Quantifying the influence of Eucalyptus bark and corncob biochars on the physical properties of an oxisol under maize cultivation

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The Congo Basin Forest

https://www.google.ca/maps/@25.6480575,3.379742,3z

Setting the scene: tropical forest / tropical soil

Photos. http://www.agenceinfolibre.fr/wp-content/uploads/2014/09/deforestation.jpg

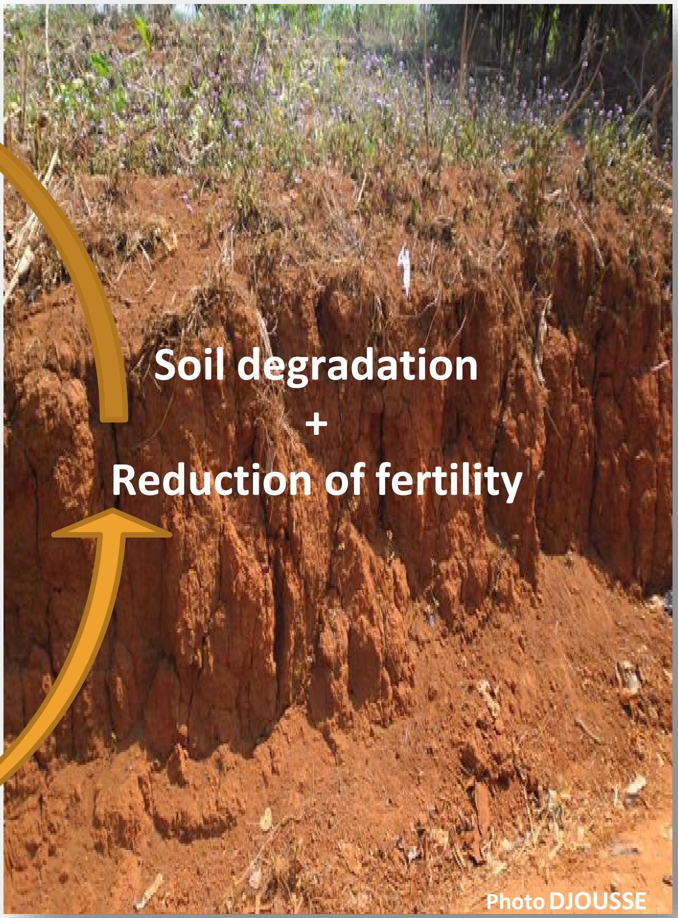
Deforestation

(487, 000 ha every year)

