Response of Vermicompost and Neem cake on Soil Health and Yield attributes of Cluster bean (*Cyamopsis tetragonoloba* L.) var. Pusa Naubahar

Abstract

The present investigation carried out at research farm of department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute, SHUATS, Prayagraj, U.P. during the *zaid* season of 2021-22 with the objective to response of different levels of vermicompost and neem cake on soil health, growth and yield attributes of Cluster bean [*Cyamopsis tetragonoloba* L.] Var. Pusa Naubahar. eThe experiment was laid out in a randomized block design with nine treatment combinations, consisting of three vermicompost levels (0, 50 and 100%) and neem cake (0, 50 and 100%). In soil parameters bulk density (Mg m^{-3}) of soil was recorded 1.18 Mg m^{-3} in treatment T_9 (100% NPK + 100% VC + 100% NC). Similar results were also reported in the particle density (Mg m^{-3}) of soil was recorded 2.14 Mg m^{-3} in treatment T_9 (100% NPK + 100% VC + 100% NC). Soil pore space was recorded 48.22% in treatment T_9 (100% NPK + 100% VC +100% NC). It was observed that Soil pH after harvesting 7.56 which was recorded in T_9 (100% NPK + 100% VC + 100% NC). Electrical conductivity (dS m^{-1}) after harvesting was 0.270 recorded with T_9 (100 % NPK + 100% VC + 100% NC). Organic carbon (%) of soil after harvesting was 54.5 in T9 (100% NPK + 100% VC + 100% NC). Available nitrogen in soil was 276.49 kg ha^{-1} after harvesting in T_9 (100% NPK + 100% VC + 100% NC). Available phosphorus in soil was 30.74 kg ha^{-1} after harvesting and highest was in T_9 (100% NPK + 100% VC + 100% NC). Available potassium in soil was 262.65 kg ha^{-1} after harvesting and highest was in T9 (100% NPK + 100% VC + 100% NC). It was observed that for post-harvest treatment T9 (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.

Introduction

Soil is a medium for plant growth. Crop production is based largely on soils. Some of the soil properties affecting plant growth include: soil texture (coarse fine), aggregate size, porosity, aeration (permeability), and water holding capacity, pH, bulk density, particle density. The rate of water movement into the soil (infiltration) is influenced by its texture, physical condition (soil structure and tilth), and the amount of vegetative cover on the soil surface. Organic matter tends to increase the ability of all soils to retain water, and also increases infiltration rates of fine textured soils. 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 **(Ghaffari *et al., 2011).*** Soil pH measurement is useful because it is a predictor of various chemical activities within the soil. As such, it is also a useful tool in making management decisions concerning the type of plants suitable for location, the possible need to modify soil pH (either up or down), and a rough indicator of the plant availability of nutrients in the soil. Three elements, carbon, oxygen and hydrogen, are essential to plant growth and are supplied by air and water. The other essential elements are referred to as plant nutrients, and are provided by the soil, or are added as fertilizers, and enter plants almost exclusively through the roots **(Singh *et al.,* 2008).** Cluster bean popularly known as 'guar' is an important self- pollinated, multipurpose, relatively drought resistant and restorative leguminous vegetable crop mainly grown under rainfed condition in arid and semi-arid regions of India during *kharif* season. It is produced for the manufacturing of gum as well as for use as feed, fodder, vegetables, and green manure. Due to the fact that legumes improve soil fertility, they play a significant part in the nitrogen cycle for succeeding crops. It isvery hardy and drought tolerant crop. **Chaudhari, J.A. (2018).** Its deep penetrating roots enable the plant to utilize available moisture more efficiently and thus offer better scope for rainfed cropping. The crop also survives even at moderate salinity and alkalinity conditions. There is no other legume crop so hardy and drought tolerant as cluster bean, which is especially suited for soil and climate of Rajasthan. India is the source of about 80 per cent (3 million hectares) of the world production **(Anonymous, 2011)**. Seed of cluster bean contain 28-33 % gum. India leads the list of the major guar producing countries of the world contributing to around 75 to 80**%** in the world's total production of around 7.5 to 10 lakh tonnes. In India Rajasthan is leading

producer of the guar seed and guar gum. It around 70**%** of the total production in India. Haryana and Gujarat have second and third position respectively. Rajasthan has an area of 30 lakh hectare, production of 15.46 lakh tones with a productivity of 515 kg ha^{-1}. Haryana and Gujarat state themselves at the second and third positions regarding the production in India **(Kherawat *et al.*, (2013 not listed in Ref.)**. The pods of cluster bean are as rich in food value as that of French bean. According to **Aykroyd (1963)** the composition of cluster bean is 81.0 (g) moisture, 10.8 (g) carbohydrate, 3.2 (g) protein, 1.4 (g) of fat, 1.4 (g) of minerals, 0.09 (mg) thiamine, 0.03 (mg) riboflavin, vitamin C, vitamin A (100 g^{-1}) of edible portion.

