Original Research Article

# Analysis The Effect of Different Levels of Inorganic and Bio Fertilizers on Physico - Chemical Properties of Soil in Mung Bean


## Abstract

An experiment was conducted during *summer* season (May to July 2022) at central research farm of Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. The experiment was laid out in randomized block design with three levels of inorganic fertilizer (0, 50 and 100 % NPK), and three level of biofertilizer (0, 50 and 100 % Rhizobium and Azotobacter). The treatments were replicated three times and allocated random of each replication. The result shows that maximum bulk density 1.38 Mg $m^{-3}$ at 0-15 cm and 1.45 Mg $m^{-3}$ at 15-30 cm, particle density 2.50 Mg $m^{-3}$ at 0-15 cm and 2.62 Mg $m^{-3}$ at 15-30 cm, % pore space 44.82 % at 0-15 cm and 42.18 % at 15-30 cm, water holding capacity 38.65 % at 0-15 cm and 35.80 % at 15-30 cm, pH 7.56 at 0-15 cm and 7.62 at 15-30 cm, EC 0.51 $dSm^{-1}$ at 0-15 cm and 0.55 $dSm^{-1}$ at 15-30 cm, organic carbon 0.54 % at 0-15 cm and 0.51 % at 15-30 cm, available nitrogen 330.45 kg $ha^{-1}$ at 0-15 cm and 326.18 kg $ha^{-1}$ at 15-30 cm, available phosphorus 19.14 kg $ha^{-1}$ at 0-15 cm and 25.82 kg $ha^{-1}$ at 15-30 cm, available potassium 211.29 kg $ha^{-1}$ at 0-15 cm and 207.62 kg $ha^{-1}$ at 15-30 cm in treatment $T_9$ [NPK @ 100 % + Rhizobium @ 100 % + Azotobacter @ 100 %] best from $T_1$ [NPK @ 0 % + Rhizobium @ 0 % + Azotobacter @ 0 %] Application of inorganic and biofertilizer increased improved physical and chemical properties of soil.


**Comment [mm1]:** Add background, aims

**Key word:** Mung bean, NPK, Rhizobium, Azotobacter, Physio-chemical Properties of Soil, etc.

## Introduction

Soils supply the essential nutrients, water, oxygen and root support that our food-producing plants need to grow and flourish. They also serve as a buffer to protect delicate plant roots from drastic fluctuations in temperature (Rautaray *et al*., 2003). A healthy soil is a living, dynamic ecosystem, teeming with microscopic and larger organisms that perform many vital functions including converting dead and decaying matter as well as minerals to plant nutrients (nutrient cycling); controlling plant disease, insect and weed pests; improving soil structure with positive effects for soil water and nutrient holding capacity, and ultimately improving crop production. A healthy soil also contributes to mitigating climate change by maintaining or increasing its carbon content (Sanchez, 1976).

Green gram (*Vigna radiata* L.) is one of the important pulse crops in India. Green gram commonly known as "mung bean" has been cultivated in India since ancient times. It belongs to *Fabaceae* family. Green gram is originated from India and central Asia. It is the third most popular pulse crop cultivated throughout in India (Miachieo *at al.,* 2019). Green gram is a protein rich staple food. It has enormous potential for the future needs to be capitalized. It has an edge over other pulses because of its high nutritive value, digestibility and non-flatulent behavior. It is grown principally for protein rich edible seeds which contain 24% crude protein, 56.7% carbohydrates, 1.3% fats, 3.5% minerals, 0.43% lysine, 0.1% methionine and 0.04% tryptophan (Kachroo, 1970).

Green gram also known as moong or mung, is the third most important pulse crop in India after gram and red gram (Miachieo *at al.,* 2019). It belongs to the "Leguminosae" family and sub family "Papillionaceae". Green gram is thought to have originated in India and Central Asia. It extends from India to China, Iraq, Japan, Africa, and other countries. Green gram is primarily growing Rajasthan, Maharashtra, Andhra Pradesh, Orissa, Gujarat, Madhya Pradesh, Punjab, and Utter Pradesh in India (Srikant, 2010).

The inorganic fertilizers, no doubt, are the important source of nutrients in crops which can meet the nutrient requirement but their imbalance and continuous use causes environmental pollution and deterioration of soil health (Zafar *et al*., 2013). Another issue for the farmer is the availability of fertilizer at reasonable rates. Under these circumstances, farmers should not depend on single source of plant nutrients like inorganic fertilizers. A balanced use of inorganic fertilizers, organic manures and bio-fertilizers are required to develop an integrated plant nutrition supply system (Anjum *et al*., 2006).

Increasing the application of N fertilizer during the early growth period promotes vegetative growth and creates conditions favouring high yield. P fertilizer promotes root growth, disease resistance, drought tolerance, and enhances nutrient and water absorption in the seedlings after they have depleted their endosperm reserves (Jian *et al*., 2014; Zafar *et al*., 2013). K fertilizer improves sugar metabolism, enhances osmotic cell concentration, maintains stomatal guard cell turgor, helps regulate stomatal opening, participates in photosynthesis, enhances drought resistance, and increases yield (Liang *et al*., 2011).

Rhizobium are known to form colonies on the root surface stimulating biological nitrogen fixation and providing nitrogen to the leguminous crops and hence considered as a significant process for improving yield and soil fertility (Aquilanti *et al*., 2004). Azotobacter spp. is sensitive to acidic pH, high salt concentration and temperature (Aquilanti *et al*., 2004). They pose advantageous impacts on the crop growth and yield through the biosynthesis of biologically active substances, instigation of rhizospheric microbes, production of phytopathogenic inhibitors, alteration of nutrient uptake and eventually magnifying the biological nitrogen fixation (Lenart, 2012).

