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Effect of waste derived materials (biochar and compost) on yield attributes and yield of wheat *Triticum aestivum* L.)

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Abstract
A field experiment was conducted during *rabi* season of 2021-22 at the Chamelti Agriculture Farm, MS Swaminathan School of Agriculture, Shoolini University of Biotechnology and Management Sciences, Solan to study the effect of waste derived materials (biochar and compost) on yield attributes and yield of wheat. The field of the experimental site represented ideal spatial unit in respect of texture, make up and fertility status. The experiment was laid out in randomized block design with three replications comprising of eight treatments of waste derived materials *viz.* (T_0) Control, (T_1) Biochar @ 2.5 t ha^{-1}, (T_2) Biochar @ 5.0 t ha^{-1}, (T_3) Biochar @ 10.0 t ha^{-1}, (T_4) Compost @ 5.0 t ha^{-1}, (T_5) Compost @ 8.0 t ha^{-1}, (T_6) Compost @ 8.0 t ha^{-1} and (T_7) 50% biochar + 50% compost. HD-3086 variety of wheat was used for sowing. Application of waste derived materials (biochar and compost) were done as per treatment. The area's recommendations for other crop management techniques were adhered to. It is to be concluded that marked improvement in yield attributes and yield of wheat were observed with application of Compost @ 10.0 t ha^{-1} under Solan conditions.

Keywords: Biochar, compost, waste derived, randomized and judicious

Introduction

The main source of food and nutrients needed to support human existence is agriculture. Many crops meet the majority of the world's food needs; among them, wheat (*Triticum aestivum* L.) accounts for up to 70% of the daily calorie intake of those living in rural areas and is a key source of zinc in developing nations (Cakmak, 2008) [4]. Among the cereals that are farmed, one of the most significant food crops in the world is wheat (Waines and Hegde, 2003) [27]. Wheat cultivation has served as a metaphor for the green revolution, which is why it is also referred to as the "Wheat Revolution". Himachal Pradesh occupied an area 0.35 million hectare under wheat cultivation and production 0.56 million tonnes but the average productivity 943 kg ha^{-1} is much lower than Punjab 4862 kg ha^{-1} and Haryana 4836 kg ha^{-1} (Agricultural Statistics at a Glance, 2021) [1]. This crop accounts for around 40% of the nation's overall food grain reserves. Despite the population having doubled since 1961, the amount of wheat available has grown from around 79 g capita^{-1} day^{-1} to more than 185 g capita^{-1} day^{-1} (Bhardwaj *et al.*, 2010) [3]. Nevertheless, the crop's production in Himachal Pradesh is less than its maximum yield. Due to a variety of factors, including varying meteorological conditions, moisture stress, genotypes, imbalance fertilizer use, sowing timing and techniques, and other management techniques, wheat production varies greatly throughout India's many agro-ecologies (Kantwa *et al.*, 2015) [10]. Wheat compares well with other important cereals in its nutritive value.

Biochar, a rich source of carbon produced when feedstock or biomass is heated in a closed container which involves breaking down of organic substances at temperatures ranging from 350ºC to 1000ºC in a low oxygen thermal process referred to as pyrolysis (Liu *et al.*, 2011) [14]. Several studies concluded that addition of biochar to soil can promote crop yield and improve properties of soil (Matovic, 2010; Jeffery *et al.*, 2011; Kookana *et al.*, 2011) [16, 9, 11] raise the level of soil carbon pool for long term (Lehmann, 2007) [13] and abate greenhouse gas emission

(N_2O, $CH_4$and CO_2) (Dong *et al*., 2013; Zhang *et al*., 2013) [7, 30]. Biochar effectively adsorbs organic and inorganic pollutants from soil (Beesley *et al*., 2011; Yuan and Xu, 2011; Xu *et al*., 2013) [2, 29, 28]. By adding biochar to soil, heavy metals become more mobile and bioavailable (Méndez *et al*., 2012) [18]. In sandy loam soils, the use of biochar enhanced soil fertility status, particularly soil O.C., CEC, accessible P, exchangeable K, Ca, and Mg, and boosted nutrient absorption and production (Sukartono *et al*., 2011) [26].