Vicious circle

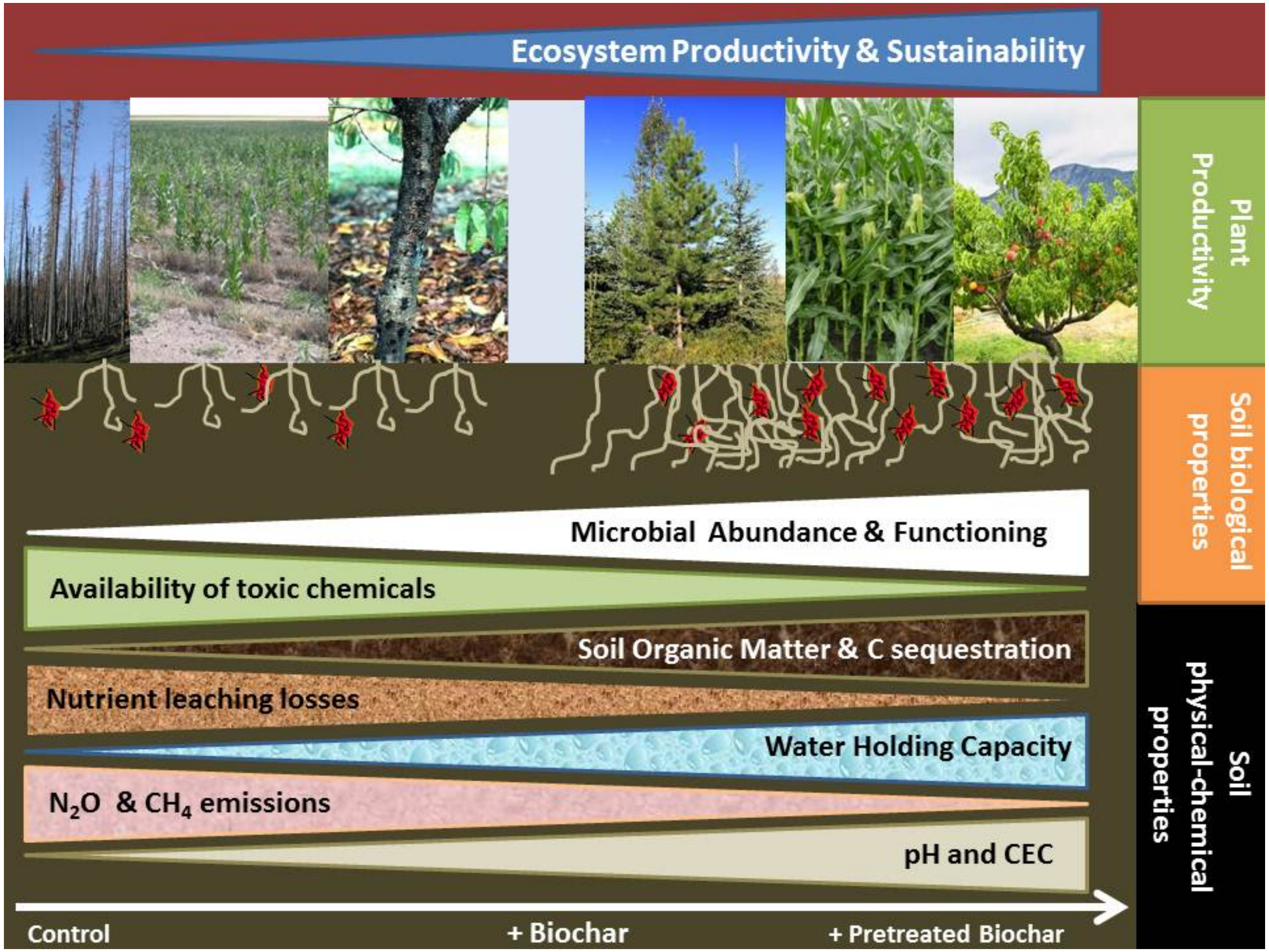
Degradation

(181, 000 ha every year)



Farm practices that maintain soil fertility help avoid the cultivation of new lands (forested and natural)

Soil conservation for sustainable agriculture: Biochar ?



http://banr.nrel.colostate.edu/banr/wp-content/uploads/2014/09/Teams_SystemSustainbility_Biochar_pic1.jpg

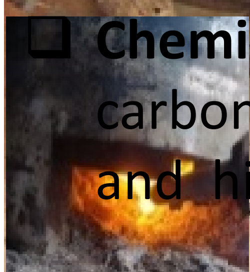
Definition, production and characterization of biochar

- **Definition** : Product of thermo-deg matter in a oxygen-poor environm use. (Lehmann and Joseph, 2009)

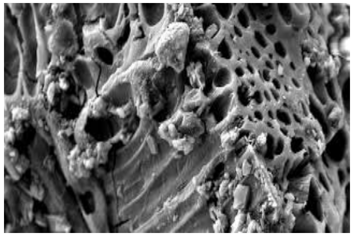
- Potential to improve soil fertility, s addition to other potential envi (Lehmann et al., 2006; Laird, 2008;

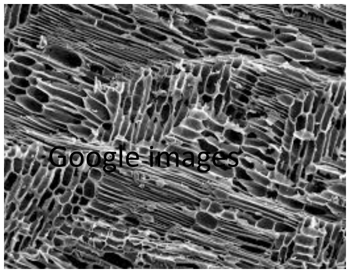
- **Properties**: Raw materials, pyrolys age (Schmidt and Noack, 2000; Leh

- **Chemical properties** : recalcitra carbon and ash, low initial CEC, hy and high C/N



Biochar: Physical properties





- High surface area
- High porosity (nano, micro, macro)
- Low bulk density

(Atkinson et al., 2010; Major et al., 2010)

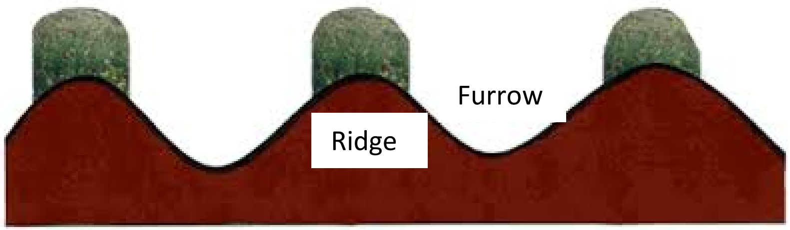
- Bulk density (ρa)
- Total porosity (Θ)
- Saturated hydraulic conductivity (Ks)
- Water content at saturation (Θs)
- Residual water content (θr)
- Available water content (AWC)

