Conserving soil moisture, does stubble or a fallow help on a red loam?

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Aim
To determine if various farm management techniques improve the storage of out-of-season rainfall and whether this leads to improvements in crop growth and/or yield.

Background
After a decade of variable rainfall, in particular sporadic winter and summer rainfall, Liebe growers wanted a better understanding on how stubble management over the summer affects stored soil water, crop establishment, growth and crop yield. Storing more rainfall in the soils, compared to losing this rainfall to evaporation or weeds, can potentially increase yields by 0.3-0.5 t/ha (Oliver, 2011) and reduce the risk from drought stress. Therefore it is important to understand how much water your soils can hold (the plant available water capacity - PAWC), how much water can be stored over the summer and how it is affected by summer stubble cover and rainfall distribution.

Fallow is also being reconsidered as a management tool with potential benefits including early sowing, weed control, using extra stored soil moisture to reduce 'drought' risk, and nitrogen mineralisation.

The type of fallow used in this trial was a short 'opportunistic' fallow, where the crop was planted but then sprayed out in August. This is opposed to a strategic fallow, where no crop is planted. This trial was set up in 2010, with crop yields being recorded in 2011 and 2012.

Trial Details

Property	Keith Carter, east of Wubin
Plot size & replication	15m x 300m, not replicated
Soil type	Red loamy duplex (York gum)
Soil pH ($CaCl_2$)	0-10cm: 4.8 10-40cm: 4.8-5.1 40-100cm: 6.4-7.8
EC	Non saline (0.15-0.32 dS/m)
Sowing date	5/5/12
Seeding rate	44 kg/ha Scope barley
Fertiliser	5/5/12: 70 kg/ha Agstar Extra, 65 L/ha Flexi-N banded
Paddock rotation	2009 field peas, 2010 wheat, 2011 wheat
Herbicide	15/2/12: 1.2 L/ha Roundup, 0.5 L/ha Ester 800, 0.2 L/ha Garlon, 0.03 L/ha Atrazine 7/5/12: 1.8 L/ha Trifluralin, 150 g/ha Metribuzin, 0.5 L/ha Sprayseed 3/7/12: 0.6 L/ha Intervix
Growing season rainfall	126mm

Table 1: Trial treatments.

Treatment	Details	Date imposed
Fallow	Wheat crop sown then sprayed out before anthesis using a knockdown herbicide.	August 2011
Old fallow	Wheat crop was sown then sprayed out in August 2010, thus the 2012 crop is its second wheat since a fallow was imposed.	August 2010
Standing stubble	Stubble harvested at 200mm and spread (normal district practice).	December 2010/2011
Flat stubble	Stubble flattened by dragging a chain between two vehicles. This practice was once used in district but is now rarely seen.	January 2010

Results

Table 2: Barley yield and quality after fallow or flattening stubble.

Treatment	Yield (t/ha)	% NN control*	Protein %	Hectolitre weight (g/hL)
Continuous crop with standing stubble	2.0	100	12.7	63
Old fallow	2.1	105	13.5	65
Flattened stubble	2.0	104	13.0	65
Continuous crop with standing stubble	1.9	100	12.8	65
Fallow	2.1	109	12.6	67

*Continuous crop with standing stubble is used as the control treatment in this trial. Different treatments (ie Fallow) are compared to the nearest continuous cropped strip, known as nearest neighbour control.

The fallow plot yielded 0.2 t/ha more than the continuously cropped strip alongside it. There also appears to be a second year yield benefit from the old fallow plot which was fallowed in 2010 and cropped in 2011 and 2012, which yielded 0.1 t/ha more than the continuously cropped strip alongside it. The trial was not replicated and thus confidence in this result is reduced, yield benefit may be due to natural variations such as soil type.

Nitrogen

Mineralisation of nitrogen over the fallow period has resulted in an extra 21 kg/ha of nitrogen being available according to the March soil test results and this extra nitrogen could have contributed to the high yields seen after fallow (Table 3). An additional 37 units (kg/ha) of N were added at seeding as Agstar Extra and Flexi-N, making total N in the soil at seeding 177 units. This is sufficient nitrogen to support a 3.4 t/ha or better crop based on the assumption that 45 kg/ha of N is required per tonne of grain. However, the amount of nitrogen available to the plant at any one time depends on where nitrogen is distributed down the soil profile and root growth.

At harvest, all treatments had ~44 kg N/ha remaining. Majority of this remaining nitrogen was in the 60-90cm layer (14 kg/ha for all plots). The 10-20cm layer has only 5 kg/ha remaining in November (data not presented).

Table 3: Total nitrogen (ammonium and nitrate) in top 90cm of soil on 1st March 2012.

