

THE IMPACT OF BIOCHAR INCORPORATION ON INORGANIC NITROGEN FERTILIZER UPTAKE, BY BARLEY AND SUNFLOWER, IN A TEMPERATE ARABLE FIELD TRIALS USING ^{15}N TRACERS.

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Research Questions

Does biochar application have an impact on inorganic-fertilizer N uptake in temperate cropping systems?

Does biochar application effect N cycling in a temperate agricultural cropping system?

Experimental set up

TREATMENT	Biochar t/ha	Nitrogen kg/ha
BC 3	90	0
NPK	0	120
BC 1N	30	120
BC 3N	90	120

Beech wood charcoal, slow
pyrolysis 550°C

80 % C
1.6% N



Site description

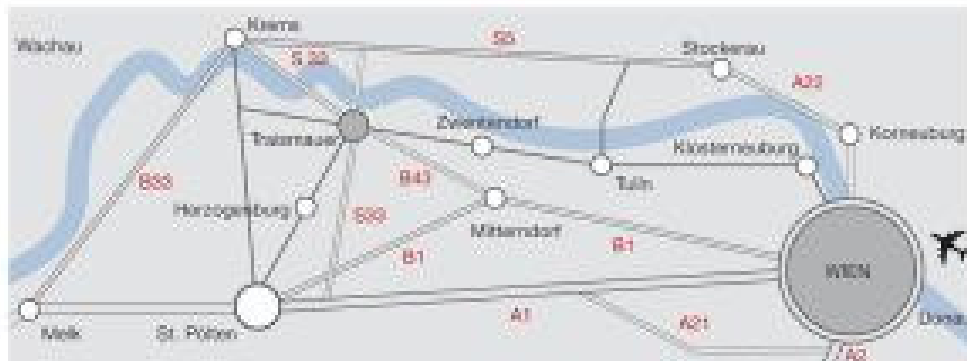
Traismauer:

Parent material: quaternary & to a lesser extent tertiary loess.

Calcareous sandy to loamy silt.

