Research Note: Coconut biochar: Taveuni field trial

Biochar is a charcoal compound with the potential to improve soil health, crop productivity and sequester carbon over the long term. The production of CocoVeneer utilises an average of 60-65% of the coconut stem. One possible use for the by-product of veneer production is coconut biochar. Analysis of the coconut biochar showed significant levels of available potassium and phosphorous, and a relatively high pH. Along with the observed cation exchange indicating good nutrient retention properties, coconut biochar shows potential as a soil amendment as shown in the Coconut biochar research note. This research note discusses the results of a field trial on Taveuni, Fiji examining the potential of biochar produced from cocowood to alleviate soil heath problems.

Introduction

On the island of Taveuni, Fiji, the predominant crop is taro supplying up to 70% of the taro exports to Pacific Island communities living in Australia and New Zealand. Continuous cropping of taro and kava on the island has led to reduced crop yields and increased incidence of corm rots and insect pests resulting in high reject rates. Over-cropping has resulted in reduced soil fertility and organic matter levels. Therefore, farmers perceive that the soil is worn out and new cropping ground must be found. As a consequence increased areas of forest are being cut and Taveuni has some of the highest forest clearance rates in Fiji. With the benefits of organic amendments, rotations and other agronomic practices, soil “health” can be improved and farmers can continue to crop in existing areas.

Previous research has shown that biochar has a high cation exchange capacity that increases levels of exchangeable cations in the soil as well as reducing the leaching of nutrients and lowering fertiliser requirements. Due to the highly porous nature and large surface area of biochar, adsorption capacity is very high resulting in a high water holding capacity. The high porosity also provides habitat for soil biology that contribute to both unlocking of soil nutrients and improved soil aggregation.

This research note discusses the results of a field trial on Taveuni examining the potential of coconut biochar to alleviate soil health problems. Results were evaluated by changes in the yield of taro produced after the addition of coconut biochar to the soil. This trial was part of an analysis conducted on coconut biochar as a by-product in the ACIAR-funded CocoVeneer project. The characteristics of the biochar used in the trial is reported in a previous Research Note.

Figure 1. Broadcasting a biochar treatment

Figure 2. Broad-scale incorporation of biochar treatment

Method

With few tractors on and often rocky and hilly terrain, hand planting of taro is standard practice. Prior to the planting of taro basal fertiliser is applied to each hole. As such the application of biochar in a similar way was justified. This allowed relatively small amounts of biochar to be used, a significant consideration due to the high expense of shipping material to and from Australia for treatment. However, in most research conducted on biochar to date, large amounts of biochar have been broadcast and then incorporated into the soil. Thus a comparison of this scale was conducted (as shown in Figure 2). This large-scale treatment allowed a greater opportunity to demonstrate any potential yield benefits from biochar. The downside was a significantly greater quantity of biochar required in each plot and this was only economically feasible for locally produced biochar. Thus the study also included comparison treatments of locally produced biochar. This was from two sources: low density cocowood and guava wood (an aggressive weed in parts of the Pacific). As there was sufficient quantity of local biochar an additional trial was included with different rates of biochar applied in the hole (see Table 1 for treatment list).

Priming of biochar with nutrients and beneficial organisms is generally regarded as improving the timeliness of the biochar effects and reducing the potential for fixing soil nutrients. Therefore, all biochar treatments were primed except for controls.

Table 1. Results of biochar treatments applied to a taro corm crop in Taveuni, Fiji

Trt	Feedstock	Temp (°C)	Incorporation method	Rate	Units	Primed	Corm wt (g)	% of cntl
1	None (nil)	-	applied to hole	0	g/hole	-	1291	100
2	none	-	applied to hole	0	g/hole	=y	1205	93
3	cnut-Aus	**350**	applied to hole	100	g/hole	y	1257	97
4	cnut-Aus	**500**	applied to hole	100	g/hole	y	1280	99
5	cnut-Aus	**750**	applied to hole	100	g/hole	y	1208	94
6	cnut-Tav	500	applied to hole	50	g/hole	y	1189	92
7	cnut-Tav	500	applied to hole	100	g/hole	y	1154	89
8	cnut-Tav	500	applied to hole	200	g/hole	y	1256	97
9	cnut-Tav	500	applied to hole	100	g/hole	**no**	1209	94
10	guava-Tav	500	applied to hole	100	g/hole	y	1202	93
11	guava-Tav	500	applied to hole	200	g/hole	y	1275	99
12	guava-Tav	500	applied to hole	100	g/hole	**no**	1220	95
13	none	-	spread, incorp	0	t/ha	=y	1293	100
14	cnut-Tav	500	spread, incorp	10	t/ha	y	1349	105
15	guava-Tav	500	spread, incorp	10	t/ha	y	1308	101
16	guava-Tav	500	spread, incorp	10	t/ha	**no**	1253	97

Results and Discussion

A mean corm weight of 1247g was measured across all treatments. Factoring in the low rainfall during the growing season, this result was exceptionally good. However, there were no statistically significant differences in mean corm weight between biochar treatments and no consistent effects of initial feedstock, pyrolysis temperature, rate of biochar and priming. Mean corm weights were high with only 2% rejected (less than 600g) and these were not aligned with any particular treatment. There was also very little corm rot (0.5%) and no incidence of mealybugs.

Biochar has a very high water holding capacity and is able to hold up to five times its mass in water. However, due to the extreme drought conditions, the trial received some irrigation potentially masking the water holding effects of the biochar. Previous research has also shown potential for a reduction in the level of fertiliser required when added with biochar. Due to the trial being conducted largely through farmer support as part of a commercial operation, this aspect could not be assessed with optimal nutrition provided. It is not un-expected that under close to non-limiting conditions biochar will have less effect.

While it is generally believed that declining taro yields can be attributed to decreased soil fertility and loss of organic matter, a soil test at the trial site showed 4.5% organic matter which may have masked any nutrient exchange benefits from biochar treatments. In contrast, labile C was shown to be low (0.3%) compared with other areas tested and therefore the inert nature of additional carbon supplied in biochar may be of little value due to existing adequate levels of total C present.

Finally, it is also generally recognized that the benefits of biochar are long term and thus there may have been insufficient time for the benefits to show. Therefore, marker posts have been established to indicate the trial perimeter and allow for further analysis of future taro crops.

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This research note is part of the ACIAR-funded CocoVeneer project FST/2009/062: Development of advanced veneer and other product from coconut wood to enhance livelihoods in South Pacific communities.The project team includes researchers and collaborators from the University of Tasmania, the Queensland Department of Agriculture, and Fisheries (DAFF), the Secretariat of the Pacific Community (SPC), the Fiji Department of Forests; Forest Research and Development Section, Forestry Division, Ministry of Natural Resources and Environment, Samoa; Ministry of Forestry, the Solomon Islands, and industry in Australia and Pacific Islands. The project supports economic development in Fiji, Samoa and the Solomon Islands and includes activity in market and value-chain assessment, log harvesting, veneer production and product manufacture, and the development of viable uses for coconut residues at the harvest site or the production facility. More information about the project is available at www.cocowood.net.