ROTATIONAL EFFECTS OF LEGUME TERMINATION

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Take home messages

- In a dry season, there was a small grain yield benefit (90kg/ha) for wheat that followed terminated vetch and field peas (1.5-2.4t/ha of biomass), compared with fallow and terminated medic.
- Soil water benefits from fallow and legume termination don't occur with dry spring finishes.
- Using soil tests to measure nitrogen mineralisation helps you to properly evaluate the benefit of a legume crop or pasture in a rotation.

Background

The value of a legume crop or pasture in cropping rotations, and for the ensuing crop in particular, is well known. This arises from a number of factors including grass weed control, disease break, grazing or grain production value, fixation of soil nitrogen and effect on stored soil moisture.

However, there are an array of system implications when choosing a legume to fit into a rotation that need consideration. For example, the cost of seed, hard seededness, timing of termination and consideration of herbicide residue issues such as Lontrel® for susceptible crops.

Aim

To compare fallow and termination timing treatments of legumes on biomass and grain production (2014), and their impact on sowing-time, soil nitrogen and water, and subsequent yield and quality of cereal sown the following season (2015).

Trial details

Location:	Beulah
Soil type:	Clay loam
Annual rainfall:	216mm
GSR (Apr-Oct):	144mm
Crop type/s:	Mace wheat

Sowing date:	7 May
Seeding equipment:	Knife points, press wheels, 30cm row spacing
Target plant density:	150 plants/m^2
Fertiliser:	Granulock Supreme Z @ 30 kg/ha + Impact @ 110mL/ha at sowing (following a decile 1 season in 2014)

Weeds, pests and diseases were controlled to best management practice.

Method

In 2014, a replicated field trial was sown on 22 April with two plots each of Morava vetch, Kaspa field peas and Barrel medic with Granulock Supreme Z @ 50kg/ha + Impact @ 200mL/ha at sowing. Brown manuring of these plots occurred at two times; early termination in July, and at peak biomass in September. Two plots were also left unsown for fallow treatments; one had complete weed control from July onwards, while the other had weed control only in September. Assessments included NDVI biomass at each termination, and soil water and nitrogen on all plots at harvest time.

In 2015, the trial site was kept weed free until sowing. The trial was then sown with wheat to measure the rotation effects from 2014. Assessments included NDVI biomass, soil water and nitrogen (in increments to 120cm depth), and grain yield and quality parameters.

Results and interpretation

In 2014, there was 35mm of plant available water (PAW) and 45kg/ha of available soil nitrogen prior to sowing. The season was a decile 1, receiving just 126mm of growing season rainfall (GSR). Due to low rainfall, soil moisture would not have penetrated the profile very far, and hence root growth and nitrogen fixation was limited.

Field peas and vetch produced the highest biomass by July but field peas had highest production by the September termination (Table 1).

Post-harvest soil water in the top 10cm was the same across all treatments, averaging 17mm. Albeit only small amounts, for 10-30cm deep, July fallow had slightly higher post-harvest soil moisture (34.5mm), compared with most other treatments (averaging 26.7mm) except medic terminated in September (22mm). Post-harvest soil water was the same for all treatments from 30-120cm depth.

Post-harvest soil N at 0-10cm was highest at 24.2kg N/ha for vetch terminated in July, followed by the July fallow. Most other treatments had similar post-harvest soil N ranging from 14.5-18.5kg N/ha, except the September fallow with only 12.6kg N/ha – a result of the late fallow having weeds up until September that used N rather than fixing N.

A similar soil N response to treatments was measured in the 10-30cm soil layer but, with medic terminated in September, also having lower N. There were no further differences between treatments in post-harvest soil N from 30-120cm.

Despite there being more biomass in September than July, crops were not able to fix more nitrogen between July and September. For some legume treatments nitrogen was utilised post-July, as seen by lower post-harvest soil N levels for September termination treatments. This is an important observation and warrants further investigation as it may influence the ideal time for termination to conserve water and nitrogen.

Table 1. Biomass production and differences in post-harvest soil water and soil N for legumes and fallow at termination times, Beulah 2014.

Legume	Termination timing	Biomass (t/ha)	Soil water post-harvest 10-30cm (mm)	Soil N post-harvest 0-10cm (kg/ha)	Soil N post-harvest 10-30cm (kg/ha)
Field peas	July	1.66^{b}	26.4^{b}	15.7^{bc}	20.7^{b}
	September	2.43^{a}	26.5^{b}	16.8^{cd}	21.1^{b}
Vetch	July	1.47^{b}	27.8^{b}	24.2^{f}	32.5^{c}
	September	1.66^{b}	27.8^{b}	18.5^{d}	21.2^{b}
Medic	July	0.74^{c}	26.2^{b}	15.5^{bc}	19.8^{b}
	September	1.40^{b}	22.0^{c}	14.5^{ab}	12.3^{a}
Fallow	July	-	34.5^{a}	21.1^{e}	32.5^{c}
	September	-	25.9^{b}	12.6^{a}	9.7^{a}
	Sig. diff.	P<0.001	P<0.001	P<0.001	P<0.001
	LSD (P=0.05)	0.44	3.1	2.0	6.4
	CV%	18.5	7.7	7.9	20.5

2015

Following marginal differences between treatments at the end of the 2014 harvest, as would be expected there were no differences in soil moisture at any depth at sowing in 2015. In 2015, 69mm had fallen by the end of March, followed by another 24mm in April.

Pre-sowing 0-10cm soil N was highest following 2014 treatments of vetch (at both termination times) and July fallow – reflecting the post-harvest assessments for soil N (Table 2). At 10-30cm however, field peas, along with vetch had at least 20kg N/ha more than fallow and medic.

