Lotus in south-eastern Australia: aspects of forage quality and persistence

W.M. Kelman and M.J. Blumenthal

CS RO, Division of Plant Industry, GPO Box 1600, Canberra ACT 2601 NSW

Agriculture, Pasture Research Unit, PO Box 63, Berry NSW 2535

Summary. Greater lotus, *Lotus pedunculatus,* cv. Grasslands Maku is being adopted as a summer-growing perennial in coastal eastern Australia. A survey of 14 sites in NSW and Victoria revealed that condensed tannin (CT) levels in Maku lotus were greater than 5% of dry weight (dwt). It is proposed that lower CT lines within Maku lotus and other promising lotus accessions be sought. The breakdown of hardseededness (HS) in Maku lotus and three promising diploid Portuguese accessions was followed over an 11-month period under controlled temperature regimes. The initial level of HS in Maku lotus was low (48%), but temperature fluctuations had little effect on the further breakdown of HS in this cultivar. High HS levels are considered an advantageous feature for the long-term persistence of greater lotus.

Introduction

Greater lotus, *L. pedunculatus,* non auct. Ca[y]. is a rhizomatous perennial legume that is productive on wet, acid and infertile soils of coastal NSW. Local ecotypes of greater lotus have become naturalized along damp stream banks in this region and the potential of this legume as a forage drew early attention from agronomists (8). Following the release of cv. Grasslands Maku in 1975, the adoption of greater lotus was enhanced and Maku lotus is now established on approximately 50,000 ha in NSW, 25% of which is under intensive dairy or beef production. A survey under controlled conditions showed that greater lotus is highly tolerant of aluminium and manganese in acid nutrient solutions and moderately tolerant of salinity (6). Improvements in lotus agronomy and breeding are being researched and we focus on two aspects of this task: forage quality and persistence.

The forage quality of Maku lotus is influenced by the presence of condensed tannins in the leaves. Condensed tannin concentrations of 2-4% of dwt are believed to provide an optimum level for both bloat protection and enhanced use of nitrogen in the diet of ruminants (2). Condensed tannin levels appear to be sensitive to soil fertility and concentrations of 6-8% dwt have been recorded on trial plots with low fertility (4). At these high levels adverse effects on rumen carbohydrate digestion and voluntary intake can be expected (2). The first objective of this paper is to report the condensed tannin concentrations measured in Maku lotus from established pastures in NSW and Victoria and to correlate these with measurements of soil fertility.

Another aspect of lotus agronomy requiring basic information in Australia is persistence. Persistence of herbaceous perennials in temperate environments is usually related to survival and vegetative spread of original plants. However, infrequent but severe drought or flooding, a feature of the Australian climate, will challenge the persistence of lotus through its ability to recruit individuals from the seedbank to the surviving population. Thus, the second objective of this paper is to present the results of an experiment that recorded the breakdown of hardseededness in Maku lotus and three other lotus accessions under temperature regimes that simulate maximum diurnal fluctuations in the field.

Methods

Condensed tannins in Maku lotus

One kilogram of fresh forage was sampled at random from each of 14 sites in NSW and Victoria where Maku lotus is established (Table 1). Samples were collected over the period from November 1990 to April 1991. A soil sample of 100 g was taken at 10-20 cm depth at the site of each forage sample. The forage samples were dried at 70?C for 24 to 48 h to attain constant dwt. After drying, main stems were removed from the sample and the remaining leaf tissue was assayed for condensed tannins (7,4). For soil pH, Al

and Mn measurements, filtered extracts were made from 0.01 M $CaC1_2$, and for soil P filtered extracts were made in Bray No. 1 solution. All extracts were analysed on an Auto-Analyser.

