Response of vermicompost and neem cake on Soil health and yield attributes of cluster bean
(Cyamopsis tetragonoloba L.) Var. Durgapura Safed

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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 kharif season of 2019 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. Durgapura Safed. The 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 1.28 Mg m⁻³ in treatment T₃ (100% vermicompost + 100% neem cake). Similar results were also reported in the particle density (Mg m⁻³) of soil was recorded 2.72 Mg m⁻³ in treatment T₃ (100% vermicompost + 100% neem cake). Soil pore space was recorded 51.00% in treatment T₃ (100% vermicompost + 100% neem cake). It was observed that Soil pH after harvesting 7.20 which was recorded in T₃ (i.e. 100% vermicompost + 100% neem cake). Electrical conductivity (dS m⁻¹) after harvesting was 0.17 recorded with T₃ (i.e. 100% vermicompost + 100% neem cake). Organic carbon (%) of soil after harvesting was 0.70% in T₃ (i.e. 100% vermicompost + 100% neem cake). Available nitrogen in soil was 302.25 kg ha⁻¹ after harvesting in T₃ (i.e. 100% vermicompost + 100% neem cake). Available phosphorus in soil was 27.69 kg ha⁻¹ after harvesting and highest was in T₃ (i.e. 100% vermicompost + 100% neem cake). Available potassium in soil was 195.45 kg ha⁻¹ after harvesting and highest was in T₃ (i.e. 100% vermicompost + 100% neem cake). It was observed that for postharvest, treatment T₉ (i.e. 100% vermicompost + 100% neem cake) was best in terms of growth, yield and economic parameters with maximum plant height 234.67 cm, number of leaves plant⁻¹ 31.96, pods cluster⁻¹ 12.82, pods plant⁻¹ 98.87, seeds per pod 8.87, pod yield 63.08 kg ha⁻¹ and maximum cost benefit ratio (C:B) of (1:4.28).

Keywords: Soil properties, organic fertilizers, vermicompost, neem cake, cluster bean

Introduction

Cluster bean popularly known as ‘gaur’ 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 grown for feed, fodder, vegetable, green manure as well as for gum production. Being legumes, it builds soil fertility and thus has a great role to play in nitrogen economy for succeeding crop. It is very hardy and drought tolerant crop. 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) [1]. Seed of cluster bean contain 28 to 33 per cent gum [2]. Seed of cluster bean contain 28 to 33 per cent gum.
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, beddng 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 plant growth hormones & enzymes.

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 micronutrients, beneficial soil microbes and also contain plant growth hormones & enzymes.

Materials and Method

The experiment was conducted at research farm of department of Soil Science and Agricultural Chemistry which is situated six km away from Prayagraj city on the right bank of Yamuna river, the experimental site is located in the sub-tropical region with 25°24'23" N latitude, 81°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 °C-48 °C and seldom falls as low as 4 °C – 5 °C. The relative humidity ranges between 20 to 94 percent. 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 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.

Table 1: Treatment combinations of cluster bean

| Treatment combination | Treatment combination |
|-----------------------|-----------------------|
| T1                   | Control               |
| T2                   | @ 0% Vermicompost + @ 50% Neem cake |
| T3                   | @ 0% Vermicompost + @ 100% Neem cake |
| T4                   | @ 50% Vermicompost + @ 0% Neem cake |
| T5                   | @ 50% Vermicompost + @ 50% Neem cake |
| T6                   | @ 50% Vermicompost + @ 100% Neem cake |
| T7                   | @ 100% Vermicompost + @ 0% Neem cake |
| T8                   | @ 100% Vermicompost + @ 50% Neem cake |
| T9                   | @ 100% Vermicompost + @ 100% Neem cake |

Table 2: Physical analysis of pre sowing soil samples

| Particulars       | Results     | Method employed                      |
|-------------------|-------------|--------------------------------------|
| Sand (%)          | 58          | Bouyoucos Hydrometer (Bouyoucos, 1927) [7] |
| Silt (%)          | 27          | Munsell Colour Chart (Munsell, 1971) [16] |
| Clay (%)          | 15          | Graduated Measuring Cylinder (Muthuaval et al., 1992) [17] |
| Textural class    | Sandy loam  |                                      |
| Soil Colour       |             |                                      |
| Dry Soil          | Pale brown Colour |                                |
| Wet Soil          | Olive brown Colour |                               |
| Bulk density (Mg m⁻³) | 1.37       |                                      |
| Particle density (Mg m⁻³) | 2.42       |                                      |
| Pore Space (%)    | 47.53       |                                      |

