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Role of biochar and FYM on enhancement of soybean (*Glycine max* L. Merrill) yield

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Abstract
The field investigation was conducted during *kharif* season of the year 2024-2025 at Central Farm, College of Agriculture, VNMKV, Parbhani to assess the role of Biochar and FYM on enhancement of Soybean (*Glycine max* L. Merrill) yield. The experiment was laid out in Randomized Block Design with three replications and ten treatments. The treatments were T_1: Control, T_2: 100% RDF, T_3: 75% RDF + 2 t ha $^{-1}$ Biochar, T_4: 75% RDF + 1 t ha $^{-1}$ Biochar, T_5: 75% RDF + 2 t ha^{-1} Biochar + 5 t ha^{-1} FYM, T_6: 75% RDF + 1 t ha^{-1} Biochar + 2.5 t ha^{-1} FYM, T_7: 100% RDF + 2 t ha^{-1} Biochar, T_8: 100% RDF + 1 t ha^{-1} Biochar, T_9: 100% RDF + 2 t ha^{-1} Biochar + 5 t ha^{-1} FYM, T_{10}: 100% RDF + 1 t ha^{-1} Biochar + 2.5 t ha^{-1} FYM. On the basis of present study the results revealed that, higher yield attributes and yield were obtained with the application of 100% RDF + 2 t ha^{-1} Biochar + 5 t ha^{-1} FYM (T_9) which was at par with the application of 100% RDF + 1 t ha^{-1} Biochar + 2.5 t ha^{-1} FYM (T_{10}) and 75% RDF + 2 t ha^{-1} Biochar + 5 t ha^{-1} FYM (T_5) and found significantly superior over rest of the treatments.

Keywords: Soybean, biochar, FYM, RDF, yield

Introduction
Soybean (*Glycine max* L. Merrill) often termed as "miracle crop" holds a significant place in India's agricultural economy and ranks fifth globally in production. Belonging to the family *Fabaceae*, it is valued for its dual role as an oilseed and pulse crop (Chauhan & Joshi, 2005). In India, soybean covers 132.55 lakh ha with 130.62 lakh tonnes production (Anonymous, 2025a) [1], mainly concentrated in Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, and Telangana. Maharashtra alone contributes 51.15 lakh ha area and 52.58 lakh tonnes of production with productivity of 1028 kg ha^{-1} (Anonymous, 2025b) [2]. Soybean serves as an economical source of high-quality protein, comparable to animal products, making it crucial in addressing malnutrition. About 85% of India's soybean is used for oil extraction, while the remainder goes for seed and food purposes.

Biochar, a carbonaceous product derived from pyrolysis of crop residues and other organic materials, has gained considerable attention for its potential role in sustainable crop production. Its application improves soil physical, chemical, and biological properties by enhancing porosity, water-holding capacity, and cation exchange capacity, while reducing nutrient leaching (Lehmann & Joseph, 2015) [11]. Biochar also provides a stable pool of organic carbon, contributing to long-term soil fertility and climate change mitigation (Woolf *et al.* 2010) [13]. Furthermore, it creates a favorable microhabitat for beneficial soil microorganisms, thereby enhancing nutrient mineralization and availability (Lehmann *et al.* 2011) [12]. When integrated with farmyard manure or chemical fertilizers, biochar enhances nutrient-use efficiency, promotes root growth, and increases crop productivity with improved economic returns (Jeffery *et al.* 2017) [9].

