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Effect of soil fertility management practices on dry matter accumulation of wheat (Triticum aestivum L.) in the Varanasi region of Uttar Pradesh

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Abstract
A field experiment was conducted over two consecutive years (2019-20 & 2020-21) at the Agricultural Research Farm of the Institute of Agricultural Sciences (I.A.S), Banaras Hindu University (B.H.U). The experiment was laid out in a split-plot design and replicated thrice. Results revealed that the treatment of 100% RDF + 5 kg Zn + 5 kg Fe recorded the highest dry matter accumulation (g) compared to the control and the application of 75% RDF at 30 (6.22, 7.29, and 6.75 g). and 60 DAS (98.21, 104.27, and 101.24 g) of wheat during both years and pooled analysis, respectively. However, at 90 DAS (407.17, 412.54, and 409.86 g) it was found significantly superior over the rest of the treatments in both years and pooled analysis, respectively. While application of various organic inputs and AMF did not produce any significant effect on dry matter accumulation (g) at 30 and 60 DAS of wheat during both years and in the pooled analysis, respectively. However, at 90 DAS, there was a significant effect on dry matter accumulation. The treatment of sludge + rice husk biochar + bagasse converted biochar + AMF (350.68, 362.71, and 356.70 g) recorded the highest dry matter accumulation at all growth stages of observation followed by the treatment sludge + rice husk biochar + AMF (344.02, 356.84, and 350.43 g) than that of other treatments in both years and pooled analysis, respectively.

Keywords: Biochar, dry matter, wheat, sludge

Introduction
As one of the most important *Rabi* crops, wheat plays a crucial role in ensuring food and nutritional security. it is the second most important staple crop, after rice, which provides around 20% of daily protein and food calories to people. In the Varanasi region of Uttar Pradesh, wheat crop is grown on an area of 70642 ha with a production of 1980070 qt and a productivity of 28.03 qt/ha. Every 100 g of wheat contains 72 g of carbohydrates, 13.2g of proteins, 10.7g of fiber, 2.5 g of fat, 0.4g of sugar, along with 11% water, and provides about 340 calories of energy. Nearly 55% of carbohydrate intake and 20% of food calories consumed in the world are attributed to wheat (Breiman and Graur, 1995) [1]. The Indiscriminate use of inorganic fertilisers converts productive soil into barren land over time. Sustainable plant development and soil productivity can be maintained by carefully balancing the use of inorganic and organic fertilizer sources. Yield determination and plant productivity depend critically on the accumulation of dry matter and its effective partitioning. Dry matter plays an important role in plant growth and development, impacting structure components, energy storage, yield, and response to environmental conditions. Both organic and inorganic nutrition sources are essential to the creation of dry matter. While organic sources enhance soil health and gradually feed nutrients, resulting in more balanced and sustainable plant growth, inorganic fertilizers offer minerals that are easily accessible and encourage rapid growth. Agri-residue converted biochar has great potential to improve soil conditions as organic fertilizer with many benefits that can improve soil health, and sustainable agronomic productivity (Dotaniya and Datta, 2014) [2]. Agri-residue converted into biochar is a most promising technology for Agri-residues management. Hence, the final biochar products could be used in the agricultural field as a fertilizing agent. Biochar application promotes sustainable crop production in the degraded lands due to continuous and excessive use of chemical fertilizers and pesticides. The biochar used with Arbuscular

mycorrhizal fungi (AMF) is an innovative approach, which promotes the dry matter accumulation and grain quality, and restores the soil health. Use of sludge in agriculture as an organic fertilizer has been found beneficial for a variety of field crops (Saha *et al*. 2017) [4]. Thus, judicious use of different organic sources can improve dry matter production in the long-term process and

Materials and methods

The field experiment was laid out over two consecutive years at the Agricultural Research Farm of the Institute of Agricultural Sciences (I.A.S), Banaras Hindu University (B.H.U), Varanasi. The soil of the experimental site was sandy clay loam in texture, having neutral reaction, low in SOC, low available N and K, while medium in available P content. The meteorological data were collected from the meteorological observatory at the time of the crop period. The experiment was laid out in a split-plot design with three replicates. Four fertility levels comprising F_1 (Control), F_2 (75% recommended dose of fertilizer (RDF) of NPK), F_3 (100% RDF of NPK), and F_4 (100% RDF of NPK+ 5 kg Zn +5 kg Fe) were applied in the main plot. The six combinations of sludge, biochar, and bioinoculant (*Arbuscular mycorrhizal fungi (AMF)*), *i.e.*, Sludge + Rice husk biochar + Bagasse converted biochar + AMF, Sludge + Rice husk biochar + AMF, Sludge + Bagasse converted biochar + AMF, Bagasse converted biochar + AMF, Rice husk biochar + AMF, and Sludge + AMF, were applied in the sub-plot in both years.