Table 3: Chemical Analysis of pre-sowing soil samples

| Parameters         | Method employed                           | Results  |
|--------------------|------------------------------------------|----------|
| Soil pH (1:2)      | Glass Electrode, pH meter (Jackson, 1958) [11] | 7.50     |
| Soil EC (ds m⁻¹)   | Electrical Conductivity meter (Wilcox, 1950) [27] | 0.29     |
| Organic Carbon (%) | Wet Oxidation Method (Walkley and Black’s, 1947) [26] | 0.39     |
| Available Nitrogen (Kg ha⁻¹) | Kjeldahl Method (Subbaiah and Asija, 1956) | 228.40   |
| Available Phosphorus (Kg ha⁻¹) | Colorimetric method (Olsen et al., 1954) [18] | 20.00    |
| Available Potassium (Kg ha⁻¹) | Flame photometric method (Toth and Prince, 1949) [25] | 148.30   |
Results and Discussion

After harvesting the maximum Bulk density (Mg m⁻³) of soil was recorded 1.28 Mg m⁻³ in treatment T₁ (control) and minimum Bulk density (Mg m⁻³) of soil was recorded 1.03 Mg m⁻³ in treatment T₉ (100% Vermicompost + 100% Neem cake). Similar results were also reported by Ramawat et al. (2017) and Swapna et al. (2012). The maximum particle density (Mg m⁻³) of soil was recorded 2.72 Mg m⁻³ in treatment T₉ (100% Vermicompost + 100% Neem cake) and minimum particle density (Mg m⁻³) of soil was recorded 2.56 Mg m⁻³ in treatment T₁ (control). Similar results were also reported by Ramawat et al. (2017) and Swapna et al. (2012). The maximum soil pore space was recorded 51.00% in treatment T₉ (100% Vermicompost + 100% Neem cake) and minimum soil pore space was recorded 44.90% in treatment T₁ (control). Similar results were also reported by Ramawat et al. (2017) and Swapna et al. (2012). The maximum soil pH was recorded 7.63 in treatment T₁ (control) and minimum soil pH was recorded 7.20 in treatment T₉ (100% Vermicompost + 100% Neem cake) Ramawat et al. (2017) and Swapna et al. (2012). The maximum EC (dS m⁻¹) of soil was recorded 0.17 dS m⁻¹ in treatment T₉ (100% Vermicompost + 100% Neem cake) and minimum EC (dS m⁻¹) of soil was recorded 0.11 dS m⁻¹ in treatment T₁ (control). Similar results were also reported by Sajid et al. (2009) and Deepa et al. (2016). The maximum% organic carbon in soil was recorded 0.70% in treatment T₉ (100% Vermicompost + 100% Neem cake) which was significantly higher than any other treatment combination and the minimum% organic carbon in soil was recorded 0.54% in treatment T₁ (control). Legumes have potential to improve soil nutrients status through biological nitrogen fixation and incorporation of biomass in to the soil as green manure. Similar findings were recorded by Jat et al. (2016). The maximum available Nitrogen in soil was recorded 302.25 kg ha⁻¹ in treatment T₉ (100% Vermicompost + 100% Neem cake) which was significantly higher than any other treatment combination and the minimum available Nitrogen in soil was recorded 248.49 kg ha⁻¹ in treatment T₁ (control). The increase in available Nitrogen in soil after crop harvest by Vermicompost and Neem cake seed inoculation might be due to increased efficiency of Nitrogen fixing capacity and nodule formation. Legumes have potential to improve soil nutrients status through biological nitrogen fixation and incorporation of biomass in to the soil as green manure. Similar findings were also recorded by Muhammad et al. (2009) and Deepa et al. (2016). The maximum available Phosphorus in soil was recorded 27.69 kg ha⁻¹ in treatment T₉ (100% Vermicompost + 100% Neem cake) which was significantly higher than any other treatment combination and the minimum available Phosphorus in soil was recorded 21.00 kg ha⁻¹ in treatment T₁ (control). Similar findings were also recorded by Muhammad et al. (2009) and Deepa et al. (2016). The maximum available potassium in soil was recorded 195.45 kg ha⁻¹ in treatment T₉ (100% Vermicompost + 100% Neem cake) which was significantly higher than any other treatment combination and the minimum available potassium in soil was recorded 115.65 kg ha⁻¹ in treatment T₁ (control). Similar findings were also recorded by Kherawat et al. (2013).

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

| Treatment | Bulk Density (Mg m⁻³) | Particle Density (Mg m⁻³) | Pore space (%) |
|-----------|-----------------------|---------------------------|----------------|
| T₁        | 1.28                  | 2.56                      | 44.90          |
| T₂        | 1.27                  | 2.61                      | 45.58          |
| T₃        | 1.25                  | 2.64                      | 46.38          |
| T₄        | 1.22                  | 2.65                      | 46.69          |
| T₅        | 1.20                  | 2.66                      | 47.40          |
| T₆        | 1.17                  | 2.68                      | 48.09          |
| T₇        | 1.07                  | 2.68                      | 49.27          |
| T₈        | 1.05                  | 2.71                      | 50.38          |
| T₉        | 1.03                  | 2.72                      | 51.00          |
| F-test    | S                     | S                         | S              |
| S. Em (±) | 0.017                 | 0.025                     | 0.03           |
| C.D.      | 0.035                 | 0.052                     | 2.59           |

