Liebe Group Soil Biology Trial

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Aim
To investigate the potential of organic matter inputs to increase soil water storage, increase yield and improve soil health.

Background
This long term trial was established in 2003 to investigate how soil biology and carbon affect crop yield and soil health.

The trial site was selected as it had no significant chemical or physical soil constraints, therefore capacity to increase grain production through improved moisture conservation and enhanced soil biota can be demonstrated.

The trial aims to understand how agronomic factors such as yield and grain quality are affected by organic matter (OM) breakdown and cycling. Although the application of 20 t/ha of organic matter is not practical in a commercial farming enterprise this treatment is designed to demonstrate the potential upper level of organic carbon for sandy soils in our environment. After three separate applications (2003, 2006, and 2010) of organic matter, totalling 60 t/ha, we assume the soil is near soil organic carbon capacity.

In 2010 treatments used in the Soil Biology Trial were simplified, microbial products that previously have not shown any yield and quality benefit were removed from the trial.

Trial Details

Property	Liebe Group Long Term Research Site, West Buntine
Plot size & replication	10.5m x 80m x 3 replicates
Soil type	Sandy Loam
Soil pH	Topsoil= 6, Subsoil = 5.9 to 4.6
EC	0.02 dS/m
Sowing date	28/5/10
Seeding rate	60 kg/ha Magenta
Fertiliser	28/5/10: K-till Extra at 60 kg/ha 12/7/10: Flexi-N at 40 L/ha
Paddock rotation	07 Wheat, 08 Wheat, 09 Lupins
Herbicides	6/4/10 at 1L/ha Powermax, 28/5/10 at 2.5 L/ha BoxerGold, 21/6/10 at 0.3 L/ha Jaguar, 6/8/10 at 0.8 L/ha Ester 680
Growing Season Rainfall	166mm

2010 Treatment List
1. Control (minimum till with knife points and full stubble retention)
2. Tilled soil using offset disks
3. Till soil plus 20 t/ha organic matter (organic matter is applied once every 3 years)
4. Tilled soil, organic matter run down (plots where organic matter was previously applied in 2003/2006)
5. Burnt (plots last burnt in March 2009)

Trial history

Year	Crop type	Yield range	Treatment notes
2003	Lupin	None recorded	Set up phase: 20 t/ha Barley chaff applied, Lupin crop brown manured
2004	Wheat (cv. Wyalkatchem)	2.9-3.5 t/ha	Brown manuring and addition of 20 t/ha organic matter increased yield by 18-22%
2005	Wheat (cv. Wyalkatchem)	2-2.8 t/ha	Burnt plots yielded 25% higher than control.
2006	Lupins	None recorded	Set up phase: 20t/ha Canola chaff applied, brown manure
2007	Wheat – sprayed out	None recorded	Trial sprayed out for weed control.
2008	Wheat (cv. Wyalkatchem)	2.4-3.4 t/ha	Addition of organic matter increased yield by 23% compared to control.
2009	Lupin	1.5 t/ha	Set up phase.
2010	Wheat (cv. Magenta)	2.5-1.9 t/ha	20 t/ha chaff applied. No significant difference between treatments

Results

There were no statistically significant differences in yield between treatments. There was a trend towards a lower yield in the organic matter plots however large variation between replicates made it difficult to draw any strong conclusions about the relationship between organic matter inputs and grain yield in this season. There was also no significant difference between grain quality parameters. Organic matter plots had a significantly lower harvest index than the other treatments, indicating the amount of grain was low relative to crop biomass.

The low yield and small grain size in the organic matter plot (although not statistically different from the other treatments) could be explained by the dry season. High OM treatments may have increased water retention following rainfall events compared to other treatments, allowing for early crop growth and therefore increase biomass early in the season. A lack of rain during the latter stages of crop growth may have contributed to the trend toward a lower yield in this treatment. This would also explain the significantly lower harvest index of the high OM treatment.

Table 1: Harvest yield and grain quality of wheat comparing different tillage and stubble retention methods at West Buntine.

Treatment	Yield (t/ha)	Harvest Index (%)	Hect-weight (kg/hL)	Protein (%)	Screen. (%)
Control	**2.5**	**20 b**	**74**	**13.8**	**15**
Organic Matter	1.9	15 a	73	12.3	22
OM run down	2.5	21 b	74	14.6	19
Till	2.4	19 ab	75	12.3	14
Burnt	2.4	21 b	75	13.7	18
l.s.d	NS	3.9	NS	NS	NS

Table 2: Soil analysis for 0-10cm as sampled in August 2010.

