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The impact of application of biocar on peanuts growing

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Abstract. The object of this study was to investigate the impact of application biocar on peanuts growing. It was based on a long-term fertilization experiment which researched the effect of applying different amounts of biochar and BBF when continuously cropping peanuts for 5 years. There were five treatments: no fertilizer, low level of biochar (C15), high level of biochar (C50), chemical nitrogen–phosphorus–potassium (NPK) fertilizer and biochar-based fertilization (BBF).We determined peanuts stem and leaf weight, root weight, plant and the relative content of chlorophyll at every growth stages in 2016. The results showed that all fertilization can increase these indexes and in application of NPK improve them the most which close to BBF. The peanuts stem and leaf weight, root weight, plant and the relative content of chlorophyll was higher than the same level carbon treatment (C15) 62.85%, 6.67%, 18.73% and 25.58%, respectively. Expect stem and leaf weight, plant height, root weight and chlorophyll were higher when high level biochar (C50) applied than the low one (C15).

1. Introduction

Biochar, a solid elemental carbonaceous material, from the thermochemical conversion of biomass in an oxygen-limited environment, is a much more durable form of carbon than parent plant biomass or most forms of carbon in soil organic matter [1.2] Biochar contains a large amount of carbon-containing substances and is manufactured by the thermal cracking of biomass such as agricultural and forestry wastes in oxygen-deficient conditions. It has high carbon content, abundant soil pore space, a large specific surface area, and stable physical and chemical properties [3]. The abundant soil pore space provides good protection for the breeding of microorganisms [4]. Different types and constituents of substances that are adsorbed and stored in the pore space can provide adequate sources of nutrition for soil microorganisms [5, 6]. Biochar has been described as a possible means to improve soil fertility as well as other ecosystem services and sequester carbon to mitigate climate change [7, 8]. However, biochar has also been shown to change soil biological community composition and abundance [9]. Such changes may well have effects on nutrient cycles [10] or soil structure [11] and, thereby, indirectly affect plant growth [12]. Biochar-based fertilizer (BBF) is an exclusive slow-release complex fertilizer, which is produced by the incomplete combustion of fodder, corncobs, peanut shells, and agricultural in anaerobic conditions with an admixture of different proportions of nutrients [13].BBF can slowly fertilization release to decreased fertilization waste and adjust soil pH. At same times, BBF can improve

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soil temperature. It was help to peanuts growth such as ratio of seeding improvement [14].This research aimed to study the influence of biochar and biochar-based fertilization to peanuts stem, leaf, root, plant height and chlorophyll.

2. Materials and methods

The long-term experiment was located in Liaoning Province at the Shenyang Agricultural University Peanut Scientific Research Center (40 °48'N, 123 °33' E). The soil at the experimental site was a brown soil classified as an alfisol, with hydromica as a dominant clay mineral. This experiment began in 2011 and the basic physical and chemical properties are detailed in Table 1.

Table 1 Basic properties of soil at the beginning of the experiment

Soil layer (cm)	Organic matter (g/kg)	Total N (g/kg)	Total P (g/kg)	Total K (g/kg)	Available N (mg/kg)	Available P (mg/kg)	Available K (mg/kg)	pH
0–20	13.1	0.53	0.67	18.8	56.2	12.5	89.6	6.81

The experimental field cropping system consisted of one annual crop of peanuts in continuous cultivation and the cultivar was Huayu33. The planting density was 30000/hm^2. Five treatments (three replicates each) were established in 2011 using a randomized block design in 15 plots (6 × 4.5 m). The ridging spacing was 90 cm and two lines of peanuts were planted. The distance between rows was 30 cm and the plant spacing was 15cm.All fertilizers were applied to the soil at one time in strip-till planting at a depth of 15–20cm.

Five treatments (three replicates each) were established in 2011 and end in 2016. There were 5 treatments: no fertilization (CK), low levels of biochar (C15, 225 kg/hm^2), high levels of biochar (C50, 750 kg/hm^2), chemical fertilizer (NPK, 82.5 kg/hm^2 N, 82.5 kg/hm^2 P_2O_5, and 97.5 kg/hm^2 K_2O), and biochar-based fertilzier (BBF, C 6.6%, N-P_2O_5-K_2O 11-11-13, 750 kg/hm^2). The carbon content with BBF treatment was the same as with C15 treatment and the NPK number with BBF treatment was the same as with NPK treatment.

The stem, leaf and root weight were determined after every sampling and cleaned, dried and weighted them. The plant height referred to the height of main stem. The chlorophyll was relative value. It was measured by Portable chlorophyll meter (CCM-200).