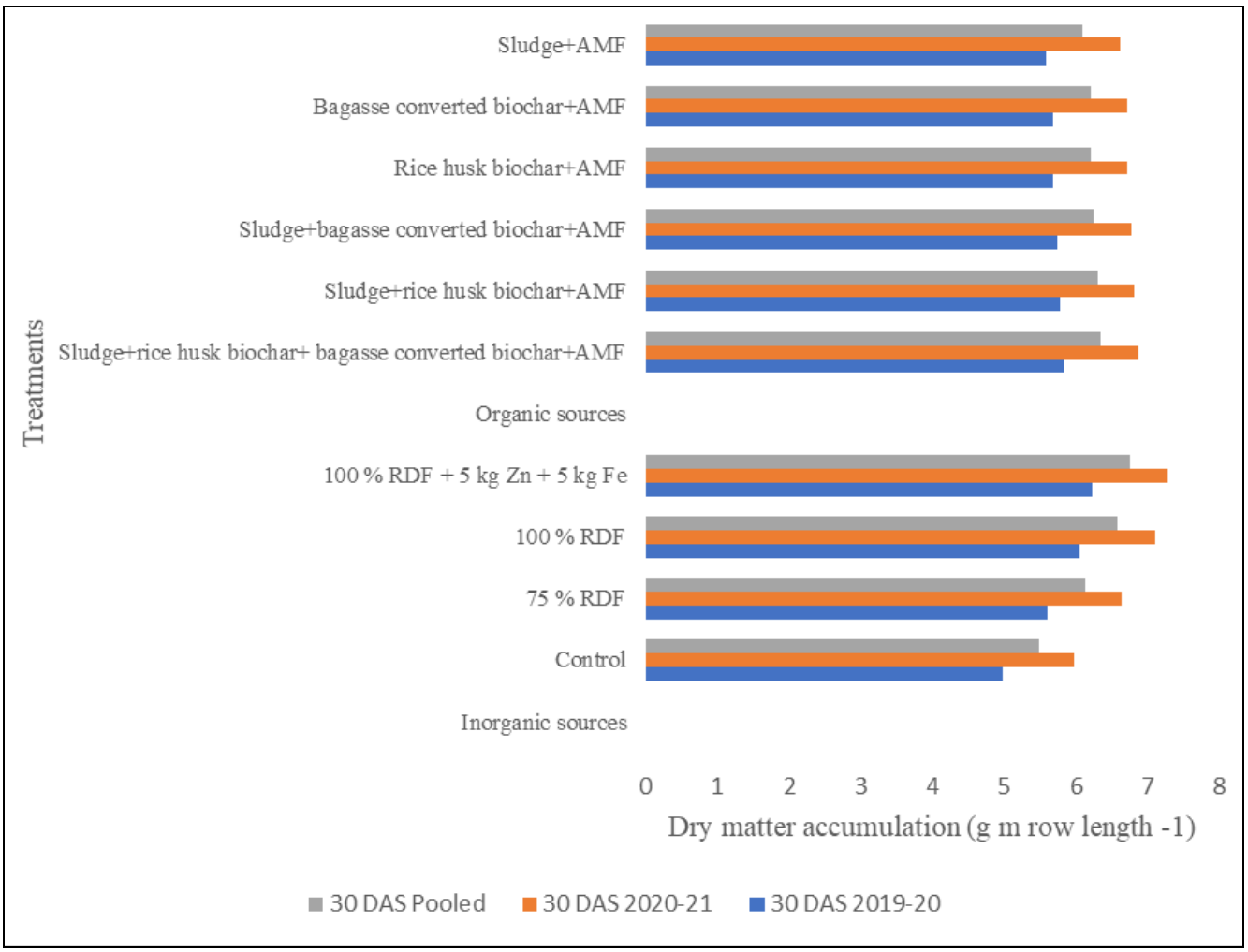

Fig 1: Effect of different sources of nutrients on dry matter accumulation of wheat (g m row length^{-1} at 30 DAS during two years of study and pooled analysis