**Materials and Methods**

A field experiment conducted at the Soil Science Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, during *summer* season May to July 2022 growing mung bean *Var*. RMG-975 applied 3 levels of NPK and Rhizobium + Azotobacter respectively 0 %, 50 % and 100 % including RDF for mung bean = 20:60:40 kg ha$^{-1}$ experiment is lead to observe the physical and chemical parameters. In physical parameters like that bulk density, particle density, pore space and water holding capacity through method by 100 ml graduated measuring cylinder and process by Muthuvel *et al*., 1992.

In chemical parameters through method by-

a) Soil pH – method given by (Jackson, M. L. 1958) through using digital pH meter.
b) Soil EC (dSm$^{-1}$) - method given by (Wilcox, 1950) through using digital EC meter.
c) Organic Carbon (%) - Wet oxidation method given by (Walkley and Black, 1947)
d) Available Nitrogen (kg ha$^{-1}$) - Kjeldhal Method (Subbiah and Asija, 1956)
e) Available Phosphorus (kg ha$^{-1}$) - Colorimetric method by using Jasper single beam U.V. Spectrophotometer at 660 nm wavelength given by (Olsen *et al.*, 1954)
f) Available Potassium (kg ha$^{-1}$) - Flame photometric method by using Metzer Flame Photometer given by (Toth and Prince, 1949)

## Result and Discussion

### Physical Properties of Soil

#### Bulk density (Mg $m^{-3}$)

The data presented in table and fig. 1 show the influence on bulk density (Mg $m^{-3}$) of soil after crop harvest due to application of inorganic and bio fertilizers. The response in bulk density of soil was found non-significant due to level of inorganic and bio fertilizers. The maximum bulk density of soil 1.38 and 1.45 Mg $m^{-3}$ at 0-15 and 15-30 cm was recorded in treatment $T_1$ (NPK @ 0 % + Rhizobium @ 0 % + Azotobacter @ 0 %) and minimum 1.26 and 1.30 Mg $m^{-3}$ at 0-15 and 15-30 cm was recorded in treatment $T_9$ (NPK @ 100 % + Rhizobium @ 100 % + Azotobacter @ 100 %) respectively. Similar result has been recorded by Abbas *et al*., 2011; Meena *et al.,* 2014; Chaudhari *et al.,* 2016 and Venkatarao *et al.,* 2017.

#### Particle density (Mg $m^{-3}$)

The data presented in table and fig. 1 shows the influence on particle density (Mg $m^{-3}$) of soil after crop harvest due to application of inorganic and bio fertilizers. The response in particle density of soil was found non-significant due to level of inorganic and bio fertilizers. The maximum particle density of soil 2.50 and 2.62 Mg $m^{-3}$ at 0-15 and 15-30 cm was recorded in treatment $T_1$ (NPK @ 0 % + Rhizobium @ 0 % + Azotobacter @ 0 %) and minimum 2.32 and 2.37 Mg $m^{-3}$ at 0-15 and 15-30 cm was recorded in treatment $T_9$ (NPK @ 100 % + Rhizobium @ 100 % + Azotobacter @ 100 %) respectively. Similar result has been recorded by Abbas *et al*., 2011; Meena *et al.,* 2014; Chaudhari *et al.,* 2016 and Venkatarao *et al.,* 2017.

#### Percent pore space

The data presented in table and fig. 1 depicted the influence in percent pore space of soil after crop harvest due to application of inorganic and bio fertilizers. The response in percent pore space of soil was found significant due to level of inorganic and bio fertilizers. The maximum percent pore space of soil 44.86 and 42.18 % at 0-15 and 15-30 cm was recorded in treatment $T_9$ (NPK @ 100 % + Rhizobium @ 100 % + Azotobacter @ 100 %) and minimum 38.28 and 35.62 % at 0-15 and 15-30 cm was recorded in treatment $T_1$ (NPK @ 0 % + Rhizobium @ 0 % + Azotobacter @ 0 %) respectively. Similar result has been recorded by Kumawat *et al*., 2009; Patel *et al*., 213 and Bhavya *et al*., 2018.

#### Water holding capacity (%)

The data presented in table and fig. 1 depicted the influence in water holding capacity (%) of soil after crop harvest due to application of inorganic and bio fertilizers. The response in water holding capacity (%) of soil was found significant due to level of inorganic and bio fertilizers. The maximum water holding capacity of soil 38.65 and 35.80 % at 0-15 and 15-30 cm was recorded in treatment $T_9$ (NPK @ 100 % + Rhizobium @ 100 % + Azotobacter @ 100 %) and minimum 32.63 and 29.26 % at 0-15 and 15-30 cm was recorded in treatment $T_1$ (NPK @ 0 % + Rhizobium @ 0 % + Azotobacter @ 0 %) respectively. Similar result has been recorded by Kumawat *et al*., 2009; Patel *et al*., 213 and Bhavya *et al*., 2018.

**Chemical Properties of Soil**

**Soil pH (1:2.5) w/v**

The data presented in table and fig. 2 depicted the influence in pH of soil after crop harvest due to application of inorganic and bio fertilizers. The response in pH of soil was found non-significant due to level of inorganic and bio fertilizers. The maximum pH of soil 7.56 and 7.62 at 0-15 and 15-30 cm was recorded in treatment $T_1$ (NPK @ 0 % + Rhizobium @ 0 % + Azotobacter @ 0 %) and minimum 6.80 and 6.92 at 0-15 and 15-30 cm was recorded in treatment $T_9$ (NPK @ 100 % + Rhizobium @ 100 % + Azotobacter @ 100 %) respectively. Similar result has been recorded by Ghanshyam *et at*., 2010 Rathour *et al*., 2015; Bhavya *et al*., 2018; and Rekha *et al*., 2018.

