EFFECT OF CHARRED BIOMASS ADDITION ON FERTILITY CHARACTERISTICS OF SOIL

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Introduction

Agricultural soils in the Chemmani series of Jaffna peninsula have meager soil fertility characteristics because of their alkaline pH values, low nutrient content diminutive soil organic carbon contents and low cation exchange capacity. We hypothesized that charred biomass additions will help ameliorate some of these fertility problems. The study objectives were to assess the effects of firewood based charred biomass addition alone and in combination with inorganic fertilizers on soil fertility characteristics of soils of Chemmani series of Jaffna peninsula.

Methodology

The top soil layer (0-15) was sampled from uncultivated lands in Arali belonging to Chemmani series, followed by the removal of plant debris. Soil sample was air dried and sieved through 2mm sieve prior to physical and chemical analysis of soil. Table 1 shows few selected physical and chemical properties of soil. Charred biomass was produced from firewood. Firewood was heated in a conventional kiln about 450-500°F and removed to metal tray from kiln when reached red hot stage. Water was sprinkled on the live coal and it was allowed to cool. Finally charred biomass (CB) was ground to fine texture and analyzed (Table 2).

Table 1: selected properties of soil used for study

Characters	Arali
Texture	Sandy clay loam
Sand (%)	61.74
Silt (%)	10.2
Clay (%)	28.06
pH (1:5 / soil: water)	8.2
EC (dS/m)	0.358
Total N (mg/kg)	616
Available N (mg/kg)	7
Available P (Kg/ha)	33.3
Available K (Kg/ha)	702.13
CEC (c mol $_{(+)}$/ Kg of soil)	9.5
Organic matter (%)	0.862

Table 2: Nutrient content of charred biomass (CB)

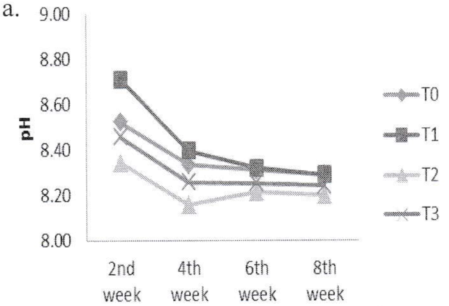
Total Nitrogen (%)	2.1
Available nitrogen (mg/kg)	17.1
Total phosphorous (mg/kg)	412.82
Total potassium (mg/kg)	11750.68

Treatments and analysis: 250g of air-dried soil was placed in transparent plastic bottles. Complete randomized design was used with four treatments and three replicates. The treatments were control (T_0), CB (T_1), NPK fertilizers (T_2), combination (T_3). Inorganic fertilizers were applied at following rate: urea 165kg/ha, TSP 270kg/ha and MOP 125kg/ha. CB was applied at the rate of 20 t/ha. In T_3 (combination), CB and NPK fertilizers were applied at half of T_1 & T_2 rate. pH and Ec were measured at two weeks interval until two months of incubation (1:5/ soil: water suspension). Available N (Kjeldhal method, Bremner and Mulvaney, 1982), Available K (flame photometer, Knudsen *et al.*, 1982) and P (colorimetry, Olsen and Sommers, 1982) were measured after 2 weeks. At the end of ten weeks cation exchange capacity (Chapman, 1965), and microbial biomass carbon (fumigation- extraction method, Vance *et al.*, 1987) were analyzed. Results were analyzed by SAS package and the mean separation was done by LSD at p=0.05.

Discussion and Conclusion

The soil pH was significantly higher in CB compared to other treatments at second and fourth week (Figure 1a). However pH was significantly low in combination compared to control. Sixth week on wards, there were no significant differences among all treatments. pH reduced with time in all treatments. Hence by adjusting the time of application of charred biomass the effect of change in pH on crops can be overcome. Biochar applications can significantly alter soil pH as it contains varying concentrations of ash alkalinity (Chan and Xu, 2009). Inorganic fertilizers decrease the soil pH after application due to acidification resulting from dissociation of urea to produce H+ ions (Yeboah *et al.*, 2009).

a.



b.