Table 2. Pre-sowing soil N levels following different 2014 crops or fallow, Beulah 2015.

	Pre-sowing soil N (kg N/ha)		
Termination timing	**July**	**September**	
2014 crop/fallow	**0-10cm**		**10-30 cm**
Field peas	43.8	39.8	65.9
Medic	38.1	36.7	33.4
Vetch	48.8	47.4	64.6
Fallow	48.0	30.4	44.7
Sig. diff.			
Legume	P=0.001		P=0.002
Timing	P=0.002		-
Legume x timing	P=0.008		-
LSD (P=0.05)			
Legume	5.0		17.6
Timing	3.5		-
Legume x timing	7.1		-
CV%	11.6		32.3

Mineralisation over summer did not differ between treatments – possibly because this site did not receive enough summer rainfall to drive differences in mineralisation.

Mace wheat was sown across all treatments and NDVI assessment (measures greenness and groundcover) on 25 August 2015 measured the same. By 6 October, NDVI was slightly higher on plots that had field peas terminated in September, and lower on complete fallow.

Grain yield did not respond to 2014 termination timing, but did have a small response to the previous rotation (P=0.027, LSD=0.11, CV%=6.8). Mace grown after field peas and vetch yielded 1.17t/ha, while after medic and fallow yielded 1.08t/ha.

There was no difference in any of the grain quality characteristics following the 2014 legume termination or fallow treatment. Protein averaged 13.9 per cent, screenings 9.3 per cent and test weight 72.5g/hL. Again these results are a reflection of the lower plant growth in 2014 and subsequent effects on soil nitrogen and moisture post-harvest and pre-sowing in 2015, and that the crop is unlikely to have been nitrogen limited in 2015.

Legume systems trial – Berriwillock 2015

A subsequent Grain & Graze 3 legumes systems trial was sown at Berriwillock in 2015, with essentially the same approach of measuring the system effects of different legumes (including faba beans), but comparing the end use of grazing and brown manuring rather than termination timing.

For the grazed treatments, grazing took place when peas had 11 branches, faba beans eight branches and vetch four branches (11 August), and medic five branches (14 September). At this stage the legumes were providing enough ground cover and bulk for ground protection and good grazing value.

Feed tests indicated that all legumes had very good nutrition that would support lactating ewes and growing lambs (16% protein, 11MJ/kg and >30% NDF, Table 3).

At the time plots were grazed, there was good feed value which was greater for medic and peas compared with vetch and faba beans. This was a result of timing. Treatments were sampled a month later than grazed cereal assessments usually occur (where grain recovery is important), and medic was sampled later than other crops (Table 3).

Table 3. Feed values and DSE grazing days for legumes, Berriwillock 2015.

Crop	Dry matter of feed available (kg/ha)	Neutral detergent fibre (%)	CP (% DM)	Metabolisable energy (MJ/kg DM)	DSE grazing days*	Post-harvest total soil N (kg/ha)
Faba beans	322.1[a]	20.9[a]	26.7	10.7	428.3[a]	109.9b
Medic	1043.5[c]	37.8[b]	26.5	10.7	1366.1[c]	79.8c
Peas	536.0[b]	33.3[b]	28.5	11.7	782.5[b]	77.6c
Vetch	325.6[a]	35.3[b]	28.8	11.4	462.7[a]	75.8c
Fallow	-	-	-	-	-	153.5a
Sig. diff.	P<0.001	P<0.001	NS	NS	P<0.001	P<0.001
LSD (P=0.05)	164.0	5.2	-	-	190.0	26.5
CV%	19.6	6.8			14.2	23.0

* DSE grazing days = DM (kg/ha) x feed test metabolisable energy (ME) / 8 MJ, which assumes that one DSE requires 8 MJ ME/day.

Post-harvest soil N was highest following a fallow in 2015 – this may have again been due to the drier conditions preventing the legumes from fixing nitrogen and instead utilising nitrogen from the profile. The trial will be over-sown with wheat in 2016.

Commercial practice

While 2014 legume crop and pasture effects were limited due to a low rainfall year, this trial shows that the capability of a legume to provide system benefits in a dry season is low. If the outlook is dry, there will be little advantage in allowing a legume crop to continue, and a decision can be made for an alternative use (to grain production) without penalty to soil nitrogen and moisture, particularly if there is a need to control grass or there is a plant disease control benefit. The consideration for management will be maintaining enough groundcover to protect the soil from erosion.

Mineralisation in the top 0-30cm soil following both fallow and terminated legumes was 36.2kg N/ha. This nitrogen is valuable for the following cereal. Many growers in the Mallee top-dress 23-32kg N/ha (50-70kg urea/ha) to a cereal crop if rainfall permits.

In a previous BCG trial conducted from 2012-2014 near Birchip, where wheat was sown in 2013 (decile 1 GSR) following different termination timings of vetch in 2012, differences in mineralised N were recorded and wheat hayed off after later terminations (August-September) and where biomass grown in the previous season was above 2t/ha (Ferrier, D 2014) .

On-farm profitability

At a urea price of $500/t (urea being 46% N), then 1kg N/ha fixed is worth $1.08/ha. Even in poorer seasons, 36.2kg N/ha was mineralised by sowing, which has a value of $39/ha. It is worth using soil tests to calculate mineralised N when considering the value of a legume crop or pasture in a rotation.

References

Ferrier, D., 2014, *2014 BCG Season Research Results*, 'Vetch termination', pp.33-38.

Acknowledgements

This research was funded by the GRDC as part of the Grain & Graze 3 project (BWD00081).