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ENHANCING WHEAT CROP YIELD AND GROWTH WITH INTEGRATED APPLICATION OF BANANA DERIVED BIOCHAR AND PRESS MUD

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A B S T R A C T

Biochar and press mud improves plant growth and crop productivity. However, biochar interaction with press mud in calcareous soil is not fully recognized. The man objective of the present study was to determine the effect of the banana derived biochar and press mud on the growth and the yield components of wheat crop. The experiment was conducted at Lasbela University of Agriculture, Water and Marine Sciences, Uthal Balochistan. Five treatments i.e., T1 control (No amendment), T2 biochar (40 tons ha^{-1}), T3 (40 tons ha^{-1} biochar + 25 tons ha^{-1} press mud), T4 (40 tons ha^{-1} biochar + 12.5 tons ha^{-1} press mud) and T5 (25 tons ha^{-1} press mud) were kept. Results revealed that combine application of 40 tons ha^{-1} biochar + 25 tons ha^{-1} press mud increased the plant fresh weight by 51%, root fresh weight by 39 %, root dry weight by 50%, shoot fresh weight by 123.2%, shoot dry weight by 65%, plant height by 38%, root length 45%, spike length 55% and number of grains per spike 65% as compared to control where no any amendments was applied. Increase in all attributes was due to suitable and positive short term effect of banana derived biochar and press mud availability near the root zone. The results proved that combine application of banana derived biochar and press mud significantly increased the growth and yield parameters of the wheat crop as compared to the control treatment.

Keywords: Biochar; Press mud; Yield; Growth biomass; Wheat crop

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INTRODUCTION

Wheat (*Triticum aestivum* L.) is considered as an key cereal crop for food among the world. Maize (Zea mays L.) and wheat are the foremost cereal crops for the food production in the world (Zhang et al., 2017a). Wheat is the utmost essential cereal crop from food security point of view and it is considered as the largest crop among cereals of the country cultivated under almost all ecological zones of Pakistan. Wheat belongs to poacea family, among all cereal crops, wheat has a high value in the world, measured by production or cultivated land area (Jagshoran and Tripathi, 2004). Wheat has been grown worldwide on the land of 215,901,958 million ha, which produced 765,769,635 million tons of grains with an average yield of 35,468 kg ha^{-1} during 2019 (FAO, STAT). In Pakistan during 2019, wheat has been grown on the land of 8,677,730 million ha According to the data released by FAO, the world's wheat production has reached 24,348,983 million tons. The countries that are major wheat producers are China, India, Russia, USA, and Canada. Pakistan is at 7th place in the world's wheat production. In Pakistan, small-scale farmers grow wheat, which contributes for 15% of all agriculture and much more than 50% of all agricultural production (Anon., 2011). It is particularly nutrient-dense because it produce more amino acids per acre than animal's products (Qiu et al., 2008). It reached its upper spot as a results of the unique protein known as gluten which is in charge of wheat flours capacity to produce breads (Agegnehu et al., 2015).

Water resources and food production have been significantly impacted by the ongoing rise in world population. Due to use of continuous chemical fertilizer and the lack of organic additions, agricultural soil fertility is continuously declining. The usage of nitrogen fertilizers in particular (Neff et al., 2002) has reduced soil organic carbon (SOC) levels (Sial et al., 2019), and inefficient fertilizer use (Azhar et al., 2019) also pays to the deterioration of soil fertility. Due to the high cost of fertilizer inputs farmers apply wide dose of chemical fertilizers to produce maximum grain yields (Zhang et al., 2016), which has major environmental and economic consequences (Zhang et al., 2017b). Ali et al. (2020) found that applying chemical fertilizer to agricultural fields continuously and exclusively results in soil degradation and poor crop quality (Jones et al., 2013). For soil organic carbon stock and root characteristics, chemical fertilizers alone are ineffective. These significant problems affect farming systems everywhere (Khan et al., 2019). Providing for the food coming generations will put additional strain on the soil and water resources (Laghari et al., 2015). Some previous studies (Akhtar et al., 2018; Ding et al., 2018; Sial et al., 2019) reported that co application of chemical fertilizers along with organic amendments enhanced the soil fertility and boosted crop development, grain production, and root characteristics. Particularly, recycling nutrient through the creation of biochar from organic waste and their use as a soil amendments is a sustainable method for meeting crop nutrient needs and root characteristics (Ali et al., 2020; Kubar et al., 2022; Sial et al., 2019). The plant receives nutrients from the soil media mostly through its roots, where it also connects to its above-ground biomass and soil water (Sial et al., 2019). Numerous environmental problems, including stress of water, salt stress, poor soil fertility, and metal toxicity have an impact on this path way (Kubar et al., 2023; Laghari et al., 2015; Sial et al., 2019). Applying biochars to agricultural soil has been shown to be beneficial for combating change of climate and soil carbon sequestrations and it is also had favorable impacts on root morphology and functions (Prendergast-Miller et al., 2014).

Rapid nutrient losses and declining soil fertility in third-world nations are the greatest threats to food security and agriculture production (Jones et al., 2012). Agricultural nutrients are scarce, thus synthetic fertilizers are used more frequently than organic ones (Nicholson et al., 1999). Due its spectacular achievements, that have doubled and sometimes quadrupled agricultural grain yields when compared to organic manure, use of artificial fertilizers has been considered as a need for expanding crop production since the green revolution (Widowati et al., 2011). Other side the rate of fertilizers slowly increase for the same production from year to year due to reduction in the soil quality. Inorganic fertilizers use not only stunts yield production but also harms the soil and causes a host of environment problems (Liu et al., 2010). The availability of plant nutrients and soil production are improved by long-term usage of biochar (Kubar et al., 2020; Steiner et al., 2004). Compared to using no biochar, using biochar increase the amount of available P, exchangeable Ca, Mg, and K (Sukartono et al., 2011). Improved soil N content and wheat nutrient uptake are results of using biochar in conjunction with other organic additions (Ali et al., 2015). It may also enhance cations exchange capacity which strengthens the capability to hold nutrients (Castaldi et al., 2011). Utilizing biochar speeds up nutrient absorption (Ali et al., 2015). Similar to how applying biochar enhanced nitrogen content of soil, content of the organic carbon and pH (Zhang et al., 1998). According to Lehmann et al. (2003) and Steiner et al. (2004), biochar infused soil increased the efficiency of nitrogen uptake. The use of biochar is necessary to improve soil biology that influences microorganisms and structure (Steiner et al., 2004).