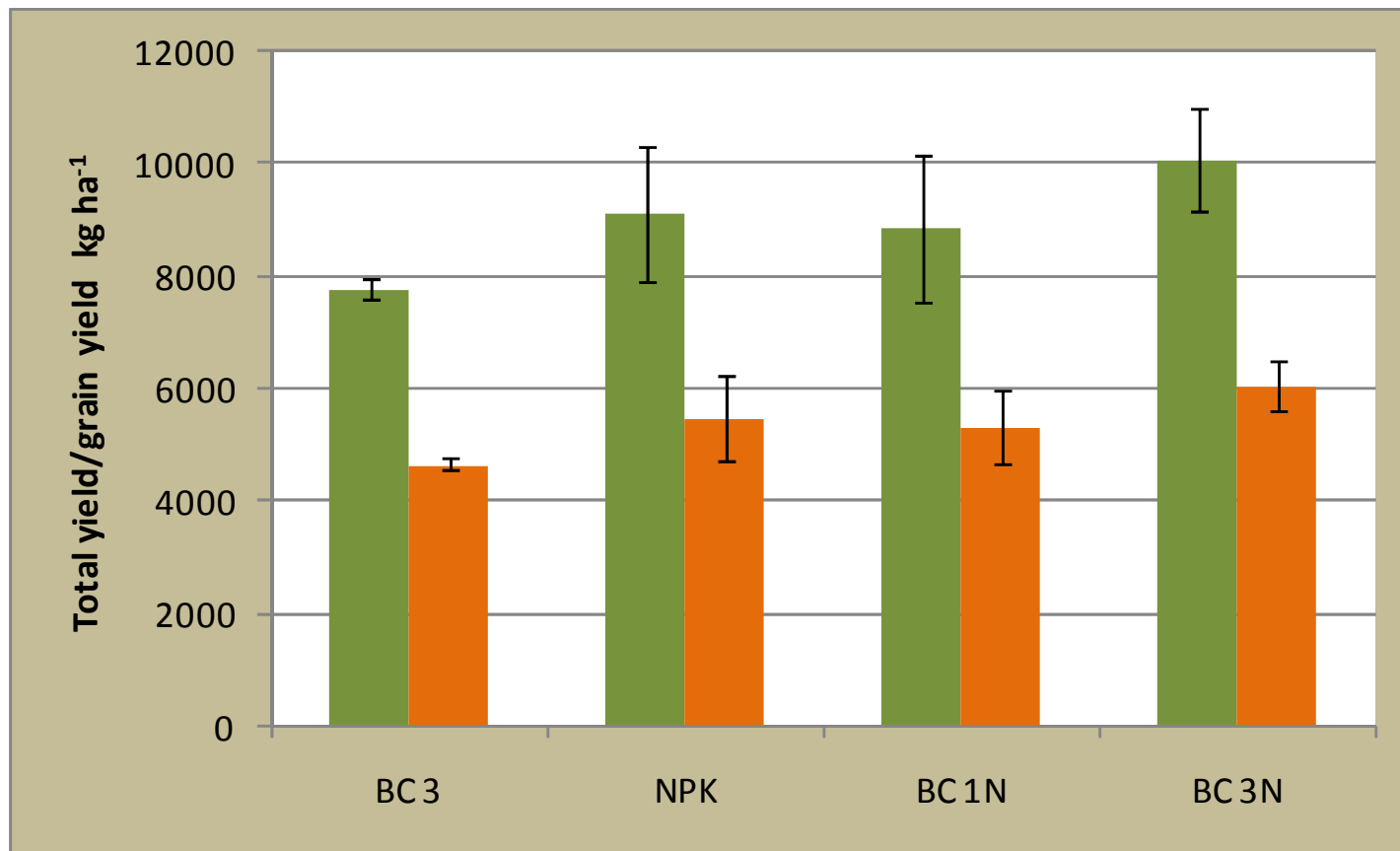
Luvisol or Chernozem on a loess

567 mm rainfall per annum, pH 7.4



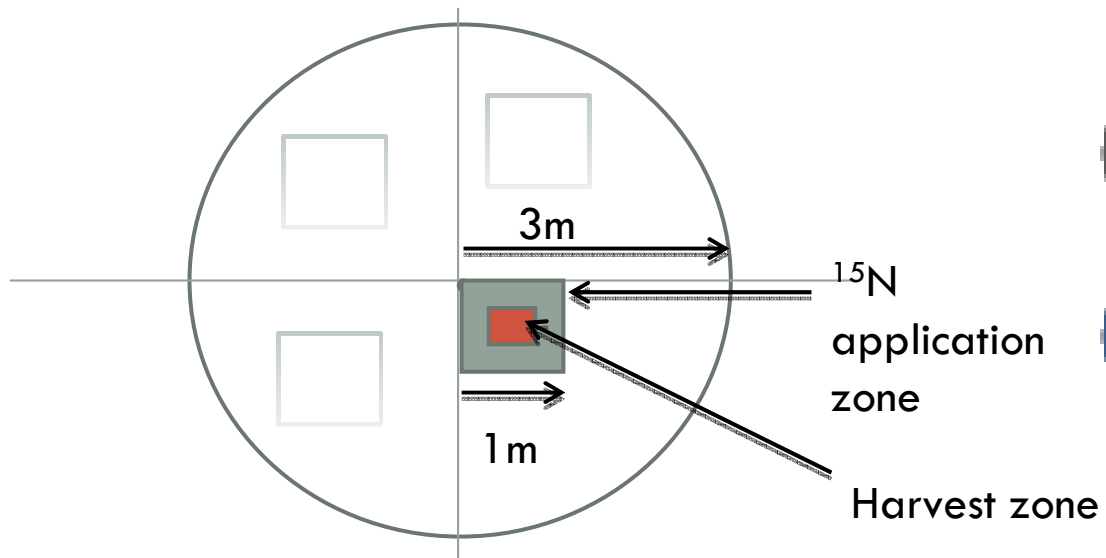
2011 Barley,
2012 Sun flower

No significant difference in barley yields when biochar and fertilizer was added



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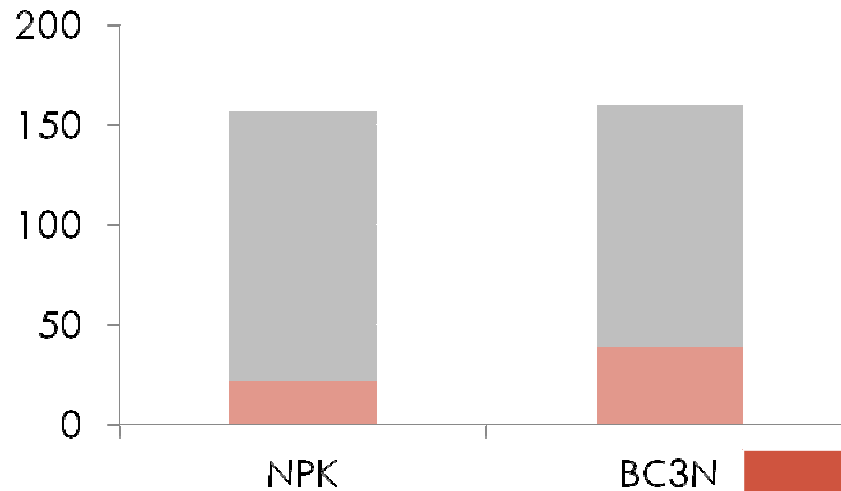
There was a significant difference in % nitrogen derived from fertilizer, however this did not consequently translate difference in total N uptake.

	%Ndff Grain	%Ndff shoot
NPK	13 $\pm 8^a$	12 $\pm 9^a$
BC3N	24 $\pm 4^b$	26 $\pm 6^b$

$$\%Ndff = \frac{\text{atom } \%^{15}\text{N excess in the crop}}{\text{atom } \%^{15}\text{N excess of the fertilizer added}} \times 100$$