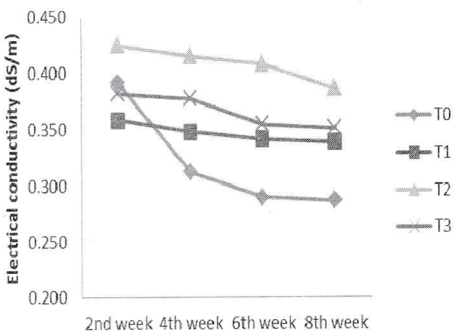


Figure 1: Effect of different treatments on pH(a) and Electrical conductivity(b)

T_0 control, T_1 CB, T_2 NPK fertilizer, T_3 Combination

Ec was sinificantly higher in NPK fertilizer followed by combination and CB addition compared to T_0 (control). However Ec reduced with time. The reason may be the soluble nutrient content of inorganic fertilizers increased EC in T_2. Immobilization of nutrients, ammonia volatilization and adsorbtion by clay particles due to increased CEC would have contributed to reduced EC with time. N availability was significantly higher in combination and NPK fertilizer compared to control. However there is no significant differences between CB and other treatments. Biochar increases the N availability through both the direct nutrient additions by the biochar and greater nutrient retention (Lehmann *et al.*, 2003a), and it can also due to the effect of changes in soil microbial dynamics. Immobilization of N in the microbial biomass, due to the addition of a labile carbon source with the added biochar, is another possible mechanism contributing to improved N retention in the top soil (Sohi *et al.*, 2010).

	T_0(control)	T_1(CB)	T_2(NPK fertilizer)	T_3 (combination)
Available N(mg/kg)	15.47 b	27.53 ab	28.56 a	36.49 a
Available P(kg/ha)	31.77^{c}	52.02^{c}	123.41^{a}	88.55^{b}
Available K(kg/ha)	696.11^{b}	942.43^{a}	771.08^{b}	910.3^{a}
Cation exchange capacity (cmol/kg)	9.42^{b}	10.1^{a}	9.45^{b}	9.96^{a}
Microbial biomass C(µg/g)	627.49^{b}	855.67^{a}	641.8^{b}	798.63^{ab}

Table 3: Fertility characteristics of soil under different treatments
Same letters with in rows are not statistically different by the LSD at p=0.05.

Available P significantly increased in NPK fertilizer compared to other treatments and in combination compared to CB and control (Figure 2). There was no significant different between CB and control. However CB had higher mean value than control (Table 3). Significantly highest available K was recored in CB and combination compared to control & NPK fertilizers (Table 3). However there were no significant differences between CB and combination. increased supply of available K and uptake by addition of biochar has already been reported (Lehmann *et al.*, 2003b; Chan *et al.*, 2007). Cation exchange capacity was higher in CB and combination than other treatments (Table 3). The high specific surface area, oxidation of the biochar itself and adsorption of organic matter to biochar surfaces may have contributed to the high CEC found in soils containing biochar (Liang *et al.*, 2006). Significantly higher biomass carbon observed in CB followed by combination (Table 3). However there was no significant difference between CB and combination. Biochar may shift the soil microbial community structure through metabolically available labile-C and changes in soil physicochemical properties (Condron *et al.*, 2011).

The ability of charred biomass to improve soil fertility characteristics had mixed results. Though charred biomass alone increase the pH initially, with time pH is decreased. In the combination treatment pH was significantly reduced up to 4th week. Charred biomass addition alone and combination increase the available N, available K, cation exchange capacity and microbial biomass compared to control or inorganic fertilizer. CB also increased available P compared to control. Combination treatment shows better results compared to CB. Even though charred biomass addition has the potential to improve fertility of soil, it also increases the pH of the soil when applied alone. Appling charred biomass mixed with inorganic fertilizer could overcome this effect.

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