Response of NPK and Vermicompost on Soil Properties, Growth and Yield Attributes of Cluster Bean (*Cyamopsis tetragonoloba* L.) Cv. Pusa Navbahar

ABSTRACT

An experiment was conducted during *Kharif* (July to October) on season 2022-24 to study "Response of different level of NPK and vermicompost on soil properties, growth and yield attributes of cluster bean (*Cyamopsis tetragonoloba* L.) cv. Pusa Navbahar" at the research farm of Soil Science and Agricultural Chemistry, design laid out in randomized block design (RBD) with three replications. Cluster bean was taken for study with recommended doses of fertilizers (NPK @ 0, 50, and 100% ha^{-1}) was applied along with Vermicompost (Vermicompost @ 0, 50 and 100% ha^{-1}). A variety of cluster bean, Pusa Navbahar was taken for a research trial. Bulk density (mg m^{-3}) and Particle density (mg m^{-3}) was recorded maximum in T_1 (Absolute Control) and minimum in T_9 (NPK @ 100% + Vermicompost @ 100%). pH (1:2.5) w/v was recorded maximum in T_1 (Absolute Control) and minimum in T_9 (NPK @ 100% + Vermicompost @ 100%). Pore space (%), Water holding capacity (%), EC (dS m^{-1}), Organic carbon (%), Nitrogen (kg ha^{-1}), Phosphorus (kg ha^{-1}) and Potassium (kg ha^{-1}) was measured maximum in T_9 (NPK @ 100% + Vermicompost @ 100%) and minimum in T_1 (Absolute Control).

Keywords: cluster bean, vermicompost, nitrogen, phosphorus, potassium

1. INTRODUTION

Soil is defined as the unconsolidated upper part of the earth's crust that serves as natural medium for the growth of higher plants [1]. The soil characteristics is categorized into three viz: physical, chemical and biological which interact to sustain the growth and development of crops. When the soil is properly managed, crop productivity is sustained. Soil physical and chemical properties play a central role in crop growth, development and yield by influencing the availability of air, nutrients and water to crops [2]. Cluster bean (*Cyamopsis tetragonoloba* L.) belongs to the family Fabaceae and subfamily Faboideae. It is commonly known as guar, an annual legume crop, are widely grown for its guar gum that contain ample amount of soluble dietary fibres. Cluster bean is a cash crop due to its application in agriculture, paper, juice, textile, purification of waste water, mining, petroleum, explosives, pharmaceuticals and food industries. Globally, India ranks first and produces about 80% of the world's cluster beans. Major cluster bean producing states in India are Rajasthan, Haryana, Gujarat, Uttar Pradesh, Punjab, and Madhya Pradesh. This legume is a valuable plant in a crop rotation cycle, as it reduces weeds and enrich the soil by partnering with nitrogen fixing bacteria in the soil. Being a legume crop, it has the capacity to fix atmospheric nitrogen by its effective root nodules. Hence, guar is considered as an excellent soil building crop, like other legumes, with respect to available nitrogen, which improve yield of succeeding crops [3]. Cluster beans or guar, among leguminous crops is comparatively more drought tolerant hardy crop, grown under rainfed condition in arid and semi-regions of India during kharif season. The crop can tolerate moderate salinity and alkalinity conditions. Its deep penetrating roots enable the plant to utilize available moisture more efficiently and thus offer better scope for rainfed cropping. Due to high degree of drought and salinity tolerance, guar could be a valuable alternative crop for the exploitation of the semi-arid environment, where high temperature, poor erratic rainfall and elevated soil salt content restrict the cultivation of other crops [4]. Nitrogen is considered as one of the significant macronutrients among all the mineral elements for all living tissues of the plant from metabolism to resource allocation, growth and development. It increases the protein content in grains, fruits and seeds of plants. Deficient plants may have stunted growth due to decreasing photosynthesis, leaf area and longevity of green leaves. Phosphorus plays a vital role in photosynthesis,

respiration, energy storage, cell elongation and improves the quality of crops. Potassium is an important essential nutrient after nitrogen and phosphorus and plays a vital role in plant cell sap, support enzymatic activity, photosynthesis and transportation of sugar, synthesis of protein and starch but doesn't bound with carbon or oxygen. It develops tolerance to drought condition and enhances plant ability to resist attacks of pests and diseases. Vermicompost is a peat-like organic fertilizer with high nutritional contents, aeration, porosity, and water-holding capacity, prepared by the joint action of earthworms and microbes. In addition to organic waste management, vermicompost is recognized as an effective plant growth promoter [5].

