

## Effects of Different Forms of Palmyrah Coir Dust as Soil Amendments on Some Physical and Chemical Characters of Calcic Red Yellow Latasole Soil and the Yield of *Capsicum annum*

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### Abstract

A study was carried out to assess the possibilities of using different forms of Palmyrah coir dust (PCD) as a potting soil amendment. The PCD was converted into three different forms and applied along with NPK fertilizer. A pot experiment was done in calcic red yellow latasol using *Capsicum annum* as test crop with five treatments, namely T<sub>1</sub> (Control-NPK fertilizer), T<sub>2</sub> (NPK fertilizer+ Raw PCD), T<sub>3</sub> (NPK fertilizer+ Decomposed PCD), T<sub>4</sub> (NPK fertilizer+Charred raw PCD) and T<sub>5</sub> (NPK fertilizer +Charred decomposed PCD). Oyster mushroom was cultivated in PCD for decomposition. In T<sub>2</sub> raw PCD and soil were mixed as 1:3 (0.5kg: 1.5kg) ratios. For T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub>, same amount of raw PCD used in T<sub>2</sub> was decomposed or charred or initially decomposed then charred and mixed with the same amount of soil used in T<sub>2</sub>. Experiment was performed in Complete Randomized Design (CRD) with three replicates. Bulk density, porosity, total nitrogen, available nitrogen, phosphorous, potassium, organic matter, cation exchange capacity (CEC), total exchangeable bases (TEB), pH and electrical conductivity of soil were determined three weeks after transplanting. Crop yield was also measured. Total nitrogen, available nitrogen, phosphorous and potassium, organic matter, CEC and TEB significantly increased when different forms of PCD were used as soil amendments, compared to control. Bulk density decreased and porosity increased significantly with the application of all forms of PCD. Crop yield of T<sub>5</sub> was the highest, however, not significantly differed from that of T<sub>4</sub> and slightly higher than that of T<sub>3</sub>. Compared to treatment containing raw PCD, all the other three PCD forms performed better with respect to yield and physicochemical properties. By considering crop yield it was concluded that the application of charred biomass of PCD is more useful than other forms.

**Keywords:** Amendment, Biochar, Coir dust, Decomposition, Palmyrah

### Introduction

Palmyrah (*Borassus flabellifer.L.*) fiber is one of the non-edible products obtained from base of leaf petiole of 5 to 10 years old palm. Fiber production center of Palmyrah Development Board is located at Sarasalai, Jaffna where mainly stiff fiber is produced. During fiber extraction, equal quantities of stiff fiber and fiber waste are generated and hence a large quantity of fiber waste is accumulated. It is disposed by burning which consequently creates environmental pollution. Fiber waste is a mixture of dust, bits and fiber of less length. Mohanadas, (1983) reported that coir dust is a spongy material, which has a potential to absorb water, a low resistance to root penetration, and a resistance to the microbial degradation under natural condition due to the high C:N ratio, lignin content and polyphenol. Puthisigamani, (2014), showed that PCD could be used as a potting medium with soil, where the yellowing of leaves was a problem during the cultivation. Biodegradation of PCD increases the levels of N, P, K and micronutrients, and reduces the lignin content and C: N ratio. Mushroom cultivation is one of the possible ways for that (Mohanadas, 1983). Converting PCD into biochar can help to reduce the bulkiness. Biochar increases

availability of soil nutrients, improves surface, provides habitat to beneficial microorganisms, reduces leaching of nutrients and enhances soil moisture retention (Lehmann 2006). In this background, an experiment was carried out to find a suitable form of PCD (raw, partially decomposed, biochar produced from raw and biochar produced from decomposed PCD) application to soil using *Capsicum annum* as the test crop.

