Dryland Legume Pasture Systems: Legume adaptation trial 2019 regeneration

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Location
Minnipa Agricultural Centre, paddock S8
Rainfall
Av. Annual: 324 mm
Av. GSR: 241 mm
2019 Total: 254 mm
2019 GSR: 234 mm
Paddock history
2018: Legume adaptation trial sown and established
2017: Scepter wheat
2016: Medic pasture
Soil type
Red sandy loam
Soil test
$pH_{(H20)}$ (0-10 cm) 8.4
Plot size
5 m x 1.5 m x 4 reps

Key messages

- **This is a component of a new 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.**
- **Annual medics continue to be the best pasture option for neutral/alkaline soils on the upper Eyre Peninsula. Common vetch is an alternative option where a sown legume ley of one year duration is preferred.**
- **Building up a seed bank is critical to the longer term performance of the pasture. The aim in the pasture establishment year should be to maximise seed set.**
- **Levels of hard seed affect regeneration. Legumes with high hard seed levels should be cropped in the year following establishment.**

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, and improve fertility through nitrogen (N) fixation. 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 needed 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.

The Dryland Legume Pasture Systems project will both develop and evaluate a range of pasture legumes together with innovative establishment techniques, measure their downstream benefits to animal and crop production and promote their adoption on mixed farms.

This trial was established in 2018 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. In 2019 the trial was allowed to regenerate to determine which legumes regenerated and how their performance differed from the establishment year.

How was it done?

The trial sown in 2018 at Minnipa in paddock S8 was arranged in a fully randomised block design, with four replications. Similar trials were established at Loxton (SA), Piangil (Vic), Kikoira (NSW) and Condobolin (NSW). Data was analysed using Analysis of Variance in GENSTAT version 19. The least significant differences were based on F probability=0.05.

Table 1. Annual pasture legume species sown in the legume adaptation trial at Minnipa in 2018.

Pasture species	Notes
Harbinger Strand medic	Old cultivar; West Coast ecotype
Herald Strand medic	Old cultivar; aphid resistant
Jaguar Strand medic	Pod and leaf holding medic from Pristine Forage Technologies
PM-250 Strand medic	Powdery mildew resistant; tolerant of sulfonylurea (SU) herbicide residues; specifically developed for SA dryland Mallee farming systems
Pildappa Strand medic	West Coast ecotype, previously considered for release
Caliph Barrel medic	Old cultivar
Cheetah Barrel medic	Pod-holding medic from Pristine Forage technologies
Sultan-SU Barrel medic	Tolerant of SU residues; Boron tolerant; good aphid resistance
Boron Burr medic	Boron tolerant; spineless
Scimitar Burr medic	Old cultivar; spineless
Toreador Disc medic	Developed for sandy soils
Minima medic	Widely naturalised in dry areas; spineless
SARDI Rose Clover	Developed in upper mid-north; not widely sown in Mallee but reports of good performance
Rose Clover Early 35623	Experimental; early flowering and aerial seeded
Bartolo Bladder Clover	WA cultivar; aerial seeded, limited testing in the southern region
Prima Gland Clover	WA cultivar
Zulu Arrowleaf Clover	WA cultivar; earliest flowering line
Tammin Subterranean Clover	New cultivar; high level of hard-seed and tolerant of Red-legged Earth Mite
Balansa Clover X nigrescens clover	Experimental; an aerial seeded hybrid
Volga Common Vetch	Old cultivar
Studenica Common Vetch	New vetch specifically developed for drier areas
Capello Woolly Pod Vetch	Old cultivar
Casbah Biserrula	WA cultivar; with limited testing in the southern region
Margurita French Serradella	WA cultivar suited to acid soils
Santorini Yellow Serradella	WA cultivar; hard-seeded suited to acid soils with limited testing in the southern region
Trigonella balansae 5045	New species, aerial seeded.
Trigonella balansae Early 37928	New species, early line; aerial seeded
Astragalus	Experimental Australian Pasture Genebank selection; new rhizobia
Lotus arenarius	Experimental Australian Pasture Genebank selection
Lotus ornithopodiodies	Experimental Australian Pasture Genebank selection

Thirty different pasture legume species (Table 1) were sown to provide a broad range of legume species and attributes. The chosen species are a mixture of old varieties, new varieties, pre-releases, legumes with new traits, and pasture gene-bank selections based on their likely adaptation to rainfall and soil type. Some legume cultivars developed in Western Australia have also been included. These have performed well in WA and more recently in NSW, on their acid-dominant soils, but have had limited evaluation in South Australia where neutral to alkaline soils prevail.