3. Results and discussion

3.1. Stem and leaf

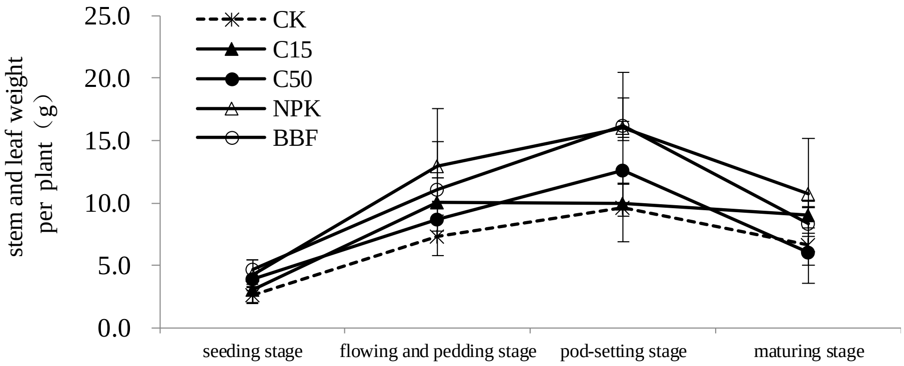

Figure 1. Stem and leaf weight per plant in different stages with different fertilization applied

The stem and leaf weight per plant reached the highest in pod-setting stage no matter what fertilization applied expect C15. The pod-setting stage peanuts growth had seriously relationship with yield. Comparison with all treatments, BBF's stem and leaf weight was the highest which was 16.22g higher than the same level of carbon treatment (C15) 62.85% and the same level nutrient treatment (NPK) only 0.12%. However, application of NPK average of all stages stem and leaf weight was the highest which was 10.99g higher than BBF 9.14%. The stem and leaf weight per plant of C50 treatment was higher than C15 26.20% in pod-setting stage but the average of all stages with C15 applied was higher 2.81%. In comparison with all biochar fertilization treatment and CK, all fertilizer can improve stem and leaf weight. It showed that biochar can help to peanuts growth.

There were some research studied why microorganism occurrence directly effects on plant growth. For example, Graber et al.[15]demonstrated through phylogenetic characterization of bacterial isolates based on 16S rRNA gene analysis that of the 20 unique identified isolates from the biochar-amended growing media cropped to pepper and onion, 16 were affiliated with previously described plant-growth-promoting and biocontrol agents. The Genus Trichoderma, known for including plant-growth-promoting species, was only isolated from the rhizosphere of pepper when biochar had been added. A possible explanation for the observed greater crop growth observed by Graber was therefore the promotion of beneficial microorganisms in the rhizospherer.

3.2. Root

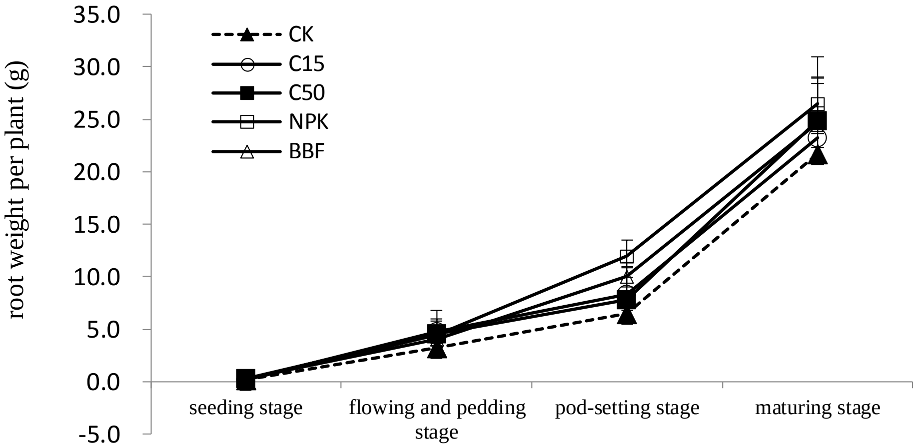

Figure 2. Root weight per plant in different stages with different fertilization applied

The root weight per plant was heavier with peanuts growing in all treatments and reached the heaviest in maturing stage. It increased from 0.23g to 10.87g when NPK applied which was the most. In comparison with the same level nutrient treatment (BBF) increased by 7.50%. In application of BBF increased by 6.67% average root weight in four stages compared to C15. Compared to the application of C15, the extent of C50 root weight increasing was higher 6.72%. It showed that high level biochar more effectively improved root weight. No matter what kind of fertilizations applied, per plant root weight was higher than no fertilization applied. It proved that fertilization promote root growth.