Composting organic waste is a method of recycling waste materials that contributes to a sustainable waste management strategy by supplying plant nutrients and restoring soil organic matter that has been lost as a result of various human activities. It improves soil structure and adds beneficial microorganisms to the soil such as bacteria, fungi, and protozoa. Compost enriches the soil, adds nutrients, and reduces the use of chemical fertilizers, prevents soil erosion, conserves water, and helps in the pathogen, disease, and weed suppression. The compost addition also improves manure handling, reduces the risk of pollution, remediate the soil affected by hazardous wastes and promotes a high yield of crops. It is also used as mulch and holds nutrients tightly to prevent them from washing out. In agriculture, it is used to improve soil structure by adding nutrients to the soil (Mukherjee *et al*., 2016 and 2021) [20, 19]. Since not much work has been done on the relation to application of biochar and compost on wheat under Solan conditions to exploit its yield potential; it becomes imperative to identify suitable application of waste derived materials (Biochar and compost).

Materials and Methods

The experiment was concluded during *rabi* season of 2021-22 at the Chamelti Agriculture Farm, MS Swaminathan School of Agriculture, Shoolini University of Biotechnology and Management Sciences, Solan. The experimental site's field represent as an excellent spatial unit in terms of fertility, composition, and texture. The experiment was laid out in randomized block design with three replications comprising of eight treatments of waste derived materials *viz*. (T_0) Control, (T_1) Biochar @ 2.5 t ha^{-1}, (T_2) Biochar @ 5.0 t ha^{-1}, (T_3) Biochar @ 10.0 t ha^{-1}, (T_4) Compost @ 5.0 t ha^{-1}, (T_5) Compost @ 8.0 t ha^{-1}, (T_6) Compost @ 8.0 t ha^{-1} and (T_7) 50% biochar + 50% compost. The wheat variety HD-3086 was seeded. Application of waste derived materials (biochar and compost) were done as per treatment. The area's recommendations for other crop management techniques were adhered to. Observation related to yield attributes and yield of wheat were recorded as per standard procedure. The data relating to each character will be statistically analyzed with standard method of analysis of variance (ANOVA) as suggested by Panse and Sukhatme (1984) [22]. The comparison of treatment means was made by critical difference (RBD) at $p = 0.05$.

Table 1: Nutritional composition of Biochar and Compost

S. No.	Nutrient content (%)	Biochar	Compost
1.	Carbon	67.0	8.24
2.	Nitrogen	1.05	1.25
3.	Phosphorous	0.034	0.420
4.	Potassium	0.17	1.14