The trial was sown on 27 June 2018 under relatively dry conditions, having received 22 mm of rain in the three weeks prior to seeding. All seed was inoculated with the best available strain of rhizobia and lime pelleted before sowing.

In 2019 the trial was allowed to regenerate. The growth of pasture lines that successfully regenerated were monitored to determine how their performance differed from the establishment year.

The seed of all species was reassessed in the field on 26 March 2019, with seed still present in all plots. On 29 April all plots were raked, to improve seed to soil contact and knock taller lines such as the Zulu Arrowleaf clover, to the ground. Plant emergence counts were completed on 20 May 2019. On 29 July all plots were given a visual score for plot vigour in terms of regeneration and biomass. A Green Seeker was then run over all plots.

Early dry matter (DM) cuts were completed on 31 July 2019 on selected lines. Plots were then mowed to simulate a grazing in late August. No further measurements were taken on the trial during the 2019 season.

What happened?

All lines showed some regeneration apart from the vetches, which have been selected to have <5% hard seed to prevent them becoming a weed in the following cereal crop. The regeneration of the biserrula and serradellas was poor, averaging 5 or less plants/m2, despite the biserrula producing reasonable seed levels in 2018. This is due to their high hard seed level (> 90%) and is consistent with the recommendation that biserrula be cropped the year following its establishment, to enable some breakdown of hard seed. The regeneration of Astragalus, the best adapted alternative legume species in the 2018 trial, was also poor with an average plot score of only 3.0. This was also probably due to high hard seed levels.

Once emerged, the regenerated pasture species continued to grow well thanks to favourable seasonal conditions. Toreador Disc medic consistently appeared to be the pasture legume with the best regeneration in terms of visual biomass, followed by Scimitar Burr medic.

The annual medics developed for alkaline soils, had the highest DM production. After a slower start, PM-250 Strand medic produced the most early (winter) DM (1.27 t/ha), although one of the Toreador plots still appeared to be the best plot in the trial from a visual perspective. Caliph Barrel medic, which produced the most biomass last year (along with Studenica Common vetch) with 1.3 t/ha, was slower to regenerate than the other medic lines, probably due to having harder seeds (>90%), however it still produced above average growth with 1.14 t/ha. The WA bred legumes (bladder clover, serradella and biserrula) developed for acidic sands, produced less DM; the result of poor regeneration and sub-optimal adaptation to soil type (Table 2).

Table 2. Average plot score, early DM and 2018 late DM for selected pasture legume species.

Legume species	Average plot score	Average early DM 31/7/19 (t/ha)	Average late DM 26/9/18 (t/ha)
PM-250 Strand Medic	8.8	1.27	0.72
Toreador Disc Medic	8.8	1.22	0.88
Bartolo Bladder Clover	2.0	0.001	0.18
Trigonella 5045	8.5	0.72	0.31
Casbah Biserrula	2.0	0.002	0.12
Margurita French Serradella	1.4	0.003	0.08
Scimitar Burr Medic	8.0	1.13	0.68
EP Harbinger Strand Medic	8.8	1.10	0.93
SARDI Rose Clover	2.5	0.04	0.23
Caliph Barrel Medic	8.1	1.14	1.30
Jaguar Strand Medic	8.1	0.92	0.65

What does this mean?

Pasture legume production, regeneration and persistence is determined by multiple factors including adaptation to soil type (texture and pH) capacity to set seed (early flowering is desirable in low rainfall areas) and hard seed levels that allow regeneration and persistence through the cropping sequence.

On the alkaline sandy loam and low rainfall conditions at the Minnipa Agricultural Centre, annual medics continue to provide the best option where a self-regenerating legume is preferred. If seed set is maximised in the establishment year the resultant seed bank may be 25 times what is initially sown, and will support pasture regeneration for many years. Common vetch may be a better option where a sown legume ley of one year is preferred, because of its ability to provide early production and options for late weed control. The new vetch cultivar Studenica, which equalled the DM of the most productive annual medic (Caliph barrel) in 2018, is scheduled for commercial release in 2021.

In 2020 the trial will be sown to wheat, with pasture legume regeneration following the cropping phase measured in 2021.

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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.