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Effect of Biochar, Carpet Waste, FYM and PGPR on Growth and Yield of Rice under Organic Farming System

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A B S T R A C T

Present investigation was aimed for improving growth and yield of crop using waste products of different activities and also useful in ecological stability of soil environment. The experiment was conducted in the organic farming plot of the Institute of Agricultural Sciences, BHU, Varanasi during kharif season of rice crop (*Oryza sativa* L.) in 2017. The field experiment was laid out in Randomized Block Design with 10 treatments and three replications. It is evident that there is increase in plant height from 79.37 to 99.60 in Control to T_{10}. It was higher in treatment T_{10} (Biochar + carpet waste + FYM (2+1+1 t) ha^{-1} + PGPR) 99.60cm followed by T_9 (BC1 + CW1 + FYM1 t ha^{-1} + PGPR) 96.53. Significant differences were found between the treatments after application of PGPR in plot. There was a significant increase in the chlorophyll content of the rice crop. The maximum chlorophyll content in rice leaf was found in T_{10} (Biochar + carpet waste + FYM (2+1+1 t) ha^{-1} + PGPR) i.e. 45.93 followed by T_7 (BC1 + CW1 + FYM1 t ha^{-1} + PGPR).In treatment T2 (BC1 + CW1 t ha^{-1}) increase in chlorophyll over control was 2.20% , while T_6 (PGPR) increased 12.77% and in T_{10} (Biochar + carpet waste + FYM (2+1+1 t) ha^{-1} + PGPR) increased 23.76%. Application of graded level of biochar, carpet waste FYM and PGPR was found to significantly enhance the straw and grain yield of rice. Application of BC2, CW1 FYM1 and PGPR was found 60.17% higher over the treatment T1 (control). Grain and straw yield of rice significantly increased with the application of graded level BC, CW, FYM and PGPR the increase was found 92.8% higher over control T_1.It can be concluded that using of these organic sources has good impact on the soil health under long term.

Introduction

Rice (*Oryza sativa* L.) is one of the most important cereal crops belonging to the Poaceae family Oryza genus, ranked first among the three major cereals followed by wheat and maize. It provides more than 50 percent caloric intake for one out of three people on earth, shaping the lives of millions of people. Rice provides 21% of global human energy per capita and 15% of protein per capita (FAO, 2011). Among the rice developing nations on the planet, India has the largest rice trim zone (around 45 million ha) and second-place positions alongside China (IRRI 2016, Standard Rice Assessment

Framework). Essentially, the Indian rice generation is expected to be around 109 meters in 2016-17, which is the most amazing ever rice creation to date (AICRIP annual gathering 2017).

Biochar is charcoal used as soil modification Biochar is a stable solid, rich in carbon that can last in soil for thousands of years. Like most charcoal, biochar is made from biomass via pyrolysis Biochar is being investigated as a carbon sequestration approach. Therefore, Biochar has the potential to help mitigate climate change through carbon sequestration Independently, biochar can increase soil fertility of acidic soil (low pH soil), raise agricultural productivity, and provide protection against certain foliar and soil-borne diseases. Most of the experiments were conducted in low fertility soils, including tropical soils, and in general, major yield improvements were achieved when biochar was applied to such soils, up to 300 % above adequate, unamended control (reviewed by Van Zwieten *et al*., 2010).

The PGPR refers to the rhizobacteria that exert the beneficial effect on plant growth. PGPR inoculants promote plant growth through at least one mechanism; improved nutrient acquisition by atmospheric nitrogen fixation and nutrients solubilization, suppression of plant disease and or phytohormone production. PGPR stimulate plant growth directly either by synthesizing hormones, by phosphate solubilization or generally by accelerating mineralization process. They can also stimulate growth indirectly by acting as biocontrol agent by protecting the plant against soil born fungal pathogens or deleterious bacteria. Some PGPR suppress pathogen by synthesizing metabolites (Vassilev *et al.,* 2006).Positive interaction between biochar and PGPR resulted in improved growth attributes and biomass yield in switch grass (Shanta, 2012).