Biochar, also known as BC, is referred to as "Black Gold" in the agricultural sector. Through a process known as pyrolysis which is the anoxic breakdown of organic molecules thermally transformed into the charred solid materials (Ahmed et al., 2024; Joseph et al., 2010). Biochar is the most effective method for combating the negative effects of climate change through carbon sequestration, as it also enhances soil fertility and the water holding capacity to increase crop yields (Hussain et al., 2017; Lehmann and Joseph, 2015). BC amended soil boosts agricultural output in arid and irrigated areas by retaining more precipitation and using less irrigation water (Basso et al., 2013). Crop residue derived BC increased the soils ability to hold water and its porosity, preserving the soils organic fertility and lowering carbon dioxide emissions (Sohi et al., 2010).

Sugarcane press mud is the term for the solid byproduct of the filtration of sugarcane juice. The juice is separated in a clear liquid that rise into the top and is used to make sugar and a mud like juice that sinks to the bottom after it has been filtered (Bokhtiar et al., 2001; Gaikwad et al., 1996; Sharma et al., 2019). The suspended materials are filtered to remove the fine bagasse and insoluble salts (Partha and Sivasubramanian, 2006). For every 100 kg of sugarcane, a variable yields of a filter cake or press mud varies from 1 to 7 kg (on a wet basis). Global production of filter fresh press mud might be projected to be 30 million tones with conservative yields of 2% and a total productions of 1700 million tons in 2009 (Yaduvanshi and Swarup, 2005).

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Pressmud, a byproduct of the sugar industry that is a solid waste, is rich in micronutrients, NPK, and OC (Rakkiyappan et al., 2001). As a result, the press mud can be used to improve organic fertilizer quality, provide an alternative supply of agricultural nutrients, and improve soil quality (Bangar et al., 2000; Juwarkar et al., 1993). Numerous investigations have been conducted to see if Press mud can be used to grow crops and produce power (Ibrahim et al., 2008; Partha and Sivasubramanian, 2006; Yaduvanshi and Swarup, 2005).

Amongst organic sources of nutrition, press mud a byproduct of the sugar industry, occupies a distinctive position. Press mud can be utilised as a good basis of organic matter, a replacement for plant nutrients, and a soil conditioner, according to Bokhtiar et al. (2001). It's also called as filter mud and filter cake and it is used as manure in soil (Sharma et al., 2019). Pressmud is abundant in ash containing P, Ca, Mg, Si, and K oxides as well as fiber, crude protein, sugar, crude wax, and lipids (Partha and Sivasubramanian, 2006). Pressmud organic material is very soluble and accessible to the microbial activity, and consequently to the soil (Rangaraj et al., 2007). Additionally, the sugarcane pressmud typically contains a trace quantity of heavy metals like lead, copper, and zinc (Kumar and Chopra, 2015; Rangaraj et al., 2007). When utilized as an amendment, the high concentration of these compounds in pressmud of sugarcane not only impacts crop growth but also ruins the soil qualities (El-Keltawi et al., 2003; El-Naggar, 2005; Sarwar et al., 2008).

Biochar is a carbon-rich material derived from biomass, while press mud refers to the residual organic matter obtained from sugarcane processing. The aim of this study is to investigate how application of biochar and press mud together effects on various aspects of wheat cultivation. By studying these aspects, researchers can determine whether a combination of biochar and press mud can be an effective strategy for improving agricultural productivity while also managing waste materials generated by sugarcane processing. These experiments demonstrate once more how adding biochar to compost can enhance its properties, giving it a maximum added value and improved carbon sequestrations potential. Keeping these facts in mind, this present study was conducted to determine the eeffect of the banana derived biochar and press mud on the growth and the yield components of wheat crop

MATERIALS AND METHODS

The experiment was established in Rabi season during 2020-21 at the department of Soil Science of the Lasbela university of Agriculture water and marine sciences (25.8420° N, 66.6248° E). The area climate is tropical, with mean annual rainfall of 30.48 mm in the summer and mean maximum temperature of 40°C, and lowest temperatures of 28.3°C respectively. Minimum temperature in winter is 10.5°C with a maximum temperature of 26.1°C. Ca, Mg and Na deficiencies exist in the soil.

Experimental Design

Randomized complete block design was the experiment's chosen experimental design. Four replicates of a randomized complete block split plot design were employed for each crop. Plots were treated with various concentrations of biochar and press mud or a mix of biochar and press mud. The initial treatment, which had no modifications, was regarded as the control treatment (T1). Treatments two was 100% of Biochar of banana derived (T2) . Treatment three was the 50% of biochar of banana derived and 50% of press mud (T3) . Treatment four was 25% of biochar of banana derived and 50% of press mud (T4) .Treatments five was 100% of press mud. The biochar and press mud was applied on the soil before the day of sowing. The biochar was applied on the soil and thoroughly mixed with deep soil. The press mud was applied on the surface of soil using RCBD with four replications. The experimental details are given below:

Treatments Details

T1: Control (No amendment)

T2: Biochar 40 tons ha^{-1}

T3: 40 tons ha^{-1} Biochar + 25 tons ha^{-1} press mud

T4: 40 tons ha^{-1} biochar + 12.5 tons ha^{-1} press mud

T5: 25 tons ha^{-1} press mud

Seed Sources

The Wheat seeds were purchased from a store in Uthal. The used variety of wheat is Local variety.

