LONG TERM SOIL BIOLOGY TRIAL

Emma Glasfurd, Project Coordinator, Liebe Group

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 has been 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 and 2004 was the first cereal crop followed by a cereal crop in 2005. Yields were obtained to reflect differences in treatment effects in these wheat rotations.

Wheat (cv. Wyalkatchem) grown after brown manured lupins and wheat after addition of 20 t/ha organic matter (barley straw) in 2004 were significantly higher yielding than the control, with a 500-600 kg/ha improvement or 18-22% increase in grain yield above the control treatments (harvested lupin: wheat rotation). In 2004, main treatment effects from a brown manure crop and addition of organic matter overshadowed any yield benefits from other treatments that aim to encourage microbial activity. However, this was not unexpected as improving soil biological fertility is a long term process.

In 2005, the trial was again sown to wheat (cv. Wyalkatchem) to assess the residual value of treatments and to determine the ongoing improvement to the soil resource. The long term biology trial provided some very interesting results in 2005. 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 and microbiological processes that occur in the soil. The highest yielding treatment in 2005 was burnt stubble, yielding 560 kg/ha or 25% greater than full stubble retention (control).

The Lupin phase within the soil biology trial is effectively a 'set up' rotation, allowing weeds to be controlled and specific treatments such as brown manuring and organic matter to be applied for the subsequent wheat crop. Harvest cuts are not obtained in a lupin phase and so no yield results and gross margins have been presented in this report. However, in 2006 the ongoing improvement to the soil resource has been evaluated, results from 2006 are presented below.

TRIAL RESULTS FROM 2004 AND 2005

Table 1: *Grain yield components of Wyalkatchem wheat grown in 2004 under treatments imposed at the long term Liebe trial site.*

Treatment Averages	Yield (t/ha)	Harvest index (%)	Hectolitre weight (g)	Protein (%)	N uptake (kg N ha)	Head no./m²	Grain no/head
6. Control Brown Manure	**3.56**	**42.49**	**82.89**	**10.85**	**67.18**	**209.03**	**25.94**
10. BM +Humates + Zeolites + Microbes	3.56	41.65	82.75	10.68	66.12	221.11	21.76
8. BM + Zeolite	3.52	41.87	83.11	11.09	67.90	200.97	25.46
18. Western Mineral package (compare to brown manure control)	3.47	42.74	83.07	10.91	65.84	181.53	27.38
9. BM + Microbes	3.46	41.89	83.64	10.8	64.99	198.61	23.05
7. BM+ Humates	3.44	42.94	82.66	10.89	65.15	211.81	24.61
13. Load-up organic matter	3.44	42.25	82.87	11.43	68.38	194.03	21.91
14. Load-up organic matter + decomp agent	3.41	42.8	82.07	12.19	72.30	213.33	23.31
12. Control Incorporate stubble	3.23	41	83.03	9.4	52.80	165.69	24.31
16. Incorporate stubble + decomposing agent	3.20	42.72	83.03	10.02	55.76	167.78	25.71
2. Control + Humates	3.14	44.51	83.48	9.99	54.56	184.38	24.65
4. Control + Microbes	3.14	41.47	82.12	10.7	58.38	176.67	24.25
3. Control +Zeolite	3.12	42.29	82.38	9.78	53.06	169.72	24.96
5. Control + Humates + Zeolites + Microbes	3.06	40.57	82.93	9.8	52.16	170.69	23.74
1. Control	**2.91**	**41.68**	**83.16**	**9.61**	**48.64**	**167.36**	**24.57**

*Table 2****: Grain yield components of Wyalkatchem wheat grown in 2005 under treatments imposed at the long term Liebe trial site.***

