

Effect of Biochar on Phosphorus Availability and Fixation in Some Rubber Growing Soils of Sri Lanka

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Introduction

In most rubber growing soils in Sri Lanka, Phosphorus (P) availability is very low and added P fertilizer becomes unavailable to the rubber plant due to strong fixation into Fe and Al oxide minerals prevalent in these soils (Dissanayake et al., 1994).

Biochar (BC) may significantly improve soil fertility in acid and highly weathered soils (Lehmann and Rondon, 2006). With respect to soil chemical fertility, Dharmakeerthi et al. (2012) observed a significantly high P uptake in some BC amended rubber growing soils. BC have high P concentration than in other organic materials (Brown 2009). However, no experiment has been so conducted so far on dynamics of soil P (availability and fixation) in BC amended rubber soils, both in Sri Lanka and other rubber growing countries.

Therefore, objectives of the present study were: (i) to study the changes in P availability with time in three contrasting soil types in rubber growing areas when they were amended with rubber wood biochar (RWBC), and (b) to determine the effect of RWBC on P fixation in those soils.

Methodology

Two factorial experiments with two factors; three soil types and three BC rates were conducted under laboratory conditions at Rubber Research Institute of Sri Lanka. Biochar was produced from rubber wood (RW) at 350°C and added in to the three soils: Reddish Brown Latasolic soil from Parambe (PR), Reddish Brown Earth soil from Thanamalwila (TW), and Red Yellow Podsollic soil from Payagala (PY). Three BC rates were 0, 2 and 5% (w/w) from RW BC. Soils and BC samples were characterized for some important chemical properties using standard methods.

In the first experiment each soil type was amended with the 3 BC rates and incubated in four replicates at 80% of water holding capacity (WHC), for 4 weeks. Available P contents were measured at 0, 1, and 4 weeks after incubation. In the second experiment, P fixation capacity of the three soils amended with three different BC rates was assessed, in triplicate, using the Portch and Hunter (1998) method with slight modifications. Five ml solution containing 0, 20, 40, 60 and 80 ppm of P were added to BC amended and unamended soils after air-drying of 3-5 days.

Available P from these two experiments were extracted according to the Bray II (Bray and Kurtz, 1945) method and determined by using a SKALAR San++auto analyzer. Data were analyzed using PROC GLM program of the SAS software package

Results and Discussion

Changes in Phosphorus Availability Study on Soil Type × BC Rate Interaction

Figure 1 illustrates P availability in three soil types as affected by RWBC rates during the first 4-week incubation period. The unamended TW soil had the lowest available P content, while the highest was observed in PR soil. Over the time, the P availability decreased in all soils as well as at all BC rates. It was apparent that soil P availability was increased significantly ($P < 0.05$) as the BC rate increased from 0 to 5%. The PY soil resulted the greatest increase of available P. Similar increases have been observed by others (DeLuca et al., 2009).

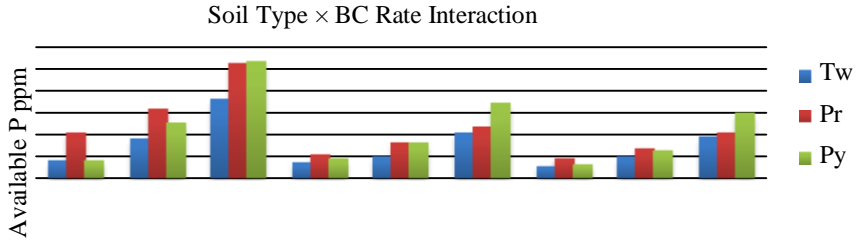


Figure 1. Soil type \times BC rate interaction on P availability measured at different times after BC addition.

P Fixation Study on Soils as affected by Different Biochar Rates

Figure 2, 3 and 4 illustrate the P fixation curves for TW, PR and PY soils, respectively, when amended with RWBC rates. The increase in available P at 80 ppm added P level was higher for 5% BC amended soils, compared to that of 0% amended soils, in both TW and PY soils (Fig 2 and 4). DeLuca et al. (2009) have observed the similar increases.

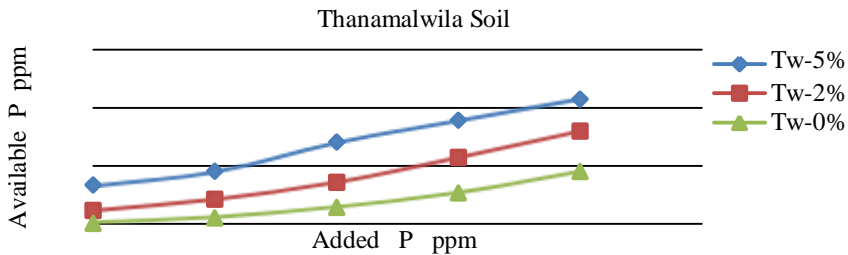


Figure 2. P fixation curves in TW soils as affected by RW biochar rates

According to figure 2-4, increasing BC rates from 2 to 5% does not significantly decrease ($p < 0.05$) P fixation in all three soils. The higher increase in available P content at 5% BC levels in PY soils could be due to low P fixation. It is however apparent that application of BC has decreased the P fixation in TW and PR soils but not in PY soil.

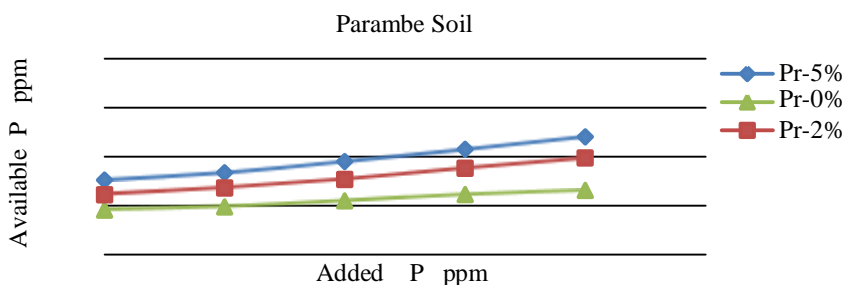


Figure 3. P fixation curves in PR soils as affected by RW biochar rates.

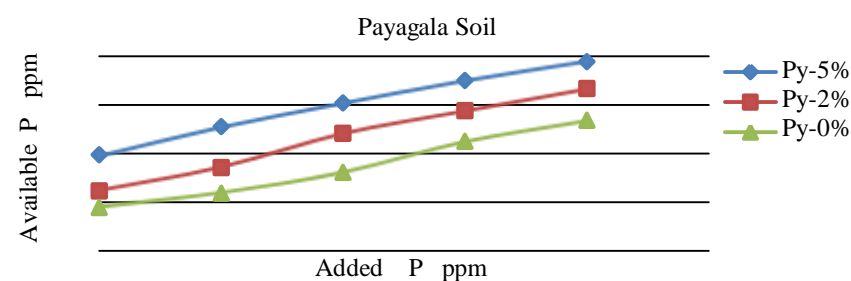


Figure 4. P fixation curves in PY soils as affected by RW biochar rates.

Conclusions

Available P contents were different among the three soils and were in the order TW < PR < PY. RWBC could act as a source of P. After amending soils with BC, the available P increased in order of TW soil < PY soil < PR soil. Among of all soil types studied, PY and PR soils had the lowest and the highest P fixing ability, respectively. Application of RWBC decreased the P fixation in TW and PR soils but not in PY soils.

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