Soil Analyses

Two soil sample were taken from the site of experiment at depth of 0-15 and 15-30cm. To create a composite sample, each soil sample was properly mixed after being randomly selected from two different field locations. Prior to analysis, the composite sample was air-dried for 24 hours after being run through a 2-mm sieve. By suspending soil in distilled water at a 1:2 ratio, This present study had about 8.22 pH, electrical conductivity 146.3 us/cm, and 314 mg/l TDS.

Collection of Biochar and Press Mud

The banana leaves were collected from the local farm of the Uthal city. Used Banana leaves for production of biochar. Biochar was prepared using a furnace in the soil science department green house at the LUAWMS in Uthal. Banana leaves were pyrolyzed by slow pyrolysis at a high temperature of 400 °C for 1 hour and applied on the field. The sugar cane was collected in the local market from sugarcane juice shop of Uthal city and were dried in the green house and later applied on the field.

Observation of Parameters

In this experiment different observation factors are used to determine Effect of the Banana derived biochar and pressmud on the yield and growth components of wheat crop. Each parameter is separately discussed along with observation. The parameters include plant fresh weight, root fresh weight, shoot fresh weight, root dry weigh, shoot dry weight, number of leaves per plant, plant height, root length, numbers of grain per spike and spike length.

Statistical Analysis

Statistical analysis of variance (ANOVA) was carried out using STATITAX 8.1 software by one way ANOVA. Difference among the treatments was checked through the LSD.

RESULTS AND DISCUSSION

Effect of the Banana Derived Biochar and Press Mud on Plant Fresh Weight

Banana derived biochar and pressmud significantly affected the plant fresh weight of the wheat crop in uthal region Balochsitan (Figure 1). The highest plant fresh weight 3.48 g was recorded under the combine applications of 25 tons ha^{-1} pressmud and 40 tons ha^{-1} biochar followed by the treatment 40 tons ha^{-1} biochar along with 12.5 tons ha^{-1} press mud. While, the lowest plant fresh weight 0.7 g was achieved under the control treatment where no application of biochar and press mud was applied. In general, banana derive biochar and press mud had significant contribution for the yield, biomass and growth components of the crop of wheat. In our study. Biochar and pressmud positively increased the fresh biomass of the wheat crop. Our study outcomes remain in the agreements with research conducted by (Ali et al., 2020). Ijaz et al. (2020) undertook a study to evaluate the use of biochar made from several organic feedstocks, including sugarcane press mud, farmyard manure, and poultry manure. According to those who conducted the research, application of biochar derived from farmyard manure (FYM) increased the number of tillers (77%), plant height (69), chlorophyll SPAD value (74%), grain production (77%) and biological yield (82%) of wheat.

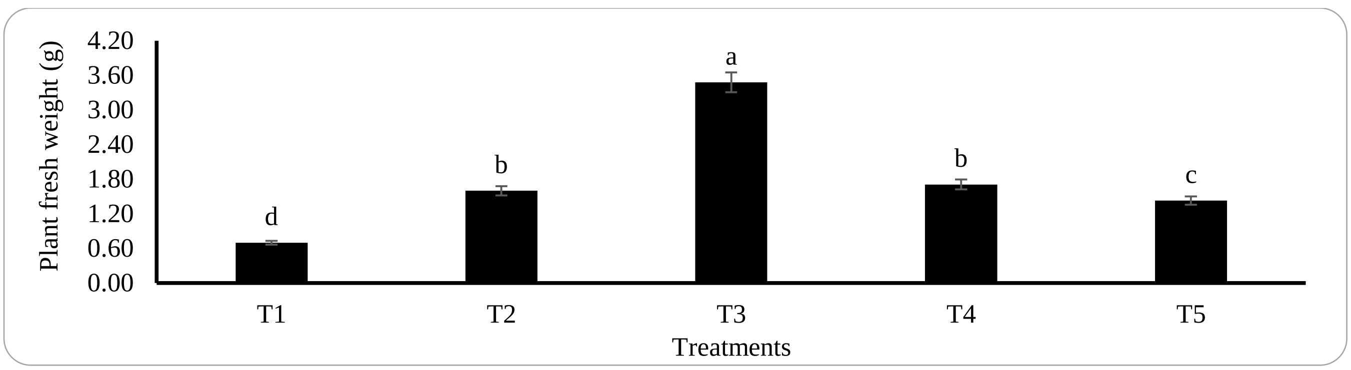

Figure 1. Influence of the banana derived biochar and press mud on plant fresh weight of the wheat crop.
T1 Control (No amendment), T2 Biochar (40 tons ha^{-1}), T3 (40 tons ha^{-1} Biochar + 25 tons ha^{1} press mud), T4 (40 tons ha^{-1} biochar + 12.5 tons ha^{-1} press mud) and T5 (25 tons ha^{-1}) press mud.

Effect of the banana derived biochar and press mud on shoot fresh weight

Banana derived biochar and pressmud significantly affects the shoot fresh weight of the wheat crop in uthal region Balochsitan (Figure 2). Highest shoot fresh weight 3.03 g was recorded under the combine applications of 25 tons ha^{-1} pressmud and 40 tons ha^{-1} biochar followed by 1.55 g in treatment 40 tons ha^{-1} biochar along with 12.5 tons ha^{-1} press mud. While, the lowest shoot fresh weight 0.56 g was achieved under the control treatment where no application of biochar and press mud was applied. Biochar made from bananas and press mud generally contributed significantly to the maize crop's growth, biomass, and yield in our research. The shoot fresh weight of the wheat crop was positively increased by biochar and press mud. The findings of our investigation are similar with other studies by conducted (Abbas et al., 2017; Ali et al., 2015). Budiyanto (2021) conducted a study whose outcomes revealed interactions between potassium fertilizer and sugarcane press mud compost on the effects dry weight, fresh weight, shoot fresh weight and root dry weight. With the use of a combine treatments involving 25 tons of sugarcane pressmud composts per hectare and 90kg of K_2O per hectare the maximum dry weight and fresh weight dry weight of shoots were obtained (B_2P_2). The B0P3 mixture, which contained 0 tons of sugarcane pressmud compost and 120kg of K_2O per hectare, provided the maximum dry weight and of the plant roots.

