Effects of Biochar on Ca, Mg and B Uptake of Peach Seedlings

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Abstract. A pot experiment was conducted to study the effects of different biochar types [addition of rape straw biochar (RB), addition of paddy straw biochar (PB), addition of wheat straw biochar (WB) and addition of corn straw biochar (MB)] on the absorption of Ca, Mg and B in peach seedlings. The result showed that compared to the control, all treatments added with biochar significantly decreased the Ca content in roots in peach seedlings. The Ca content in stems and leaves under the treatment of RB and PB in peach seedlings was higher than the control. The Mg content in roots and stems under the treatment of PB in peach seedlings was higher than the control. The Mg content in leaves in peach seedlings of all treatments added with biochar was lower than the control. The B content in roots, stems and leaves under the treatment of PB, WB and MB in peach seedlings was higher than the control and the B content under the treatment of PB was at a higher level. Therefore, the treatment of PB was beneficial to the absorption of trace elements in peach seedlings.

1 Introduction

Biochar is a fine-grained and porous carbon material obtained by pyrolysis of organic materials such as crop straw, sawdust and animal manure under hypoxic or anaerobic conditions [1]. Many studies at home and abroad have shown that biochar has broad application prospects in improving soil physical and chemical properties and increasing crop yield [2]. The study shows that biochar can increase soil water holding capacity in the field, which is conducive to plant growth and soil nutrient conservation [3]. And the yield of rice and the number of spikelets per spike, grain number per panicle and seed setting rate are increased by treated with biochar. The average yield increases by 25.28% compared with the control [4]. Biochar could significantly reduce the leaching loss of soil phosphorus, promote plant uptake and growth of phosphorus, and improve the bioavailability of soil phosphorus [5-7]. The application of biochar in tropical and subtropical areas shows that the application of biochar not only increases the yield of soybean and maize, but also significantly increases the content in Mg and Ca in plants [8]. In this experiment, peach seedlings was used as the research object to study the effect of biochar on absorption of Ca, Mg and B in peach seedlings after applying four different straw biochar, so as to select the biochar which is beneficial to the absorption of trace elements in peach seedlings.

2 Materials and methods

2.1 Materials

Peach seeds were purchased from a market in Chengdu, Sichuan, China. Non-polluted soil was collected from the Chengdu campus of Sichuan Agricultural University (30°42'N, 103°51'E) in Chengdu, Sichuan, China. The basic soil properties were as follows: pH, 7.71; organic matter content, 15.29 g/kg; alkaline nitrogen content, 87.99 mg/kg; available phosphorus content, 55.77 mg/kg; and available potassium content, 41.96 mg/kg. The basic physical and chemical properties of the soil were based on references [9]. The rape straw, paddy straw, wheat straw and corn straw were collected in farmland around Sichuan Agricultural University. The straw was dried, cut and put into the muffle furnace, and carbonized at 500 degrees for two hours to produce biochar.

2.2 Experimental design

The Experiment was conducted in a greenhouse at the Chengdu campus of Sichuan Agricultural University from April to June 2019. In April 2019, peach seeds were sown in perlite while watering them in time to keep them moist. In April 2019, the soil was air-dried, ground and passed through a 5-mm sieve and each plastic pot (15 cm high, 18 cm in diameter) was filled with 3 kg of ground soil. There were five treatments in the experiment, including addition of rape straw biochar (RB), addition of paddy straw biochar (PB), addition of wheat straw biochar (WB), addition of corn straw biochar (MB) and no addition (CK). The proportion of adding biochar to soil in each pot was 10 g/kg, and it was blended. All pots were watered every day to keep the soil moist. In April 2019, three uniformly growing seedlings until the seedlings reached a height of 10 cm (with about seven true leaves) were transplanted into the previously

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prepared plastic pots. All pots were watered every day to keep soil moisture at 80%. Each treatment was repeated three times, completely randomized block arrangement until the plants were harvested. After 1 month, the roots, stem, and leaves of each plant were separately harvested, washed with tap water, and rinsed three times with deionized water. The plant materials were blanched at 110 °C for 15 min, dried at 75 °C until reaching a constant weight, and weighed, and crushed, which was used to determine the Ca, Mg and B content in various parts of peach seedlings [10].

2.3 Statistical analyses

Statistical analysis was carried out by using SPSS 18.0 statistical software. The data were analyzed by one-way ANOVA, with the least significant difference at the 5% confidence level.

3 Results and discussion

3.1 Effects of biochar on absorption of Ca in peach seedlings

Table 1. Effects of biochar on absorption of Ca in peach seedlings

Treatments	Roots (mg/g)	Stems (mg/g)	Leaves (mg/g)
CK	12.67±0.45a	9.49±0.49d	17.01±1.03c
RB	10.55±0.66b	15.94±0.90a	24.14±2.08b
PB	11.97±0.76ab	13.38±0.90b	30.26±1.23a
WB	10.63±0.93b	8.16±0.38d	18.86±1.52c
MB	11.95±0.24ab	11.58±0.08c	16.22±0.22c

Value are means ± standard errors. Means with the same letter within each column are not significantly different at $p < 0.05$. RB = addition of rape straw biochar, PB = addition of paddy straw biochar, WB = addition of wheat straw biochar, MB = addition of corn straw biochar.

