**Original Research Article**

# Impact of Different Levels of NPK and Neem Cake on Soil Health of Cowpea (*Vigna unguiculata* L.) Var. Gomati.


## ABSTRACT

A field experiment was conducted during March-June (Late *Zaid*) 2022 at the research farm of Department Soil Science and Agricultural Chemistry, NAI, SHUATS, laid out in Randomized Block Design. To achieve higher growth and yield of rainy cowpea variety Gomati, it was found application of $T_9$ @ 100% NPK+ @ 100% Neem Cake has shown effective growth under Prayagraj climatic conditions. It was observed that for physical and chemical properties of soil in treatment $T_9$ (@100% NPK+ @100% Neem Cake) were improved significantly due to application of Nitrogen, Phosphorus, Potassium and Neem Cake use of inputs. This physico-chemical like Bulk density (Mg $m^{-3}$), Partical density (Mg $m^{-3}$), Pore space (%), Water Holding Capacity (%), pH, Electrical conductivity (dS $m^{-1}$), Organic Carbon (%), Available Nitrogen (kg $ha^{-1}$), Available Phosphorous (kg $ha^{-1}$), Available Potassium (kg $ha^{-1}$) were analysis. Result revealed that Soil Organic carbon content, Water holding capacity and available NPK significantly increased in most of the treatments after harvest of cowpea in $T_9$, whereas Bulk density (Mg $m^{-3}$), Partical density (Mg $m^{-3}$) and pH recorded minimum value in $T_9$ (@100% NPK + @100% Neem Cake) was best in terms of growth, yield and economic parameters with maximum plant height, number of branches $plant^{-1}$, pods $plant^{-1}$, seeds $pod^{-1}$, pod yield and maximum cost benefit ratio.



**Keywords:** Physico-Chemical properties, Nitrogen, Phosphorus, Potassium, Neem Cake and Cowpea.

## 1. INTRODUCTION

Cowpea belongs to the family Leguminosae and sub family Fabaceae. It is a warm season. annual and herbaceous legume. Plant types are often categorized as erect, prostrate or creeper. There is much variability within the species. Growth habit ranges from intermediate to profuse. Flowers are born in multiple racemes on 8-20 inches long flower stalk that arise from the long leaf axils. Cowpea seeds contain 54.4% carbohydrates, 24.2% protein and 0.1% fat. Moreover, it is a rich source of phosphorus, calcium and iron. The crop produces such heavy vegetative growth and completely covers the ground that it prevents soil erosion in problematic areas and can later be ploughed under to produce green manure. This might be the result of the plant receiving more nutrients over time, as well as more leaf fall and field waste. It has considerable promise as an alternative pulse crop (Madukwe *et al.*, 2008).

Pulses are least preferred by farmers because of high risk and less remunerative than cereals consequently, the production of the pulses is sufficiently low. Among the pulse crops. cowpea is more cosmopolite and grown in most of the regions of India which showed very encouraging results and promises to have a far-reaching significant in achieving a breakthrough in the pulse production. Cowpea is cultivated throughout India for its long green pods as vegetables, seeds and pulses, as foliage, as green manure, as well as green fodder. The cultivars grown for their immature pods are variously known as “Asparagus bean”, "Snake bean” and “Yard long bean”. Cowpea is originated in India and Ethiopia and it is widely grown in India as well as all over the world. (Sailajakumari, and Ushakumari, 2002).

Nitrogen is vitally important for plant nutrient. Nitrogen is a crucial component of protein and is also found in many other compounds that have a significant physiological impact on plant metabolism. Nitrogen is called a basic constituent of life. Crop production approaches involve the growth of nitrogen-fixing leguminous crops, such as cowpea (*Vigna unguiculata* L.), which is able to fix up to 337 kg N ha. In addition, cowpea can provide vital micronutrients, enhancing nutritional yield. When growing cowpea under subsistence farming system, some rural communities add, for example, inorganic fertilizer in addition to inter-cropping in order to optimise limited agricultural productive land. Inter-cropping by rural resource-poor farmers dates back to ancient civilization and is today still being practiced. (Buhlebelive *et al.,* 2020)

Phosphorus is an essential component of numerous plant processes, including energy metabolism, nitrogen fixation, membrane and nucleic acid synthesis, photosynthesis, respiration, and enzyme regulation. Phosphorus is critical to Cowpea yield because it is reported to stimulate growth, initiate nodule formation as well as influence the efficiency of the Rhizobium legume symbiosis. Phosphorus decreases zinc concentration in the cowpea grain, thereby affecting its nutritional quality. It is required for the physiological processes of protein synthesis and energy transfer in plants. Application of Phosphorus has been reported by several authors to improve yield of Cowpea. Seed yield is, therefore, governed by number of factors which have a direct or indirect impact. Among these factors some are yield components such as number of pods plant$^{-1}$, number of seeds pod$^{-1}$ and 100-seed weight over a given land area (Ndakidemi and Dakora, 2007).

