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Synthesis of Biochar-Based Composites to Evaluate Morphology of Wheat Seedling

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ABSTRACT: *Recently, biochar has emerged as an effective nutritive source that plays a noteworthy contribution in improving the growth of various crops. Current research signifies the role of Biochar-composite in the growth of wheat seedlings. In this study, the carbonaceous biomass synthesized from garden waste was impregnated with macro- and micro-nutrients. The effectiveness of this synthesized Biochar-composite (GW-B) was studied by using wheat (Triticum aestivum) as an experimental crop. The GW-C was applied to wheat seeds grown in petri plates and pots by supplementing them with different concentration of prepared biochar. Application of biochar composites improved the growth of wheat seedlings in both petri plates and pots in addition to enhancement in morphological attributes. Higher concentration of biochar-composites improved the morphology of wheat seedlings in a dose-dependent manner e.g. shoot fresh weight, shoot dry weight, root fresh weight, root dry weight, number of leaves per plant, plant height, leaf area and root length. Biochar-composite at concentration of 0.8 enhanced morphology of supplemented wheat seedlings sown in petri plates at equidistance manner over 5 layers of Whatman filter paper (no. 1). Biochar-composite of 0.03 g enhanced the morphological attribute of wheat seedling that were sown in equidistance manner in pot experiment. It was found that biochar amended soil improved the growth and morpho-physiological attributes of wheat seedlings, thereby enhancing the yield of crop.*

Key words: *Biochar, composites, wheat seedlings, nutritive source.*

INTRODUCTION

Biochar congregated from horticulture or boscage residue, usage as a soil alteration such as carbon. When alteration happens into the soil, biochar better the soil fertility, and increased the development of farming (Agegnehu et al., 2016; Agbna et al., 2017; Werner et al., 2018; Adli, 2019; Das et al., 2020).

Enhance the bio-oil temperature proceed to the considerable carbonized raw-material in which enhance the carbon content, acquired a favorable product must be assembled in temperature reactor, increase the temperature or time period of this procedure at the eventual temperature. Bio-oil boost the biochar usage in which extensively content of carbon or inexpensive development at the same period applicable for their utilization. Biochar utilized in surrounding areas, or their valid features and their quality (Butnan et al., 2015).

Recently, biochar usage as a catalyst, soil alteration, fuel cell, impurity sorption, and activated charcoal. The charcoal is also known as biochar when utilized as a soil alternation for the strengthened of the soil condition. Biochar usage improved the productive of fuel and advantageous to both farming and surrounding areas. The utilization of biochar, associate with inanimate fertilizer or living alteration, upgrade the effectiveness of fertilizers and development of soil agriculture (Ahmed et al., 2016; Amin et al., 2016; Al-Wabel et al., 2018; Braghiroli et al., 2018). According to Blackwell et al. (2015) biochar mineral complex has a great influence on mycorrhizal association.

The major use of Biochar is it utilize as a renewable energy source (Ozcimen and Karaosmanoglu, 2004). Carbonization substance can be burned or co-burned by adjoining power plants. Biochar differentiate with bio fuels hold minimum quantity of notable chlorine, and vapors affect the depletion of boiler productivity and enhance the discharge of inorganic particles. The chlorine altered consequences from the attentiveness of the pyrolysis operation. Throughout pyrolysis, the chlorine holds the bio energy is free in gaseous shape and proceed to the environment. These consequences alter the composition of substances and the processes of bio-energy. Inorganic combination establishes the admirable particles enhance the slurry manufacturing in combustion boilers. This issue vanishes the short time of carbonization of a combustible, which is significantly necessary for the production of bio-energy combustion. Accordingly, Biochar is a main element in decreasing this drawback. Similarly, combustible is replacement to standard natural gases. Biochar-mediated sorption of organic impurity may be built on the concept of electrostatic interconnections with polar and non-polar category. Sorption of inorganic impurities, involvement the ion of massive metals, by the utilization of biochar is distinguished by four procedures:

➢ Cation and anion exchangers, ➢ Precipitation, ➢ Anionic metal attractiveness, ➢ Cationic metal attractiveness.

