***Original Research Article***

# Influence of NPK and FYM on Physical and Chemical properties of Soil under Spinach in an Inceptisol of Prayagraj, Uttar Pradesh, India


## ABSTRACT

The study pertaining to Physical and Chemical properties of Soil under Spinach in an Inceptisol of Prayagraj, Uttar Pradesh, India during *Rabi* seasons of 2021. Study was carried out at the Research Farm, Department of Soil Science and Agricultural Chemistry. The excavated soil sample from experimental site before conducting research operation, mentioned that, the land topography range was nearly levelled with 1-3% slope, soil is of sandy loam texture with neutral to alkaline in reaction (7.21), electrical conductivity was non-saline (0.23 dS $m^{-1}$) in nature, low organic carbon content (0.35%), low to medium available N (235.23 kg $ha^{-1}$), available P (21.45 kg $ha^{-1}$) and available K (199.32 kg $ha^{-1}$). Among nine treatments, during field experimentation, the conjunctive use of NPK and different FYM levels, together come with best results significantly. However, the physical and chemical soil parameters, cumulative mean value for Bulk density (1.28 Mg $m^{-3}$ and 1.33 Mg $m^{-3}$), Particle density (2.60 Mg $m^{-3}$ and 2.62 Mg $m^{-3}$) and Soil pH (7.21 and 7.26) was found optimum in $T_1$ (Absolute control) at 0-15 cm depth and 15-30 cm depth, respectively. Percentage pore space (49.09% and 46.08%), Water holding capacity (48.05% and 44.28%), Electrical conductivity (0.38 dS $m^{-1}$ and 0.36 dS $m^{-1}$), Percentage organic carbon (0.53% and 0.46%), Available N (262.82 kg $ha^{-1}$ and 232.03 kg $ha^{-1}$ ), Available P (41.73 kg $ha^{-1}$ and 32.48 kg $ha^{-1}$ ), Available K (241.62 kg $ha^{-1}$ and 220.52 kg $ha^{-1}$ ) were found optimum in $T_9$ consisting of RDF (90:50:50 NPK kg $ha^{-1}$ ) + FYM (20 t $ha^{-1}$) in comparison to other NPK and FYM levels application.



**Key words:** Soil health, Spinach, FYM, soil properties.


## 1. INTRODUCTION

Spinach is commonly grown in all soil types and is one of the most popular leafy vegetables with high calorific values. It is a cheap and rich source of vitamin A, which helps improve eyesight. It is also a good source of vitamin C and mineral elements like iron, zinc, calcium, magnesium, and phosphorus, and the cheapest source of antioxidants and dietary

fibres. Green leafy vegetables have a unique place in our daily diet because of their colour, flavour, and healthy benefits. They are rich in minerals and hence can be called "mines of minerals." (Singh *et al.,* 2015).

Spinach (*Beta vulgaris* L.) 2n = 2x = 18, commonly known as "Indian spinach" in English and "Palak" in Hindi, originated in the Indo-Chinese region and belongs to the genus Beta, specie vulgaris, and family Chenopodiaceae. (Jabeen *et al.,* 2018).

In India, leafy vegetables grow on nearly 10.29 million ha, with an annual production of 18.80 metric tonnes. In India, spinach will be grown on a total area of 53.3 thousand hectares during 2020. Total production will be 463.9 thousand metric tonnes, with a productivity of 8.5 metric tonnes per hectare.

The combination of organic and inorganic fertilisers can increase plant production (Mahmoud et al. 2009). Organic composts increase the content of nutrients in soil and their availability for plants (Boldrin *et al*., 2009) and may contribute towards reducing inorganic nitrogen fertilisation, which has negative environmental impacts. (Graham *et al.,* 2017).

FYM provides food for soil microorganisms; this increases the activity of microbes, which in turn help to convert unavailable plant nutrients into available forms, and being rich in organic matter is required for supplementing the nutrients to the plants. Soil organic matter indirectly affects some of the plant and soil aspects important to plant growth, like soil bulk density, particle density, soil moisture content, and crop water use efficiency.

Essentially, the presence of organic matter in soils is responsible for improving the physical and chemical properties of the soil through mineralization and gelation of soil particles. According to some studies, applying FYM along with N fertilisers can increase the plant height, leaf number, leaf length, leaf width, fresh weight, and yield of spinach compared to applying N alone. In spinach, nitrogen is essential for vegetative growth, chlorophyll synthesis, nitrate reductase activity, and protein formation.