2. MATERIAL AND METHODS

The experiment was conducted during kharif season in 2023 at the central research farm of department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute (NAI), Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, U.P., situated on the south of Prayagraj on the right side of the river Yamuna on the South of Rewa Road at a distance of about 6 km away from Prayagraj city. It is situated at $25^0 57' 69''$ N latitude, $81^0 59' 74''$ E longitude and at the altitude of 98 meter above the sea level. The area of Prayagraj district comes under subtropical belt with a sub-tropical and semi-arid climate in the South east of Uttar Pradesh, which experience extremely hot summer and fairly cold winter. The maximum temperature of the location reaches up to 46^0C – 48^0C and seldom falls as low as 4^0C – 5^0C. The relative humidity ranged between 20 to 94 percent. The average rainfall in this area is around 1100 mm annually and rains mostly during July- September. The soil samples were randomly collected from three different sites in the experiment plot prior to tillage operation from a depth of 0-15 cm. The size of the soil sample was reduced by conning and quartering the composites soil sample and was air dried, passed through a 2 mm sieve for preparing the sample for physical and chemical analysis [6] (bulk density, particle density, water holding capacity and pore space: Muthuvel et al. [7]; pH: Jackson [8]; EC: Wilcox [9]; organic carbon: Walkley and Black [10]; available nitrogen: Subbaih and Asija [11], phosphorus: Olsen et al. [12]; potassium: Toth and Prince, [13]).

2.1 Treatment Combination

Table 1: Treatment combinations of cluster bean

Treatment	Treatment Combination	Symbol
T_1	Control	L_0V_0
T_2	NPK @ 0% + Vermicompost @ 50%	L_0V_1
T_3	NPK @ 0% + Vermicompost @ 100%	L_0V_2
T_4	NPK @ 50% + Vermicompost @ 0%	L_1V_0
T_5	NPK @ 50% + Vermicompost @ 50%	L_1V_1
T_6	NPK @ 50%+ Vermicompost @ 100%	L_1V_2
T_7	NPK @ 100% + Vermicompost @ 0%	L_2V_0
T_8	NPK @ 100% + Vermicompost @ 50%	L_2V_1
T_9	NPK @ 100% + Vermicompost @ 100%	L_2V_2

Note: RDF: - 20:40:40 NPK, Vermicompost 4 t ha^{-1}

3. RESULTS AND DISCUSSION

3.1 Response of N, P, K and Vermicompost on physical properties of soil after harvest of cluster bean

The data of soil samples showed maximum bulk density (1.35 Mg m^{-3} and 1.36 Mg m^{-3}) and particle density (2.55 Mg m^{-3} and 2.55 Mg m^{-3}) at 0-15 cm and 15-30 cm depth, respectively that were recorded in the treatment T_1 (Absolute control) and minimum bulk density (1.27 Mg m^{-3} and 1.29 Mg m^{-3}) and particle density (2.51 Mg m^{-3} and 2.52 Mg m^{-3}) at 0-15 cm and 15-30 cm depth, respectively that were recorded in the treatment T_9 (NPK @ 100% + Vermicompost @ 100%). The soil samples data also showed maximum percentage pore space (49.60 and 48.81 %) and water holding capacity (46.93 and

47.05 %) at 0-15 cm and 15-30 cm depth, respectively that were measured in the treatment T_9 (NPK @ 100% + Vermicompost @ 100%) and minimum percentage pore space (47.06 % and 46.67 %) and water holding capacity (42.79 % and 43.05 %) was recorded in treatment T_1 (Absolute control) at 0-15 cm and 15-30 cm depth, respectively (Table 2 and fig. 2). Similar findings were also observed [14], [15] and [16].

