Rice Straw Biochar Influence on Seed Germination and Early Growth of Triticum Aestivum

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Abstract—*Biochar is the carbonaceous residue of the pyrolysis process, potential candidate for carbon sequestration, management and soil amendment. Fly ash is the solid waste generated from the thermal power plants for electricity generation and is a menace. Utilization of fly ash as soil ameliorant to improve the soil quality and plant growth have been documented in the literature. Thus a composite integrated waste management approach has been sought as a possible strategy for the application of rice straw biochar and lignite fly ash.*

Biochar were prepared by slow catalytic pyrolysis of rice straw at 400 ^{o}C and fly ash was procured from Guru Nanak Dev Thermal Power Plant (GNDTP), Bathinda, an ex situ co-application of rice straw biochar and fly ash were prepared in varying proportions viz. 0:1, 1:3, 1:1, 3:1 and 1:0 (w/w, Fly ash: Rice Straw biochar).

In vitro soil-less petri-dish bioassay experiments were conducted to understand the effect of different concentrations of biochar and fly ash composites on the seed germination and early seedling growth of the Triticum aestivum L. var. HD 2967. A decrease in the germination from 100 upto 88% upon increasing the fly ash proportions in the biochar sample was observed. Similarly a retarded early seedling growth with increase in the fly ash content was observed from 3 to 2.7. Results revealed that the co-application of fly ash and biochar influences the seed germination and seedling growth of the crop.

Keywords*: Biochar, Fly ash, Rice Straw, Germination*

1. INTRODUCTION

Being an agronomic nation India accounts for about 435.98 Million Tons (MT) of agricultural waste every year, mainly contributed by cereal crops like wheat, barley, millet, rice and maize [1]. Agriculture largely accounts for 17.6 per cent of Green House Gas (GHG) emissions and 2 percent is accounted by open on-field burning [2]. Agri based waste management is a challenge, due to various constrains much of the crop residue is left as such in the fields and is left un-utilized. Rice crop residue is subjected to on field burning due to presence of high silica content which makes the fodder unfit for cattle as the silica content reduces the milk production [3]. Thus, a proper strategy is required for agro based waste management, in recent years much interest is growing on conversion of biomass to value added products by physical, chemical and thermo chemical conversion processes [4]. Utilization of biomass for bioenergy by thermal degradation process results in solid residue which has multifaceted application [1].

Biochar is the solid carbonaceous residual product from the pyrolysis of the organic materials like plant and animal origin [5,6]. During pyrolysis, various minerals present in the plant biomass get concentrated in the carbonaceous skeletons and thus the biochar produced has greater potential to improve the soil mineral content [7,8].

Coal fly ash, another waste generated by thermal power plants during electricity production is a menace due to various environmental hazard. According to CEA [9], 83.64 MT of fly ash is generated in India and only 56.04% is utilized the other half left is dumped near the river embankments.

Soil application of fly ash is gaining interest in recent times due to its favourable physico-chemical properties [10,11]. Kumari [12] advocated the growth of fern *Thelypteris dentana* on coal fly ash landfill sites, presence of crystalline alumino silicates in the fly ash are helpful for its utilization in soil amendments.

Presently few reports have been published where lignite fly ash has been applied along with the biochar for soil amelioration purpose [13,14].

In light to this we attempted the biochar production from rice straw and its co-application with fly ash on the test plant in order to understand its effect on the seed germination and early growth. Thus, the objective of the present study is to evaluate the effect of biochar/ fly ash composites on the seed germination and radicle growth of the wheat.

2. MATERIALS AND METHODS

2.1 Biochar preparation

Biochar was prepared from the rice straw, collected from the Gulabgarh village of Bathinda district. The straw was air dried and grinded to achieve 1.18 mm size. Rice straw was pyrolyzed at 400 ^{o}C with one hour hold time and after the prescribed temperature hold time was attained, the samples were cooled, powdered and kept in desiccator till further use.For ex situ application, fly ash procured from Guru Nanak Dev Thermal Power Plant (GNDTP), Bathinda were mixed in gravimetric proportion 1:3, 1:1 and 3:1 (*w/w*) along with the biochar.The rice straw biochar and fly ash composites thus prepared are given the acronym BE410, BE431, BE411, BE413, BE401 respectively for 1:0, 3:1, 1:1, 1:3, 0:1 (FA: Rice Straw biochar), respectively.

2.2 Germination Studies

Uniform sized, healthy, large seeds (n=20) of wheat (*Triticum aestivum* L var. HD 2967) were surface sterilized with 0.1% (w/v) sodium hypochlorite solution, washed thoroughly with distilled water. Treatments were prepared by adding 1 gm of respective biochar/ fly ash composite in the 25 ml distilled water and without biochar fly ash composite with only distilled water was considered as control. Wheat seeds were uniformly sown in the petri dishes (20 cm diameter) on a layer of filter paper moistened with respective treatments (25 ml) with three replicates. The petri dishes were incubated for 72 hrs at 25 ˚C at dark conditions. After 72 hrs the germination percentage and root length was accessed.

Germination percentage was calculated as:

Percent germination= Number of germinated seeds / Total number of seeds *100

The seedlings were harvested after 72 hrs and after drying the surface of the seedlings the root length was measured using metric scale.

