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Influenced of Vermicompost and Biofertilizer on Physico-Chemical Properties of Soil under Hybrid Maize (*Zea may* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Field experiment was conducted at Soil Science Research Farm of SHUATS Prayagraj, (U.P.) on, sandy loam soil to" Influenced of Vermicompost and Biofertilizer on Physico-chemial properties of soil under hybrid Maize (*Zea may* L.)" during *kharif* season of 2022. There are nine treatment combinations were comprised in randomized block design with three replications. The results showed that the application of Vermicompost and PSB had a significant and non-significant effect on soil physico-chemical properties. The maximum bulk density (1.34 and 1.37 Mg m^{-3}), particle density (2.56 and 2.62 Mg m-3), pH (7.23 and 7.25) and EC (0.45 and 0.41 dS m^{-1})

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was recorded in T1 (Absolute control) at 0-15 and 15-30 cm depth. Similarly, the maximum percentage pore space (47.76 and 47.65%), water holding capacity (45.27 and 45.01%), percentage organic carbon (0.54 and 0.51%), available nitrogen (230.47 and 226.49 kg ha^{-1}), phosphorus (29.29 and 28.29 kg ha^{-1}) and potassium (148.87 and. 140.27 kg ha^{-1}) was recorded in T9 (VC @100% + PSB @ 100%).

Keywords: Soil parameters; vermicompost; biofertilizer; maize.

1. INTRODUCTION

Maize is also known as “Queen of cereals” and kind of fodder Maize, has been usually considered as poor man's crop and occupying the place in the rich communities due to its multifarious use as industrial food and feed crops [1].

Fertilization treatments increased the seedling height and root collar diameter by 21% and 29%, respectively, and the mean dry weight of the stems and leaves by 72% and 123%, respectively; but a synergistic effect of the organic manure and NPK fertilizer was not observed. Compared to the effects of the fertilization treatments on the soil properties, the effects on nutrient concentrations in the leaves, stems, and roots were relatively small. These findings indicate that organic manure derived from earthworm by-products can be utilized in seedling production systems [2].

Vermicomposting is a green technology that converts organic wastes into plant-available nutrient rich organic fertilizer. It has also been found to reduce heavy metal concentration in contaminated feeding materials. Vermicompost (VC), when used as fertilizer, not only bears a positive impact on soil quality, plant growth and yield but also enhances nutritional value of crops produced [3].

The application of vermicompost helps to improves and conserves the fertility of soil. Vermicompost imparts a dark colour of the soil and thereby help to maintain the temperature of soil. Vermicompost is one of the manures used by the farmer in growing crops because of early availability and presence of almost all the nutrients required by plants. The composition of vermicompostiing 0.6-1.2% N, 0.13-0.22% P and 0.40-0.75% [2].

Biofertilizers are low cost, renewable sources of plant nutrients which supplement chemical fertilizers. These are nothing but selected strains of beneficial soil microorganisms cultured in the laboratory and packed in a suitable carrier. They can be used either for seed treatment or soil application. Biofertilizers generate plant nutrients like nitrogen and phosphorous through their activities in the soil or rhizosphere and make available to plants in a gradual manner. Biofertilizers are also ideal input for reducing the cost of cultivation and for practicing organic farming [4].

Biofertilizers are the inoculations of microbial cultures which are actually multiplied artificially of certain soil microorganisms that can improve soil fertility and crop productivity. Biofertilizers provides nutrient supply like nitrogen and phosphorous through their activities in the soil or rhizosphere and makes them available to the plants on the soil. Biofertilizers are now very important because they are properly maintaining the health of the soil and are reducing pollutions in the environment by cutting down the use of chemicals.

2. MATERIALS AND METHODS

The field experiment was conducted at Research Farm of Soil Science and Agricultural Chemistry at Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj. It is situated at $25^0 24' 23''$ N latitude, $81^0 50' 38''$ Longitude and at the altitude of 98 meter above the sea level.

