

Response of Integrated Nutrients on Soil Health and Yield Attributes of Cluster bean (*Cyamopsis tetragonoloba* L.) cv. Neelam

ABSTRACT

An experiment was conducted during *Zaid* (April- July) season 2022 to study “Response of integrated nutrients on soil health and yield attributes of cluster bean (*Cyamopsis tetragonoloba* L.) cv. Neelam” on central Research farm Department of Soil Science and Agricultural Chemistry, SHUATS, Prayagraj. The design applied was 3×3 factorial randomized block design consisted nine treatment three @NPK 0, 50, and 100% ha⁻¹, three levels of @Vermicompost 0, 50 and 100% ha⁻¹, three levels of Zinc 0, 50 and 100% ha⁻¹ respectively. The best treatment was T₉ (100% RDF+100% ZnSO₄+ Vermicompost @10 t ha⁻¹) has effect on physical and chemical property of soil and yield of cluster bean. The data observed in post-harvest soil were significantly increased maximum values of percentage pore space (%) (46.533) water holding capacity (41.103), organic carbon (%) (0.56), Nitrogen (kg ha⁻¹) (328.32), Phosphorus (kg ha⁻¹) (20.270) and Potassium (kg ha⁻¹) (234.893). Plant height at different days 30, 60 and 90 DAS was (23.03, 54.22 and 121.86 cm), No. of leaves per plant at different days 30, 60 and 90 DAS was (29.11, 47.74 and 82.60) Pod length (14.11), number of cluster plant⁻¹ (6.47), number of pods cluster⁻¹ (7.47), number of pods per plant (48.35), number of seed pods (9.76), pod weight (g) (2.35). The combination of T₉ (100% RDF+100% ZnSO₄+ Vermicompost @10 t ha⁻¹) showed slight decrease in pH (7.250), bulk density (Mg m⁻³) (1.172) and particle density (Mg m⁻³) (2.228) The maximum cost benefit ratio (C:B) 1:2.67, maximum gross return 750900.00, Rs/ha maximum net profit 469604.00 Rs ha⁻¹, and highest yield with 25.03q ha⁻¹ in T₉ (100% RDF+100% ZnSO₄+ Vermicompost @10 t ha⁻¹).

Keyword: Soil nutrients, yield attributes, vermicompost, NPK, Zn, Cluster bean

1. INTRODUCTION

“The agricultural soil supports the crop growth better, if the suitable fertilizers are supplied for the growth of all vegetable crops” (Chavan *et al.*, 2014). ‘*Cyamopsis tetragonoloba* or cluster bean (Guar) belongs to the family Fabaceae (Leguminosae). It is commercially grown for its seeds as a source of natural polysaccharide (galactomannan), commercially known as guar gum. Guar gum has several uses in food” (Khalil, 2001). “Use of inorganic fertilizers alone though increases the production at a faster rate but it may not sustain the productivity in long run and affects soil health. Moreover, inorganic fertilizers are costly and their imbalanced use deteriorate soil physio-chemical environment. On the other hand, organic sources of nutrients are cheaper, ecofriendly, improve soil properties and can substitute nutrient requirement of crops partially. Hence, integrated use of inorganic fertilizers, organic manures, and low-cost nutrient sources such as bio fertilizers is the better option for sustainable production and maintenance of soil health” (Parmar *et al.*, 2019). “The application of vermicompost helps to improve and conserves the fertility of soil. Vermicompost imparts a dark color 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 vermicompost is 0.6-1.2% N, 0.13-0.22% P and 0.40-0.75%” (K Pawar. 2007) and (Kumar *et al.*, 2018). “For soils low in

