Summer weed control conserves soil moisture across varying soil types in the Eastern Wheatbelt

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Key messages

Results from a demonstration in December of 2012 suggest weed control had an impact on stored soil moisture and consequent yield in 2013 across a range of soil types at seven locations across the Eastern Wheatbelt. Another factor that could have been quantified in this work, was the effect of weed control on nitrogen status (and consequent effect of N on yield). Opening values were collected at the beginning of the trial but no closing N values were measured. Removing summer weeds has an impact on the nitrogen levels in the soil, and this will be further quantified with more field work in 2014.

Aims

This demonstration aimed to highlight the effectiveness of summer weed control in conserving soil moisture for winter cereal cropping in the Central-Eastern Wheatbelt of WA. Trial sites were distributed across a range of locations to determine the differences in stored soil moisture between soil types. Hunt et al. (2013) found that nitrogen conservation due to weed control was a significant factor in the yield benefits attributable to chemical fallow, however complete N analysis was not conducted in the work presented here.

Method

Nine demonstration sites were selected based on differing soil types, and were spread over a large area from Narembeen in the south, Beacon in the north, Kellerberrin in the west to Southern Cross in the east. Two sites were compromised by grazing and were therefore excluded from this analysis.

The demonstrations were non-replicated 20mx10m plots, with 5m left between plots to reduce potential spray drift effects. The spraying treatments consisted of a single 6L/ha of glyphosate applied via knapsack on the 13th, 14th and 15th of December 2012. Blue dye was used to ensure complete coverage.

Soil coring locations were selected from the areas of most uniform soil type within each plot. Gravimetric soil moisture was determined from a single core taken at each sprayed and unsprayed plot at each location. Cores were divided into 10cm increments to a depth of 40cm, with an additional subsoil sample taken at 60-80cm. Soil moisture measurements were calculated by oven dried weights at DAFWA's Merredin office.

Soil moisture samples were taken at the initial December site visit, then again on the 9th and 10th of January 2013 prior to a summer rainfall event, with final soil coring undertaken on the 26-27th of February prior to further thunderstorm activity. All moisture cores were taken from within 1m of the initial location during subsequent sampling. Bulked 0-10cm samples were also taken for Predicta-B soil disease testing at the final soil coring.

Cereal crops (all wheat apart from barley at Beacon North) were established on each plot using growers' knifepoint or disc seeding equipment and grown using normal district

agronomic practices including knockdown and selective herbicides and fungicide treatments where appropriate. Sowing dates ranged from the 4th to the 15th of May.

Treatment yields were calculated from handcuts by DAFWA and cross-referenced with growers' yield data for verification of accuracy.

Electromagnetic induction (EM) surveys of each trial plot were conducted at the initial and final site visits, however these results are not presented here and will form the basis of future analyses.

Results

Glyphosate treatments in December led to successful weed kill at all trial sites. Predicta-B results indicated a high risk of Crown rot on the sprayed plot at Narembeen but a low Crown Rot risk on the unsprayed plot, suggesting a degree of inherent heterogeneity at this site. The remaining sites had 'low' to 'borderline' assessments for Cereal Cyst Nematodes, Take-all and different strains of Fusarium.

November to February ('summer') rainfall varied from 66mm to 167mm across the trial sites, with a high degree of local variability as indicated by the difference between growers' summer rainfall observations and Bureau of Meteorology records. For example, the grower records for the Beacon North site indicated 22mm for November-February, whist the nearest BOM station (approx. 20km away) recorded 81mm for the same period. BOM records are shown here for consistency. Growing season rainfall (GSR) was less variable between the trial sites, ranging from 197mm at Southern Cross to 233mm at Bodallin (Table 1).

Table 1 'Summer', 'Autumn' and growing season rainfall (GSR) and sowing dates

	Soil Type	Nov-Feb rain (mm)[1]	Mar-Apr rain (mm)	Nov-Apr rain (mm)	GSR (mm)[2]	Sowing date
Nungarin	Duplex (30cm sand)	88	58	146	220	5th May
Narembeen	Duplex (30cm sand)	148	48	196	251	6th May
Southern Cross	Sandy gravel/loam[4]	104	41	145	197	4th May
North Bencubbin/Beacon South	Heavy Loam	161	42	203	190	11th May
Westonia/Bodallin	Duplex (30cm sand)	167	61	228	233	20th May[3]
Beacon North	Sandy loam	81	16	97	207	15th May

[1] – BOM data from nearest station; [2] – Grower data; [3]- estimated; [4] – two sites

At each trial site we compared the soil water and grain yield of the sprayed and unsprayed treatments. Initial December (i.e. pre-spraying) soil moisture ranged from 38mm to 115mm, with small and variable differences in 0-40 and 60-80cm soil moisture between the sprayed and unsprayed plots (Table 2). The exceptions were at the Southern Cross loamy and Nungarin sites, where the sprayed plots started with 22mm less and 15mm more soil moisture than the unsprayed plots respectively.