**Soil Electrical Conductivity (dSm$^{-1}$)**

The data presented in table and fig. 2 show the influence in electrical conductivity (dSm$^{-1}$) of soil after crop harvest due to application of inorganic and bio fertilizers. The response in electrical conductivity of soil was found non-significant due to level of inorganic and bio fertilizers. The maximum electrical conductivity of soil 0.51 and 0.55 dSm$^{-1}$ at 0-15 and 15-30 cm was recorded in treatment $T_9$ (NPK @ 100 % + Rhizobium @ 100 % + Azotobacter @ 100 %) and minimum 0.38 and 0.41 dSm$^{-1}$ at 0-15 and 15-30 cm was recorded in treatment $T_1$ (NPK @ 0 % + Rhizobium @ 0 % + Azotobacter @ 0 %) respectively. Similar result has been recorded by Ghanshyam *et at*., 2010, Rathour *et al*., 2015; Bhavya *et al*., 2018; and Rekha *et al*., 2018.

**Organic Carbon (%)**

The data presented in table and fig. 2 depicted the influence in organic carbon (%) of soil after crop harvest due to application of inorganic and bio fertilizers. The response in organic carbon (%) of soil was found significant due to level of inorganic and bio fertilizers. The maximum organic carbon of soil 0.54 and 0.51 % at 0-15 and 15-30 cm was recorded in treatment $T_9$ (NPK @ 100 % + Rhizobium @ 100 % + Azotobacter @ 100 %) and minimum 0.41 and 0.37

% at 0-15 and 15-30 cm was recorded in treatment $T_1$ (NPK @ 0 % + Rhizobium @ 0 % + Azotobacter @ 0 %) respectively. Similar result has been recorded by Rathour *et al*., 2015 and Rekha *et al*., 2018.

**Available Nitrogen (kg ha$^{-1}$)**

The data presented in table and fig. 3 depicted the influence in available nitrogen (kg ha$^{-1}$) of soil after crop harvest due to application of inorganic and bio fertilizers. The response in available nitrogen (kg ha$^{-1}$) of soil was found significant due to level of inorganic and bio fertilizers. The maximum available nitrogen of soil 260.45 and 264.18 at 0-15 and 15-30 cm was recorded in treatment $T_9$ (NPK @ 100 % + Rhizobium @ 100 % + Azotobacter @ 100 %) and minimum 242.15 and 245.32 kg ha$^{-1}$ at 0-15 and 15-30 cm was recorded in treatment $T_1$ (NPK @ 0 % + Rhizobium @ 0 % + Azotobacter @ 0 %) respectively. Similar result has been recorded by Shete *et al*., 2010; Jat *et al*., 2012; Chaudhari *et al*., 2016; Venkatarao *et al*., 2017.

**Available Phosphorus (kg ha$^{-1}$)**

The data presented in table and fig. 3 depicted the influence in available phosphorus (kg ha$^{-1}$) of soil after crop harvest due to application of inorganic and bio fertilizers. The response in available phosphorus (kg ha$^{-1}$) of soil was found significant due to levels of inorganic and bio fertilizers. The maximum available phosphorus of soil 29.14 and 25.82 kg ha$^{-1}$ at 0-15 and 15-30 cm was recorded in treatment $T_9$ (NPK @ 100 % + Rhizobium @ 100 % + Azotobacter @ 100 %) and minimum 16.42 and 14.26 kg ha$^{-1}$ at 0-15 and 15-30 cm was recorded in treatment $T_1$ (NPK @ 0 % + Rhizobium @ 0 % + Azotobacter @ 0 %) respectively. Similar result has been recorded by Shete *et al*., 2010; Jat *et al*., 2012; Chaudhari *et al*., 2016; Venkatarao *et al*., 2017.

**Available Potassium (kg ha$^{-1}$)**

The data presented in table and fig. 3 depicted the influence in available potassium (kg ha$^{-1}$) of soil after crop harvest due to application of inorganic and bio fertilizers. The response in available potassium (kg ha$^{-1}$) of soil was found significant due to levels of inorganic and bio fertilizers. The maximum available potassium of soil 211.29 and 207.62 kg ha$^{-1}$ at 0-15 and 15-30 cm was recorded in treatment $T_9$ (NPK @ 100 % + Rhizobium @ 100 % + Azotobacter @ 100 %) and minimum 182.32 and 178.25 kg ha$^{-1}$ at 0-15 and 15-30 cm was recorded in treatment $T_1$ (NPK @ 0 % + Rhizobium @ 0 % + Azotobacter @ 0 %) respectively. Similar result has been recorded by Shete *et al*., 2010; Jat *et al*., 2012; Chaudhari *et al*., 2016; Venkatarao *et al*., 2017.