available P, the nutrient must be applied in either organic or inorganic P sources to obtain optimal crop yield. However, excessive use of applied P sources can cause eutrophication in water bodies from surface runoff of sediments carrying P or leaching of P in sandy soils” (Chien *et al.*, 2011). “Vermicomposting is a process in which vermicompost is produced by earthworms and is proving to be an extremely nourishing organic fertilizer and more omnipotent growth promoter over the traditional compost. It has a protective function against the pestilential chemical fertilizers which destroy the soil richness and affect natural soil fertility adversely. Vermicompost is rich in NPK, micronutrients, crude proteins, beneficial soil microbes, and growth-promoting plant hormones and enzymes” (Kumar *et al.*, 2022). “Vermicompost can withhold nutrients for a longer period, while the traditional compost fails to provide the essential amount of macro and micronutrients to plants in a shorter time, the vermicompost does. Vermicompost works as a ‘slow-release organic fertilizer’ whereas the chemical fertilizers release their nutrients more rapidly in soil and soon get depleted. Nitrogen and phosphorus are not completely available to the roots of the plant in the first year, because nitrogen and phosphorus compost are higher in ‘ammonium content’ while the vermicompost contains a higher content of ‘nitrates’ which is an extensively available form of nitrogen to plants. Vermicompost acts as an efficient ‘soil conditioner’ and its prolonged application over the years lead to the up gradation of soil quality and soil fertility. Vermicompost possesses high-water holding capacity, aeration, and drainage. The soil treated with vermicompost over the years is characterized by near-neutral pH and more electrical conductivity. The high levels of beneficial microbial population in vermicompost paves a way for inhibition of plant pathogens by out-competing plant pathogens for available food resources. Vermicompost improves the physiochemical and biological properties of the soil and contributes to organic enrichment” (Ansari *et al.*, 2016) and (Chauhan and Singh 2013). “Zn deficient soil can lead to Zn deficiency in human and livestock as well. Such nation communities, having maize as their staple food are prone to the Zn deficiency induced health challenges” (Jiang *et al.*, 2008). “In order to reverse this trend, method of zinc application is a critical concern. Many researchers found soil application of Zn to be a better alternative of Zn nutrition whereas, some reported foliar application to be beneficial and more zinc fertilizer efficient. It was recently documented that zinc foliar application is a simple way for making quick correction of plant nutritional status, as reported for wheat” (Erenoglu *et al.*, 2002) and maize (Grzebisz *et al.*, 2008).

2.MATERIALS AND METHODS

2.1 Experimental Site

The experiment was conducted at research Farm of Soil Science at Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, the area is situated on the south of Prayagraj on the right bank of the river Yamuna on the South of Rewa Road at about 6 km from Prayagraj city. It is situated at 25⁰57” N latitude, 81⁰59” E longitude and at the altitude of 98 meter above the sea level.

2.2 Climatic Condition

The area of Prayagraj district comes under subtropical belt in the South east of Uttar Pradesh, which experience extremely hot summer and cold Winter. The maximum temperature of the location reaches up to 46⁰C – 48⁰C and seldom falls as low as 4⁰C – 5⁰C. The relative humidity ranged between 20 to 94 percent. The average rainfall in this area is around 1100mm annually.

Table 1. Treatment combinations of cluster bean

S. No.	Treatments No.	Treatment combinations
1.	T ₁	Control
2.	T ₂	0% RDF + 0%ZnSO ₄ + Vermicompost @5 t ha ⁻¹
3.	T ₃	0% RDF +0%ZnSO ₄ + Vermicompost @10 t ha ⁻¹
4.	T ₄	50% RDF +50%ZnSO ₄ + Vermicompost @ 0 t ha ⁻¹
5.	T ₅	50% RDF +50%ZnSO ₄ + Vermicompost @5 t ha ⁻¹
6.	T ₆	50% RDF +50%ZnSO ₄ + Vermicompost @10 t ha ⁻¹
7.	T ₇	100% RDF +100%ZnSO ₄ + Vermicompost @ 0 t ha ⁻¹
8.	T ₈	100% RDF +100%ZnSO ₄ + Vermicompost @5 t ha ⁻¹
9.	T ₉	100% RDF +100%ZnSO ₄ + Vermicompost @10 t ha ⁻¹

2.3 Collection of soil sample for Analysis

The soil sample were randomly collected from twenty-seven different sites in the experiment plot prior to tillage operation from a depth of 0-15 and 15-30cm.soil sample was air dried and passed through a 2mm sieve for Physical and Chemical Analysis.

2.3.1 Physical Analysis

The Physical Analysis were bulk density, particle density, pore space, and water holding capacity done using a Graduated measuring cylinder (Muthuvel *et al.*, 1992).

2.3.2 chemical analysis

The chemical analysis was pH, Ec (Wilcox, 1950), organic carbon (Walkley and black, 1934), available nitrogen (Subbiah and Asija, 1956), available phosphorous (Olsen *et al.*, 1954), available potassium (Toth and prince, 1949) and zinc (Shaw and dean, 1952 and Holmes 1945).

