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Combined Application of Biochar with Fertilizers Influence available Nitrogen, Phosphorus and Potassium Quantity in Soil

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A B S T R A C T

A pot experiment was conducted in Completely Randomized Design with three repetitions in the field of School of Agriculture, Lovely Professional University, from 31st November 2017 to 28th April 2018 to study the combined application of biochar with fertilizers influence available nitrogen, phosphorus and potassium quantity in soil. Different pots were treated with different level of biochar and inorganic amendments *viz.*, T_1 (100% RDF), T_2 (3% Biochar+50% RDF), T_3 (3% Biochar+75% RDF), T_4 (3% Biochar+100% RDF), T_5 (5% Biochar+50% RDF), T_6 (5% Biochar+75% RDF), T_7 (5% Biochar+100% RDF) with control. Result revealed that application of (3% Biochar+75% RDF) recorded significantly highest soil chemical parameter like, soil available nitrogen (mg/kg), soil available phosphorus (mg/kg), soil available potassium (mg/kg) after 30, 60, and 90 DAS.

Introduction

Soil is the back bone of agriculture which having all the macro and micro essential nutrient which is most important for plant growth and development. Soil physical condition has direct impact on soil productivity for crop production. The soil having good structure, porosity, bulk density provide good medium for growth of beneficial microorganism which helps to increase nutrient retention in soil (Aslam *et al.,* 2014). Soil organic matter plays vital role in this nutrients availability in soil. Organic matter improves soil porosity, soil structure, soil water holding capacity, boast up some essential nutrients which helps to increase crop yield and soil productivity. The current situation is that because of high input method of crop cultivation, top soil gets deteriorated as a result losses of soil fertility. To improve soil health need to increase the soil available nutrient content. For this purpose integrated use of organic and inorganic amendments is the best way to maintain soil health (Vanlauwe *et al.,* 2004). Organic fertilizer like manure, FYM, poultry manure, slurry generally are used but it is having high

decomposition rate so need to use those organic manure which having lower decomposition rate for longer period of time (Aslam *et al.,* 2014; Palm *et al.,* 2001).

Biochar is a combination of two words one is "Bio" that means biomass and another one is "Char" that means charcoal (Nartey *et al.,* 2014). It is a solid and high carbon compound in nature. It is made by Pyrolysis. Pyrolysis is a process which known as thermal decomposition of biomass (Aslam *et al.,* 2014). During the biochar production all the biomass install in Pyrolysis chamber under low oxygen condition. It is having more surface area, negative charged surface which will hold the cations from the soil (Dume *et al.,* 2017). Biochar addition expands the porosity in soil. Porosity implies space between two particles present in soil (Bhattacharjee *et al.,* 2015). The biochar treatment were found to build the shoot biomass, root biomass, plant tallness and number of leaves in all the cropping cycles in contrast with no biochar treatment (Gebremedhin *et al.,* 2015). Since biochar draws in and holds soil supplements, it conceivably diminishes fertilizer necessities. As a result, fertilization costs are minimized and fertilizer (organic or chemical) is retained in the soil for longer. On the other hand it also helps to increase the soil K dissolving bacteria which help to increase soil available potassium contents in soil (Wang *et al.,* 2018).

Materials and Methods

Experiment area

The trial was directed at the Agricultural research farm of Lovely Professional University, Phagwara. The cultivated area is geologically occupied at 31 degree 22 minutes and 31.81 seconds' north scope and 75 degree and 23 minutes and 3.02 seconds' east longitude with a height of around 252 meters over the ocean level. This territory falls under the trans-gangetic plain of agro-climatic zone of the Punjab state.

Experimental discussion

The trial was conducted on pot were arranged in completely randomized design with three replication. The hybrid variety of wheat HD2967, obtained from Wheat Research Station, Punjab Agriculture University, Ludhiana, Punjab for Combined application of biochar with fertilizers influence available nitrogen, phosphorus and potassium quantity in soil. Different pots were treated with different level of biochar and fertilizers *viz.,* T_1 (100% RDF), T_2 (3% Biochar+50% RDF), T_3 (3% Biochar+75% RDF), T_4 (3% Biochar+100% RDF), T_5 (5% Biochar+50% RDF), T_6 (5% Biochar+75% RDF), T_7 (5% Biochar+100% RDF) with control. The observation was recorded at 30, 60 and 90 days after sowing with different soil chemical parameter like soil available nitrogen (mg/kg), soil available phosphorus (mg/kg), soil available potassium(mg/kg).

