EVALUATION OF NEW MEDIC CULTIVARS FOR THE LOW RAINFALL WHEATBELT OF WESTERN AUSTRALIA: 1. DEVELOPMENT OF SEED RESERVES OVER FOUR YEARS UNDER GRAZING

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SUMMARY

The seed reserves of 3 annual medic treatments were compared under set stocking on a red loam in the northern wheatbelt of Western Australia. The aphid tolerant cultivar, Parabinga barrel medic, maintained 3 times the seed reserve of the highly susceptible Cyprus barrel medic at the same stocking rate over a 4 year period. Improved persistence was also achieved in Parabinga at a 60% higher stocking rate. Parabinga pastures contained a seed reserve of 443 kg/ha at 5 Merino wether hoggets/ha after 4 years compared to 185 kg/ha in Cyprus pastures at 3 hoggets/ha. The higher summer seed reserves correlated with an increased production of early winter dry matter and a higher legume content in the later years of the experiment. Serena and Santiago burr medics (sown as an equal part mixture) appeared to have only marginal value in terms of persistence and no advantage in production of dry matter over Cyprus. Reduced seed yields through susceptibility to aphid damage appears to be a major factor in the deterioration of Cyprus pastures.

Keywords: medics, seed reserves, aphid tolerance.

INTRODUCTION

Pasture ley is an integral part of the mixed farming systems of southern Australia, forming the link between livestock and cropping components. Much of the development and success of these farming systems is due to the beneficial effects of legume-based pastures on the efficiency of the whole farming system (Puckridge and French 1983). The nitrogen input from the legume component of improved pastures not only drives increased pasture production but also improves rotational cereal yields and quality. However, the benefits derived from legume-based pasture in the long term is dependant on the ability of the legume to persist and regenerate without resowing.

Cyprus barrel medic *(Medicago truncatula),* released commercially in 1959, was found to be particularly suited to heavier textured, higher pH soils in low rainfall areas (Argyle 1962; Parkin 1966). Three key features that led to the success of Cyprus were early maturity, good forage production and a high proportion of hardseed (Quinlivan 1968). In spite of these advantages, pastures with a high Cyprus content were rare in the wheatbelt of Western Australia **(WA)** by the late 1980's and the performance of the those remaining was unreliable. Susceptibility to the *blue-green* aphid *(Acyrthosiphon kondoi),* a common spring pest in legume-based pastures in WA since the early 1980's, could be a major factor in the recent poor performance of Cyprus.

Evaluation of a range of pasture legume species and cultivars in ungrazed small plots in the 1980's identified possible alternatives to Cyprus barrel medic for red loam soils in low rainfall districts (Nutt, unpublished data). Serena and Santiago burr medic (*M. polymorpha),* registered in 1976 and 1988 respectively, are slightly more tolerant to aphids than Cyprus and have the added advantages of potentially high seed yields and a greater tolerance to moderately acid soil conditions (Howieson and Ewing 1986). Parabinga barrel medic (*M. truncatula),* registered in 1986, is moderately tolerant of blue-green aphids and has good spring dry matter production in ungrazed swards. This paper reports on the seed resources of these alternative pasture cultivars compared to Cyprus under set stocked grazing. A complementary paper in these proceedings (McDonald *et al.* 1994) reports on dry matter availability, stock liveweight changes and wool production in the same experiment.

MATERIALS AND METHODS

Site details

The experiment was established in 1990 at Mullewa, 70 km east of Geraldton, in the northern wheatbelt of WA. The soil type is a red loam, Northcote classification Gn 2.12, with surface soil characteristics of pH of 5.5 (1:5, soil:0.01M $CaCl_2$), 5% clay, 0.37% organic carbon, 18 ppm phosphorous (1:100, soil:0.5M $NaHCO_2$) and 216 ppm potassium (1:100, soil:0.5M $NaHCO_2$). The site had been previously used for a cereal:pasture rotation with a low legume population of Cyprus, burr medic (*M. polymorpha)* and goldfields medic *(M. minima).* The experimental design consisted of 3 pasture cultivar treatments (Cyprus, Parabinga and a mixture of Serena and Santiago in equal parts by weight) grazed at the typical district stocking rate of 3 Merino wether hoggets/ha, with additional plots of Parabinga and Serena/Santiago being stocked at 5 Merino wether hoggets/ha. The plots were either 1.7 ha or 1 ha in size. Each treatment was replicated 3 times and distributed randomly over the experimental site. Exceptional growing conditions in the early part of the 1991 season (Table 1) required higher stocking rates of 5 and 8 Merino hoggets/ha.