Inconsistency in the effects of biochar on soil physical properties

- Unclear effects, sometimes contradictory (Hardie et al., 2013; Barnes et al., 2014; Jeffery et al., 2015 ; Ojeda et al., 2015; Omondi et al., 2016)

- Mainly influenced by biochar properties, soil type and cropping system

- Few studies conducted on the furrow-ridges system widely used in the Congo Basin Forest



Objective

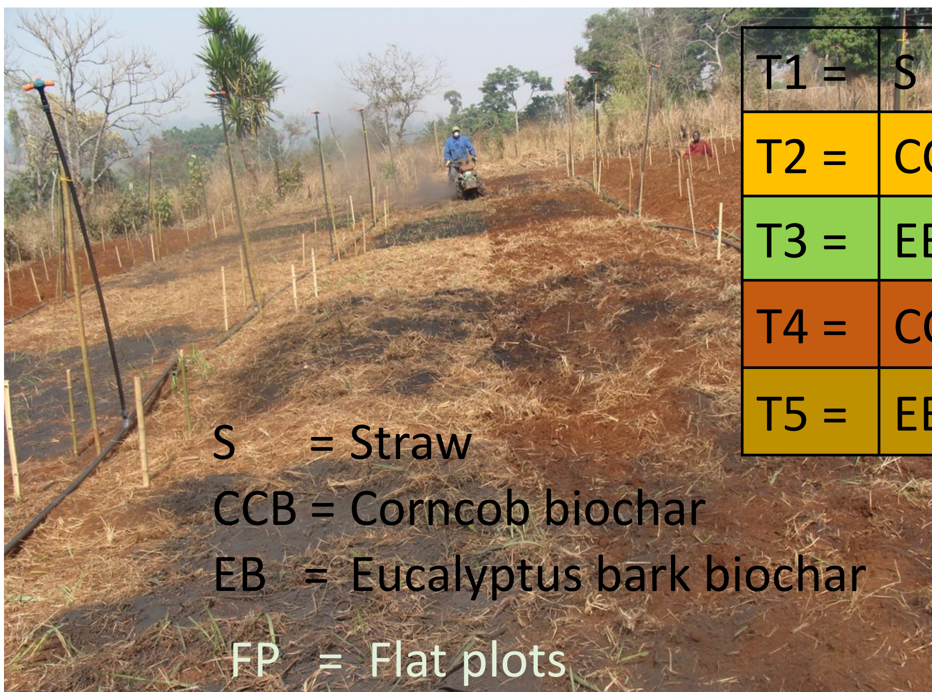
To evaluate the effects of two types of biochar applied, at a rate of 15 t ha^{-1} on the physical properties of an oxisol (clay loam) and maize yield

- ✓ Bulk density (ρa)
- ✓ Total porosity (Θ)
- ✓ Saturated hydraulic conductivity (Ks)
- ✓ Water content at saturation (Θs)
- ✓ Residual water content (Θr)
- ✓ Available water content (AWC)
- ✓ Yield

