Canola plant emerging

CROP AGRONOMY

Conserving moisture during summer

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Take home messages

- **controlling summer weeds conserved both water and nitrogen and doubled wheat yields in 2011 on both sand and clay soil types**
- **retaining or removing stubble has only minor effects on wheat yield**
- **complete control of summer weeds pays, and there is no excuse for weedy paddocks during summer in the Wimmera and Mallee!**

Background

Capturing, storing and making best use of summer rainfall is one of the most effective ways of improving crop yields in low to medium rainfall environments. The value of storing summer soil moisture has been proven in recent years through various BCG trials (1999 to 2010). Results have shown time and time again the value of controlling summer weeds in terms of increased yield of the following crop. Even in the exceptional growing season of 2010, controlling weeds in the summer of 2009/2010 gave a substantial yield increase due to enhanced nitrogen availability to the crop (see *BCG 2010 Season Research Results* p30).

Aim

To quantify how paddock stubble load and weed burden during summer can affect available soil water, nutrients and subsequent crop yield.

Method

This field experiment was established 13km south-east of Hopetoun on Warrakirri's *Bullarto Downs* property on two soil types typical to the region, 2km apart. The sand site lay on top of an east-west dune with sandy topsoil and clay subsoil. The clay site was located on a low-lying flat with clay loam topsoil and moderate subsoil constraints.

At each field site, six stubble treatments were established on 2 December 2010 into existing canola stubble loads: 5.3t/ha at the sand site and 4.8t/ha at the clay site. The treatments were

1. standing stubble
2. standing stubble and summer weeds
3. slashed stubble
4. bare earth
5. bare earth and summer weeds
6. cultivation

Stubble on treatments 3, 4 and 5 was slashed with a whipper-snipper; stubble was then removed from the plots in treatments 4 and 5.

Two soil cores per plot (segmented into layers to a depth of 1.3 m) were taken on 14 December 2010, 28 March 2011 and 2 December 2011. Plant available water (PAW) and mineral nitrogen were determined on the samples.

Following rain in December 2010 and January 2011, summer weeds (volunteer cereals, melons and heliotrope) emerged in all treatments. On 25 January 2011, treatments 1, 3 and 4 were sprayed with Amicide® 625 600mL/h and Companion® 1%. On 9 February and 11 March treatments 1, 3 and 4 were sprayed again with Roundup® 1.5L/ha, Goal 75mL/ha and Hasten® 1%. Treatment 6 was cultivated on 25 January at both sites and the sand site was cultivated again on 3 March due to subsequent weed emergence. Weeds in treatments 2 and 5 were allowed to continue growing throughout the summer.

All treatments were sown to Correll wheat on 29 April 2011. Plots were kept weed-free throughout the season. Crop biomass was measured as Normalised Difference Vegetation Index (NDVI) at GS15-22, GS30, GS65 and GS85 with a hand-held GreenSeeker® crop sensor (NTech Industries Inc., Ukiah, California). Dry matter production was measured at flowering and again at maturity. Grain yield was measured with a plot harvester and grain quality analysed (protein, moisture, screenings and test weight).

After the 2011 harvest, all treatments were re-implemented and the experiment will be repeated again in 2012 for the final year of the five-year trial.

Location:	Hopetoun
Replicates:	4
Sowing date:	29 April 2011
Sowing rate:	70kg/ha
Crop type/s:	Correll wheat
Inputs/fertiliser:	both sites – 55kg/ha MAP at sowing, 21kg/ha N top-dressed as ammonium sulfate on 1 July.
Seeding equipment:	knife points press wheels, inter-row sown, 30cm row spacing
Summer rain:	387 mm
Growing season rain:	198 mm

Results

At both sites, crop establishment was better when summer weeds were controlled (Table 1).

Stubble retention also improved establishment at the sand site, but made no difference at the clay site (Table 2).

Early growth was better where weeds were controlled over summer, at GS30 NDVI was higher in these treatments (Table 3).

Table 1. Mean plant density for weedy and non-weedy treatments

Treatment	Plant density (plants/m²)	
	Sand	Clay
Weeds (treatments 2 & 5)	104	91
No Weeds (treatments 1, 3, 4, & 6)	139	113
Sig. diff.	**P=<0.001**	**P=0.010**
LSD (P=<0.05)	**13**	**16**
CV%	**10%**	**17%**

Table 2. Mean plant density for stubble retained and no stubble treatments

Treatment	Plant density (plants/m²)	
	Sand	Clay
Stubble (treatments 1,2 & 3)	141	105
No Stubble (treatments 4, 5 &6)	115	107
Sig. diff. **LSD (P=<0.05)** **CV%**	**P=<.001** **12** **10%**	**NS**

Table 3. Mean wheat NDVI at GS33 on 4 August 2011 for weedy and non-weedy treatments

Treatment	Sand	Clay
Weeds (treatments 2 & 5)	0.07	0.12
No Weeds (treatments 1, 3, 4, & 6)	0.12	0.26
Sig. diff. **LSD (P=<0.05)** **CV%**	**P=<.001** **0.03** **28%**	**P=<.001** **0.05** **27%**

Controlling summer weeds resulted in more PAW and mineral N prior to sowing and as a result doubled yields at both sites (Table 4 & 5).