### Materials and Methods

Experiment was conducted at Palmyrah Research Institute under a greenhouse using Calcic red yellow latosols soil obtained from Kopay, Jaffna. Study was performed in Complete Randomized Design with five treatments (Table1) with three replicates. *Capsicum annum* was used as the test crop. Palmyrah fiber waste was collected from Palmyrah fiber production centre at Sarasalai, Jaffna and it was sieved through 5 mm sieve to get PCD. PCD was used as substrate for mushroom cultivation. Decomposition was allowed for four weeks. Decomposed substrate was removed and one part was used directly and other part was converted to charred biomass. Raw PCD and decomposed PCD (0.5 kg of each) were

converted into charred biomass. Soil and raw PCD were mixed at the ratio of 3:1 (1.5 kg: 0.5 kg) for T<sub>2</sub>. Amount obtained through decomposition and biochar preparation from 0.5 kg were mixed with 1.5kg of soil. Seedlings were transplanted in 20 cm diameter plastic pots. Basal and top dressing were applied in recommended rate (Table 2). Forty eight days after the transplanting harvesting was done as six pickings were done. Fresh weight of fruits was measured. Three weeks after transplanting soil samples were collected to determine the basic soil properties (pH, EC, total nitrogen, available nitrogen, phosphorous and potassium, organic matter, cation exchange capacity (CEC), total exchangeable bases (TEB), bulk density and porosity). All properties were analyzed in methods described in FAO fertilizer and plant nutrition bulletin (Motsara and Roy, 2008). Results were analyzed by using the SAS package and mean separation was done by using Least Significant Difference at p=0.05.

**Table 1:** Different treatment combinations used in the study

Treatments (T)	Composition
T <sub>1</sub>	Soil - +NPK fertilizer (Control)
T <sub>2</sub>	Raw PCD + NPK fertilizer (RPCD)
T <sub>3</sub>	Decomposed PCD + NPK fertilizer (DPCD)
T <sub>4</sub>	Charred raw PCD + NPK fertilizer (CRPCD)
T <sub>5</sub>	Charred decomposed PCD + NPK fertilizer (CDPCD)

### Results and Discussion

Application of all forms PCD significantly increased total nitrogen, available nitrogen, phosphorous and potassium, organic matter, CEC, TEB, porosity and yield, and decreased pH,

EC and bulk density. Decomposition might have reduced the EC due to utilization of ions in PCD as mushrooms require minerals for their growth. The highest total N, available phosphorous and potassium, CEC and TEB were obtained in T<sub>3</sub> (DPCD). Total N was significantly lower in T<sub>2</sub> (RPCD) than T<sub>3</sub> (DPCD). There was no significant difference between T<sub>4</sub> (CRPCD) and T<sub>5</sub> (CDPCD) in total N, available P and available potassium. Available N significantly reduced in the order of T<sub>2</sub> (RPCD), T<sub>3</sub> (DPCD), T<sub>4</sub> (CRPCD) and T<sub>5</sub> (CDPCD). Protein source presents in substrate may contribute to total N content. Although decomposition of PCD by mushroom releases organic N and increases available P due to cleavage of some organic bonds, available N was lower in T<sub>3</sub> (DPCD) than T<sub>2</sub> (RPCD). Soil samples were collected 3 weeks after transplanting hence until that released N has been used by the plant in T<sub>3</sub> (DPCD) and raw PCD has been just started to decompose and hence releases N in T<sub>2</sub> (RPCD). Pyrolysis reduces N through volatilization as NH<sub>3</sub>. Addition of DPCD reduces P absorption by soil because of presence of organic acids and enveloping effects of organic matter.

There was no significant difference in organic matter content between T<sub>2</sub> (RPCD) and T<sub>3</sub> (DPCD) as well as between T<sub>4</sub> (CRPCD) and T<sub>5</sub> (CDPCD). Carbon in PCD will be broken by decomposition. Lehmann *et al.*(2006) reported that carbon present in feedstock will be lost in biochar production. Decomposition will increase the available K in coir pith (Reghuvaran and Ravindranath, 2012). These might be the reasons for high available K in decomposed forms of PCD. The CEC and TEB significantly increased in the order of T<sub>4</sub> (CRPCD), T<sub>5</sub> (CDPCD) and T<sub>2</sub> (RPCD).