Vermicompost

Vermicompost is the product of the composting process using various species of worms, usually red wigglers, white worms and other earthworms, to create a mixture of decomposing vegetable or food waste, bedding materials, and vermicast. Vermicast (also called worm castings, worm humus, worm manure, or worm feces) is the end-product of the breakdown of organic matter by earthworms. These castings have been shown to contain reduced levels of contaminants and a higher saturation of nutrients than the organic materials before vermicomposting. Vermicompost is rich in NPK (nitrogen 2- 3%, phosphorus 1.55-2.25% and potassium 1.85-2.25%), micronutrients, beneficial soil microbes and also contain plantgrowth hormones & enzymes. **(Gandhi, 2010)**

Neem cake

Neem cake has an adequate quantity of NPK in organic form for plant growth. Being a totally botanical product it contains 100% natural NPK content and other essential micro nutrients as 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), Cu (Copper 4 to 20 ppm), Fe (Iron 500 to 1200 ppm), Mn (Manganese 20 to 60 ppm). It is rich in both Sulphur compounds and bitter limonoids**.** Neem cake improves the organic matter content of the soil, helping improve soil texture, water holding capacity, and soil aeration for better root development **(Lokanadhan *et al.*, 2012)**

Materials and Method

The experiment was conducted at research farm of department of Soil Science and

Agricultural Chemistry which is situated 6 km away from Prayagraj city on the right bank of Yamuna River, the experimental site is located in the sub–tropical region with $25^0 24' 23''$ N latitude, $81^0 50' 38''$ E longitude and at an altitude of 98 m above mean sea level. The area of Prayagraj district comes under subtropical belt 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 ranges between 20 to 92 %. The average rainfall in this area is around 1013.4 mm annually. The soil of experimental area falls in order of *Inceptisol*. 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 samplewas 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.

Table 1: Treatment combinations of cluster bean

Treatment	**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 samples

Parameters	**Method employed**	**Results**

Soil pH (1:2)	(Jackson, 1958)	7.56
Soil EC (dS m^{-1})	(Wilcox, 1950)	0.236
Organic Carbon (%)	(Walkley and Black's, 1947 not listed in Ref.)	0.481
Available Nitrogen (Kg ha^{-1})	(Subbaih and Asija, 1956)	217.30
Available Phosphorus (Kg ha^{-1})	(Olsen *et al*., 1954)	18.63
Available Potassium (Kg ha^{-1})	(Toth and Prince, 1949)	209.57

Results and Discussion

After harvesting the maximum Bulk density (Mg m^{-3}) of soil was recorded 1.38 Mg m^{-3} in treatment T_1 (control) and minimum Bulk density (Mg m^{-3}) of soil was recorded 1.18Mg m^{-3} in treatment T_9 (100% NPK + 100% VC + 100% NC). The maximum particle density (Mg m^{-3}) of soil was recorded 2.38 Mg m^{-3} in treatment T_1 (100% NPK+ 100% VC + 100% NC) (control) and minimum particle density (Mg m^{-3}) of soil was recorded 2.14 Mg m^{-3} in treatment T_9 (control) (100% NPK+ 100% VC + 100% NC). The maximum soil pore space was recorded 48.22 %in treatment T_9 (100% NPK+ 100%VC + 100% NC) and minimum soil pore space was recorded 44.82% in treatment T_1 (Control). The maximum soil pH was recorded 7.56 in treatment T_1 (control) and minimum soil pH was recorded 7.14 in treatment T_9(100% NPK + 100% VC + 100% NC. The maximum EC (dS m^{-1}) of soil was recorded 0.270 dS m^{-1} in treatment T_9 (100% NPK +100% VC + 100% NC) and minimum EC (dS m^{-1}) of soil was recorded 0.236 dS m^{-1} in treatment T_1 (control). The maximum % organic carbon in soil was recorded 0.545% in treatment T_9 (100% NPK +100% VC + 100% NC) which was significantly higher than any other treatment combination and the minimum % Organic carbon in soil was recorded 0.481 % in treatment T_1 (control). Legumes have potential to improve soil nutrients status through biological nitrogen fixation and incorporation of biomass into the soil as green manure. The maximum available Nitrogen in soil was recorded 276.49 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 Nitrogen in soil was recorded 217.30 kg ha^{-1} in treatment T_1 (control). The increase in available Nitrogen in soil after crop harvest by VC and NC seed inoculation might be due to increased efficiency of Nitrogen fixing capacity and nodule formation. The maximum available Phosphorus in soil was recorded 30.74 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 Phosphorus in soil was recorded 18.63 kg ha^{-1} in

treatment T_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 (%)
T1	1.38	2.38	44.82
T2	1.27	2.20	47.15
T3	1.26	2.16	48.96
T4	1.32	2.34	44.18
T5	1.26	2.26	46.97
T6	1.16	2.12	47.19
T7	1.31	2.42	45.03
T8	1.27	2.20	46.19
T9	1.18	2.14	48.22