2.4 Statistical analysis

The data recorded during the investigation will be subjected to statistical analysis by 3×3 RBD, as per the method “Analysis of Variance (ANOVA) technique”. Experiment will be laid out in RBD and the treatment will be replicated three times. The significant and non-significant

Effect was judged with the help of F table. The significant difference between the means was tested against the critical difference of 5%level. Fisher (1950)

3.RESULT AND DISCUSSION

3.1 Effect of Integrated nutrients on physical properties of soil after harvest

The data showed that the minimum bulk density (mg m^{-3}) (1.172 and 1.462), Particle density (mg m^{-3}) (2.228 and 2.503) at 0-15 and 15-30cm of soil depth was found in treatment T₉ 100% RDF+100% ZnSO₄+Vermicompost@10t ha⁻¹ and maximum bulk density (mgm^{-3}) (1.194 and 1.580), particle density (2.377 and 2.600) which was found in T₁(control).The pore space(%) (46.533 and 44.404), Water holding capacity(%) (44.84 and 42.82) are maximum in T₉ 100% RDF+100%ZnSO₄+Vermicompost @10 t ha⁻¹.However minimum values were detected in the treatment T₁ (control) at 0-15 and 15-30cm of soil depth respectively (Table 2 and fig 1.)

3.2 Effect of Integrated nutrients on chemical properties of soil after harvest

The data showed that minimum pH. (7.250 and 7.567), Ec (0.260 and 0.257) at 0-15 and 15-30cm of soil depth was found in T₉ 100% RDF+100%ZnSO₄+ Vermicompost@10 t ha⁻¹ and the maximum pH. (7.657 and 7.810) and Ec ds m⁻¹ (0.353 and 0.326) which was found in T₁ (control) respectively. The organic carbon (%) (0.56 and 0.53), Nitrogen (kg ha⁻¹) (328.32 and 310.80), phosphorus (kg ha⁻¹) (33.063 and 29.867), potassium (kg ha⁻¹) (234.893 and 197.617) and Zinc (Mg ha⁻¹) (0.95 and 0.82)are maximum in T₉ 100% RDF+100%ZnSO₄+ Vermicompost @10 t ha⁻¹ .However minimum values were detected in the treatment T₁ (control) at 0-15 and 15-30cm of soil depth respectively (Table 3 and fig 2,3)

3.3 Effect of integrated nutrients on growth parameters and yield attributes of cluster bean

It is indicated from table (4) that nutrient sources significantly improved the growth and yield attributes of cluster bean. Among the nutrient sources 100%RDF+100%ZnSO₄+ Vermicompost @10 t ha⁻¹ gave highest values of plant height at 90DAS (121.86), no of leaves per plant at 90DAS (82.60) pod length (14.17), no of pods per cluster (7.47), pod weight (2.35g), pod yield per plant (113.79g), pod yield per plot (10.01kg), pod yield t ha⁻¹ (25.03)

Table 2: Effect of different levels of NPK, Vermicompost and zinc on bd, pd, pore space, WHC, and ph.

S. No.	Treatments No.	Treatment combinations	Bulk Density (mg m^{-3})		Particle Density (mg m^{-3})		Pore space (%)		Water holding capacity (%)		pH	
			0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
1	T ₁	Control	1.194	1.580	2.377	2.600	45.703	42.900	41.103	40.193	7.657	7.810
2	T ₂	0% RDF+0%ZnSO ₄ + Vermicompost @5 t ha ⁻¹	1.186	1.551	2.369	2.574	45.907	42.980	42.183	40.550	7.553	7.767
3	T ₃	0% RDF+0%ZnSO ₄ + Vermicompost @10 t ha ⁻¹	1.182	1.499	2.260	2.547	46.317	43.710	42.340	41.663	7.537	7.697
4	T ₄	50% RDF+50%ZnSO ₄ + Vermicompost @ 0 t ha ⁻¹	1.180	1.502	2.255	2.559	46.307	43.790	41.277	41.107	7.503	7.660
5	T ₅	50% RDF+50%ZnSO ₄ + Vermicompost @5 t ha ⁻¹	1.178	1.501	2.253	2.556	46.353	43.917	43.170	42.080	7.487	7.663
6	T ₆	50% RDF+50%ZnSO ₄ + Vermicompost @ 10 t ha ⁻¹	1.176	1.492	2.241	2.533	46.280	44.010	43.670	42.344	7.403	7.633
7	T ₇	100% RDF+100%ZnSO ₄ + Vermicompost @ 0 t ha ⁻¹	1.177	1.498	2.240	2.554	46.356	44.021	41.550	41.383	7.400	7.657
8	T ₈	100% RDF+100%ZnSO ₄ + Vermicompost @5 t ha ⁻¹	1.175	1.479	2.234	2.526	46.453	44.327	44.630	42.518	7.367	7.603
9	T ₉	100% RDF+100%ZnSO ₄ +Vermicompost @ 10 t ha ⁻¹	1.172	1.462	2.228	2.503	46.533	44.404	44.840	42.827	7.250	7.567
		F-Test	NS	S	S	NS	NS	NS	S	S	NS	NS
		C. D. at 0.5%	0.05	0.07	0.10	0.14	2.06	2.29	1.88	1.57	0.34	0.25
		S. Ed. (+)	0.02	0.02	0.03	0.05	0.69	0.76	0.63	0.52	0.11	0.08