Experimental Design

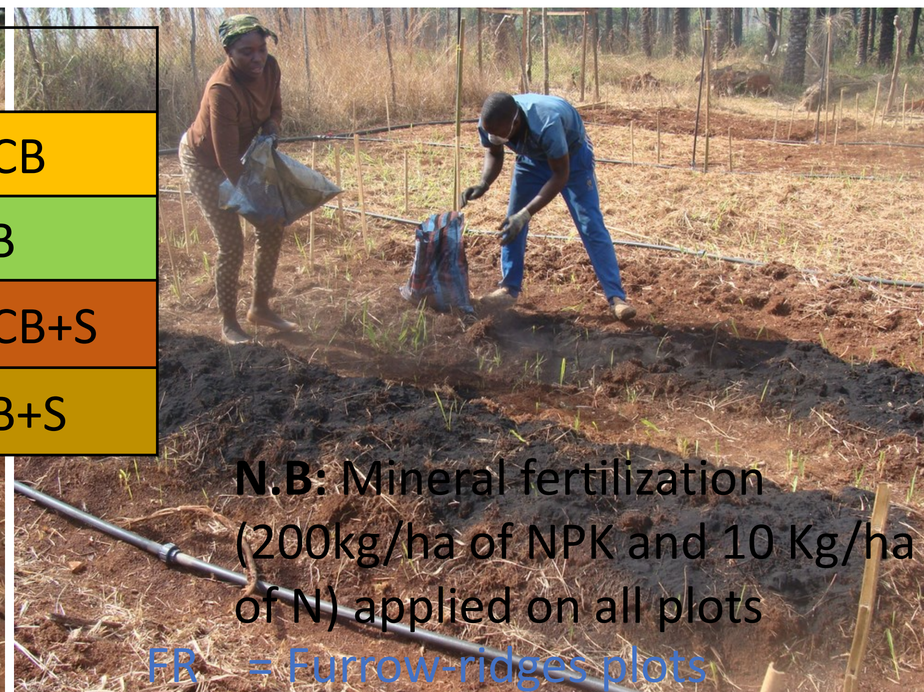
BLOCK 3	FP	T2	T3	T5	T1	T4
	FR	T3	T4	T1	T2	T5
BLOCK 2	FR	T4	T1	T5	T3	T2
	FP	T3	T5	T2	T1	T4
BLOCK 1	FP	T4	T2	T5	T1	T3
	FR	T2	T5	T4	T3	T1

Direction of Slope



T1 =	S
T2 =	CCB
T3 =	EB
T4 =	CCB+S
T5 =	EB+S

S = Straw
CCB = Corncob biochar
EB = Eucalyptus bark biochar
FP = Flat plots



N.B: Mineral fertilization (200kg/ha of NPK and 10 Kg/ha of N) applied on all plots

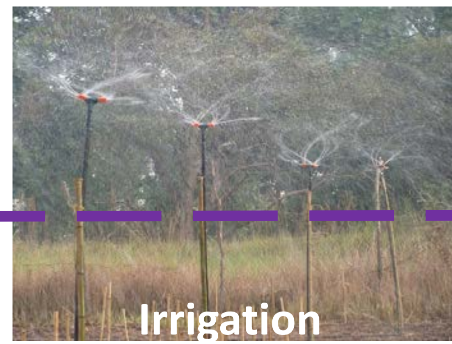
FR = Furrow-ridges plots

1st Production period

Soil sampling at beginning (12)

Soil sampling 6 months after (30)

2nd production period



Soil sampling 12 months after

Table.1. Summary of methods of analyses

Parameters		Methods / Equipment
Bulk density	ρ_a	Astm:D7263 (Core method)
Total porosity	Θ	Calculations (1-(ρa/ρs))
Saturated hydraulic conductivity	K_s	Constant head permeameter
Saturated water content	θs	Tension table + pressure plate Modelling using SWRC version 3.00 beta, Piracicaba, SP, 2001
Residual water content	θr	
	alpha	
	n	
	m	
Available water content	AWC	Difference between θ at 0.33 and 10 bars
Field water content	θ	Gravimetric method