Potassium plays important role in formation of protein and chlorophyll and it provide much of osmotic "pull" that draw water into plant roots. Potassium helps reduce lodging in maize and produces strong, stiff straw. Potassium gives plants more strength and resistance to disease. (Cobbinah *et al.*, 2011). Nitrogen is vitally important for plant nutrient. Nitrogen is a crucial component of protein and is also found in many other compounds that have a significant physiological impact on plant metabolism. Nitrogen is called a basic constituent of life. Crop production approaches involve the growth of nitrogen-fixing leguminous crops, such as cowpea (*Vigna unguiculata* L.), which is able to fix up to 337 kg N ha. In addition, cowpea can provide vital micronutrients, enhancing nutritional yield. When growing cowpea under subsistence farming system, some rural communities add, for example, inorganic fertilizer in addition to inter-cropping in order to optimise limited agricultural productive land. Inter-cropping by rural resource-poor farmers dates back to ancient civilization and is today still being practiced. (Buhlebelive *et al.*, 2020)

Neem cake known as non-edible oilcake organic manure. The composition of neem cake is 5.2% N, 1.0% P, 1.4% K. Neem cake also act as a nematocide. Neem cake act as a nitrogen inhibitor means reduce the nitrification. It supplys the available nitrogen for a long time in the soil. (Katyayan ,2012). The Neem cake obtained from the expeller contains 8-10% oil, which is recovered by solvent extraction. The cake's residual oil and limonoids repel insects, and solvents or water extracts make the product a strong antifeedant and growth inhibitor. The seed cake is rich in plant nutrients (crude protein 13-18%, carbohydrate 24-50%, crude fiber 8-26%, fat 2-13%, ash 5- 18% and acid insoluble ash 1-17%, with nitrogen, phosphorous, calcium, and magnesium) and is used as manure for soil amendment and for urea coating. (Manoj Kumar, 2018).

## 2. MATERIALS AND METHODS

The experiment was conducted at Research Farm of Soil Science and Agricultural Chemistry at Sam Higginbottom University of Agriculture Technology and Sciences 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 $25^0$58'N latitude, $81^0$52'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 $46^0$ C-$48^0$ C and seldom falls as low as $4^0$ C – $5^0$ C. The relative humidity ranges between 20 to 94 percent. The average rainfall in this area is around 1100 mm annually. The soils of experimental area fall in order of Inceptisol and soil was alluvial. 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 and 15-30 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 Cowpea**

| Treatments | Treatment description |
|---|---|
| $T_1$ | Absolute Control |
| $T_2$ | @50% NPK +@0% Neem Cake |
| $T_3$ | @100% NPK +@0% Neem Cake |
| $T_4$ | @0% NPK +@50% Neem Cake |
| $T_5$ | @50% NPK +@50% Neem Cake |
| $T_6$ | @100% NPK +@50% Neem Cake |
| $T_7$ | @0% NPK +@100% Neem Cake |
| $T_8$ | @50% NPK +@100% Neem Cake |
| $T_9$ | @100% NPK +@100% Neem Cake |