Experimental analysis

Data were analysed by using SPSS 22 and Microsoft excel. Analysis of variance (ANOVA) namely biochar with inorganic fertilizer with seven treatments were performed to see the significant difference on soil chemical parameters. Mean separation was done by using least significant difference after the treatment was found significant at $p< 0.05$.

Results and Discussion

Soil available nitrogen (mg/kg)

Effect of biochar with recommended dose of fertilizer and their combination on soil

available nitrogen was studied in wheat variety HD2967 during the year 2017-18. The data was recorded at 30, 60 and 90 DAS. It is evident that the soil nitrogen was highest in T_3 (17.76) at 30 DAS. The soil nitrogen was minimum in T_1 (12.20) at 30 DAS, non significantly, with T_3 as compare to control. At 60 days after sowing the available nitrogen was increased by 48.03 in T_3 and 45.63 in T_6. The minimum results were shown in T_1 (27.86). The result which estimated at 90 days after sowing it also give same result like 60 DAS. The increment of values was in T3 and T6 as early discussed and minimum value was in T_1 as compare to control. After considered all the result which from 30 DAS to 90 DAS in available nitrogen was increased in T_3 which was combination of 3% biochar + 75% RDF. Gao *et al.,* conclude that in natural process microorganism oxidized ammonia and converted into nitrate which makes soil nitrogen available for plant growth but after application of biochar it increases soil ammonia oxidizing micro organism in soil. Nelissen *et al.,* 2012; Song *et al.,* 2013 also conclude same result (Fig. 1).

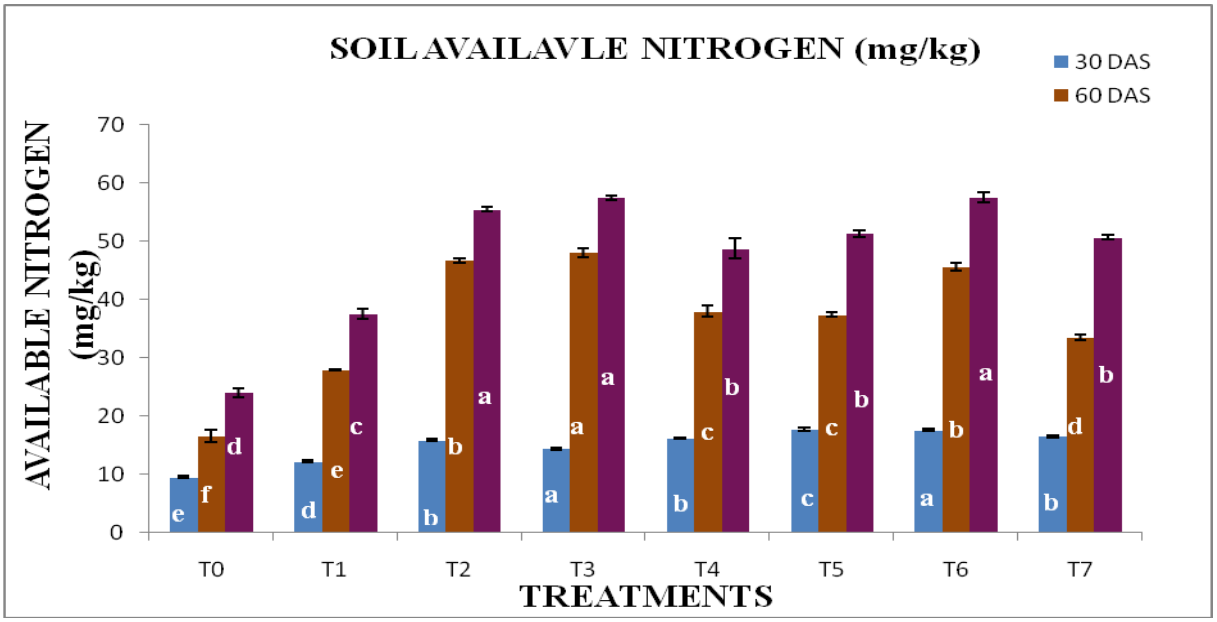
Soil available phosphorus (mg/kg)

Effect of biochar with recommended dose of fertilizer and their combination on soil available Phosphorus (mg/kg) was studied in wheat variety HD2967 during the year 2017-18. The data was recorded at 30, 60 and 90 DAS (Figure 2). It is evident that the higher soil available phosphorus found in T_3 and T_5 with the value of 24.42 mg/kg and 22.40 mg/kg and the lowest available phosphorus found in T_1(19.13) as compare to control at 30 days after sowing. On the other hand after application of biochar with recommended dose the soil available phosphorus was highest in T_3 (32.43) and T_7 (31.16) at 60 days after sowing and the lowest value was found in T_1. The soil available phosphorous also give satisfactory result in T_3 and T_6 with the value of 38.65mg/kg and 37.54mg/kg at 90 days after sowing. In this case also the minimum value was in T_1 as compare to control. So from the above discussion can conclude that biochar helps to increase P availability in soil. Dume *et al.,* 2017 reported that after application of biochar in acid and calcareous soil helps to minimize P insolubility by absorbing the cations. Same result also concludes by the Borno ML *et al.,* 2018. It can be said that biochar application helps to increase P in soil and also helps to maintain sustainability.