The fieldwork was done in the Prayagraj district, which is part of the subtropical belt and has semi-arid climatic conditions with both winter and summer temperature extremes. “The maximum temperature of the location reaches up to 46˚- 48˚C and seldom falls as 4˚-5˚C. The relative humidity ranges between 20% to 94%. The average annual rainfall in Prayagraj is around 900-1100 mm annually. The minimum temperature during the crop season was to be 5.9˚C and the maximum is to be 29.04˚C. The maximum humidity was to be 42.72% and maximum was to be 93.28%” [5]. The present research investigation was setup in randomised

Table 1. Treatment details

Treatment	Treatment Combination	Symbool
T 1	Absolute Control	VC_0PSB_0
T 2	Vermicompost @ 0% + PSB @ 50%	VC_0PSB_{10}
T 3	Vermicompost @ 0% + PSB @ 100 %	VC_0PSB_{20}
T 4	Vermicompost @ 50%+ PSB @ 0 %	VC_2PSB_0
T 5	Vermicompost @ 50 %+ PSB @ 50 %	VC_2PSB_{10}
T 6	Vermicompost @ 50 %+ PSB @ 100 %	VC_2PSB_{20}
T 7	Vermicompost @ 100 %+ PSB @ 0 %	VC_4PSB_0
T 8	Vermicompost @ 100 % + PSB @ 50 %	VC_4PSB_{10}
T 9	Vermicompost @ 100 %+ PSB @ 100 %	VC_4PSB_{20}

block design (RBD) with nine treatment combinations, which are replicated three times and randomly allocated in each replication, dividing the research site into twenty- seven plots. In this study, inorganic fertilizers like nitrogen, phosphorus, and potassium were used as RDF, Vermicompost and biofertilizer like PSB was applied in three different doses. Sowing of the Maize crop was carried out on the 29 July, 2022, respectively, by hand. The seed variety Moti was sown at a rate of 20 kg ha^{-1} and at a row-to-row spacing of 60 cm and plant-to-plant spacing of 45 cm. The recommended doses of NPK were applied @120:60:40 $kgha^{-1.}$ The graded level of NPK were applied through Urea, Diammonium phosphate and Murate of potash. Half dose of nitrogen and full dose of phosphorus and potassium were applied basally at the time of sowing. In addition to these applications, Vermicompost was used as a basal dose at 0, 2, and 4 t ha^{-1} for the treatment. The sources of biofertilizer were PSB was apply three different dose 0g/kg seed,10g/kg seed, and 20 g/kg seed.

The soils from each plot were separately collected, air-dried, ground, and passed through a 2-mm-size sieve for laboratory analysis. Soil samples were analysed for bulk density, particle density, Percentage pore space, and water holding capacity [6], pH [7], EC [8], Percentage Organic Carbon [9], Available Nitrogen [10], Available Phosphorus [11] and Available Potassium [12] before sowing and after harvest of the crop

3. RESULTS AND DISCUSSION

3.1 Soil Physical Properties

The interaction effect of VC and PSB on the bulk density of soil after crop harvest was also found significant. The maximum bulk density 1.34 and 1.37 Mg m^{-3} of soil was revealed at 0-15 and 15-30 cm depth in VC_0PSB_0 and minimum bulk density 1.31 and 1.32 Mg m^{-3} of soil was found in $VC_4PSB_{20.}$The interaction effect/response of VC and PSB on the Particle density of soil after crop harvest was found significant. The maximum Particle density 2.56 and 2.62 Mg m^{-3} of soil was revealed at 0-15 and 15-30 cm depth in VC_0PSB_0 and minimum Particle density 2.40 and 2.44 Mg m^{-3} of soil was found in $VC_4PSB_{20.}$ The interaction effect/response of VC and PSB on the Pore space of soil after crop harvest was found significant. The maximum Pore space 47.76 and 47.65 % of soil was revealed at 0-15 and 15-30 cm depth in $VC_{20}PSB_{20}$ and minimum Pore space 45.3 and 45.25% of soil was found in VC_0PSB_0The interaction effect/response of VC and PSB on the Water Holding Capacity of soil after crop harvest was found significant. The maximum Water Holding Capacity 45.27 and 45.01% of soil was revealed at 0-15 and 15-30 cm depth in $VC_{20}PSB_{20}$ and minimum Water Holding Capacity 42.27 and 42.16 % of soil was found in VC_0PSB_0.

