Effects of Biochar on Absorption of Iron, Sodium and Manganese in Peach Seedlings

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Abstract. An experiment was conducted to study the effect of biochar on absorption of iron (Fe), sodium (Na) and manganese (Mn) in peach. The results showed that compared with the control (CK), the Fe content of roots in wheat straw biochar addition (WB), corn straw biochar addition (MB) and the Fe content of leaves in paddy straw biochar addition (PB) remarkably increased by 244.8\%, 265.2\% and 28.3\% respectively, and other treatments had no pronounced differences or apparently decreased. Biochar treatments significantly reduced the Na content of roots and significantly increased the Na content of stems and leaves with the exception of rape straw biochar addition (RB). RB and PB caused a significant decrease of the Mn content of roots and stems, expect for the Mn content of stems in RB, RB and PB significantly increased the content of Mn in leaves. The Mn content of peach seedlings in WB and MB had opposite change with RB and PB. Stated thus, MB promoted the absorption of Fe by peach seedlings, and most Fe stored in roots. Biochar treatments promoted Na accumulation in stems and leaves. RB and PB promoted the accumulation of Mn in leaves, WB and MB promoted the accumulation of Mn in roots.

1. Introduction
Biochar is a carbonrich co-product of thermal degradation of biomass precursor material, intended for the use as a soil amendment which plays an important role in increasing soil carbon storage, improving soil fertility [1]. Biochar provides a stable and inert form of carbon sequestration which is potentially long-term and substantial, with a low risk of return into the atmosphere [2]. Soil incorporated biochars can improve soil fertility so that enhance plant growth. In general, biochar incorporation improves available nutrient content due to the abundant soluble mineral elements which formed in the process of biochar, addition of rice straw biochar was effective in enhancing the availability of phosphorus [3], and ash in miscanthus biochar rapidly releases K, Ca, and Mg ions into the soil solution and providing readily available nutrients for plant growth [4]. Also, rice husk biochar increased the growth of plant and changed the contents of leaf nutrients (calcium, magnesium, potassium, sodium, iron, manganese and zinc), the Ca content of mallow, the Mg content in cabbage, dill, and mallow, the Mn content in cabbage, dill, mallow and tatsoi, the content of Zn in cabbage, dill, and mallow were significantly increased, whereas the Na content was less in the leaves of cabbage and dill [5].

Application of biochars from different feedstocks may result in different absorption of trace elements in peach seedlings due to their different physicochemical properties [6]. Therefore, trace
elements (Fe, Na and Mn) in peach seedlings, following the addition of biochars from different feedstocks (rape straw biochar, paddy straw biochar, wheat straw biochar and corn straw biochar) were investigated in this study.

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 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 Experiments were conducted in a greenhouse at the Chengdu campus of Sichuan Agricultural University from April to July 2019. In April 2019, the plump seeds were surface-sterilized and sown in perlite and cover them with vermiculite, while watering them in time to keep them moist. In April 2019, the soil was air-dried, passed through a 5-mm sieve and each plastic pot (15 cm high, 18 cm in diameter) was filled with 3 kg air-dried soil. There were five treatments in the experiment, including rape straw biochar addition (RB), paddy straw biochar addition (PB), wheat straw biochar addition (WB), corn straw biochar addition (MB) and control (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 seedlings which germinated robustly in good trim, about 10 cm high (with about seven true leaves) were transplanted into the previously prepared plastic pots. The soil moisture content was maintained at 80% of field capacity. Each treatment was repeated three times, completely randomized block arrangement. The seedlings were experienced the treatments for one month, then harvested, the content of Fe, Na and Mn were determined as described by Hao et al. [7].

2.3. Statistical analysis
The data were used Microsoft Excel 2010 and DPS 7.5 software for statistical analysis, data analysis by one-way ANOVA with least significant difference at 5% confidence level.

3. Results and discussion

3.1. Fe content of peach seedlings
Fe contents in roots, stems, and leaves in peach seedlings was examined (Table 1). Different biochar treatments had different influences on Fe absorption of peach seedlings. The Fe content of roots in WB and MB remarkably increased by 244.8% and 265.2% respectively, compared with the CK, while the Fe content of roots in PB and RB was no significantly statistical difference. The Fe content of stems apparently decreased, except for MB. In all the treatments, there were no pronounced differences in Fe content of leaves, compared to CK, except the Fe content of leaves treated with PB was significantly higher than that of the CK.

3.2. Na content of peach seedlings
The variation trend of Na contents in roots, stems, and leaves in peach seedlings were different (Table 2). Compared to CK, biochar treatments significantly reduced the Na content of roots, expect for RB, the Na content of roots had no significant between RB and CK. While PB, WB and MB significantly increased the Na content of stems, and PB increased the most. And, all the biochar treatments significantly the Na content of leaves.
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3.3. biochar followed different treatments

Different lowercase letters indicate significant differences based on one-way analysis of variance in DPS 7.5 followed by the least significant difference test \((p < 0.05)\). Rape straw biochar abbreviated as RB, paddy straw biochar abbreviated as PB, wheat straw biochar abbreviated as WB, corn straw biochar abbreviated as MB.

3.3. Mn content of peach seedlings

The effects of different biochar on Mn uptake in peach seedlings were different (Table 3). Compared to CK, RB and PB caused a significant decrease of the Mn content of roots; the increase of the Mn content of roots was observed in WB and MB \((p<0.05)\). Compared with the CK, no significant difference was observed in Mn content of stems treated with RB, and PB and WB apparently decreased Mn content of stems, and MB was significant higher than that of other treatments. The Mn content of leaves was different from roots, the Mn content of leaf in RB and PB increased significantly, by 190.9 % and 163.6 % respectively, compared with the CK, while that in WB and MB decreased significantly.

4. Conclusions

Biochar treatments the effects of different biochar on Fe, Na and Mn uptake by peach seedlings are different. In PB, RB and WB, there were no pronounced differences in Fe content of roots leaves, except the Fe content of roots in WB and the Fe content of leaves in PB was significantly higher than that of the CK, the Fe content of stems apparently decreased. MB increased the Fe content of roots \((p<0.05)\).
< 0.05), stems (p > 0.05) and leaves (p > 0.05). All the biochar treatments significantly reduced the Na content of roots and significantly increased the Na content of stems and leaves with the exception of RB, the Na content of roots and stems had no significant between RB and CK. RB and PB caused a significant decrease of the Mn content of roots and stems, expect for the Mn content of stems in RB (p > 0.05), and in which the marked increase of the Mn content of leaves was observed compared with the CK. The Mn content of peach seedlings in WB and MB has opposite change with RB and PB, WB and MB increased significantly the Mn content of roots, apparently decreased in stems and leaves, expect for the Mn content of stems in MB.

Stated thus, MB promoted the absorption of iron by peach seedlings, and most Fe stored in roots for peach seedlings growth. All the biochar treatments promoted Na uptake and the transport rate from root to shoot, led to the accumulation in stems and leaves of peach seedlings. RB and PB promoted the accumulation of Mn in leaves, WB and MB promoted the accumulation of Mn in roots.

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