Treatment	Yield (t/ha)	Biomass at anthesis (t/ha)	Plant density (no./m²)	Head density (no.m²)	Protein (%)	Screenings (%)	Gross Return ($/ha)
17. Burn Stubble	2.79 a	4.81 a	115	303 ab	9.00 abc	1.73	346
14. Till + OM + decomp agent	2.60 ab	5.06 a	112	291 a-f	9.30 a	2.55	317
13. Till + OM	2.49 bc*	4.63 a*	112	286 a-g*	9.06 ab	1.95	309
7. BM + humate	2.44bcd	3.36 b	118	293 a-e	8.67 def	2.04	293
5. Control+hum+zeo+mic	2.38 bcde	3.92 b	115	299 abcd	8.60 defg	1.41	290
8. BM + zeolite	2.34 bcde	4.24 a	120	301 abc	8.83 abcd	2.26	281
9. BM +microbe	2.33 bcde	4.11 a	122	265 a-h	8.43 fgh	1.78	280
18. Western Mineral package (compare to brown manure control)	2.31 bcde	4.07 ab	110	252 efgh	8.70 bcde	1.83	282
10. BM + hum + zeo +	2.30 bcde	4.21 a	112	304 a	8.35	1.49	276

mic					fghi		
6. Control Brown manure	**2.25 cde**	**4.33 a**	**108**	**268 a-h**	**8.00 ij**	**1.74**	**270**
1. Control	**2.23 cde**	**3.58 b**	**117**	**270 a-h**	**8.00 ij**	**2.02**	263
3. Control + zeolite	2.18 de	3.66 b	113	236 h	8.10 hij	1.73	262
12. Control Till	2.17 de*	4.09 b*	117	273 a-h*	8.07 hij	2.25	256
16. Till + decomposing agent	2.11 de	4.18 a	112	272 a-h	7.97 j	1.99	247
2. Control + humate	2.08 e	3.55 b	112	276 a-h	8.15 hij	1.65	250
4. Control + microbe	2.08 e	3.80 b	110	260 a-h	8.20 hij	2.37	245
LSD (5%)	0.33, 0.29*	1.05, 0.91*	-	45.2, 39.2*	0.38	n.s.	-

TRIAL DETAILS 2006

Property	Liebe Long Term Research Site (LTRS), West Buntine
Plot size & replication	10.5m x 80m x 3 replicates
Soil type	Yellow sand
Sowing date	8/5/06
Seeding rate	75 kg/ha Mandelup Lupins
Fertiliser (kg/ha)	50 kg/ha TSP
Paddock rotation	2005 Wheat, 2004 Wheat, 2003 Lupin, 2002 Wheat
Herbicides	1 L/ha Glyphosate, 1.25 kg/ha Simazine, 0.5 kg/ha Atrazine, 1.3 L/ha Sprayseed, 10 g/ha Metrabuzin, 10 g/ha Brodal, 16 g/ha Select, 30 g/ha Leopard and 1 L/ha Sprayseed (crop-topping)
Growing Season Rainfall	131mm

TRIAL DESIGN

The trial consists of 3 banks of 19 randomised plots. The site was deep ripped to 300mm on 450mm spacing prior to seeding in 2004, to ensure subsurface compaction was not constraining yield. Average topsoil pH across all treatments in 2005 is 5.26.

Treatment List 2006:

1. Control (full stubble retention)
2. Control (full stubble retention)+ Humates
3. Control (full stubble retention)+ *Zeolite (removed 2006, to be replaced by a pelletised Custom Compost Product in 2007)*
4. Control (full stubble retention)+ Microbes (foliar application)

5. Control (full stubble retention)+ Humates + *Zeolite (removed 2006, to be replaced by a pelletised Custom Compost Product in 2007)* + Microbes (foliar application)
6. Control Brown manure Lupin 2003 (full stubble retention of 2004 cereal crop)
7. Brown manure Lupin 2003 (full stubble retention of 2004 cereal crop) + Humates
8. Brown manure Lupin2003 (full stubble retention of 2004 cereal crop) + *Zeolite (removed 2006, to be replaced by a pelletised Custom Compost Product in 2007)*
9. Brown manure Lupin2003 (full stubble retention of 2004 cereal crop) + Microbes
10. Brown manure Lupin 2003 (full stubble retention of 2004 cereal crop) + Humates + Zeolite + Microbes
12. Control Tilled soil (incorporate all stubbles)
13. Tilled soil (incorporate all stubbles) + Load up organic matter (2003 only)
14. Tilled soil (incorporate all stubbles) + Load up organic matter (2003 only) + decomposing agent
16. Tilled soil (incorporate all stubbles) + decomposing agent
17. Burnt stubble (Brown manure Lupin 2003, burn 2004, 2005 cereal stubble)
18. Western Mineral Fertiliser Package (Compare to brown manure control plots. Treatment will not be implemented in 2007)

Applications

Table 3: Rate and application method of various treatment components.

