Influence of Phosphorus and Zinc on Physio-chemical Properties of Soil on Cowpea (*Vigna unguiculata* L.)

ABSTRACT

Field experiment was conducted at Soil Science Research Farm of SHUATS Prayagraj, (U.P.) on, sandy loam soil to "Influence of Phosphorus and Zinc on Physio-chemical Properties of Soil, Growth and Yield on Cowpea (*Vigna unguiculata* 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 Phosphorus and Zinc had a significant and non-significant effect on soil physico-chemical properties. The maximum bulk density (1.52 and 1.52 Mg^{-3}), particle density (2.61 and 2.63 Mg m-3) and pH (7.20 and 7.25) was recorded in T1 (Absolute control) at 0-15 and 15-30 cm depth. Similarly, the maximum percentage EC (0.48 and 0.49 dS m^{-1}), pore space (48.49 and 47.99%), water holding capacity (44.75 and 44.03%), percentage organic carbon (0.47 and 0.46%), available nitrogen (288.14 and 287.68 kg ha-1), phosphorus (29.60 and 28.85 kg ha-1) and potassium (192.41 and. 191.54 kg ha-1) was recorded in T9 (P_2O_5 @100% + Zn @ 100%)

Keywords: Soil parameters, Phosphorus, Zinc, cowpea.

Comment [DSS1]: To study the abstract must followed the format as below
Justification
Aim and objectives
Methods
Results
Conclusion

INTRODUCTION

Soil is a critical component for the proper functioning of agricultural system. (*Kibblewhite et al.*, 2007).The fertility of a soil plays an important role in sustainable crop production (FAO 2015).Due to continuous rice-wheat cultivation in Indo-Gangetic region, fertility of soil is deteriorating, raising a serious concern about the sustainability of Indian

Comment [DSS2]: Define your research area and support your research area with the previous literature
Identify knowledge gap and explain the novelty of your research area
Why are you intending to carry out this research
Your hypothesis and techniques adopted to prove your hypothesis
Write the aim and objectives of your research area

agriculture (Singh *et al.*, 2021). The introduction of high yielding varieties, extensive tillage and imbalanced use of chemical fertilizers and pesticides caused disturbance in soil ecosystem (*Latare et al.*,2015)

Cowpea, a crop well-suited to impoverished soil conditions and regions with limited rainfall, emerges as a promising solution. It thrives best in fertile, loamy soils receiving an annual rainfall ranging from 760 to 1150 mm during the growing season. Cowpea holds crucial importance for both human and livestock nutrition as it addresses food scarcity by efficiently utilizing water and nutrients while being a cost-effective protein source compared to meat (Moura et al., 2012).

Zinc (Zn) plays a pivotal role in cowpea's nitrogen metabolism and protein accumulation in grains. Furthermore, Zn influences water absorption and helps mitigate the adverse effects of heat and salt stress (Chalak et al., 2018). Phosphorus, another vital mineral nutrient after nitrogen, promotes the development of a robust root system and expedites plant maturity (Prem et al., 2020).

Pulses, including cowpea, hold significant value in the Indian diet, providing high-quality protein and essential nutrients. However, pulse production in India falls behind cereals, necessitating increased productivity to address the protein malnutrition resulting from the burgeoning population. Cowpea, with its elevated protein content (ranging from 21.2% to 30.6%) and nutritional value, can play a crucial role in bridging this gap (Ghosh and Hassan, 1979). Despite its potential, cowpea productivity remains subpar in India, including Karnataka, primarily due to low seed replacement rates, imbalanced fertilizer application on nutrient-deficient soils, and shifting rainfall patterns. Endeavours should be made to improve productivity and address these challenges effectively.

To summarize, cowpea stands out as a valuable crop in India, well-adapted to adverse conditions while providing essential nutrition. However, addressing soil nutrient deficiencies and augmenting cowpea productivity are imperative for sustainable agriculture and meeting the nutritional requirements of the population. Additionally, the widespread zinc deficiency can be mitigated by incorporating food sources with a high zinc content, such as cowpea, into the diet.