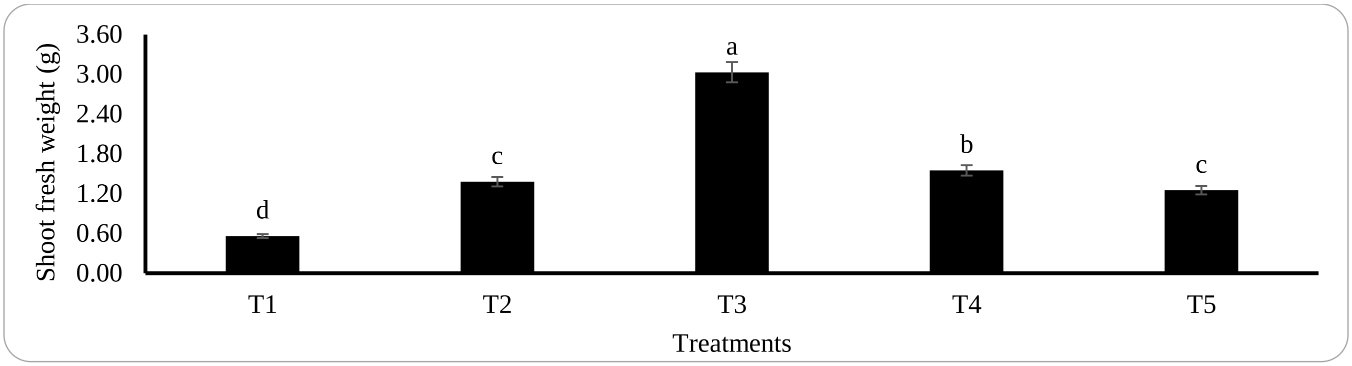

Figure 2. Influence of the banana derived biochar and press mud on plant shoot fresh weight of the wheat crop.
T1 Control (No amendment), T2 Biochar (40 tons ha^{-1}), T3 (40 tons ha^{-1} Biochar + 25 tons ha^{1} press mud), T4 (40 tons ha^{-1} biochar + 12.5 tons ha^{-1} press mud) and T5 (25 tons ha^{-1}) press mud.

Effect of the banana derived biochar and press mud on root fresh weight

Banana derived biochar and pressmud significantly affected the root fresh weight of the wheat crop in uthal region Balochsitan (Figure 3). The highest root fresh weight 0.45 g was recorded under the combine applications 25 tons ha^{-1} pressmud and 40 tons ha^{-1} biochar followed by the treatment Biochar alone 0.21 g. While the minimum root fresh weight 0.13 g was achieved under the control treatments where no application of biochar and press mud was applied. Generally Biochar made from bananas and press mud contributed significantly to the wheat crop's growth, biomass, and yield. The root fresh weight of the wheat crop was positively increased by biochar and press mud. The findings of our investigation are comparable with these other studies (Ijaz et al., 2020; Sadaf et al., 2017). Majeed et al. (2021) conducted a study in which the effects of 1% w/w rates of farmyard manure, rice straw biochar, maize stalk biochar, and press mud (PRM) were investigated. The results showed that in comparison to the control treatment, the addition of amendments increased the straw production grains number per spike and grain yield. While increasing the phosphorus (P), nitrogen (N), potassium (K) and zinc (Zn) concentrations in the wheat plants' leaves and grain.

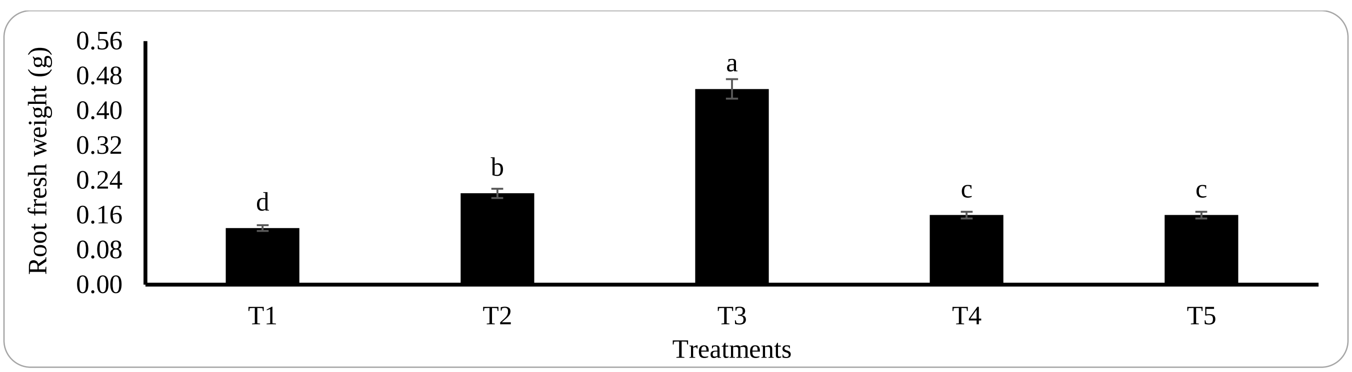

Figure 3. Influence of the banana derived biochar and press mud on root fresh weight of the wheat crop.
T1 Control (No amendment), T2 Biochar (40 tons ha^{-1}), T3 (40 tons ha^{-1} Biochar + 25 tons ha^{1} press mud), T4 (40 tons ha^{-1} biochar + 12.5 tons ha^{-1} press mud) and T5 (25 tons ha^{-1}) press mud.