Table 1. Rainfall (mm) over the growing season and total for the year at the experimental site near Mullewa, WA, 1990 to 1993

	Apr	May	Jun	Jul	Aug	Sep	Oct	Total for year
1990	38	58	31	26	7	21	0	263
1991	24	21	82	83	13	10	17	293
1992	20	2	78	16	109	46	10	340
1993	25	40	65	24	44	20	11	255

Establishment and management

All pastures were established into a seed bed which had been cultivated at the break of the season and the subsequent weed germination sprayed with a glyphosate herbicide prior to sowing. At seeding, a rate of 15 kg/ha of seed, inoculated and lime pelleted with the commercial WA peat inoculant for medics *(Rhizobium meliloti* strain WSM540) was mixed with superphosphate applied at 100 kg/ha. In subsequent years 70 kg/ha of superphosphate was top dressed in autumn.

The pastures were stocked between the following dates, according to dry matter availability -

1990 - 3 July to 12 September (early removal of stock to maximise seed set);
1991 - 11 June to 12 November;
1992 - 5 May to 13 January, 1993 - Serena/Santiago at 5 head/ha,
22 February 1993 - Cyprus and Serena/Santiago at 3 head/ha (extra 40 days),
22 March 1993 - Parabinga at 5 head/ha (extra 68 days),
7 April 1993 - Parabinga at 3 head/ha (extra 84 days);
1993 - 2 June to 15 December 1993 - Serena/Santiago at 5 head/ha,
11 January 1994 - Parabinga at 5 head/ha, Cyprus and Serena/Santiago at 3 head/ha (extra 27 days),
11 February 1994 - Parabinga at 3 head/ha (extra 56 days).

Measurements

Seed reserves in the top 2 cm of soil were measured after both plant senescence (early summer) and seed germination (early winter). In summer, a vacuum harvesting method was used with 10 quadrats of 0.2 m^2 harvested per plot. In winter, 25 soil cores of 0.03 m^2 were sampled per plot. At both times of sampling the burrs and free seed were separated by hand from the sample for counting and weighing. The seed contained in burrs was removed and cleaned by hand and added to the free seed for total seed reserve. Available dry matter was estimated from a visual rating averaged from 50 points/plot and calibrated against direct pasture cuts. Pasture composition was estimated using the dry weight rank method outlined by t'Mannetje and Haydock (1963). All results were compared by analyses of variance.

RESULTS

Parabinga barrel medic produced significantly higher seed yields and maintained greater winter seed reserves at both the same and 60% higher stocking rates than Cyprus over the duration of the experiment (Table 2). At the low stocking rate the Serena/Santiago treatments also contained higher seed reserves than Cyprus, however the difference was only significant ($P < 0.05$) in the first year, 1990. Both the Cyprus and the Serena/Santiago treatments were unable to recover the seed loss through germination in 1991, in fact Cyprus set no seed at all. The seed reserves after germination in *1992* were therefore extremely low in the Cyprus and Serena/Santiago treatments compared to Parabinga. Better seed yields were achieved by all treatments in the 1992 season, the seed reserves increased by 185,253 and 386 kg/ha in the Cyprus, Serena/Santiago and Parabinga treatments respectively at the 3 head/ha stocking rate. The total seed reserves in the summer of 1992 in Parabinga were over 500 kg/ha, significantly higher than the other pasture treatments which were below 310 kg/ha. The 1993 season enlarged the reserves by 23, 45, and 78 kg/ha in the Cyprus, Serena/Santiago and Parabinga treatments respectively at 3 head/ha, replacing seed lost through germination and maintaining the relative performance seen in previous seasons.

The changes in the seed reserves of the Cyprus and Serena/Santiago treatments corresponded with heavy infestation of blue-green aphids in 1991, moderate infestations in 1990 and 1993, and an absence of aphids in 1992. The damage from the aphids was visually apparent on the Cyprus, Serena and Santiago and led to an earlier senescence compared to Parabinga. The low spring rainfall of 1990 and 1991 could also have been a contributing factor to the low seed yields (Table 1). Only 28 mm and 40 mm of rain were received at the experimental site between August and October in 1990 and 1991, respectively, compared to 165 mm over the same period in 1992.