Table 2. Effect of Different Levels of N, P, K and Vermicompost on physical properties of post-harvest soil sample of cluster bean

Treatments	Bulk Density (Mg m^{-3})		Particle Density (Mg m^{-3})		Pore space (%)		Water holding capacity (%)	
	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm
T_1	1.35	1.36	2.55	2.55	47.06	46.67	42.79	43.05
T_2	1.32	1.34	2.54	2.54	48.03	47.24	43.96	44.75
T_3	1.29	1.31	2.53	2.54	49.01	48.42	45.16	46.07
T_4	1.34	1.35	2.54	2.55	47.24	46.85	42.15	42.96
T_5	1.31	1.33	2.53	2.53	48.22	47.43	43.16	44.17
T_6	1.28	1.30	2.52	2.53	49.21	48.62	45.18	45.70
T_7	1.33	1.34	2.53	2.53	47.43	47.04	43.00	43.75
T_8	1.30	1.32	2.52	2.52	48.41	47.62	44.14	44.95
T_9	1.27	1.29	2.51	2.52	49.60	48.81	46.93	47.05
F- test	**NS**	**NS**	**NS**	**NS**	**S**	**S**	**S**	**S**
S.Em. (±)	-	-	-	-	0.46	0.45	0.55	0.67
C.D (P=0.05)	-	-	-	-	1.41	1.38	1.67	2.03

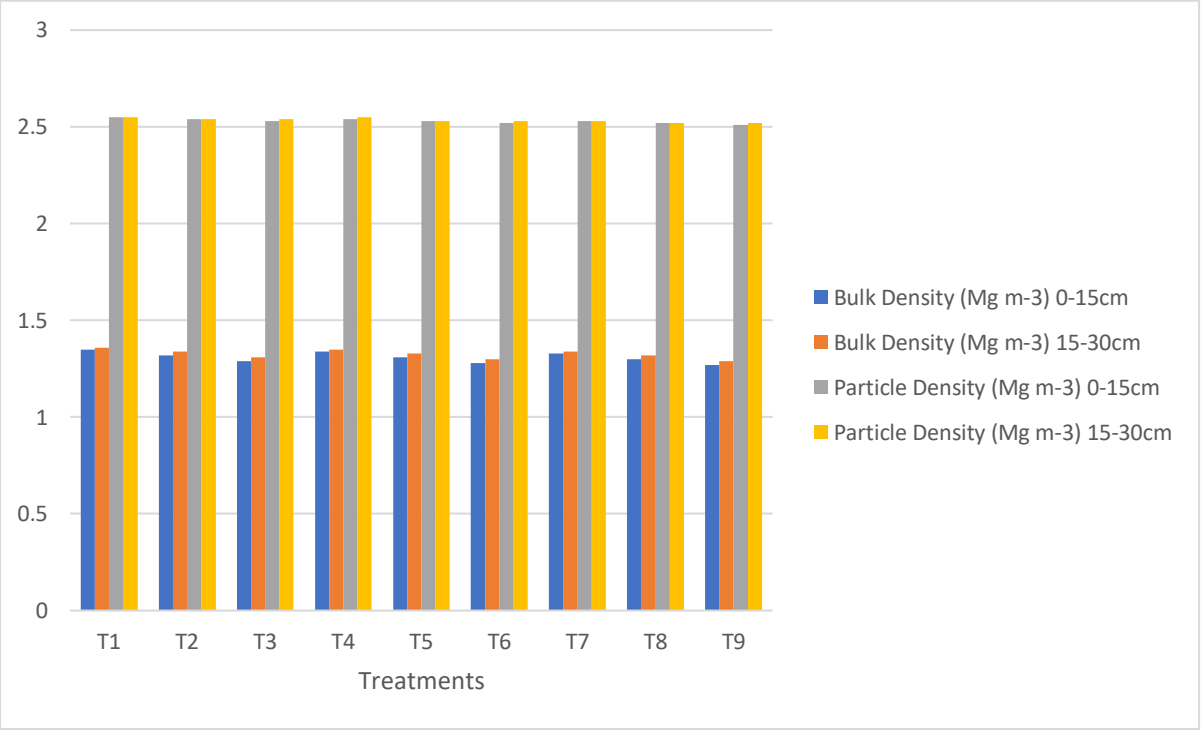

Fig. 1. Effect of Different Levels of N, P, K and Vermicompost on Bulk density and Particle density of the post-harvest soil sample