Effect of the banana derived biochar and press mud on shoot dry weight

Banana derived biochar and pressmud significantly affected the shoot dry weight of the wheat crop in uthal region Balochsitan (Figure 4). The highest shoot dry weight 1.28 g was observed under the combine applications of 25 tons ha^{-1}

pressmud and 40 tons ha^{-1} biochar followed by the treatment Biochar 0.64g. While lowest shoot dry weight 0.29 g was achieved under the treatment control where no application of biochar and press mud was applied. generally In our investigation, the wheat crops growth, biomass, and yield were considerably influenced by biochar generated from press mud and bananas. Biochar and press mud helped to positively boost the shoot dry weight in the wheat crop. Our study findings are in the agreement with the studies conducted by Budiyanto (2021). study conducted by Abbas et al. (2017), it was found that applying BC and press mud increased spike length, plant height and grains yield in a dose dependent way when compared to treatment control. In comparison to controls, biochar treatments increased the photosynthetic pigment characteristics and gaseous exchange in leaves. BC treatment increased the action of antioxidant enzyme while lowering oxidative stresses in the shoot when compared to the control.

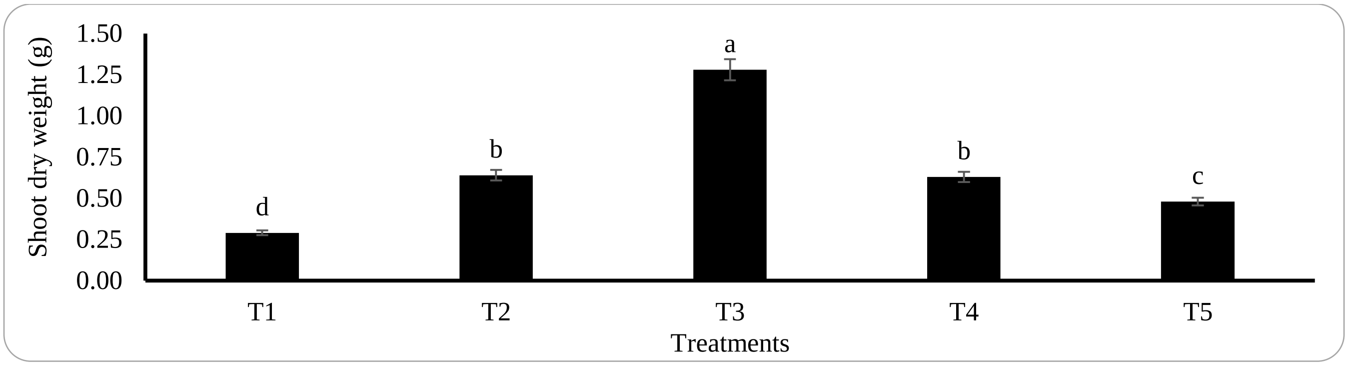

Figure 4. Influence of the banana derived biochar and press mud on shoot dry weight of the wheat crop.
T1 Control (No amendment), T2 Biochar (40 tons ha^{-1}), T3 (40 tons ha^{-1} Biochar + 25 tons ha^{1} press mud), T4 (40 tons ha^{-1} biochar + 12.5 tons ha^{-1} press mud) and T5 (25 tons ha^{-1}) press mud.

Effect of the banana derived biochar and press mud on root dry weight

Banana derived biochar and pressmud significantly affected the roots dry weight of the wheat crop in uthal region Balochsitan (Figure 5). The highest root dry weight 0.21 g was found under the combine applications 25 tons ha^{-1} pressmud and 40 tons ha^{-1} biochar followed by the treatment biochar 0.17g. While minimum dry root weight 0.1 g was achieved under treatment control where no application of biochar and press mud was applied. In general, banana derives biochar and press mud had significant contribution for the biomass, growth and yields component of wheat. In our study biochar and press mud positively increased the root dry weight of the wheat crop. Our study outcomes are in the agreements with the studies conducted by (Abbas et al., 2017; Ijaz et al., 2020). In a study by Azhar et al. (2019), the efficiency of biochar made from various feed stocks, such as cotton sticks biochar, rice husk biochar and wheat straw biochar were compared to that of conventional organic material, such as poultry manure, farm manure and pressmud for their capacity to indorse plants growth development.

Effect of the banana derived biochar and press mud on number of Leaves/Plant

Banana derived biochar and pressmud significantly affected the leaves number per plant of the wheat crop in uthal region Balochistan (Figure 6). The Maximum numbers of leave per plant 4.66 was observed under the applications of biochar followed by the treatment press mud 4.5. While, the lowest number of leaves per plant 3.66 was achieved under the control treatment where no application of biochar and press mud was applied. Biochar made from bananas and press mud generally contributed significantly to the wheat crop growth, biomass, and yield. In the current research biochar and press mud meaningfully increased the number of leaves\plant in wheat crop. Findings of our study are constant with these of studies (Ahmed et al., 2024; Majeed et al., 2021). Ahmed et al. (2024) conducted a study to examine the combined effect of banana derived biochar and straw residues application on the biomass production and the yield components of maize crop, who found that combine effect of Biochar with straw residues enhanced the shoot fresh biomass (208%), Root fresh biomass (85%), Root length (85%), Number of grains per cob (262%), Seed index (68%), cob length (79%), grain yield (120%) and leaf area (80%) as compared to control. While, Most of the growth parameters were positively correlated with yield components.