Results and Discussion

Yield attributes and yield

Data related to yield attributes and yield of wheat were significantly influenced by waste derived materials except for test weight. Significantly higher number of spikes (328.40 m^{-2}), grains spike^{-1} (57.66), spike length (12.78 cm), grain yield (4799 kg ha^{-1}), straw yield (12715 kg ha^{-1}), biological yield (17514 kg ha^{-1}) and harvest index (27.50%) were recorded with application of (T_6) Compost @ 10.0 t ha^{-1} over rest of the treatments. However, application of (T_6) Compost @ 10.0 t ha^{-1} was statistically at par with (T_3) Biochar @ 10.0 t ha^{-1} and (T_5) Compost @ 8.0 t ha^{-1} for number of spikes m^{-1}. Whereas, least values of these characters were recorded under (T_0) control treatment. In case of test weight (43.83 g), higher values were recorded under application of (T_6) Compost @ 10.0 t ha^{-1} but the difference was found to be non-significant. This may be due to slow release of nutrients from enriched compost during the crop season that continuous enhanced availability of nutrients to wheat. Moreover, compost added a decent amount of nitrogen and potassium and relatively good amount of phosphorus in the soil, besides furnishing other essential micronutrients. In association with soil microorganisms, compost are known to help in providing of certain phytohormones and vitamins which stimulate the growth and yield of crop. Improved soil structure, decreased soil moisture evaporation, improved soil temperature stability, improved nitrogen utilization, and consistent moisture conservation throughout the growing season can all contribute to improved crop development and increased crop yields. These factors may also account for the increase in yield components. Combined effect of compost and fertility levels was also found significant on seed and straw yield (Choudhary *et al*., 2015) [5]. These results are in agreement with those Singh *et al.* (2015) [24]; D'souza *et al.* (2017) [8]; Meena (2017) [17] and Ruth *et al.* (2017) [23]. It has been reported (Mandal and Sinha, 2004) [15] that adequate supply of nutrients through the combined use of compost favourably influenced the seed setting and seed development of wheat by improving the source-sink relationships and photosynthate partitioning which ultimately lead to increase the yield of wheat. Higher growth, yield attributes and grain, straw and biological yield of wheat by using Compost @ 10.0 t ha^{-1} (Kumar *et al*., 2018 and Murali *et al*., 2018) [12, 21] have also been reported. Because nutrients were available for a longer period of time, appropriate use of them led to greater crop development and, eventually, higher yields of grain and straw. This might possibly explain the higher yields. These findings are in close conformity with those reported by De and Sinha (2012) [6]. The results were in conformity with the findings of Singh and Singh (2006) [25].

Table 2: Yield attributes of wheat as influenced by waste derived materials (biochar and compost)

Treatments	Yield attributes			
	Spike (m^{-2})	Grains spike^{-1}	Spike length (cm)	Test weight (g)
T_0: Control	204.25	39.97	10.05	41.45
T_1: Biochar @ 2.5 t ha^{-1}	240.94	42.26	11.51	42.96

T_2: Biochar @ 5.0 t ha^{-1}	251.47	44.10	11.71	43.19
T_3: Biochar @ 10.0 t ha^{-1}	319.83	52.60	12.62	43.65
T_4: Compost @ 5.0 t ha^{-1}	271.59	46.28	12.23	43.25
T_5: Compost @ 8.0 t ha^{-1}	303.48	50.06	12.43	43.54
T_6: Compost @ 10.0 t ha^{-1}	328.40	57.66	12.78	43.83
T_7: 50% biochar + 50% compost	287.33	47.55	12.25	43.45
S.Em±	10.10	1.62	0.27	1.51
LSD (p=0.05)	30.63	4.91	0.81	NS

Table 3: Yield (kg ha^{-1}) and harvest index (%) of wheat as influenced by waste derived materials (biochar and compost)

Treatments	Yield (kg ha^{-1})			Harvest index (%)
	Grain yield	Straw yield	Biological yield	
T_0: Control	1459	5234	6693	21.80
T_1: Biochar @ 2.5 t ha^{-1}	2803	8284	11088	25.28
T_2: Biochar @ 5.0 t ha^{-1}	3019	8765	11783	25.60
T_3: Biochar @ 10.0 t ha^{-1}	4231	11313	15544	27.22
T_4: Compost @ 5.0 t ha^{-1}	3471	9731	13202	26.29
T_5: Compost @ 8.0 t ha^{-1}	4049	10968	15017	26.96
T_6: Compost @ 10.0 t ha^{-1}	4799	12715	17514	27.50
T_7: 50% biochar + 50% compost	3637	10086	13724	26.49
S.Em±	184	405	502	0.81
LSD (p=0.05)	557	1229	1524	2.44

Conclusion

On the basis of one year experiment it is to be concluded that marked improvement in yield attributes and yield of wheat were observed with application of Compost @ 10.0 t ha^{-1} under Solan conditions.

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