Nitrogen is also a component of all proteins and enzymes, and it is engaged in some energy-transformation metabolic activities. (Lal *et al*., 2014).

In spinach, phosphorus is an essential component of photosynthetic processes that are involved in the synthesis of sugars, oils, and starches, as well as the conversion of solar energy to chemical energy, plant development, and stress resistance. It enhances crop maturity and encourages early root growth, leaf size, tillering, flowering, grain output, and Deep roots also benefit the plant by keeping it rooted in the soil and preventing water loss due to lodging. (Oladipo *et al.,* 2015).

Potassium is a plant nutrient that has a high association with crop quality. It's vital for optimal crop quality, plant health, stress tolerance, seed quality, regulating water balance, stomatal movement, enzyme activation, and carbohydrate translocation, as well as for healthy growth. (Roy *et al.,* 2006).

## 2. MATERIALS AND METHODS

### 2.1 Experimental Site and Location

the investigative site of the crop research farm which falls under Geographical Co-ordinates of Prayagraj District which is located at $25^0$ 58' N latitude and $81^0$ 52' E longitude with an altitude of 98 meter above mean sea level and is situated 5 km away on the right bank of Yamuna-river. Representative the Agro-Ecological Sub Region [North Alluvial plain zone (0-1% slope)] and Agro-Climatic Zone (Upper Gangetic Plain Region).

### 2.2 Climate Condition

The field study was conducted in Prayagraj district which comes under subtropical belt with semi-arid climatic condition with both extremes of temperature i.e., winter and summer. The maximum temperature of the location reaches up to 46˚-48˚C and seldom falls as 4˚-5˚C. The relative humidity ranges between 20% to 94%. The average rainfall in this area is around 900-1100 mm annually. The minimum temperature during the crop season was to be 5.9˚C and the maximum is to be 29.04˚C. The maximum humidity was to be 42.72% and maximum was to be 93.28%.

**Table 1. Symbolic presentation of treatment combination**

| Treatment | Treatment combination | Symbols |
|---|---|---|
| $T_1$ | RDF @ 0% + FYM @ 0% | $R_0F_1$ |
| $T_2$ | RDF @ 0% + FYM @ 50% | $R_0F2$ |
| $T_3$ | RDF @ 0% + FYM @ 100% | $R_0F3$ |
| $T_4$ | RDF @ 50% + FYM @ 0% | $R_1F_1$ |
| $T_5$ | RDF @ 50% + FYM @ 50% | $R_1F_2$ |
| $T_6$ | RDF @ 50% + FYM @ 100% | $R_1F_3$ |
| $T_7$ | RDF @ 100% + FYM @ 0% | $R_2F_1$ |
| $T_8$ | RDF @ 100% + FYM @ 50% | $R_2F_2$ |
| $T_9$ | RDF @ 100% + FYM @ 100% | $R_2F_3$ |

**Note:**

**Recommended Dose of Fertilizer: - 90:50:50 (NPK)**

**Farm Yard Manure: 20 t $ha^{-1}$**

### 2.3 Experimental Details

The present research investigation was setup in a randomised block design (RBD) with nine treatment combinations, which are replicated three times and randomly allocated in each replication, dividing the research site into twenty-seven plots. In this study, inorganic fertilisers like nitrogen, phosphorus, and potassium were used as RDF, and organic manure like FYM was applied in three different doses. Sowing of the spinach crop was carried out on the 2nd of December, 2021, respectively, by hand. The seed variety Harit Shobha was sown at a rate of 25 kg ha1 and at a row-to-row spacing of 30 cm and plant-to-plant spacing of 10 cm.

### 2.4 Fertilizer Application

The recommended doses of NPK 90:50:50 (100%) were applied to the spinach: N (196 kg ha-1), $P_2O_5$ (312 kg $ha^{-1}$), and $K_2O$ (83 kg $ha^{-1}$). The 100 percent application of N, P, and K was used as the basal dose at the time of sowing. In addition to these applications, FYM was used as a basal dose at 0, 10, and 20 t $ha^{-1}$ for the treatment. The sources of NPK fertilisers were nitrogen through urea (46% $N_2O$). Phosphorus through single superphosphate (16% $P_2O_5$) and potassium through muriate of potassium (60% $K_2O$) were applied earlier to sowing in regards to treatments just before the seed sowing. Nitrogen and urea (46% N) were applied in two different doses.

