Dryland Legume Pasture Systems: Development of new pasture systems in NW Victoria

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Frontier Farming

Location
Piangil, Victoria Mallee
Rodney Haydon
Rainfall
Av. Annual: 330 mm
Av. GSR: 220 mm
2019 Total: 142 mm
2019 GSR: 100 mm
Yield
Potential: Pasture @ 45kg biomass/mm PAW (85 mm estimated) = 4 t DM/ha
Actual: Treatment 2 t DM/ha, Vetch 3.2 t DM/ha
Paddock history
2018: Wheat
Soil type
Alkaline red loamy sand
Soil test
pH $CaCl_2$ 7.4 0-10 cm, 8.4 70-100 cm
Nitrate N 0-10 cm 5.8 mg/kg
Colwell P 0-10 cm 11 mg/kg
S KcL 0-10 cm 6.5 mg/kg, 70-100 cm 9.6 dS/m
OC 0-10 cm 0.53%, 70-100 cm 0.19%
Salinity Ec 1:5 0-10 cm 0.11 dS/m, 70-100 cm 0.38 dS/m
Plot size
1.85 m x 20 m x 4 reps
Trial design
Fully randomised block with time of sowing as main plots and pastures species as the sub
Yield limiting factors
An early finish, a total 25 mm rainfall for August, September and October

Key messages

- **Legume pasture species that have not traditionally been grown in the Victorian Mallee established, largely successfully, in 2019 from hard but germinable seed sown in June 2018 (Twin sown) and February 2019 (Summer sown).**
- **They produced up to 2 t/ha of biomass and 400 kg/ha of seed in a season of only 40% of average growing season and annual rainfall.**

Why do the trial?

The trial aims to identify the application and system benefits of novel legume pasture species that have not traditionally been grown in the target region (Victorian Mallee). Recent research (Moodie *et al*., 2017) found that legumes grown in sequence with cereals increased wheat yields by 0.5–1.5 t/ha and improved annual profits by up to $100/ha in the low rainfall mixed farming regions.

Vetch is the most commonly grown pasture legume in the region. However, there are alternative pasture legumes which have the potential to increase production on certain soil types unsuited to vetch. They also have hard seed characteristics that may allow them to regenerate after a cropping phase, similar to annual medic. Pastures regenerating at high populations will increase early biomass production and livestock forage, with associated N fixation and weed competition benefits for the following cereal. The hard seed characteristic may also allow the pasture seed or pod to be sown in the cereal crop or during the summer preceding the pasture phase.

How was it done?

The trial included three establishment methods; Twin sowing (28 June 2018) with a companion crop of wheat, summer sowing (7 February 2019) and autumn sowing (13 May 2019). To protect against a false break, the twin and summer sown seed was "hard", but assessed to be germinable by the autumn seasonal break at a species specific level. The seeding rates (Table 1) were calculated on the basis of providing each species with similar numbers of germinable seeds in autumn 2019, taking into account species specific "soft" seed percentages. The autumn sown seed was commercially prepared scarified seed with approximately 80% "soft" seed. The vetch and barley were autumn sown only with commercial seed.

Chemicals applied pre-sowing were 2 L/ha glyphosate as a site application on 5 February 2019, trifluralin and glyphosate @ 1 L/ha to the barley treatment and Diuron and Simazine each at 200 g/ha to the vetch treatment. No pre-sowing chemicals were applied to pasture legume treatments due to the prior times of sowing. At all times of sowing, 50 kg of Granulock Z MAP was applied and the legume seed was inoculated with the dry granular species specific Group rhizobia.

Herbicides applied in-crop to the twin and summer sowing were Bromoxynil @ 1 L/ha to the Biserrula on 21 June 2019 and Select @ 500 mL/ha and Verdict @ 30 mL/ha to all the legumes on 26 June. No in-crop herbicides were applied to the autumn sowing.

Table 1. Alternative pasture legume common names, species and cultivars, and seed (kg/ha) sown at the twin, summer and autumn time of sowing and vetch and barley sown at the autumn sowing.