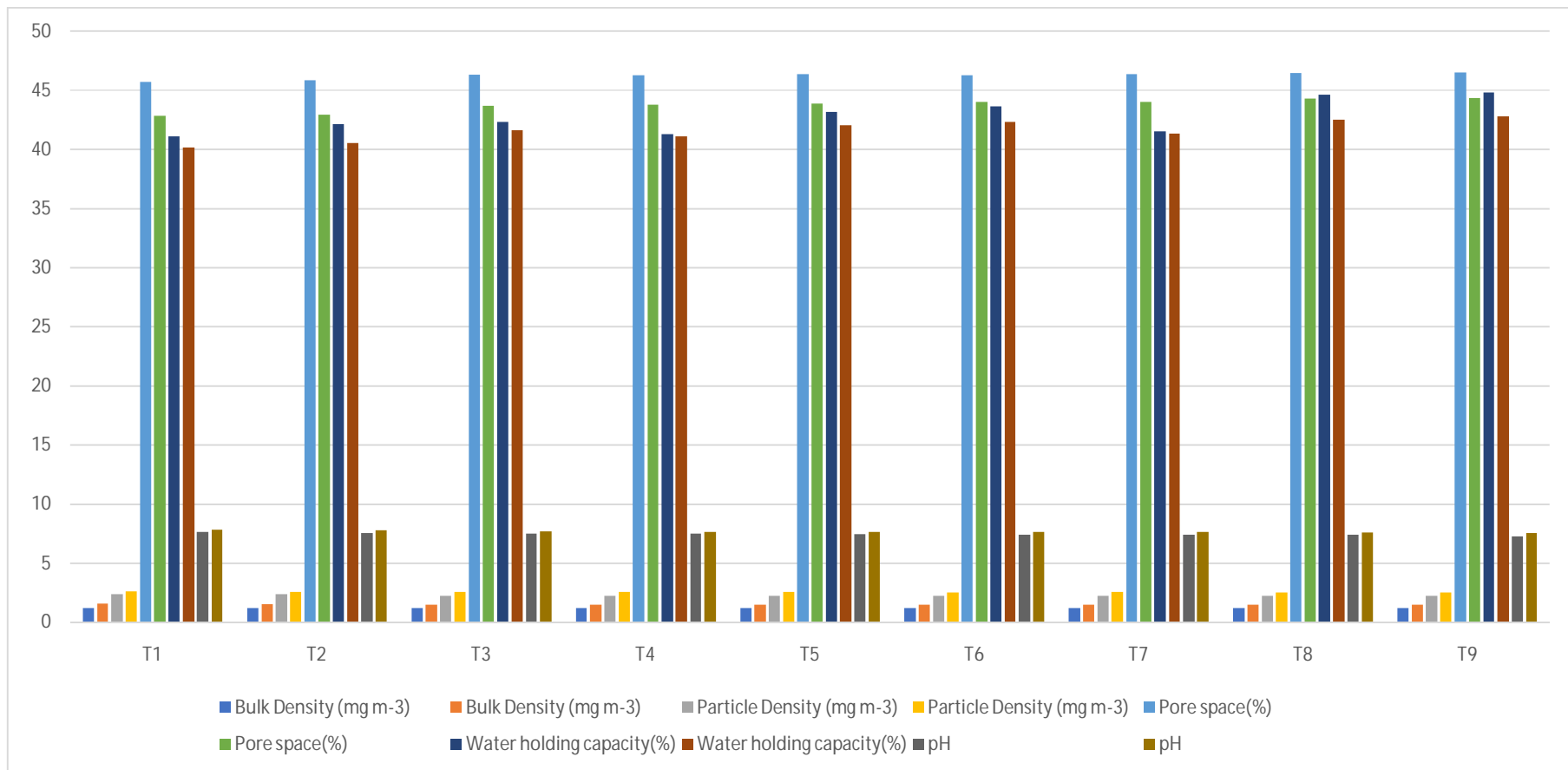


Fig 1. Effect of different levels of NPK, Vermicompost, Zinc on bd, pd. pore space, water holding capacity and ph.