### 2.5 Soils Analysis

The soils from each plot were separately collected, air-dried, ground, and passed through a 2-mm-size sieve for laboratory analysis. Soil samples were analysed for bulk density, particle density, Percentage pore space, and water holding capacity (WHC) using a 100-ml measuring cylinder (Muthuvel *et al*., 1992) [10], pH [8], EC (Wilcox, 1950) [22], Percentage OC (Walkley and Black, 1934) [21], Available Nitrogen (Subbiah and Asiija, 1956) [17], Available Phosphorus (Olsen *et al*., 1954) [14] and Available Potassium (Toth and Prince, 1949) [19] before sowing the experimental crop and after the harvest of the crop.

### 2.6 Statistical Analysis

The statistical analysis of the data was carried out using STATISTICA (7.0) software [1].

## 3. RESULTS AND DISCUSSION

### 3.1 Effect of Nutrient Management on Physical Properties of Soil after Harvest of Spinach

The data showed that the treatment $T_1$ (Absolute control) non-significantly influenced the Bulk density of soil (1.28 Mg $m^{-3}$ and 1.33 Mg $m^{-3}$), Particle density 2.60 Mg $m^{-3}$ and 2.62 Mg $m^{-3}$ at 0-15 cm depth and 15-30 cm depth and significantly influenced Percentage pore space (49.07% and 46.18%), Water holding capacity (48.05% and 44.28%) of soil were found optimum in treatment $T_9$ [RDF (90:50:50 NPK kg $ha^{-1}$) + FYM (20 t $ha^{-1}$)] over $T_1$ (Absolute control) treatment at 0-15 cm depth and 15-30 cm depth, respectively (Table 2 and fig. 1). This corroborates with the findings of [9-20].

### 3.2 Effect of Nutrient Management on Chemical Properties of Soil after Harvest of Spinach

The data showed that the treatment $T_1$ (Absolute control) non-significantly influenced the soil pH is maximum (7.21 and 7.26) at 0-15 cm and 15- 30 cm depth, respectively (Table 2 and fig.1). There was significantly influenced maximum build-up of Electrical Conductivity (0.38 and 0.36), Percentage Organic Carbon (0.53% and 0.46%), Available N (262.85 and 232.03 kg $ha^{-1}$), Available P (41.73 kg $ha^{-1}$ and 32.48 kg $ha^{-1}$) and Available K (241.62 kg $ha^{-1}$ and 220.52 kg $ha^{-1}$) were observed under the treatment $T_9$ [RDF (90:50:50 NPK kg $ha^{-1}$) + FYM (20 t $ha^{-1}$)] content in soil, however minimum values were detected in the treatments $T_1$ (absolute control) at 0-15 cm depth and at 15- 30 cm depth, respectively (Table 3 and fig.2, 3). This corroborates with the findings of [9-20].

**Table No. :2 Effect of Organic and Inorganic source of Nutrient on Bulk density, Particle density, Pore space, Water holding capacity and pH.**