Materials and Methods
The experiment was conducted during *kharif* season of the year 2024-2025 at Central Farm, College of Agriculture, VNMKV, Parbhani to assess the role of Biochar and FYM on enhancement of Soybean (*Glycine max* L. Merrill) yield. The soil of experimental site was clayey in texture and well drained. Initial soil characterization of experimental site indicated that

soil had a pH of 8.2, EC of 0.26 dSm^{-1} with the organic carbon content of 0.57%. The soil was low in available nitrogen (131.71 kg ha^{-1}), medium in available phosphorus status (17.8 kg ha^{-1}) and high in available potassium status (551.84 kg ha^{-1}). The experiment was laid out in randomized block design with three replications of ten treatments. The treatments were T_1: Control, T_2: 100% RDF, T_3: 75% RDF + 2 t ha^{-1} Biochar, T_4: 75% RDF + 1 t ha^{-1} Biochar, T_5: 75% RDF + 2 t ha^{-1} Biochar + 5 t ha^{-1} FYM, T_6: 75% RDF + 1 t ha^{-1} Biochar + 2.5 t ha^{-1} FYM, T_7: 100% RDF + 2 t ha^{-1} Biochar, T_8: 100% RDF + 1 t ha^{-1} Biochar, T_9: 100% RDF + 2 t ha^{-1} Biochar + 5 t ha^{-1} FYM, T_{10}: 100% RDF + 1 t ha^{-1} Biochar + 2.5 t ha^{-1} FYM. The recommended dose of fertilizer was 30:60:30 N, P_2O_5 and K_2O kg ha^{-1}. Each experimental unit had a gross plot size of 5.4 m x 4.8 m and net plot size of 4.5 m x 3.5 m. Biochar and FYM were mixed and applied to respective plots as per the treatments before sowing of the crop. Observations on yield and yield contributing characters were recorded on randomly selected five plants from each net plot and tagged for recording the observations.

Results and Discussion

Yield Parameters

The data on yield contributing characters *viz.*, number of seeds pod^{-1}, number of seeds $plant^{-1}$, pod yield $plant^{-1}$ (g), seed yield $plant^{-1}$ (g) and seed index (g) are presented in Table 1. The application of 100% RDF + 2 t ha^{-1} Biochar + 5 t ha^{-1} FYM (T_9) recorded significantly maximum number of seeds pod^{-1} which was at par with the application of 100% RDF + 1 t ha^{-1} Biochar + 2.5 t ha^{-1} FYM (T_{10}), 75% RDF + 2 t ha^{-1} Biochar + 5 t ha^{-1} FYM (T_5) and 75% RDF + 1 t ha^{-1} Biochar + 2.5 t ha^{-1} FYM (T_6). Similar reports were recorded by Arif *et al.* (2012) [4] and Arunkumar and Tippeshappa (2020) [6].

The significantly maximum number of seeds $plant^{-1}$ were recorded with the application of 100% RDF + 2 t ha^{-1} Biochar + 5 t ha^{-1} FYM (T_9) which was at par with the application of 100% RDF + 1 t ha^{-1} Biochar + 2.5 t ha^{-1} FYM (T_{10}) and 75% RDF + 2 t ha^{-1} Biochar + 5 t ha^{-1} FYM (T_5) and found significantly superior over rest of the treatments. The data showed similar trend with respect to pod yield $plant^{-1}$ (g) and seed yield $plant^{-1}$ (g). The seed index of soybean seeds was not influenced significantly due to different treatments. However, the highest seed index was recorded with the application of 100% RDF + 2 t ha^{-1} Biochar + 5 t ha^{-1} FYM (T_9) and 100% RDF + 1 t ha^{-1} Biochar + 2.5 t ha^{-1} FYM (T_{10}). These enhancements may be due to the combined benefits of balanced nutrient supply from both inorganic and organic sources, better soil structure, and increased nutrient and moisture retention resulting from biochar application. Similar reports were recorded by Arif *et al.* (2012) [4], Anusha *et al.* (2025) [3], Budania *et al.* (2014) [7] and Arunkumar and Tippeshappa (2020) [6].