Differences in post-spraying soil moisture conservation in January and February ranged from 6mm to 34mm (except -14mm Southern Cross loamy site and -4mm at the Bodallin site) in January and 6mm to 62mm in February. The sprayed plot at the Southern Cross loam site was also drier than the unsprayed plot in January, however the decline in soil moisture was slower than in the unsprayed plot. By February, the sprayed plot at the Southern Cross loam site had 62mm more soil moisture than the unsprayed plot, the largest difference recorded across all sites.

A crude measure of fallow efficiency (soil moisture conserved/summer rainfall) was used to compare treatments, with a paired two-sample t-test indicating significantly greater ($p<0.05$) 'fallow efficiency' across the sprayed treatments

Table 2 Soil moisture (0-40cm and 60-80cm) and grain yield differences between sprayed (+) and unsprayed (-) treatments, and estimated production efficiency of sprayed treatments.

Location[2]	Dec (mm)		∆Dec-Feb (mm)		Wheat yield (t/ha)		Difference (t/ha)	kg/mm[1]
	-	+	-	+	-	+		+
Nungarin	74	89	-9	2	1.55	3.16	1.6	14
Narembeen	45	55	7	35	2.20	2.80	0.6	11
Southern Cross (l)	41	37	-20	-1	0.72	1.13	0.4	6
Southern Cross (g)	79	57	-29	55	0.80	1.03	0.2	5
North Bencubbin/Beacon South	115	115	-24	-7	0.86	1.06	0.2	6
Westonia/Bodallin	57	68	-1	3	1.50	1.60	0.1	7
Beacon North	82	74	-19	-5	1.73	1.68	-0.1	8

[1]Yield*1000/Apr-Oct(mm)

[2] – l = loam; g = gravel

The difference in grain yield between sprayed and unsprayed treatments ranged from -0.1t/ha at Beacon North (which only received 22mm of rain between December and February) to 1.6t/ha at Nungarin (Table 3). A rough production efficiency (kg/mm GSR) indicates that there are underlying problems with the crop at all locations other than Nungarin and Narembeen, which have resulted in lower than expected yield for the seasonal rainfall.

Subsoil acidity (4.5 to 4.8 ($CaCl_2$) at 30-40cm) was a possible yield constraint at the Southern Cross gravelly site, however the nearby loamy site had a healthy pH (6.8 to 8.1 ($CaCl_2$) throughout the soil profile, but experienced a similarly low production efficiency. The pattern of the 2013 season (i.e. dry June-July) is possibly responsible for the low production efficiencies due to the impacts on crop establishment and tillering, ultimately limiting yield potential.

Sites with higher production efficiencies (i.e. Nungarin and Narembeen) had better responses to weed control.

Conclusion

The results presented here suggest weed control between December and February through application of glyphosate led to greater fallow efficiency (albeit a crude measure thereof) across a range of soil types in the Eastern Wheatbelt. Wheat crops were established by growers using standard, no-till sowing techniques, with yield increases ranging from around 10% to 100% where summer weeds were controlled, with most spraying treatments resulting in a yield increase of at least 20%. There was very little yield effect at one site where grower records indicated low summer rainfall (22mm).

These results suggest that summer weed control can be economic where summer rainfall is sufficient to lead to fallow soil moisture conservation and GSR is sufficient to establish crops that will be able to utilise the stored soil moisture. However, the extent to which the relative contributions of soil moisture and nitrogen conservation led to differences in yield were unable to be determined due to incomplete nitrogen analysis. This will be the focus of subsequent demonstration work.

Soil moisture probes will be installed at selected summer spray demonstration sites in 2013-14, with further summer spray trial work planned for the 2014-15 growing season. Multiple spray timings will be carried out, and these will be used to assess the effect of weed germinations from summer rainfall events and the influence of summer weeds on stored soil nitrogen. The priority, however, is to establish a more rigorous methodology with replicated treatments and soil moisture observations.

Acknowledgements

This project was made possible through the GRDC's Kwinana East Regional Cropping Solutions Network and the collaboration of Mick Caughey, Alan and Stuart Yandle, Matt Steber, Ty Kirby, Nick Gillett, Clint Della Bosca, Tim and John Butcher and Scott Dixon.

References

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Paper reviewed by Yvette Oliver and Doug Abrecht