**Table. 2 Results of Physic-chemical properties of pre-soil sample. (Before sowing of crop)**

| Particulars | Results | | Methods |
|---|---|---|---|
| | (0-15) cm | (15-30) cm | |
| Sand (%) | 61.1 | 59.5 | Bouyoucos hydrometer (Bouyoucos 1927) |
| Silt (%) | 24.4 | 25.3 | |
| Clay (%) | 14.5 | 15.2 | |
| Textural Class | Sandy loam | Sandy loam | |
| Bulk density | 1.322 | 1.329 | Graduated measuring cylinder (Muthuaval *et al*. 1992) |
| Particle density | 2.184 | 2.201 | |
| Pore space (%) | 45.69 | 44.77 | |
| Water holding capacity (%) | 41.75 | 39.95 | |
| Soil pH (1:2.5) | 7.601 | 7.609 | Digital pH meter (Jackson 1958) |
| Electrical Conductivity (dS $m^{-1}$) | 0.175 | 0.196 | Digital conductivity meter (Wilcox 1950) |
| Organic Carbon (%) | 0.253 | 0.247 | Wet oxidation method (Walkley and Black 1947) |
| Available Nitrogen (kg $ha^{-1}$) | 167.10 | 148.64 | Modified alkaline permanganate oxidation method (Subbiah and Asija 1956) |
| Available Phosphorus (kg $ha^{-1}$) | 23.61 | 20.37 | Spectrophotometric method (Olsen *et al.* 1954) |
| Available Potassium (kg $ha^{-1}$) | 194.51 | 186.79 | Flame photometric method (Toth and Prince 1949) |

## 3. RESULTS AND DISCUSSION

### 3.1 Physical analysis

The maximum Bulk density of soil was recorded 1.25 Mg $m^{-3}$ and 1.29 Mg $m^{-3}$ at depth 0-15 cm and 15-30 cm, respectively in $T_1$ (Absolute control) and minimum bulk density was recorded in 1.12 Mg $m^{-3}$ and 1.13 Mg $m^{-3}$ at depth 0-15 cm and 15-30 cm, respectively in $T_9$ (@ 100% NPK + @100% Neem Cake).

The maximum Particle density of soil was recorded 2.26 Mg $m^{-3}$ and 2.28 Mg $m^{-3}$ at depth 0-15 cm and 15-30 cm in $T_1$ (Absolute control) and minimum Particle density recorded in 2.13 Mg $m^{-3}$ and 2.17 Mg $m^{-3}$ at depth 0-15 cm and 15-30 cm, respectively in $T_9$ (@ 100% NPK + @100% Neem Cake).

Treatment $T_9$ (@ 100% NPK + @100% Neem Cake) recorded maximum Pore space 57.32%, 55.42% at depth 0-15 cm and 15-30 cm. and minimum pore space was recorded in 46.23%, 45.27% at depth 0-15 cm and 15-30 cm, respectively in $T_1$ (Absolute Control).

The response of Water holding capacity of soil was found to be significant level of NPK and Neem Cake. The maximum water Holding capacity was recorded in $T_9$ (@ 100% NPK + @ 100% Neem Cake) 52.31%,39.37% at depth 0-15 cm and 15-30 cm and minimum Water holding capacity was recorded in 41.29%, 32.29% at depth 0-15 cm and 15-30 cm, respectively in $T_1$(Absolute Control).

### 3.2 Chemical analysis

The maximum pH of soil was recorded 7.53, 7.65 at depth 0-15 cm and 15-30 cm in $T_1$ (Absolute control) and minimum pH of soil was recorded in 7.15,7.25 at depth 0-15 cm and 15-30 cm, respectively in $T_9$ (@ 100% NPK + @100% Neem Cake).

The maximum EC of soil was recorded 0.26, 0.28 dS $m^{-1}$ at depth 0-15 cm and 15-30 cm in $T_9$ (@ 100% NPK + @100% Neem Cake) and minimum EC of soil was recorded in 0.15, 0.21 dS $m^{-1}$ at depth 0-15cm and 15-30 cm, respectively in $T_1$ (Absolute Control).

The maximum Organic carbon of soil was recorded in 0.65%, 0.57% at depth 0-15c m and 15-30 cm in $T_9$ (@ 100% NPK + @100% Neem Cake) and minimum organic carbon was recorded in 0.42, 0.36 at depth 0-15 cm and 15-30 cm, respectively in $T_1$ (Absolute Control).

The maximum Available Nitrogen of soil was recorded in 281.39, 273.24 kg $ha^{-1}$ at depth 0-15 cm and 15-30 cm in $T_9$ (@ 100% NPK + @100% Neem Cake) and minimum Available Nitrogen of soil was recorded in 256.71, 251.12 at depth 0-15 cm and 15-30 cm, respectively in $T_1$ (Absolute Control).

The maximum Available Phosphorous of soil was recorded in 27.89, 25.96 kg $ha^{-1}$ at depth 0-15 cm and 15-30 cm in $T_9$ (@ 100% NPK + @100% Neem Cake) and minimum Available of Phosphorous of soil was recorded in 20.26, 18.36 kg $ha^{-1}$, at depth 0-15 cm and 15-30 cm, respectively in $T_1$ (Absolute Control).

