Balansa and persian clover lines outproduce registered cultivars, and subterranean clover and medics, in a 400 mm annual rainfall zone in Western Australia.

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Summary. Over two million hectares are affected by waterlogging and/or salinity in Western Australia. Under these conditions, subterranean clovers and medics perform poorly. Thirteen alternative legumes were tested in a 400 mm annual rainfall environment at two sites, and grazed under normal farm conditions for three seasons. Balansa clover cv Paradana and two slightly earlier maturing selections from this cultivar, with a level of hardseededness of around 70%, performed well. The best Persian clovers were SA 14433 and SA 18904 with a time to flower of around 115 days and hard seed levels of 87 and 83% respectively.

Introduction

Waterlogging is a major problem of pastures and crops in Western Australia (1,2). Often this condition is compounded by salinity (3). In these situations the normally recommended pasture species, subterranean clover and annual medics, do not persist and these areas are colonized by almost pure stands of barley grass.

Tolerance to both waterlogging and salinity has been reported for balansa clover. *Trifolium michelianum, (4,5)* and for Persian clover, *Trifolium resupinatum, (6,7).* Commercial cultivars of these species are believed to be too late maturing for the medium rainfall zones of Western Australia and also, in the case of Kyambro, *(T. resupinalum).* possibly too soft seeded.

If low quality stands of barley grass could be replaced by productive clovers, then stocking rates would be increased and root disease carry-over to subsequent cereal crops reduced. Should these areas be devoted to permanent pasture, it would be desirable to include in the mixture better quality grasses with tolerance to waterlogging and salinity.

To test the hypothesis that early maturing and hard seeded Persian and balansa clovers can persist and produce in waterlogged/slightly salt affected areas, and that perennial grasses with tolerance to these conditions can provide successful companion species, a number of legume lines were planted at two sites in binary mixtures with four perennial grasses.

Methods

Site selection

The sites selected were situated 18 km E of Tambellup, W.A. (34 03' S; 117 50' E) and Mindarrabin (33 45'S; 118 15'E). The soil at Tambellup is a grey clay of pH 8.1 (1:5 water), prone to waterlogging with a conductivity of 44 mS/m, which indicates mild salinity. The mean annual rainfall is 402 mm.

The soil at Mindarrabin is a grey mallee sand of pH 5.3 (1:5 water). The experimental area is situated low in the landscape, so it normally gets waterlogged in winter. Mean annual rainfall is 400 mm.

Experimental design

Thirteen legumes, namely, one subterranean clover, *Trifolium subterraneum,* seven Persian clovers, *T. resupinatum,* three balansa clovers, *T. michelianum,* and two strawberry clovers, *T. fragiferum,* (Table 1) were sown, after inoculation with appropriate rhizobia, at 10 kg/ha in binary mixtures with each of the following four grasses; phalaris, *Phalaris aquatica* cv. Sirosa, tall wheatgrass, *Agropyron elongatum* cv. Tyrrell, tall fescue, *Festuca arundinacea* cv. Au Triumph, and puccinellia, *Puccinellia ciliata* cv.

Menemem. A nil treatment was also included, consisting of only volunteer grasses and legumes. Phalaris and Puccinellia were sown at 2 kg/ha and tall wheatgrass and fescue at 5 kg/ha.

The trials were arranged as a randomised block design with three replicates. They were sown into a prepared seed-bed with 120 kg/ha superphosphate (9.1% P, 10.5% S) and 70 kg/ha potassium chloride (49.8% K) at Tambellup and Mindarrabin on 14 June 1990 and 22 June 1990 respectively. Plot size was 2x2 m with I m buffers.

Management

Soon after sowing, the two experimental areas were sprayed to control red legged earth mites. They were not fenced and, except for a short period in the first spring to allow seed set, were grazed continuously with the rest of the paddock. After eight months of frequent grazing, the Tambellup site was fenced on 8 August 1991 to measure dry matter production.

Measurements

Herbage yields were obtained by cutting one 0.25 m2 quadrat per replicate on 2 October 1991 and weighing the oven-dry herbage. A population was considered to be flowering when half the plants had at least one inflorescence. Percentage of hard seed was measured after placing the seeds in an alternating temperature cabinet (60-15?C) for four months.

Results

Tambellup

As there were no significant differences between grass treatments, because the perennial grasses did not survive the dry summer and frequent grazing, legume production was analysed as a completely randomised design with twelve replicates. There were no significant differences in dry matter production between the balansa clovers, which produced over 5 t/ha from August 8 1991 until October 2 1991. The most productive persian clover was SA 14433, a hard seeded introduction from Iraq with around 4 t/ha. The commercial cultivar Kyambro produced 2.7 t/ha. The two strawberry clovers, Trikkala and the nil plot (consisting mainly of regenerating annual medic and perennial ryegrass) all produced between 1.8 and 2.4 t/ha (Table 1). No measurements were taken in 1992, as regenerating legumes were killed by RLEM infestation. This will be used to simulate the effect of a crop phase on next year's regeneration and production.

Table I. Second year dry matter production (kg/ha). time to flower and percentage hard seed, for thirteen legumes and a nil treatment at Tambellup, W.A.

Mindarrabin

No data was collected from this site in 1990/91. After three seasons of normal farm management (consisting of set-stocking at 6 dse/ha) an assessment was made on November 9 1992. All but five of the sown species had disappeared. Those remaining were three balansa clovers,(45856-4, 45856-1 and Paradana) and two persian clovers,(SA 14433 and SA 18904). These match exactly the best five performers in 1991 at Tambellup.

