LIEBE GROUP SOIL BIOLOGY TRIAL

Emma Glasfurd, Project Coordinator, Liebe Group

Grains Research & Development Corporation

AIM

To investigate the potential of biological and organic matter inputs to increase soil water storage, target long-term yield increases and soil improvement.

BACKGROUND

This trial forms part of the Liebe Group's GRDC funded adoption project, '**Growers critically analysing new technologies for improved farming systems**'. This project continues work from the GRDC funded soil health project **'A sustainable dryland community achieved through proactive research on effective management of the soil resource'.**

This long term trial was established to address management of soil constraints limiting yield, specifically the biological component. The trial site was selected as it had no significant chemical or physical soil constraints and is intended to demonstrate the capacity for increasing grain production through improving moisture conservation and enhancing the soil biota. The basic treatment structure of the trial was established in 2003 with a lupin crop, followed by two consecutive years of wheat in 2004 and 2005 to establish differences in grain yield between treatments.

In 2004, wheat (cv. Wyalkatchem) grown either after brown manured lupins or after the addition of 20 t/ha organic matter (barley straw) yielded 500-600 kg/ha (18-22 %) more grain than the control treatment (harvested lupins). Any additional treatments that aimed to increase yield through encouraging microbial activity, failed to improve grain yield further (e.g. zeolite and humate).

In 2005, wheat (cv. Wyalkatchem) was again sown to assess the residual value of treatments and determine the ongoing improvement to the soil resource. The yields obtained reflect what many farmers encounter in the initial phases of converting to a full stubble retention system as opposed to stubble burning, and these yield differences relate mostly to a change in the C:N balance affecting nitrogen supply and microbiological processes that occur in soil. The highest yielding treatment in 2005 was burnt stubble, yielding 560 kg/ha or 25% greater than full stubble retention (control).

In 2006, lupins were used in rotation to control weeds and provide a break crop for cereal disease. Along with the yearly treatments the 3yr treatments were also applied which included brown manuring and organic matter load up of 20 t/ha canola chaff. Harvest cuts were not obtained in the lupin phase and so yield results and gross margins have not been presented in this report.

In 2007, the trial was sown to wheat (cv. Wyalkatchem). The aim was to assess the combined effect of the residual and new organic matter and brown manure treatments together with the continued annual treatments, on the soil resource. However, a significant weed burden was observed during the season within the trial and despite attempts to control the weeds through post emergent herbicide options, the decision was made, late in the season to use a broad spectrum knock down (2 L/ha Sprayseed) on the trial site to reduce weed numbers for the 2008 wheat crop. Although grain harvest in 2007 was prevented, additional biomass was removed from the site using normal harvesting management.

TRIAL DETAILS

Property	Liebe Group Long Term Research Site, west Buntine
Plot size & replication	80m x 10.5m x 3 replications
Soil type	Yellow sand
Sowing date	25/06/07- 27/06/07
Seeding rate	80 kg/ha
Fertiliser (kg/ha)	25/06/07- 27/06/07: 100 kg/ha NPK Vigour
Paddock rotation	2002 = Wheat, 2003 = Lupins, 2004 = Wheat, 2005 = Wheat, 2006 = Lupins, 2007 = Wheat
Herbicides	25/7/07:25 g/ha Monza 5/9/07: 300 mL/ha Lontrel, 500 mL/ha Paragon, 1 L/ha Cheetah 5/10/07: 2 L/ha Sprayseed
Growing Season Rainfall	127mm

TREATMENTS APPLIED IN 2007

All treatments (Table 1 and 2) received basal fertiliser (see above) and retained stubble unless otherwise specified.

Table 1: Treatment descriptions.

Treatment #	Treatment description
1	**Control (District fertiliser practice, full stubble retention)**
2	Treatment 1 + Humate
3	Treatment 1 + Custom Compost
4	Treatment 1 + Microbes (foliar application)
5	Treatment 1 + Humate + Custom Compost + Microbes (foliar application)
6	**Brown manure lupin (applied 2003 and 2006) - control**
7	Treatment 6 + Humate
8	Treatment 6 + Custom Compost
9	Treatment 6 + Microbes
10	Treatment 6 + Humates + Custom Compost + Microbes
11	**Tilled soil (stubble incorporated) - control**
12	Treatment 12 + organic matter (applied 2003 and 2006)
13	Treatment 12 + organic matter (applied 2003 and 2006) + stubble decomposing agent
14	Treatment 12 + stubble decomposing agent
15	**Burnt stubble (stubble burnt after cereal phase only - 2004, 2005)**

Table 2: Rate and application method of various treatment components.

