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Development of Innovative Low Cost *Biochar* Production Technology

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ABSTRACT

Biochar is a solid product of thermal decomposition of organic matter at a temperature below 900 °C under conditions of oxygen deficit, produced for environmental or agricultural application. The selection of low cost biochar production technology will help to the resource poor farmers for application of such a wonderful soil amendments in their own field. In present study, an attempt has been made to develop an eco-friendly low cost biochar production technology which is very easy, economical and cost effective. Both the drum method (portable kiln) and pit method were very suitable for preparation of biochar and thus these two methods can be recommended to the farming community. The recovery of biochar was more in drum method as compared to pit method.

Key Words: Biochar, Development, Low cost, Production, Technology.

INTRODUCTION

Biochar is the by-product of biomass pyrolysis in an oxygen depleted atmosphere. Applications of biochar have received significant attention for its ability to enhance soil fertility, carbon sequestration, bio-energy production, and immobilization of organic and inorganic pollutants. Significant body of knowledge reported that biochar application increased plant growth and biomass and nutrient uptake under drought and salt stress (Bruun *et al*, 2011 and Wiedner *et al*, 2015). Biochar also improved soil physicochemical properties including soil pH, cation exchange capacity (CEC), soil structure, water holding capacity (WHC), and surface area under abiotic stresses. A wide range of common raw materials are used as the feedstock, including wood chip, organic wastes, plant residues, and manure. In recent years, an increasing interest in applying biochar is focused on the amendment of nutrient-poor soil for soil ecological restoration including sequestering carbon. Farmers apply huge quantities of lime/dolomite to neutralize acidic soils at great expense. Biochar is basic in nature (pH > 7.0). It can react similarly as agricultural lime does i.e., by increasing soil pH (Windeatt *et al*, 2014 and Yuan *et al*, 2011). There is no specific rate of application of biochar in soil. It depends on many factors including type of biomass used, the types and proportions of various nutrients (N, P, K), the degree of metal contamination in the biomass, and also climatic and topographic factors of the land (Das et al, 2016). It was found that rates between 5-10 t/ha (0.5-1 kg/m2) have often been found better. Even low rates of biochar application can significantly increase crop productivity assuming that the biochar is rich in nutrients (Das and Avasthe, 2015). Various methods are available to prepare biochar amendments but considering production cost economics most of the biochar production technology fails to provide benefits to the farming community. This is due to the expensive process for production of biochar. However, a low cost technology for biochar production under farmer's field is not there in the literature. Herein, it was tried to develop a low cost biochar production technology in agricultural production under farmer's field condition.

MATERIALS AND METHODS

The study was conducted during the year 2016-

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17 at the experimental farm of ICAR Research Complex for NEH Region, Sikkim Centre, Gangtok located in the Indian Himalayan region at Tadong (27˚20’N latitude and 88˚37’E longitude with 1350m amsl), in the state of Sikkim, India. Six different weed biomass viz., Lantana camera, Ageratum spp., Neyraridia spp., Artemisia vulgaris, Bidens spp. and Chromolaena odorata and three different biomass from maize stalk, black gram stover and pine needle were collected from nearby farm area and shredded to pieces of less than 12 inch. Shredded pieces were sun–dried before charring into biochar production unit. Charring of all the biomass was carried out in portable charring kiln (drum) and soil pit having size (2×2×3 ft3) developed by ICAR, Sikkim Centre to keep the process simple, quick and low cost. Biomass was inserted both in drum and pit and combustion carried out. The picture of the drum method and pit method has been presented in Figure 1. Biochar was prepared at ~450°C from the biomass by using both pit method and drum method. The percentage of biochar yield from both the method was calculated using the equation described below (Srinivasan et al, 2015)-

Yieldbiochar = mbiochar/mraw × 100%; where Yieldbiochar = mass yield of biochar, %; mbiochar = mass of biochar, kg; mraw = mass of raw biomass, kg.

After preparing of biochar they were dried in a hot air oven at 110OC for 24 h, pulverized to fine powder, sieved and used for field application.

Figure 1. Biochar preparation technology by drum (kiln) and pit method

RESULTS AND DISCUSSION

The biochar production efficiency from different biomass using drum method and pit method has been shown in Table 1. The results revealed that biochar production efficiency was more in drum method as compare to pit method. In drum method the production efficiency of *Lantana camera, Ageratum spp., Neyraridia spp., Artemisia vulgaris, Bidens spp.* and *Chromolaena odorata*, maize stalk, pine needle and black gram stover biochar were 23.2, 13.2, 19.6, 15.1, 14.6, 16.4, 31.7, 27.3 and 18.9 per cent, respectively. In drum method the production efficiency was highest in maize (31.7 %) and lowest in *Ageratum spp*. (13.2 %). The varying production efficiency could be attributed to variable moisture content in each biomass Mondal *et a*l (2013). In pit method the production efficiency of *Lantana camera, Ageratum spp., Neyraridia spp., Artemisia vulgaris, Bidens spp.* and *Chromolaena odorata, maize* stalk, pine needle and black gram stover biochar were 21.5, 10.7, 16.2, 14.8, 12.5, 15.1, 28.6, 26.4 and 15.8, respectively. Similar to the drum method, in pit method the production efficiency was also highest in maize (28.6 %) and lowest in Ageratum spp. (10.7 %). But drum method was good at any time of the season either it is rainy season or winter. On the other hand pit method is not suitable during rainy season or winter season. Pit method is only suitable during summer and spring season. These two methods are very simple, energy efficient and easy to prepare the biochar and thus these methods can be recommended to farmers for preparation of biochar for application in their field.

CONCLUSION

Using locally available materials (biomass) for making biochar with low cost production technology (drum method and pit method) could provide an unique opportunity to improve soil fertility and soil acidity for longer period of time to the farming community in India.

Table 1. Biochar production efficiency under drum and pit method.

Sr. No.	Biomass	Production efficiency (%)	
		Drum method	**Pit method**
1.	*Lantana spp*.	23.2	21.5
2.	*Ageratum spp*.	13.2	10.7
3.	*Neyraridia spp*.	19.6	16.2
4.	*Artemisia vulgaris*	15.1	14.8
5.	*Bidens spp.*	14.6	12.5
6.	*Chromolaena odorata*	16.4	15.1
7.	Maize stock biochar	31.7	28.6
8.	Pine needle biochar	27.3	26.4
9.	Black gram stover biochar	18.9	15.8

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