The maximum Available Potassium of soil was recorded in 158.15, 156.32 kg $ha^{-1}$ at depth 0-15 cm and 15-30 cm in $T_9$ (@ 100% NPK + @100% Neem Cake) and minimum Available Potassium of soil was recorded in 124.16, 120.65 kg $ha^{-1}$ at depth 0-15 cm and 15-30 cm, respectively in $T_1$ (Absolute Control).

**Table. 3 Physical properties of soil sample after harvesting of Cowpea.**

| Symbols | Treatments | Bulk Density ($Mg\ m^{-3}$) | | Particle Density ($Mg\ m^{-3}$) | | Pore space (%) | | Water holding capacity (%) | |
|---|---|---|---|---|---|---|---|---|---|
| | | Depth (cm) | | Depth (cm) | | Depth (cm) | | Depth (cm) | |
| | | 0-15 | 15-30 | 0-15 | 15-30 | 0-15 | 15-30 | 0-15 | 15-30 |
| $T_1$ | Control | 1.25 | 1.29 | 2.26 | 2.28 | 46.23 | 45.27 | 41.29 | 32.29 |
| $T_2$ | @50% NPK +@0% Neem Cake | 1.21 | 1.26 | 2.21 | 2.25 | 48.56 | 46.35 | 43.67 | 33.35 |
| $T_3$ | @100% NPK +@0% Neem Cake | 1.19 | 1.21 | 2.19 | 2.22 | 52.24 | 51.29 | 48.56 | 31.16 |
| $T_4$ | @0% NPK +@50% Neem Cake | 1.14 | 1.17 | 2.17 | 2.23 | 51.78 | 50.78 | 44.36 | 30.56 |
| $T_5$ | @50% NPK +@50% Neem Cake | 1.18 | 1.19 | 2.20 | 2.21 | 52.39 | 51.58 | 50.30 | 38.45 |
| $T_6$ | @100% NPK +@50% Neem Cake | 1.16 | 1.17 | 2.15 | 2.18 | 54.68 | 53.65 | 48.63 | 36.35 |
| $T_7$ | @0% NPK +@100% Neem Cake | 1.17 | 1.18 | 2.12 | 2.20 | 53.67 | 52.32 | 46.68 | 34.26 |
| $T_8$ | @50% NPK +@100% Neem Cake | 1.13 | 1.15 | 2.16 | 2.19 | 55.49 | 54.26 | 49.56 | 37.63 |
| $T_9$ | @100% NPK +@100% Neem Cake | 1.12 | 1.13 | 2.13 | 2.17 | 57.32 | 55.42 | 52.31 | 39.37 |
| | **F-test** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** |
| | **S.Em±** | 0.018 | 0.017 | 0.026 | 0.021 | 0.664 | 0.836 | 0.564 | 0.737 |
| | **C.D.@5%** | 0.056 | 0.072 | 0.080 | 0.064 | 1.999 | 2.517 | 1.700 | 2.219 |