Treatment	Rate	Application Method
Organic matter (barley straw 2004, canola chaff 2007)	20 t/ha	Spread pre seeding by hand
Brown manure Lupin (2003 and 2006)	5 t/ha biomass (2003) 1.3 t/ha biomass (2006)	Foliar Desiccant (1 L/ha Glyphosate)
Custom Compost (2007)	50 kg/ha (50% mix with conventional fertiliser)	Down the tube at seeding.
Humate (2004, 2005, 2006, 2007)	5 kg/ha	Top dressed pre seeding
Stubble decomposing agent (2004, 2005, 2006, 2007)	10 L/ha brewed concentrate	Pre seeding spray
Microbes (2004, 2005, 2006, 2007)	20 L/ha brewed concentrate	Post emergent foliar spray

RESULTS

In 2007, the Soil Biology Trial was 'knocked down' in October with the intention of significantly reducing the weed burden at the site to improve crop potential for the subsequent wheat crop forecasted to be grown in 2008. The site was harvested to remove the biomass following the knockdown, to eliminate any offset effects the residual biomass may have had on the treatments applied to the site. Although, no yield results were taken from the site in 2007 evaluation of the soil resource (Table 3) continued throughout the year.

Table 3: Soil analysis for 0-10cm as sampled 28th August 2007.

	EC (Ds/m)	pH ($CaCl^2$)	Organic Carbon (%)	Nitrate N (mg/kg)	P (mg/kg)	K (mg/kg)	Sulphur (mg/kg)
Control	**0.047**	**5.57**	**0.76**	**8.33**	**34.67**	**80.00**	**8.50**
+ Humate	0.042	5.57	0.83	6.33	28.33	90.67	8.10
+ Custom Compost	0.045	5.27	0.69	9.00	28.00	70.00	8.33
+ Microbe	0.044	5.33	0.80	5.33	36.33	73.67	9.50
+ Humates+ Custom Compost +Microbes	0.045	5.57	0.78	7.33	31.33	98.67	8.20
Brown Manure	0.037	5.37	0.84	8.67	29.67	130.67	7.00
+ Humate	0.047	5.30	0.74	9.00	32.67	64.33	9.40
+ Custom Compost	0.045	5.63	0.75	11.33	29.67	79.67	7.37
+ Microbe	0.044	5.40	0.76	9.00	32.00	63.33	8.23
+ Custom Compost +Humate+Microbe	0.051	5.37	0.87	6.00	33.67	68.00	8.83
Tilled Soil	0.037	5.23	0.68	7.67	27.00	59.00	7.93
+ Organic Matter	0.121	6.10	**0.95**	**15.67**	**52.83**	**292.83**	**24.62**
+ Organic Matter + decomposing agent	0.111	6.07	**1.00**	**19.33**	**53.00**	**298.67**	20.93
Burnt Stubble	0.039	5.17	0.63	7.00	30.67	68.67	6.67
LSD (5%)	ns	ns	0.168	5.123	11.9		13.06

NB: Bold figures treatment results that are significantly different from the control

A significant increase in total soil organic carbon (soil sieved to < 2 mm) was observed for treatments where organic matter (barley hay, canola chaff) was added to plots (Table 3). This compares to the remainder of treatments where the total organic carbon pool was not observed to have changed in the short term.

Whilst it is difficult to illustrate changes in soil nitrogen reserves as the season progresses without an expensive and intense sampling procedure, the results of topsoil analysis (Table 3) sampled in August, suggest soil nitrogen (measured as nitrate-N) is higher in treatments where organic matter has been loaded up in comparison to both the stubble retained and cultivated soil control treatments. They also show significantly higher phosphorus, potassium and sulphur levels in comparison to the controls. This was reflective of previous treatments in 2003, where higher potassium concentrations were measured in organic matter treatments and illustrates one of the longer term benefits that can be achieved under a stubble retention system.