Table 3: Effect of different levels of NPK, Vermicompost and zinc on Ec, Oc, N, P, K and Zinc.

S. No.	Treatments No.	Treatment combinations	EC ds m ⁻¹		Organic carbon (%)		Nitrogen (Kg ha ⁻¹)		Phosphorus (Kg ha ⁻¹)		Potassium (Kg ha ⁻¹)		Zinc (Mg ha ⁻¹)	
			0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
1	T ₁	Control	0.353	0.326	0.32	0.30	280.53	271.76	20.270	17.267	209.330	177.427	0.56	0.41
2	T ₂	0% RDF+0%ZnSO ₄ + Vermicompost @5 t ha ⁻¹	0.294	0.290	0.41	0.39	284.61	273.20	23.790	17.987	212.420	179.267	0.72	0.57
3	T ₃	0% RDF+0%ZnSO ₄ + Vermicompost @10 t ha ⁻¹	0.284	0.282	0.42	0.40	287.33	272.21	24.930	21.140	214.510	178.960	0.75	0.60
4	T ₄	50% RDF+50%ZnSO ₄ + Vermicompost @ 0 t ha ⁻¹	0.280	0.279	0.43	0.42	291.42	282.77	27.443	22.693	229.853	185.023	0.61	0.58
5	T ₅	50% RDF+50%ZnSO ₄ + Vermicompost @5 t ha ⁻¹	0.272	0.270	0.45	0.43	296.23	291.12	29.053	24.340	230.763	187.200	0.81	0.67
6	T ₆	50% RDF+50%ZnSO ₄ + Vermicompost @10 t ha ⁻¹	0.267	0.263	0.47	0.41	308.75	301.49	30.027	24.540	231.657	187.570	0.86	0.75
7	T ₇	100% RDF+100%ZnSO ₄ + Vermicompost @ 0 t ha ⁻¹	0.265	0.264	0.46	0.44	313.87	304.98	30.177	25.557	232.107	194.237	0.88	0.78
8	T ₈	100% RDF+100%ZnSO ₄ + Vermicompost @5 t ha ⁻¹	0.264	0.262	0.54	0.51	325.41	315.27	31.423	27.247	233.803	195.957	0.090	0.79
9	T ₉	100% RDF+100%ZnSO ₄ + Vermicompost @10 t ha ⁻¹	0.260	0.257	0.56	0.53	328.32	310.83	33.063	29.867	234.893	197.617	0.95	0.80
		F-Test	S	S	S	S	S	S	S	S	S	S	S	S
		C. D. at 0.5%	0.044	0.038	0.021	0.010	0.043	0.274	0.713	0.526	0.713	0.526	0.51	0.057
		S. Ed. (+)	0.021	0.018	0.010	0.005	0.021	0.129	0.336	0.248	0.336	0.248	0.024	0.027

