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Assessment of biochar as soil conditioner for maximizing yield in rainfed greengram

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Abstract

Agriculture is the livelihood of people living therein. The agriculture of this region is unique in the sense that crops are mostly grown under rainfed conditions. This region receives usually rain largely from the onset of north-east monsoon with erratic behavior which affects level and spread of rainfall distribution. On an average, the seasonal rainfall was received to the extent of 656.4 mm and it has a downpour in short span of 40 days. Given the prevalence of drought vulnerability, farmers continue to face the consequences of rainfall Application of biochar @ 5t/ha along with soil test-based application NPK Fertilizers (TO3) registered higher yield of green gram (8.64 q/ha), which was closely followed (7.23 q/ha) by application of FYM along with soil test-based application NPK Fertilizers (TO2). The Farmers practice **(**Application of DAP as basal without any soil test) recorded lower yield of green gram (5.49 q/ha).

Keywords: Biochar, soil conditioner, greengram (*Vigna radiata*), rainfed agriculture

Introduction

Pulses are an important component of Indian farming allowing the land to restore fertility by fixing atmospheric nitrogen and adding enough organic matter through leaf fall and root biomass as reported by Tomar *et al.*, 2023 [10]. In India, green gram cultivation covered over 33.45 lakh hectares in 2022-23. Rajasthan, Karnataka, Maharashtra, Odisha, Madhya Pradesh, and Telangana are green gram is extensively grown and are among the top producers of this crop. This is third important leguminous crop after chick pea and pigeon pea. South East Asia and Indian subcontinent, and occupies nearly sixteen per cent of the total pulse area in India. It is rich in protein (20-25%) but also containing low fat and high fiber content, better palatability, high market price and easy digestibility as enumerated by Kumar *et al.*, 2022 [6]. The production levels of greengram are related to yield limiting factors such as water and nutrients. Water is indeed a very limiting factor in Virudhunagar district where annual rainfall is, on an average, 810 mm but with irregular periodicity in terms of quantum and spread resulting in poor recharge. Traditionally, Greengram is a rain-fed crop, with most greengram farmers being small-holder; they have limited resources and seldom use inputs (fertilizers and supplemental irrigation systems) to address these production constraints. The acute water stress has necessitated developing appropriate technology to improve soil properties and maximize greengram yield. Moreover, soil organic matter and fertility status of rainfed soil have been declining over the decades due to climatic variability and imbalanced fertilizer application. Enhancing the organic matter, nutrient status and crop productivity in the rainfed soil is an urgent need for sustaining food security. Greengram being a major pulse crop grown in Virudhunagar district is taken up for assessing application of biochar as soil conditioner for maximizing yield in rainfed greengram.

Materials and Methods

Virudhunagar district is one of the backward districts in Tamil Nadu. It is a dry land region. Agriculture is the livelihood of people living therein. The agriculture of this region is unique in the sense that crops are mostly grown under rainfed conditions. The soil type is red soil but with fertility status of low N, medium P and medium K. This region receives usually rain largely from the onset of north-east monsoon with erratic behavior which affects level and spread of rainfall distribution. On an average, the seasonal rainfall was received to the extent of 656.4 mm and it has a downpour in short span of 40 days. The treatments were TO1 – Farmers Practice **(**Application of DAP as basal without any soil test); TO2 – Soil test-based application of NPK fertilizer + Farm yard manure and TO3 – Soil test-

based application NPK Fertilizers + Biochar (5 t ha^{-1}). Totally five farmers, each farmer one acre were selected for assessing the treatments.

Results and Discussion

Given the adverse effects of climate change on soil health and crop productivity, it is crucial to maintain the threshold level of organic matter in the soil for maintaining physical, chemical and biological integrity of the soil and also to perform its agricultural production and environmental functions. Biochar addition to soil has potential to increase carbon in the soil over a long period of time due to its recalcitrant nature, and half-life of biochar in soil is estimated to range from hundreds to several thousand years. Therefore, conversion of organic waste to biochar using pyrolysis process is one of the viable options that can enhance long-term carbon sequestration in the soil, reduce farm waste and improve the soil quality. The aim of this study was to evaluate the effect of biochar yield of green gram in red soil under rainfed condition. Biochar was prepared from maize stalk using pilot scale slow pyrolysis biochar unit. The above sources of biochar at the rate of 5 t/ha and Farm yard manure were applied as basal with soil test based on recommended nitrogen, phosphorous and potassium fertilizer.