Statistical analyses: SAS GLIMIX procedure and post hoc Tukey HSD test

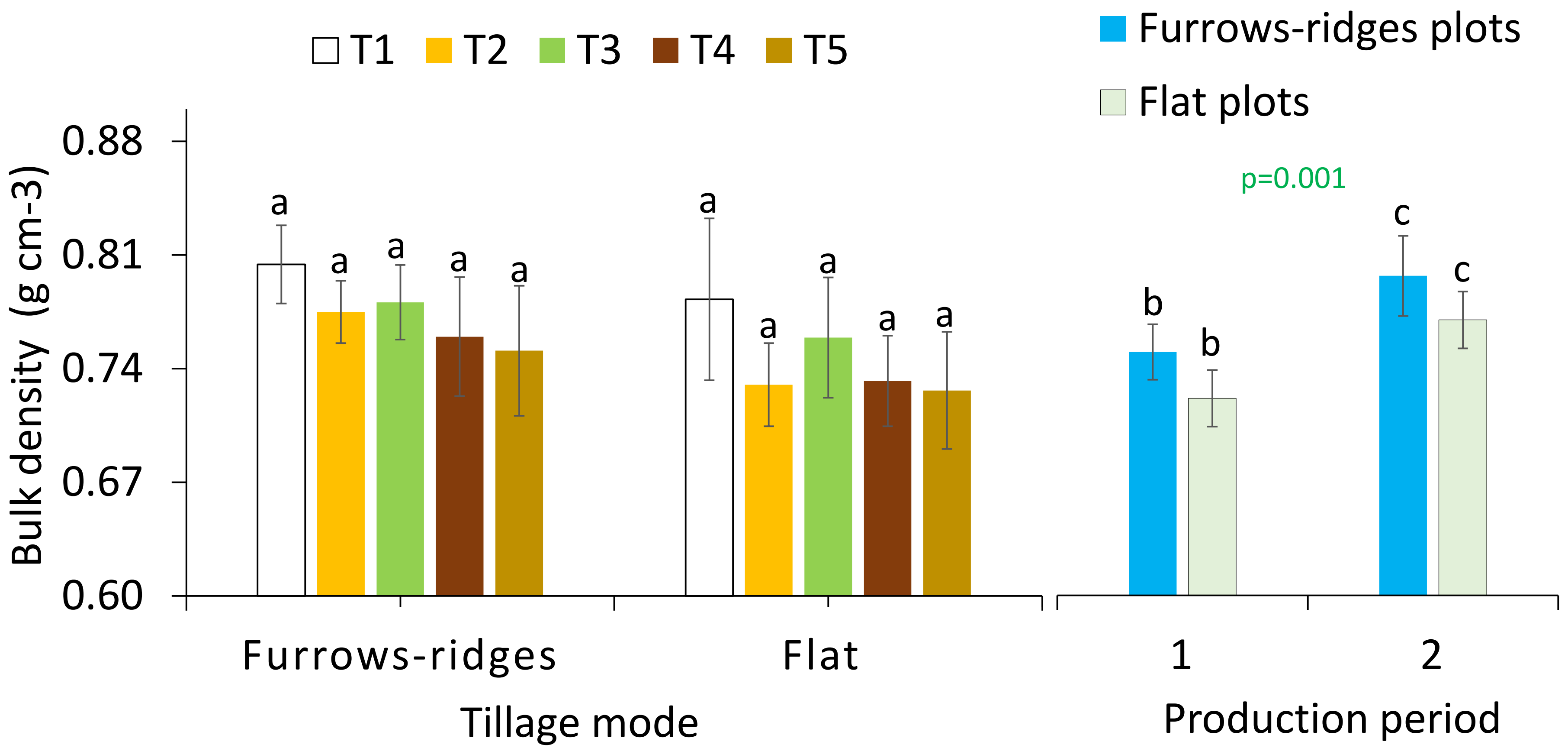


Fig.1. Effect of biochar, tillage mode and production period on soil bulk density

Fertilizers applied in all plots
T2= Corncob biochar (CCB)
T3= Eucalyptus biochar (EB)

