Impact of Biochar on Crop Yield and Nitrogen

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Key Messages

- 4 t/ha of biochar applied in 2010 has not influenced yield this season.

Aim

- To determine the impacts of biochar on crop yield and quality.
- To compare the effectiveness of different methods of applying biochar to the soil.

Background

Biochar is a carbon rich product created when organic matter is heated to temperatures greater than 250°C in low oxygen conditions (Antal and Grønli 2003). During the conversion of organic matter to biochar, volatile compounds are released. These compounds can be combusted to produce energy; hence it can be considered a carbon negative method of producing energy. Biochar is also very stable in soils. It can remain in soils for many hundreds, or thousands of years, providing a method of carbon sequestration (Ascough et al. 2009).

From an agronomic perspective it is suggested that biochar could improve soil health by improving nutrient retention, particularly in coarsely textured soils (Chan et al. 2008). As most biochar is alkaline, it may also provide a neutralising effect similar to liming. From a biological perspective, biochar is also a potential habitat for microbes to avoid predation by nematodes and protozoa. Some biochars can also supply nutrients. The aim of this experiment is to examine the interaction between biochar (made from wheat chaff) and nitrogen (N). From this we hope to determine whether biochar changes N fertiliser use efficiency.

The Experiment

If biochar does prove to be a beneficial soil ameliorant, growers will need to consider how to apply the product. In this trial biochar was either banded or applied on the soil surface at a rate of 4 t/ha using the Department of Agriculture and Food's trial seeder. The biochar was applied in April 2010 and therefore this is the fourth cropping year after biochar application to the site. To investigate the claim that biochar increases fertiliser efficiency the trial compares 3 N rates (0, 20 or 40 units of N) applied as urea at seeding. No further N was applied.

Trial Details

Property	Long Term Research Site, west Buntine
Plot size & replication	20m x 2m x 4 replications
Soil type	Deep yellow sand
Soil pH ($CaCl_2$)	0-10cm: 5.5 10-20cm: 4.6
EC (dS/m)	0.04
Sowing date	22/05/2014
Seeding rate	70 kg/ha
Paddock rotation	2010: wheat, 2011: wheat, 2012: canola, 2013: barley
Fertiliser	22/05/14: As per treatment (N), 40kg/ha Triple Super
Herbicides	06/05/2014: 2 L/ha Spray.Seed, 0.5L/ha Diuron, 0.5L/ha Dual Gold 22/05/2014: 2 L/ha Spray.Seed 250 26/06/2014: 25 mL/ha Glean, 1% wetter
Growing Season Rainfall	185mm

Results

Table 1: Yield and quality of oaten hay sown at Buntine 2014, standard error for yield ±0.23.

Fertiliser Rate and Treatment	Yield (t/ha)	DEMD* (%)	NDF* (%)	ME* (%)	WSC* (%)	ADF* (%)
Nil Rate (0N)						
Banded	1.97	70.87	51.7	10.53	16.4	28.07
None	1.78	70.13	52.37	10.43	14.53	28.57
Top Dressed	1.75	70.93	52.43	10.60	15.60	28.27
Half N Rate (20 N)						
Banded	1.88	72.40	50.73	10.83	15.53	27.27
None	2.12	71.27	52.23	10.63	14.87	27.90
Top Dressed	2.29	71.20	51.37	10.63	14.60	27.60
Full N Rate (40 N)						
Banded	2.38	73.07	49.80	10.93	16.50	26.10
None	1.99	72.47	50.43	10.83	15.37	26.70
Top Dressed	1.99	71.27	51.37	10.63	13.73	27.03
LSD	NS	NS	NS	NS	NS	NS
CV	19.7					

NS = Fertiliser and biochar treatments both not significant (p>0.05).
***Note:** Dry Energy Matter Digestibility (DEMD) is the proportion of forage that is digestible (high is better).
Neutral Detergent Fibre (NDF) is the structural component of the plant, it provides bulk or fill (low is better).
Metabolise Energy (ME) is the net energy available to the animal (high is better).
Water Soluable Carbohydrate (WSC) are the sugars such as sucrose, glucose and fructose (high is better).
Acid Detergent Fibre (ADF) is the least digestible plant components, including cellulose and lignin (low is better).

The application of 4 t/ha of biochar (2010) had no statistical significance on yield or hay quality in 2014. There was no interaction between the biochar and fertiliser treatments. The three differing N rates also had no significant impact on yield or quality; this could be due to the dry/hot August as in all other years that the trial has been monitored fertiliser rates have had an impact on yield.

Comments

Two factors (along with a host of others) that influence hay palatability are the Acid Detergent Fibre (ADF) and Neutral Detergent Fibre (NDF). The ADF and NDF were low, indicative of highly palatable hay. These two factors are controllable by seeding date and rate, the lower the ADF and NDF the more palatable the hay becomes.

All the hay samples where on track for top grade but the Water Soluable Content (WSC) was the result that let the quality down (see Appendix 1). This is controlled more by the weather and due the dry August all of Western Australia's oaten hay was low in WSC. The hay was valued at $210/t (Grade: OH1QV).

Another factor to note was that these hay samples were dried indoors and if this hay crop had a serious rain event on it whilst in the windrow curing, we would expect the hay quality to be damaged; as all hay in the growing area was affected by rain this year.

The biochar has been in the soil for five years and the trial results collected for four years (2010, 2011, 2013 and 2014) have shown no major impacts on yield. Biochar is considered to be a long term soil ameliorant and is largely untested in broadacre agriculture.

References

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Appendix 1
Table: Hay Receival Standards 2014.

Grade	DEMD	ADF	NDF	WSC	Green (%)	Brown (%)	Weather Damage	Chaff (%)	Aroma	Stem (mm)
OH1QQQV	>60	<30	<52	>23	>70	<10	Nil	<25	Bland	<6
OH1QQQ	>60	<30	<52	>23	>70	<10	V. Minor	<25	Bland	<6
OH1QQV	>60	<32	<54	>20	>50	<15	Nil	<25	Bland	<6
OH1QQ	>60	<32	<54	>20	>50	<15	Minor	<25	Bland	<6
OH1QV	>58	<33	<56	>18	>50	<20	Nil	<25	Bland	<6
OH1V	>56	<36	<59	>12	>50	<20	Nil	<25	Bland	<7
OH1	>56	<36	<59	>12	>30	<20	Moderate	<25	Bland	<7
OHMINV	>54	<39	<64	>6	>30	<20	Nil	<25	Bland	<7
OHMIN	>54	<39	<64	>6	>30	<25	Moderate	<25	Bland	<7