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Response of Vermicompost and Neem Cake on Soil Health and Yield Attributes of Cluster Bean (*Cyamopsis tetragonoloba* L.) var. Pusa Naubahar

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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

An experiment was carried out at during the *Zaid* season of 2021-22 at central research farm of Soil science and agriculture chemistry at different level of vermicompost and neem cake on soil health, growth and yield attributes of cluster bean [*Cyamopsis tetragonoloba* L.] var. Pusa

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Naubahar. The experiment was laid out in a randomized block design with nine treatment combinations of total 27 combination consisting of three vermicompost levels (0, 50 and 100%) and neem cake (0, 50 and 100%). In soil bulk density (Mg m^{-3}) of soil was recorded 1.18 Mg m^{-3}, particle density (Mg m^{-3}) of soil was recorded 2.14 Mg m^{-3}, pH of soil after harvesting 7.56, Electrical conductivity (dS m^{-1}) after harvesting was 0.270, Organic carbon (%) of soil after harvesting was 54.5 , available nitrogen in soil was 276.49 kg ha^{-1} after harvesting, available phosphorus in soil was 30.74 kg ha^{-1} after harvesting , available potassium in soil was 262.65 kg ha^{-1} after harvesting and highest was in T_9 (100% NPK + 100% VC + 100% NC). It was observed that for post-harvest treatment T_9 (100% NPK + 100% VC + 100% NC) was best in terms of growth, yield and economic parameters with maximum plant height 82.25 cm, number of leaves $plant^{-1}$ 26.19, number of branch $plant^{-1}$ 6.90, pods $plant^{-1}$ 79.50, pod yield 56.13 and maximum cost benefit ratio (C: B) of (1:2.52).

Keywords: Soil properties; inorganic fertilizers; vermicompost; neem cake; cluster bean; etc.

1. INTRODUCTION

"A medium for plant development, soils play a major role in agricultural production. The degree of soil texture (coarse or fine), aggregate size, porosity, aeration (permeability), and water holding capacity, pH, bulk density, and particle density are some of the soil characteristics that have an impact on plant growth. The texture, physical state (soil structure and tilth), and amount of vegetation on the soil surface all have an impact on how quickly water moves into the soil (infiltration). All soils' capacity to hold onto water tends to be increased by organic matter, and fine-textured soils' infiltration rates are also increased.Bulk density reflects the soil's ability to function for structural support, water and solute movement, and soil aeration. Soil pH directly affects the solubility of many of the nutrients in the soil needed for proper plant growth and development" [1]. "Because it may be used to anticipate a variety of chemical activities in the soil, measuring the pH of the soil is helpful. As a result, it is also a helpful tool for making management choices about the kind of plants that are appropriate for a certain area, whether or not soil pH has to be adjusted (up or down), and an approximate indicator of the availability of nutrients to plants in the soil. Air, water, and three more elements—carbon, oxygen, and hydrogen—are required for plant development. The remaining components are known as plant nutrients, and they are supplied by the soil or applied as fertilisers. Plants almost exclusively absorb these nutrients through their roots" [2]. Cluster bean, also known as guar, is a drought-resistant, multipurpose vegetable crop in India, used for gum production, feed, fodder, vegetables, and green manure.fact that legumes improve soil fertility, they play a significant part in the nitrogen cycle for succeeding crops. It is very hardy and drought tolerant crop [3]. Cluster bean is a hardy, drought-tolerant legume suitable for Rajasthan's soil and climate, offering efficient moisture utilization and survival in moderate salinity and alkalinity conditions. India accounts for 80% of global production [4]. Cluster bean seeds have a 28–33% gum content. India tops the list of the major guar producing nations, providing around 75–80% of the global output, which ranges from 7.5–10 lakh tonnes. Guar gum and seed are mostly produced in Rajasthan, India. It makes up over 70% of India's entire production. Gujarat and Haryana are in second and third place, respectively. "With an output of 15.46 lakh tonnes and a productivity of 515 kg ha-1, Rajasthan has a land area of 30 lakh hectares. Haryana and Gujarat state themselves at the second and third positions regarding the production in India" Kherawat et al. [5]. "The pods of cluster bean are as rich in food value as that of French bean". [6] According to Aykroyd [7] "The cluster bean has the following nutrients per 100 g of edible portion: 81.0 (g) moisture, 10.8 (g) carbohydrate, 3.2 (g) protein, 1.4 (g) fat, 1.4 (g) minerals, 0.09 (mg) thiamine, 0.03 (mg) riboflavin, vitamin C, and vitamin A".