**Table 1: Influence in bulk density (Mg m$^{-3}$), particle density (Mg m$^{-3}$), pore space (%) and water holding capacity (%) of soil after crop harvest due to application of inorganic and bio fertilizers.**

| Treatment | | Bulk density (Mg m$^{-3}$) | | Particle density (Mg m$^{-3}$) | | Pore space (%) | | Water holding capacity (%) | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0 – 15 cm | 15 – 30 cm | 0 – 15 cm | 15 – 30 cm | 0 – 15 cm | 15 – 30 cm | 0 – 15 cm | 15 – 30 cm |
| $T_1$ | NPK @ 0 % + Rhizobium @ 0 % + Azotobacter @ 0 % | 1.38 | 1.45 | 2.50 | 2.62 | 38.28 | 35.62 | 32.63 | 29.26 |
| $T_2$ | NPK @ 0 % + Rhizobium @ 50 % + Azotobacter @ 50 % | 1.36 | 1.44 | 2.46 | 2.58 | 39.35 | 35.92 | 33.02 | 29.85 |
| $T_3$ | NPK @ 0 % + Rhizobium @ 100 % + Azotobacter @ 100 % | 1.35 | 1.40 | 2.43 | 2.54 | 40.62 | 36.29 | 33.78 | 30.12 |
| $T_4$ | NPK @ 50 % + Rhizobium @ 0 % + Azotobacter @ 0 % | 1.37 | 1.42 | 2.42 | 2.52 | 40.92 | 37.06 | 34.15 | 30.72 |
| $T_5$ | NPK @ 50 % + Rhizobium @ 50 % + Azotobacter @ 50 % | 1.33 | 1.39 | 2.40 | 2.49 | 41.22 | 37.82 | 34.78 | 31.82 |
| $T_6$ | NPK @ 50 % + Rhizobium @ 100 % + Azotobacter @ 100 % | 1.30 | 1.36 | 2.37 | 2.45 | 42.71 | 39.20 | 35.60 | 32.48 |
| $T_7$ | NPK @ 100 % + Rhizobium @ 0 % + Azotobacter @ 0 % | 1.32 | 1.38 | 2.35 | 2.42 | 43.08 | 40.36 | 36.06 | 33.24 |
| $T_8$ | NPK @ 100 % + Rhizobium @ 50 % + Azotobacter @ 50 % | 1.30 | 1.35 | 2.33 | 2.38 | 44.12 | 41.32 | 36.82 | 34.26 |
| $T_9$ | NPK @ 100 % + Rhizobium @ 100 % + Azotobacter @ 100 % | 1.26 | 1.30 | 2.32 | 2.37 | 44.86 | 42.18 | 38.65 | 35.80 |
| | **F-Test** | NS | NS | NS | NS | S | S | S | S |
| | **S.Ed. (±)** | - | - | - | - | 0.65 | 0.48 | 0.42 | 0.35 |
| | **C.D. at 0.5%** | - | - | - | - | 1.32 | 0.98 | 0.87 | 0.73 |

**Table 2: Influence in pH (1:2.5) w/v, electrical conductivity ($dSm^{-1}$) and organic carbon (%) of soil after crop harvest due to application of inorganic and bio fertilizers.**

| Treatment | | Soil pH (1:2.5) w/v | | Electrical Conductivity ($dSm^{-1}$) | | Organic carbon (%) | |
|---|---|---|---|---|---|---|---|
| | | 0 – 15 cm | 15 – 30 cm | 0 – 15 cm | 15 – 30 cm | 0 – 15 cm | 15 – 30 cm |
| $T_1$ | NPK @ 0 % + Rhizobium @ 0 % + Azotobacter @ 0 % | 7.56 | 7.62 | 0.38 | 0.41 | 0.41 | 0.37 |
| $T_2$ | NPK @ 0 % + Rhizobium @ 50 % + Azotobacter @ 50 % | 7.42 | 7.58 | 0.40 | 0.43 | 0.42 | 0.38 |
| $T_3$ | NPK @ 0 % + Rhizobium @ 100 % + Azotobacter @ 100 % | 7.40 | 7.52 | 0.44 | 0.46 | 0.43 | 0.40 |
| $T_4$ | NPK @ 50 % + Rhizobium @ 0 % + Azotobacter @ 0 % | 7.34 | 7.46 | 0.39 | 0.42 | 0.42 | 0.39 |
| $T_5$ | NPK @ 50 % + Rhizobium @ 50 % + Azotobacter @ 50 % | 7.27 | 7.38 | 0.41 | 0.45 | 0.44 | 0.41 |
| $T_6$ | NPK @ 50 % + Rhizobium @ 100 % + Azotobacter @ 100 % | 7.18 | 7.26 | 0.42 | 0.49 | 0.47 | 0.44 |
| $T_7$ | NPK @ 100 % + Rhizobium @ 0 % + Azotobacter @ 0 % | 7.01 | 7.15 | 0.45 | 0.51 | 0.48 | 0.45 |
| $T_8$ | NPK @ 100 % + Rhizobium @ 50 % + Azotobacter @ 50 % | 6.88 | 6.97 | 0.49 | 0.53 | 0.51 | 0.47 |
| $T_9$ | NPK @ 100 % + Rhizobium @ 100 % + Azotobacter @ 100 % | 6.80 | 6.92 | 0.51 | 0.55 | 0.54 | 0.50 |
| | **F-Test** | NS | NS | NS | NS | S | S |
| | **S.Ed. (±)** | - | - | - | - | 0.08 | 0.05 |
| | **C.D. at 0.5%** | - | - | - | - | 0.20 | 0.12 |