3. RESULTS AND DISCUSSION

3.1 Soil less bioassay of *T. aestivum*

The Co-application of biochar and fly ash significantly affected wheat germination (Table 1). A decrease in the germination from 100 upto 88% upon increasing the fly ash proportions in the biochar sample was observed in BE411, also the germination percent was 86% in case of pure biochar BE401. Biochar application increases seed germination at lower rates of biochar [15], in our study the application rate was 1 gm/ petri dish equivalent to 20 T/ha on a volume basis at 10 cm soil depth. Increase in fly ash content increased the germination percentage as in BE410, 97% seed germination was accounted, indicates fly ash has seed germination promoting effect on the wheat seeds in comparison to pure biochar BE401. Petri dish bioassay are the simple preliminary screening test for ecotoxic nature of biochar, prior to large scale application as a soil amendment [16]. Toxicity effects remain pronounced in the roots, as these are the first site of contact with the treatment leading to inhibition of seed germination and radicle growth [17].

Table 1: Effect of Biochar/ Fly ash composites on the percent seed germination and radicle length of *T. aestivum*

Parameter	Control	BE 410	BE 431	BE 411	BE 413	BE 401
Germination (%)	100	97	93	88	87	86
Radicle Length (cm)	2.9	2.88	2.76	2.74	2.64	2.62

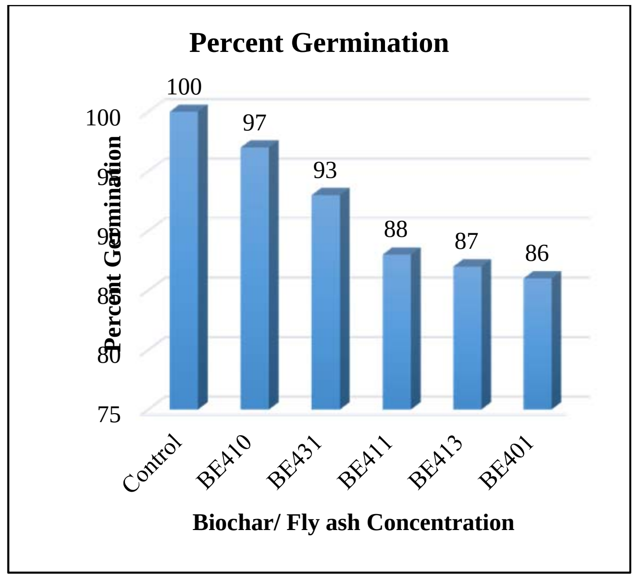

Fig. 1: Effect of Biochar/ Fly ash composites on the percent *T. aestivum* seed germination

Compositional rate of biochar fly ash composites showed a retarded early seedling growth with increase in the fly ash content from 3 to 2.7 in BE431 (Table 1), but in comparison to BE401 and BE413 the root length was higher in the BE410 and BE411 2.62, 2.64, 2.88 and 2.74 respectively.

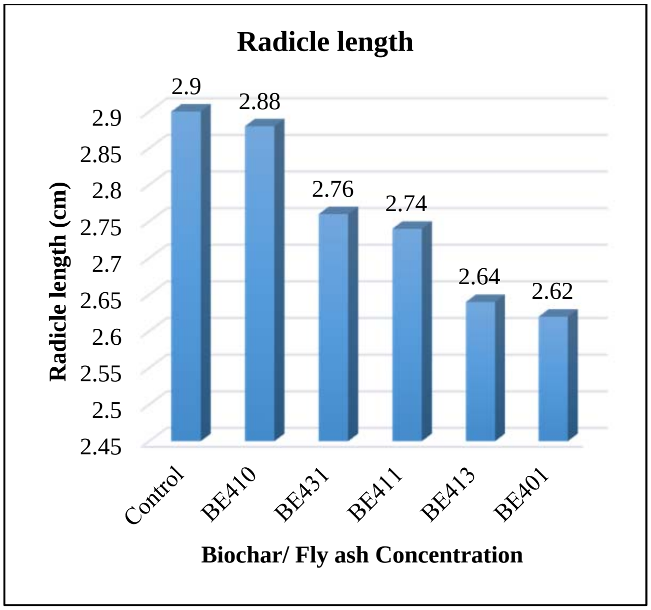

Fig. 2: Effect of Biochar/ Fly ash composites on the root length of the *T. aestivum* seedlings

4. CONCLUSION

The present study led to the documentation that co-application of fly ash and biochar has significant effect on the seed germination and early seedling growth of the wheat. Application rate 20 T/ha was used for the experiment with varying proportions of fly ash and the treatment BE411 showed stability in the results where both biochar and fly ash were in equal concentrations. Pure biochar inhibited the seed germination and radicle growth while the co-application of fly ash and biochar showed less inhibition. Depending upon the type of biomass (wood, straw, husk, peel, stem) from which the biochar is produced, the physicochemical characteristics of the biochar are altered, thus ambiguity in the response of the crop to the biochar application as soil amendment [18]. Application of fly ash and biochar have beneficial effects on the plant growth [14].

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