitro* DMD (hence predicted M/D), CP, ADF, NDF, hemicellulose and ash (Table 1). Using the ruminant feeding model GrazFeed (Freer *et al.* 1997), it is predicted that a pregnant Merino ewe (day 100 of gestation) fed the accession with the highest DMD would eat 1.2 kg of DM per day and grow at a rate of 210 g/week. In contrast the same ewe eating the accession with the lowest DMD would eat 0.97 kg of DM per day and lose 112 g/week. For mature, non reproducing sheep, the difference in weight gain would be 3-fold (125 g gain/week on the lowest quality lucerne and 440 g/week for the highest quality lucerne). Estimated M/D values range from 9.34 to 10.75 MJ ME/kg DM. DMD was positively correlated to CP and (as expected) negatively correlated to ADF and NDF

Table 1. Grand mean among 35 accessions, minimum and maximum mean values and significance of differences from AVOVA.

	DMD (%)	CP (%)	Ash (%)	NDF (%)	ADF (%)	Hemi (%)	DM (g)
Grand mean	69.5	22.7	11.7	31.6	24.4	7.2	114
Lowest accession	64.2	17.4	9.9	26.9	21.1	5.7	74
Highest accession	72.5	26.8	13.6	40.2	31.0	9.2	145
Sig. of diff.	*P*<0.001	*P*<0.001	*P*<0.001	*P*<0.001	*P*<0.001	*P*<0.05	ns

Table 2. Correlations between nutritive traits and vegetative growth. Figures in bold: *P* <0.001, other figures *P*<0.05 and ns is not a significant correlation.

	DMD	ADF	Ash	CP	NDF	Hemi.
DM production	ns	ns	-0.31	ns	ns	ns
Hemi.	**-0.48**	**0.60**	0.27	ns	**0.81**	-
NDF	**-0.78**	**0.96**	ns	**-0.42**	-	
CP	**0.55**	**-0.52**	0.25	-		
Ash	ns	ns	-			
ADF	**-0.82**	-				

(Table 2). Crude protein ranged from 18 to 23 %, and all would meet the estimated crude protein requirements of reproducing ewes and growing lambs.

Of the morphological traits, there were no significant differences in biomass production between the accessions at the vegetative phase.

Conclusion

The results of this pilot project suggest that significant genetic variation exists within Australian commercial cultivars and experimental accessions for digestibility and feed quality related traits. The range in digestibility values (64 to 72%) is biologically and economically significant, given similar levels of biomass production. As anticipated, digestibility was positively correlated to crude protein and negatively correlated to fibre content. We are now quantifying *in vitro* methane production from the fermentation of all the accessions by rumen microbes. It should be possible to exploit variation in nutritive value through cultivar selection to optimise profitability while possibly reducing methane emissions intensity within systems.

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