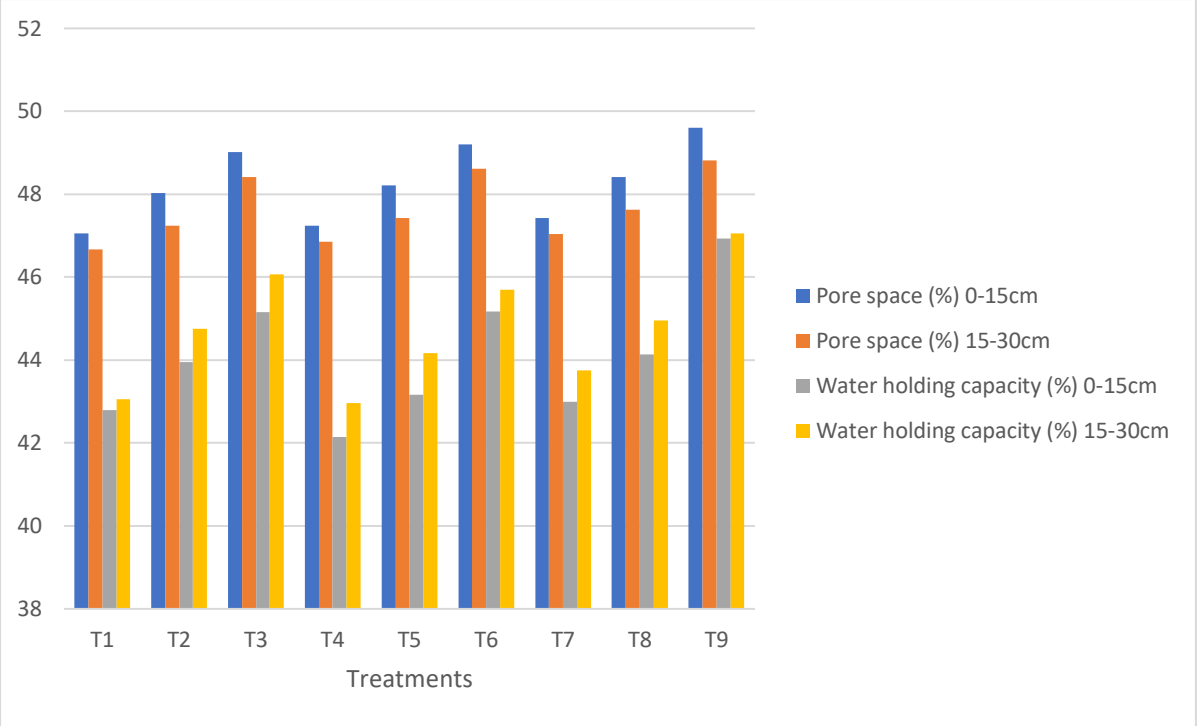

Fig. 2. Effect of Different Levels of N, P, K and Vermicompost on Pore space and Water holding capacity of the post-harvest soil sample

3.2 Response of N, P, K and Vermicompost on chemical properties of soil after harvest of cluster bean

Table 3. and fig. 3 showed that highest pH (6.88 and 6.89) but lowest EC 0.43 and 0.44 dS m^{-1} and organic carbon (0.34 and 0.33 %) was recorded in treatment T_1 (Absolute control) at 0-15 cm depth and at 15- 30 cm depth, respectively and T_9 (NPK @ 100% + Vermicompost @ 100%) resulted the lowest pH (6.80 and 6.82) but highest EC (0.46 dS m^{-1} and 0.47 dS m^{-1}), organic carbon (0.38% and 0.37%) at 0-15 cm depth and at 15- 30 cm depth, respectively. Table 4. and fig. 4 showed that lowest available nitrogen (265.51 and 263.29 kg ha^{-1}), available phosphorus (14.87 and 14.27 kg ha^{-1}) and available potassium (178.36 and 172.66 kg ha^{-1}) was measured in treatment T_1 (Absolute control) at 0-15 cm depth and at 15- 30 cm depth, respectively and T_9 (NPK @ 100% + Vermicompost @ 100%) recorded the highest available nitrogen (288.05 and 285.22 kg ha^{-1}), available phosphorus (25.28 and 24.28 kg ha^{-1}) and available potassium (201.36 and 193.73 kg ha^{-1}) at 0-15 cm depth and at 15- 30 cm depth, respectively. Similar findings were also observed [13], [14] and [15].