T1 = Straw
T4 = Straw + CCB
T5 = Straw + EB

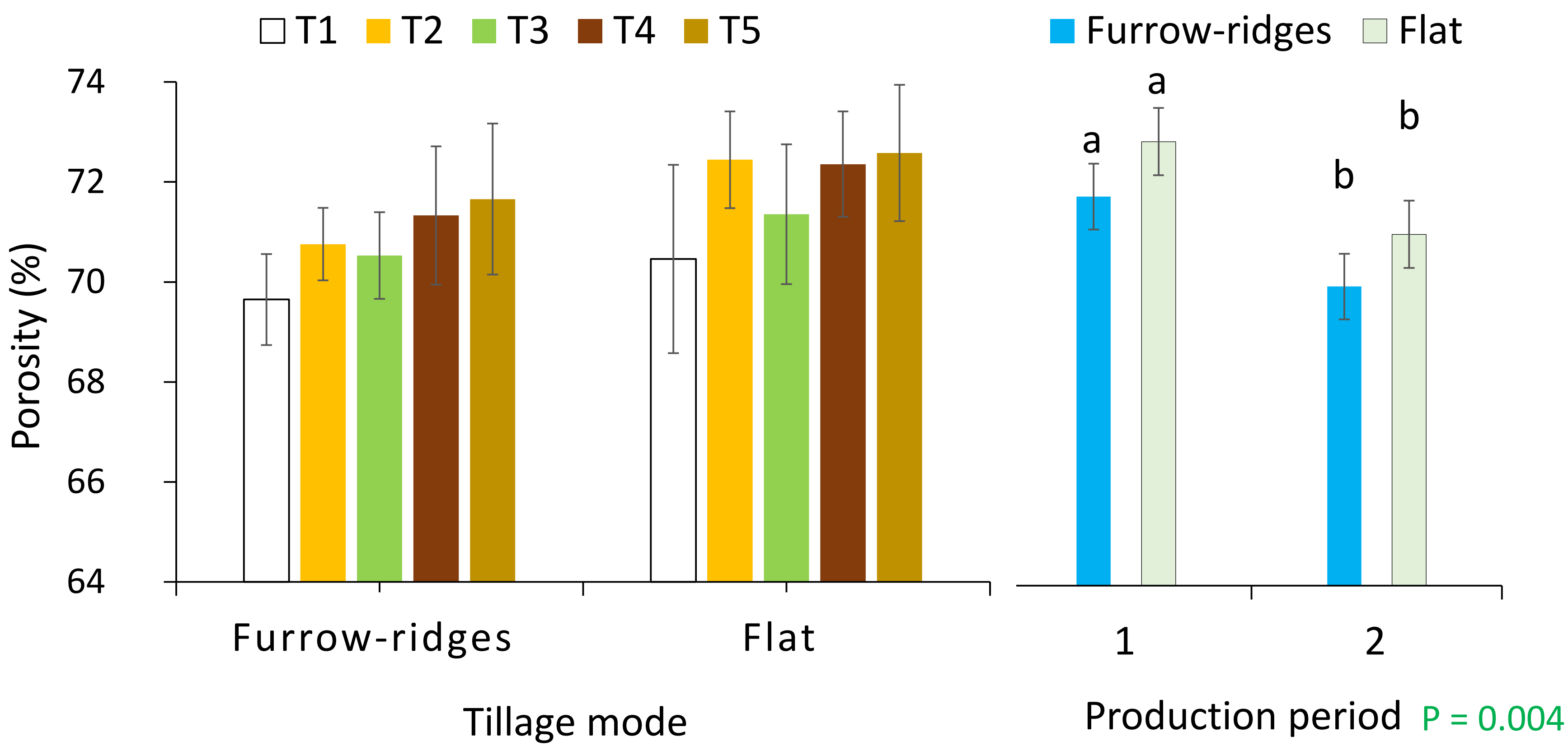


Fig.2. Effect of biochar, tillage mode and production period on soil total porosity

Fertilizers applied in all plots

T2= Corncob biochar (CCB)

T3= Eucalyptus biochar (EB)