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

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Table 5: Chemical properties of soil sample after harvesting of cluster bean

| Treatments | pH   | EC (dS m⁻¹) | Organic Carbon (%) | Available Nitrogen (Kg ha⁻¹) | Available Phosphorus (Kg ha⁻¹) | Available Potassium (Kg ha⁻¹) |
|------------|------|-------------|--------------------|-----------------------------|-------------------------------|-------------------------------|
| T₁         | 7.63 | 0.11        | 0.54               | 248.49                      | 21.00                         | 115.65                        |
| T₂         | 7.70 | 0.12        | 0.55               | 253.29                      | 21.42                         | 124.02                        |
| T₃         | 7.67 | 0.13        | 0.58               | 262.09                      | 22.20                         | 132.22                        |
| T₄         | 7.43 | 0.13        | 0.61               | 266.73                      | 22.49                         | 145.45                        |
| T₅         | 7.37 | 0.14        | 0.62               | 273.11                      | 22.75                         | 157.49                        |
| T₆         | 7.33 | 0.14        | 0.64               | 278.89                      | 23.55                         | 167.75                        |
| T₇         | 7.25 | 0.16        | 0.67               | 288.42                      | 24.83                         | 174.78                        |
| T₈         | 7.20 | 0.16        | 0.68               | 297.22                      | 25.97                         | 183.73                        |
| T₉         | 7.20 | 0.17        | 0.70               | 302.25                      | 27.69                         | 195.45                        |
| F-test     | S    | S           | S                  | S                           | S                             | S                             |
| S. Em. (±) | 0.035| 0.01        | 0.01               | 1.09                        | 0.54                          | 0.90                          |
| C.D. (P=0.05) | 0.075| 0.02        | 0.02               | 2.32                        | 1.15                          | 1.90                          |

Summary

The salient findings of the present investigation are summarized as follows. As for as the growth and yield parameters are concerned maximum plant height 235.02 cm, number of leaves per plant 42.97, number of clusters per plant 32.15, pods per cluster 13.61, pods per plant 99.29, seeds per pod 8.96 and pod yield 64.19 remained with T₉ (i.e. 100% Vermicompost + 100% Neem cake) followed by T₈ (i.e. 100% Vermicompost + 50% Neem cake). Plant height 79.07 cm, number of leaves 12.92, number of clusters per plant 11.79, pods per cluster 5.05, pods per plant 34.94, seeds per pod 4.24 and pod yield 34.26 was observed in the treatment T₁ (i.e. 0% Vermicompost + 0% Neem cake). Soil pH before sowing was 7.50 and after harvesting decreased to 7.20 which was recorded in T₇ and T₉ 7.21 followed by 7.25 by T₉. Electrical conductivity dS m⁻¹ of soil before sowing was 0.19 dS m⁻¹ and after harvesting was 0.18 dS m⁻¹ recorded with T₉ followed by T₈ -0.16 and T₇ (0.16). Organic carbon (%) of soil before sowing was 0.39 and after harvesting was 0.70% in T₉, followed by T₈ 0.68% Available nitrogen in pre-sowing soil was 228.4 kg ha⁻¹ increased up to 302.25 kg ha⁻¹ after harvesting and highest was in T₉ followed by T₈ 297.22 kg ha⁻¹. Available phosphorus in pre-sowing soil was 20.0 kg ha⁻¹ increased up to 27.69 kg ha⁻¹ after harvesting and highest was in T₉, followed by T₈ 25.97 kg ha⁻¹. Available potassium in pre-sowing soil was 148.30 kg ha⁻¹ increased up to 195.45 kg ha⁻¹ after harvesting and highest was in T₉, followed by T₈ 183.73 kg ha⁻¹. The Maximum gross return of ₹ 2,52,320.00 and Maximum net profit of ₹ 1,93,420.00 in treatment T₈ was best in increasing plant height, number of leaves, number of branches, yield, physical and chemical properties of soil like bulk density, particle density, pore space (%), EC, organic carbon, N, P, K, in guar plants. Maximum cost benefit ratio of 1:4.28 was in the treatment combination T₉ followed by 1:4.09 in T₈.

Conclusion

It was concluded that the treatment T₈ was the best in terms of all soil parameters like bulk density (Mg m⁻³), particle density (Mg m⁻³), pore space (%), Soil pH, Electrical Conductivity (dS m⁻¹), Organic Carbon (%), Available Nitrogen, Phosphorus and Potassium (Kg ha⁻¹) and in growth parameters the plant height, number of leaves per plant, number of clusters per plant, pods per cluster, pods per plant, seeds per pod and pod yield was highest. Treatment T₈ (i.e. 100% vermicompost + 100% neem cake) was best in terms of economic parameters too with maximum gross return of ₹ 2,52,320.00 and net profit was ₹ 1,93,420.00 with cost benefit ratio (C: B) (1:4.28).
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