The results revealed that application of biochar @ 5t/ha along with soil test-based application NPK Fertilizers (TO3) registered higher yield of green gram (8.64 q/ha), which was closely followed (7.23 q/ha) by application of FYM along with soil test-based application NPK Fertilizers (TO2). The Farmers practice **(**Application of DAP as basal without any soil test) recorded lower yield of green gram (5.49 q/ha) was shown in table 1 and Fig.1. Timely availability of nutrients mainly N and P from biochar might have increased the dry matter accumulation and better crop growth that has positively changed the physiological functions of greengram. Similar results were also observed by Iswarya *et al*. (2019) [2], Kumar *et al*. (2012) [4] Pandya and Mehta (2021) [7], Pramanick *et al*. (2013) [8] and Kavipriya *et al*. (2011) [3] have reported in green gram, Ghosh *et al*. (2020) [1] was reported in black gram, Rathore *et al*. (2009) [9] given in soybean, Kumar *et al*. (2023) was reported in winter cereals, Kumar *et al*. was observed in cotton.

Table 1: Effect of Integrated use of Biochar with fertilizer on greengram yield

Technology Option	No. of trials	Yield (q/ha)	Gross cost in (Rs./ha)	Gross return (Rs./ha)	Net Returns (Rs./ha)	B:C ratio
TO 1 – Farmers Practice (Application of DAP as basal without any soil test)	5	5.49	21060	32952	11892	1.56
TO 2 – Soil test based application of NPK fertilizer + FYM		7.23	22220	43380	21160	1.95
TO 3 –Soil test based application NPK Fertilizers + Biochar (5 t ha^{-1})		8.64	23220	51828	28608	2.23

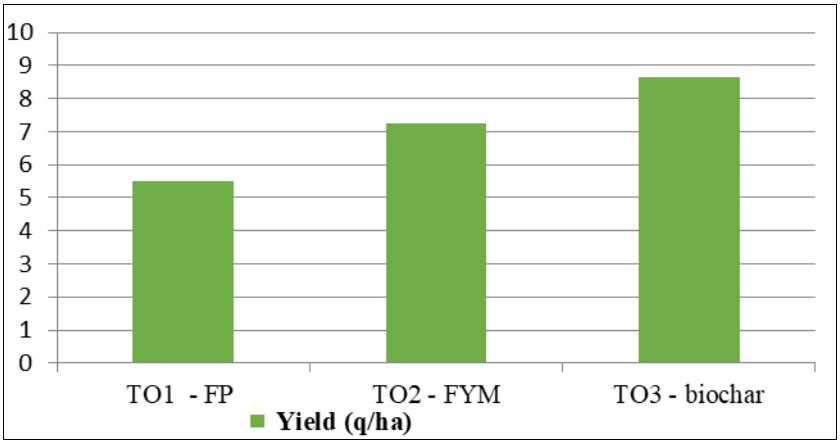

Fig 1: Effect of Integrated use of biochar with fertilizer on greengram Yield (q/ha)

Conclusion

Farmers were initially reluctant to adopt the new technology of application of biochar to soil. Shortfall in rain and erratic distribution of monsoon has been leading to water scarcity during the crop growth stages which needed to be managed by moisture conservation practices. Farmers appreciated that application of biochar @ 5t/ha along with soil test-based application NPK Fertilizers have performed better in soil moisture conservation as well as higher yield. Enriching soil with organic matter, nutrient status and crop productivity in the rainfed soil is an urgent need for sustaining food security. Application of biochar at the rate of 5 t/ha favourably increased the yield of greengram under rainfed condition. Further application of biochar from crop residues may offer additional carbon-negative benefits though avoiding burning of crop residues in field and bio resource recycling, which have been a great concern for resilient Indian agriculture.

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