**Table 3: Influence in available nitrogen (kg ha$^{-1}$), available phosphorus (kg ha$^{-1}$) and available potassium (kg ha$^{-1}$) of soil after crop harvest due to application of inorganic and bio fertilizers.**

| Treatment | | 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** |
| **$T_1$** | NPK @ 0 % + Rhizobium @ 0 % + Azotobacter @ 0 % | 242.15 | 245.32 | 16.42 | 14.26 | 182.32 | 178.25 |
| **$T_2$** | NPK @ 0 % + Rhizobium @ 50 % + Azotobacter @ 50 % | 244.68 | 246.54 | 17.36 | 14.68 | 183.54 | 179.42 |
| **$T_3$** | NPK @ 0 % + Rhizobium @ 100 % + Azotobacter @ 100 % | 245.42 | 248.35 | 19.27 | 15.65 | 186.05 | 181.46 |
| **$T_4$** | NPK @ 50 % + Rhizobium @ 0 % + Azotobacter @ 0 % | 246.72 | 249.28 | 20.52 | 17.02 | 188.38 | 184.02 |
| **$T_5$** | NPK @ 50 % + Rhizobium @ 50 % + Azotobacter @ 50 % | 248.46 | 251.60 | 22.48 | 17.80 | 192.65 | 187.80 |
| **$T_6$** | NPK @ 50 % + Rhizobium @ 100 % + Azotobacter @ 100 % | 252.08 | 254.32 | 23.96 | 19.18 | 197.82 | 191.56 |
| **$T_7$** | NPK @ 100 % + Rhizobium @ 0 % + Azotobacter @ 0 % | 253.36 | 255.45 | 24.05 | 20.32 | 201.25 | 196.25 |
| **$T_8$** | NPK @ 100 % + Rhizobium @ 50 % + Azotobacter @ 50 % | 256.17 | 259.62 | 26.82 | 22.65 | 206.38 | 202.74 |
| **$T_9$** | NPK @ 100 % + Rhizobium @ 100 % + Azotobacter @ 100 % | 260.45 | 264.18 | 29.14 | 25.82 | 211.29 | 207.62 |
| | **F-Test** | S | S | S | S | S | S |
| | **S.Ed. (±)** | 2.30 | 1.95 | 0.75 | 0.60 | 1.40 | 1.15 |
| | **C.D. at 0.5%** | 4.63 | 3.98 | 1.52 | 1.24 | 2.82 | 2.34 |

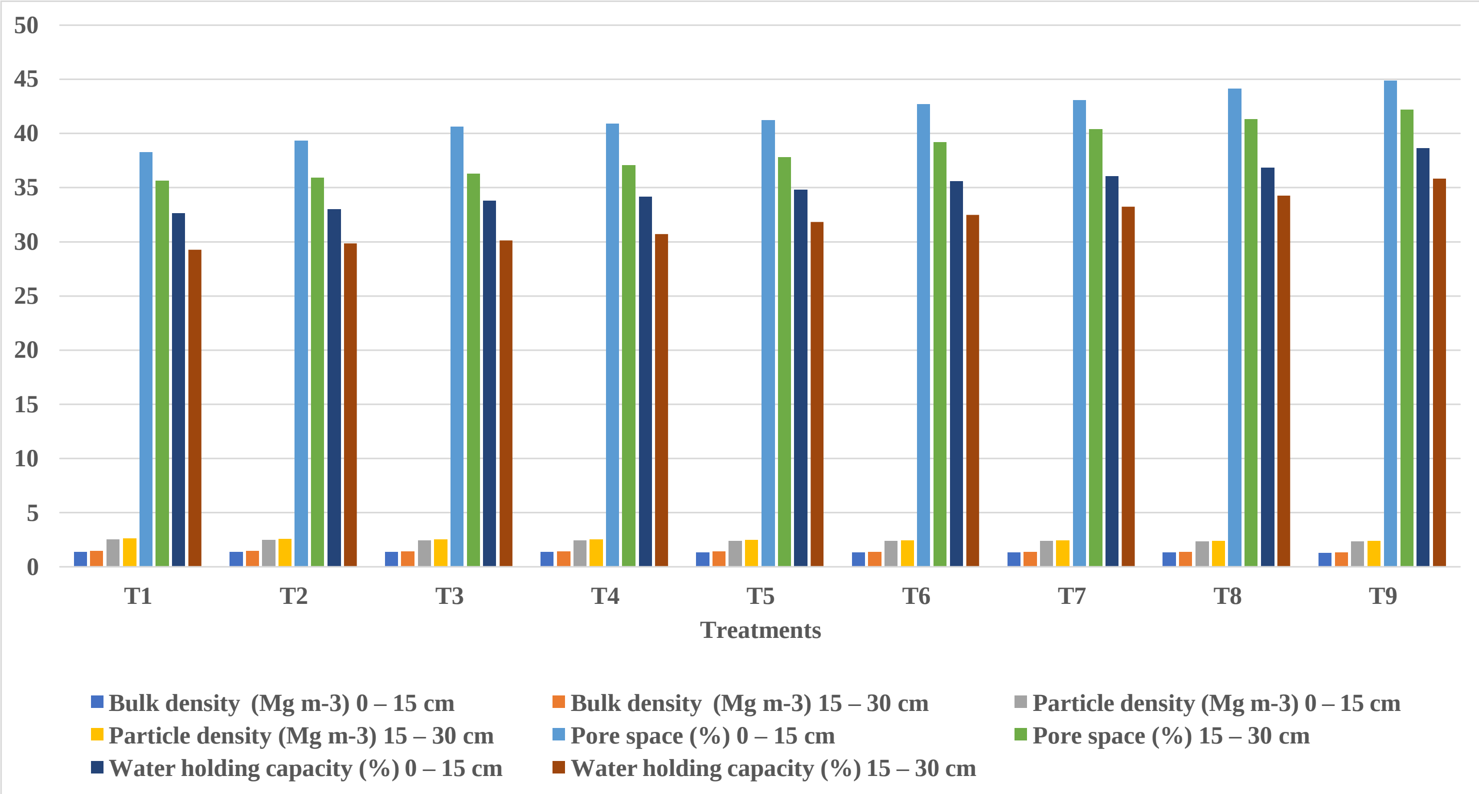


**Fig. 1: Influence in bulk density (Mg $m^{-3}$), particle density (Mg $m^{-3}$), pore space (%) and water holding capacity (%) of soil after crop harvest due to application of inorganic and bio fertilizers.**