**Table 2:** Effect of application of different forms of PCD on soil properties and crop yield

Basic soil properties and yield	Treatments				
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	T <sub>5</sub>
pH	8.15 <sup>a</sup>	7.22 <sup>b</sup>	7.32 <sup>b</sup>	7.72 <sup>ab</sup>	7.70 <sup>ab</sup>
Electrical Conductivity (µs/cm)	352 <sup>a</sup>	350 <sup>a</sup>	328 <sup>a</sup>	199 <sup>b</sup>	234 <sup>ab</sup>
Total Nitrogen (mg/100g)	183 <sup>d</sup>	342 <sup>b</sup>	439 <sup>a</sup>	281 <sup>c</sup>	284 <sup>c</sup>
Available Nitrogen (mg/100g)	13.00 <sup>e</sup>	24.22 <sup>a</sup>	19.58 <sup>b</sup>	17.86 <sup>c</sup>	15.12 <sup>d</sup>
Available Phosphorous (mg/100g)	0.82 <sup>d</sup>	2.36 <sup>c</sup>	3.60 <sup>a</sup>	3.34 <sup>b</sup>	3.36 <sup>b</sup>
Available Potassium (mg/100g)	0.6 <sup>d</sup>	0.9 <sup>d</sup>	1.44 <sup>a</sup>	1.03 <sup>b</sup>	1.04 <sup>b</sup>
Organic matter%	0.87 <sup>c</sup>	2.47 <sup>a</sup>	2.34 <sup>a</sup>	1.85 <sup>b</sup>	1.98 <sup>b</sup>
Cation Exchange Capacity (CEC) (cmol (+)/kg)	14.32 <sup>e</sup>	40.26 <sup>b</sup>	47.20 <sup>a</sup>	20.91 <sup>d</sup>	23.62 <sup>c</sup>
Total Exchangeable Bases (TEB) (cmol (+)/kg)	17.27 <sup>d</sup>	30.05 <sup>b</sup>	36.03 <sup>a</sup>	25.27 <sup>cd</sup>	29.01 <sup>c</sup>
Bulk density(g/cm <sup>3</sup> )	1.53 <sup>a</sup>	1.099 <sup>c</sup>	1.23 <sup>b</sup>	0.87 <sup>d</sup>	0.88 <sup>d</sup>
Porosity	0.324 <sup>c</sup>	0.467 <sup>b</sup>	0.407 <sup>b</sup>	0.590 <sup>a</sup>	0.643 <sup>a</sup>
Yield(g)	75.7 <sup>d</sup>	87.7 <sup>c</sup>	144.8 <sup>ab</sup>	145.4 <sup>a</sup>	146.1 <sup>a</sup>

Values having different superscripts in a row were significantly different

Bulk density and total porosity did not significantly vary between T<sub>3</sub> (DPCD) and T<sub>2</sub> (RPCD). Significantly low bulk density and high porosity were recorded in T<sub>4</sub> (CRPCD) or T<sub>5</sub> (CDPCD) compared with other treatments. The PCD has lower BD than the soil, and therefore, application of PCD to soil will decrease the bulk density, correspondingly increasing porosity.

Significantly high crop yield was observed in biochar applied treatments (T<sub>4</sub> and T<sub>5</sub>) and T<sub>3</sub> (DPCD). Chemical properties were analyzed three weeks after planting when biochar was fresh and that is reason for lower values obtained for some chemical properties than T<sub>3</sub> (DPCD) however more studies have revealed that biochar can increase crop yield. It might be the reason for the same crop yield observed in T<sub>3</sub> (DPCD), T<sub>4</sub> (CRPCD) and T<sub>5</sub> (CDPCD).

### Conclusion

Results revealed that, application of different forms of PCD along with fertilizers had potential to increase crop yield significantly by improving soil physical and chemical properties. Total nitrogen, available nitrogen, phosphorous and potassium, organic matter, CEC, TEB and yield increased due to PCD in different form as amendment. All forms of PCD significantly increased porosity and reduced bulk density of soil. Significantly higher yield was obtained by the application of charred PCD and charred decomposed PCD. It was concluded that the application of charred biomass of PCD is more useful than other forms for crop cultivation.

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