Effect of hardseededness

We found positive correlation between the percentage of hard seed after four months in an alternating temperature cabinet and dry matter production in the second season at Tambellup (yield=1918 + 33.9 * HS: r = 0.74**)

Line/cv	Species	DM (kg/ha)	Flowering time	Hard seed (%)
Palestine	strawberry	1840	-	-
Princep	"	2192	-	-
Trikkala	subclover	2176	102	17
Paradana	balansa	5120	120	72
45856-4	"	5436	113	65
45856-1	"	5524	116	77
Kyambro	Persian	2764	138	37
26205-2	"	2788	103	28
SA 14433	"	3948	115	87
SA 18904	"	3444	114	83
SA 19851	"	2204	112	24
45887-2	"	3088	86	40
26202-3	"	3308	106	21
Nil		2420		
l.s.d.(p = 0.05)		634		

Seasonal rainfall was fairly typical in 1990/91 with a very dry November, December and January (fig.1). Some germination occurred in February, 1991, only to die shortly after.

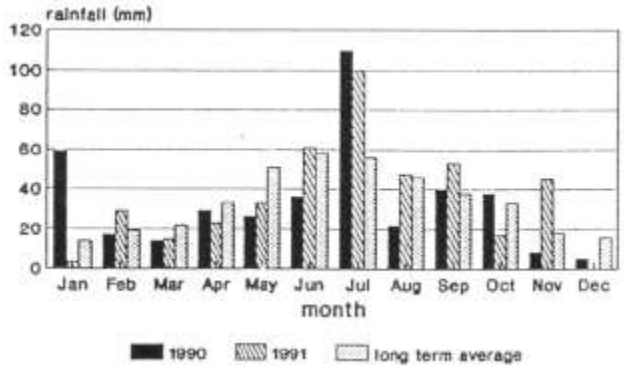

Figure 1. Monthly rainfall at Tambellup during 1990, 1991 and long term average.

Discussion

The time to flower in the best five performing legumes was 120 days or less and their percentage of hard seed, after four months in a temperature cabinet, ranged between 65 and 87%. Response to treatment of seeds at 60/15? C can vary between pasture species (8) and results can be misleading if it is assumed that all pasture species will behave like subterranean clover. For instance, Snowball (unpublished data) observed that in serradella a gradual softening occurred in a temperature cabinet with dehulled seeds, but a different response was observed when pods were subjected to the same treatment. The seed softening pattern of Persian and Balansa clovers is not known, and the February rains did not germinate the lines that were hard in the cabinet. However it could be possible that a process similar to the one observed in medics (9),where a high percentage germinate in Autumn after the heat of Summer, is operating.

We were surprised to see Paradana, and its two close relatives, 45856-1 and 45856-4, perform so well in this relatively low rainfall environment. It is normally expected that the limit for persistence of Paradana in South Australia is about 450 mm annual rainfall. The poor performance of Kyambro agrees with the recommendations by Craig (10) in which its limit is at least 550 mm annual rainfall. The two best performing Persian clovers in this environment, SA 14433 and SA 18904, are about 23 days earlier than Kyambro and considerably harder seeded. As previously stated it is not known, however, whether the

seed softening of balansa and Persian clover in a cabinet, correlates with that experienced in the field as it does with subterranean clover (11).

Not surprisingly none of the perennials persisted under frequent grazing and very dry summers. Frequent grazing should improve the proportion of Persian clover in the sward (12) but a large number of seed heads could have been consumed by sheep. This might have put the Persian clovers at a disadvantage when compared to balansa, because of the latter's ability to easily shed its seeds and therefore escape grazing.

The results, from two sites and collected in two different seasons, show that Persian and balansa clovers of the appropriate maturity and levels of hardseed can perform well and regenerate under grazing in a 400 mm annual rainfall environment. Work is needed to understand the seed softening pattern of these clovers and determine the relationship between alternating temperature treatment and field germinations.

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References

1. Wallace, J. and Wheaton, B. 1990. Western Australian Journal of Agriculture Vol, **31** No 2, 4850.

2. McFarlane, D.J., Barrett-Lennard, E.D. and Setter, T.L. 1989. Proc. 5th Aust. Agron. Conf., Perth. pp 74-83.

3. Barrett-Lennard, E., Davidson, N. and Galloway, R. 1990. Western Australian journal of Agriculture Vol, **31** No 2, 56-57.

4. Rogers, M.E.. West, D.W., Noble, C.L. and Whitfield, D.M. 1992. Proc. 6th Agron. Conf., Armidale. pp 276-279.

5. Rogers, M.E. and Noble, C.L. 1991. Aust. J. Agric. Res.,42, pp 847-857.

6. Andrew, W.D., Neal-Smith. C.A. and Hutchins, R.J. 1962. CSIRO Field Station Record, 1, pp 41.

7. Davies, D.J.G. 1962. N.Z. J. of Agric. **104** (1) pp 79.

8. Taylor, G.B. and Ewing, M.A. 1992. Aust. J. of Exptl. Agric., 32, pp 331-337.

9. Taylor. G.B. 1990. Proc. 5th Aust. Agron. Conf.. Perth. pp 434.

10. Craig, A. and Flavel, P. 1989. Fact Sheet 2/89. Agdex 137/33. S.A. Department of Agriculture.

11. Quinlivan. D.J. and Millington. A.J. 1962. Aust. J. of Agric. Res., **13,** 377-387.

12. Stockdalc. C.R. 1992. Aust. J. Exptl. Agric. 32 pp 339-344.