The reasons for changes in root growth are rarely well identified in existing studies, and will likely vary depending on biochar properties and the conditions that restrict root and shoot growth in different soil environments. Biochar with properties that improve the chemical and physical characteristics of a given soil such as nutrient or water availability, pH, or aeration will likely improve root growth [16].

3.3. *Plant height*

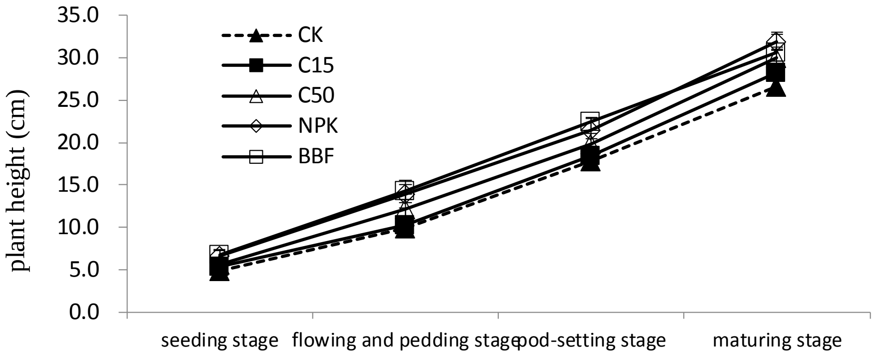

Figure 3. Plant height in different stages with different fertilization applied

The plant heights were higher and higher with peanuts growing in all treatments and reached the heaviest in maturing stage. It increased 3.79 times from seeding stage to maturing stage when only NPK fertilization applied in soil and it closely with BBF treatment which increased 3.55 times. In comparison with C15, the average of plant height increased by 6.67% when BBF applied in soil. The average plant height in different stage was highest with BBF applied which was 18.51cm. It was higher than the application of chemical fertilization (NPK) only 0.1cm. In comparison with C15 and C50, the plant height was higher 6.39% when high level of biochar applied in soil.

3.4. *Chlorophyll*

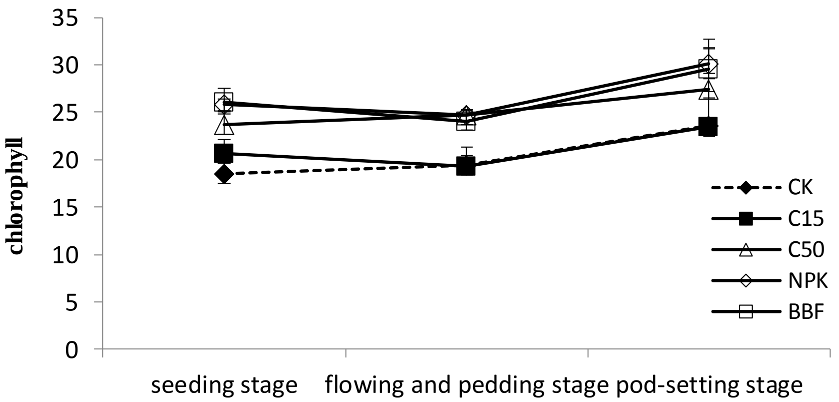

Figure 4. Chlorophyll in different stages with different fertilization applied

The chlorophyll was the lowest in flowing and pedding stage and the highest in pod-setting stage no matter what fertilizer. The application of no fertilization had the lowest average chlorophyll from all growth stages. At pod-setting stage, it reached the highest chlorophyll content when NPK applied. It was 30.09 and increased by 1.79% compared with the same level nutrient treatment (BBF). However, in comparison with the same level carbon treatment (C15), the chlorophyll improved by 25.58% when BBF applied in soil. The application of low high biochar carbon (C50) increased the average chlorophyll of tree stages by19.57% compared with low level biochar carbon treatment (C15). BBF can increase chlorophyll maybe because there are many nutrient in BBF such as major element N, P, K and medium element Mg, Ca which are good for peanuts growing. Especially, Mg is the main component of chlorophyll.

4. Conclusion

Fertilizer can increase peanuts stem, leaf and root weight, plant height and chlorophyll. The average of all indexes at different stages was the highest in application of chemical fertilization. The peanuts stem, leaf and root weight, plant height and chlorophyll in different stages when BBF applied in soil were close to NPK and higher than the same level carbon treatment (C15).Expect stem and leaf weight, plant height, root weight and chlorophyll were higher when high level biochar (C50) applied than the low one (C15).

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