TAKE HOME MESSAGES

1. When vetch is established in March and is terminated 'early' (three to four months later, in June, July), soil water will be conserved for the subsequent wheat crop; the risk of haying off due to high nitrogen will be lower than if the vetch were terminated 'later' (August, September).

2. Vetch biomass production of approximately 2t/ha is unlikely to cause a subsequent wheat crop to hay off given dry seasonal conditions.

3. Residual nitrogen from vetch brown manure can carry over for two years and influence cereal crop growth, but the conservation of soil water is more critical in seasons of Decile 2 or lower.

VETCH TERMINATION

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BACKGROUND

Terminating vetch at the optimum time to achieve the greatest benefit for consecutive wheat crops has been the focus of a three year BCG study funded through GRDC's 'Facilitating increased on-farm adoption of broadleaf species in crop sequences to improve grain production and profitability' initiative. Finding the balance between early vetch termination to maximise soil water conservation, and later termination for greater biomass and nitrogen (N) production to benefit the next crop, can be difficult given the variable climate.

In the vetch establishment year (2012) of this project, between 3-5t/ha of biomass production was measured in the later termination treatments (*BCG 2012 Season Research Results, pp. 49*). In 2013, summer and growing season rainfall were Decile 1 and 2 respectively and wheat which established on later vetch terminations, hayed off (*BCG 2013 Season Research Results, pp. 119*).

In previous work carried out at Hopetoun, wheat grown consecutively for two years after vetch brown manure increased in yield on a sandy soil, but not on clay (*BCG 2012 Season Research Results, pp. 42*).

The value of vetch termination and its influence on soil water, nitrogen and profitability on subsequent wheat crops was the focus of this study.

AIM

To determine how the management of a vetch crop (termination timing and end-use) influences the yield and quality of a following wheat crop grown for two consecutive years.

TRIAL DETAILS

Location:	Birchip
Soil type:	Mallee clay loam with sub-soil constraints
GSR (Apr-Oct):	108mm
Crop type:	Wheat (Grenade CLF Plus)
Sowing date:	28 April
Seeding equipment:	Knife points, press wheels, 30cm row spacing
Target plant density:	150 plants/m^2
Harvest date:	11 November 2014

TRIAL INPUTS

Fertiliser: Granulock Supreme Z + Impact @ 50kg/ha at sowing, plus urea @ 45kg/ha at GS22 (June 13).

Pests, weeds and diseases were controlled to best management practice.

METHOD

In 2012, four blocks were sown to Morava vetch in March following rainfall. Treatments investigating (i) termination timing, and (ii) different methods of vetch termination were established in a complete randomised design.

For the termination timing trial, five different termination timings were imposed; 8 June (three months after sowing), 20 July, 19 August, 17 September, and 13 November (harvest control). Herbicides used to carry out termination treatments were 2L/ha glyphosate and 300ml/ha of Lontrel™, followed a week later with 1.5L/ha Gramoxone® 250 (double knock).

In the termination trial, five different vetch end-uses were applied; hay (mowed and removed on 17 September), brown manure (herbicides used as above on 17 September), incorporation (17 September), simulated grazing (mowed 8 June and 25 July, terminated 24 September) and harvest (control, 13 November).

To investigate the impact of residual soil water and soil mineral nitrogen, wheat (Elmore CLF Plus) was sown the following year in 2013. Pre-sowing and post-harvest soil moisture and nitrogen, NDVI, yield and quality were measured.

Wheat (Grenade CLF Plus) was sown again in 2014 to assess whether soil water or soil mineral nitrogen influenced NDVI, biomass, yield or quality in the second consecutive wheat crop following vetch.

RESULTS AND INTERPRETATION

Rainfall

Summer-autumn rainfall in 2012 enabled the early sowing of vetch in March 2013. But, for the three years of this project GSR reached only Decile 1 or 2. Summer rainfall from November 2012 to the end of March 2013 was Decile 1 only (Table 1).