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. There are nine treatment combination were comprised in randomized block design with three replications. The treatment combination is T_1- [P_2O_5 @ 0% + Zn @ 0% Control], T_2- [P_2O_5 @ 0% + Zn @ 50%], T_3- [P_2O_5 @ 0% + Zn @ 100%], T_4 [P_2O_5 @ 50% + Zn @ 0%], T_5- [P_2O_5 @ 50% + Zn @ 50%], T_6 - [P_2O_5 @ 50% + Zn @ 100%], T_7 – [P_2O_5 @ 100% + Zn @ 0%], T_8 – [P_2O_5 @ 100% + Zn @ 50%], T_9 – [P_2O_5 @ 100% + Zn @ 100%]. Healthy seeds of cowpea variety Gomti were sown 30×15 cm spacing in sandy loam soil. The recommended doses of NPK were applied @ 20:60:60 Kg ha-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. The soil samples were collected randomly from the experimental field to ascertain the nutrient status of each plot at 0-15 and 15-30 cm depth. The size of the soil sample was reduced by air-drying and crushing with the wooden hammer and then passed through a 2 mm sieve, conning and quartering to prepare the composite soil sample for physical and chemical analysis.

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Table 1: Treatment combination for Cowpea

TREATMENT	TREATMENT COMBINATION
T_1	(Absolute control)
T_2	P_2O_5 @ 0% + Zn @ 50%
T_3	P_2O_5 @ 0% + Zn @ 100%
T_4	P_2O_5 @ 50% + Zn @ 0%
T_5	P_2O_5 @ 50% + Zn @ 50%
T_6	P_2O_5 @ 50% + Zn @ 100%
T_7	P_2O_5 @ 100% + Zn @ 0%
T_8	P_2O_5 @ 100% + Zn @ 50%
T_9	P_2O_5 @ 100% + Zn @ 100%

Result and Discussion

Effect of Phosphorus and Zinc on Soil Physical Properties

The interaction effect of Phosphorus and Zinc on the bulk density of soil after crop harvest was also found significant. The maximum bulk density 1.52 and 1.52Mgm^{-3} of soil was revealed at 0-15 and 15-30 cm depth in T_1- [P_2O_5 @ 0% + Zn @ 0%] and minimum bulk density 1.18 and 1.18 Mgm^{-3} of soil was found in T_9 – [P_2O_5 @ 100% + Zn @ 100%]. The interaction effect/response of Phosphorus and Zinc on the Particle density of soil after crop harvest was found significant. The maximum Particle density 2.61 and 2.63 Mgm^{-3} of soil was revealed at 0-15 and 15-30 cm depth in T_1- [P_2O_5 @ 0% + Zn @ 0%] and minimum Particle density 2.46 and 2.48 Mgm^{-3} of soil was found in T_9 – [P_2O_5 @ 100% + Zn @ 100%]. The interaction effect/response of Phosphorus and Zinc on the Pore space of soil after crop harvest was found significant. The maximum Pore space 48.49 and 47.99 % of soil was revealed at 0-15 and 15-30 cm depth in T_9 – [P_2O_5 @ 100% + Zn @ 100%] and minimum Pore space 45.69 and 45.30 % of soil was found in T_1- [P_2O_5 @ 0% + Zn @ 0%]. The interaction effect/response of Phosphorus and Zinc on the Water Holding Capacity of soil after crop harvest was found significant. The maximum Water Holding Capacity 44.75 and 44.03 % of soil was revealed at 0-15 and 15-30 cm depth in T_9 – [P_2O_5 @ 100% + Zn @ 100%] and minimum Water Holding Capacity 41.68 and 40.95 % of soil was found in T_1- [P_2O_5 @ 0% + Zn @ 0%].