**Fig.1 Physical properties of soil sample after harvesting of Cowpea.**

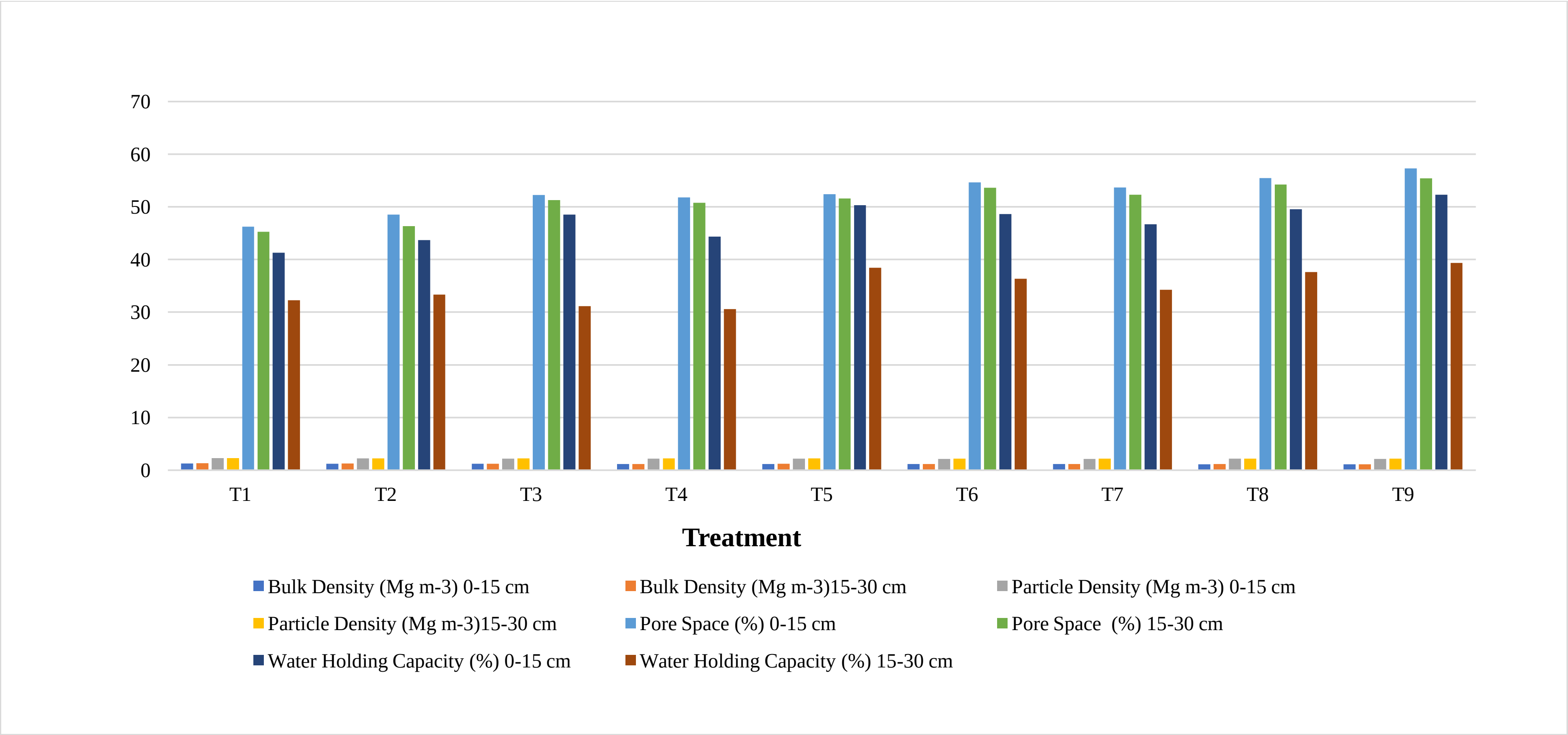
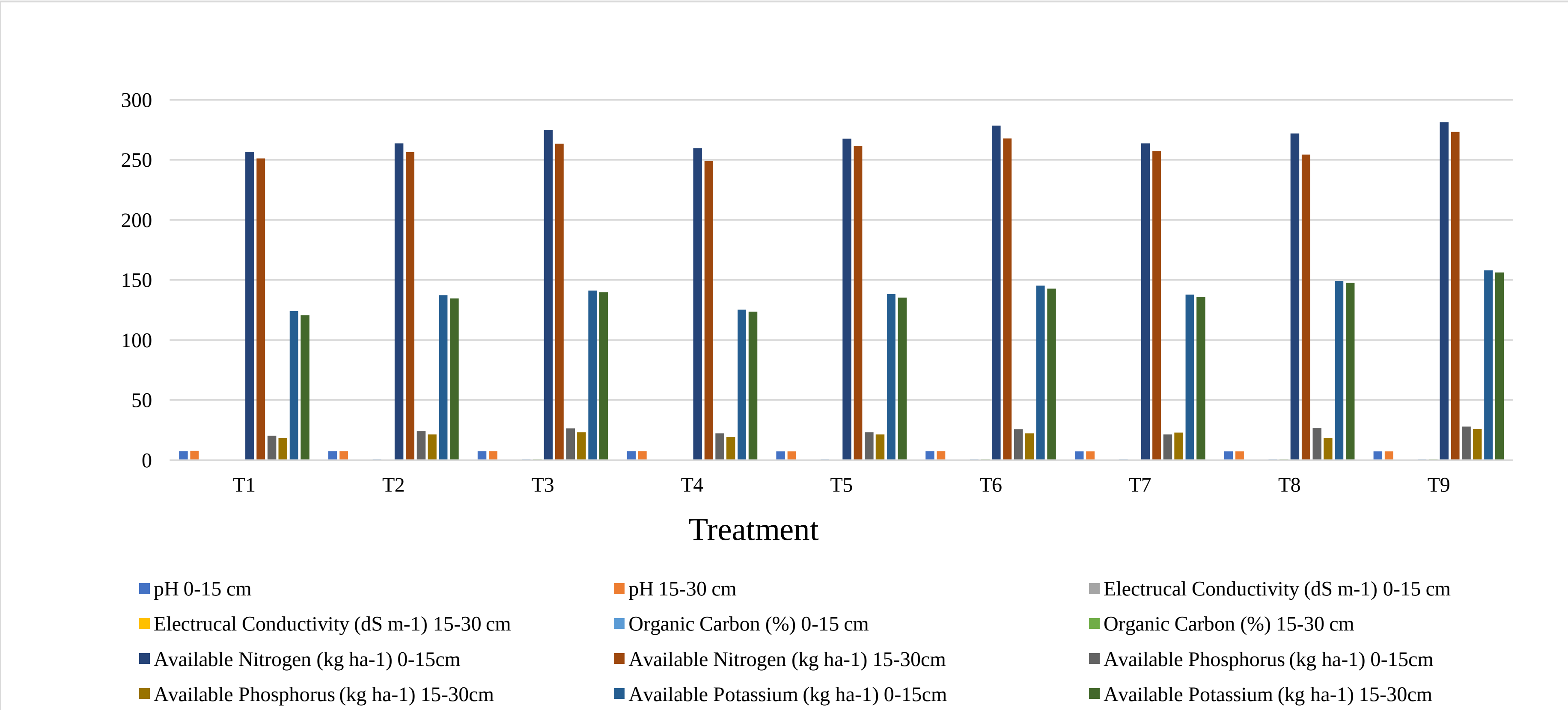