| Treatments | | Bulk Density ($Mg\ m^{-3}$) | | Particle Density ($Mg\ m^{-3}$) | | Percentage Pore space (%) | | Water holding capacity (%) | | pH | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0-15 cm | 15-30 cm | 0-15 cm | 15-30 cm | 0-15 cm | 15-30 cm | 0-15 cm | 15-30 cm | 0-15 cm | 15-30 cm |
| $T_1$ | Absolute control | 1.28 | 1.33 | 2.60 | 2.62 | 46.18 | 41.07 | 43.18 | 40.02 | 7.21 | 7.26 |
| $T_2$ | RDF @ 0% + FYM @ 50% | 1.25 | 1.30 | 2.57 | 2.59 | 47.50 | 42.95 | 45.50 | 41.82 | 7.16 | 7.23 |
| $T_3$ | RDF @ 0% + FYM @ 100% | 1.22 | 1.27 | 2.54 | 2.57 | 48.17 | 44.35 | 46.80 | 43.03 | 7.10 | 7.14 |
| $T_4$ | RDF @ 50% + FYM @ 0% | 1.27 | 1.32 | 2.58 | 2.60 | 46.58 | 41.97 | 44.58 | 40.95 | 7.19 | 7.24 |
| $T_5$ | RDF @ 50% + FYM @ 50% | 1.24 | 1.29 | 2.55 | 2.57 | 47.50 | 43.15 | 45.75 | 42.05 | 7.13 | 7.18 |
| $T_6$ | RDF @ 50% + FYM @ 100% | 1.21 | 1.26 | 2.52 | 2.54 | 48.57 | 44.65 | 47.10 | 43.35 | 7.05 | 7.11 |
| $T_7$ | RDF @ 100% + FYM @ 0% | 1.26 | 1.31 | 2.56 | 2.58 | 47.09 | 42.85 | 44.90 | 41.25 | 7.17 | 7.21 |
| $T_8$ | RDF @ 100% + FYM @ 50% | 1.23 | 1.28 | 2.53 | 2.55 | 47.90 | 44.02 | 45.80 | 42.55 | 7.09 | 7.14 |
| $T_9$ | RDF @ 100% + FYM @100% | 1.19 | 1.24 | 2.50 | 2.52 | 49.07 | 46.08 | 48.05 | 44.28 | 6.96 | 7.01 |
| F-test | | NS | NS | NS | NS | S | S | S | S | NS | NS |
| S.Em (±) | | 0.0223 | 0.0278 | 0.039 | 0.0485 | 0.5731 | 0.409 | 0.7881 | 0.6982 | 0.04948 | 0.09762 |
| CD (P=0.05) | | - | - | - | - | 1.7181 | 1.226 | 2.3628 | 2.0933 | - | - |