Treatment	Nitrogen in top 0-10cm	Nitrogen in subsoil 10-90cm.	Total Nitrogen (kg/ha)
Standing stubble	60	75	135
Fallow	74	82	156
Old fallow	70	50	120

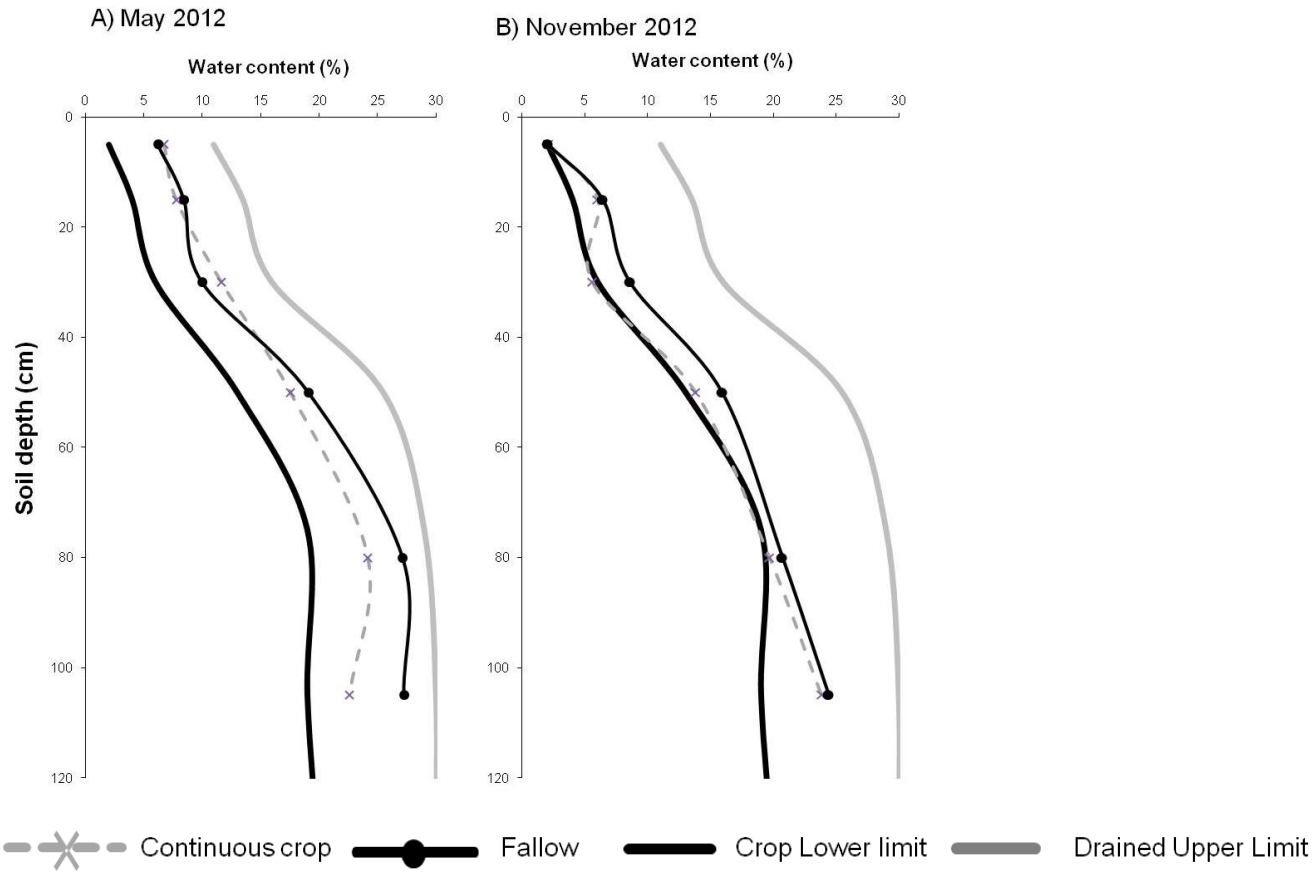

Figure 1: Soil moisture on red loamy duplex east of Wubin in May (A) and after harvest (B).

Imposing a fallow by spraying out the crop in August resulted in some extra water being saved deep down the soil profile which is the illustrated 'bulge' starting at ~50cm in Figure 1a. This extra water could have contributed to the extra yield seen in the fallow plot. By the time the crop was harvested (Figure 1b) most of the water in the soil had been used up, as expected in this climate. Although the graph does indicate that some water remains in the fallow plot, the reason for which is unknown.

The fallow showed excellent water use efficiency of 24 kg/ha/mm. The continuous crop also showed good water use efficiency by producing 21 kg/ha/mm of barley. This illustrates how efficient early sown crop with good weed control and adequate nutrition can be. (See appendix).

Comments

- Overall imposing a fallow allowed for a small amount of extra water to be stored in the soil and a small amount of extra nitrogen. As a result there was a small yield gain of 0.2 t/ha in 2012.
- In this trial the fallow treatment was planted then sprayed out in August to replicate what is known as an 'opportunistic' fallow compared to a 'strategic' fallow where no crop is planted for 18 months. 18 month fallows would have different results to the ones reported here.
- Other benefits of fallow that were not recorded in this trial but could have contributed to the yield gain are improved weed control, disease breaks and opportunity for early sowing.

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References

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Appendix

Calculation used for water use efficiency: grain yield kg/ha / (((Jan + Feb rain x 0.33) + (March rain x 0.5) + (April to October rain)) x 0.66 for evaporation) = Water use efficiency kg/ha/mm