The nutrient values of stubbles can vary depending on crop type, fertiliser history and growing season conditions. For example, previous studies (Brennan *et al. 2000)* have shown canola chaff applications to increase crop yields and also the levels of macronutrients: nitrogen, phosphorus and potassium in the soil. From laboratory examinations conducted in this study, increases in nutrients were found depending on the rate of chaff applied. The results showed increases of 60 to 80% of potassium and from 0 to 30% of phosphorus in soil test analyses following 9 week's incubation of stubble in moist soil.

Research in Australia has shown stubble retention can lead to an improved soil resource. Potential benefits include an increase in soil water and plant available water, increases in soil organic carbon, a decrease in soil erosion, decrease in soil bulk densities (i.e. looser, or less compacted soil), improved biological fertility (Perry *et al. 1992*) and a generally improved soil structure. Due to the large size of the total soil organic carbon pool and the relatively small annual contributions in organic matter in WA, it is difficult to establish that stubble retention has a positive effect on total soil organic carbon (Perry *et al.* 1992). However, the effect of retention on the more labile (or available) pools of carbon is reflected in greater nutrient availability (Table 3).

Whilst changes in soil properties are difficult to identify between treatments so early in the life of this trial, the addition of organic matter and incorporation of residue in current farming systems suggests continuing improvement in the soil resource. Although the addition of large amounts of organic residues (such as the 20 t/ha of canola chaff) is unlikely to be a viable practice for the majority of growers, it clearly illustrates the benefits of organic matter to the soil and perhaps what might be achieved after many years of stubble retention.

Small changes in organic carbon did not result in significant changes to soil moisture profiles measured to depth (Figure 1).

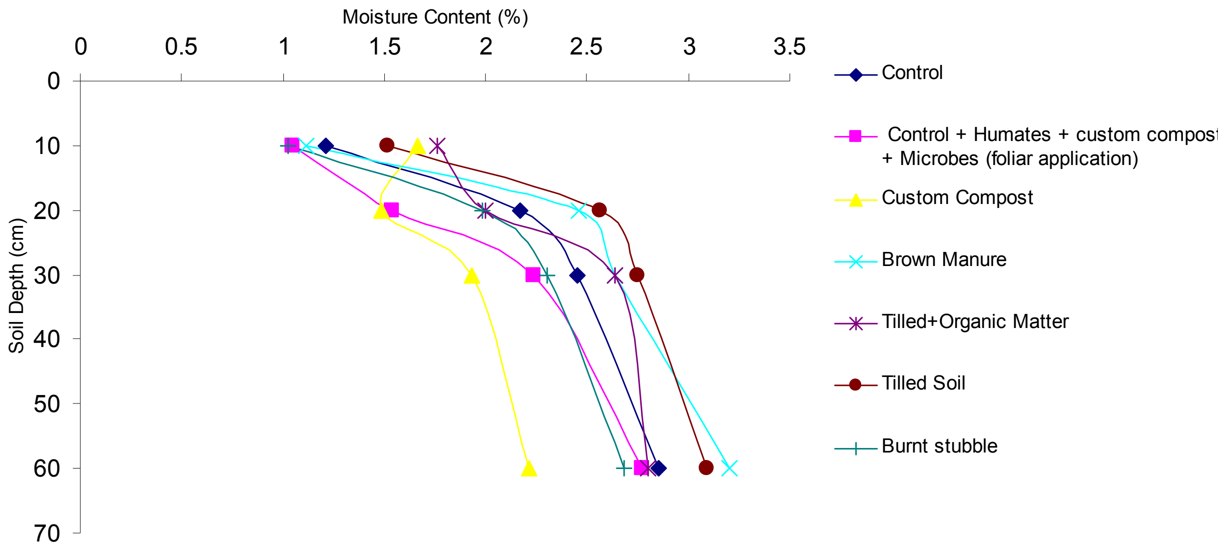

Figure 1: Gravimetric soil moisture (%) of selected treatments at six soil depths (0-10, 10-20, 20-30 and 30-60cm) in 2007. Measurements were taken in June 2007. LSD 5% (0.997).