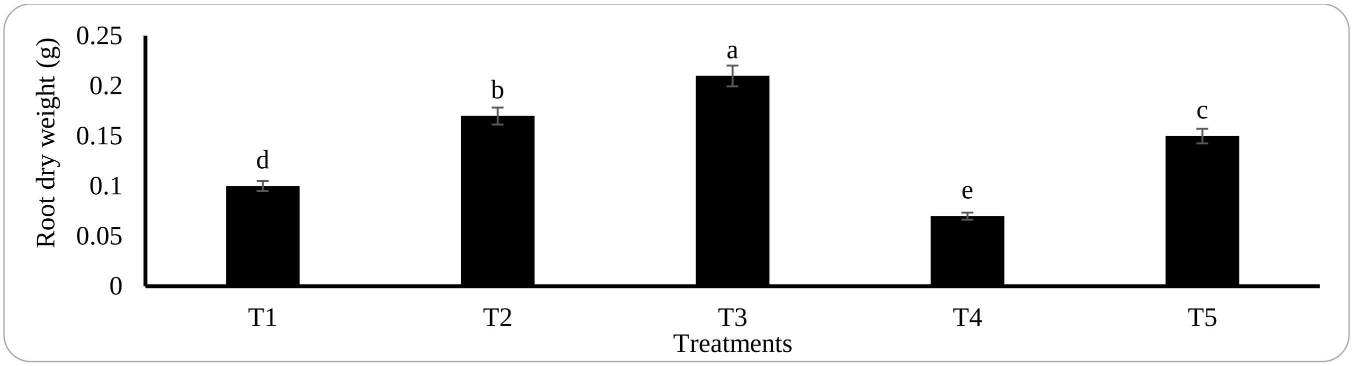

Figure 5. Influence of the banana derived biochar and press mud on root dry weight of the wheat crop.
T1 Control (No amendment), T2 Biochar (40 tons ha^{-1}), T3 (40 tons ha^{-1} Biochar + 25 tons ha^{1} press mud), T4 (40 tons ha^{-1} biochar + 12.5 tons ha^{-1} press mud) and T5 (25 tons ha^{-1}) press mud.

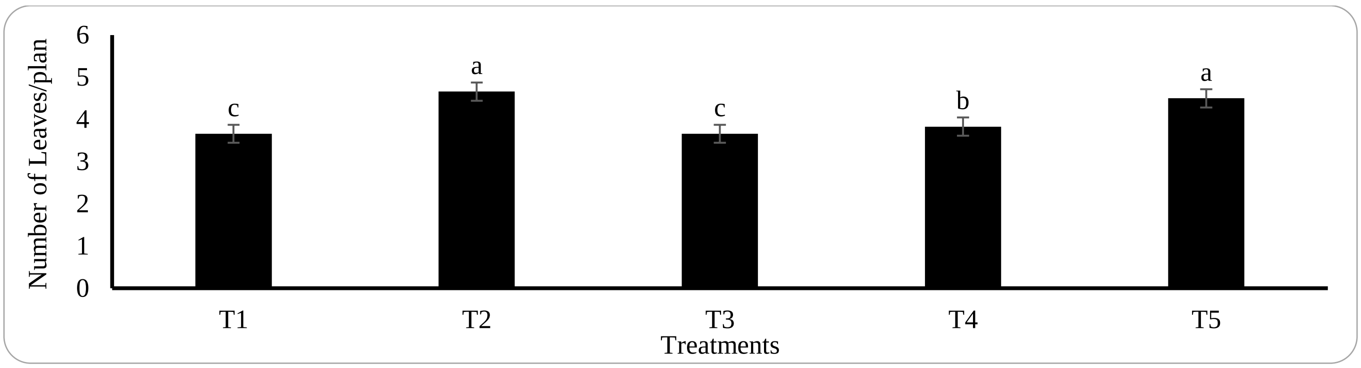

Figure 6. Influence of the banana derived biochar and press mud on number of leaves per plant if the wheat crop.
T1 Control (No amendment), T2 Biochar (40 tons ha^{-1}), T3 (40 tons ha^{-1} Biochar + 25 tons ha^{1} press mud), T4 (40 tons ha^{-1} biochar + 12.5 tons ha^{-1} press mud) and T5 (25 tons ha^{-1}) press mud.

Effect of the banana derived biochar and press mud on plant height (cm)

Banana derived biochar and pressmud significantly affected the height of plant of the wheat crop in uthal region Balochsitan (Figure 7). The maximum plant height 26.83 cm was observed under the combine applications of 25 tons ha^{-1} pressmud and 40 tons ha^{-1} biochar followed by 23.16 cm in the treatment of 40 tons ha^{-1} biochar along with 12.5 tons ha^{-1} press mud and 23.16 in the treatment of press mud. While lowest plants height 19.33 cm was achieved under the treatment control where no application of biochar and press mud was applied. In general, banana derive biochar and press mud had significant contribution for yield biomass and growth components of the wheat. In our study biochar and press mud positively increased the plant height of wheat crop. Our study outcomes are in the agreements with studies conducted by Ali et al. (2020) and Rawat et al. (2021). According to a study by Ahmed et al. (2024), the applications of PM+MUD+ BC+ 1/2 NPK increased number of leaves (17), plant height (201 cm), leaf area (184.3 cm), leaf dry weight (30 g), stem diameter (18 mm), forage yields (31 mg ha^{-1}), and dry biomass yields when compared to the control treatments (12.7 Mg ha^{-1}). Forage quality characteristics as acid detergent fiber, brix percentage, crude protein, and acid detergent lignin presented the highest values with the applications of BC+MUD+PM +1/2 NPK.

Effect of the banana derived biochar and press mud on root length

Banana derived biochar and pressmud significantly affected the root length of the wheat crop in uthal region Balochsitan (Figure 8). The highest root length 3.25 inch was recorded under the application of biochar followed by the treatment control and treatment of 40 tons ha^{-1} biochar along with 12.5 tons ha^{-1} press mud 2.5 inch. While, the lowest root length 2.08 inch was achieved under the combine applications of 40 tons ha^{-1} biochar and 25 tons ha^{-1} press mud. Biochar made from bananas and press mud generally contributed significantly to the wheat crops growth, biomass, and yield. In our research the wheat crop root length was improved by biochar and press mud. The findings of our investigation are similar with some other studies Budiyanto (2021) and Eazhilkrishna et al. (2017). Rawat et al. (2021) the finger millet crop is the subject of field studies utilizing press mud and biochar. The findings show a 30–50% increase in soil nutrients like N, P, and K following the trial. Positive growth and yield metrics lead to improved plant height and weight, root and shoot length, and improved phosphorous uptake. When compared to the control, the lengths of the shoots and roots at harvest had improved by 54% and 96%. At 130 days after sowing the weight of grains per plant rise by 70%.