1.1 Vermicompost

"Vermicompost is the end result of the composting process, which uses a variety of worm species, often red wigglers, white worms, and other earthworms, to produce a mixture of bedding materials, decaying food or vegetable waste, and vermicompost. Vermicast, also known as worm castings, worm humus, worm manure, or worm excrement, is what remains after earthworms have broken down organic

materials. It has been demonstrated that these castings are more nutrient-rich and have lower levels of pollutants than the organic materials used to make vermicompost. Vermicompost is rich in micronutrients, beneficial soil bacteria, NPK (nitrogen 2-3%, phosphorus 1.55-2.25%, and potassium 1.85-2.25%), as well as plant growth hormones and enzymes" [8].

1.2 Neem Cake

"Neem cake has enough NPK in organic form to support plant development. Being entirely botanical, it contains 100% natural NPK content as well as other essential micronutrients like N (Nitrogen 2.0 to 5.0%), P (Phosphorus 0.5 to 1.0%), K (Potassium 1.0 to 2.0%), Ca (Calcium 0.5 to 3.0%), Mg (Magnesium 0.3 to 1.0%), S (Sulphur 0.2 to 3.0%), Zn (Zinc 15 to 60 ppm), Copper (Copper 4 to (Manganese 20 to 60 ppm). It is rich in sulphur compounds and astringent limonoids. Neem cake increases the soil's organic matter level, which enhances the soil's water-holding ability, aeration, and texture for improved root growth"[9].

2. MATERIALS AND METHODS

The experiment was carried out at the department of soil science and agricultural chemistry's research farm, which is located 6 kilometres from Prayagraj city on the right bank of the Yamuna River. The experimental site is situated in the subtropical region at 25024'23" N latitude, 81050'38" E longitude, and 98 metres above mean sea level. The Prayagraj district is part of the subtropical zone in southeast Uttar Pradesh, which has very hot summers and somewhat mild winters. The location's highest temperature ranges from 460C to 480C, and it seldom drops below 40C or 50C. 20 to 92 percent relative humidity is the range. In this location, there is around 1013.4 mm of yearly rainfall. The experimental area's soil. "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].

Table 1. Treatment combinations of cluster bean

Treatments	Treatment combination
T_1	[Farmers practice]
T_2	[NPK @ 0% + VC @ 50% + NC @ 50%]
T_3	[NPK @ 0% + VC @ 100% + NC @ 100%]
T_4	[NPK @ 50% + VC @ 0% + NC @ 0%]
T_5	[NPK @ 50% + VC @ 50% + NC @ 50%]
T_6	[NPK @ 50% + VC @ 100% + NC @ 100%]
T_7	[NPK @100% + VC @ 0% + NC @ 0%]
T_8	[NPK @ 100% + VC @ 50% + NC @ 50%]
T_9	[NPK @ 100% + VC @ 100% + NC @ 100%]

Table 2. Chemical Analysis of pre-sowing soil

Parameters	Method employed	Results
Soil pH (1:2)	[10]	7.56
Soil EC (dS m^{-1})	(Wilcox, 1950)	0.236
Organic Carbon (%)	[11]	0.481
Available Nitrogen (Kg ha^{-1})	[12]	217.30
Available Phosphorus (Kg ha^{-1})	[13]	18.63
Available Potassium (Kg ha^{-1})	[14]	209.57