Degradation of organic matter in soil is mainly biochemical in nature involving hydrolysis and oxidation brought about by various hydrolytic enzymes liberated by microorganisms. The actinomycetes participated mostly in decomposition of resistant component of plant residue and formation of humus. Farmyard manure is easily available, cheap, proven source of nutrition and has been traditionally used by farmers (Nanda *et al*., 2016).Application of FYM along with PGPR improved organic carbon, available N, P and K content in soil when applied in mung bean (Das and Singh, 2014). Organic waste materials are available in huge amounts in the form of farm and industrial wastes i.e. carpet wastes generated in huge amount from carpet industry. Organic carbon pools in Indian soils is declining due to heavy and imbalanced incorporation of chemical fertilizers and ignorance or unavailability or inaccessibility of the organic matter. Considering all these facts in Indian context there is a need to study the combined effect of Biochar, FYM, Carpet waste and PGPR as a source of organic material to soil.

Materials and Methods

The experiment was conducted at the Research Farm, Institute of Agricultural Sciences, Banaras Hindu University and Varanasi. In the experiment, three replications of each treatment were maintained. There were 30 experimental plots along with three control plots (without any treatment). The experiment was laid out in Randomized Block Design. To determine the preliminary physicochemical properties Representative soil samples were collected from five different locations before the 0-20 cm depth experiment was conducted. The soil belongs to the class of sandy clay loam texture. The soil had a pH of 7.82 (Sparks 1996), EC 0.18 dSm^{-1} (Sparks 1996) and Organic carbon of 0.49 % (Walkley and Black, 1934). The initial soil was low in available N 218.02 kg ha^{-1} (Subbiah and Asija, 1956), medium unavailable P_2O_5 12.80 kg ha^{-1}(Olsen, 1954) and medium in available K_2O 216.70 kg ha^{-1} (Hanway and Heidal, 1952).

Results and Discussion

Effect on plant height of rice

The data pertaining to effect of biochar, Carpet waste, FYM and PGPR on height of plant are shown in Fig 1. It is clear that in Control (T_1) to T_{10} there is an increase in plant height from 79.37 to 99.60. It was higher in T_{10} treatment (Biochar + carpet waste + FYM (2 + 1 + 1 t) ha^{-1}+ PGPR) 99.60 cm followed by T_9 (BC1+ CW1 + FYM1 t ha^{-1} + PGPR) 96.53. Significant differences were found between treatments after plot application of PGPR. Treatment T7 (BC1 + CW1 t ha^{-1} + PGPR) was found at a plant of 95.53cm plant height followed by T2 (BC1 + CW1 t ha) 93.45 cm and treatment T6 (PGPR) 80.39 cm followed by T1 (control) 79.37 cm and are statically equal to each other. Mathivanan *et al.,* (2005) reported that application of PGPR significantly increased the plant height over control. The increase in plant height may be attributed due to adequate supply of nutrients by the PGPR.

Effect on Chlorophyll content

Data on the chlorophyll content of the leaf as influenced by the application of biochar, carpet waste, FYM and PGPR are shown in Fig 1. There was a significant increase in the rice crop's chlorophyll content. The maximum chlorophyll content in rice leaf was found in T10 (Biochar + carpet waste+ FYM (2 + 1 + 1 t) ha-1+ PGPR) i.e. 45.93 followed by T7 (BC1+ CW1 + FYM1 t ha^{-1}). In T2 treatment (BC1 + CW1 t ha-1), the increase in chlorophyll over control was 2.20%, while T6 (PGPR) increased 12.77% and T10 (Biochar + carpet waste + FYM (2+1+1 t) ha-1 + PGPR) increased 23.76%.

Effect on no of tillers per hill

A critical analysis of the data shown in Figure 1 revealed that there was a significant increase in the number of tillers between treatments. The maximum number of tillers was noted in T10 (Biochar + carpet waste+ FYM (2 + 1 + 1 tha^{-1}+ PGPR) and the minimum number of tillers (10.00) in T1 (Control). The T2 (BC1 + CW1 t ha^{-1}), T9 (BC1+ CW1+ FYM1 t ha-1+ PGPR) and T10 (Biochar + carpet waste+ FYM (2 + 1 + 1 t)ha^{-1}+ PGPR) were therefore statically matched.