Table 2: Influence of Phosphorus and Zinc on bulk density particle density pore space and water holding capacity of post-harvest soil

TREATMENT	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
T_1	1.52	1.52	2.61	2.63	45.69	45.30	41.68	40.95
T_2	1.48	1.49	2.60	2.61	46.01	45.62	42.10	41.20
T_3	1.44	1.45	2.58	2.60	46.52	46.15	42.42	41.72
T_4	1.37	1.38	2.56	2.58	46.85	46.44	43.08	42.30
T_5	1.37	1.37	2.55	2.57	47.04	46.64	43.49	42.68
T_6	1.30	1.30	2.53	2.54	47.31	46.94	43.78	43.05
T_7	1.26	1.26	2.51	2.52	47.79	47.39	44.12	43.38
T_8	1.22	1.22	2.48	2.51	47.95	47.52	44.48	43.70
T_9	1.18	1.18	2.46	2.48	48.49	47.99	44.75	44.03

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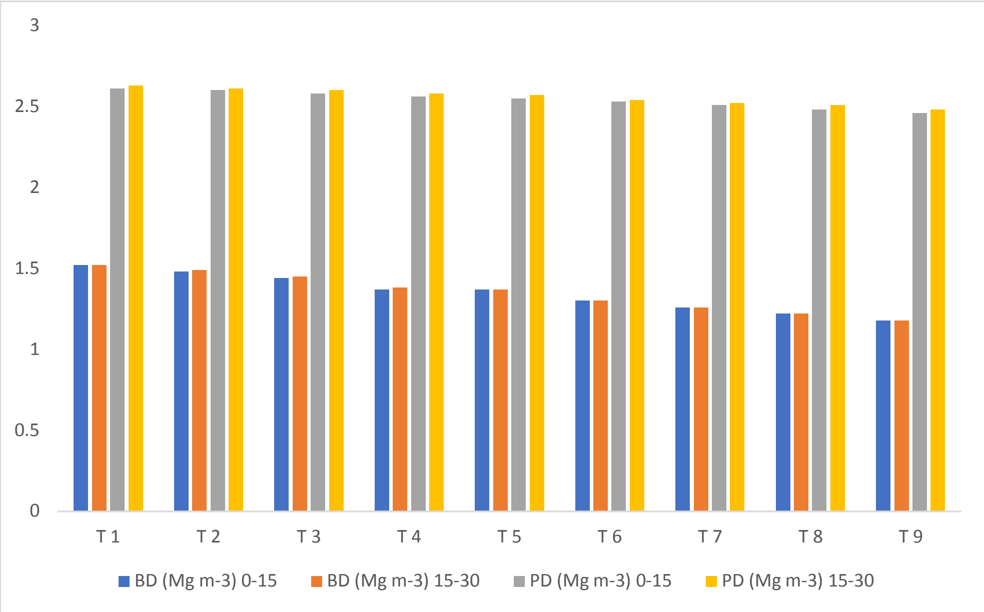
Tables are statistically done
Figures cannot be accepted in its current form
Need to be revised with statistical analysis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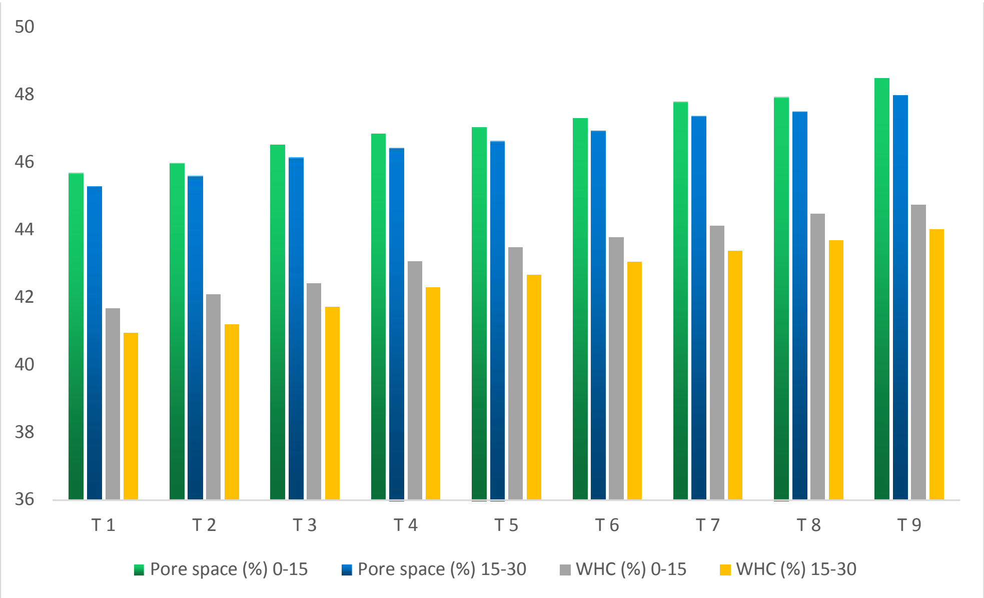
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WHC (%) 15-30