Hardseededness

Seed of greater lotus cv. Grasslands Maku, CPI 67676, CPI 67677, CPI 67678 and white clover cvv. Tamar and Haifa were hand-harvested from mature seed-pods of plants growing at Ginninderra Experiment Station, near Canberra during February 1990. A sample of 300 seeds of each entry, except Maku lotus, was divided in six replicates of 50 seeds. For Maku lotus each replicate was 25 seeds. Each batch of seed was placed on filter paper in a petrie dish and wetted to determine the initial level of hardseededness after 24 h. The petrie dishes were then placed in a fluctuating temperature cabinet where maximum (8 h)/minimum (16 h) temperatures were held at 43/15?C, 25/5?C and 43/15?C sequentially for four, five and two months respectively. At monthly intervals during the course of the experiment the seed samples were removed from the cabinet, wetted with distilled water, and the numbers of germinated or imbibed seeds in each dish recorded after 24 h.

Results and discussion

Condensed tannins in Maku lotus

The condensed tannin concentrations of Maku lotus from all sites sampled was greater than 5% of dryweight (Table 1). In situations where Maku lotus is the predominant component of the sward, such as in wet and acid sites, these high levels of condensed tannins can be expected to reduce the digestibility and intake of forage. In contrast to this, where Maku lotus is not predominant, the overall concentration of tannins in the forage would be reduced. In any event, since ruminant nutrition and health are improved by concentrations that are generally lower than was evident in Maku lotus from this survey, we propose that lower tannin-producing lines be sought within this cultivar and among other promising greater lotus accessions that will be further evaluated in the next two to three years.

Table 1. Condensed tannins (CT) in Maku lotus leaf at localities in NSW and Victoria, with corresponding measurements of soil parameters from each site.

Locality	CT (% dwt)	Soil pH	Soil (ppm) BrayP	Al	Mn
Booyong, NSW	13.15	4.59	8.5	0.6	42.8
Glen Innes, NSW	9.23	5.04	1.4	0.0	8.8
Guyra, NSW, site 1	9.07	4.80	2.8	0.2	4.2
Guyra, NSW, site 2	6.26	4.66	34.0	0.7	5.6
Braidwood, NSW	7.79	4.08	1.9	21.6	7.4
Pambula, NSW[a]	7.52	4.92	5.0	0.6	11.2
Deniliquin, NSW[a]	6.78	5.41	20.5	0.1	2.4
Warragul, Victoria, site 1	6.66	4.19	14.0	4.2	1.5
Warragul, Victoria, site 2	5.53	4.45	2.1	1.7	3.0
Bonang, Victoria	9.09	5.24	6.5	0.2	0.9
Correlation with CT (n=14)		-0.13	-0.38	-0.04	0.83**[b]

[a]Values for Deniliquin are means of four sites and for Pambula means of two sites.
[b]Significant at P<0.01.

The correlations of CT with soil parameters were not statistically significant except in the case of Mn where very high levels of CT and Mri were present at one site (Booyong, Table 1). From these results and

those of glasshouse experiments under controlled P and S nutrition it appears that the influence of other abiotic factors, such as soil moisture, temperature and light intensity need to be investigated before conditions can be set to quantify the tannin-producing potential of greater lotus.

Hardseededness

The initial levels of hardseededness (HS) of the entries were: Maku lotus 48%, CPI 67676 86%, CPI 67677 77%, CPI 67678 95%, white clover cv. Tamar 96% and cv. Haifa 95%. Figure 1 presents the breakdown of HS of the remaining seeds of each entry under the two fluctuating temperature treatments. There was little breakdown of HS in Maku lotus and at the end of the experiment 84% of the seed was unimbibed. The pattern of HS breakdown among the diploid accessions of greater lotus was similar, showing a gradual decline under the 43/15?C treatment and little influence of the 25/5?C treatment. The final level of HS in this group ranged from 39% to 68%. In white clover cv. Haifa HS broke down rapidly to 18% in the first five months, while cultivar Tamar remained 90% HS at the end of the first high temperature treatment, but declined to less than 20% at the end of the low temperature regime.

