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Dryland Legume Pasture Systems: Small plot species adaptation trial

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Location
Minnipa Agricultural Cenre, paddock S8
Rainfall
Av. Annual: 324 mm
Av. GSR: 241 mm
2019 Total: 254 mm
2019 GSR: 234 mm
Paddock history
2018: Medic pasture
2017: Scepter wheat
2016: Medic pasture
Soil type
Red sandy loam
Soil test
$pH_{(H2)}$ (0-10 cm) 8.4
Plot size
5 m 1.5 m x 3 reps x 25.5 cm row spacing

Key messages

- **This is a component of a five year Rural Research and Development for Profit funded project supported by GRDC, MLA and AWI; and involving Murdoch University, CSIRO, SARDI, Department of Primary Industries and Regional Development; Charles Sturt University and grower groups.**
- **This trial aims to assess a diverse range of annual pasture legumes in order to determine whether there are more productive and persistent options for the drier areas (<400 mm) of the mixed farming zone of southern Australia.**
- **The annual medics were the most productive pasture legume producing > 2 t/ha DM and setting > 500 kg/ha of seed. A new Tetraploid Barrel medic was the most productive.**
- **Astragalus was the most promising alternative legume and warrants further evaluation.**

Why do the trial?

Legume pastures have been pivotal to sustainable agricultural development in southern Australia. They provide highly nutritious feed for livestock, act as a disease break for many cereal root pathogens, improve fertility through nitrogen (N) fixation and mixed farming reduces economic risk. Despite these benefits, pasture renovation rates remain low and there is opportunity to improve the quality of the pasture base on many low to medium rainfall mixed farms across southern Australia. A diverse range of pasture legume cultivars are currently available to growers and new material is being developed. Some of these legumes, such as the annual medics, are well adapted to alkaline soils and have high levels of hard seed, which allow them to self-regenerate from soil seed reserves after cropping (ley farming system). Other legume cultivars and species are available and being developed that offer improved seed harvestability, are claimed to be better suited to establishment when dry sown and/or provide better nutrition for livestock. Regional evaluation is being undertaken to determine if they are productive and able to persist in drier areas (<400 mm annual rainfall) and on Mallee soil types common to the mixed farming zone of southern Australia.

How was it done?

The trial at Minnipa in paddock S8 was arranged in a fully randomised block design with three replications.

Nine legume entries were sown comprising two new tetraploid (double chromosome number) barrel medics; the new French serradella cultivar Frano, developed by Murdoch University; Ioman astragalus along with a new rhizobia strain; diffuse clover and Cefalu arrowleaf clover. Strand medic line PM-250 and barrel medic cultivar Sultan-SU were included as the controls for comparison.

The trial was sown on 16 May 2019 into moist soil. Plant emergence counts were completed on 18 June. Plots were scored for vigour on 6 August. Ioman astragalus and Frano French Serradella were sampled to determine if nodulation was satisfactory on 2 September. Early dry matter (DM) cuts were completed on 13 September. These samples will be used to determine nutritive value, however the results are not yet available. Plots were sampled to estimate seed production on 4 November 2019.

What happened?

The season opened in May with 44 mm of rainfall, enabling the trial to be sown into moist soil and over a month earlier than in 2018. Although Minnipa received less overall rainfall in 2019, the majority of the rain fell in the growing season, with an early September rainfall providing a valuable boost. This may have allowed some of the later maturing legumes to perform better than they might have in a more typical season.

All legume lines emerged 3 weeks post-sowing, however it was apparent that some lines had uneven or poor emergence, especially the two clover species. This was likely due to their smaller seed size resulting in them being sown too deeply. At this time the best emerged plots were Frano serradella and Ioman astragalus.

All lines continued to grow with the annual medics consistently the most productive species, producing > 2 t/ha DM. The new Tetraploid Barrel medic 1-2 was the most productive line, producing 2.24 t/ha DM.

Ioman astragalus performed well throughout the trial with vigorous early growth and good DM production, over three times that of the accession grown in 2018, with 1.74 t/ha this season compared to only 0.50 t/ha in 2018. Ioman astragalus also appeared to be fixing nitrogen as active nodules were found on its roots.

Frano French serradella consistently displayed more vigorous growth and more biomass than Margurita French serradella (Table 1). Frano produced 0.36 t/ha DM, which was over twice that of Margurita's 0.12 t/ha, however towards the end of their growing season in mid-October, the two cultivars were difficult to tell apart, Margurita having caught up; however in general the performance of the serradellas was poor. From early July the two serradella cultivars began to display a yellowish leaf colour, possibly the result of poor nodulation (2 nodules per plant) which is a known problem for this legume on alkaline soils and observed previously at Minnipa. The discolouration persisted until late September when 46 mm rain freshened up the trial and the serradellas appeared to fully recover.

