The short term effect of different soil treatments on organic carbon and barley yield on a sandy soil

Frances Hoyle, Department of Agriculture and Food Western Australia
Nadine Hollamby, The Liebe Group

Key messages

- The application of compost at 2 t/ha had no effect on grain yield or quality in 2013 on this soil.
- Spading increased late water stress and as a result grain yield was lower and screenings were higher than in non-spaded treatments.
- The main increases in grain yield were associated with the application of fertilisers and represented the largest profit margin for growers.
- Changes in soil organic carbon (SOC) will be determined in February 2014.

Aim

To assess the effects of physical, chemical and biological soil manipulation (or inputs) on soil organic carbon in relation to changes in long term crop yields and quality.

Background

Growers are constantly assessing the long term profitability and sustainability of their farming systems. Often growers look to target an optimum gross margin rather than highest yield. This demonstration study was developed in conjunction with the practice for profit trials which have been conducted over the last 10 years and underpin the Liebe Group's approach.

This demonstration trial was established to determine whether an increase in soil organic carbon and productivity can be achieved by changing the chemical, physical and biological inputs that are applied to the soil. In this instance the chemical inputs were compared by plus and minus chemical fertiliser, the physical inputs were compared by plus and minus spading and the biological inputs were compared by plus and minus compost.

The study site was established in 2013, and includes a variety of replicated treatments aimed to alter SOC. Further to yield and profitability, the impact of these different inputs on SOC storage is also being assessed.

Experimental Approach

We are utilising the Liebe Group's Long Term Research Site at Buntine to answer questions being addressed by the research project. For example, by amending soil conditions and increasing crop production can we observe any measureable changes in SOC?

In 2013, crop yield response to fertiliser and compost applications was determined on replicated field plots of contrasting soil treatments (non-spaded, spaded) at the experimental site (Table 1). Spading was conducted in mid May 2013 prior to compost spreading (end May) and plots were planted to barley (*Hordeum vulgare* cv Roe) on 5 June 2013. Treatments receiving fertiliser had 80 kg/ha triple superphosphate (TSP) applied at sowing and 40 kg/ha urea during early tillering. Further experimental details are listed below.

2013 Trial Details

Property	Long Term Research Site, Buntine
Plot size & replication	50m x 18.2m x 4 replications
Soil type	Deep yellow Sand (Tenosol, 13% clay 0-30 cm)
Soil pH ($CaCl_2$)	0-10 cm: 6.0 10-30 cm: 4.7
EC	0.1 dS/m (0-10 cm), 0.04 dS/m (10-30 cm)
Sowing date	5/06/2013
Seeding rate	60 kg/ha Roe barley
Fertiliser	As per protocol (see treatment details below)
Paddock rotation	2012: Canola, 2011: Wheat , 2010: Wheat

Soil amelioration	17/5/2013: Rotary spading
Herbicides	21/5/2013: 2L/ha glyphosate 5/06/2013: 2 L/ha Spray seed, 2.5 L/ha boxer gold, 130 g/ha Metribuzin 10/10/2013: 2L/ha Reglone
Growing Season Rainfall	189mm (weather station)

Results

Soil sampling (baseline)

Baseline soil sampling was conducted in March 2013 (Table 1). There was no water repellence measured at this site.

Subsoils below 10 cm depth, are marginally low in soil pH and suggest some level of compaction in the 10-20 cm layer (Table 1). Inorganic nitrogen was marginal at this site (Table 1).

Table 1: Selected soil properties (0–30 cm) for soil collected in March 2013 at the Buntine experimental site prior to treatments being imposed.

Depth	Phosphorus (Colwell, mg/kg)	Potassium (Colwell, mg/kg)	Sulfur (mg/kg)	Organic carbon (%)	Organic carbon (t C/ha)	pH ($CaCl_2$)	Bulk density (g/cm^3)	C/N ratio
0-10 cm	29.4	72.8	25.1	0.86	12.9	6.0	1.45	12
10-20 cm	18.2	51.2	15.1	0.50	8.7	4.7	1.76	10
20-30 cm	6.6	52.6	20.0	0.26	1.9	4.7	1.63	8

The microbial biomass (mass of microorganisms) at this site in surface soil (0-10 cm) measured 92 kg/ha or 63 mg C/kg soil (low). Water holding capacity (0-10 cm) of this soil is approximately 29%.

Grain Yield

A significant ($p<0.1$, data not presented) yield response was observed between spaded (1.9 t/ha) and non-spaded areas (2.2 t/ha). Average yield and quality responses associated with fertiliser and compost treatments are presented in Table 2.

Spaded treatments had higher grain protein on average (11.3%) and slightly lower hectolitre weight (63 kg/hl) than non-spaded treatments (9.6%, 65 kg/hl).