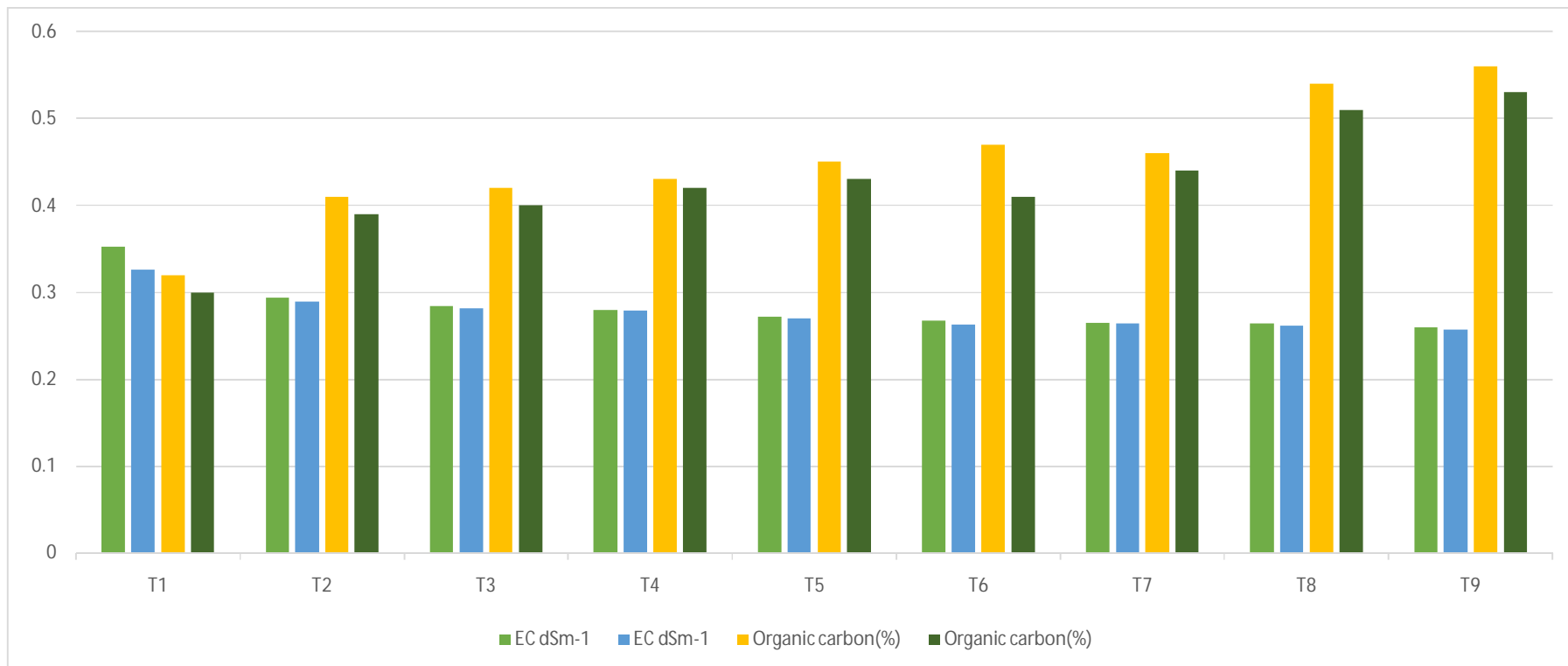


Fig 2. Effect of different levels of NPK, Vermicompost and zinc on Ec, Organic carbon.