There was compensatory uptake of N suggesting N was not limiting in the fertilized system.

N Uptake kg N ha⁻¹



$$\text{Ndff (kg)} = \frac{\% \text{Ndff}}{100} \times \text{N(kg) in the crop}$$

	N Uptake kg N ha ⁻¹	
	From labelled fertilizer	Total
NPK	22 ± 18 ^a	157 ± 17 ^a
BC3N	39 ± 5 ^a	160 ± 18 ^a

In barley 201,1 a dry year, there was a significant effect of biochar on water use efficiency.

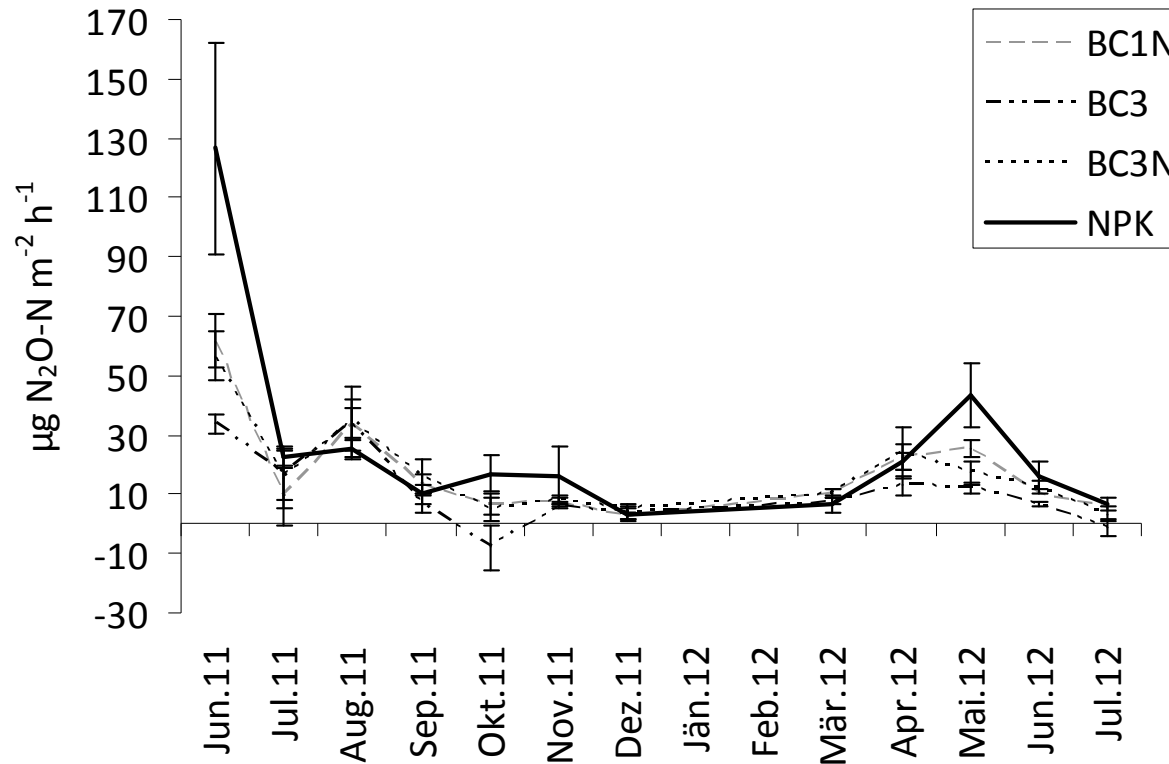
	$\Delta^{13}\text{C} \text{ ‰}$ Grain	$\Delta^{13}\text{C} \text{ ‰}$ Leaves/shoot
NPK	18.62 $\pm 0.06^a$	20.06 $\pm 0.19^c$
BC3N	18.96 $\pm 0.37^b$	20.22 $\pm 0.51^c$