While the yield and protein results were different between the spaded and non-spaded, both treatments took up approximately 35 kg/ha of nitrogen. High screenings on the spaded treatments (42% screenings < 2.5mm) suggests the spaded areas may have experienced higher water stress later in the season and may explain the slightly lower grain weight compared to non-spaded areas (30% screenings < 2.5mm). This would be supported by seasonal observations that crop height and biomass were greater in spaded treatments than non-spaded treatments.

Table 2. Average grain yield and quality responses for Roe barley to treatments imposed (data is the average of spaded and non-spaded areas).

Treatment	Grain yield (t/ha)	Protein (%)	Hectolitre weight (kg/hl)	Screenings (%)
Control	1.95	9.1	66	27
Compost	1.81	10.1	64	37
Fertiliser	2.28	11.1	64	38
Compost + Fertiliser	2.15	11.5	63	42
LSD (p<0.05)	*0.25*	*0.6*	*1.5*	*11*

There was no difference ($p<0.05$) in grain colour between treatments. Grain met feed standard requirements. Changes in soil condition will assessed across the treatments in February 2014 and reported in future trial reports.

Economics

The application of compost at 2 t/ha did not result in higher returns and the response under compost plus fertiliser treatments could be attributed to the application of fertiliser (Figure 1). Spading did not return any further gains in terms of yield or quality at this site in 2013 (Figure 1). The high cost of spading and compost in the first year, have negatively influenced profit outcomes. Depending on future yield improvements, these treatments may pay for themselves over the longer term.

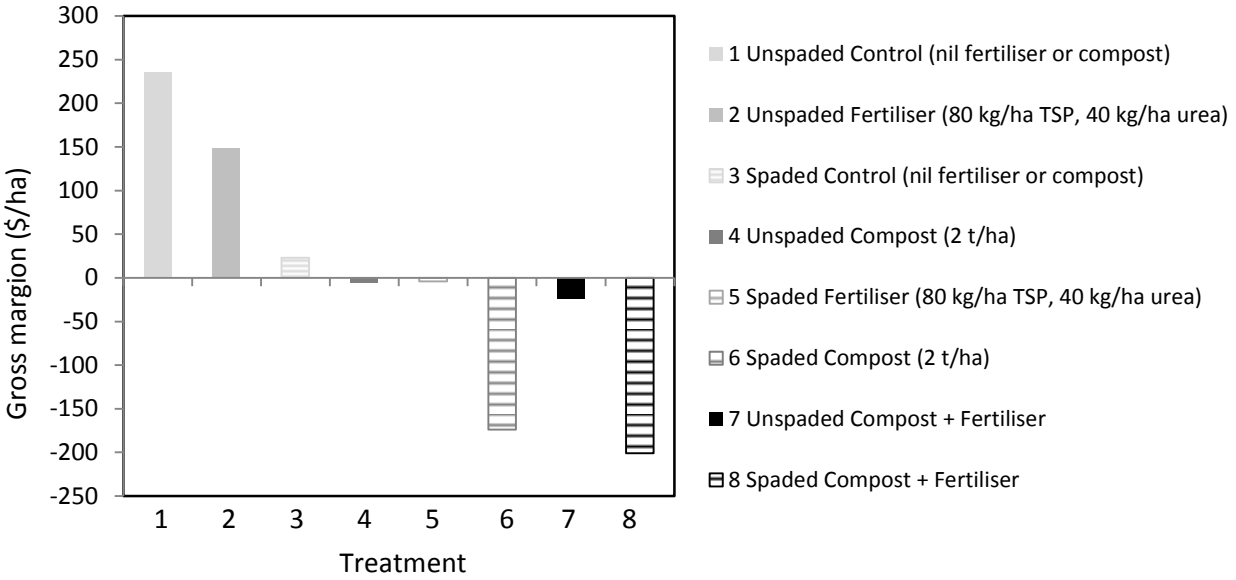

Figure 1: Gross margins ($/ha) for soil treatments applied to barley in 2013 on a deep sand at Buntine. Light shaded areas represent spaded treatments; dark shaded areas are non-spaded treatments. Treatment numbers are on the bottom axis of graph.

Thus in this instance the most profitable treatments would have been the non-spaded control (Treatment 1) and the non-spaded fertiliser (Treatment 2; Figure 1).

Comments

Machinery used for composting caused some compaction and due to the dry post-sowing conditions germination was very patchy. The trial site experienced significant moisture stress early in the season and may not be representative of seasons experiencing an average or wetter start.

This trial will be continued in 2014 to assess any further changes in soil condition and production.

Extended moisture in spring supported good yields associated with high grain weights.

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Contact:

Frances Hoyle, DAFWA

frances.hoyle@agric.wa.gov.au