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Effects of straw biochar on the growth of flue-cured tobacco and soil fertility

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Outlines

- **Introduction**
- **Materials**
- **Results**
- **Conclusions**
- **Further study**

Introduction



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❖ According to preliminary statistics, China produces 0.6-0.7 billion tons of straw each year, accounting for 30% of the world annual production, of which more than 50% are directly burned in the field, abandoned at the edge of the field, or combusted as cooking and heating fuel.

Straw burning in the field is very common in China



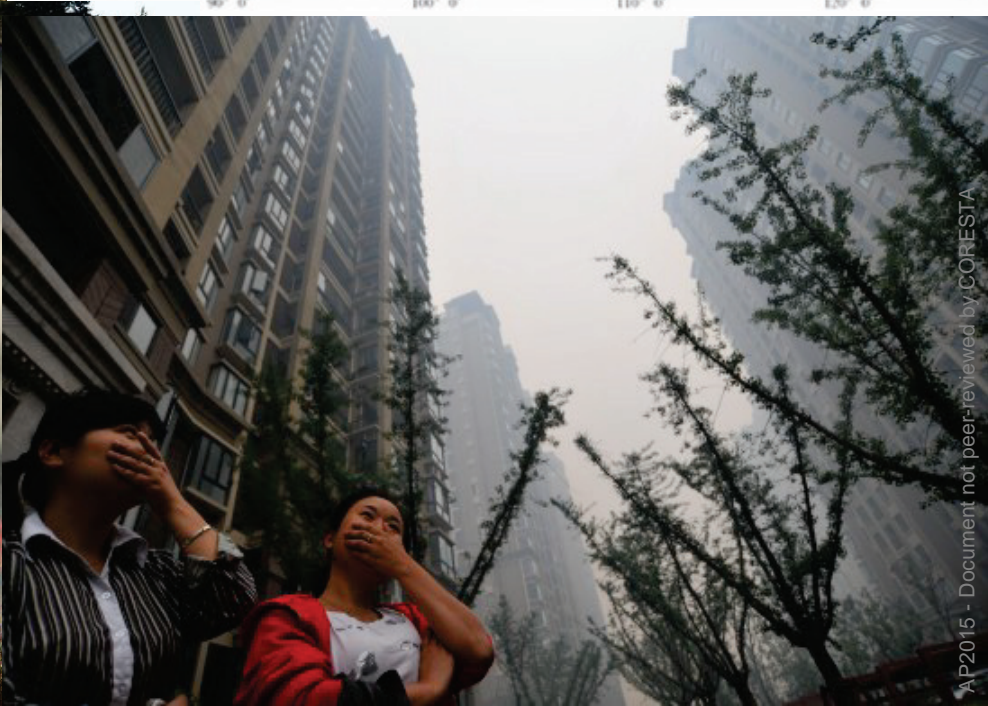
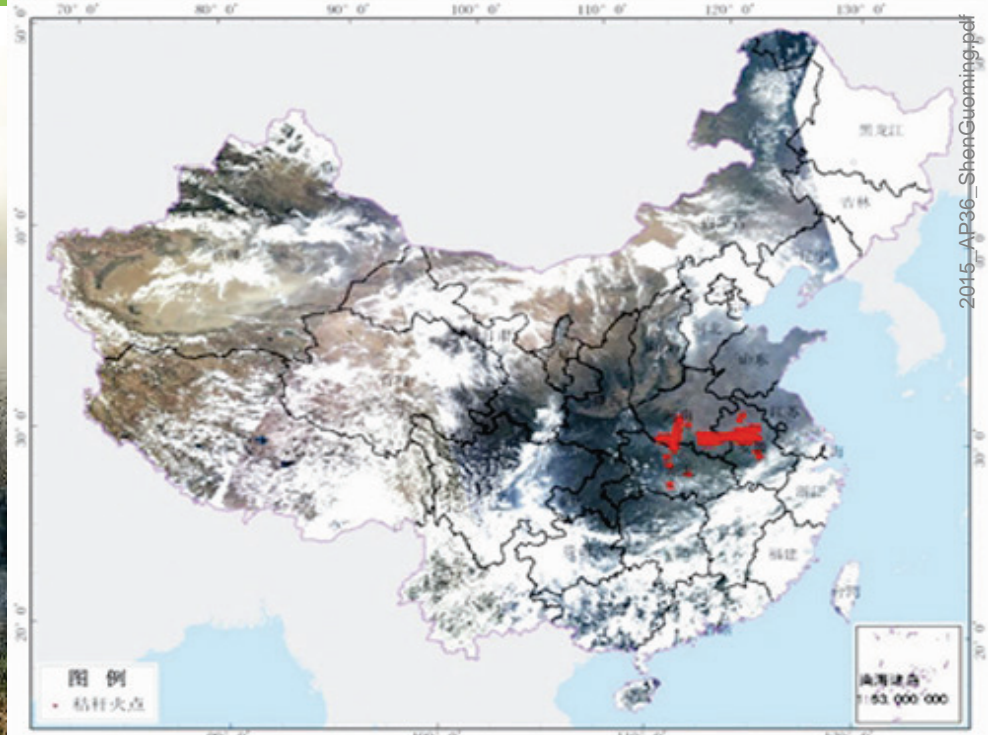