Table 3. Effect of Different Levels of N, P, K and Vermicompost on pH, EC and Organic carbon of the post-harvest soil sample

Treatments	pH		Electrical conductivity (dS m^{-3})		Organic carbon (%)	
	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm
T_1	6.88	6.89	0.43	0.44	0.34	0.33
T_2	6.86	6.87	0.44	0.45	0.35	0.34
T_3	6.82	6.84	0.45	0.46	0.36	0.35
T_4	6.87	6.88	0.43	0.44	0.35	0.34
T_5	6.85	6.86	0.44	0.45	0.36	0.35
T_6	6.81	6.83	0.45	0.46	0.37	0.36
T_7	6.86	6.87	0.44	0.45	0.36	0.35
T_8	6.84	6.85	0.45	0.46	0.37	0.36
T_9	6.80	6.82	0.46	0.47	0.38	0.37

F- test	NS	NS	NS	NS	S	S
S.Em. (±)	-	-	-	-	0.01	0.01
C.D (P=0.05)	-	-	-	-	0.02	0.02

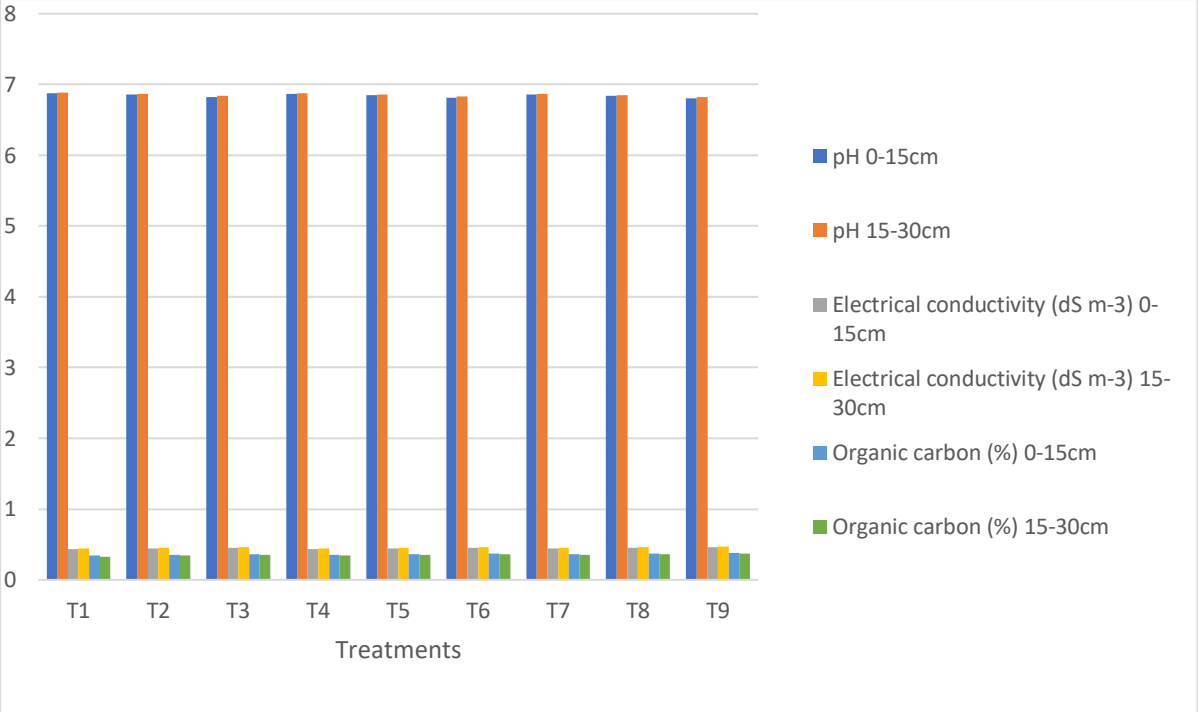

Fig. 3. Effect of Different Levels of N, P, K and Vermicompost on pH, EC and Organic carbon of the post-harvest soil sample

Table 4. Effect of Different Levels of N, P, K and Vermicompost on Available Nitrogen, Available Phosphorus and Available Potassium of the post-harvest soil sample