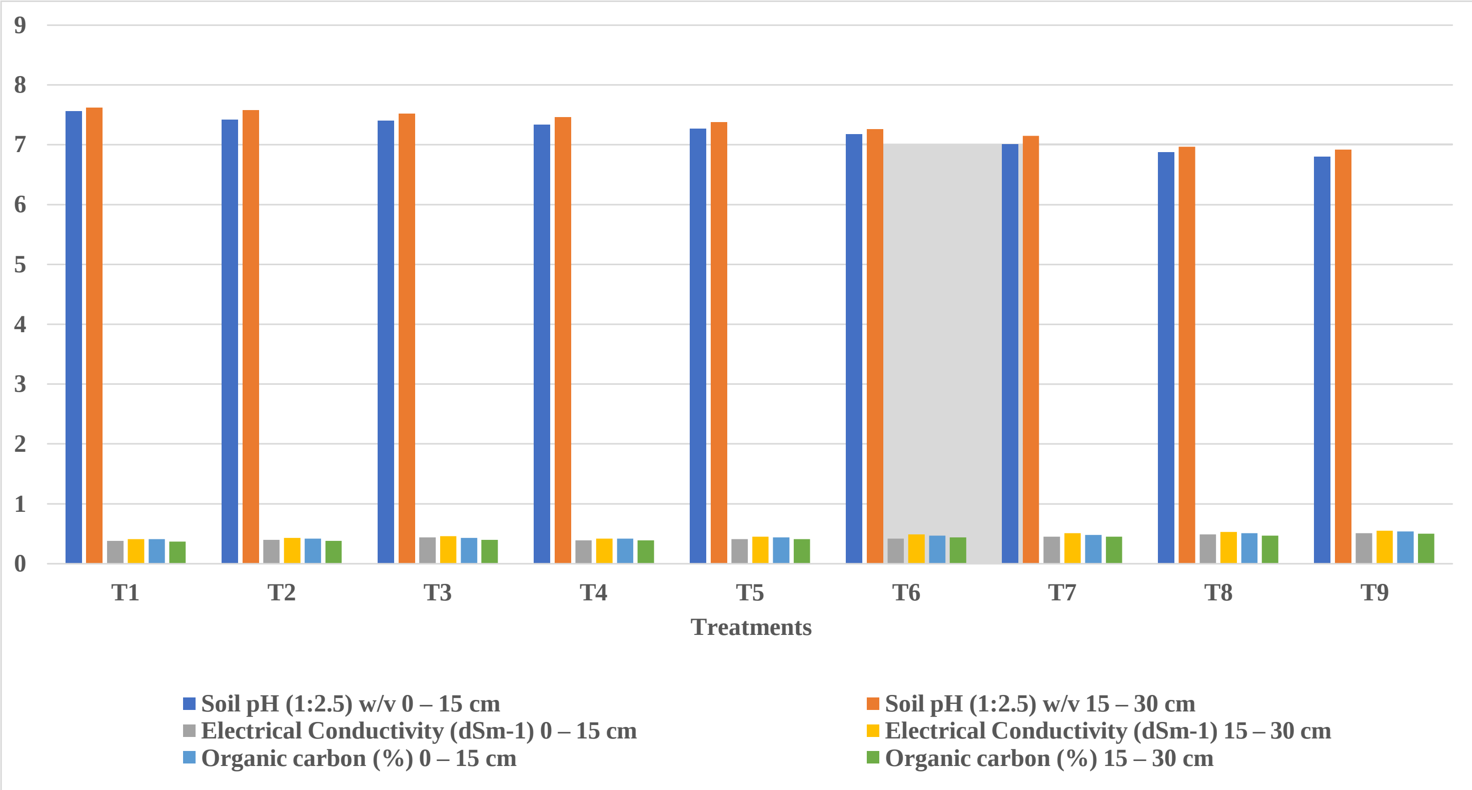


**Fig. 2: Influence in pH (1:2.5) w/v, electrical conductivity ($dSm^{-1}$) and organic carbon (%) of soil after crop harvest due to application of inorganic and bio fertilizers.**