The current research planned to see the role of Biochar-composite in the growth of wheat seedlings.

MATERIALS AND METHOD

Biochar Composite Synthesis

The steam activation was utilized for the production of charcoal. This charcoal was activated in the cooking-pot at a medium temperature in the absence of oxygen for 24 days. The charcoal which was prepared in the cooking pot was remained stay hot and it required a sufficient time i.e. 30-40 minutes to cool down. Transfer the charcoal in the mortar and pestle and grind up into a very fine powder. After that, the powder was transferred into the clean bowl. Powder was dried and used to prepare the solution. Add the required nutrients to the powder in a small quantity, stirring it with rod under the magnetic stirrer hot plate until the mixture was dissolved. Separate the filtrate and residue by vacuum suction pump. The residue was dried at 100°C for 24 hours in an oven. The actual yield of charcoal was 100 grams and the residue was 87.55 grams.

Slow release fertilizer was synthesized by using biochar as a support material. A homogenous suspension was achieved by adding 100 grams of charcoal in 250 ml distilled water. Afterwards, following solutions were added in reaction flask and allowed to stir at room temperature for 30min;

1). 50ml solution of 0.003 moles of sodium nitrate
2). 0.06 moles of sodium phosphate
3). 0.0003 moles of sodium chloride
4). 0.0001 moles of calcium chloride
5). 0.0002 moles of manganese nitrate
6). 0.0003 moles of iron sulfate
7). 0.0003 moles of magnesium chloride
8). 0.03 moles of potassium dihydrogen phosphate

Later on, the contents were filtered by vacuum filtration technique and followed by drying at 100°C for 24 hours in oven. Final product was grinded and stored in air-tight jar. Four Biochar treatments were used for the present study and labelled as B1= 0.01g, B2= 0.02 g, B3= 0.03 g and B4= 0.04 g.

RESULTS

Biochar composites have significant effect on growth and morphology of wheat seedling as compared to untreated ones in petri dish. Application of biochar composites improved the growth of wheat seedlings in both petri plates and pots. At concentration of 0.8 enhanced morphology of supplemented wheat seedlings sown in petri plates

Petri plate

A significant increase in plants height was observed in plants supplemented with B4 treatment as compared to B3, B2 and B1. The increase in plant height and various other parameters such as shoot fresh weight, shoot dry weight, root fresh weight and root dry weight obeyed the order i.e. (B4) > (B3) > (B2) > (B1) > (control) (Fig 1-5). Highest value of root dry weight was observed in B4 treatment. B2 and B3 treatments showed no significant differences (Fig 5). B4 treatment showed 1.5 folds' increase in root dry weight as compared to control conditions.

Number of leaves increased with increasing concentrations of biochar. The number of leaves in B1 and B2 did not differ significantly (Fig 6). The number of leaves in B4 treatment showed 1.6 folds increase as compared to wheat seedlings grown in controlled conditions. Both B3 and B4 treatments showed significant increase in number of leaves as compared to control conditions (Fig. 6).