T1 = Straw

T4 = Straw + CCB

T5 = Straw + EB

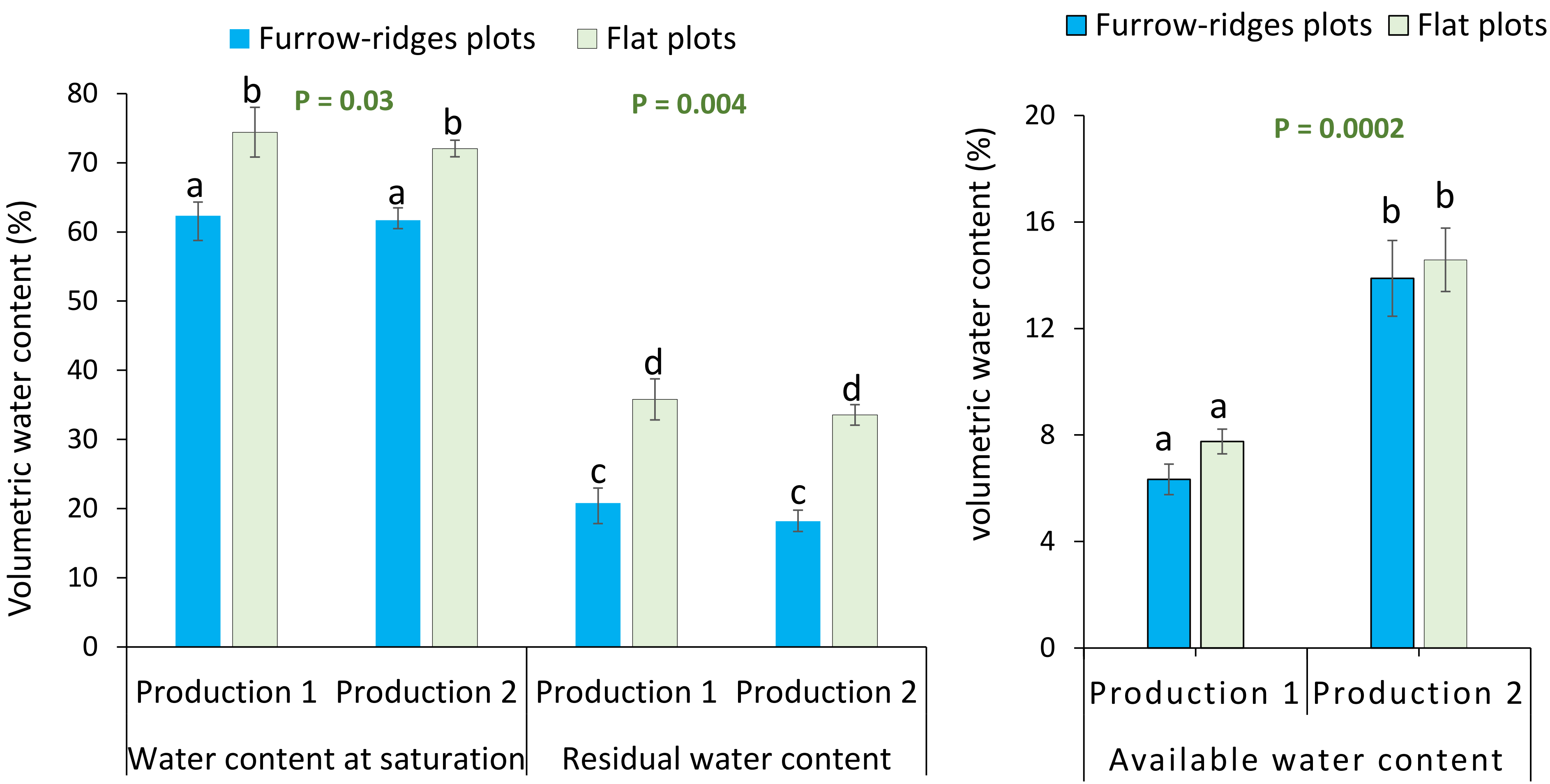


Fig.3. Effect of tillage mode and production period on saturation, residual and available water content