Effect of Phosphorus and Zinc on Soil Chemical Properties

The interaction effect/response of Phosphorus and Zinc on the pH of soil after crop harvest was found significant. The maximum pH 7.20 and 7.25 of soil was revealed at 0-15 and 15-30 cm depth in T_1- [P_2O_5 @ 0% + Zn @ 0%] and minimum pH 6.75 and 6.77 of soil was found in T_9 – [P_2O_5 @ 100% + Zn @ 100%]. The interaction effect/response of Phosphorus and Zinc on the EC (dSm^{-1}) of soil after crop harvest was found significant. The maximum EC (dSm^{-1}) 0.48 and 0.49 of soil was revealed at 0-15 and 15-30 cm depth in T_9 – [P_2O_5 @ 100% + Zn @ 100%] and minimum EC (dSm^{-1}) 0.33 and 0.34 of soil was found in T_1- [P_2O_5 @ 0% + Zn @ 0%]. The interaction effect/response of Phosphorus and Zinc on the % Organic carbon of soil after crop harvest was found significant. The maximum % Organic carbon0.47 and 0.46 of soil was revealed at 0-15 and 15-30 cm depth in T_9 – [P_2O_5 @ 100% + Zn @ 100%] and minimum % Organic carbon 0.34 and 0.32 of soil was found in T_1- [P_2O_5 @ 0% + Zn @ 0%]. The interaction effect/response of Phosphorus and Zinc on the Nitrogen (Kg ha-1) of soil after crop harvest was found significant. The maximum Nitrogen (Kg ha-1) 288.14 and 287.68 of soil was revealed at 0-15 and 15-30 cm depth in T_9 – [P_2O_5 @ 100% + Zn @ 100%] and minimum Nitrogen (Kg ha-1) 261.56 and 261.19 of soil was found in T_1- [P_2O_5 @ 0% + Zn @ 0%]. The interaction effect/response of Phosphorus and Zinc on the Phosphorus (Kg ha^{-1}) of soil after crop harvest was found significant. The maximum Phosphorus (Kg ha^{-1}) 29.60 and 28.85 of soil was revealed at 0-15 and 15-30 cm depth in T_9 – [P_2O_5 @ 100% + Zn @ 100%] and minimum Phosphorus (Kg ha^{-1}) 20.92 and 19.78 of soil was found in T_1- [P_2O_5 @ 0% + Zn @ 0%]. The interaction effect/response of Phosphorus and Zinc on the Potassium (Kg ha^{-1}) of soil after crop harvest was found significant. The maximum Potassium (Kg ha^{-1}) 192.41 and 191.54 of soil was revealed at 0-15 and 15-30 cm depth in T_9 – [P_2O_5 @ 100% + Zn @ 100%] and minimum Potassium (Kg ha^{-1}) 175.44 and 174.08 of soil was found in T_1- [P_2O_5 @ 0% + Zn @ 0%].