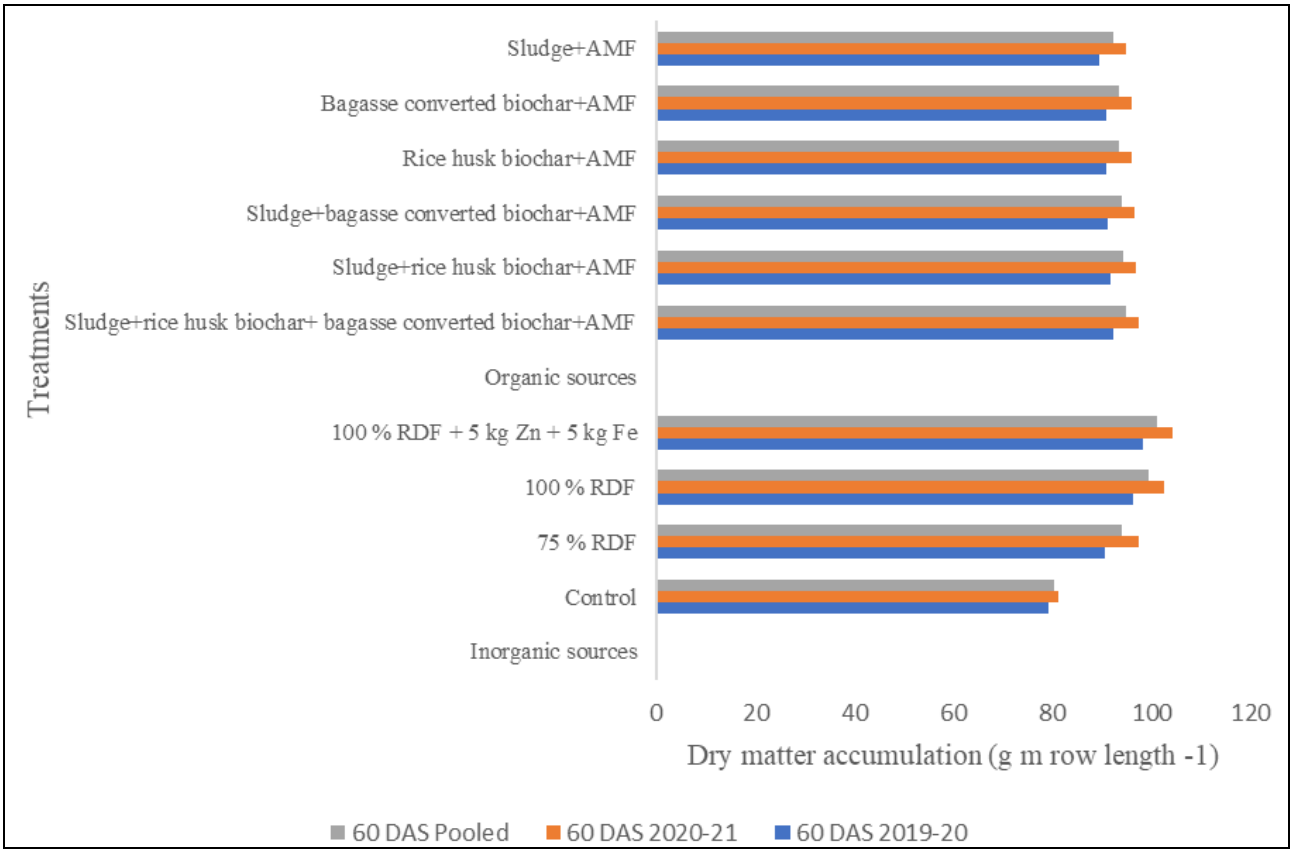

Fig 2: Effect of different sources of nutrients on dry matter accumulation of wheat (g m row length^{-1} at 60 DAS during two years of study and pooled analysis