Table 1. Rainfall and rainfall deciles for 2012, 2013 and 2014.

Year (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	GSR (dec*)	Annual
2012	14	20	47	11	16	29	47	17	6	15	3	5	141 (1)	230 (2)
2013	4	20	2	3	24	47	27	21	21	13	4	0	156 (2)	186 (1)
2014	4	4	16	37	20	18	18	2	10	4	17	4	109 (1)	154 (1)

*Rainfall deciles presented in brackets.

Year 1: vetch crop

Vetch biomass production in 2012 ranged from 1t/ha in June to 5t/ha in September at peak biomass. Shoot N fixed ranged from 25kg N/ha in June to 135kg N/ha in September (Figure 1 and Table 2). When the biomass was multiplied by shoot N content (4%) and multiplied by a

below ground root factor of 1.5 (Peoples, pers.com), N produced by the whole plant ranged from 63kg N/ha to 294kg N/ha.

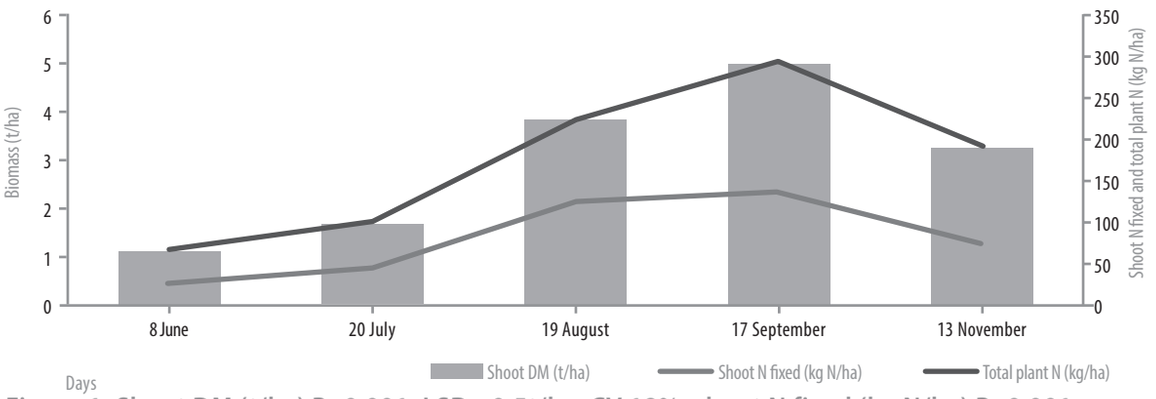

Figure 1. Shoot DM (t/ha) P<0.001, LSD= 0.5t/ha, CV 18%; shoot N fixed (kg N/ha) P<0.001, LSD= 20 kg N/ha, CV 25%; and total plant N (kg N/ha).

At the end of 2012, following different vetch termination timings, the difference in plant available water (PAW) between the July termination and harvested vetch was 65mm (0-120cm). In the case of soil mineral nitrogen, the June termination timing measured 69kg N/ha more than the harvested vetch.

Table 2. The effect of termination timing on shoot dry matter and N fixation in relation to cumulative rainfall, PAW and soil mineral N (0-120cm) at the end of the 2012 growing season.

Termination timing	Rainfall (mm)*	Shoot DM (t/ha)	Shoot N fixed (kg N/ha)	Plant available water (mm)	Soil mineral N (kg N/ha)
8 June	45	1.05[a]	25[a]	98[b]	158[a]
20 July	103	1.6[b]	43[a]	129[a]	122[ab]
19 August	118	3.8[c]	123[b]	92[bc]	108[b]
17 September	127	4.9[c]	135[b]	86[bc]	113[b]
13 November (control)	149	3.2[d]	74[c]	64[c]	89[b]
Sig. diff. (date)		P<0.001	P<0.001	P=0.013	P=0.028
LSD (P=0.05)		0.5	20	30	39
CV%		18	25	20	22

*Cumulative rainfall from sowing (13 March) to termination time/sampling date. (Note: Letters following a treatment result indicate whether there were significant differences between treatments: same letter not significantly different, different letter significantly different).