Soil available potassium (mg/kg)

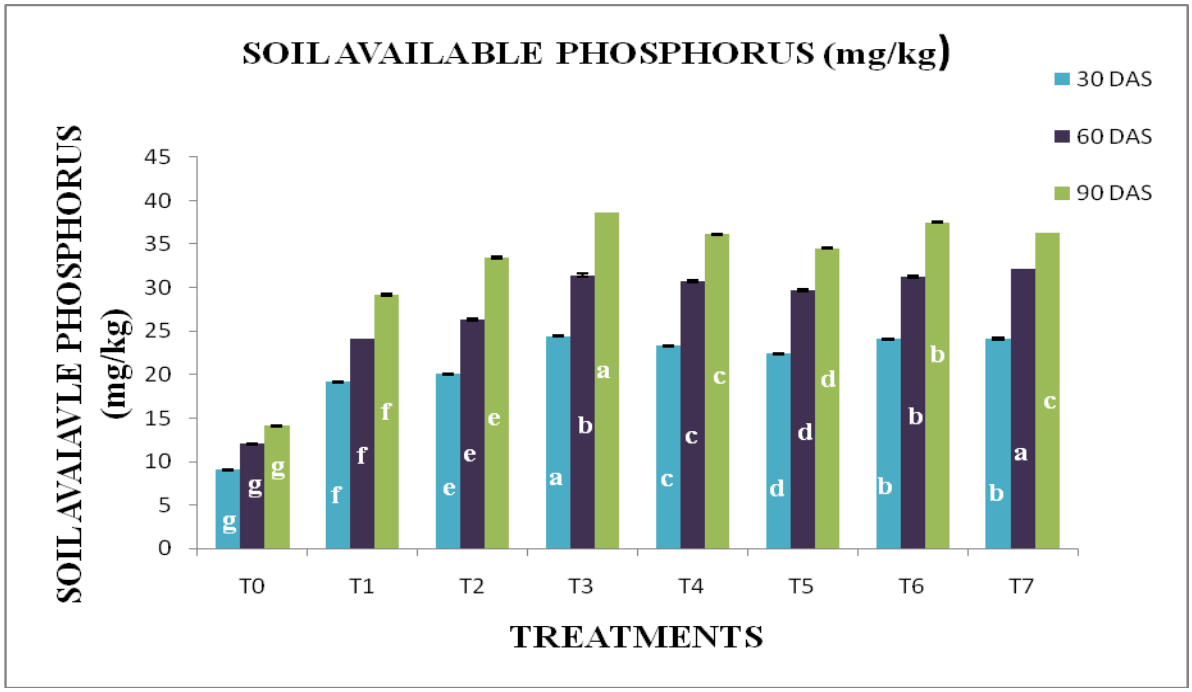
Effect of biochar with recommended dose of fertilizer and their combination on soil available potassium (mg/kg) was studied in wheat variety HD2967 during the year 2017-18. The data was recorded at 30, 60 and 90 DAS (Figure 3). It is revealed that the highest soil available potassium was present in T_3 (48) and T_7 (46) at 30 days after sowing while T_1 having very less quantity of soil available potassium as compare to control. The soil available potassium also gives better result in T_3 and T_7 at 60 and 90 days after sowing. The value was 53 and 54 at 60 DAS respectively with lowest value in T_1 as compare to control. Wang *et al.,* 2018 conduct an experiment to check the effect of biochar application on potassium dynamics of soil resulted that after application of biochar helps to increase the K dissolving bacteria in soil which increase the microbial activity as a result more potassium fixation by the micro organism in soil which helps to increase soil available potassium. On the other hand Gao *et al.,* (2018) reported that biochar with high pH, more surface area, more surface negative charge, and higher charge density has a greater ability to adsorb cations per unit carbon than other soil organic materials which helps to make unavailable form to available form of potassium in soil non significantly.