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The straw burning is not only a great waste of natural resources but also a significant source of air pollution, which will lead to forest fire, highway traffic accident and respiratory disease.





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Now, the comprehensive utilization of crop straw is causing more and more attention in China.

And the conversion of crop straw into biochar could be a beneficial soil amendment as a novel crop straw management .



Straw returning



Straw feed



Straw biofuel

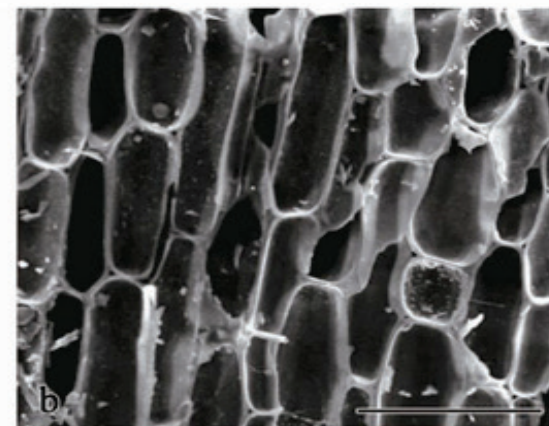
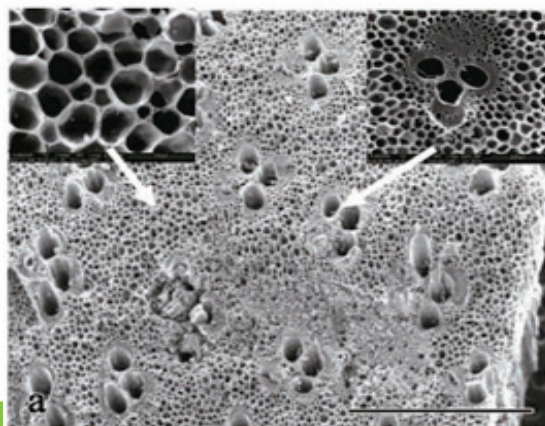
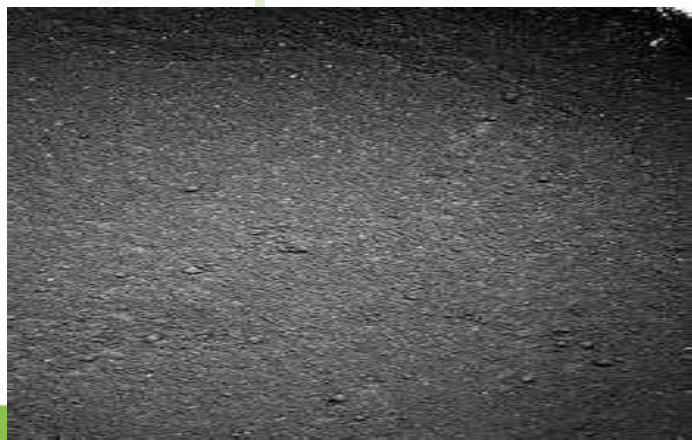


Straw biochar



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- **Biochar is rich in carbon, and has good poroid structure, large porosity, and surface area. These properties make biochar an excellent material for use in agricultural production and environmental protection**
- **The beneficial effect of biochar on the physical and chemical properties of soil helps to improve the soil's ecological function, which has great significance in promoting crop growth and development.**





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- Many studies show that application of biochar in field causes increase in the growth and yield of crops such as corn, wheat and rice to different extents.
- Currently there is little knowledge on the effect of straw biochar on tobacco growth, development and on soil properties.
- Hence, The objectives of the study was to investigate the effect of different amounts of straw biochar on the growth and development of flue-cured tobacco in aboveground and underground and soil fertility.