Compared to the control, all treatments added with biochar significantly decreased the Ca content in roots in peach seedlings and the Ca content in roots in peach seedlings were 16.73%, 5.85%, 16.1% and 6.03%, respectively, lower than the control (Table 1). The Ca content in stems in peach seedlings was significant difference between the treatment of adding biochar and the control except for the treatment of WB. The Ca content in stems in peach seedlings increased by 67.97%, 40.99% and 22.02% under the treatment of RB, PB and MB compared with the control, respectively. The Ca content in leaves in peach seedlings increased by 41.92%, and 77.90% under the treatment of RB and PB compared with the control, respectively.

3.2 Effects of biochar on absorption of Mg in peach seedlings

The Mg content in roots, stems and leaves of peach seedlings all treatments added with biochar was significant difference compared with control (Table 2). Compared to the control, all treatments added with biochar significantly increased the Mg content in roots in peach seedlings and the Mg content in roots in peach seedlings were 8.87%, 35.17%, 33.18% and 108.41%, respectively, higher than the control. The Mg content in stems in peach seedlings increased by 8.14% under the treatment of PB compared with the control. On the contrary, the Mg content in stems in peach seedlings decreased by 12.68%, 32.62% and 17.6% under the treatment of RB, WB and MB compared with the control, respectively. The Mg content in leaves in peach seedlings of all treatments added with biochar was lower than control and the Mg content in leaves in peach seedlings decreased by 38%, 73.3%, 31.49% and 30.27% under the treatment of RB, PB, WB and MB compared with the control, respectively.

Table 2. Effects of biochar on absorption of Mg in peach seedlings

Treatments	Roots (mg/g)	Stems (mg/g)	Leaves (mg/g)
CK	6.54±0.38c	13.64±0.31b	30.26±0.94a
RB	7.12±0.10c	11.91±0.74c	18.76±0.66c
PB	8.84±0.26b	14.75±0.04a	8.08±0.39d
WB	8.71±0.89b	9.19±0.46d	20.73±0.61bc
MB	13.63±0.26a	11.24±0.22c	21.10±1.29b

Value are means ± standard errors. Means with the same letter within each column are not significantly different at $p < 0.05$. RB = addition of rape straw biochar, PB = addition of paddy straw biochar, WB = addition of wheat straw biochar, MB = addition of corn straw biochar.

3.3 Effects of biochar on absorption of B in peach seedlings

Table 3. Effects of biochar on absorption of B in peach seedlings

Treatments	Roots ($\mu\text{g/g}$)	Stems ($\mu\text{g/g}$)	Leaves ($\mu\text{g/g}$)
CK	52.97 $\pm$ 1.20c	57.66 $\pm$ 2.37c	57.37 $\pm$ 1.74c
RB	52.70 $\pm$ 1.55c	53.36 $\pm$ 2.41c	49.82 $\pm$ 3.00d
PB	55.27 $\pm$ 1.72bc	79.12 $\pm$ 2.24a	89.37 $\pm$ 2.04a
WB	59.72 $\pm$ 1.52a	59.68 $\pm$ 1.41c	62.34 $\pm$ 1.92bc
MB	57.84 $\pm$ 1.28ab	72.22 $\pm$ 3.78b	67.04 $\pm$ 1.30b

Value are means $\pm$ standard errors. Means with the same letter within each column are not significantly different at $p < 0.05$. RB = addition of rape straw biochar, PB = addition of paddy straw biochar, WB = addition of wheat straw biochar, MB = addition of corn straw biochar.

The B content in roots, stems and leaves in peach seedlings under the treatment of RB was all lower than the control (Table 3). On the contrary, the B content in roots, stems and leaves in peach seedlings under the other treatments added with biochar was higher than the control. The B content in roots in peach seedlings increased by 12.94%, and 9.2% under the treatment of WB and MB compared with the control, respectively. The B content in stems in peach seedlings of the treatment of PB and MB was higher than the control and the B content in stems in peach seedlings increased by 37.22% and 25.25% under the treatment of PB and MB compared with the control, respectively. Compared to the control, the treatment of PB, WB and MB significantly increased the B content in leaves in peach seedlings and the B content in leaves in peach seedlings were 8.87%, 35.17%, 33.18% and 108.41%, respectively, higher than the control.

4 Conclusions

According to the experiment, the Ca content in roots in peach seedlings of all treatments added with biochar was lower than the control. The Ca content in stems and leaves under the treatment of RB and PB in peach seedlings was higher than the control. The Mg content in roots and stems under the treatment of PB in peach seedlings was higher than the control. However, the Mg content in leaves in peach seedlings of all treatments added with biochar was lower than the control. The B content in roots, stems and leaves under the treatment of PB, WB and MB in peach seedlings was higher than the control and the B content in treatment of PB was at a higher level. Therefore, the treatment of PB was beneficial to the absorption of trace elements in peach seedlings.

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