Treatment		Cultivar	Twin	Summer	Autumn
			Sowing rate (kg/ha)		
Biserrula	(*Biserrula pelecinus*)	Casbah	5.7	5.7	4.5
Bladder clover	(*Trifolium spumosum*)	Bartolo	14.7	14.7	6.8
Gland clover	(*Trifolium glanduliferum*)	Prima	Not determined		4.6
Annual medic	(*Medicago littoralis*)	PM-250	7.2	7.2	6.8
Rose clover	(*Trifolium hirtum*)	SARDI	9.8	12.5	6.8
Serradella	(*Ornithopus sativus*)	Margurita	7.4	7.4	6.8
Trigonella	(*Trigonella balansae*)	5045	4.9	4.9	4.5
Vetch	(*Vicia sativa*)	Studenica	-	-	25
Barley	(*Hordeum vulgare L.*)	Compass	-	-	50

The 2019 measurements included soil chemical analysis and soil water content immediately prior to establishing the summer sown treatments from 2 cores to 1 m in depth within each plot. Plant measurements of the novel pasture legumes included emergence on 5 June from 8 x 0.1m^2 quadrants, pasture biomass on 19 August, 17 September and 16 October, seed yield on 5 December 2019 all from 5 x 0.1m^2 quadrants. The vetch was chemically fallowed on 5 September with 3.2 t DM/ha. The barley continued on to harvest, yielding 2.7 t/ha. The 5 June plant emergence and 19 August biomass measurements are presented as comparisons to the novel pastures.

Statistical analysis with GenStat of plant density, biomass production and seed yield was carried out by a general analysis of variance with time of sowing as the main plots and pasture species as the sub plots. The barley and vetch measurements were not included in the analyses.

What happened?

A key trial impact was the rainfall, 100 and 142 mm, growing season and annual rainfall respectively, approximately 40% of the long-term average for the location.

The mean plant density of all 7 pasture legumes (Table 2) had less established plants on 5 June 2019 from twin sowing (June 2018) than summer (February 2019) and autumn (May 2019) sowing treatments. The biomass and seed production were similar for all establishment methods at each time of measurement.

The means of the three establishment methods (Table 3) found Biserrula and Gland clover had lower plant numbers, biomass and seed yield, and Trigonella lower biomass, than other entries. Bladder clover produced more seed and annual medic similar or more biomass than all other entries.

In comparison to autumn sowing, Biserrula (Table 4) established less plants and was less productive from twin and summer sowing. Bladder clover was similarly productive from all times of sowing irrespective of less plants from summer sowing. Summer sown gland clover failed. Annual medic established less plants from twin and summer sowing but had similar biomass and seed production across all establishment treatments. Rose clover had less plants and biomass production from summer sowing. Serradella established more plants from summer sowing and more biomass in August from twin sowing. Trigonella twin sown established less plants and was less productive.

Vetch and barley established at greater than optimum plant densities, more than 50 and 150 plants/m^2 respectively. Vetch produced similar biomass by August to the total annual biomass of annual medic, the next best.

Table 2. Mean 2019 plant establishment (plants/m^2), biomass production (t DM/ha) and seed yield (kg/ha) for the three establishment methods.

	5 June	19 Aug	17 Sept	16 Oct	5 Dec
	(plants/m^2)	(t DM/ha)			(kg/ha)
Twin Sowing	34	0.57	1.10	1.15	174
Summer Sowing	48	0.39	0.92	0.90	183
Autumn Sowing	58	0.55	1.25	1.45	240
LSD P=0.05	*13.9*	*ns*	*ns*	*ns*	*ns*

Pastures

What does this mean?

The new project "Dryland Legume Pasture Systems" (DLPS) aims to discover resilient low-cost pasture legumes with appropriate management packages to provide livestock and cropping benefits to the low-medium rainfall mixed farming regions of Australia. There are two main components of novel pasture systems studied through this project.

1. New legume pasture species/ cultivars that have not traditionally been grown in the target region. Each species may provide benefits such as increased production on certain soils types; improved value to livestock; the ability for seed to be retained; hard seed characteristics that provides a viable pasture after many cropping phases.

Established near Piangil in the Victorian Mallee the trial did not measure any production benefits from the novel pasture systems in comparison to vetch in 2019, the initial pasture establishment year. Vetch is well adapted to the alkaline loamy sand soil type of the trial site and by August had produced similar biomass to the best novel pasture legumes total October 2019 production. However, it should be noted that vetch established at near optimum plant density, 77 plants/m^2, compared to only approximately 25% of optimum densities for the pasture legumes.