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Materials and Methods

- ◆ Pot experiments were conducted in the greenhouse of the "Qing Jiang Yuan" modern tobacco agriculture science and Technology Park in Enshi, Hubei province, in 2013.
- ◆ The soil type used was yellow brown soil.

The physical and chemical properties of the soil

pH [⊃]	organic matter g/kg [⊃]	alkali-hydrolysable nitrogen [⊃] mg/kg [⊃]	available phosphorus [⊃] mg/kg [⊃]	available potassium mg/kg [⊃]
6.9 [⊃]	19.23 [⊃]	85.37 [⊃]	62.70 [⊃]	318.67 [⊃]

- ◆ The flue-cured tobacco variety was Yunyan 87.



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The biochar was derived at 550 °C for 8 h from rice straw. Its physical and chemical properties were as follows:

pH [⊃]	total carbon content [⊃] g/kg [⊃]	total nitrogen content [⊃] g/kg [⊃]	ash content g/kg [⊃]	total potassium g/kg [⊃]	total phosphorus g/kg [⊃]
9.20 [⊃]	630 [⊃]	13.5 [⊃]	140 [⊃]	21.5 [⊃]	4.50 [⊃]

Biochar was thoroughly mixed with the soil and fertilizer on a plastic film, sieved to 2-mm mesh, and then carried out the pot experiment



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Experimental Design

- ❖ For the pot experiment, four treatments were designed with straw biochar at different application levels, each one repeated 15 times. The treatments were as follows:

T0: no biochar (0 g/kg dry soil)

T1: 0.2% biochar (2 g biochar/kg dry soil)

T2: 1.0% biochar (10 g biochar/kg dry soil)

T3: 5.0% biochar (50 g biochar/kg dry soil)



Results and Discussion



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❖ The effects of straw biochar on tobacco agronomic traits

Adding moderate amount of biochar (0.2-1.0%) in soil contributes to the growth of tobacco, while higher content of biochar negatively affects the growth of tobacco.

Table.1 Effect of biochar on agronomic traits of tobacco at the resetting stage

Treatments	Height (cm)	Productive Leaves (slice)	Maximal Leaf Area (cm ²)
T0	21.00ab	10.67a	371.56b
T1	21.83a	10.00a	404.94a
T2	18.50bc	10.00a	382.13ab
T3	16.67c	9.67a	351.82c

Different lowercase alphabets in the same column indicate significant difference ($p < 0.05$).



T0



T1



T2



T3



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Table.2 Effect of biochar on agronomic traits of tobacco at the squaring stage

Treatments	Height (cm)	Productive Leaves (slice)	Lower leaf	Middle leaf	upper leaf
			Leaf Area (cm ²)		
T0	132.33a	24.67b	831.99b	1005.72ab	201.80b
T1	135.67a	26.00a	846.07b	997.61b	190.95b
T2	135.33a	24.33b	947.41a	1049.94a	249.52a
T3	117.33b	23.00bc	763.65bc	884.44c	201.85b

Different lowercase alphabets in the same column indicate significant difference ($p < 0.05$).



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❖ Effects of straw biochar on growth and development of tobacco roots

During the early growth stage, there were no significant differences of root growth among the treatments.