Fig.1 Effect of combined application of biochar and fertilizers in soil available nitrogen



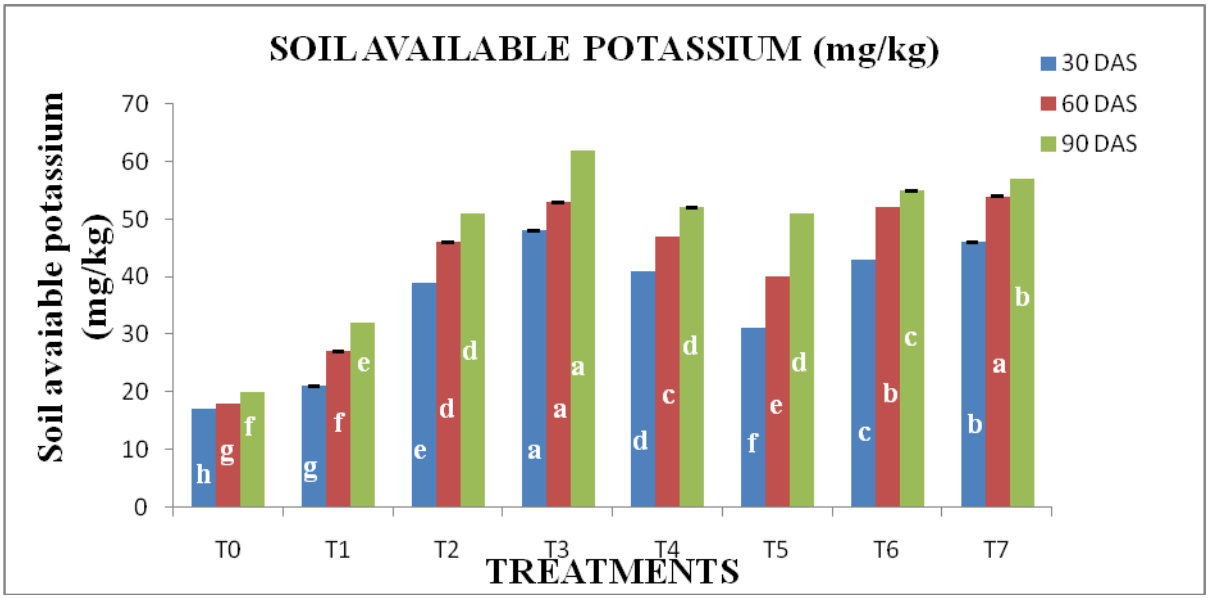
Where, DAS= Days after sowing, Data are in the form of mean ± SEM at p< 0.05. The mean followed by different letters was significantly different at p<0.05 according to DMRT for separation of means. T_0- control; T_1- 100% RDF; T_2- 3% biochar + 50% RDF; T_3 -3% biochar + 75% RDF; T_4- 3% biochar + 100% RDF; T_5-5% biochar + 50% RDF; T_6-5% biochar + 75% RDF; T_7-5% biochar + 100% RDF

Fig.2 Effect of combined application of biochar and fertilizers in soil available phosphorus



Where, DAS= Days after sowing, Data are in the form of mean ± SEM at p< 0.05. The mean followed by different letters was significantly different at p<0.05 according to DMRT for separation of means. T_0- control; T_1- 100% RDF; T_2- 3% biochar + 50% RDF; T_3 -3% biochar + 75% RDF; T_4- 3% biochar + 100% RDF; T_5-5% biochar + 50% RDF; T_6-5% biochar + 75% RDF; T_7-5% biochar + 100% RDF

Fig.3 Effect of combined application of biochar and fertilizers in soil available potassium



Where, DAS= Days after sowing, Data are in the form of mean ± SEM at p< 0.05. The mean followed by different letters was significantly different at p<0.05 according to DMRT for separation of means. T_0- control; T_1- 100% RDF; T_2- 3% biochar + 50% RDF; T_3 -3% biochar + 75% RDF;T_4- 3% biochar + 100% RDF; T_5-5% biochar + 50% RDF; T_6-5% biochar + 75% RDF; T_7-5% biochar + 100% RDF

In conclusion, the experiment emphasizes an overview of specific knowledge about biochar interaction in soil. The application of biochar increases the soil available nitrogen, phosphorus, and potassium because of its porous structure which helps to increase soil nutrient retention. Incorporation of biochar increase the ammonium absorbing bacteria and potassium dissolving bacteria in cultivate soil. It not only increase the microbial activity also helps to absorb the cations which may helps to increase the phosphorus availability in soil. The main purpose of this review is to gives knowledge about biochar, and to recommend for research needs to systematically understand about the biochar Nutrient interaction with soil over a longer period of time.

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