3.2 Soil Chemical Properties

The interaction effect/response of VC and PSB on the pH of soil after crop harvest was found significant. The maximum pH 7.23 and 7.25 of soil was revealed at 0-15 and 15-30 cm depth in VC_0PSB_0 and minimum pH 6.98 and 7.01 of soil was found in $VC_4PSB_{20.}$ The interaction effect/response of VC and PSB on the EC (dSm^{-1}) of soil after crop harvest was found significant. The maximum EC (dSm^{-1}) 0.45 and 0.41 of soil was revealed at 0-15 and 15-30 cm depth in VC_0PSB_0 and minimum EC (dS m^{-1}) 0.32 and 0.25 of soil was found in $VC_4PSB_{20.}$ The interaction effect/response of VC and PSB on the % Organic carbon of soil after crop harvest was found significant. The maximum % Organic carbon0.54 and 0.51 of soil was revealed at 0-15 and 15-30 cm depth in VC_4PSB_{20} and minimum % Organic carbon 0.34 and 0.33 of soil was found in VC_0PSB_0. The interaction effect/response of VC and PSB on the Nitrogen (Kg ha^{-1}) of soil after crop harvest was found significant. The maximum Nitrogen (Kg ha^{-1}) 230.47 and 226.49 of soil was revealed at 0-15 and 15-30 cm depth in VC_4PSB_{20} and minimum Nitrogen (Kg ha^{-1}) 206.26 and 205.17 of soil was found in VC_0PSB_0 The interaction effect/response of VC and PSB on the Phosphorus (Kg ha^{-1}) of soil after crop harvest was found significant. The maximum Phosphorus (Kg ha^{-1}) 29.29 and 28.29 of soil was revealed at 0-15 and 15-30 cm depth in VC_4PSB_{20} and minimum Phosphorus (Kg ha^{-1}) 16.87 and 16.26 of soil was found in VC_0PSB_0. The interaction effect/response of VC and PSB on the Potassium (Kg ha^{-1}) of soil after crop harvest was found significant. The maximum Potassium (Kg ha^{-1}) 144.87 and 140.27 of soil was revealed at 0-15 and 15-30 cm depth in VC_4PSB_{20} and minimum Potassium (Kg ha^{-1}) 127.83 and 125.36 of soil was found in VC_0PSB_0.

Table 2. Influence of Vermicompost and Biofertilizer on bulk density, particle density, pore space, and water holding capacity of soil

Block	BD (Mg m^{-3})		PD (Mg m^{-3})		Pore space (%)		WHC (%)	
	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30
VC_0PSB_0	1.34	1.37	2.56	2.62	45.3	45.25	42.27	42.16
VC_0PSB_{10}	1.34	1.34	2.51	2.58	45.55	45.53	43.24	43.16
VC_0PSB_{20}	1.33	1.34	2.48	2.52	45.86	45.84	43.28	43.25
VC_2PSB_0	1.33	1.34	2.46	2.49	46.07	46.05	44.27	44.24
VC_2PSB_{10}	1.33	1.33	2.45	2.48	46.09	46.01	44.89	44.3
VC_2PSB_{20}	1.32	1.33	2.45	2.47	46.2	46.00	44.94	44.75
VC_4PSB_0	1.32	1.34	2.44	2.46	46.3	46.25	44.98	44.8
VC_4PSB_{10}	1.32	1.32	2.42	2.44	46.76	46.74	45.01	44.94
VC_4PSB_{20}	1.31	1.32	2.40	2.45	47.76	47.65	45.27	45.01