Table 1: Number of seeds pod^{-1}, No. of seeds $plant^{-1}$, pod yield $plant^{-1}$ (g), seed yield $plant^{-1}$ (g) and seed index (g) of soybean as influenced by different treatments at harvest

Tr. No.	Treatments	No. of seeds pod^{-1}	No. of seeds $plant^{-1}$	Pod yield $plant^{-1}$ (g)	Seed yield $plant^{-1}$ (g)	Seed index (g)
T_1	Control	2.43	32.64	3.94	3.10	9.50
T_2	100% RDF	2.53	40.35	5.46	4.20	10.35
T_3	75% RDF + 2 t ha^{-1} Biochar	2.46	40.32	5.20	4.03	10.00
T_4	75% RDF + 1 t ha^{-1} Biochar	2.43	36.83	4.61	3.60	9.75
T_5	75% RDF + 2 t ha^{-1} Biochar + 5 t ha^{-1} FYM	2.76	50.30	7.09	5.41	10.75
T_6	75% RDF + 1 t ha^{-1} Biochar + 2.5 t ha^{-1} FYM	2.76	45.29	6.38	4.87	10.65
T_7	100% RDF + 2 t ha^{-1} Biochar	2.56	44.89	6.12	4.71	10.50
T_8	100% RDF + 1 t ha^{-1} Biochar	2.50	39.97	5.29	4.07	10.20
T_9	100% RDF + 2 t ha^{-1} Biochar + 5 t ha^{-1} FYM	2.85	55.43	8.04	6.09	11.00
T_{10}	100% RDF + 1 t ha^{-1} Biochar + 2.5 t ha^{-1} FYM	2.80	49.58	7.14	5.45	11.00
SE (m ±)		0.05	2.79	0.38	0.29	0.70
CD @ 5%		0.14	8.28	1.12	0.86	NS
G.M.		2.61	43.56	5.93	4.55	10.37

Yield of Soybean

Data on seed yield, straw yield and biological yield as influenced by various treatments is presented in Table 2. The maximum seed yield of soybean was found with the application of 100% RDF + 2 t ha^{-1} Biochar + 5 t ha^{-1} FYM (T_9) which remained at par with the treatment 100% RDF + 1 t ha^{-1} Biochar + 2.5 t ha^{-1} FYM (T_{10}) and 75% RDF + 2 t ha^{-1} Biochar + 5 t ha^{-1} FYM (T_5) and found to be significantly superior over rest of the treatments. Lowest seed yield was recorded with Control treatment (T_1). The data showed similar trend with respect to straw yield and biological yield. Present finding was in line with results obtained by Arunkumar *et al.* (2019) [6], Anusha *et al.* (2025) [3], Budania *et al.* (2014) [7] and Laharia *et al.* (2020) [10].

Table 2: Mean seed yield (kg ha^{-1}), straw yield (kg ha^{-1}) and biological yield (kg ha^{-1}) of soybean as influenced by different treatments at harvest

Tr. No.	Treatments	Seed yield (kg/ha^{-1})	Straw yield (kg/ha^{-1})	Biological yield (kg/ha^{-1})
T_1	Control	1378	2038	3416
T_2	100% RDF	1856	2486	4342
T_3	75% RDF + 2 t ha^{-1} Biochar	1792	2393	4185
T_4	75% RDF + 1 t ha^{-1} Biochar	1596	2087	3683
T_5	75% RDF + 2 t ha^{-1} Biochar + 5 t ha^{-1} FYM	2403	3072	5475
T_6	75% RDF + 1 t ha^{-1} Biochar + 2.5 t ha^{-1} FYM	2164	2839	5003
T_7	100% RDF + 2 t ha^{-1} Biochar	2095	2738	4833
T_8	100% RDF + 1 t ha^{-1} Biochar	1812	2426	4238
T_9	100% RDF + 2 t ha^{-1} Biochar +5 t ha^{-1} FYM	2710	3399	6109
T_{10}	100% RDF + 1 t ha^{-1} Biochar + 2.5 t ha^{-1} FYM	2424	3095	5519
SE (m ±)		116.16	170.21	299.27
CD @ 5%		345.16	505.73	889.20
G.M.		2023	2657	4680

Conclusion

It is concluded from the present investigation that the application of 100% RDF + 2 t ha^{-1} Biochar + 5 t ha^{-1} FYM (T_9) is best suited for getting higher yield attributes and seed yield.

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