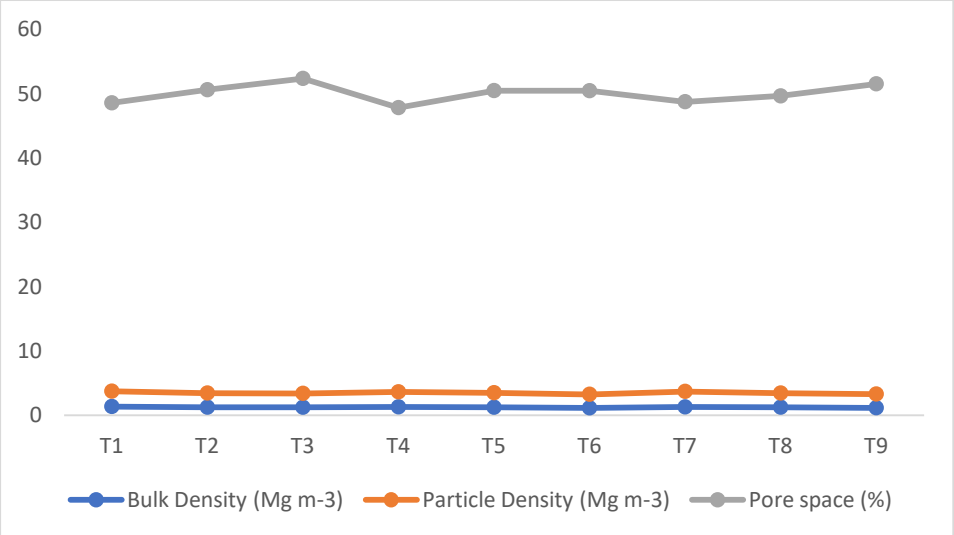

Fig 1: Physical properties of soil sample after harvesting of cluster bean

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

Treatments	pH	EC (dSm^{-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

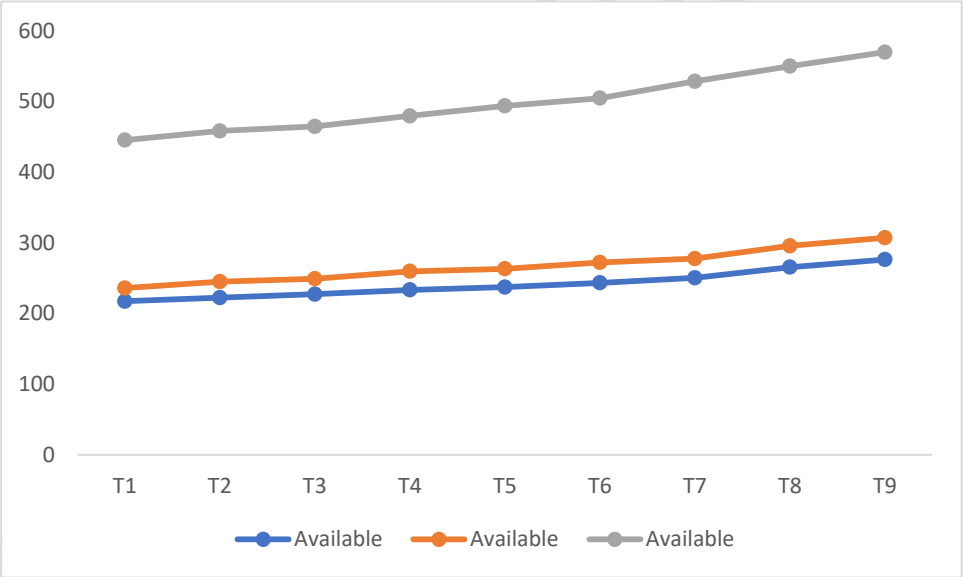

Fig. 2: Chemical properties of post-harvest soil

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Conclusion

On the basis of above finding, it is concluded that application of NPK @ 100 % + NC @ 100 % + VC @ 100 % provided the significantly highest vegetative growth as well as yield attributes and yield and showed positive effect on net return up to ₹ 82992.08 ha^{-1} with C:B ratio of 1:2.52. The available nitrogen, phosphorus and potassium content of soil after

harvest of crop was increased significantly with application of NPK @ 100 % + NC @ 100 % + VC @ 100 %. The bulk density, particle density, pH, electrical conductivity of soil after harvest stage of crop were found to be non-significant while, the organic carbon, nitrogen, phosphorus, nitrogen , porosity and water holding capacity of soil after harvest stage of cropwere significant with different treatments of Inorganic fertilizer Vermicompost and Neem Cake application. Therefore, it is suggested that application of NPK @ 100 % + NC @ 100 % + VC @ 100 % found most suitable dose for cluster bean to obtain higher yield.

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