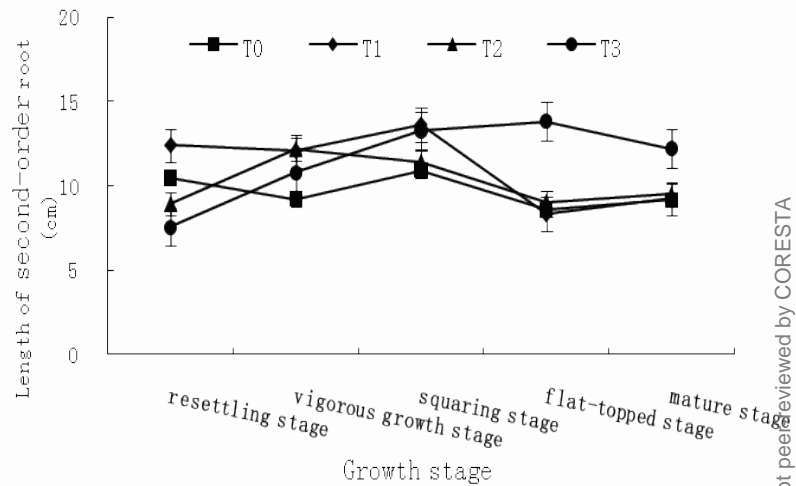
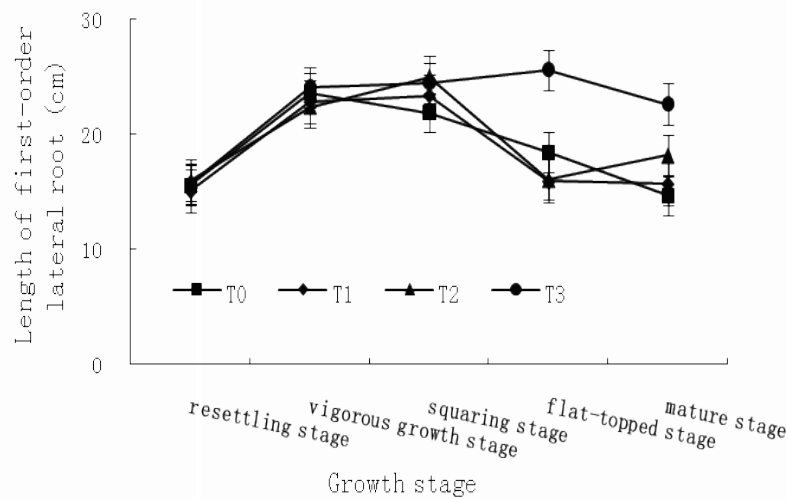
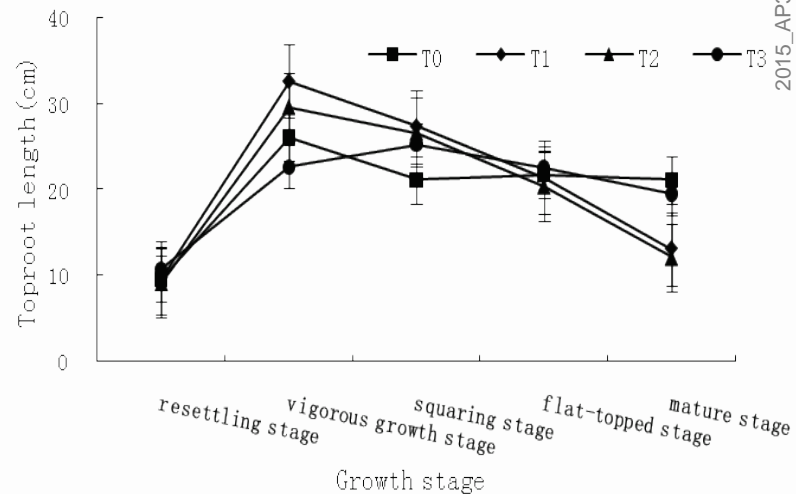
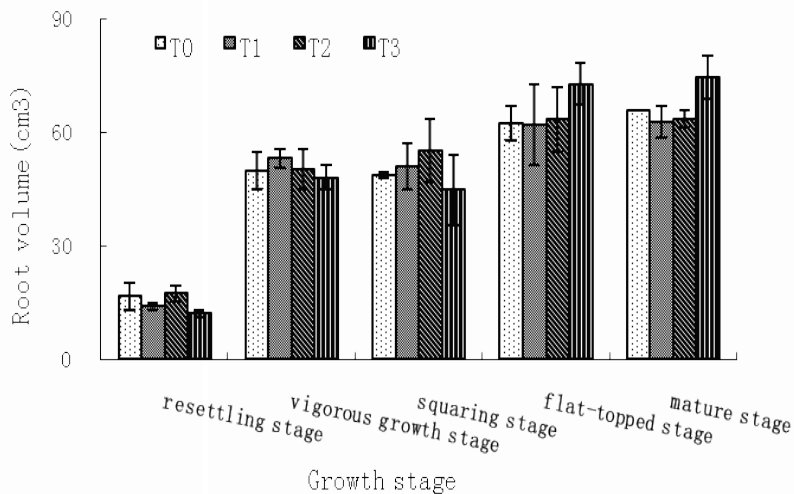
While towards the latter periods of growth, the biochar treatments, especially the T3 treatment increased the root volume, promoted the growth of first and second order lateral roots, and delayed the senility of the whole root system.



