Conserving moisture during summer

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Take home messages

- *Weeds have the biggest impact on summer water storage.*
- *Over the last two summers, the method of weed control (i.e. cultivated or sprayed) had little effect on moisture storage.*
- *Even under adequate growing season rainfall, weed control is necessary because weeds tie up and/or prevent significant amounts of nitrogen mineralizing (40 kg/ha in this experiment) which cost ~0.5 t/ha of canola yield.*

Background

Conserving summer rain is one of the most effective ways of increasing winter crop yield in the Mallee. Weed growth during the summer fallow period can impact on soil water storage, which in turn reduces subsequent crop yield, particularly during dry growing seasons. Stored plant available soil water at the beginning of the growing season is not the only advantage of summer weed control. When left to grow, summer weeds tie up significant amounts of nitrogen. Moreover, by drying out the soil profile, they prevent organic nitrogen from plant residues mineralising into forms which can be used by crops. This means that even in wet growing seasons such as those experienced in 2010, significant yield responses still result from weed control during the preceding summer.

BCG is working towards a 10% increase in water-use efficiency across the Wimmera Mallee by better capturing and using summer fallow rainfall. The moisture conservation trial described here began in December 2008. Previous results can be found on page 34 in the 2009 BCG Season Research Results.

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 18 November 2009 into existing barley stubble loads of 4.0t/ha at the clay site and 3.7t/ha at the sand 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 with the stubble being removed from the plots in treatments 4 and 5.

Two soil cores per plot (segmented into layers to a depth pf 1.3 m) were taken on 12 November 2009, 30 March 2010 and 14 December 2010 with plant available water and mineral nitrogen determined on the samples. The soil water content measured on cores sampled in November 2009 was assumed to be a good indication of crop lower limit (CLL) and was used to calculate plant available water (PAW).

Following rain in December 2009, summer weeds (volunteer cereals, melons and heliotrope) emerged in all treatments. On 7 December 2009, treatments 1, 3 and 4 were sprayed and kept clean until sowing. Treatment 6 was cultivated after all significant rainfall events and subsequent weed emergence. Summer weeds in treatments 2 and 5 were allowed to continue growing throughout the summer.

All treatments were sown to GT Scorpion canola on 24 April 2010. Plots were kept weed-free throughout the season. Crop biomass was measured as Normalised Difference Vegetation Index (NDVI) at the 5-leaf stage 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 (oil content and moisture).

After the 2010 harvest, all treatments were re-implemented and the experiment will be repeated for the next two years.

Location:	Hopetoun
Replicates:	4
Sowing date:	24 April 2010
Crop type:	GT Scorpion canola
Seeding equipment:	Knife points, press wheels, inter-row sown, 30cm row spacing
Growing season rain:	264mm
Soil fertility:	Sand site: 21mg/kg Colwell P, 35 PBI
	Clay site: 33mg/kg Colwell P, 147 PBI
	(See Table 1 for soil nitrogen prior to sowing)
Fertiliser:	Both sites – 55kg/ha MAP at sowing; 25kg/ha N top-dressed as ammonium sulphate on 24 June and 37kg/ha N top-dressed as urea on 28 July.

Results

During the 2009/2010 summer fallow, the sand site received 224mm rain and the clay site 254 mm. These included individual falls of 128 mm and 163mm at the sand and clay sites respectively. These rain events were large enough for water to infiltrate and be stored deep in the profile where it is less subject to evaporative losses.

Stubble treatment had no effect on PAW at either site, so results were analysed by grouping the weedy and non weedy treatments and comparing them. On 30 March 2010 there were large amounts of PAW at both sites in the weed-controlled plots (Table 1). In treatments where weeds continued to grow over the summer, there was significantly less PAW: 40mm on the sand site and 52mm on the clay site.

Controlling weeds over summer 09/10 also resulted in approximately 45kg/ha of additional mineral nitrogen being available at soil sampling on 30 March 2010 (Table 1).

Table 1. Mean plant available water (PAW) at 30 March 2010 (0 -130cm) for weedy and non-weedy treatments and mineral nitrogen (kg/ha) at sowing.

Treatment	Plant available water (mm)		Mineral nitrogen (kg/ha)	
	Sand	Clay	Sand	Clay
Weeds (Treatments 2 and 5)	36	52	103	114
No Weeds (Treatments 1, 3, 4 & 6)	76	104	148	158
Sig. diff	**P=<0.01**	**P=0.01**	**P=0.004**	**P=0.004**
LSD (P=<0.05)	**17**	**38**	**28**	**28**
CV%	**30%**	**26%**	**19%**	**19%**

Controlling weeds over summer resulted in more vigorous crop establishment at both sites. At the five leaf stage, NDVI was higher in treatments where weeds were controlled, indicating that differences in soil water and nitrogen had resulted in the production of greater amounts of early dry matter (Table 2).