$$\Delta = \frac{\delta a - \delta p}{1 + \delta p}$$

In sunflower 2012 there was no impact of biochar on plant yield or fertilizer uptake or WUE.

	N Uptake kg N ha ⁻¹		Fertilizer use (%)
	From labelled fertilizer	Total	
NPK	25 ± 5 ^A	151 ± 25 ^A	45 ± 10 ^A
BC3N	26 ± 4 ^A	139 ± 26 ^A	46 ± 5 ^A
BC3		98 ± 12 ^B	

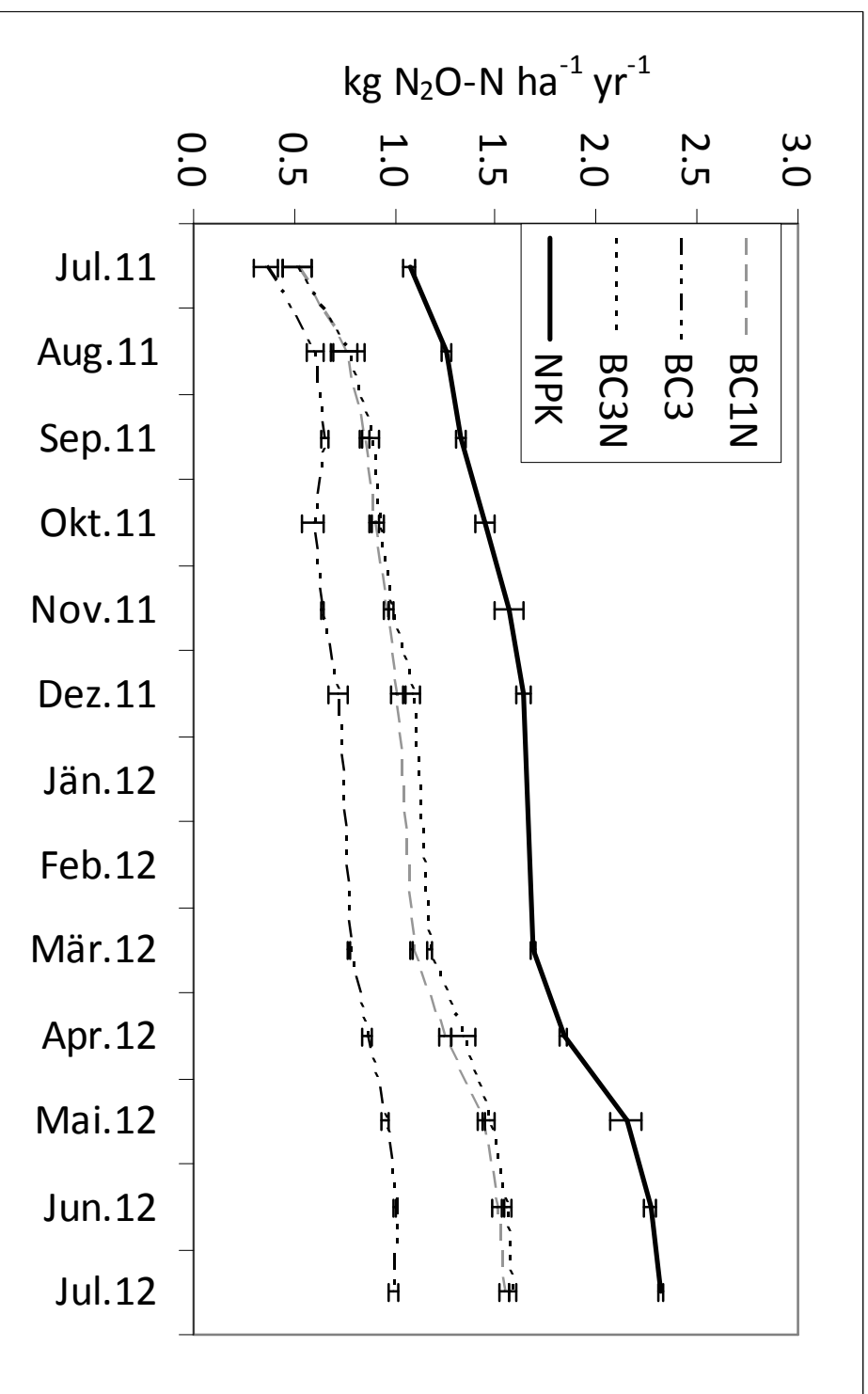
N₂O fluxes Traismauer



Significant long term reduction of N₂O emissions in the field.