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Growth and development of tobacco root system in different growth stage



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❖ **Effects of straw biochar on tobacco biomass**

Biochar addition could regulate the root-shoot ratio. And the appropriate amount of biochar (0.2%–1%) addition can promote the growth of aboveground and underground organs of tobacco.

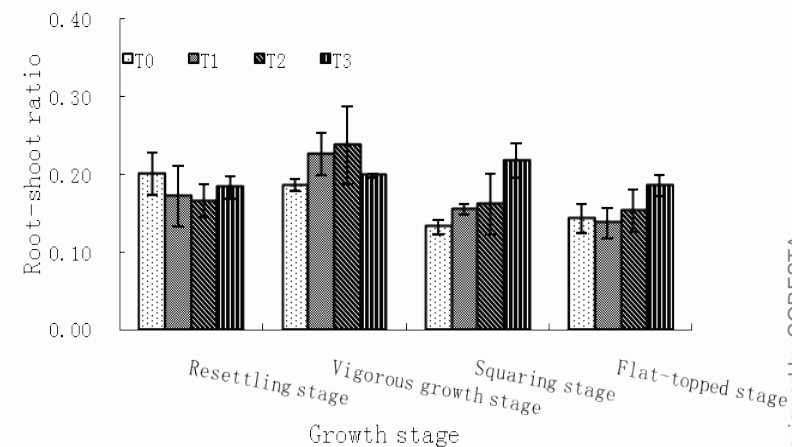
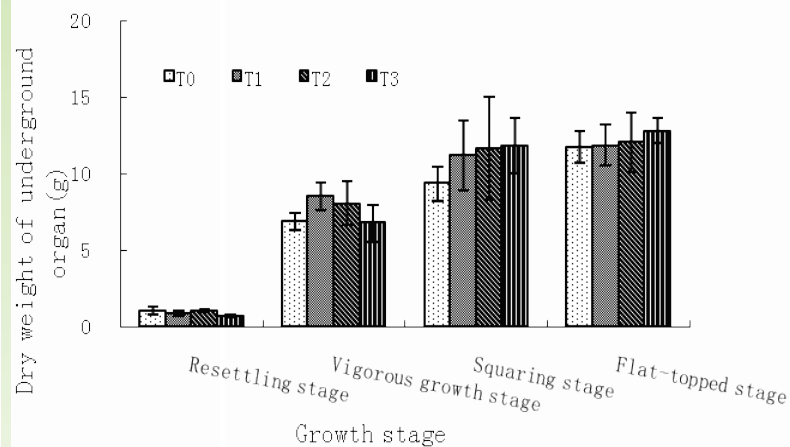
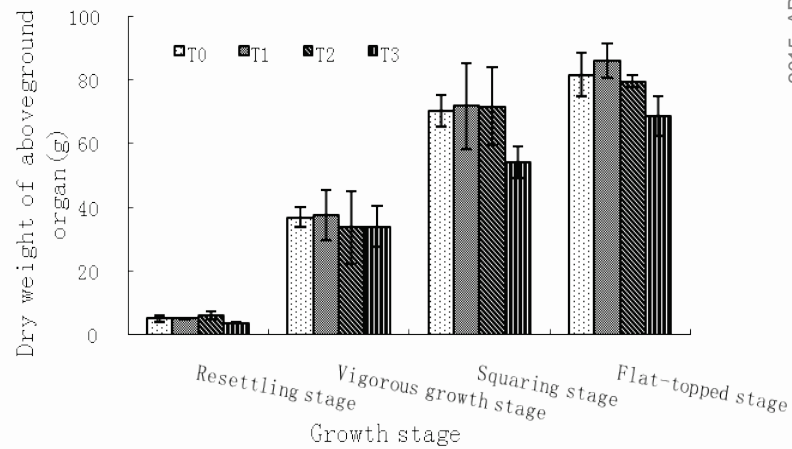
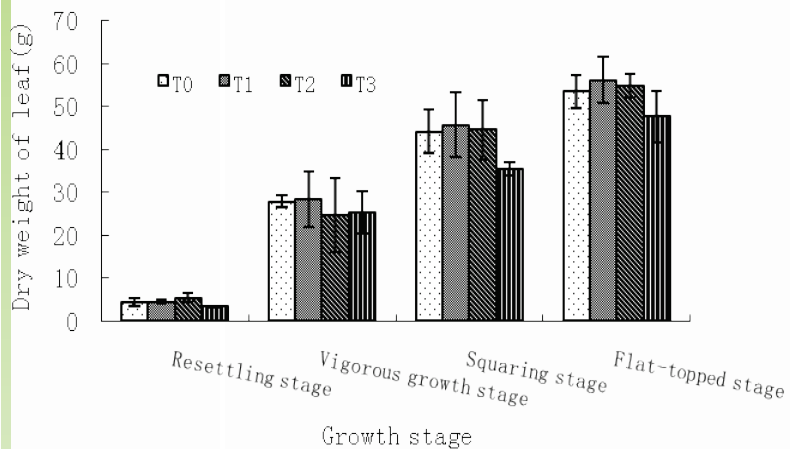
While the growth of aboveground organs of tobacco is inhibited by higher quantities of biochar (5%).