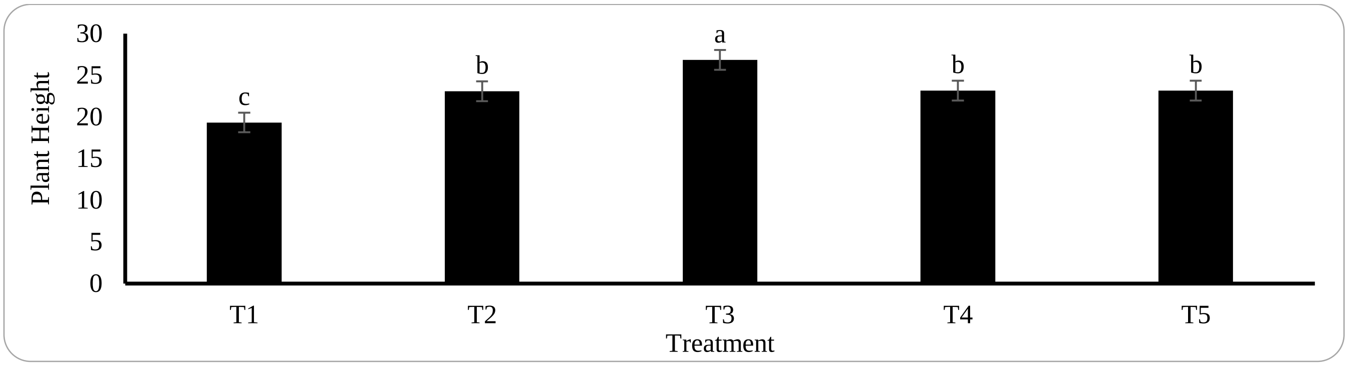

Figure 7. Influence of the banana derived biochar and press mud on plant height of the wheat crop.
T1 Control (No amendment), T2 Biochar (40 tons ha^{-1}), T3 (40 tons ha^{-1} Biochar + 25 tons ha^{1} press mud), T4 (40 tons ha^{-1} biochar + 12.5 tons ha^{-1} press mud) and T5 (25 tons ha^{-1}) press mud.

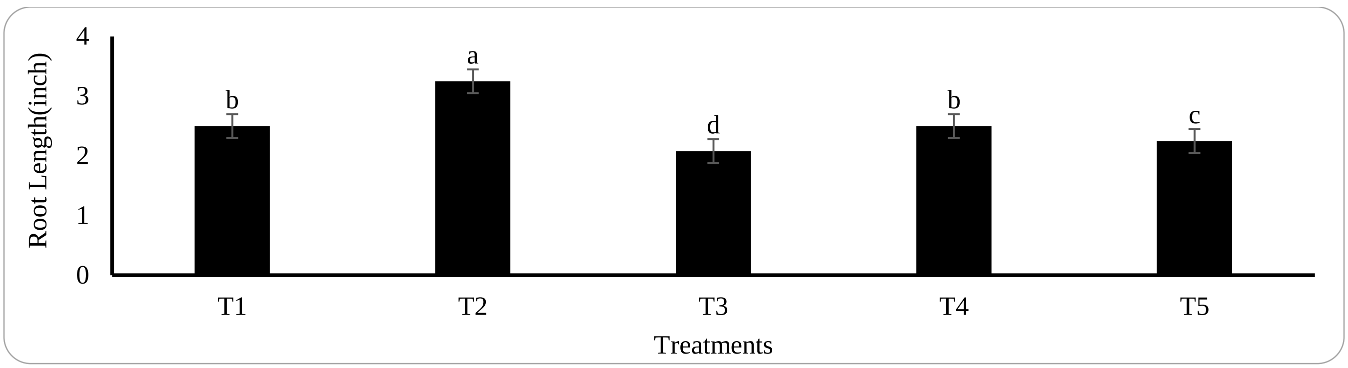

Figure 8. Influence of the banana derived biochar and press mud on plant root length of the wheat crop.
T1 Control (No amendment), T2 Biochar (40 tons ha^{-1}), T3 (40 tons ha^{-1} Biochar + 25 tons ha^{1} press mud), T4 (40 tons ha^{-1} biochar + 12.5 tons ha^{-1} press mud) and T5 (25 tons ha^{-1}) press mud.

Effect of the banana derived biochar and press mud on spike length

Banana derived biochar and pressmud significantly affected the spike length of the wheat crop in uthal region Balochsitan (Figure 9). The highest spike length 5.5 cm was observed under the combine applications of 25 tons ha^{-1} pressmud and 40 tons ha^{-1} biochar followed by 4.66 cm in the treatment of 40 tons ha^{-1} biochar along with 12.5 tons ha^{-1} press mud. While, the lowest spike length 3.16 cm was achieved under the control treatment where no application of biochar and press mud was applied. Generally banana derive biochar and press mud had significant contribution for the biomass, growth and yields components of the wheat. In our research biochar and press mud positively increased the plant spike length of wheat crop. Our study findings remain in agreements with the studies conducted by Sukartono et al. (2011) and Ali et al. (2015). Sharma et al. (2019) came to the conclusion that the highest growth parameters, dry weight of nodules, plant height, crop growth, number of nodules per plant, leaf area index, dry matter accumulation, number of branches per plant, chlorophyll content, the maximum yields attributes and yield, length of pods, pods number per plant, number of seed pods, seeds yield (922.60 kg ha^{-1}), test weight, straw yields (2496.10 kg ha^{-1}).