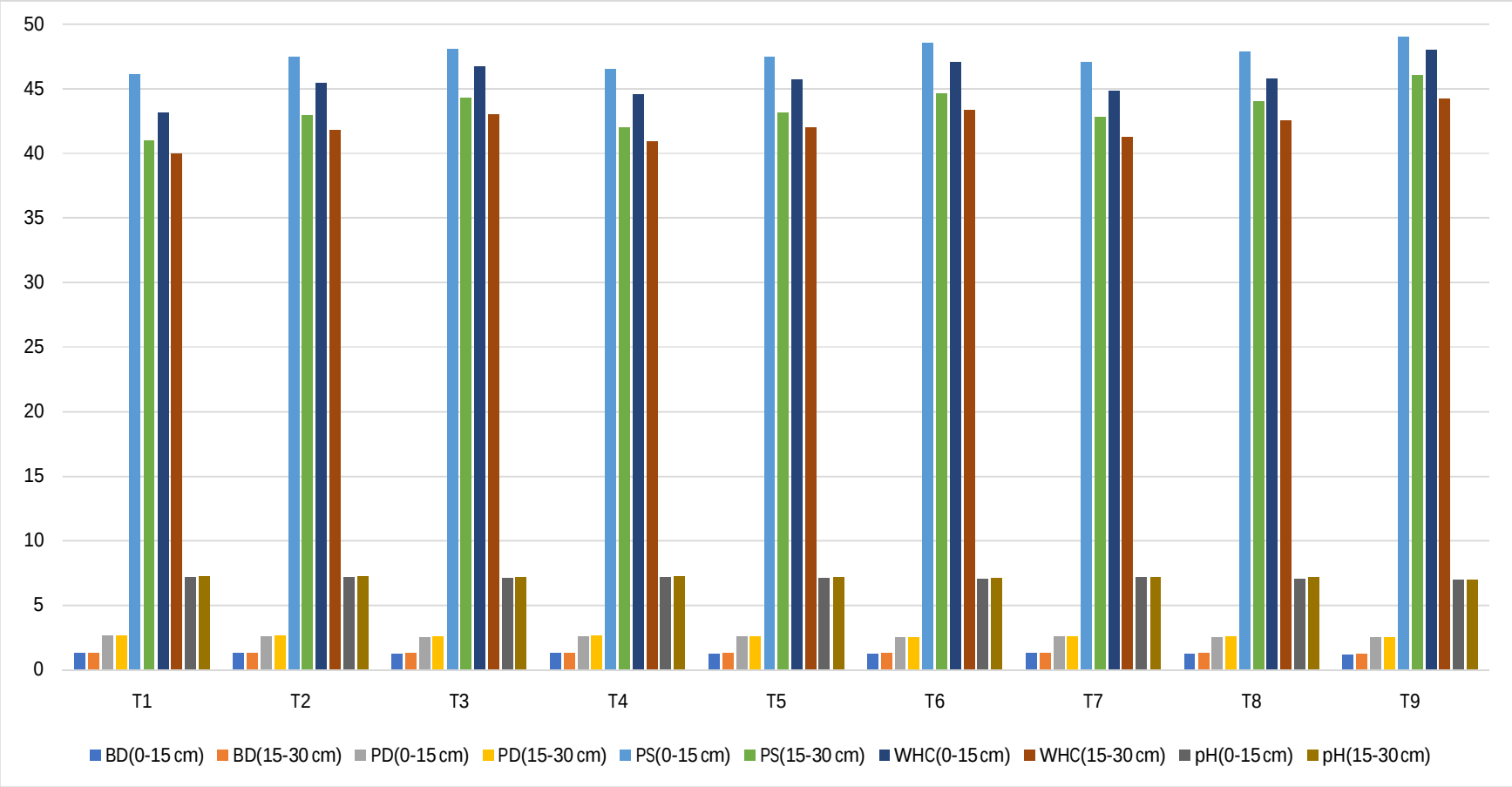


**Fig. No.: 1 Effect of Organic and Inorganic source of Nutrient on Bulk density, Particle density, Percentage Pore space, Water holding capacity and pH.**

**Table No. :3 Effect of Organic and Inorganic source of Nutrient on Electrical conductivity, Organic Carbon, Available Nitrogen, Available phosphorus and Available Potassium.**

| Treatments | | Electrical conductivity (dS $m^{-1}$) | | Percentage Organic Carbon (%) | | Available Nitrogen (kg $ha^{-1}$) | | Available phosphorus (kg $ha^{-1}$) | | Available Potassium (kg $ha^{-1}$) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0-15 cm | 15-30 cm | 0-15 cm | 15-30 cm | 0-15 cm | 15-30 cm | 0-15 cm | 15-30 cm | 0-15 cm | 15-30 cm |
| $T_1$ | Absolute control | 0.23 | 0.21 | 0.35 | 0.32 | 235.23 | 204.52 | 21.45 | 19.53 | 199.32 | 168.67 |
| $T_2$ | RDF @ 0% + FYM @ 50% | 0.26 | 0.23 | 0.42 | 0.37 | 241.70 | 209.35 | 25.69 | 22.25 | 207.55 | 188.17 |
| $T_3$ | RDF @ 0% + FYM @ 100% | 0.29 | 0.29 | 0.46 | 0.42 | 249.59 | 213.45 | 29.34 | 25.88 | 215.75 | 200.02 |
| $T_4$ | RDF @ 50% + FYM @ 0% | 0.25 | 0.23 | 0.38 | 0.34 | 245.20 | 211.63 | 27.53 | 23.35 | 214.45 | 198.97 |
| $T_5$ | RDF @ 50% + FYM @ 50% | 0.27 | 0.26 | 0.43 | 0.39 | 251.32 | 219.54 | 31.75 | 26.45 | 223.85 | 207.25 |
| $T_6$ | RDF @ 50% + FYM @ 100% | 0.33 | 0.31 | 0.49 | 0.43 | 257.73 | 224.82 | 36.85 | 29.95 | 233.98 | 213.78 |
| $T_7$ | RDF @ 100% + FYM @ 0% | 0.32 | 0.30 | 0.39 | 0.36 | 253.38 | 221.38 | 34.25 | 27.09 | 230.90 | 210.33 |
| $T_8$ | RDF @ 100% + FYM @ 50% | 0.34 | 0.33 | 0.45 | 0.40 | 259.43 | 228.10 | 38.33 | 30.08 | 237.15 | 215.55 |
| $T_9$ | RDF @ 100% + FYM @100% | 0.38 | 0.36 | 0.53 | 0.46 | 262.85 | 232.03 | 41.73 | 32.48 | 241.62 | 220.52 |
| F-test | | S | S | S | S | S | S | S | S | S | S |
| S.Em. (±) | | 0.0131 | 0.01176 | 0.0112 | 0.01042 | 1.14799 | 1.0715 | 1.07603 | 1.05409 | 1.02439 | 0.968644 |
| CD (P=0.05) | | 0.03927 | 0.03525 | 0.0336 | 0.03125 | 3.44169 | 3.212406 | 3.2259 | 3.16016 | 3.07113 | 2.903994 |