Treatments	Available Nitrogen (kg ha^{-1})		Available Phosphorus (kg ha^{-1})		Available Potassium (kg ha^{-1})	
	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm
T_1	265.51	263.29	14.87	14.27	178.36	172.66
T_2	268.14	266.02	15.36	15.26	180.46	173.58
T_3	271.09	268.06	16.89	16.38	184.68	174.90
T_4	274.37	271.54	15.27	15.02	186.79	179.56
T_5	276.49	274.47	18.29	17.01	187.46	181.67
T_6	279.25	276.41	23.27	22.45	189.89	183.59
T_7	282.49	280.24	17.28	16.25	196.97	185.23
T_8	285.34	283.32	20.49	19.26	198.98	192.43
T_9	288.05	285.22	25.28	24.28	201.36	193.73
F- test	S	S	S	S	S	S
S.Em. (±)	3.37	4.03	0.26	0.28	2.98	2.62
C.D (P=0.05)	10.20	12.10	0.79	0.84	8.96	7.90

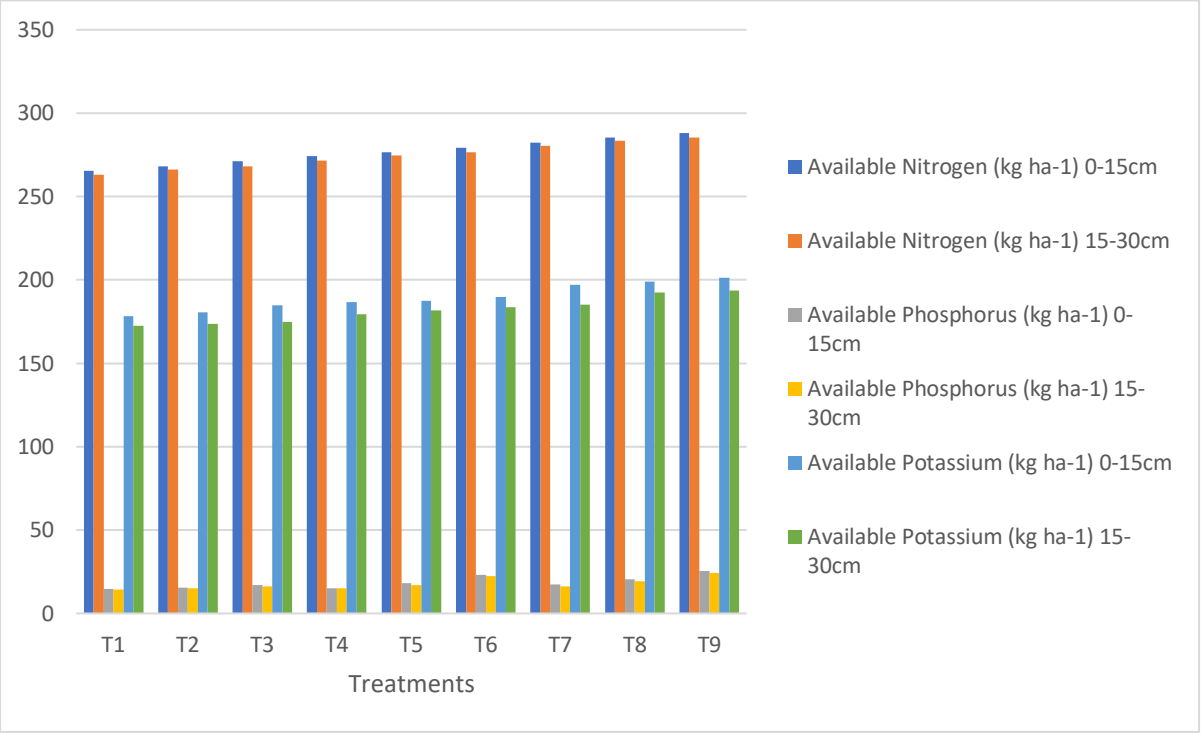

Fig. 4. Effect of Different Levels of N, P, K and Vermicompost on Available Nitrogen, Available Phosphorus and Available Potassium of the post-harvest soil sample

4. CONCLUSION

Based on the results, the application of NPK and Vermicompost was found to improve the soil's health in references to cluster bean. Application of T_9 (@ 100% NPK + @ 100% Vermicompost) was found optimal for improving Soil Properties like Pore space, Water holding capacity, Organic Carbon and Available Nitrogen, Phosphorus, Potassium. The results showed that the soil's bulk density, particle density, pH, and electrical conductivity were found non-significant after the crop was harvested, while the soil's organic carbon, nitrogen, phosphorus, nitrogen, porosity, and water holding capacity were found significant after the crop was harvested with the various applications of the N, P, K and vermicompost.

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