Treatment	Rate	Application Method
Organic matter (barley straw 2004 only)	20 t/ha	Spread pre seeding by hand
Brown manure Lupin (2003, 2006 only)	5 t/ha biomass	Foliar Desiccant
Zeolite (2004 & 2005)	1 t/ha	Top dressed pre seeding
Humates (2004, 2005, 2006)	5 kg/ha	Top dressed pre seeding
Decomposing agent (2004, 2005, 2006)	10 L/ha brewed concentrate	Pre seeding spray
Microbes (2004, 2005, 2006)	20 L/ha brewed concentrate	Post emergent foliar spray
Western Mineral Application 2004		
Dolomite	650 kg/ha	By Hand – prior to seeding
Granular Fertiliser	107 kg/ha	At seeding
UAN	60 L/ha	Pre-emergent
Top Dress WMF granular	40 kg/ha	6 weeks after seeding
WMF Nitrogold/SOP mix	40 kg/ha	8 weeks after seeding
Trichoderma microbes	120 L/ha	Foliar spray 21days after emergence
Western Minerals Applications 2005		

WMF NPK Crop mineral fertiliser (microbe coated)	120 kg/ha	Banded below seed
Liquid UAN	60 L/ha	Banded below seed
WMF Ag Blend microbes plus Liquid activator	150g microbe+150mL activator /ha	Post emergent foliar spray
Western Mineral Application 2006		
WMF high P crop mineral fertiliser (coated ag blend microbes)	80 kg/ha	Applied down the tube at seeding

RESULTS

No significant differences for soil moisture in the top 10cm of the soil profile were observed between all treatments at seeding time (Figure 3). There is however, a slight trend towards the brown manured plots having a higher soil moisture content at seeding time for the top 10cm (Figure 3). The greater moisture content in the 0-10cm soil layer can result in increased ability for early establishment and increased vigor of seedling growth for a crop. There were no significant differences between treatments for soil moisture in the soil profile at seeding (Figure 1).

Soil moisture at harvest results were taken from 3 control plot locations across the soil biology trial, these results are presented in Figure 2.