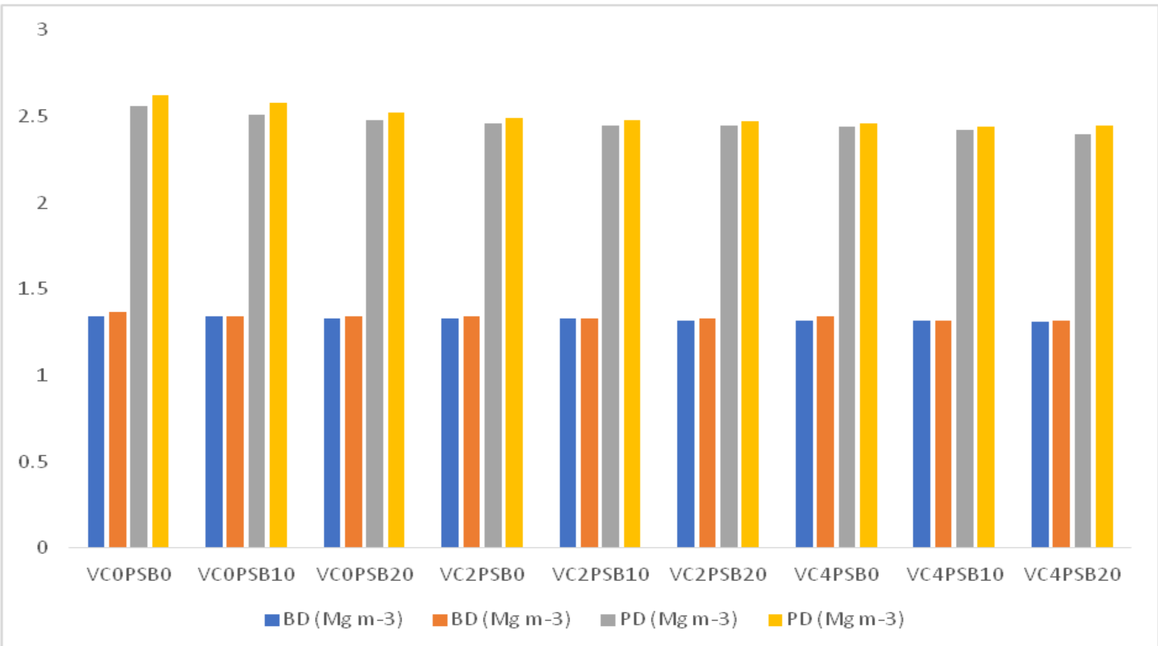

Fig. 1. The influence of VC and PSB on the bulk density and particle density of soil after crop harvest

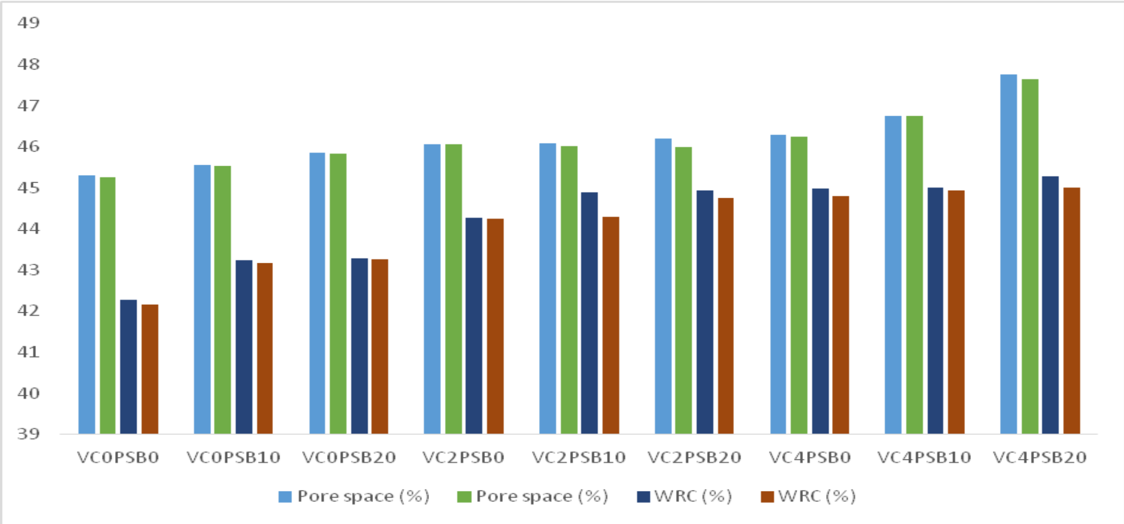

Fig. 2. The influence of VC and PSB on Pore space (%) and Water Retaining Capacity of soil after crop harvest

Table 3. Influence of Vermicompost and Biofertilizer on pH, electrical conductivity and organic carbon of soil

Block	pH		EC (dS m^{-1})		OC (%)	
	0-15	15-30	0-15	15-30	0-15	15-30
VC_0PSB_0	7.23	7.25	0.45	0.41	0.34	0.33
VC_0PSB_{10}	7.21	7.23	0.44	0.42	0.37	0.35
VC_0PSB_{20}	7.15	7.17	0.42	0.31	0.38	0.37
VC_2PSB_0	7.12	7.15	0.43	0.32	0.41	0.38
VC_2PSB_{10}	7.11	7.13	0.4	0.3	0.42	0.40
VC_2PSB_{20}	7.02	7.11	0.37	0.25	0.44	0.41
VC_4PSB_0	7.01	7.05	0.36	0.26	0.45	0.44
VC_4PSB_{10}	6.99	7.03	0.34	0.26	0.50	0.46
VC_4PSB_{20}	6.98	7.01	0.32	0.25	0.54	0.51