**Table. 4 Chemical properties of soil sample after harvesting of Cowpea.**

| Symbols | Treatments | Soil pH | | Electrical Conductivity (dS $m^{-1}$) | | Organic Carbon (%) | | Available Nitrogen (kg $ha^{-1}$) | | Available Phosphorus (kg $ha^{-1}$) | | Available Potassium (kg $ha^{-1}$) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Depth (cm) | | Depth (cm) | | Depth (cm) | | Depth (cm) | | Depth (cm) | | Depth (cm) | |
| | | 0-15 | 15-30 | 0-15 | 15-30 | 0-15 | 15-30 | 0-15 | 15-30 | 0-15 | 15-30 | 0-15 | 15-30 |
| $T_1$ | Control | 7.53 | 7.65 | 0.15 | 0.21 | 0.42 | 0.36 | 256.71 | 251.12 | 20.26 | 18.36 | 124.16 | 120.65 |
| $T_2$ | @50% NPK +@0% Neem Cake | 7.48 | 7.46 | 0.19 | 0.23 | 0.51 | 0.45 | 263.65 | 256.36 | 24.18 | 21.45 | 137.26 | 134.46 |
| $T_3$ | @100% NPK +@0% Neem Cake | 7.37 | 7.39 | 0.21 | 0.25 | 0.56 | 0.51 | 274.84 | 263.48 | 26.38 | 23.17 | 141.18 | 139.84 |
| $T_4$ | @0% NPK +@50% Neem Cake | 7.42 | 7.45 | 0.17 | 0.19 | 0.48 | 0.39 | 259.74 | 249.26 | 22.19 | 19.26 | 125.12 | 123.58 |
| $T_5$ | @50% NPK +@50% Neem Cake | 7.31 | 7.32 | 0.23 | 0.27 | 0.54 | 0.43 | 267.65 | 261.75 | 23.16 | 21.37 | 138.32 | 135.20 |
| $T_6$ | @100% NPK +@50% Neem Cake | 7.41 | 7.40 | 0.22 | 0.24 | 0.59 | 0.52 | 278.51 | 267.86 | 25.78 | 22.18 | 145.37 | 142.76 |
| $T_7$ | @0% NPK +@100% Neem Cake | 7.27 | 7.31 | 0.18 | 0.22 | 0.50 | 0.46 | 263.79 | 257.41 | 21.37 | 23.01 | 137.76 | 135.69 |
| $T_8$ | @50% NPK +@100% Neem Cake | 7.25 | 7.29 | 0.24 | 0.26 | 0.62 | 0.54 | 271.86 | 254.47 | 26.78 | 18.68 | 149.10 | 147.64 |
| $T_9$ | @100% NPK +@100% Neem Cake | 7.15 | 7.25 | 0.26 | 0.28 | 0.65 | 0.57 | 281.39 | 273.24 | 27.89 | 25.98 | 158.15 | 156.32 |
| | **F-test** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** |
| | **S.Em±** | 0.062 | 0.074 | 0.002 | 0.003 | 0.007 | 0.006 | 3.250 | 3.507 | 0.408 | 0.365 | 2.201 | 2.345 |
| | **C.D.@5%** | 0.187 | 0.223 | 0.008 | 0.009 | 0.022 | 0.018 | 9.786 | 10.559 | 1.228 | 1.099 | 6.625 | 7.060 |