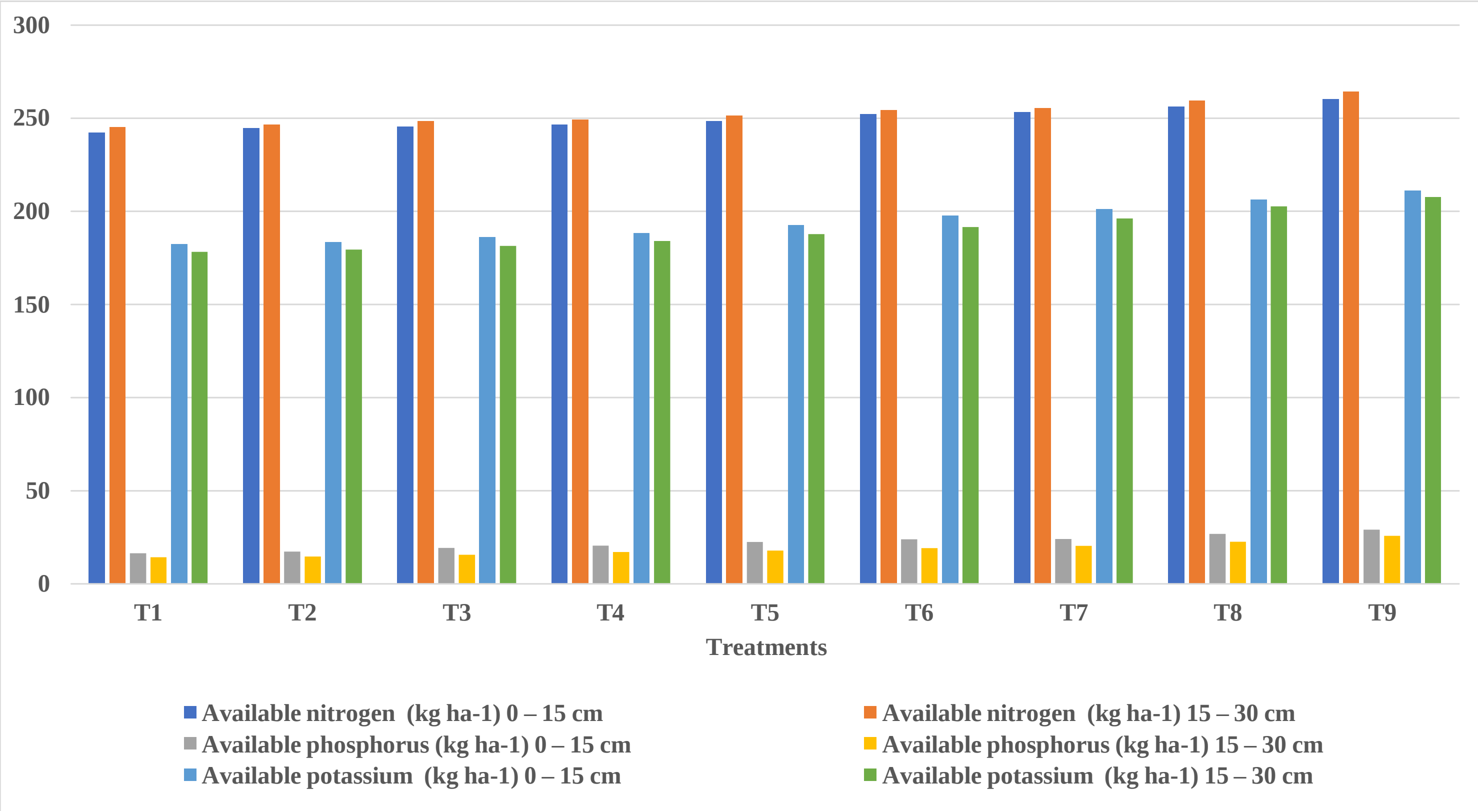


**Fig. 3: Influence in available nitrogen (kg ha$^{-1}$), available phosphorus (kg ha$^{-1}$) and available potassium (kg ha$^{-1}$) of soil after crop harvest due to application of inorganic and bio fertilizers.**

## Conclusion

The results of the experiment were concluded as the effect of inorganic and bio fertilizes on Nitrogen, Phosphorus and Potassium (kg $ha^{-1}$), % pore space and water holding capacity (%) of soil after crop harvest was found significant except on bulk density (Mg $m^{-3}$), particle density (Mg $m^{-3}$), pH, EC ($dSm^{-1}$) and organic carbon (%) of soil after harvest. The treatment $T_9$ (NPK @ 100 % + Rhizobium @ 100 % + Azotobacter @ 100 %) was recorded as best treatment for major soil parameters. The treatment $T_9$ (NPK @ 100 % + Rhizobium @ 100 % + Azotobacter @ 100 %) also shows the significantly.

## Reference

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**Abbas, G., Abbas, Z., Aslam, M., Malik, A. U., Ishaque, M. and Hussain, F. (2011)** Effects of organic and inorganic fertilizers on mungbean (*Vigna radiata* (L.)) yield under arid climate. *Int. Res. J. of Plant Sci.,* **2**(4): 94-98.

**Anjum, M. S., Ahmed, Z. I. and Rauf, C. A. (2006)** Effect of rhizobium inoculation and nitrogen fertiliser on yield and yield components of mungbean. *International Journal of Agriculture Biology*. 8: 238-240.

**Aquilanti, L., Favilli, F. and Clementi, F. (2004)** Comparison of different strategies for isolation and preliminary identification of Azotobacter from soil samples. *Soil Biol.* 36(9): 1475–1483.

**Bhavya, G., Shaker, K. C., Jayasree, G. and Reddy, M. M. (2018)** Effect of Integrate Use of Phosphorus, PSB and Vermicompost on Acid and Alkaline Phosphatase Activity and Yield of Green gram (*Vigna radiata* L.). *Int. J Curr. Microbiol. App. Sci*., 7(1): 1465-1468.

**Bouyoucos, G.L, (1927)** The hydrometer as a new method for the mechanical analysis of soils. *Soil Sci*. 23: 343-353.

**Chaudhari, S., Thanki, J. D., Chaudhari, V. and Verma, C. (2016)** Yield attributes, yield and quality of black green gram (*Vigna radiata* L.) as influenced by organic manures, biofertilizer and phosphorus fertilization. *The Bio Scan*., 11(1): 431-433.

**Fisher, R. A. and Yates (1960)** *Statistical method for research worker Oliver and Boyd Ltd*. Edin. burgh and London.10.

**Ghanshyam, Kumar, R. and Jat, R. K. (2010)** Productivity and soil fertility as affected by organic manures and inorganic fertilizers in green gram (*Vigna radiata* L.) - wheat (Triticum aestivum L.) system. *Indian Journal of Agronomy*. 55(1): 16-21.

**Jackson, M. L. (1958)** Soil chemical analysis Prentice Hall of India Ltd. New Delhi. 219-221.

**Jat, A., Arvadia, M. K., Tandel, B. and Patel, T. U. (2012)** Mehta RS. Response of saline water irrigated green gram to land configuration, fertilizers and farm yard manure in Tapi command area of South Gujarat. *Indian Journal of Agronomy*. 57(3): 270-274.