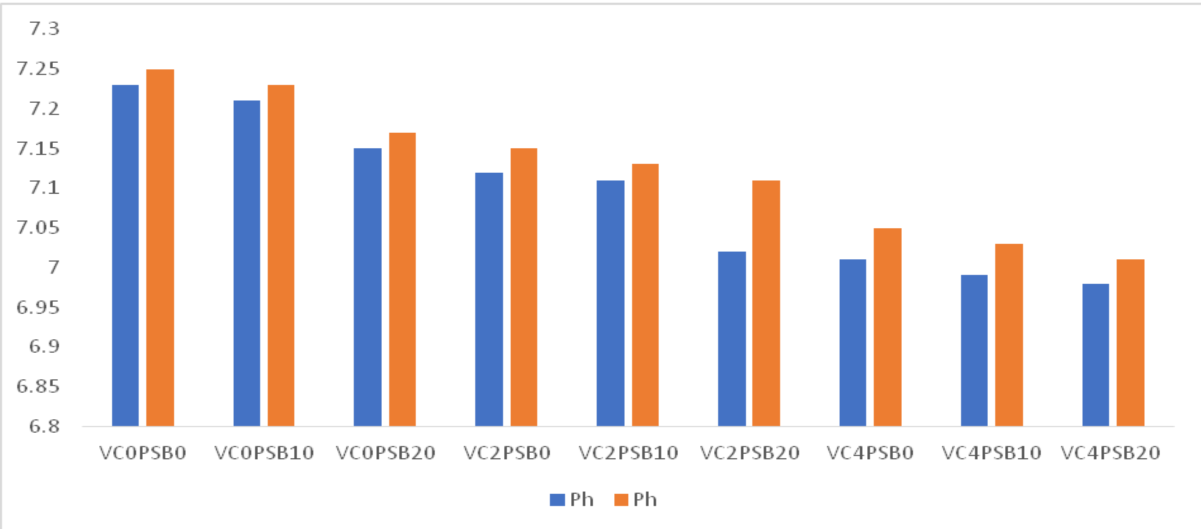

Fig. 3. The influence of VC and PSB on pH of soil after crop harvest.

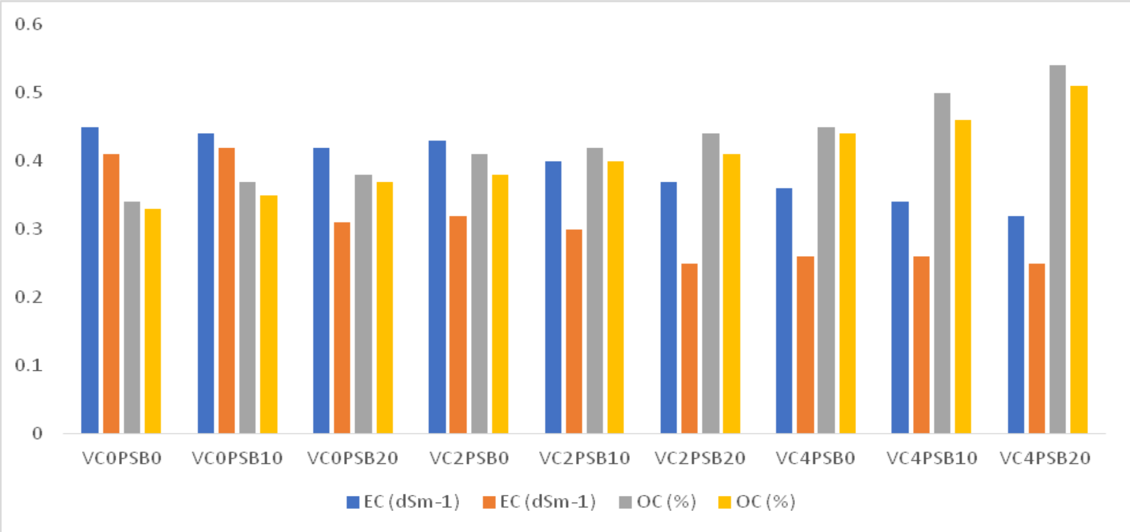

Fig. 4. The effect of VC and PSB on EC and Organic Carbon of soil after crop harvest.