The ability for seed to be harvested and retained by the farmer was considered possible with the seed pods, apart from the annual medic, remaining largely attached to the vines in December. This would allow some seed to be collected by mechanical harvester, however lack of plant height due to low plant populations and rainfall would limit potential yields in 2019. The hard seed characteristics that allow the novel pastures to produce a viable pasture after a cropping phase will not become evident until 2021, following the 2020 cropping phase.

2. Alternative pasture establishment systems aimed at reducing the cost of pasture establishment and potentially improved productivity from greater water use efficiency.

The second trial component based on alternative systems targeting opportunities to reduce the cost of pasture establishment and potentially improved productivity provided useful outputs. Sowing "hard" pasture seed/pod with a crop (twin sown) or late in the summer with no companion crop (summer sown) was partially successful. While there was generally less plants established from the twin and summer sowings than the autumn sowing control, the production differences were minimal except in the cases where virtually no plants established. This included Biserrula following both the twin and summer sowing and Trigonella following the twin sowing. There is some anecdotal evidence, based on biomass production figures, that more plants established after the 5 June plant counts from both the Biserrula and Trigonella twin sowings. The reasons for this are open to conjecture, but it is unlikely that seed softening continued through until June and more seed became available to germinate. Seed depth and the seasonal rainfall pattern may have been factors. However, in the case of Serradella and Trigonella, more plants established from the summer sowing than the autumn sowing, suggesting a greater level of "soft" seed than calculated.

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Table 3. Plant establishment (plants/m^2), biomass production (t DM/ha) and seed yield (kg/ha) of pasture legumes as a mean of the 3 times of sowing.

	5 June	19 Aug	16 Oct	5 Dec
	(plants/m^2)	(t DM/ha)		(kg/ha)
Biserrula	15	0.3	0.5	62
Bladder clover	53	0.5	1.4	440
Gland clover	23	0.2	0.5	69
Annual medic	47	0.8	1.8	255
Rose clover	50	0.6	1.6	192
Serradella	78	0.7	1.5	150*
Trigonella	61	0.3	1.0	225
LSD (P=0.05)	*15.4*	*0.21*	*0.25*	*76*

**Serradella pod weight not seed*

Table 4. Plant establishment (plants/m²), biomass production (t DM/ha) and seed yield (kg/ha) of 7 pasture legumes at 3 times of sowing (TOS).

		5 June	19 Aug	16 Oct	5 Dec
	TOS	(plants/m²)	(t DM/ha)		(kg/ha)
Biserrula	Twin	<1	0.01	0.21	31
	Summer	1	0.08	0.09	20
	Autumn	45	0.42	1.08	135
Bladder clover	Twin	54	0.57	1.37	401
	Summer	31	0.42	1.28	432
	Autumn	74	0.61	1.61	487
Gland clover	Twin	28	0.24	0.62	41
	Summer	5	0.05	0.12	19
	Autumn	35	0.4	0.81	148
Annual medic	Twin	33	0.92	1.81	249
	Summer	29	0.71	1.64	239
	Autumn	80	0.8	2.01	277
Rose clover	Twin	56	0.8	1.91	185
	Summer	28	0.29	1.13	153
	Autumn	66	0.68	1.86	237
Serradella	Twin	61	1.06	1.44	119
	Summer	130	0.68	1.33	163
	Autumn	44	0.46	1.56	169
Trigonella	Twin	4	0.04	0.72	191
	Summer	115	0.42	0.93	257
	Autumn	66	0.45	1.24	227
LSD (P=0.05)		*26.7*	*0.41*	*0.44*	*102.9*
Barley	Autumn	156	3.2		
Vetch	Autumn	77	2.3		

Reference

Moodie M, Wilhelm N, Telfer P and McDonald T (2017). Broadleaf break crops improve the profitability of low rainfall crop sequences. In: Doing More with Less. GJ O'Leary, RD Armstrong and L Hafner Eds. Proceedings of the 18th Australian Society of Agronomy Conference, 24 – 28 September 2017, Ballarat, VIC, Australia © 2017. (http://www.agronomyaustraliaproceedings.org/).