Treatment	Nitrate N (mg/kg)	Amm. (mg/kg)	Phos. (mg/kg)	Potassium	Sulphur	Organic carbon (%)
Till	13 a	2	33 a	74 a	3 a	0.7
Burnt	19 a	2	38 ab	70 a	4 ab	0.8
Control	**20 ab**	**2**	**41 abc**	**87 a**	**4 ab**	**0.9**
OM	22 ab	3	61 bc	240 b	8 bc	1.2
OM rundown	30 b	3	62 c	138 a	11 c	1.0
l.s.d	*7.38*	*NS*	*15.4*	*56.87*	*2.7*	*NS*

Levels of phosphorus, potassium and sulphur in the topsoil were all higher in the organic matter plots. In the case of potassium, adding organic matter had more than doubled the plant available nutrients compared to the control. Organic carbon tended to be higher in the plots with high organic matter additions and lowest in the tilled plot however this difference was not statistically significant. Although significant external sources of carbon have been applied in this treatment, this result is not unexpected as changes in the total soil organic carbon pool takes time (>10 yrs).

Soil moisture at seeding was not altered by organic matter or tillage in 2010 (Figure1).

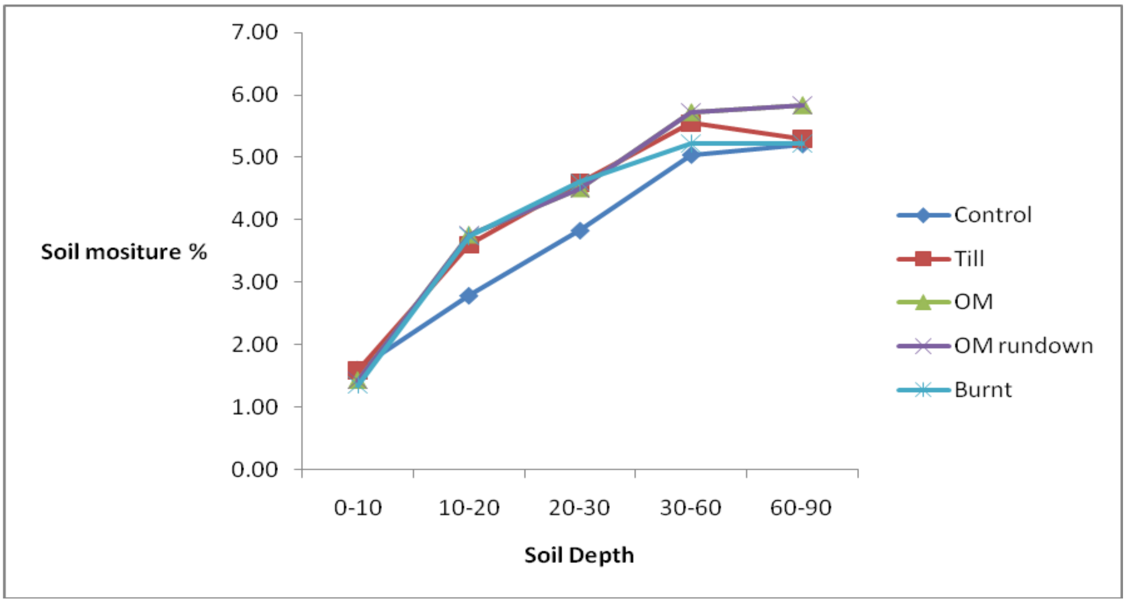

Figure 1: Soil moisture at seeding

Comments

The significantly higher potassium concentration in the OM treatments is likely to be linked to the type of organic matter added to those trial plots. In effect, the addition of chaff is having the opposite effect of hay cropping, where potassium removal requires additional K fertiliser for subsequent crops. The addition of chaff to the OM plots has lead to a significant import of K to these plots.

Nitrogen levels are not significantly higher in the OM plots as chaff will have a very high Carbon to Nitrogen ratio, which limits the organic nitrogen available for crop uptake. In essence, the addition of chaff as the organic matter source will provide very little extra nitrogen for crop growth. Cereal residues naturally have a carbon to nitrogen (C:N) ratio between 50:1 and 100:1 and therefore provide very little organic N to the soil solution. In addition, the relationship between soil microbes and the C:N ratio of residue is also important. Typically, a C:N ratio between 22:1 and 30:1 is optimal for OM breakdown (Hoyle, 2006). A C:N ratio higher than that infers there is not enough N in the system for the soil microbes themselves, resulting in net immobilisation of nitrogen in the soil. Conversely, a C:N ratio below these levels results in excess nitrogen becoming plant available. It is likely the chaff applied in 2010 is resulting in net immobilisation of nitrogen in the soil. It is important to understand organic matter quality plays a significant role in soil nitrogen cycling.

In general, the treatment effects combined with a difficult finish to the 2010 season highlighted a few important soil processes;

- High C:N ratio of the wheat chaff most likely contributed to a net immobilisation of nitrogen into the microbial biomass.
- The addition of chaff to the OM treatment was a significant source of K.

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