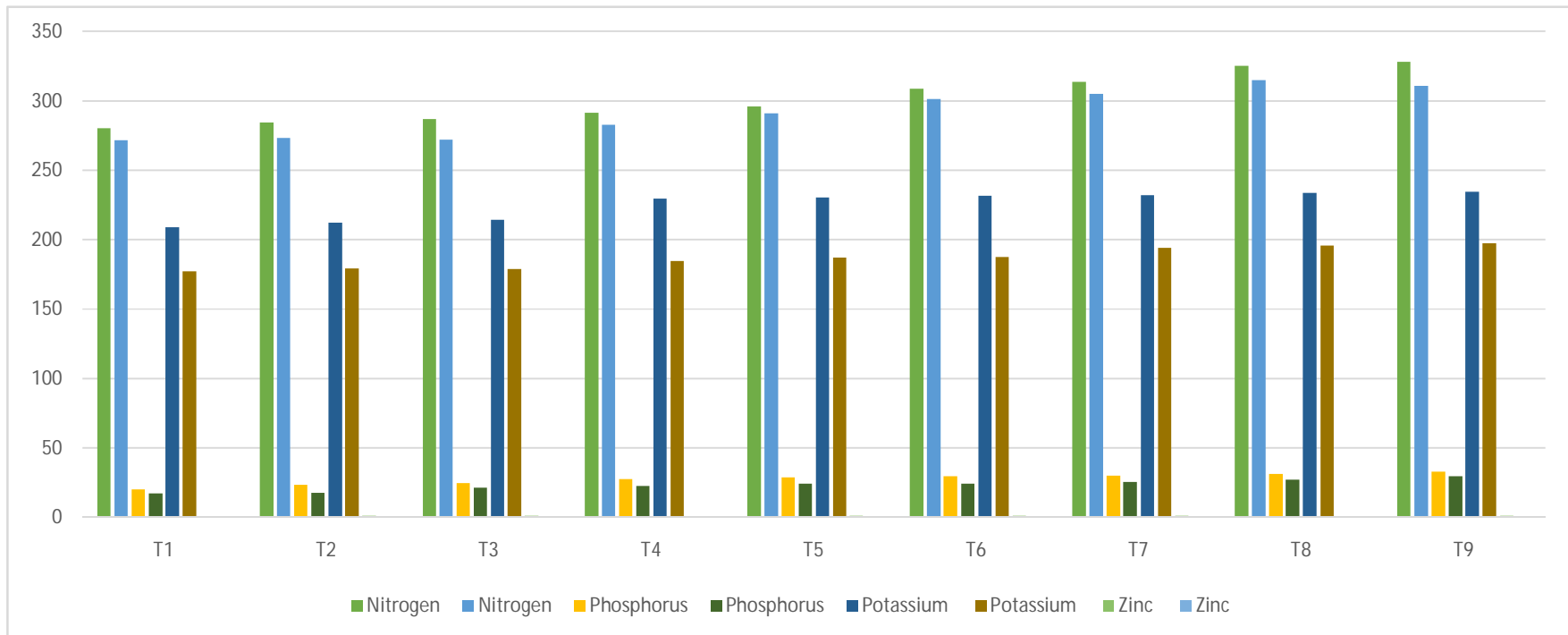


Fig 3. Effect of different levels of NPK, Vermicompost and Zinc on Nitrogen, Phosphorus, potassium, and zinc.

Table 4: Effect of different levels of NPK, Vermicompost and zinc on growth and yield attributes of cluster bean.

S. No	Treatment no	Treatment combination	plant height			no of leaves per plant			pod length	no of pods per cluster	pod wt.	pod yield per plant	pod yield t ha-1
			30D AS	60D AS	90D AS	30D AS	60D AS	90D AS					
1	T ₁	Control	15.8 2	33.7 4	80.8 1	16.1 3	25.9 3	49.6 5	10.01	5.17	2.05	45.83	10.08
2	T ₂	0% RDF + 0%ZnSO ₄ + Vermicompost @5 t ha ⁻¹	19.0 4	47.3 1	97.7 5	21.0 5	31.3 9	68.7 4	12.24	6.1	2.2	71.85	15.81
3	T ₃	0% RDF +0%ZnSO ₄ + Vermicompost @10 t ha ⁻¹	19.2 5	48.8 3	102. 28	21.9 3	38.6 1	71.8 2	13.01	6.18	2.24	77.73	17.11
4	T ₄	50% RDF +50%ZnSO ₄ + Vermicompost @ 0 t ha ⁻¹	18.3 9	41.4 2	90.1 7	17.8 1	33.4 1	62.9 7	11.43	5.84	2.12	64.22	14.13
5	T ₅	50% RDF +50%ZnSO ₄ + Vermicompost @5 t ha ⁻¹	19.3 7	50.3 9	106. 77	23.9 1	40.2 8	72.9 1	12.86	6.36	2.26	84.33	18.55
6	T ₆	50% RDF +50%ZnSO ₄ + Vermicompost @10 t ha ⁻¹	20.3 5	51.7 9	115. 75	25.7 5	42.8 1	75.9 1	13.17	6.79	2.28	93.21	20.51
7	T ₇	100% RDF +100%ZnSO ₄ + Vermicompost @ 0 t ha ⁻¹	18.8 1	45.8 6	93.4 2	19.0 2	36.1 9	66.0 6	12.04	5.64	2.17	61.89	13.62
8	T ₈	100% RDF +100%ZnSO ₄ + Vermicompost @5 t ha ⁻¹	21.4 1	52.6 1	118. 21	27.2 6	45.5 1	78.8 5	13.73	7.34	2.32	105.31	23.17
9	T ₉	100% RDF +100%ZnSO ₄ + Vermicompost @10 t ha ⁻¹	23.0 3	54.2 2	121. 86	29.1 1	47.7 4	82.6 1	14.11	7.47	2.35	113.79	25.03
		F-Test	S	S	S	S	S	S	S	S	S	S	S
		C.D.at 0.5%	1.39 1	2.87 9	4.16 7	1.90 1	2.30 2	3.14 2	0.705	0.262	0.03 1	3.984	0.876
		S. Ed. (+)	0.65	1.35	1.96	0.89	1.08	1.48	0.333	0.124	0.01	1.879	0.413