3. RESULTS AND DISCUSSION

Following harvest, the greatest bulk density (Mg m-3) of the soil was measured in treatment T1 (control), at 1.38 Mg m^{-3}, and the minimum bulk density (Mg m^{-3}) of the soil was measured in treatment T_9 (100 percent NPK + 100 percent VC + 100 percent NC), at 1.18 Mg m^{-3}. The soil's largest particle density (Mg m^{-3}) was recorded in treatment T1, at 2.38 Mg m^{-3}, and its lowest particle density (Mg m^{-3}) was found in treatment T9 (100 percent NPK + 100 percent VC + 100 percent NC). Treatment T9 (100 percent NPK+ 100 percent VC + 100 percent NC) had the highest soil pore space, 48.22 percent, and Treatment T1 had the lowest soil pore space, 44.82 percent (Control). In treatment T1 (control), the soil pH reached a high of 7.56 and a minimum of 7.14. The highest soil EC (dS m^{-1}) value was observed in treatment T9 (100 percent NPK + 100 percent VC + 100 percent NC), whereas the lowest value was recorded in treatment T1 (control). The highest recorded percentage of organic carbon in soil was found in treatment T9 (100 percent NPK + 100 percent VC + 100 percent NC), which was significantly higher than any other treatment combination. The lowest percentage of organic carbon in soil was found in treatment T1, which was recorded at 0.481 percent (control). Through biological nitrogen fixation and the integration of biomass into the soil as green manure, legumes have the ability to improve the status of soil nutrients. The Compared to other treatment combinations, treatment T9 (100 percent NPK + 100 percent VC + 100 percent NC) had the highest maximum available nitrogen in soil at 276.49 kg ha^{-1}, whereas treatment T1 had the lowest minimum available nitrogen at 217.30 kg ha^{-1} (control). The enhanced availability of nitrogen in the soil following crop harvest caused by the inoculation of VC and NC seeds may be the result of nodule formation and more effective nitrogen fixation. The highest amount of phosphorus in the soil was found in treatment T9 (100 percent NPK + 100 percent VC + 100 percent NC), which was significantly higher than any other treatment combination. The lowest amount of phosphorus in the soil was found in treatment T1, which was 18.63 kg ha^{-1} (control). The maximum available potassium in soil was recorded 262.65 kg ha^{-1} in treatment T_9 (100% NPK +100% VC+ 100% NC) which was significantly higher than any other treatment combination and the minimum available potassium in soil was recorded 209.57 kg ha^{-1} in treatment T_1 (control).

Table 3. Physical properties of soil sample after harvesting of cluster bean

Treatment	Bulk density (Mg m^{-3})	Particle density (Mg m^{-3})	Pore space (%)
T_1	1.38	2.38	44.82
T_2	1.27	2.20	47.15
T_3	1.26	2.16	48.96
T_4	1.32	2.34	44.18
T_5	1.26	2.26	46.97
T_6	1.16	2.12	47.19
T_7	1.31	2.42	45.03
T_8	1.27	2.20	46.19
T_9	1.18	2.14	48.22