Table 2. Summer and winter seed reserves of grazed annual medic cultivars over 3 years

Cultivar	Seed reserve (kg/ha)						
	1990	1991		1992		1993	
	Dec	Jul	Dec	Jul	Dec	Jul	Dec
Low stocking rate							
Cyprus	81	55	46	29	214	162	185
Serena/Santiago	165	98	147	52	305	284	329
Parabinga	186	169	271	183	569	461	639
High stocking rate							
Serena/Santiago	137	52	82	24	264	234	316
Parabinga	166	149	219	162	456	305	443
LSD ($P < 0.05$)	58	67	129	88	176	155	184

The seed reserves of Parabinga and Serena/Santiago were lower at 5 head/ha compared to 3 head/ha (Table 2). This was a consistent trend but only statistically significant ($P < 0.05$) in Parabinga for the last year of the experiment. At 5 sheep/ha, Parabinga had significantly higher seed reserves than Serena/Santiago from July 1991 to December 1992. However there was a loss of 150 kg/ha in the measured seed reserves in Parabinga between December 1992 to July 1993, compared to only 30 kg/ha in Serena/Santiago. This difference could be attributed to the extra 68 days of grazing from Parabinga compared to Serena/Santiago.

The seed reserves measured in the previous summer had a strong influence on the dry matter produced in the early winter period, particularly in the latter years of the experiment (Table 3). Therefore, Parabinga was superior to both the Cyprus and the Serena/Santiago treatments in the production of total and legume dry matter. As the dry matter estimates were made at or just after stocking, there was no

Table 3. Dry matter available from regenerating annual medic cultivars and the correlation to summer seed reserves over 3 years

Cultivar	Dry matter (kg/ha) available		
	11 June 1991	12 May 1992	22 June 1993
Cyprus	913 (140)[A]	854 (218)	2313 (436)
Serena/Santiago[B]	860 (181)	845 (102)	2000 (410)
Parabinga[B]	1029 (288)	1384 (475)	3020 (966)
LSD ($P < 0.05$)	186 (65)	147 (80)	295 (248)
Correlation to the previous summer's seed reserve	0.26 (0.66)	0.72 (0.73)	0.76 (0.77)

[A]Figures in parentheses are legume component of the dry matter.
[B]Results for Serena/Santiago and Parabinga are pooled over 2 stocking rates.

significant influence ($P < 0.05$) of stocking rate or interaction between stocking rate and cultivar on the early production of dry matter.

DISCUSSION

The importance of aphid tolerance in pasture legume cultivars has been highlighted in this experiment. Tolerant cultivars such as Parabinga barrel medic minimise the impact of aphids on seed yield and are better able to cope with seasonal variation or other factors that may limit persistence. The seed reserve of Parabinga in this experiment was over 600 kg/ha and still increasing after four years at the 3 head/ha stocking rate and had remained around 450 kg/ha in the last 2 years at 5 head/ha. The ability to develop these high levels of seed reserves increases the potential for rotational cropping without jeopardising the persistence of the pasture legume. Higher seed reserves also result in greater plant densities and dry matter production in early winter which has a direct effect on the carrying capacity of the pasture for the rest of the growing season (McDonald *et al.* 1994).

The advantage of the burr medics, Serena and Santiago, over Cyprus appear marginal in this experiment, as they were also affected by aphids. However, Serena and Santiago do escape some damage through their early maturity. Unfortunately this will not stabilise pasture performance but may increase persistence. The soil pH of 5.5 (1:5, 0.01M $CaCl_2$) at the experimental site is marginal for adequate nodulation of barrel medics (Lamond *et al.* 1989), however, the performance of Parabinga relative to Serena and Santiago suggests that pH was of less importance than the impact of blue-green aphids.

The effect of aphid infestation on seed yield, in combination with variable seasonal conditions and lost opportunities for seed production in cropping rotations, is clearly a major factor in the deterioration of once productive Cyprus pastures in the northern wheatbelt of WA. Carter (1987) recognised low seed reserves as the prime reason for poor pasture performance and suggested over-grazing of the seed reserve in the dry period as a major factor. However, there would be little seed for grazing if severe aphid infestation results in little or no seed set, as occurred with Cyprus in this experiment in 1991 and 1993. In areas of Australia where the impact of aphids on susceptible pasture legumes may not be as severe, other factors related to pasture deterioration may be of greater importance (Gilespie 1983). However the development and use of aphid tolerant cultivars minimises one possible limiting factor and can only increase the persistence of pasture legumes and the stability of pasture productivity.

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