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The biomass of different organs of tobacco and the root-shoot ratio during different growth stages



 **T0**
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T1

T2

T3



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❖ Effects of straw biochar application on soil bulk density

Biochar addition could reduce the soil bulk density to some extent, but addition of a small quantity has no significant effect.

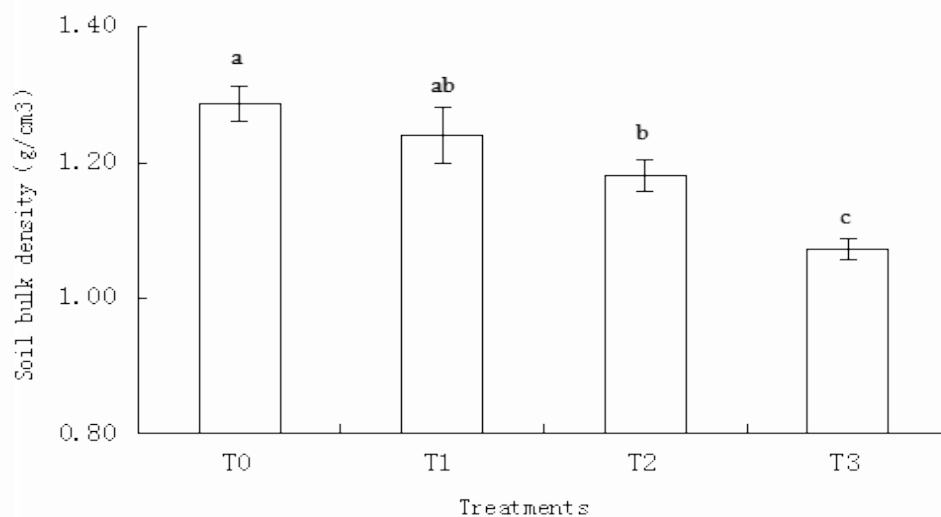


Fig.3 Effects of straw biochar application rate on soil bulk density



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❖ Effects of straw biochar on soil nutrients

The soil nutrients of pH, organic carbon, alkali-hydrolysable N, available P and available K were all increased with the amount of straw biochar added.

Soil nutrients for different treatments at tobacco mature stage

treatment	pH	Organic Carbon (g/kg)	Alkali-hydrolysable Nitrogen(mg/kg)	Available P(mg/kg)	Available K(mg/kg)
T0	6.38c	10.94c	92.18c	81.97c	695.49d
T1	6.56c	12.32bc	105.48c	87.40bc	994.16c
T2	7.12b	13.00b	124.09b	92.26b	1373.12b
T3	7.72a	43.92a	140.05a	118.88a	2352.77a

Different lowercase alphabets in the same column indicate significant difference ($p < 0.05$).



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Conclusions

- Addition of suitable amount of biochar to soil (0.2-1.0%) contributed to the growth of tobacco, but inhibited its growth when higher amounts were added (5%).
- Different amounts of biochar application could promote the growth of the tobacco root system. The root-shoot ratio was highest and the recession process of lateral roots and the whole root system was delayed at later growth stage when biochar is added at 5%.



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- **Soil pH, organic carbon and available soil nutrients increased, and soil bulk density decreased with the increase amount of biochar addition.**
- **Addition of appropriate amount of biochar (0.2-1.0%) not only promoted the growth of the aboveground and underground parts of tobacco, but also improved soil fertility in the tobacco pot experiment.**



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Further study

- **Field experiment should be conducted to study the effect of biochar on quality of tobacco in further study**
- **The biological mechanism of improving soil nutrient utilization by biochar also should be studied in the future.**

THANKS !