Effect on panicle length

The data depicted in Figure1 revealed that there is increase in the panicle length was found. The maximum no of panicles (27 cm) found in T10 (Biochar + carpet waste + FYM (2+1+1 t) ha-1 + PGPR) and minimum no of panicle (16cm) in T1 (Control).The application of biochar and carpet waste in treatment T2 (BC1 + CW1 t ha-1) increases number of panicles 12.5 % over the control, while in T6 alone (PGPR) increase the panicle length by 37.5% and T10 (Biochar + carpet waste + FYM (2+1+1 t) ha-1 + PGPR) increased 68.75 % over control . Therefore, the T2 (BC1 + CW1 t ha-1), T9 (BC1 + CW1 + FYM1 t ha-1 + PGPR) and T10 (Biochar + carpet waste + FYM (2+1+1 t) ha-1 + PGPR) were found statically at par with each other.

Effect of biochar, carpet waste, FYM and PGPR on grain and straw yield of rice at harvest

Table.1 Details of treatments followed in the field experiment

Treatments	Details of Treatment
T_1Control	
T2	Biochar + carpet waste (1+ 1 t)ha^{-1}
T3	Biochar + carpet waste (2+ 1 t)ha^{-1}
T4	Biochar + carpet waste + FYM (1+1+1 t)ha^{-1}
T5	Biochar + carpet waste + FYM (2+1+1 t)ha^{-1}
T6	PGPRconsortium
T7	Biochar + carpet waste (1+ 1 t) ha^{-1} +PGPR
T8	Biochar + carpet waste (2+ 1 t) ha^{-1} +PGPR
T9	Biochar + carpet waste + FYM (1+1+1 t) ha^{-1} +PGPR
T_{10}	Biochar + carpet waste + FYM (2+1+1 t) ha^{-1} +PGPR

Table.2 Effect of Biochar, Carpet waste, FYM and PGPR on yield of rice

Treatments	Grain yield (q ha^{-1})	Straw yield(q ha^{-1})
T_1 Control	31.27	72.21
T_2 Biochar + carpet waste (1+ 1 t)ha^{-1}	48.17	104.26
T_3 Biochar + carpet waste (2+ 1 t)ha^{-1}	54.73	107.58
T_4 Biochar + carpet waste + FYM (1+1+1 t)ha^{-1}	59.14	118.63
T_5 Biochar + carpet waste + FYM (2+1+1 t)ha^{-1}	59.24	125.35
T_6 PGPRconsortium	37.59	70.38
T_7 Biochar + carpet waste (1+ 1 t) ha^{-1} +PGPR	54.46	110.12
T_8 Biochar + carpet waste (2+ 1 t) ha^{-1} +PGPR	56.25	114.70
T_9 Biochar + carpet waste + FYM (1+1+1 t) ha^{-1} +PGPR	57.26	122.07
T_{10} Biochar + carpet waste + FYM (2+1+1 t) ha^{-1} +PGPR	60.29	140.51
S. Edm±	3.23	10.08
C.D at 5%	6.79	21.17

Table.3 Effect of biochar, carpet waste, FYM and PGPR on chlorophyll in leaves, no of tillers and yield attributes of rice

Treatments		Plant ht. (cm)	Chlorophyll (μg ml^{-1}) 60 DAS	No. of tillershill^{-1}	Panicle length (cm)
T_1	Control	79.37	37.11	10.00	16.00
T_2	Biochar + carpet waste (1+ 1 t) ha^{-1}	93.45	37.93	12.80	18.00
T_3	Biochar + carpet waste (2+ 1 t) ha^{-1}	91.33	33.93	13.08	17.00
T_4	Biochar + carpet waste + FYM (1+1+1 t) ha^{-1}	90.28	35.06	13.77	18.26
T_5	Biochar + carpet waste + FYM (2+1+1 t) ha^{-1}	92.41	41.42	14.43	18.80
T_6	PGPR consortium	80.39	41.85	14.43	21.00
T_7	Biochar + carpet waste (1+ 1 t) ha^{-1} + PGPR	95.53	43.35	15.53	22.26
T_8	Biochar + carpet waste (2+ 1 t) ha^{-1} + PGPR	92.07	41.82	14.40	23.00
T_9	Biochar + carpet waste + FYM (1+1+1 t) ha^{-1} + PGPR	96.53	38.86	16.97	25.33
T_{10}	Biochar + carpet waste + FYM (2+1+1 t) ha^{-1} + PGPR	99.60	45.93	19.47	27.00
S.Ed m±		0.18	4.07	0.37	1.17
C.D at 5%		0.39	8.54	0.78	2.47