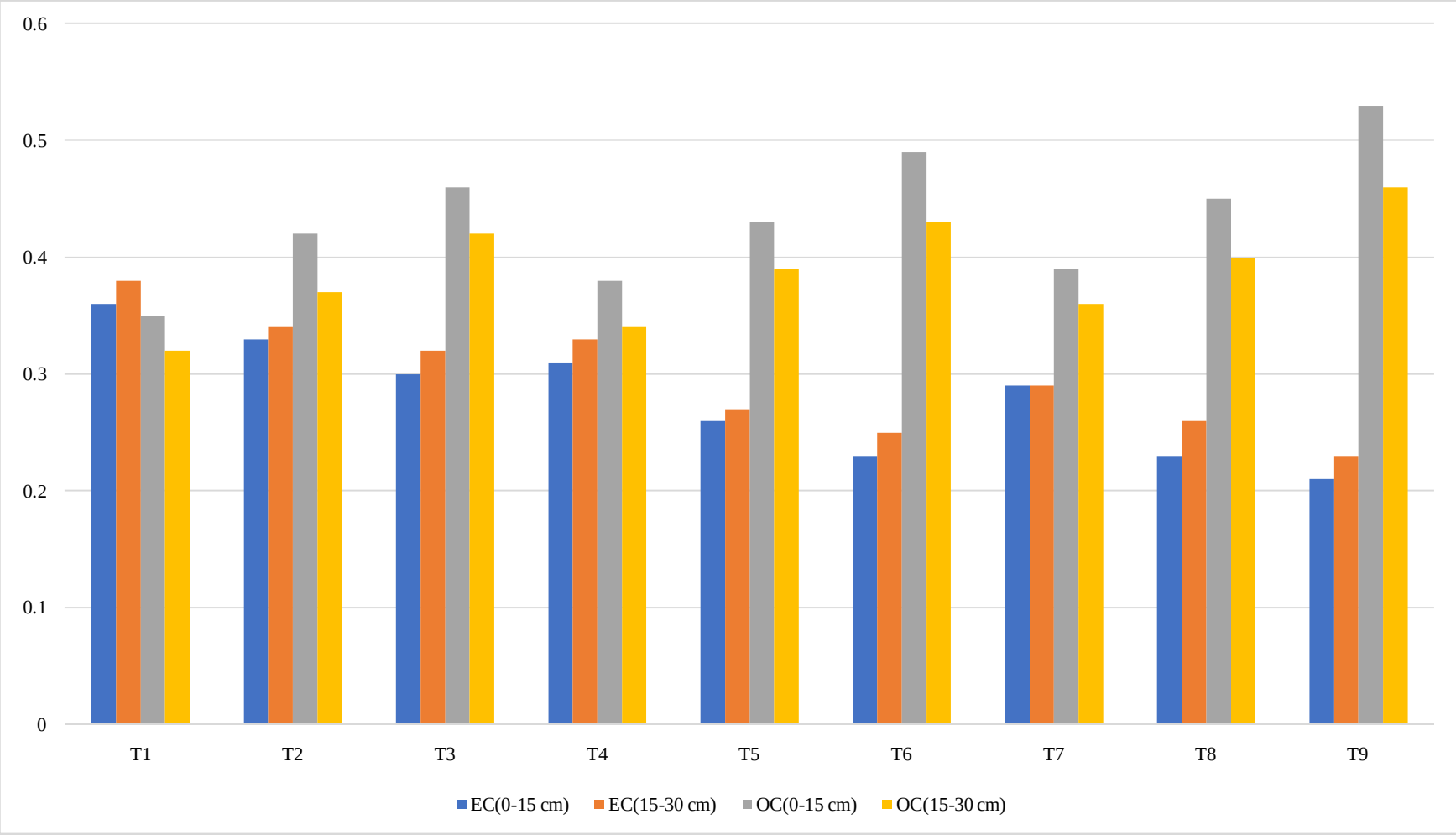


**Fig. No.: 2 Effect of Organic and Inorganic source of Nutrient on Electrical Conductivity and Percentage Organic Carbon.**

