VETCH TERMINATION: IMPACT ON THE FOLLOWING WHEAT CROP

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TAKE HOME MESSAGES

- Early termination of vetch resulted in higher soil nitrogen and soil water at sowing the following year, compared with later termination timings of vetch.
- Wheat yield in the year following vetch was highest for the earlier termination timings of the vetch.
- Brown manure vetch had higher soil nitrogen and soil water compared to vetch taken through to harvest.

KEY WORDS

Brown manure, desiccation, nitrogen, profitability, soil water, vetch end-use, vetch termination, water use.

BACKGROUND

The optimum time to terminate vetch to achieve the greatest benefit for the following wheat crop promotes eager discussion among farmers and agronomists. Finding the balance between early termination for soil water conservation as opposed to later termination for greater biomass production and nitrogen (N) fixation for the benefit of the next crop is not always simple.

Seasonal conditions, crop growth, weed spectrum and livestock feed requirements are all factors that can influence the decision of when to terminate vetch growth.

A common question is: 'how much soil moisture and nitrogen is conserved for the subsequent crop with different termination practices, such as brown manure, incorporation through cultivation, grazing, hay or harvested vetch?'

In the second year of a GRDC-funded crop sequencing project, we investigated the value of vetch as a break crop and its influence on soil water, nitrogen and profitability. In 2012, vetch termination with different methods was established and in 2013 wheat was sown over each treatment to measure the influence of soil moisture and nitrogen on wheat yield and quality.

AIM

To compare the effects of (i) five different vetch termination timings, and (ii) five different end-uses of vetch on stored soil water and mineral N, and the yield of a subsequent wheat crop.

TRIAL 1
IMPACT OF TIMING OF VETCH TERMINATION ON THE FOLLOWING WHEAT CROP

METHOD

On 13 March 2012, four complete randomised blocks were sown at Birchip to Morava vetch (60 plants/m^2) following 23mm rain on 1 March and 15mm on 5 March. The first level of treatments were designed to investigate the effect of inoculation on vetch growth, and the second level of treatments focused on vetch termination timing and the subsequent impact on the yield of wheat sown in 2013 (Table 1). Biomass, levels of N fixation (not presented), soil water and N were measured (0-15, 15-30, 30-60, 60-90, 90-120cm) post-harvest on 26 November, 2012.

On May 3, 2013 wheat was sown over the 2012 vetch termination timing trial. Pre-sowing soil moisture and nitrogen were measured to depth on 13 April (0-15, 15-30, 30-60, 60-90, 90-100cm). NDVI measurements were recorded at GS65 and the wheat was harvested on November 19 with yields and quality data recorded. Post-harvest soil sampling was repeated to depth on 2 December at the same intervals as those pre-sowing.

Location:	Birchip	
Replicates:	Four	
Crop type:	CLF Elmore Plus wheat	
Target plant density:	160 plants/m^2 (70kg/ha)	
Fertiliser:	3 May	Granulock Supreme Z + Impact (30kg/ha)
Herbicides:	3 May	TriflurX® (2L/ha) + Avadex® Xtra (2L/ha)
	8 July	Intervix® (600ml) + Lontrel™ Advance (65ml) + LVE MCPA (350ml) + Hasten™ (1%)
Seeding equipment:	BCG Gason parallelogram cone seeder (knife points, press wheels, 30cm row spacing)	

Table 1. 2012 vetch termination treatments.

2012 termination timing	2012 inoculation	2012 herbicide/rate
8 June (3 months)	plus/minus	Roundup (2L) + Lontrel (200ml)
20 July (4 months)	plus/minus	Roundup (2L) + Lontrel (300ml)*
19 August (5 months)	plus/minus	Roundup (2L) + Lontrel (150ml) + Goal (100ml) + Hasten (1%)*
17 September (6 months)	plus/minus	Roundup (2L) + Lontrel (300ml)*
13 November – harvest (control)	plus/minus	none applied

*Gramoxone (1.5L/ha) applied seven days after the first herbicide application. The June termination was small and young and did not require a second knockdown application.

RESULTS

Plus and minus inoculation

There was no difference in vetch growth and biomass production between plus/minus inoculation; only the 'plus' treatments were analysed and reported.

Rainfall

Summer rainfall was below average (November 2012 to end of March 2013 rainfall was 34mm, Decile 1), while 2013 growing season rainfall (April-October) was 156mm (Decile 2) (Table 2).

Table 2. 2012 and 2013 rainfall.

Year (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	GSR	Ann.
2012	14	20	47	11	16	29	47	17	6	15	3	5	141	230
2013	4	20	2	3	24	47	27	21	21	13	4	0	156	186

2012 baseline soil water characteristics

The trial site was located on a clay loam soil with high sub-soil constraints (chloride 1000mg/kg from 60-100cm depth).

At pre-sowing, the vetch site had a plant available water content (0-100cm) of 88mm (Figure 1) and available soil nitrogen of 50kg N/ha.