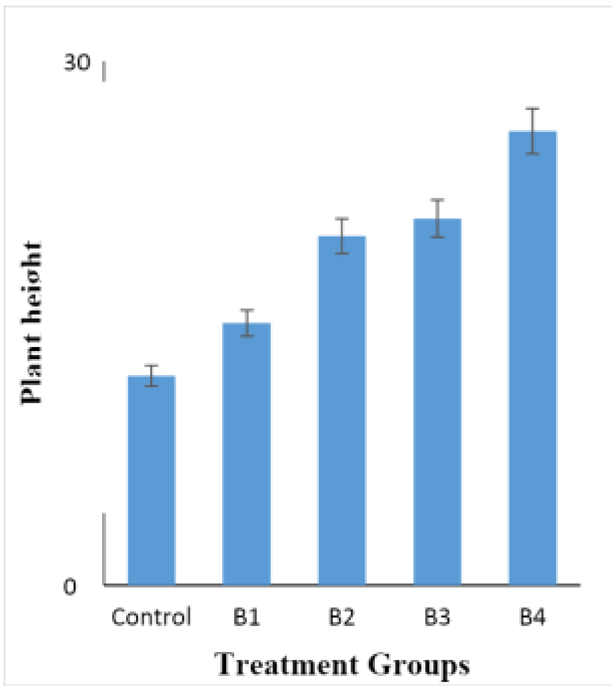

Fig. 1: Plant height against different experimental groups

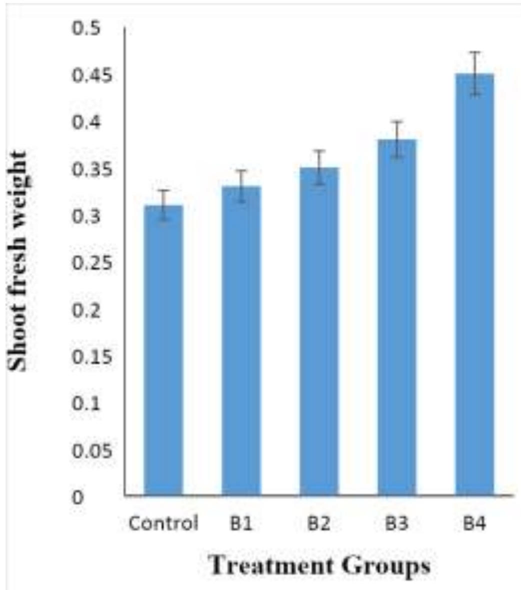

Fig. 2: Shoot fresh weight against different experimental groups

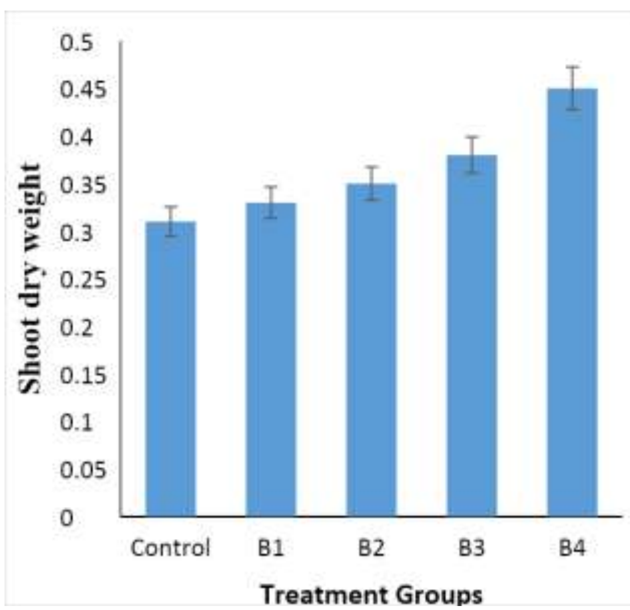

Fig. 3: Shoot dry weight against different experimental groups

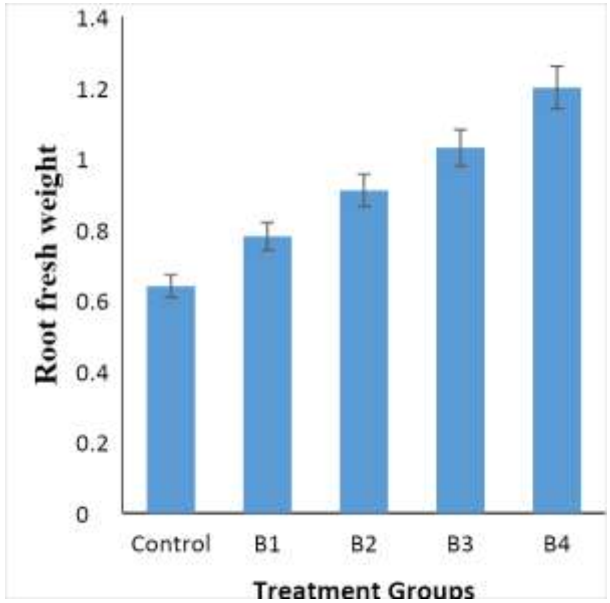

Fig. 4: Root fresh weight against different experimental groups

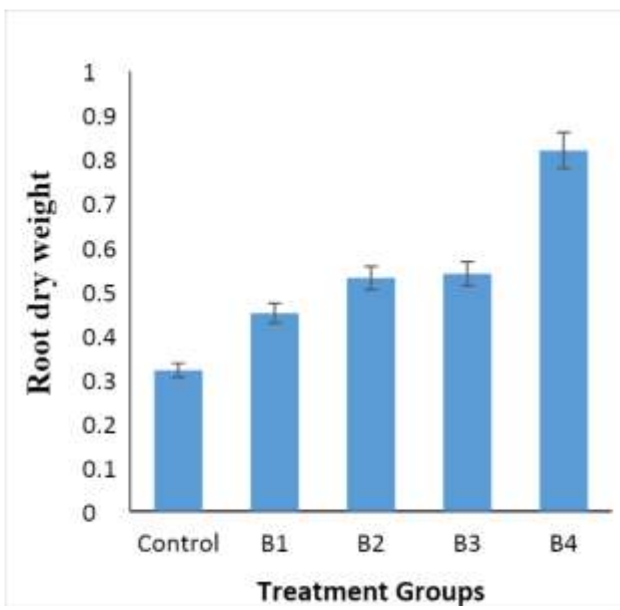

Fig. 5: Root dry weight against different experimental groups

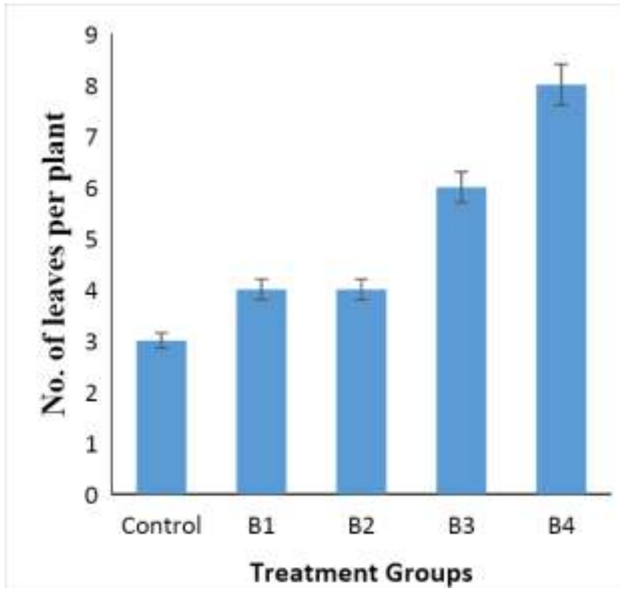

Fig. 6: No. of leaves per plant against different experimental groups

Seed tray

Biochar effect on seedling growth diverse with soil feature. Biochar composite may not be suitable as soil modification, significantly if they hold excessive amount of nutrients.it may inhibit the seed germination and assessing the presence of toxic compounds at the concentration of B4. Carbonaceous biomass may hold higher concentration of nutrients that could effect on seed germination. Biochar significantly increased the shoot dry weight of B3 at 2.7cm and B2 slightly increased at the length of 2.6cm (Fig. 7). In (Fig. 8) B3 has highest peak in plant height of 42cm. While B2 is having second highest value of plant height at 43cm. However, B1 and B4 has almost similar values. In (Fig. 9) Biochar composites remarkably increases the leaf area of B3 of wheat plant at 1.3cm. However, B2 is comparatively less than B3 at 1.2cm. Biochar composites impressively increases the root dry weight of wheat plant B3 at 46cm. While B2 is more likely similar to B3 as there is only slight difference with dry weight of 45cm (Fig. 10). Root length increased by adding biochar in the seed tray. Highest value of root length was observed in B3 treatment. However, the least root length of the plant attains at 11 in control plant which is having a deficiency of nutrient. The other concentration i.e. B1, B2, and B4 slightly increase the root length with each other at 14, 19 and 21cm (Fig. 11).