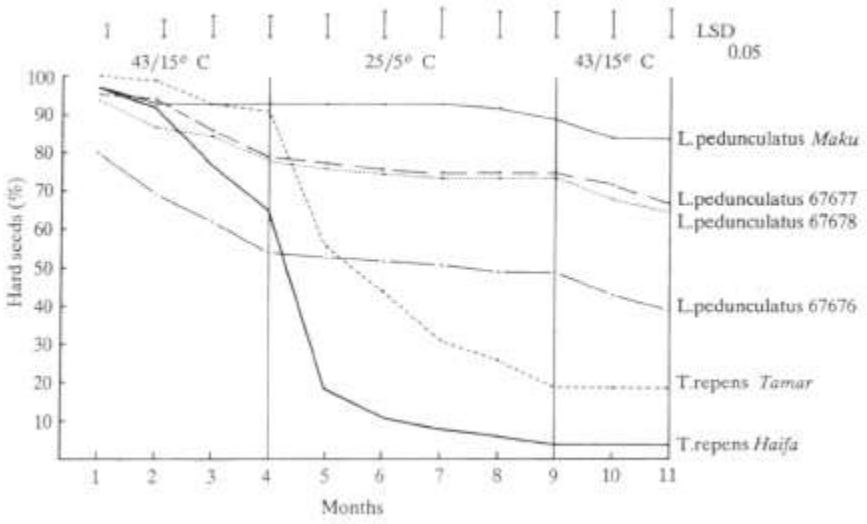

Figure 1. Percentage hard seeds in greater lotus and white clover following monthly wetting episodes at two controlled temperature regimes.

The rapid breakdown of hardseed in white clover shortly following a reduction in ambient temperature is consistent with field observations in south-east Queensland (3) and the Northern Tablelands of NSW (1) where peak germination occurred in autumn and winter. No such increase in the rate of breakdown of hardseed occurred when lotus seeds were transferred to the lower temperature regime. This suggests that lotus may be adapted to environments without distinct breaks to either a summer or winter growing season, such as coastal NSW. Moreover, little or no hardseed breakdown occurred in the Lotus accessions at the lower temperature regime suggesting that alternating high and low temperatures, with maximums greater than 40?C, are required for the breakdown of hardseed. Such a mechanism is present in other legumes such as subclover (9) and *Stylosanthes (5).* This may have consequences for the size and persistence of lotus seedbanks in farmers fields. The actual status of Maku lotus seedbanks is currently being surveyed.

CPI 67677, an accession introduced from southern Portugal, is being considered for release as cv. Sharnae (G.P.M. Wison, pers. comm., 1990) because it flowers much earlier and more freely than Maku lotus at lower latitudes. This accession has much higher leaf tannin levels than Maku lotus (4), so it is our

objective to develop recombinants with earlier flowering and free seeding capabilities at lower latitudes and low tannin concentrations.

Maku lotus, 04704 (a New Zealand bred diploid), and Sharnae were sown in autumn 1991 with and without superphosphate at eight sites in eastern Australia varying in latitude from Samford (27?30'S) in the north to Warragul (38?1 1 'S) in the south. The objective is to determine the effect of environment (latitude, temperature and rainfall) on dry matter production, pasture quality, seedbank and rhizome dynamics. This work, together with more detailed studies of forage quality and mechanisms of persistence (both hardseed and rhizomes), will help to identify objectives for breeding and management in greater lotus. It is hoped that agronomy and breeding will be broadened in scope to include lower rainfall zones and a wider range of both greater lotus and birdsfoot trefoil, *L. corniculatus,* material.

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References

Archer, K.A. and Robinson, G.G. 1989. Aust. J. Agric. Res. 40, 605-616.

Barry, T.N., Manley, T.R. and Duncan, S.J. 1986. Br. J. Nutr. 55, 123-137.

Jones, R.M. 1980. Trop. Grasslands 14, 19-22.

Kellman, W.M. and Tanner, G.J. 1990. Proc. NZ Grassland Assoc. 52, 51-54.

McKeon, G.M. and Mott, J.J. 1982. Aust. J. Agric. Res. 33, 75-85.

Schachtman, D.P. and Kelman, W.M. 1990. Aust. J. Agric. Res. 42, 139-149.

Stafford, H.A. and Lester, H.H. 1986. Amer. J. Bot. 73, 1555-1562.

Strang, J. 1963. NSW Agric. Gazette 74, 344-347.

Quinlivan, B.J. 1966. Aust. J. Agric. Res. 17, 625-631.