In dry periods (Oct. 11) even an uptake of N₂O was found at treatment BC3.

Cumulative N₂O fluxes



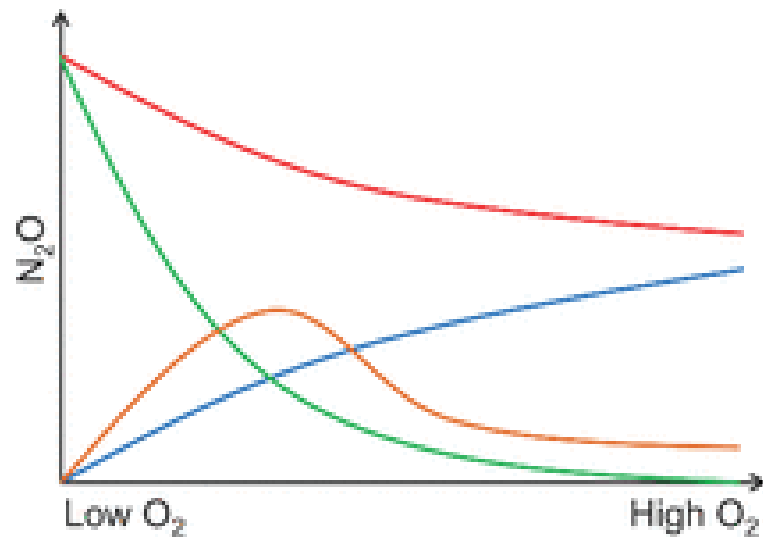
annual sums

	kg N ₂ O-N ha ⁻¹
NPK	2.3
BC3N	1.6 (-31%)
BC1N	1.5 (-34%)
BC3	1.0 (-56%)

Big deal in terms of GHG emissions, not a big in terms of plant N uptake.

NPK Equivalent to 1.46 Kg N ha⁻¹

But could be indicative of N₂ loss

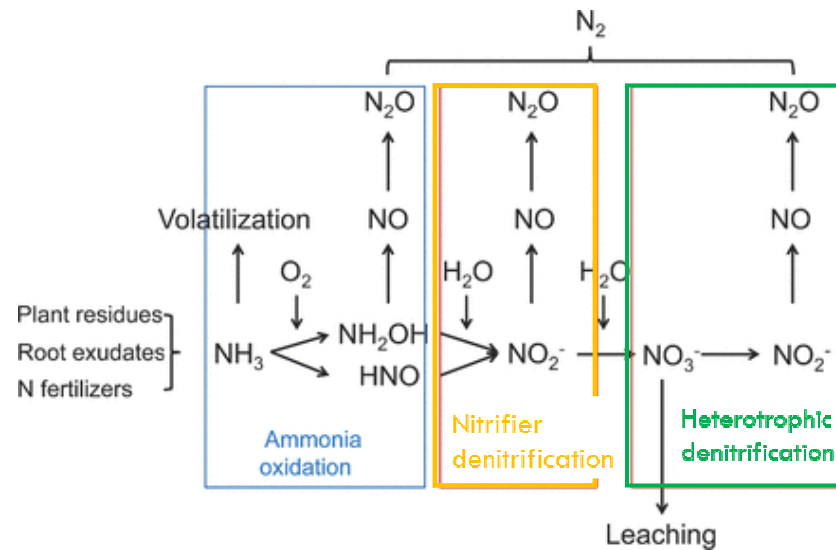


Gravimetric water content was significantly higher in BC treatment.