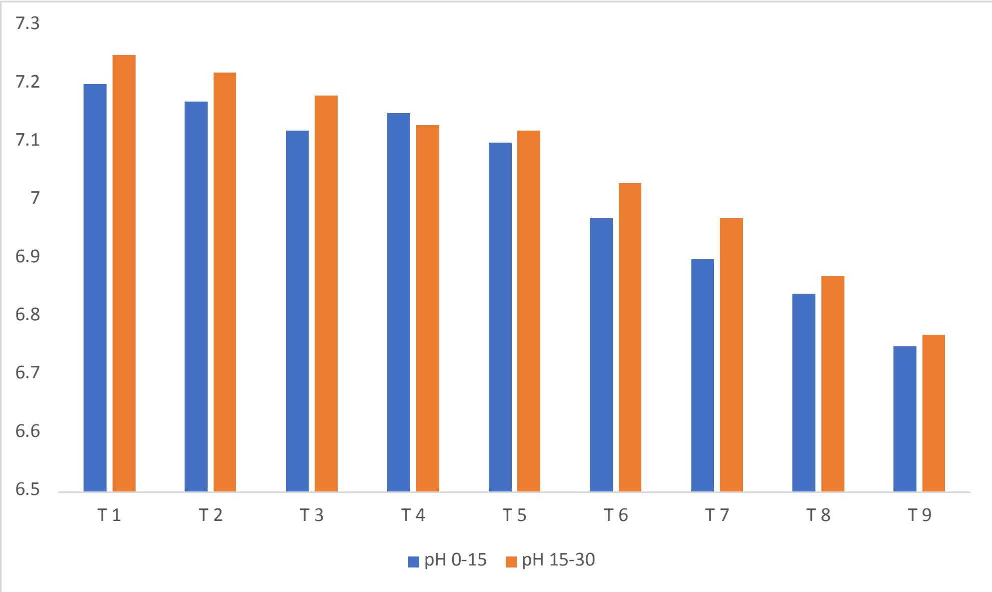
Table 3: Influence of Phosphorus and Zinc on pH electrical conductivity and organic carbon of post-harvest soil

TREATMENT	pH		EC (dSm^{-1})		OC (%)	
	0-15	15-30	0-15	15-30	0-15	15-30
T_1	7.20	7.25	0.33	0.34	0.34	0.32
T_2	7.17	7.22	0.35	0.36	0.35	0.34
T_3	7.12	7.18	0.38	0.39	0.38	0.36

T 4	7.15	7.13	0.37	0.39	0.37	0.35
T 5	7.10	7.12	0.40	0.41	0.39	0.38
T 6	6.97	7.03	0.43	0.44	0.42	0.41
T 7	6.90	6.97	0.43	0.45	0.42	0.41
T 8	6.84	6.87	0.45	0.47	0.44	0.44
T 9	6.75	6.77	0.48	0.49	0.47	0.46

Table 4: Influence of Phosphorus and Zinc on available nitrogen available phosphorus and available potassium of post-harvest soil