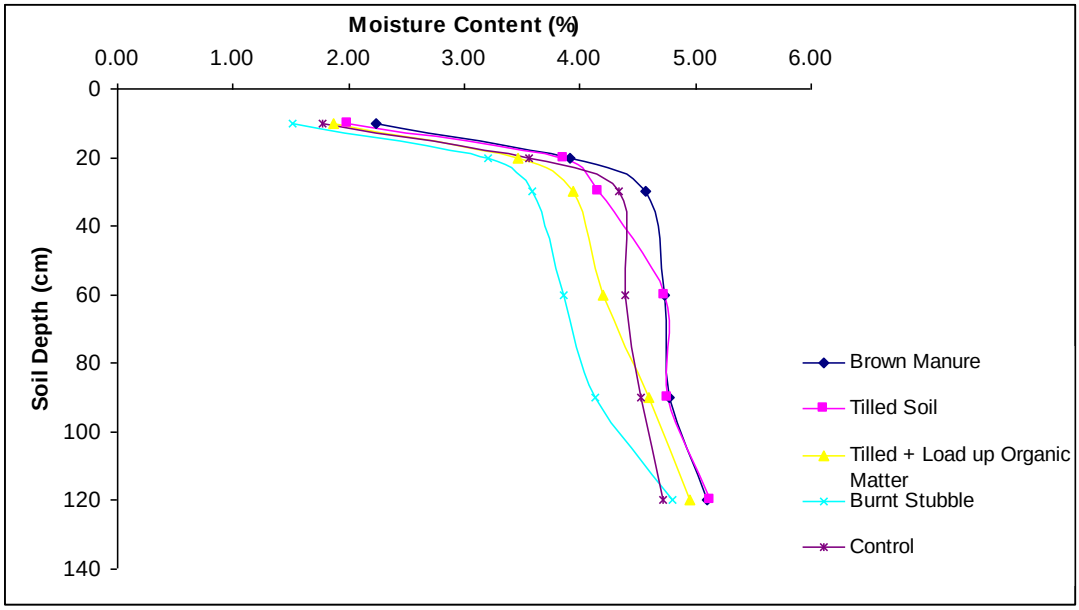

Figure 1: Gravimetric soil moisture (%) of selected treatments at six soil depths (0-10, 10-20, 20-30, 30-60, 60-90 and 90-120 cm) during lupin seeding May 2006.

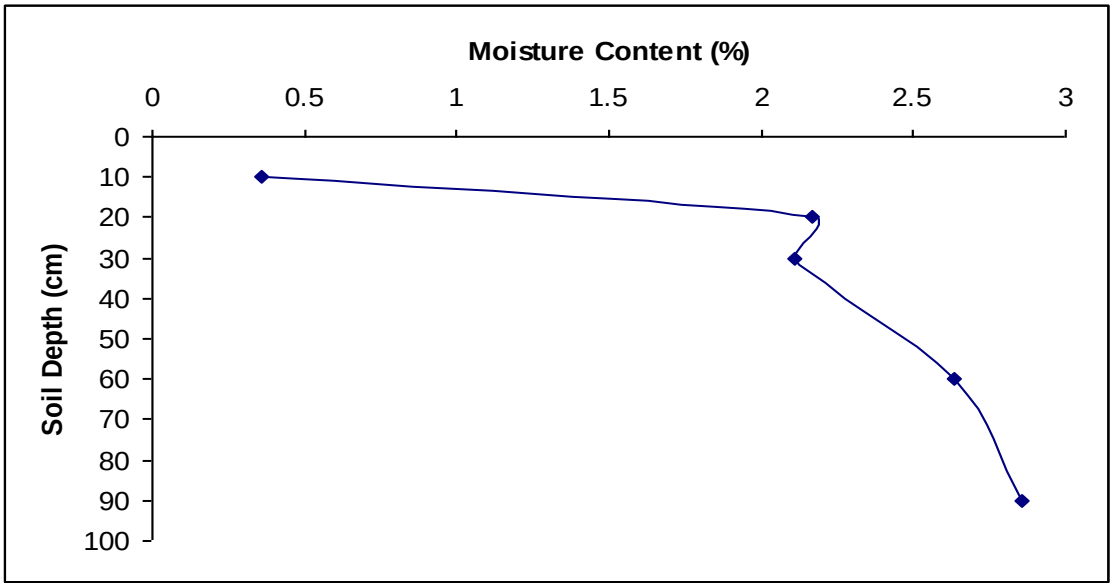

Figure 2: Gravimetric soil moisture (%) at five depths (0-10, 10-20, 20-30, 30-60, 60-90 cm) at four random sites across the Long Term Soil Biology Trial at time of harvest 2006.