Biochar composite increases the length of B3 at 37cm of wheat plant. However, B2 and B4 are little less in root length with B3 as B2 root length of wheat plant is at 33cm while B4 root length of wheat plant is at 35cm. B1 is having root length of wheat plant of 21cm. In all, control plant is having smallest root length of wheat plant at 8cm. On the other hand, B3 is having largest root length in this biochar at 37cm (Fig. 11). B3 has highest value of number of values of wheat plant while control plant and B4 having same quantity of number of leaves and both have smallest number of leaves of wheat plant comparatively (Fig. 12).

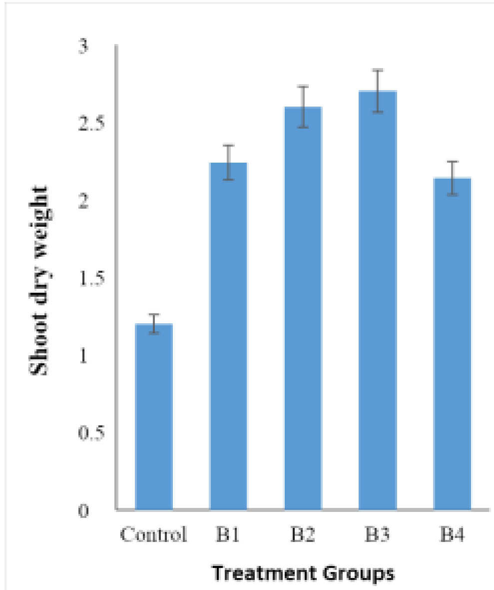

Fig. 7: Shoot dry weight against different experimental groups

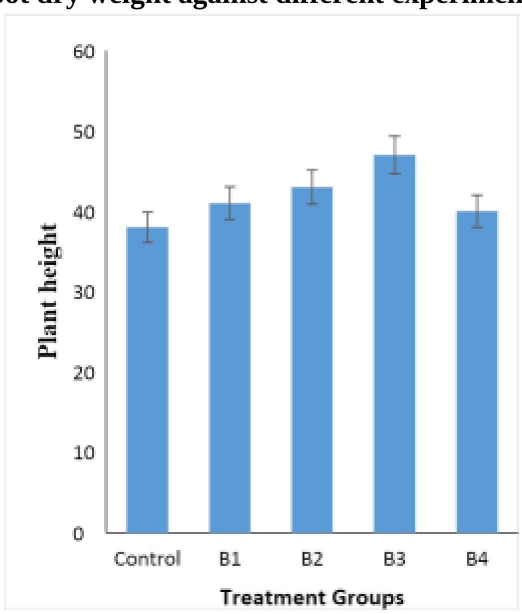

Fig. 8: Plant weight against different experimental groups