**Jian, J., Lauricella, D., Armstrong, R., Sale, P. and Tang, C. (2014)** Phosphorus application and elevated co2 enhance drought tolerance in field pea grown in a phosphorus-deficient vertisol. *Ann Bot.* 116(6): 975.

**Kachroo, P. (1970)** Pulse Crops of India. ICAR, New Delhi. 148.

**Kumawat, N., Kumar, R. and Sharma, O. P. (2009)** Nutrient uptake and yield of mungbean (*Vigna radiata* (L.) Wilczek) as influenced by organic manures, PSB and phosphorus fertilization. *Environment and Ecology*. 27(4B): 2002-2005.

**Lenart, A. (2012)** Occurrence, characteristics, and genetic diversity of Azotobacter chroococcum in various soils of Southern Poland. *Pol. J. Environ. Stud*. 21(2): 415–424.

**Liang, J., Yin, Z. C., Wang, Y. J., Xiao, H. Y., Zhang, W. Q. and Yin, F. X. (2011)** Effects of Different Density and Fertilizer Application Methods on the yield of mung bean. *J. Horticulture and seed*. 6: 81–83.

**Meena, J. S., Verma, H. P. and Pancholi, P. (2014)** Effect of fertility levels and biofertilizers on yield, quality and economic of cowpea. *Agriculture for Sustainable Development*. 2(2): 162-164.

**Miachieo, P., Ardakani, M.R., Farzad, P. and Saied, V. (2019)** Effects of vermicompost, mycorrhizal symbiosis and biophosphate soulbilizing bacteria on seed yield and quality of chickpea as autumn plantation in rainfed conditions. *Bulletin of Environment, Pharmacology and Life Sciences* **3**(2): 53-58.

**Munsell, A. H. (1971)** Munsell's description of his colour system, from a lecture to the American Psychological Association. *American Journal of Psychology* 23(2): 236-244.

**Muthuvel, P., Udayasoorian, C., Natesan, R. and Ramaswamy, P. P. (1992)** Introduction to Soil Analysis, *Tamil Nadu Agricultural University Coimbatore*-641002.

**Olsen, S. R., Cole, C. V., Watanabe, F. S. and Dean, L. A. (1954)** Estimation of available phosphorus in soils by extraction with sodium bicarbonate ($NaHCO_3$), *U.S.D.A. Circular*. 939: 1-19.

**Patel, H. R., Patel, H. F., Maheriya, V. D. and Dodia, I. N. (2013)** Response of kharif green gram (*Vigna radiata* L. Wilczek) to sulphur and phosphorus fertilization with and without bio fertilizer application. *The Bio scans*. 8(1): 149-152.

**Rathour, D. K., Gupta, A. K., Choudhary, R. R. and Sadhu, A. C. (2015)** Effect of integrated phosphorus management on growth, yield attributes and yield of summer green gram (*Vigna radiata* L.). *The Bio Scan*. 10(1): 05-07.

**Rautaray, M. H., Solaiman, M. N., Rahman, M. J., Hossain, M. M. and Islam, M. N. (2003)** Effect of bio-fertilizer and nitrogen fertilizer on growth and yield in mung bean (*Vigna radita* l. *Wilczek). J. Subtropical Agric. Res. Devp.*,**03** (1):22-28.

**Rekha, K., Pavaya, R. P., Malav, J. K., Chaudhary, N., Patel, I. M. and Patel, J. K. (2018)** Effect of FYM, phosphorus and PSB on yield, nutrient content and uptake by green gram [*Vigna radiata* (L.)] on loamy sand. *Indian Journal of Chemical Studies*. 6(2): 1026-1029.

**Sanchez, P. A. (1976)** Properties and management of soils in tropic. John Willey and sons, New York, USA.

**Shete, P. G., Thanki, J. D., Baviskar, V. S. and Adhav, S. L. (2010)** Effect of land configuration, fertilizers and FYM levels on quality and nutrient status of rabi green gram. *Green farming*. 1(4): 409-410.

**Srikant, K., Siddaramappa, R. and Parama, V. R. R. (2010)** Direct and residual effect of enriched composts, FYM, vermicompost and fertilizers on properties of an Alfisols. *Journal of Indian Society of Soil Science*. 48(3): 496-499.

**Subbiah, B. V. and Asiija, E. C. (1956)** A rapid procedure for estimation of available nitrogen in soil. *Current Science* 25(8): 259-260.

**Toth, S. J. and Prince, A. L. (1949)** Estimation of cation exchange capacity and exchangeable Ca, K and Na content of soil by flame photometer technique. *Soil Sci.*, 67: 439-445.

**Venkatarao, C. V., Naga, S. R., Yadav, B. L., Koli, D. K. and Rao, I. J. (2017)** Effect of Phosphorus and Biofertilizers on Growth and Yield of Mungbean [*Vigna radiata* (L.) Wilczek]. *Int. J. Curr. Microbiol. App. Sci*., 6(7): 3992-3997.

**Walkley, A. and Black, I. A., (1947)** Estimation of soil organic carbon by the chromic acid titration method. *Soil Science*. 47: 29-38.

**Wilcox, L.V. (1950)** Electrical conductivity. Am. Water Works Assoc. *J*. 42: 775-776.

**Zafar, Z. U. and Athar, H. U. R. (2013)** Influence of different phosphorus regimes on disease resistance in two cotton (*Gossypium hirsutum* L.) cultivars differing in resistance to cotton leaf curl virus (clcuv). *Pakistan Journal Botany*. 45(2): 617–627.