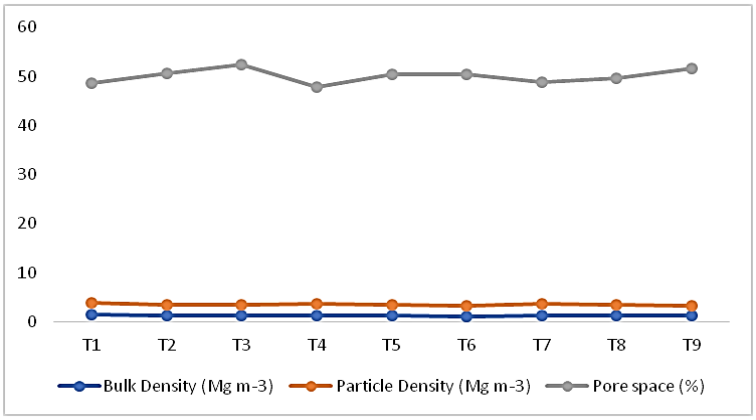

Fig. 1. Physical properties of soil sample after harvesting of cluster bean

Table 4. Chemical properties of soil sample after harvesting of cluster bean

Treatments	pH (1:2.5) W/V	EC (dS m^{-1})	Organic Carbon (%)	Available Nitrogen (Kg ha^{-1})	Available Phosphorus (Kg ha^{-1})	Available Potassium (Kg ha^{-1})
T_1	7.56	0.236	0.481	217.30	18.63	209.57
T_2	7.43	0.257	0.488	222.43	22.67	213.28
T_3	7.36	0.259	0.511	227.31	21.95	215.51
T_4	7.41	0.240	0.512	233.54	26.28	219.77
T_5	7.40	0.252	0.532	237.31	26.06	230.55
T_6	7.30	0.265	0.573	243.50	28.79	232.60
T_7	7.19	0.247	0.521	250.48	27.19	251.00
T_8	7.17	0.248	0.522	265.66	30.09	254.45
T_9	7.14	0.270	0.545	276.49	30.74	262.65
F-Test	NS	NS	S	S	S	S
S.Em. (±)	0.09	0.03	0.01	5.43	0.62	4.44
C.D. (5%)	0.28	0.08	0.02	16.29	1.84	13.32

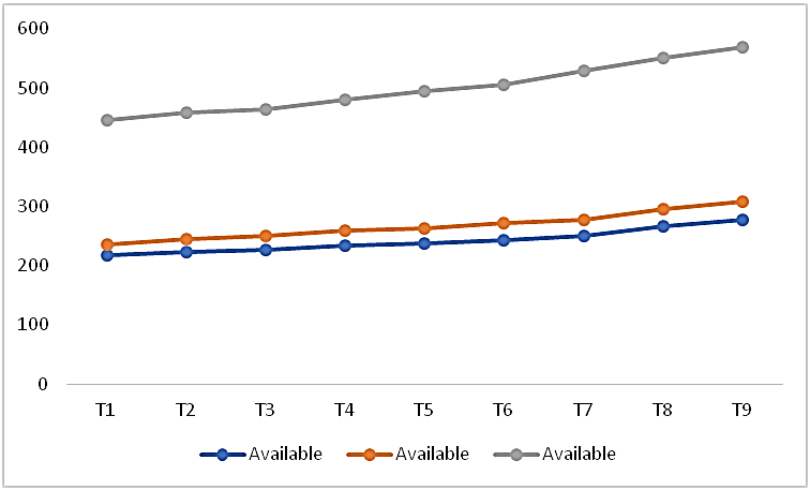

Fig. 2. Chemical properties of post-harvest soil

4. CONCLUSION

The results showed that the soil's bulk density, particle density, pH, and electrical conductivity were non-significant after the crop was harvested, while the soil's organic carbon, nitrogen, phosphorus, nitrogen, porosity, and water holding capacity were significant after the crop was harvested with various applications of the inorganic fertilisers vermicompost and neem cake. The application of [NPK @ 100% + NC @ 100% + VC @ 100%] considerably enhanced the accessible nitrogen, phosphorus, and potassium content of soil following crop harvest. The use of T9 [NPK @ 100% + NC @ 100% + VC @ 100%] resulted in significantly higher vegetative growth and yield characteristics, as well as a positive impact on net return up to 82,992:08 ha^{-1} with a C:B ratio of 1:2.52. Therefore, the application of [NPK @ 100 % + NC @ 100 % + VC @ 100 %] found most suitable dose for cluster bean to obtain higher yield.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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