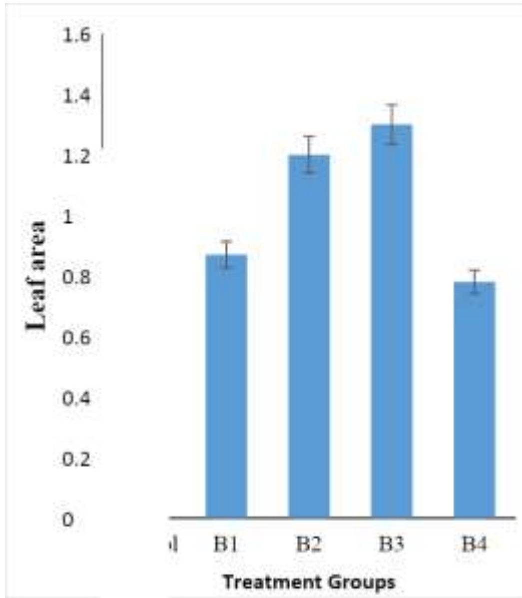

Fig. 9: Leave area against different experimental groups

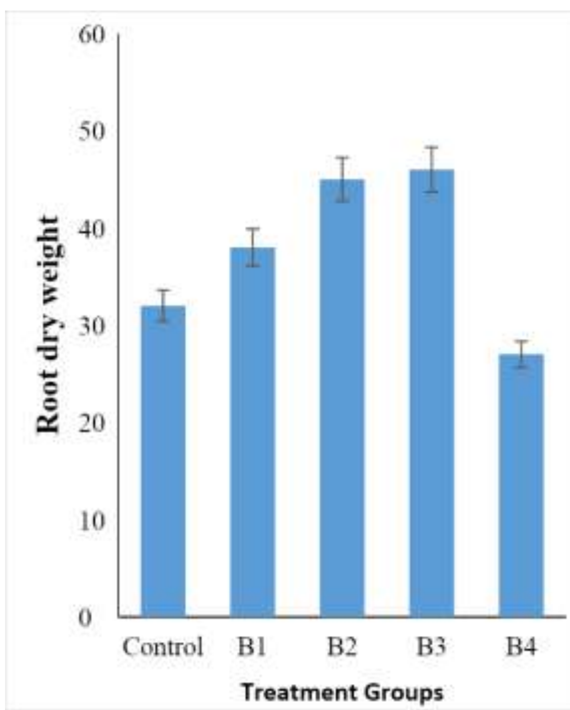

Fig. 10: Root dry weight against different experimental groups

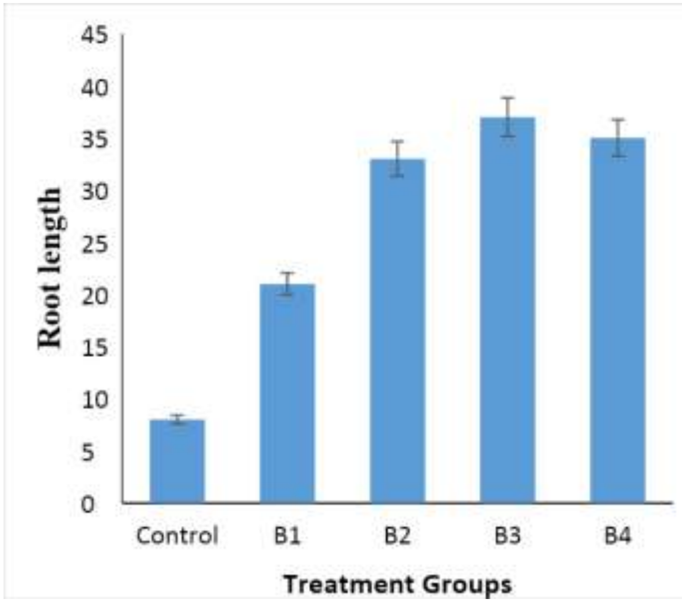

Fig. 11: Root length against different experimental groups

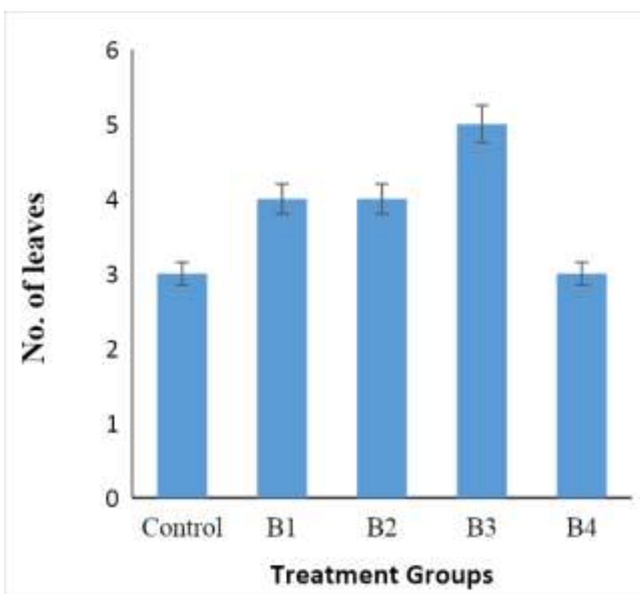

Fig. 12: No. of leaves against different experimental groups

DISCUSSION

Biochar significant enhance the plant growth, shoot and root dry weight under moistures levels as compared to untreated ones and at lower straw rate. Biochar effectively enhance the plant growth at the highest rate of their application (Mohawesh et al., 2018). Kasak et al. (2018) showed two possible reasons, improved bacterial inhabitants and little amounts of biochar substances enhance plant evolution (hormesis).