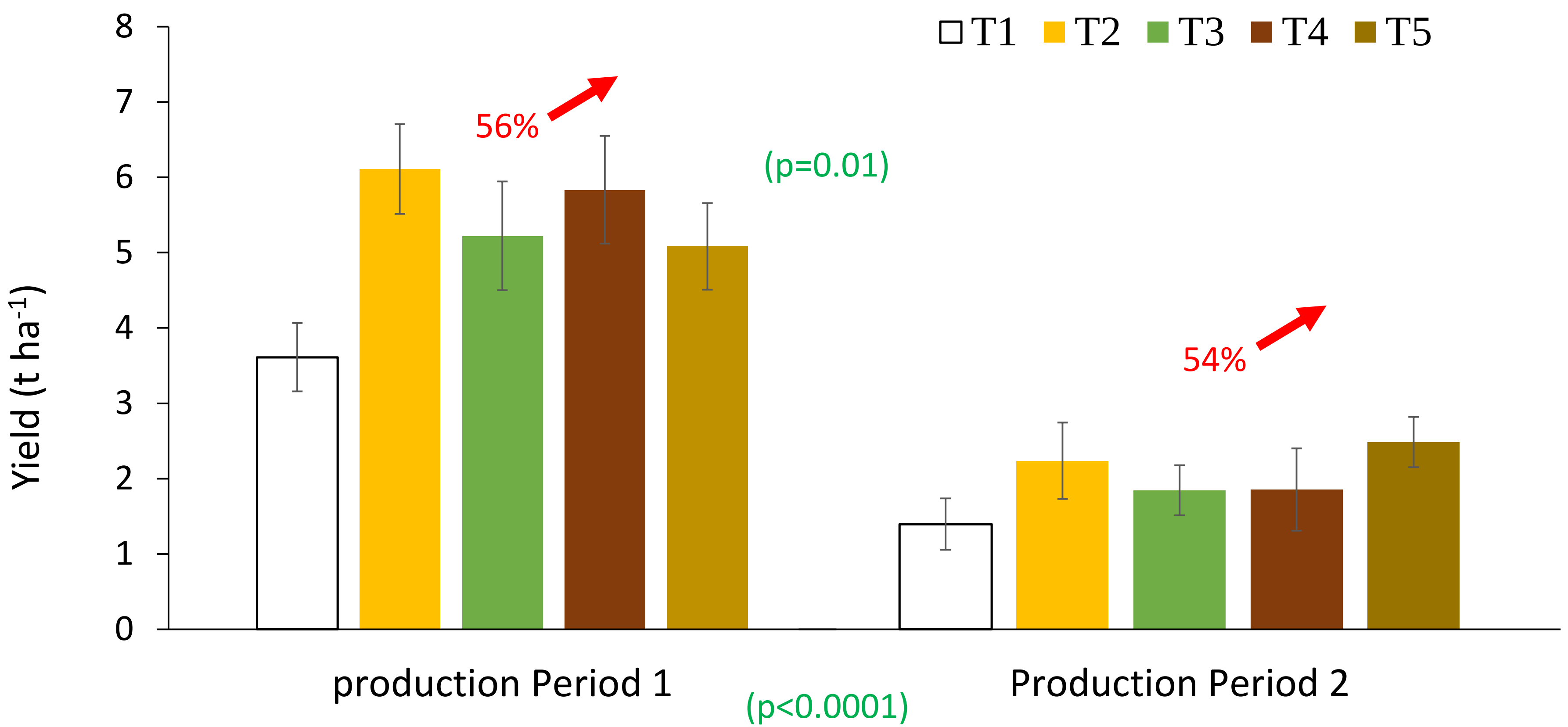


Fig.4. Effect of biochar and its type on maize yield during each production period

Fertilizers applied in all plots
T2= Corncob biochar (CCB)
T3= Eucalyptus biochar (EB)

T1 = Straw
T4 = Straw + CCB
T5 = Straw + EB

- ❑ Both biochars applied at the rate of 15 t ha^{-1} had no significant effect on bulk density, porosity, hydraulic conductivity, available water content, water content at saturation and residual water content

- ❑ Flat plots had higher residual water content and water content at saturation compared to furrow-ridges plots

- ❑ During the second production period, porosity decreased; soil air entry point (α) and available water content increased compared to the first period

1. In the short run, farmers should not expect:

   a. Significant effect of low temperature biochars (250-300°C) on available water content in well drained oxisols with around 5% organic matter

      - Initial high hydrophobicity of such biochar
      - Initial high porosity of the soil.

   b. Significant difference in using straw instead of biochars or the combination of both in furrow-ridges, as far as soil available water content is concerned

2. In the short run, farmers:
   a. Should not expect a different effect of biochar on soil physical parameters relatively to the tillage mode
      - Thus, either tillage mode could be used with biochar by local producers, according to the topography of their land and their level of mechanization

   b. Should expect significant increase in maize yield following biochar application for at least 2 production periods
      - This could be due mainly to changes in soil chemical parameters

1. Biochar used was of similar size as soil particles, only one dose, manufactured at low temperature and tested in a relative short time frame
   - ***Effect of biochar particle size and dose in the short and long term***
   - ***Effect of size and doses of medium to high temperature origin biochar***

2. No difference observed in using straw instead of biochars or the combination of both in furrow-ridges with reference to soil AWC
   - ***Fate of biochar carbon in oxisols on GHG emissions in the short and long term (****reported carbon sequestration could potentially justify the use of biochar instead of straw****)***

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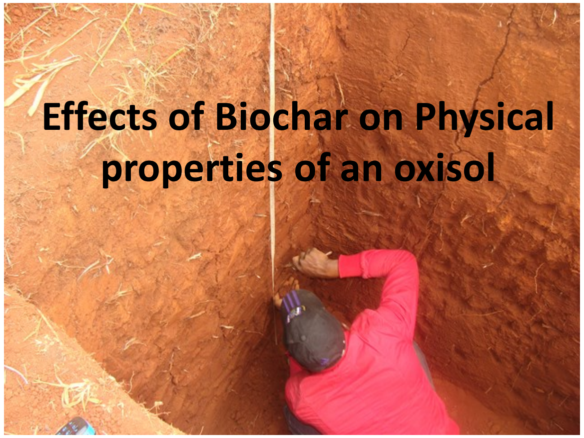
Thank you!

Questions



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