Year 2: wheat crop

In 2013, wheat grown on the later vetch termination treatments (Aug-Sep 2012) hayed off, and all treatments had high protein (BCG 2013 Season Research Results, pp 119).

Year 3: wheat crop

Due to a very dry year in 2014 (Table 1), yields were very low and essentially the wheat crop 'failed'. Higher protein and NDVI measurements occurred in treatments where vetch was terminated late in 2012 and where the wheat crop hayed off in 2013. These results suggested

that carryover nitrogen was possibly greater in these treatments. However, this trend was insufficient to translate into dry matter (DM), test weight or yield differences, which probably is a reflection of the dry spring.

Table 3. 2012 vetch termination timing: 2014 wheat yield, quality, dry matter and NDVI.

2012 Vetch termination timing	2014 wheat yield (t/ha)	Protein (%)	Test Wt (kg/hL)	Screenings (%)	DM (t/ha)	NDVI 2 July	NDVI 8 Aug
8 June (3 months)	0.2	14.1[a]	73.4	4.3	2.4	0.40[a]	0.31[a]
20 July (4 months)	0.2	14.2[a]	72.5	4.4	2.3	0.45[a]	0.31[ab]
19 August (5 months)	0.2	14.7[ab]	69.3	5.0	2.5	0.48[b]	0.33[bc]
17 September (6 months)	0.1	15.1[b]	69.1	4.3	2.6	0.51[bc]	0.34[cd]
13 November – harvest (control)	0.1	15.0[b]	69.3	3.7	2.6	0.50[c]	0.35[d]
Sig. diff.	NS	P=0.029	NS	NS	NS	P<0.001	P<0.001
LSD (P=0.05)	-	0.7	-	-	-	0.03	0.02
CV%	5.2	4.9	5.6	1.4	10.2	6.1	5.7

Very low wheat yields and high protein also resulted following treatments where vetch was terminated in spring at peak biomass with different end-uses in 2012. (Table 4).

Higher NDVI measurements occurred in July in treatments where vetch was not removed in 2012, including brown manure, incorporation or where harvest residue remained and where wheat hayed off most significantly (high protein and screenings) in 2013. These differences were not reflected in August NDVI measurements or in harvested yield and quality results from 2014. This may also be a reflection of the dry September-October.

Table 4. 2012 vetch end-use: 2014 wheat yield, quality, dry matter and NDVI.

2012 end-use treatment	2012 termination date	Yield (t/ha)	Protein (%)	Test Wt (kg/hL)	DM (t/ha)	NDVI 2 July	NDVI 8 Aug
Hay	17 September	0.1	14.2	67.5b	2.4	0.46a	0.31
Brown manure	17 September	0.1	15.2	57.3a	2.3	0.51b	0.34
Incorporation	17 September	0.1	14.7	67.5b	2.5	0.48ab	0.32
Grazed (x2)	8 June, 25 July 24 September	0.1	14.4	64.7b	2.6	0.46a	0.33
Harvest (control)	13 November	0.1	13.3	66.6b	2.6	0.51b	0.35
Sig. diff.		NS	NS	P=0.003	NS	P=0.014	NS
LSD (P=0.05)		-	-	4.8	-	0.03	-
CV%		33.7	2.9	4.8	10.2	4.6	5.9

Gross margins (GMs)

Cumulative gross margins from 2012-2014, revealed that the June and July vetch termination treatments made a three year profit of $348/ha and $331/ha (Figure 2). These gross margins resulted from higher wheat yields in the first wheat crop after vetch due to increased soil water.

