Impact of Biochar on crop yield and nitrogen

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Aim

- To determine the impacts of biochar on crop yield
- To determine how biochar influences plant nitrogen uptake and soil nitrogen mineralization
- 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 liming effect. 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. From this we hope to determine whether biochar changes nitrogen fertiliser use efficiency.

In the first year of this trial (2010) addition of biochar did not alter grain yield or protein content, nor did it have any positive effect on nitrogen fertiliser usage. Biochar is considered a long term soil ameliorant and is largely untested in broadacre agriculture; therefore this trial continues to be monitored into the future.

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 second year that wheat has been grown on the site. To investigate the claim that biochar increases fertiliser efficiency the trial compares 3 nitrogen rates (0, 20 or 40 units of N) applied as urea at seeding. No further nitrogen was applied.

Trial Details

Property	Liebe Long Term Research Site, West Buntine
Plot size & replication	20m x 2m x 4 replications
Soil type	Deep yellow sand
Soil pH (CaCl2)	Topsoil 5.5, Subsoil 4.6
EC	0.04 dS/m
Sowing date	30/5/11
Seeding rate	60 Kg/ha Mace
Fertiliser	As per treatment (N), 50 kg/ha Bigphos + Mn
Paddock rotation	2008 wheat, 2009 canola, 2010 wheat
Herbicides	2 L/ha Roundup PowerMax, 2.5 L/ha BoxerGold
Growing Season Rainfall	295mm

Results

Table 1: Average grain and straw yield, and biomass production for 2011 after biochar was applied on surface and deep banded with 3 rates of nitrogen fertiliser (0, 20, 40 units of N). The least significant difference (LSD) used is for comparing nitrogen and biochar treatments. Percent yield increase was calculated over absolute control (nil nitrogen and nil biochar). NS stands for not statistically significant.

Treatment		Yield	Yield	Post-tillering	Anthesis
Nitrogen (kg N/ha)	Biochar (4 t/ha)	(t/ha)	increase %	biomass (t/ha)	biomass (t/ha)
40	Nil	2.71	42	0.32	5.38
40	Banded	2.76	45	0.38	4.85
40	Spread	2.33	22	0.34	4.93
20	Nil	1.99	4	0.36	3.77
20	Banded	2.31	21	0.28	3.62
20	Spread	2.38	25	0.29	4.04
0	Nil	1.91	-	0.25	4.00
0	Banded	2.00	-	0.23	3.58
0	Spread	2.18	-	0.25	3.16
LSD (Nitrogen)		*0.34*	*-*	*0.03*	*0.70*
LSD (Biochar)		*NS*	*-*	*NS*	*NS*

Table 2: Average grain protein in 2011 after biochar was applied on surface and deep banded with 3 rates of nitrogen fertiliser (0, 20, 40 units of N).

Treatment		Grain Protein
Nitrogen (kg N/ha)	Biochar (4 t/ha)	%
40	Nil	8.95
40	Banded	8.60
40	Spread	8.90
20	Nil	8.85
20	Banded	8.85
20	Spread	8.82
0	Nil	8.55
0	Banded	8.70
0	Spread	9.07
LSD (Nitrogen)		*NS*
LSD (Biochar)		*NS*

Biochar application methods had no effect on wheat biomass and grain yield in 2011 (Table 1). More nitrogen did increase yield but there was no interaction between biochar and nitrogen. Grain protein was also unchanged by biochar application or nitrogen application (Table 2).

Comments

This is the second year in a row in which biochar has had no effect on wheat yield. Trial conditions were not ideal due to a high weed burden and glyphosate damage which has reduced grain yield. Biochar is considered a long term soil ameliorant and once applied it cannot be removed therefore the Liebe Group and the University of Western Australia will continue to conduct biochar research in order to determine its effects on broadacre agriculture.

References

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