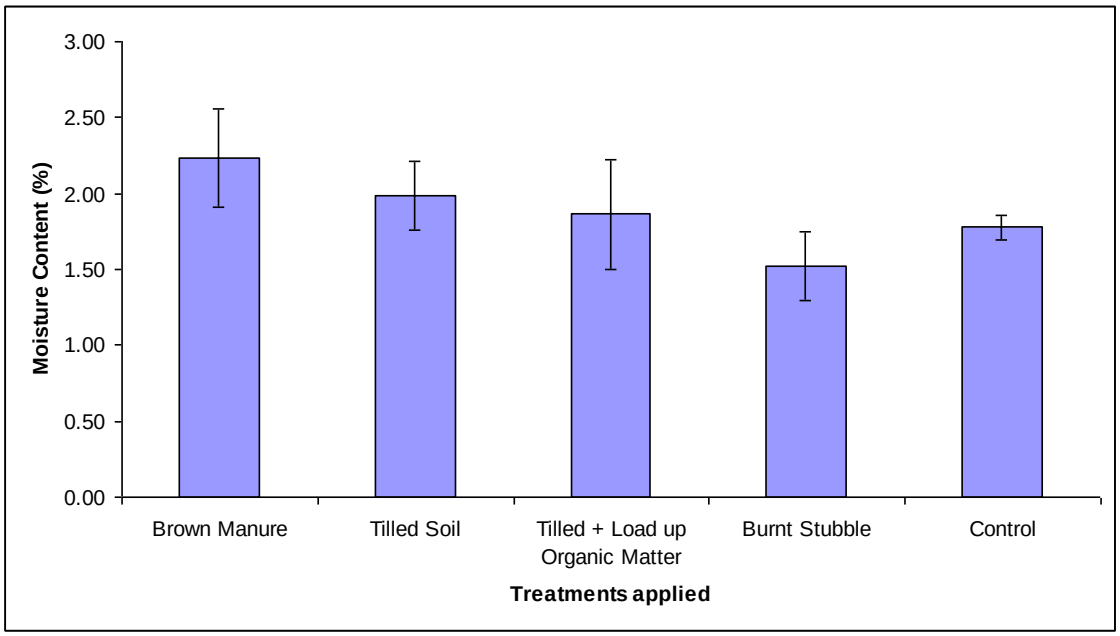

Figure 3: Gravimetric soil moisture content at 0-10 cm at time of sowing May 2006, showing means and ± standard error bars (LSD: 0.834).

Soil resistance results derived in 2005 indicated that the effect of deep ripping conducted in 2003 prior to the implementation of this trial has been short-lived with indications of a hard pan developing at 30cm. Thus root penetration to deeper soil layers (and associated water and nutrients) may have been constrained. With respect to this observation the soil biology trial site will be deep ripped prior to seeding in 2007. Soil resistance, when measured with a penetrometer is best collected when the soil profile is at its upper drained limit. Due to the dry July/August/September period experienced in 2006, resistance data was unattainable.

Table 4: Bulk density (0-10cm) of treatments sampled at seeding for the Long Term Soil Biology Trial in 2006.

Treatment	Bulk Density (g/cm3)
Burn Stubble	1.42a
Till + Decomposing Agent	1.38ab
Control	**1.38ab**
Western Mineral Fertiliser Package (Brown manure control)	1.38ab
Control +Microbe	1.36ab
Brown Manure + Microbe	1.36ab
Tilled Soil	1.36ab
Control + Humate	1.35ab
Brown manure (Control)	**1.34ab**
Till + Organic Matter + Decomposing Agent	1.33ab
Till + Organic Matter	1.33ab
Brown Manure + Zeolite	1.33ab
Tilled Soil + Organic Matter	1.33ab
Control+Humates+Zeolite+Microbes	1.32ab
Brown Manure + Humates + Zeolite + Microbes	1.30ab
Brown Manure + Humate	1.29b
Control + Zeolite	1.27b
LSD 5%	0.12

Bulk densities of all treatment plots were collected in 2006 and although there were are no consistent trends between treatments there are significant differences between the burnt stubble plots and Brown Manure + Humate and also Control + Zeolite (Table 4). Microbial data has been collected and once processed will be included in subsequent newsletters.

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.

COMMENTS

- The Lupin phase is primarily a ‘set up’ rotation which continues evaluation of the soil resource. No yield results are obtained in the Lupin rotation.

- No significant differences have been found between treatments in relation to the soil resource.

- In 2007 the soil biology trial will be in a wheat rotation. Following the 2006 uncharacteristic seasonal conditions it is hoped that results in 2007 will be more responsive the soil biology treatments.

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