Table 2. Mean canola NDVI at the 5-leaf stage on 23 June 2010 for weedy and non-weedy treatments.

Treatment	NDVI	
	Sand	Clay
Weeds (Treatments 2 and 5)	0.10	0.11
No Weeds (Treatments 1, 3, 4 & 6)	0.16	0.26
Sig. diff	**P=0.05**	**P=<0.01**
LSD (P=<0.05)	**0.05**	**0.07**
CV%	**2.8%**	**46%**

The additional water and nitrogen in treatments without weeds allowed significantly more biomass to accumulate by the time the crop was 70% flowered (Table 3). The only significant response to the presence of stubble was found in dry matter production at the clay site when the crop was 70% flowered (Table 3). Treatments with stubble accumulated 0.6 t/ha dry matter at that time.

Table 3. Mean canola dry-matter production at 70% flowered for weedy and non-weedy treatments.

Treatment	Dry matter (t/ha)	
	Sand	Clay
Weeds (Treatments 2 and 5)	3.5	2.8
No Weeds (Treatments 1, 3, 4 & 6)	4.7	3.9
Sig. diff **LSD (P=<0.05)** **CV%**	**P=<0.01** **0.5** **10.9%**	**P=<0.01** **0.5** **12.1%**
Stubble (Treatments 1,2 and 3)	4.4	3.9
No Stubble (Treatments 4, 5 and 6)	4.3	3.3
Sig. diff **LSD (P=<0.05)** **CV%**	**P=0.79** **NS**	**P=<0.01** **0.5** **12.1%**

At both sites, summer weeds strongly limited the grain yield of canola (Table 4). Neither the presence nor absence of stubble, nor it's being standing or slashed, affected yield.

Table 4. Mean canola grain yield for weedy and non-weedy treatments.

Treatment	Grain yield (t/ha)	
	Sand	Clay
Weeds (Treatments 2 and 5)	2.7	2.1
No Weeds (Treatments 1, 3, 4 & 6)	3.1	2.7
Sig. diff **LSD (P=<0.05)** **CV%**	**P=0.021** **0.3** **9.2%**	**P<0.01** **0.2** **3%**

Soil sampling in December 2010 showed that the differences in PAW measured in March between weedy and non-weedy treatments (Table 1) were still present at the clay site (Table 5), but no longer existed at the sand site due to lower water holding capacity of the sand compared to the clay.

Table 5. Mean plant available water (PAW) at 14 December 2010 for weedy and non-weedy treatments.

Treatment	Plant available water (mm)	
	Sand	Clay
Weeds (Treatments 2 and 5)	102	94
No Weeds (Treatments 1, 3, 4 & 6)	101	131
Sig. diff **LSD (P=<0.05)** **CV%**	**P=0.868** **NS** **14%**	**P=0.017** **30** **24%**

The increase in grain yield in the weed-controlled plots equated to an extra income of $205/ha and $308/ha respectively above the weedy plots (Table 6).

Table 6. Return on investment for 09/10 summer spraying (Wipe-out + Ally 7/12/09 and Amine 3/3/10).

	Cost of summer weed control $/ha	Value of additional N ($/ha)	Value of additional grain yield ($/ha)	Return on investment (%)
Sand	43	56	205	376
Clay	43	55	308	616

Interpretation

The two seasons of this study illustrate that in the Mallee region of Victoria, summer fallow rain is a highly variable resource, contributing around 10mm to crop water use in 2009 but more than 100mm at the clay site in 2010. Control of summer weeds had by far the biggest impact on how much summer fallow rain was stored. Crop residue and tillage made no significant difference in either season and did not affect subsequent crop yield in 2009 or 2010. This finding is consistent with previously reported studies of summer fallow efficiency in southern Australia. However, stubble did result in increased flowering biomass at the clay site, which was probably due to stubble reducing evaporation during the growing season (Table 4). The most likely reason for this observation is that stubble is known to be more effective at reducing evaporation during cooler months than it is during summer when evaporative demand is high. Clay soils hold more moisture at the surface of the profile and are more prone to evaporation; hence the effect was not observed at the sand site.

The results of this experiment clearly illustrate that even in seasons such as 2009/2010 with a wet summer and growing season, it is still vital to control summer weeds. This is due to the presence of significant amounts of stored soil water at sowing which provided a yield 'guarantee' which allowed the crop to be managed in a more aggressive and profitable way e.g. selection of canola as a higher risk/profit crop, early sowing for higher yield potential and high nitrogen applications as determined by Yield Prophet.

The analysis of return on investment showed the importance of spraying summer weeds due to the extra value of nitrogen which is contributed to the system. At the clay site this year, the return of $6.16 for every $1 invested in summer weed control spoke for itself. The results have thus far shown that summer weeds have the highest impact on yield and water storage and even in wet years a considerable return on investment may be achieved.

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References

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