One of the main aims of this trial is to demonstrate improvements that can be obtained from improving soil condition, including the importance of biological aspects of soil health. Soil micro-organisms mineralise organic matter to obtain carbon, nitrogen and other nutrients for their own metabolism and growth (Murphy *et al,* 2007). Microbial activity is measured by carbon dioxide evolution and reflects a range of biological processes in the soil. This is dependent on soil moisture, temperature and labile carbon (Murphy *et al,* 2007).

Management practices influence microbial activity by altering carbon availability and conditions reflecting rapid changes in the biological function of the soil (Murphy *et al,* 2007). This may be the reason a significant increase in microbial biomass for treatments with added organic matter in 2007 (Figure 2). In this treatment the microbes were exposed to a dramatic increase in the availability of carbon, as well as other nutrients through the 20 t/ha canola chaff applied pre-seeding. The application of suitable food substrates (carbon) and/or introduction of beneficial micro organisms to soils is however largely untested.

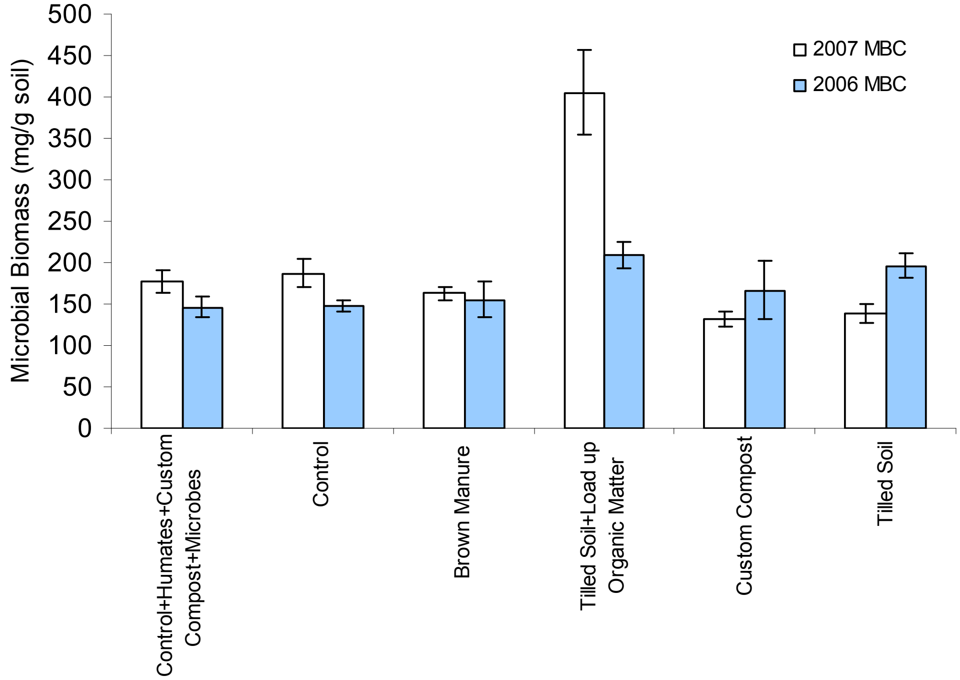

Figure 2: Microbial biomass measured in 2006 and 2007 for selected treatments (± standard error). Samples were taken in July 2006 and August 2007 (LSD 5% 2007 = 71; 2006 = 40).

There were no significant differences between treatments for bulk density in either 2006 or 2007. Bulk density of the control plot was 1.38 g/m^3 in 2006 and 1.22 g/m^3 in 2007.

Conclusions

This trial was designed to improve long term yield increases through improved water storage and soil biology. As such, it will continue into the future with the ongoing collection of valuable data to assist in the evaluation of the treatments being trialed.

Management practices influence microbial activity by altering carbon availability and conditions reflecting rapid changes in the biological function of the soil, although the research is still in preliminary stages this has been highlighted where increased microbial biomass (approximately 50% greater than the control) and nutrient availability was associated with plots receiving high amounts of organic matter.

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Paper reviewed by: FRAN HOYLE.

Contact

Emma Glasfurd
Ph. 0429795212
Email. liebe.emma@bigpond.com