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Effect of the banana derived biochar and press mud on spike on number of grain per spike

Banana derived biochar and press mud significantly affected the grains number per spike of grains per spike of wheat of the wheat crop in uthal region Balochsitan (Figure 10). The maximum number of grain per spike 10.16 was observed under the combine applications of 25 tons ha^{-1} pressmud and 40 tons ha^{-1} biochar followed by 6.5 in the treatment of biochar. While the lowest number of grain per spikes 3.66 was achieved under the control treatment where no application of biochar and press mud was applied. In general, banana biochar and press mud had a considerable impact on the wheat crop growth, biomass, and yield components. In our study. The plant grain per spike of the wheat crop was positively impacted by biochar and press mud. The findings of our investigation are consistent with some other studies (Sial et al., 2019).

Muhammad et al. (2020) conducted a study in which the findings of the BCs demonstrated that increasing HTT has resulted in notable beneficial changes in basic properties such as, cation exchange capacity, dissolved organic carbon, porosity, surface area potassium and phosphorus. According to the wheat crop's analytical results, the applications of BC considerably (p 0.05) decreased the concentrations of PTEs in the plant shoot (38–91%), plants roots (48–95%), grains (38–93%) and leaves (30–91%). Following the application of BCs, the following agronomic characteristics were improved shoot length, germination rate, spike biomass, shoot biomass, spike length, root biomass and grain biomass. These improvements ranged from 6 to 18%, 18 to 38, 17 to 46, 13 to 45, 15 to 42, 22 to 55, and 34-57%, respectively.

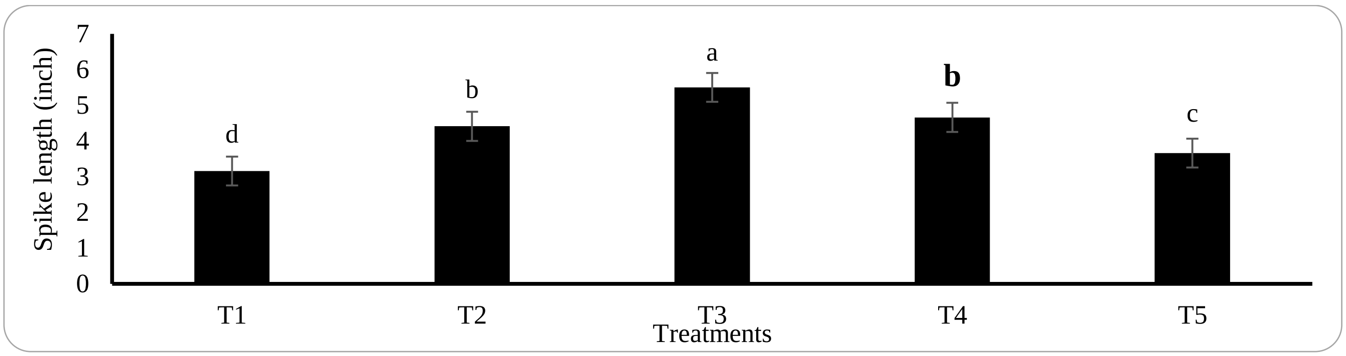

Figure 9. Influence of the banana derived biochar and press mud on plant spike length of the wheat crop.
T1 Control (No amendment), T2 Biochar (40 tons ha^{-1}), T3 (40 tons ha^{-1} Biochar + 25 tons ha^{1} press mud), T4 (40 tons ha^{-1} biochar + 12.5 tons ha^{-1} press mud) and T5 (25 tons ha^{-1}) press mud.

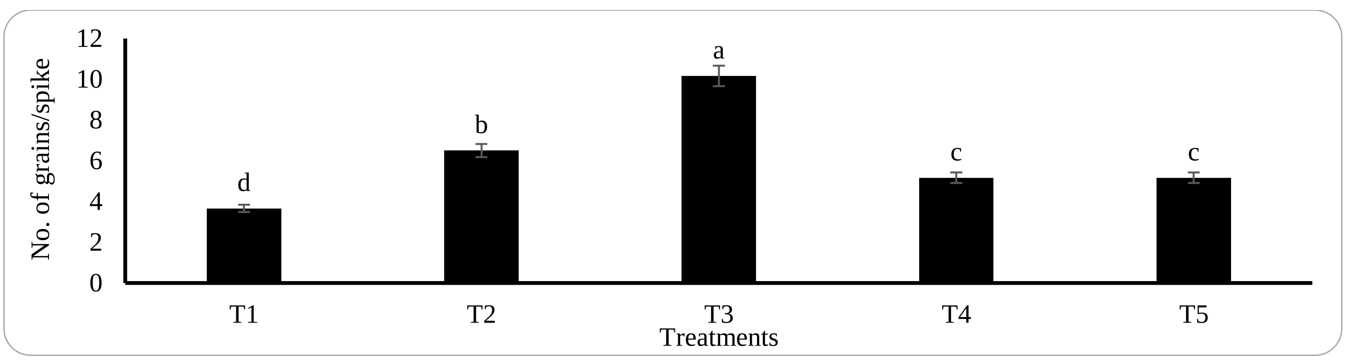

Figure 10. Influence of the banana derived biochar and press mud on plant number of grains per spike of the wheat crop.
T1 Control (No amendment), T2 Biochar (40 tons ha^{-1}), T3 (40 tons ha^{-1} Biochar + 25 tons ha^{1} press mud), T4 (40 tons ha^{-1} biochar + 12.5 tons ha^{-1} press mud) and T5 (25 tons ha^{-1}) press mud.

CONCLUSION

The findings demonstrated that combine application of press mud 25 tones ha^{-1} and biochar 40 tones ha^{-1} improved wheat growth and yield components. The best organic soil addition for improving wheat development, grain yield, and environmental benefits is biochar. Press mud also contained macro- and micronutrients, which boosted yield and yield-related characteristics. In order to establish soil management methods and sustain soil fertility for the reductions of economic and environmental difficulties, this study suggested testing the co-application of biochar with press mud in long-term field studies is needed.

CONFLICT OF INTEREST

The authors declare that there is no conflict in the publication of this article.

AUTHOR'S CONTRIBUTION

All the authors contributed equally in the manuscript.

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