Cultivation and retention of stubble had significant but much smaller impacts on yield at both sites. At the sand site, the slashed stubble treatment out-yielded the standing stubble, bare earth and cultivation treatments. At the clay site, cultivation out-yielded both slashed and standing stubble treatments.

Table 4. Sand site mean plant available water (PAW) & mineral nitrogen at 28 March 2011 (0-130cm) for all treatments, yield, protein and gross margin

Treatment	PAW at 28 March 2011 (mm)	Mineral N at 28 March 2011 (kg/ha)	Yield (t/ha)	Protein (%)	Gross Margin ($/ha)
Standing stubble	97	131	3.7	9.9	$298
Standing stubble + summer weeds	78	77	2.2	10.2	$126
Slashed stubble	113	123	4.2	9.8	$346
Bare earth	101	105	3.7	9.6	$304
Bare earth + summer weeds	67	70	2.1	9.9	$84
Cultivation	96	101	3.7	9.2	$305
Sig. diff. **LSD (P=<0.05)** **CV%**	**P=0.028** **27** **19%**	**P=0.003** **29** **19%**	**P=<0.001** **0.3** **6%**	**NS**	**P=<0.001** **46** **12%**

Table 5. Clay site mean plant available water (PAW) & mineral nitrogen at 28 March 2011 (0-130cm) for all treatments, yield, protein and gross margin

Treatment	PAW at 28 March 2011 (mm)	Mineral N at 28 March 2011 (kg/ha)	Yield (t/ha)	Protein (%)	Gross Margin ($/ha)
Standing stubble	145	145	2.6	12.1	$296
Standing stubble + summer weeds	99	97	1.4	12.9	$58
Slashed stubble	133	123	2.8	11.8	$321
Bare earth	125	149	2.9	11.9	$351
Bare earth + summer weeds	97	111	1.4	12.2	$55
Cultivation	133	145	3.0	12.0	$369
Sig. diff.		**P=0.014**	**P=<.001**	**P=0.006**	**P=<0.001**
LSD (P=<0.05)	**NS**	**30**	**0.2**	**0.5**	**70**
CV%		**15%**	**7%**	**3%**	**19%**

Interpretation

The results of this trial in 2011 have once again clearly demonstrated that controlling summer weeds has a much bigger impact on plant available water, nitrogen and crop yield than retaining stubble. This is the first season in which a small but significant effect of stubble management on yield has been found, and this worked in opposite directions at each site. The cultivation and bare earth treatments yielded more than the stubble retention treatments at the clay site, whilst the slashed stubble treatment yielded the most at the sand site. The increased yield due to stubble at the sand site may have been the result of improved establishment. Reasons for the yield decrease at the clay site are less obvious.

Return on investment in summer weed control in 2011 was excellent; this has been the case for two of the three years that the trial has run (Table 6). Modelling over 120 years of climate data has shown that years such as 2009, in which there is no return on investment from controlling summer weeds, are rare, occurring in only 29% and 3% of years at Hopetoun on clay and sand soil types respectively.

Table 6. Mean additional PAW, nitrogen, yield and return on investment ($/ha) from controlling summer weeds at both sites 2009-2011. Crop type in 2009 was barley, 2010 canola and 2011 wheat

Site	Year	Mean additional PAW at sowing (mm)	Mean additional Nitrogen (kg N/ha)	Mean additional grain yield (t/ha)	ROI (%)
Sand	2009	26	-5	0.1	170
	2010	40	45	0.4	205
	2011	29	41	1.6	662
Clay	2009	10	10	0.0	6.6
	2010	52	44	0.6	308
	2011	36	53	1.4	909

Because controlling summer weeds results in more soil water and nitrogen, yield responses are very reliable. In seasons with high growing season rainfall (e.g. 2010), the yield increase is driven by additional nitrogen. In seasons with low growing season rainfall, the yield increase is driven by additional water, and in average seasons the yield increase is driven by both water and nitrogen.

Commercial practice: what this means for the farmer

- growers and consultants are right to focus attention on summer weed control. Complete control of summer weeds is highly profitable and one of the safest input investments in broad-acre grain farming.
- in north-west Victoria, there is no excuse for weedy paddocks over summer. Research by NSW DPI has shown that whilst complete control of summer weeds is preferable, delayed control is better than no control.
- weed control by cultivation is as effective at storing water and increasing yields, as are herbicides. It should not be ruled out as an option, particularly on heavy soils and on bare paddocks (e.g. pulse stubbles etc.) where it is likely to reduce rather than exacerbate wind erosion. Weed control by cultivation can be begun within a few days of rainfall (longer is required for herbicides), and can be done when weather conditions prevent spraying. Because of this, it may have a role on farms where timely summer weed control with herbicides is difficult.
- retaining or removing stubble has only minor implications for yield. The best reason for retaining stubble is to prevent wind and water erosion, and 70% cover (~2 t/ha) of cereal stubble is required to achieve this. Stubble levels should be managed on a paddock-by-paddock basis to ensure system benefits (prevent erosion, reduce labour, facilitate faster sowing, and improve establishment) and avoid system penalties (increased labour, delayed sowing, reduced pre-emergent herbicide efficacy and, increased disease e.g. crown rot, yellow leaf spot).

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