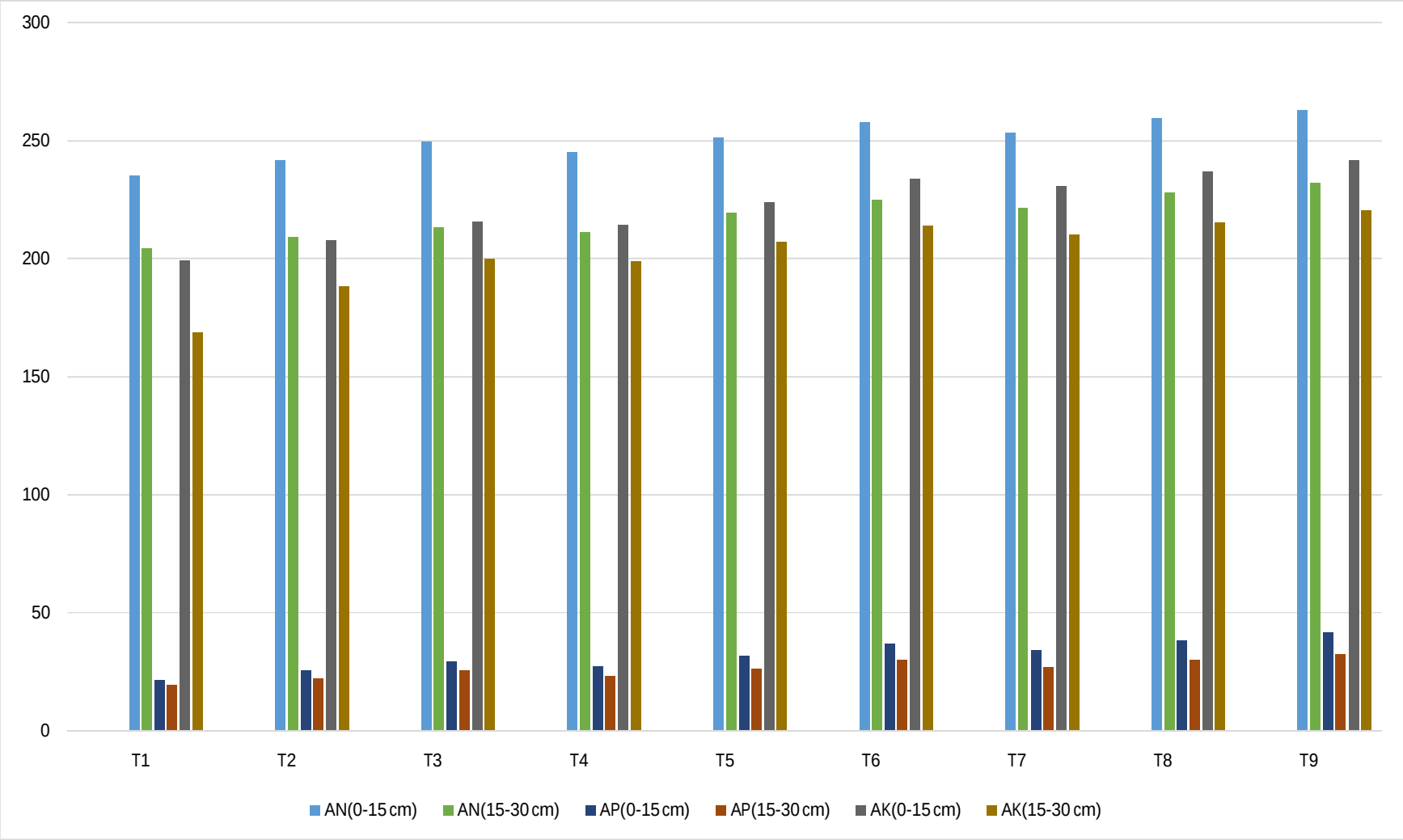


**Fig. No.: 3 Effect of Organic and Inorganic source of Nutrient on Available Nitrogen, Available phosphorus and Available Potassium.**

## 4. CONCLUSION

Conclusion Based on the results, the application of organic manure and inorganic fertilizer was found to improve the soil's health in references to spinach. Application of $T_9$ [RDF (90:50:50 NPK kg $ha^{-1}$) + FYM (20 t $ha^{-1}$)] was found optimal for improving Soil Properties like Pore space, Water holding capacity, Electrical conductivity, Organic Carbon and Available Nitrogen, Phosphorus, Potassium.

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