In the year following the later vetch terminations, wheat yields were lower due to a combination of low soil water, high nitrogen and poor wheat quality (size and weight). GMs of only $14/ha and $8/ha were achieved.

The harvested vetch grain treatment made a profit in both the first and second years. No treatments made a profit in year three due to poor yields. The cumulative GM was $288/ha.

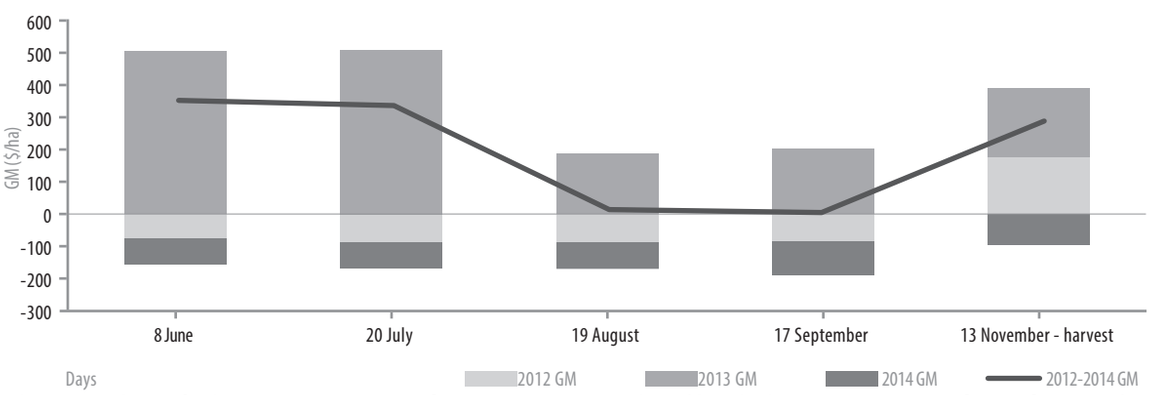

Figure 2. Cumulative, 2012, 2013 and 2014 gross margins. (Statistics were not conducted on GM).

COMMERCIAL PRACTICE

Early establishment of vetch on soil moisture can produce between 1t/ha of biomass (three months after sowing) and 5t/ha of biomass (six months after sowing).

Vetch biomass of 3-5t/ha can fix between 74-135kg N/ha of shoot nitrogen and when combined with root matter can produce between 200-300kg N/ha. This level of nitrogen can cause the following wheat crop to hay off if a dry summer and growing season follow the vetch production year.

As a result, early vetch termination is lower risk, particularly in a Mallee environment where soil water is often limited and haying off can occur if too much mineral nitrogen is taken up by the subsequent crop and a dry finish occurs.

Regardless of sowing time, approximate vetch biomass production of 2t/ha (up to 120kg N/ha of total plant N produced if no losses occur) may be a good target if a wheat crop is to follow and a dry season is forecast (Decile 3 or less). Clearly variation in seasonal conditions, soil type and livestock need to be considered.

In dry seasons, residual mineral nitrogen from vetch brown manure can influence cereal crop growth in the following two years. However, this trial demonstrates that soil water is more critical than nitrogen in Decile 1 and 2 rainfall years.

ON-FARM PROFITABILITY

The June and July termination timings, followed by two consecutive years of wheat, made an additional $60 and $43 respectively when compared with the harvested vetch grain-wheat-wheat sequence. Although a positive outcome, this constitutes a small return in a commercial sense.

If the season in the second year of this study had been a Decile 6 GSR year (270mm), wheat yields to the order of 3.5t/ha may have been achievable and the supply of 140kg N/ha would have been necessary. This N requirement could have been supplied by 2.3t/ha of biomass (and the corresponding below ground material) production from vetch or from urea which at $470/t would cost $143/ha.

ACKNOWLEDGEMENTS

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KEY WORDS

vetch termination, vetch end-use, brown manure, nitrogen, water use, soil water, haying off profitability