Root biomass production, root distribution, and soil water dynamics of three alternative perennial pasture legumes in comparison with *Medicago sativa* during their early growth

G.Y. Wijaya, **W.D. Bellotti***, and D.R. Coventry.

Department of Agronomy and Farming System,
The University of Adelaide, Roseworthy, South Australia 5371, Australia.
www.roseworthy.adelaide.edu.au/AFS/. Email (corresponding author*).william.bellotti@adelaide.edu.au

Abstract

The purpose of this research was to determine if alternative perennial legumes may be better adapted to the common subsoil constraints found in agricultural soils of southern Australia. During December 2000-July 2001, three alternative perennial pasture legume species i.e. *Hedysarum coronarium*, *Melilotus alba*, and *Dorycnium rectum*, were compared with *Medicago sativa* for root growth and soil-water dynamics at Roseworthy, South Australia. None of the species tested had a significant advantage over lucerne under these soil and climatic conditions. Persistence of the alternative species was poor, with none of the species maintaining an adequate plant density after just one year.

Key Words
Subsoil constraints, recharge reduction.

Introduction

Medicago sativa (lucerne) has been the first choice among pasture plants for reducing drainage in recharge areas (1). However as the cost and area of dryland salinity increases, there is a need to expand the choice of species that can be sown to reduce recharge (2). *Hedysarum coronarium*, *Melilotus alba*, and *Dorycnium rectum* are perennial pasture species from the Mediterranean region that have been known to have similar characteristics to lucerne (3). The experiment reported here compared the root growth and soil-water dynamics of these species with lucerne on a soil with known subsoil constraints at Roseworthy, South Australia.

Methods

The experiment was located on Roseworthy Campus in paddock East 3. The soil was characterised by alkalinity (pH_w 7.2-10.2), salinity (EC 0.39-1.55 dS/m^2), sodicity (ESP 3.5-11% in top 10cm), high boron (1.70-21.90 mg/kg soil) and was a texture contrast soil (sandy loam at top 30cm and light clay to sandy clay loam below 30 cm).

The four species were sown by hand in January 2001 into plots measuring 5x5 m at a density of 8 plants m^{-2} and replicated four times. A fallow treatment was included in the randomised complete block design. On July 20, 2001, roots were sampled by two cores with 6.8 cm internal diameter from each plot in a 1m^2 quadrat of uniform perennial legume population, directly over the plants, and between four plants (5cm from the edge of the first core) to a depth of 150cm (4). The root samples obtained were analysed using a computerized root scanning system (5).

Soil water was monitored by neutron moisture meter (NMM) Campbell-Pacific Nuclear-503 DR Hydroprobe during December 2000-July 2001 (6). An aluminium tube 5cm external diameter was installed at the centre of each plot to a depth of about 3m and soil water contents were measured fortnightly at depth intervals of 15, 30, 50, 70, 90, 120, 160, 200, 240, and 280. Bare plots were used as a control.

Results

H. coronarium produced significantly higher main root biomass (842 kg/ha) than *M. sativa* (700 kg/ha) and *M. alba* (329 kg/ha) which produced significantly lower root biomass than all other species (Table 1). *M. alba* (42 kg/ha) and *M. sativa* (57 kg/ha) produced significantly higher lateral root biomass than *H. coronarium* (34 kg/ha) and *D. rectum* (38 kg/ha) (p<0.05). Similar distribution patterns (data not shown) of main root systems were shown with *M. sativa*, *H. coronarium*, and *M. alba,* while *D. rectum* had higher root biomass at each depth, especially below 60cm.

Table 1. Biomass of main and lateral roots of *D.rectum, H. coronarium, M. alba, M. sativa* (July 2001)

Species	Main root system		Lateral root system	
	(kg/ha)	s.d.	(kg/ha)	s.d.
D.rectum	811	853	38	10
H.coronarium	842	122	34	7
M. alba	329	177	42	12
M. sativa	700	313	57	34

The soil profiles under the perennials were wetter for longer periods than under fallow during summer 2000-2001 until early autumn, especially at 0 to 30-40cm depths (Figure 1). Thereafter, during autumn 2001, the perennials had drier profiles down to 50-60cm compared to the fallow treatment. *H. coronarium* had the driest soil profile at the top 40cm in winter while other perennials showed lower water content at depths between 120-150cm compared to *H. coronarium*. For example, volumetric water content on the 9th July at 70 cm depth was 0.24 under *H. coronarium* compared to 0.29 under fallow. The other three species were in between this range.

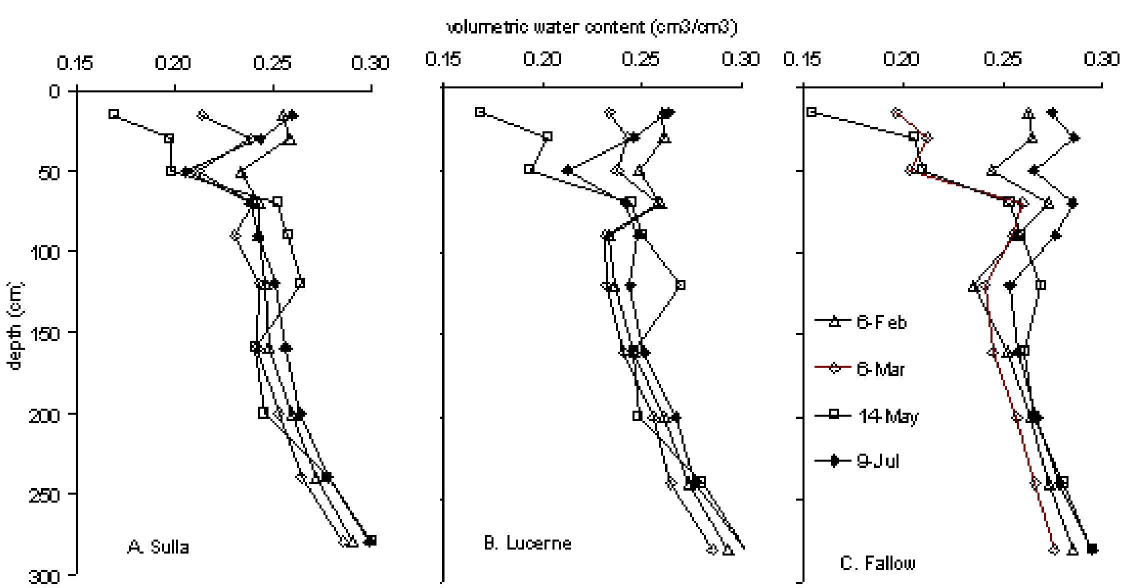

Figure 1. Soil water dynamics under a.Sulla (*Hedysarum coronarium*), b.Lucerne (*Medicago sativa*) and c.Fallow at Roseworthy in 2001.

Plant persistence after one year (data not shown) was ranked *M. sativa>H. coronarium>M. alba>D. rectum*. Further research is needed to define what soil factors determine the success or failure of these species on these typical South Australian soils.

Conclusion

Under these soil and climatic conditions, none of the alternative species appear to have a significant advantage over lucerne in terms of root growth and soil water uptake. *H. coronarium* has an advantage over lucerne in winter dry matter production and water use, and may have a role where these traits are desired.

References

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