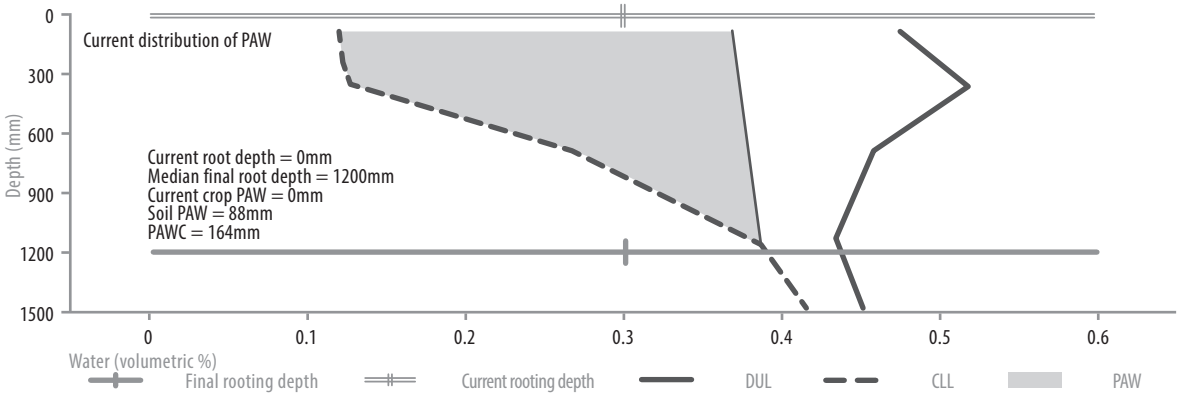

Figure 1. Baseline distribution of water in the soil profile prior to sowing vetch in 2012.

Soil water

Due to the high salt levels (as measured by high chloride concentration at depth) the effective rooting depth of the vetch was taken as 60cm and statistical analyses were undertaken on the 0-60cm layer. At harvest in 2012, there was a significant difference in soil water content between the five different vetch termination timings: the earliest termination timings (June 6 and July 18) having a higher soil water content than the soil water content for vetch taken through to harvest ($P<0.001$) (Table 3). At sowing, these differences were much less, but still significantly different ($P=0.03$) (Table 3).

Table 3. Soil available nitrogen (0-60cm) for five different vetch termination timings as measured post-harvest 2012, 2013 pre-crop and post-harvest.

2012 vetch termination treatment	2012 post-harvest soil water (vol. mm) 0-60cm	2013 pre-sow soil water (vol. mm) 0-60cm	2013 post-harvest soil water (vol. mm) 0-60cm
6 June (3 months)	185	147	139
18 July (4 months)	182	160	126
19 August (5 months)	150	143	130
17 September (6 months)	164	137	139
13 November harvest (control)	148	148	128
Sig. diff.	P<0.001	P=0.03	P=0.03
LSD (P=0.05)	13	13	9
CV%	8.6	10	7.6

Soil available nitrogen

The 2012 post harvest soil nitrogen (kg N/ha) was higher for the June (158kg N/ha) and July termination timings than the August and September terminations and the November harvest control. The differences between treatments in soil nitrogen remained the same at the pre-sowing measurements (Table 4).

Following the 2013 wheat crop, about 20kg N/ha remained in the soil (0-120cm) for all treatments.

Table 4. Soil available nitrogen (0-120cm) for five different vetch termination timings as measured post-harvest 2012, 2013 pre-crop and post-harvest.

2012 vetch termination treatment	2012 post- harvest soil N (kg N/ha) 0-120cm	2013 pre-sow soil N (kg N/ha) 0-120cm	2013 post- harvest soil N (kg N/ha) 0-120cm
6 June (3 months)	158a	150[a]	22
18 July (4 months)	122[ab]	132[b]	22
19 August (5 months)	108[b]	127[b]	21
17 September (6 months)	113[b]	132[b]	23
13 November Harvest (control)	89[b]	108[c]	23
Sig. diff.	P=0.03	P=0.02	NS
LSD (P=0.05)	39	23	
CV%	22	17	20

Biomass

NDVI measurements of the wheat crop on 7 October (GS65) showed that the early June and July treatments 'reflected more greenness' than the September termination treatment and the November harvest control.

Grain yield and quality

Significant differences were observed between yield, protein, test weight and screenings. June and July early termination treatments yielded higher, had higher test weights and larger seed than the later termination timings. Protein and screenings were lower for the early termination timings and higher for the later termination timings (Table 5). This implies that the wheat crop established on the later vetch termination treatments had run out of water during the grain-filling phase, exhibiting the classic 'haying off' effect.

Table 5. 2013 wheat (CLF Elmore Plus) yield, quality and estimate of biomass (at GS65).