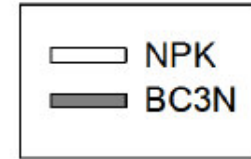
Porosity also significantly higher in BC treatment.

WFPS ns

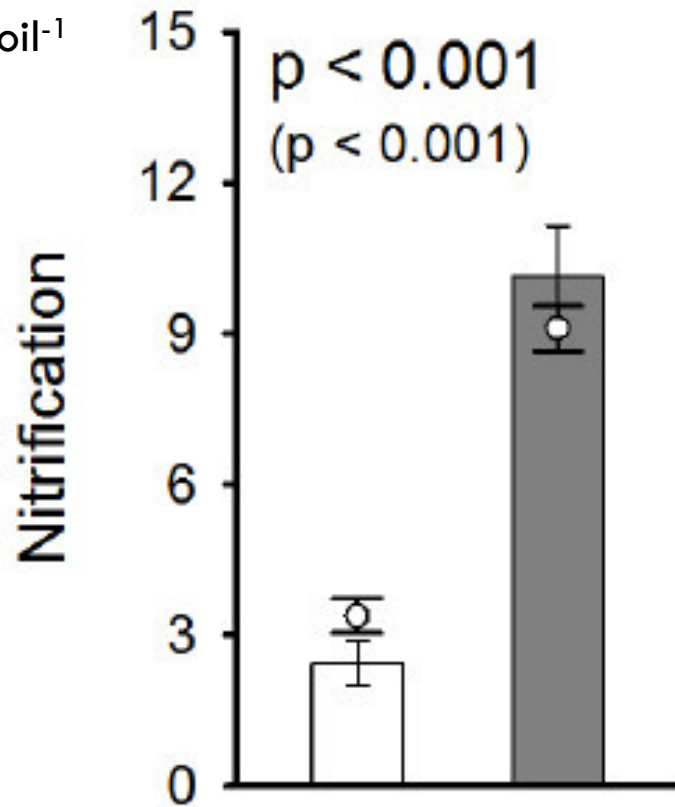
- Total N_2O production
- Nitrifier denitrification
- Ammonia oxidation
- Heterotrophic denitrification



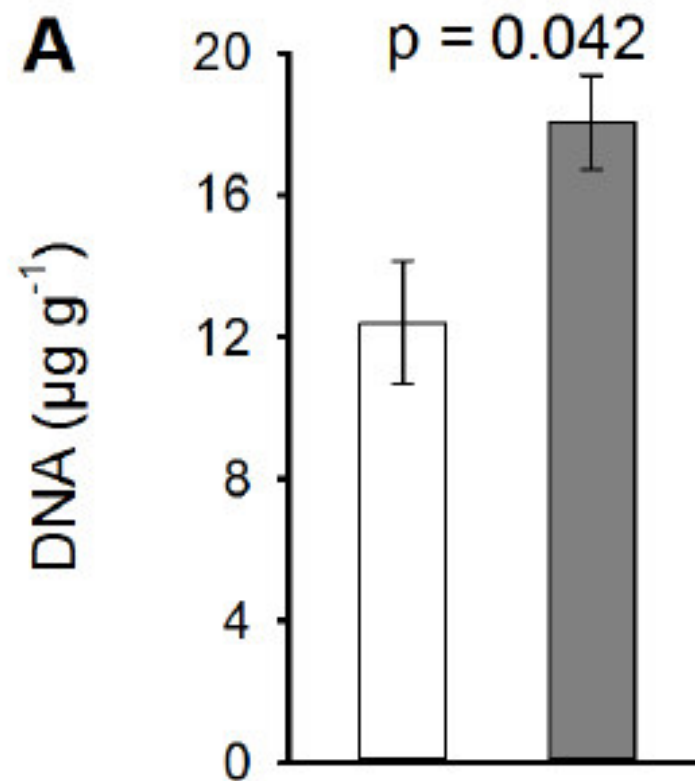
We have some evidence for this.