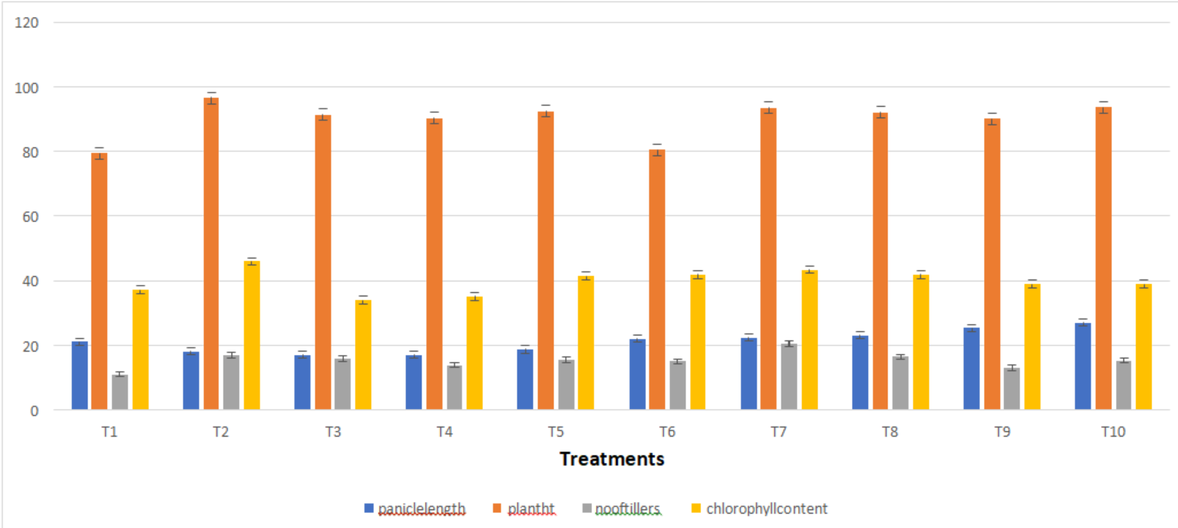

Fig.1 Effect of biochar, carpet waste, FYM and PGPR on chlorophyll in leaves, no of tillers and yield attributes of rice

Effect on grain yield

A critical perusal of the data presented in Table 3 revealed that the grain yield of rice was ranging from 31.27 to 60.29 qha^{-1}. The maximum grain yield (60.29 qha^{-1}) was recorded in the T10 (Biochar + carpet waste + FYM (2+1+1 t ha^{-1} + PGPR) which was 1.77% higher than treatment T5 (59.24) (BC2 + CW1 + FYM1 t ha^{-1}). The treatment T10 (Biochar + carpet waste + FYM (2+1+1 t ha^{-1} + PGPR) was found 92.8% higher over the treatment T1 (Control). The treatment T7 (BC1 + CW1 t ha^{-1}+ PGPR) gave 54.46 qha^{-1}grain yield which was 13.0% higher over T2 (BC1 + CW1 t ha^{-1}).

Treatment T6 (PGPR) gave 20.21% higher grain yield over the T1 (Control). But, the treatment T2 (BC1 + CW1 t ha^{-1}), T3 (BC2 + CW1 t ha^{-1}), T9 (BC1 + CW1 + FYM1 t ha^{-1}+ PGPR) and T10 (Biochar + carpet waste + FYM (2+1+1 t ha^{-1}+ PGPR) were found statically at par to each other. Rodon *et al.*, (2007) reported that the bean yield increased by 46% and biomass production by 39% over the control at application of 60g biochar per kg soil.

Effect on straw yield

A critical perusal of the data presented in Table 2.revealed that the maximum straw yield (140.51 qha^{-1}) yield was recordedin treatment T10 (Biochar + carpet waste + FYM (2+1+1 t ha^{-1}+ PGPR) which was 94.58 % increased over control T1and 12% increased over treatment T5 (BC2 + CW1 + FYM1 t ha^{-1}) .The straw yield in treatment T7 (Biochar + carpet waste (1+ 1 t) ha^{-1}+ PGPR) was found (110.12 qha-1) which was 5.62% higher over the T2 (BC1 + CW1 t ha-1) .Treatment T6 (PGPR) gave 3.00% higher over T1 (Control). Significant increase in straw yield was might be due to the availability of all essential elements to the rice crop in sufficient amount by the FYM, carpet waste and PGPR application.

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