**Fig.2** **Chemical properties of soil sample after harvesting of Cowpea.**



## 4. CONCLUSIONS

It was concluded that the treatment $T_9$ 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 $ha^{-1}$), as well as helps to increase yield of cowpea, thus overall benefit to Indian farmers.

## REFERENCES


Buhlebelive, Mndzebele., ORCID.Bhekumthetho. Ncube., Melvin, Nyathi., Sheku, Alfred. Kanu. and Melake, F. (2020) Nitrogen Fixation and Nutritional Yield of Cowpea-Amaranth Intercrop. *Agronomy* 2020 **10**(4):565.

Joshi D, Gediya KM, Patel jS, Birai MM. Effect of organic manures on growth and yield of summer cowpea (*vigna unguiculata* L.). Journal of Agricultural science digest. 2016; 36(2):134-137.

Khandelwal R. Effect of inorganic and biofertilizers on productivity and nutrients uptake in cowpea [*Vigna unguiculata* (L.) Walp]. Legumes Research. 2012 35(3): 235-238.

Kumar Yadav, Ramawat Naleeni and Singh Dashrath. Effect of organic manures and biofertilizers on growth and yield parameters of cowpea (*Vigna unguiculate* (L.) Walp.). Journal of Pharmacognosy and Phytochemistry 2019; 8(2): 271-274.

Taniya Mistri, Narendra Swaroop, AA David and A Barthwal. Assessment of organic and inorganic fertilizers on physico-chemical properties of soil of tomato. The Pharma Innovation Journal. 2021; 10(8): 703-707

Wilcox LV. Electrical Conductivity Journal American Water works Association 1950; 42: 775-776.

Walkley, A. and Black, IA. Critical examination of rapid method for determining organic carbon in
soils, effect of variance in digestion conditions and inorganic soil constituents. Soil science.1947; 632:251.

Toth, SJ, and Prince AL. Estimate of cation exchange capacity and exchangeable Ca, K, Na, content of soil by flame photometer technique soil sci. 1949; 67(6): 439-445.

Subbiah, BV, and Asija, GL. A rapid procedure for the estimate of available Nitro gen in Soil Current Sci. 1956;25: 259-260.

Olsen, SR, Cole CV, Watanabe, F.S. and Dean, LA. (1954) Estimate of available Phosphorus In soils by extraction with sodium bicarbonate. United States Department of Agriculture circular.1954; 939:1-19.

Jackson ML. Soil chemical analysis Second edition Indian reprint, prentice hall of India, New Delhi.1973; 498.

Madukwe, D. K., Christo, I. E. C. and Onuh, M. O. (2008). Effect of organic manure and cowpea walp varieties on the chemical properties of the soil and root nodulation. Sel World.3 (1):210-214.

ManojKumar KP, Tarence Thomas, Amreen Hasan P, Smriti Rao. Effects of vermicompost and inorganic fertilizers on physico-chemical properties of soil in Indian mustard. *Journal of Pharmacognosy and Phytochemistry* 2018; **7(**3): 1999-2001.

Ndakidemi, PA. and Dakora, FD. (2007) Yield components of nodulated cowpea (*Vigna unguiculata*) and maize plants grown with exogenous phosphorus in different cropping systems. *Aust. J. Exp. Agric.* 4**7**:583-589.

Sailaja kumari, M.S. and Ushakumari, K. (2002). Effect of vermicompost enriched with rock phosphate on yield and uptake of nutrients in cowpea. *Journal of Tropical Agriculture*, **40**: 27-30.