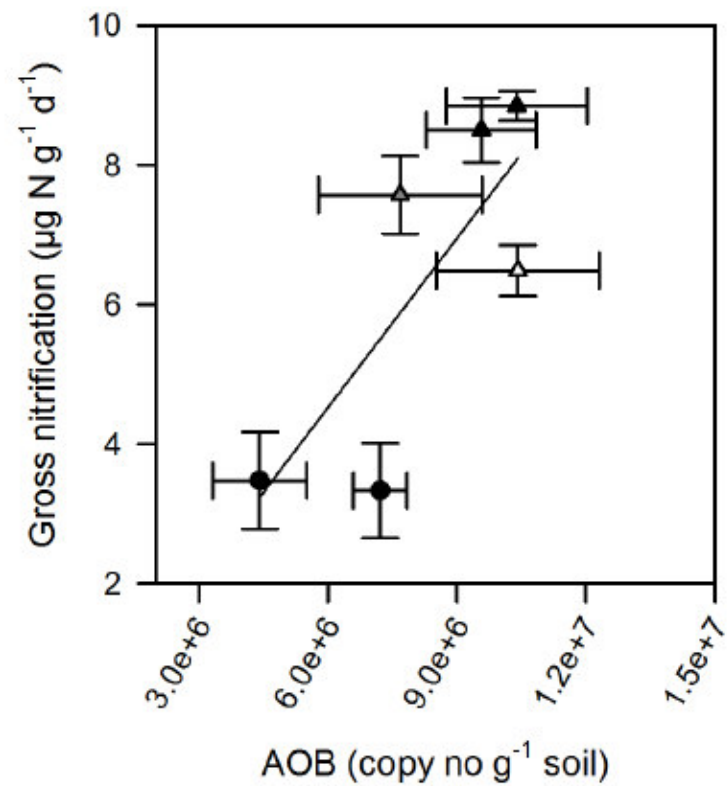
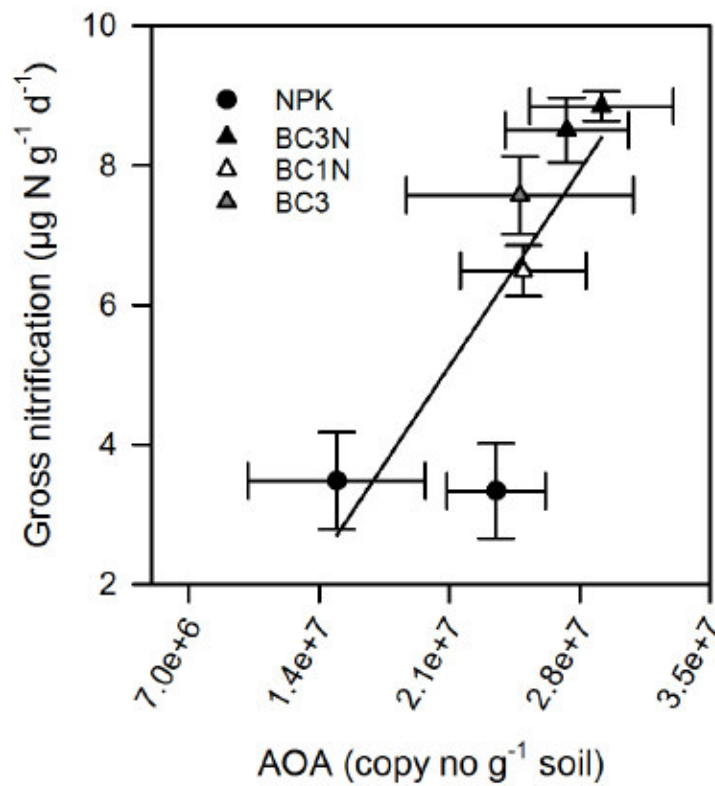
$\mu\text{gN g soil}^{-1}$
 day^{-1}



A



It appears to be due to a change in community.



Fate of applied fertilizer after biochar

Plant uptake	≈
Physical retention	
Microbial biomass	↑
Nitrous oxide loss	↓
Nitric oxide loss	?
NH ₃ volatilisation	?
Leaching	?
N ₂ loss	↓

Conclusions:

- No significant immobilization of N despite 40t ha⁻¹ addition of carbon to the soil.
- In dry years biochar could improve soil water status
- Impact of biochar on gross nitrification and community structure
- Possible impact of biochar on N₂ loss.