Cefalu Arrowleaf clover and diffuse clover also had strong responses to the September rainfall, with vigorous growth into early November when the other lines, especially the medics, had already senesced. This extra growth was unfortunately not quantified as the decision was made not to take extra DM cuts, in order to maximise seed set for regeneration. Visually the late biomass of diffuse clover appeared similar to Frano French serradella, despite its very low DM cut of 0.09 t/ha on 13 September.

All legume lines flowered and set seed (Table 2). Ioman astragalus had the highest seed production with 35,761 seeds/m^2 (1698 kg seed/ha). This is considerably more than the 12,643 seeds/m^2 generated by the astragalus accession grown in 2018, but is a reflection of a threefold increase in biomass for 2019. PM-250 Strand medic also produced considerably more seed in this trial with 17,888 seeds/m^2 (601 kg seed/ha) compared to the 2018 trial (6,181 seeds/m^2) as a result of increased biomass.

Table 1. Average plant density (plants/m^2), plot vigour score and dry matter (t/ha) at Minnipa, 2019.

Pasture legume species	Plant density (plants/m^2) 18 June	Average plot vigour score 6 Aug	Dry matter (t/ha) 13 Sept
Ioman Astragalus	152	7.7	1.74 a
Frano French Serradella	116	6.7	0.36 b
Margurita French Serradella	64	5.3	0.12 b
Cefalu Arrowleaf Clover	107	6.5	0.43 b
Diffuse Clover	47	4.8	0.09 b
Tetraploid Barrel medic 1-2	89	7.3	2.24 a
Tetraploid Barrel medic 2-1	112	7.5	2.11 a
Sultan-SU Barrel Medic	120	7.5	2.16 a
PM-250 Strand Medic	75	7.8	2.14 a
LSD (P=0.05)			*0.70*

Table 2. Seed assessment measurements at Minnipa, 4 November 2019.

Pasture legume species	Average No. of seed pods/m²	Average No. of seeds/pod	Average No. of seeds/m²	Average seed yield (kg/ha)
Ioman Astragalus	1698	21	35761	1698
Frano French Serradella	500	3	1465	29
Margurita French Serradella	423	3	1145	20
Cefalu Arrowleaf Clover	383	79	30542	318
Diffuse Clover	372	82	30545	338
Tetraploid Barrel Medic 1-2	2172	6	13781	530
Tetraploid Barrel Medic 2-1	2220	7	14575	575
Sultan-SU Barrel Medic	1857	7	13030	563
PM-250 Strand Medic	3005	6	17888	601

The seed production of the serradellas was the least and may be insufficient for adequate regeneration. Margurita's seed set was only 1,145 seeds/m² (20 kg seed/ha). This was probably due to its flowering period through mid-September and October, which coincided with some extremely hot temperatures. Cefalu Arrowleaf clover and diffuse clover had even later flowering periods, from mid-October into November. Although both lines still set very large amounts of seed with >30,000 seeds/m², this may not have occurred in the absence of the September rainfall.

What does this mean?

Despite another challenging season with less annual rainfall than in 2018, all of the pasture legume lines established, flowered and set seed, although the amount set by the serradellas may be insufficient for regeneration. The annual medics were the most productive pasture legume in terms of both dry matter and seed set. They continue to be the best pasture option for neutral to alkaline soils on the upper EP.

In the 2018 and 2019 Dryland Legume Pasture Systems Legume Adaptation trials, astragalus was the best adapted alternative legume species. This 2019 trial included the cultivar Ioman that grew vigorously, set large amounts of seed and appeared to be actively fixing nitrogen; it can also have seed harvested by a grain harvester. Astragalus merits further investigation in the Minnipa environment, however seed is not commercially available.

The clovers and serradellas showed the ability to respond to spring rain when the medics had already set seed and begun to senesce, however their overall production was poor and the seed set of the serradellas was penalised by its late flowering time. Whilst the clovers still managed to set a considerable amount of seed despite an even later flowering window, which fell through some extremely hot temperatures, their productivity and ability to set seed has not yet been assessed in the Minnipa environment in a season with average spring rainfall.

In 2020 the trial will be sown to wheat, with pasture legume regeneration following the cropping phase measured in 2021. Their regeneration after the cereal phase, which is the recommended practice for some pasture legumes following their establishment year, will be a function of the amount of seed set and suitability of their hard seed level to the Minnipa environment.

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Commercial annual legume cultivars are produced by a range of companies and we appreciate them making their cultivars available for this work.