Stubble and nutrient management trial to increase soil carbon

RESEARCH

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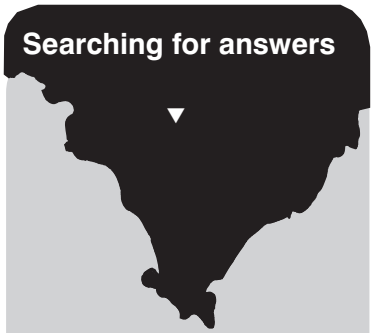

Location:
Minnipa Ag Centre, South 2/8
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2014 Total: 407 mm
2014 GSR: 290 mm
Yield
Potential: 4.0 t/ha (W)
Actual: 3.8 t/ha
Paddock History
2014: CL Grenade wheat
2013: Mace wheat
2012: Scout wheat
Soil Type
Red sandy loam
Plot Size
12 m x 3 m x 4 reps

Key messages

- **Average trial yield was 3.8 t/ha, close to the potential as identified by Yield Prophet® during the season.**
- **No significant differences in yield were found between stubble treatments (stubble retained, worked or removed) and nutrient treatments (normal practice, normal practice plus additional nutrients to enhance stubble breakdown).**
- **Changes in soil organic matter fractions over the duration of the trial (2012 to 2014) resulting from the stubble and nutrient treatments will be assessed in March, 2015.**

Why do the trial?

The soil organic matter content of Australian soils is either decreasing or remaining stable. Trials have demonstrated that No-Till stubble retention systems are adding to the partially broken-down particulate organic carbon fraction but are not contributing to the stable humus fraction. Without an increase in soil humus the important functions of soil organic matter (i.e. improved soil water holding capacity, increased nutrient supply (N and cations), pH buffering capacity and better soil structure) are unlikely to be realised.

What is humus and how can it be increased?

Humus consists of the remains of bacteria and other micro-organisms that consume and break down plant material returned to the soil from a crop or pasture. This plant material consists mainly of carbon (C). For soil microbes to consume this material they also need nitrogen (N), phosphorus (P) and sulphur (S) otherwise they cannot thrive and multiply. Australian soils are inherently low in nutrients and in most soils there is insufficient N, P and S for soil micro-organisms to rapidly break down the plant material returned to the soil. To increase the stable humus fraction in the soil, we need to supply soil microbes with additional N, P and S; this may have to be supplied as extra fertiliser.

How much N, P and S need to be supplied to stubble to form humus?

Dr Clive Kirkby, from CSIRO, has been working on this question and found that:

- In humus 1000 kg of C is balanced with 80 kg N, 20 kg P and 14 kg S.
- Dr Kirkby argues that for soil micro-organisms to breakdown stubble and form humus, we need to add sufficient nutrients (N, P and S) to feed these micro-organisms.
- For micro-organisms to efficiently break down wheat stubble to humus additional nutrients have to be added. Wheat stubble has a low nutrient:C ratio and one tonne of cereal stubble needs to be balanced with 5.8 kg N, 2.2 kg P and 0.9 kg S.

The DAFF and GRDC funded national trial will examine existing, new and alternative strategies for farmers in the cereal sheep zone to increase soil carbon. The trial will be used as baseline data for carbon accumulation in soils and to:

- discuss the various forms of soil organic carbon (plant residues, particulate, humus and resistant fractions),
- investigate how management affects each of these pools and how humus can be increased over the medium to long term,
- communicate how soil organic matter affects soil productivity (through nutrient and water supply, and improvements in soils structure).

Identical trials are being run by eight farm groups in SE Australia (Victoria: Mallee Sustainable Farming, Birchip Cropping Group, Southern Farming Systems; NSW: FarmLink, Central West Farming Systems; SA: Hart and Eyre Peninsula Agricultural Research Foundation, both through Ag Ex Alliance; and Tasmania: Southern Farming Systems) so information can be collected on different soils and climates in the Southern Region.

How was it done?

2014 was the third year of the trial. The 2013 trial stubble load was determined on 5 February 2014.

Soil samples were collected on 10 February for Yield Prophet® (0-10, 10-40, 40-70, 70-100 cm) to determine soil available nitrogen and soil moisture.

In March the stubble management treatments: (i) stubble left standing, (ii) stubble worked in with single operation of the seeder before sowing (1 March) and (iii) stubble removed by raking and burning (2 March) were imposed.

Nutrient application treatments at seeding were: (i) normal practice for P at sowing and N in crop as per Yield Prophet® and (ii) normal practice PLUS extra nutrients (N, P, S) required to break down the measured wheat stubble. Based on the 2013 stubble load, the extra nutrients (17.5 units N, 2.7 units P and 5.2 units S) required to break down the stubble were applied on 13 February with a rainfall event. The extra nutrients (PLUS treatment) were applied as DAP (18:20:0:0) @ 14 kg/ha, ammonium sulphate (21:0:0:24) @ 22 kg/ha and urea (46:0:0:0) @ 37.5 kg/ha. Treatments were replicated 4 times.

The trial was sown on 30 April with CL Grenade wheat @ 60 kg/ha and a base fertiliser of DAP (18:20:0:0) @ 50 kg/ha. Pre sowing chemical applications were Roundup @ 1.2 L/ha, Trifluralin @ 1 L/ha and a wetter. On 2 June, Intervix was applied at 750 ml/ha with 500 ml/ha Supercharge. Prosaro @ 300 ml/ha was applied on 15 July for Yellow Leaf Spot, and tebuconazole was applied @ 290 L/ha on 21 August on the whole paddock using a plane.

Emergence counts, flowering date, grain yield and grain quality were measured.

What happened?

The mean stubble load calculated from 2013 was 5.7 t/ha and additional nutrient treatments were applied to aid in the breakdown of the stubble to humus.

Emergence counts were taken on 21 May with an average of 131 plants/m^2. Flowering occurred (GS 65 - when 50% of heads have anthers) on 30 August. The trial was harvested on 24 October. There were no significant differences between treatments in yield, test weight, grain weight and screenings (Table 1). There was a small increase in protein for those treatments that received additional nutrients (Table 1).

Table 1 Grain yield and quality as affected by stubble treatments and additional nutrients at Minnipa 2014

Stubble treatment	Nutrition treatment	Yield (t/ha)	Protein (%)	Test weight (kg/hL)	1000 Grain weight (g)	Screenings (%)
Stubble removed	normal practice	3.81	10.6	85.5	42.5	2.7
Stubble removed	normal practice PLUS N,P&S	3.90	10.9	85.3	41.2	3.4
Stubble standing	normal practice	3.55	10.4	85.4	42.6	2.8
Stubble standing	normal practice PLUS N,P&S	3.61	10.7	85.5	41.7	2.6
Stubble worked	normal practice	3.81	10.7	85.0	41.5	2.7
Stubble worked	normal practice PLUS N,P&S	3.96	11.0	85.0	42.9	2.5
LSD (P=0.05)		*ns*	*0.30*	*ns*	*ns*	*ns*

Yield Prophet® was used early in the season (22 July) to predict if extra nitrogen fertiliser was required to achieve potential yield. UAN @ 50 L/ha was applied on 28 July using a broad-acre boom over all treatment plots.

What does this mean?

It is expected that the imposed treatments to increase soil organic matter will take a few years to become noticeable. The trial site was soil sampled for soil organic matter fractions at the start of the trial in 2012, and will be repeated prior to sowing the trial in 2015.

Acknowledgements

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