Table 4. Influence of Vermicompost and Biofertilizer on available nitrogen, available phosphorus and available potassium of soil

Block	N (kg ha^{-1})		P (kg ha^{-1})		K (kg ha^{-1})	
	0-15	15-30	0-15	15-30	0-15	15-30
VC_0PSB_0	206.26	205.17	16.87	16.26	127.83	125.36
VC_0PSB_{10}	211.59	211.19	17.36	17.26	136.37	134.29
VC_0PSB_{20}	221.26	220.2	18.89	18.39	141.27	139.27
VC_2PSB_0	209.36	207.16	17.26	17.01	131.11	130.11
VC_2PSB_{10}	216.58	216.48	21.39	20.01	135.27	133.26
VC_2PSB_{20}	226.29	225.29	25.36	24.46	143.27	141.39
VC_4PSB_0	210.26	206.49	19.29	18.26	130.11	129.27
VC_4PSB_{10}	220.29	217.39	23.49	22.26	140.34	138.29
VC_4PSB_{20}	230.47	226.49	29.29	28.29	148.87	140.27

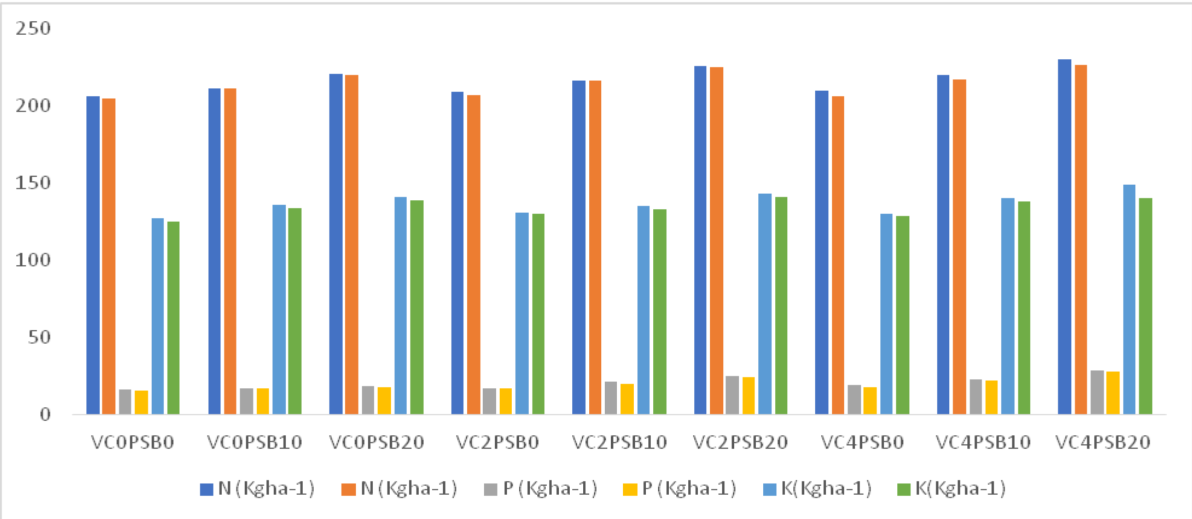

Fig. 5. The effect of VC and PSB on Available NPK of soil after crop harvest

4. CONCLUSION

The results of experiment concluded as the application of Vermicompost and PSB in treatment T_9 (VC_4PSB_{20}) was found sample most effective in improving physico-chemical properties of soil as decrease in bulk density, particle density, pH, and electrical conductivity, an increase in Pore space, Water retaining capacity, organic carbon and Available Nitrogen, Phosphorus and Potassium. Similarly, the maximum plant height, number of leaves per plant, number of cobs per plant, number of grains per cobs, average cob weight, grain yield and Harvesting index was found in treatment T_9 (VC_4PSB_{20}). The economically of different treatment concerned, the treatment T_9 (VC_4PSB_{20}) provides maximum Gross Return ₹ 87475.00 ha^{-1}, Net Return of ₹ 31217.00 ha^{-1} with Cost benefit ratio is 1:1.13 in. VC_2PSB_0.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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