Biochar synthesized from coir in composted green manure improved root and shoot length, plant height, root fresh and dry weight of Calathea insignis compared with the controlled plant (Huang et al., 2019). After biochar combination, increased plant growth lead to improved nutrients accessibility and increase water retention. Pumpkin *(Cucurbita pepo)* and muskmelon *(Cucumis melo)* increased plant height by 50% sugarcane biochar composite compared to controlled plant. (Yu et al., 2019) also revealed that biochar composite with the rest being perlite enhance dry weight and evolution of Chinese cabbage. Biochar application mainly improved the plant evolution and crop than particular modifications without BC enhance dry weights of shoot and root. Application of biochar soil enhance the development of wheat seedling under the cadmium stressful state. Biochar increased the plant height due to development in soil properties (Rizwan et al., 2018). Enhancement in wheat development with BC application under cadmium stress due to their lower concentrations in plant. In our study, biochar composite also enhances the dry and fresh weight of root and shoot. Plant height, number of leaves, and leaf area.

Biochar application has multiple effects on the soil chemistry, ultimately affecting the growth of the crops. The composition and application of biochar depends on the biotic and abiotic environmental factors. This carbonaceous material is nutritive and plays significant contribution in regaining lost nutrients from the soil. Different concentrations of biochar have marked influence on the growth of wheat seedlings. Soil pH have greater impact on the surface features of biochar that alters the adhering capacity of this complex material (Mohamed et al., 2017). Moreover, observed a strong correlation between the biochar levels and growth. Just like biochar efficiency in stimulating growth in numerous crops, our studies also depicted increase in growth attributes of wheat seedlings. Biochar amended soil enhances the crop productivity (Novak et al., 2016).

Biochar amended soil increases crop productivity in both acidic and neutral soil. The statistical analysis showed increase in crop productivity with the increasing concentrations of biochar (Cornelissen et al., 2018). Application of biochar composites have significant effect on the growth of wheat seedlings (Vijayaraghavan, 2019). During the current study, increasing concentrations of biochar enhanced the morphological attributes of wheat seedlings. Crop improvement was noticed in plants supplemented with biochar amended soil due to increase of water holding capacity and nutritive capacity of soil (Abbas et al., 2018). Higher concentrations of biochar enhanced the formation of roots and reduces the leaching of nitrogen and phosphorous from the soil (Karhu et al., 2018). Furthermore, the present study elicited improvement in morphological parameters; a sign of efficient growth in biochar-amended soil.

The soil deficient in nutrients results in decrease in growth of agronomic crops. This nutrient deficiency can be mitigated by application of biochar in soil (Yu et al., 2019). Zheng et al. (2018) reported that biochar application along with fertilizer can enhance the growth of numerous crops. The application of biochar to soil have multiple effects on the growth of crops. It is important to understand the soil chemistry for better applied approach of biochar. In our study, biochar along with different nutritive compounds increased the growth of supplemented wheat seedlings.

CONCLUSION

Recently, biochar has emerged as an effective nutritive source that plays noteworthy contribution in improving growth of diverse crops. Biochar may be added in combination with different nutrients. Biochar-composites are effective, perpetual and eco-friendly additives that have potential to enhance the growth of different crops. Addition of biochar augments the porosity of soil; thereby improving the soil properties. During the current study, biochar composites were added in Petri plates and pot to appraise its potential to enhance growth of wheat seedlings. Improvement of growth in wheat seedling on exposure to biochar composites was concentration-dependent. Optimum concentration of biochar-composite enhanced the morphology of supplemented wheat seedlings in Petri plates and pots. Different morphological parameters improved in wheat seedlings on exposure to biochar composites i.e., shoot fresh weight, shoot dry weight, root fresh weight, root dry weight, number of leaves per plant, plant height, leaf area and root length. It is concluded that biochar composites may be supplemented in soil to enhance the growth in different crops. Moreover, the utilization of this carbonaceous material is an operative and eco-friendly techniques that is effective for growth of wheat seedling.

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