TREATMENT	**N (kg ha^{-1})**		**P (kg ha^{-1})**		**K (kg ha^{-1})**	
	0-15	**15-30**	**0-15**	**15-30**	**0-15**	**15-30**
T 1	261.56	261.19	20.92	19.78	175.44	174.08
T 2	266.52	265.96	22.49	21.28	176.38	175.47
T 3	269.27	267.71	23.04	22.01	178.61	177.15
T 4	279.09	276.86	23.88	22.87	179.06	178.67
T 5	280.28	279.1	24.6	23.42	180.55	179.93
T 6	283.01	282.12	25.48	24.52	182.94	182.186
T 7	285.42	284.21	25.98	25.29	185.73	185.08
T 8	287.05	285.60	28.41	27.18	188.35	187.24
T 9	288.14	287.68	29.60	28.85	192.41	191.54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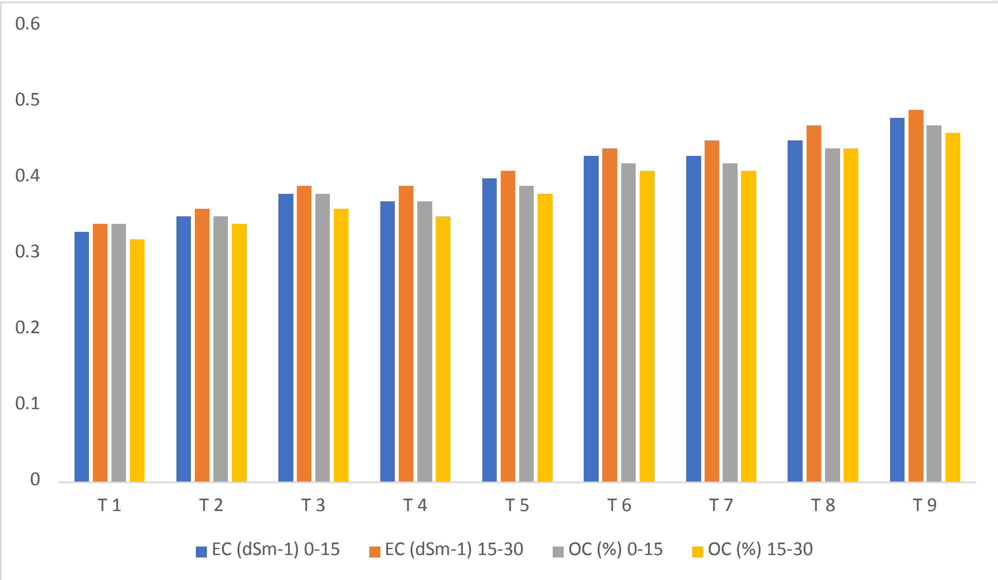
pH 15-30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EC (dSm-1) 0-15
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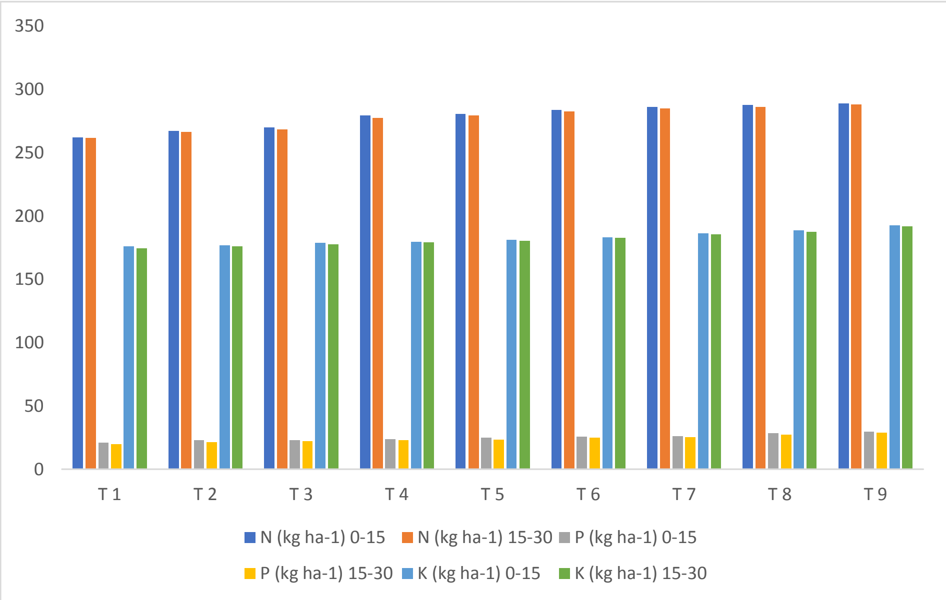
OC (%) 0-15
OC (%) 15-30



CONCLUSION

The results of experiment concluded as the application of Phosphorus and Zinc in treatment T_9 – [P_2O_5 @ 100% + Zn @ 100%] was found sample most effective in improving physico-chemical properties of soil as decrease in bulk density, particle density and pH an increase in electrical conductivity, Pore space, Water retaining capacity, organic carbon and Available Nitrogen, Phosphorus and Potassium. Similarly, the maximum plant height, number of Branch per plant, Pod Per Plant ,Length of Pod, Seed and Straw yield and Harvesting index was found in treatment T_9 – [P_2O_5 @ 100% + Zn @ 100%].The economically of different treatment concerned, the treatment T_9 – [P_2O_5 @ 100% + Zn @ 100%] provides maximum Gross Return ₹ 129340.00 ha^{-1}, Net Return of ₹ 91211.00 ha^{-1} with Cost benefit ratio is 1:3.39.

Comment [DSS5]: Discussion is completely missing include the discussion and support your results with the previous literature

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