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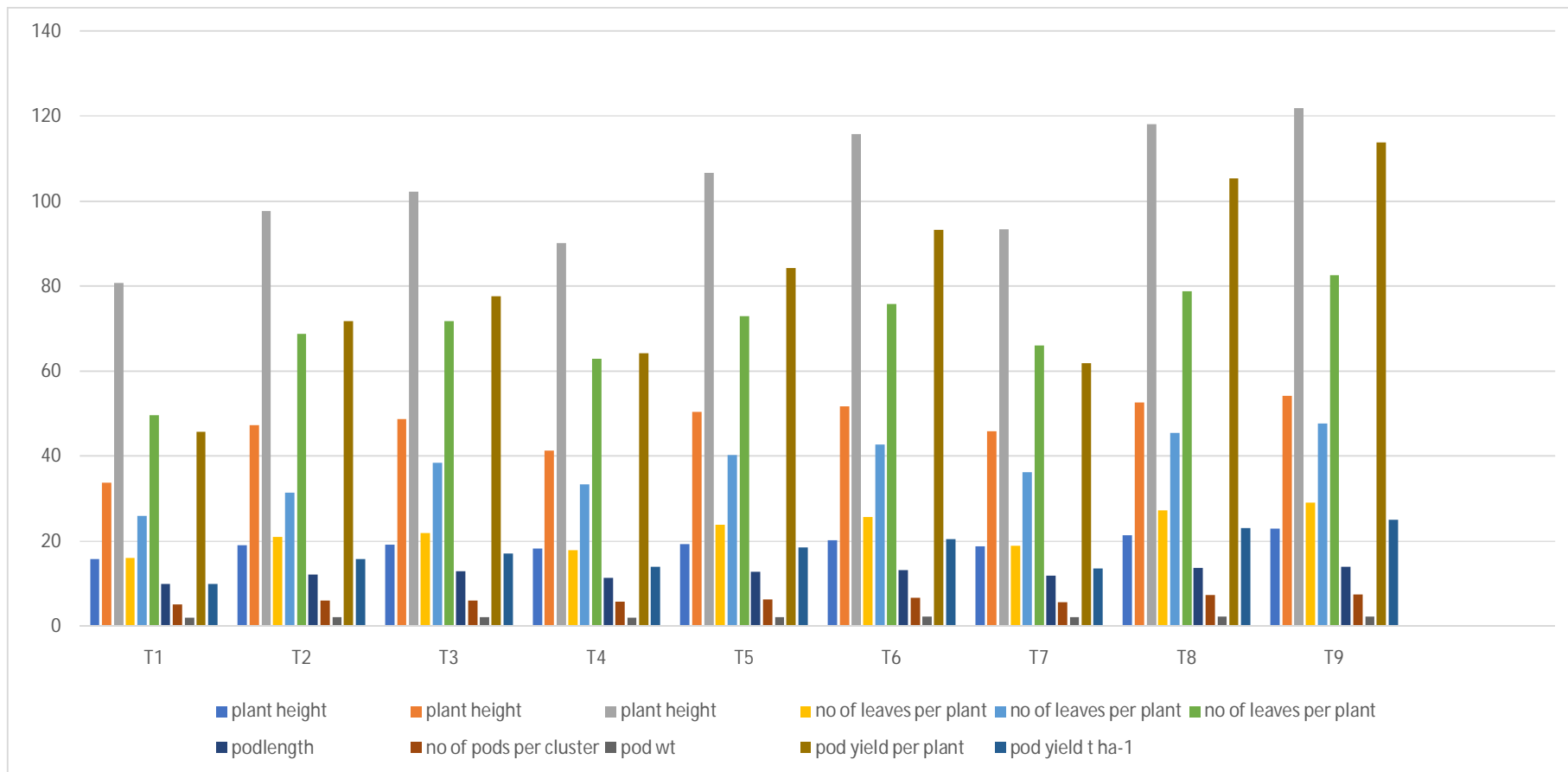


Fig 4. Effect of different levels of NPK, Vermicompost and Zinc on growth and yield attributes.

CONCLUSION

Based on findings, it is concluded that the treatment combination 100% RDF+100%ZnSO₄+ Vermicompost @10 t ha⁻¹ i.e., Treatment T₉ shows best result on physio-chemical properties of soil analysis after harvest of cluster bean (*Cyamopsis tetragonoloba* L.) in comparison to other treatment combination. The minimum bulk density (mg m⁻³), particle density (mg m⁻³), Water holding capacity, pH and EC ds m⁻¹ was noted in 100% RDF+100%ZnSO₄+ Vermicompost @10 t ha⁻¹ which was significantly superior over T₀Control. Whereas the maximum pore space (%), organic carbon, available nitrogen (kg ha⁻¹), available phosphorus (kg ha⁻¹) and available potassium (kg ha⁻¹), Zinc (mg ha⁻¹) was noted in 100% RDF+100%ZnSO₄+ Vermicompost @10 t ha⁻¹ which was significantly superior over T₀ Control.

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