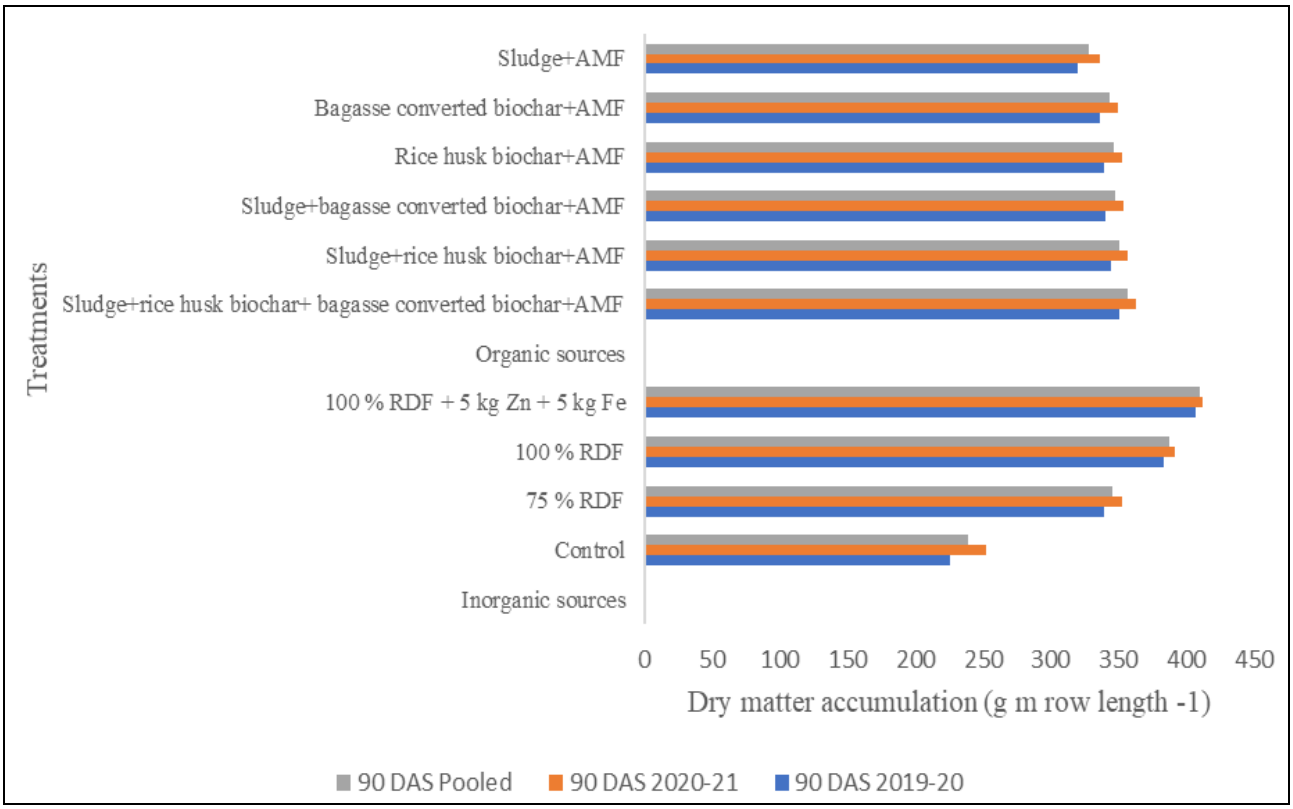

Fig 3: Effect of different sources of nutrients on dry matter accumulation of wheat (g m row length^{-1} at 90 DAS during two years of study and pooled analysis

Result and discussion

The analysis of the data presented in Fig. (1-3) showed that the combined application of RDF levels had found significant effect on dry matter accumulation during all growth stages (30, 60, and 90 DAS) in both years of the experiment and pooled analysis, respectively. The treatment of 100 % RDF + 5 kg Zn + 5 kg Fe has significantly recorded the highest dry matter accumulation over the control and application of 75% RDF at 30 (6.22, 7.29,

and 6.75g). and 60 DAS (98.21, 104.27, and 101.24 g) of wheat during both years and pooled analysis, respectively. It was found statistically at par with the application of 100 % RDF levels. However, at 90 DAS (407.17, 412.54, and 409.86g), it was found significantly superior over the rest of the treatments in both years and pooled analysis, respectively.

The data presented in Fig. (1-3) indicated that the application of various organic inputs and AMF did not produce any significant effect on dry matter accumulation (g) at 30 and 60 DAS of wheat during both years and in the pooled analysis. However, at 90 DAS, there was a significant effect on dry matter accumulation. The treatment of sludge + rice husk biochar + bagasse converted biochar + AMF recorded the highest dry matter accumulation at all growth stages of observation, followed by the treatment of sludge + rice husk biochar + AMF, then that of other treatments. At 90 DAS, the treatment sludge + rice husk biochar + bagasse converted biochar + AMF recorded 350.68, 362.71, and 356.70 g of maximum dry matter accumulation over the other applied treatments during both the years and pooled analysis, respectively. It was found significantly superior to the treatment of sludge + AMF, while at par with the rest of the treatments. At 90 DAS, 9.5, 7.8, and 8.7% increase in dry matter accumulation of the applied treatment sludge + rice husk biochar + bagasse converted biochar + AMF was more of the treatment sludge + AMF.

The dry matter accumulation in wheat linearly increased with the increase in fertility levels. At 30 and 60 DAS, there was no significant effect due to the slow release of nutrients from the different organic nutrient sources. However, at 90 DAS, the treatment sludge + rice husk biochar + bagasse converted biochar + AMF recorded significantly more dry matter than the treatment sludge + AMF. Similar findings were reported by Patel *et al*. (2018) [3] and Singh *et al*. (2017) [5].

Conclusion

The result of the experiment showed that among the inorganic sources for fertility the treatment of 100 % RDF + 5 kg Zn + 5 kg Fe has significantly recorded the highest dry matter accumulation than other treatments. While among the different organic inputs, the treatment sludge + rice husk biochar + bagasse converted biochar + AMF gave highest dry matter accumulation than other treatments.

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