2012 vetch termination treatment	Yield (t/ha)	Protein (%)	Test wt (hL/ha)	Screenings (%)	1000 grain weight (g)	NDVI (GS65)
6 June (3 months)	2.7[a]	13.0[b]	81[a]	6[c]	29[a]	0.29[a]
18 July (4 months)	2.7[a]	13.2[b]	81[a]	7[c]	29[a]	0.29[a]
19 August (5 months)	2.1[b]	14.8[a]	77[b]	18[b]	24[b]	0.27[ab]
17 September (6 months)	2.2[b]	15.2[a]	76[c]	22[ab]	25[b]	0.26[b]
13 November control	2.3[b]	14.7[a]	76[c]	24[a]	23[b]	0.22[c]
Sig. diff.	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001
LSD (P=0.05)	0.3	0.7	1	6	2	0.03
CV%	14.0	5.0	2	36	6.5	10.6

TRIAL 2
IMPACT OF VETCH 'END-USE' ON THE FOLLOWING WHEAT CROP

AIM

To compare soil moisture, soil nitrogen and profitability of five different vetch end-use treatments from 2012, sown to wheat in 2013.

METHOD

See Trial 1 methodology.

The five vetch end-use treatments were hay, brown manure, cultivated, grazed and harvested (Table 6). CLF Elmore Plus wheat was sown over all 2012 treatment plots on 3 May 2013.

Table 6. Vetch end-use termination treatments.

2012 treatment	2012 end-use	Termination treatment
Hay	17 September	mowed, residue removed from plots *
Brown manure	17 September	Roundup PowerMax (2L/ha) + Lontrel (300ml)
Cultivated	17 September	worked by disc Roundup PowerMax (2L/ha) + Lontrel (300ml)
Grazed x 2	8 June, 25 July	simulated grazing by mowing
	24 September	Roundup PowerMax (2L/ha) + Lontrel (300ml)
Harvest (control)	13 November	header harvest

RESULTS

Soil moisture and soil nitrogen

There was no difference between termination treatments in 2013 pre-sowing soil moisture, but differences were observed post-harvest in the harvest (control) treatment, which only had 26mm of soil water remaining, while other treatments ranged from 39-40mm of soil water.

The hay treatment had significantly lower pre-sow soil nitrogen than the other termination treatments. Post-harvest soil nitrogen was between 33 and 39kg N/ha and no differences were found between treatments (Table 7).

Table 7. Vetch end-use termination treatment effect on pre- and post-harvest soil nitrogen and soil water (0-120cm).

2012 vetch termination treatment	2013 pre-sow soil nitrogen (kg N/ha) 0-120cm	2013 pre-sow soil water (mm) 0-120cm
Cultivated	66[b]	57
Brown Manure	85[a]	70
Grazed x 2	78[ab]	67
Harvest (control)	71[ab]	54
Hay	44[c]	51
Sig. diff.	0.004	NS
LSD (P=0.05)	17	
CV%	15	32

Wheat yield and quality

Wheat yield ranged between 1.8t/ha to 2.3t/ha, and there were no significant differences between the 2012 vetch termination treatments (Table 8).

Protein was 13% or above for all treatments; the hay treatment had the lowest and brown manure the highest protein of all the termination treatments. These results corresponded to the amount of soil N at sowing for the wheat crop.

Brown manure vetch had a higher soil N and soil water than vetch taken through to harvest, but the following wheat crop hayed off (low yield with high screenings) possibly due to low growing season rainfall (Decile 2 season).

Table 8. Vetch end-use, soil nitrogen, water, yield and quality parameters.

2012 treatment	Yield (t/ha)	Protein (%)	Test wt (kg/hL)	Screenings (%)	1000 grain weight
Cultivated	2.3	15.2[ab]	77[ab]	21[b]	21[b]
Brown manure	2.1	16.0[a]	75[bc]	33[a]	19[c]
Grazed x 2	2.1	14.1[bc]	80[a]	14[b]	24[a]
Harvest (control)	1.9	15.4[ab]	74[c]	35[a]	19[c]
Hay	1.8	13.1[c]	80[a]	12[b]	25[a]
Sig. diff.	NS	<0.001	<0.001	<0.001	<0.001
LSD (P=0.05)		1.6	1	6	2
CV%	14.0	7.2	2	36	5

COMMERCIAL PRACTICE

This study showed that, 'haying off' can occur if wheat is grown in a low rainfall season following a vetch crop that was terminated later in the season (August and September) where spring-summer rainfall was also low.

In addition, results demonstrated that brown manure vetch can lead to higher soil N and soil water than vetch taken through to harvest, but the following wheat crop can hay off (low yield with high screenings) possibly due to low growing season rainfall (Decile 2 season).

Haying off occurs when high amounts of N are taken up by the plant, which leads to the development of extra tillers and the dilution of stem sugars necessary for grain filling in a dry finish (*van Herwaarden, 2001*). In this trial, grain of light weight, high screenings and protein was harvested.

Sub soil constraints were also evident, which reduced the ability of plant roots to access soil water beyond 60cm. This highlights that growers should be wary of selecting paddocks for later vetch termination or brown manuring if sub-soil constraints are prevalent.

In seasons of low spring and summer rainfall, early termination of vetch (three months after sowing) can result in higher soil N and soil water content in the following year prior to sowing wheat than later termination timings. Higher soil N is most likely due to a longer period of N mineralisation over the winter and summer. High soil water content is due to early termination of vetch, which kept in a clean fallow situation, enabled winter rainfall to be stored for the following crop.

REFERENCES

Van Herwaarden, A (2001) Careful management reduces haying-off risks. Farming Ahead No 110, February.

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