Response of Neem Cake Rhizobium and Inorganic Fertilizer on Soil Health Growth and Yield of Green gram (Vigna radiata L.) var. Samrat

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INTRODUCTION

In India, production of pulses is around 13.5-15 million tonnes during the last decade, while annual domestic demand is 18-19 million tons. The yield of pulses has remained virtually stagnant for the last 40 year (539 kg/ha in 1961 to 544 kg/ha in 2001 to 651 kg/ha in 2013-14).

India is short of supply by 2 to 3 million tonnes annually. (Agropedia, 2014-15). Green gram [Vigna radiata L.] (2n= 2x= 22) is third important pulse after chickpea and Pigeon pea. It is a self-pollinated crop and is an important grain legume of the tropical area. Greengram is also called mung, moong, mungo, greengram, goldengram, chicksaw pea and Oregon pea. It belongs to the Family Fabaceae and sub Family Papilionaceae. The center of origin is India (Karpechenko, 1925). Majority of Indian population is vegetarian,
pulses are cheap and best source of protein for Indian diet. It contains 20-25 percent protein, which is more than two times of cereals. India is importing about 3 million tonnes and the future demand of pulses by 2017 will be 28.0 million tonnes (Anonymous, (2011).

In India, it is cultivated in Maharashtra, Andhra Pradesh, Rajasthan, Orissa, Karnataka and Uttar Pradesh. Green gram contributes 18.07 % of total pulses area and 11.48 % of total pulses production in India.

Area, production and productivity of greengram in India are 34.4 lakh ha, 14 lakh tonnes and 406.98 kg/ha respectively (lipr.res.in, 2014-15).

Green gram is an excellent source of protein. It is rich in lysine and deficient in methionine and legume, which is free from anti-nutritional factor. The range for protein content is fairly wide (20- 24% per 100g of dry grain).

Temperature of 28°C to 33°C is optimum for seed germination and plant growth. Green gram plants are erect with few branches carrying pods borne is cluster and near the top of the pant. Pods contain 8- 15 green seeds (Prasad, 2009).

The green gram (Vigna radiata L. Wilczek) is one of the important pulse crop because of its adaptation to short growth duration, low water requirement, soil fertility and is favoured for consumption due to its easy digestibility and low production of flatulence (Shil and Bandopadhyya, 2007).

**Nitrogen**

Green gram is capable of fixing atmospheric nitrogen, it responds to small quantity of nitrogenous fertilizers applied as starter dose. Application of higher dose of nitrogen may reduce nodule number and nodule growth and thus adversely affect the nitrogen fixation capacity.

**Phosphorus**

Phosphorus plays a vital role in photosynthesis, respiration, energy storage, cell elongation and improves the quality of crops. Deficient plants may have thin, erect and spindly stems and leaves turn into bluish-green colour. Phosphorus is an essential constituent of majority of enzymes, which are of great importance in the transformation of energy, in carbohydrate metabolism, in fat metabolism and also in respiration of plants. It enhances the activity of Rhizobium and increased the formation of root nodules. Thus, it helps in fixing more of atmosphere nitrogen in root nodules (Rajveer et al., 2016).

**Neem cake**

Neem cake is a potential source of organic manure. Neem has demonstrated considerable potential as a fertilizer. Our Neem cake also reduce alkalinity in soil, as it produce organic acid on decomposition, being totally natural, the Neem cake we offer hence ensure fertility of the soil, it also improve the organic matter contain of the soil, helping improvement in soil texture, water holding capacity, soil aeration for batter root development.

The addition of Neem cake also positively affected the available soil organic carbon, N P K and Mn content of soil resulting better growth and grain yield of mung bean (Vigna radiata L.) besides suppressing soil borne pathogens (Murugan, 2011). The composition of Neem cake is 5.2 % N, 1.0 % P, 1.4 % K. Neem cake act as a nitrogen inhibitor means reduce the nitrification. It supplies the available nitrogen for a long time in the soil (Katyayan, 2012).
Rhizobium

The use of biofertilizers are more eco-friendly in nature. They can play a significant role in fixing atmospheric nitrogen; biofertilizers enrich soil fertility and improves soil fertility. Of these biofertilizers, Rhizobium inoculants specific for different leguminous crop is the most important in India. The largest contribution of biological nitrogen fixation to agriculture is derived from the symbiosis between legumes and Rhizobium species (Meena et al., 2016).

Materials and Methods

A field experiment was conducted on research farm of department of Soil Science and Agricultural Chemistry SHUATS Allahabad, (U.P.) India. The soil of experimental area falls in order Inception and the experimental field is Alluvial in nature. The design applied for statistical analysis was carried out with 3x2x2 factorial randomized block design having three factors with three levels of N P K @ 0, 50, and 100% ha\(^{-1}\), two levels of Neem cake @ 0 and 100%ha\(^{-1}\) and two level of Rhizobium @ 0 and 100% ha\(^{-1}\) respectively (Table 1).

Experimental site

The experiment was conducted at research Farm of Soil Science at Sam Higginbottom University of Agriculture Technology and Sciences, Allahabad, the area is situated on the south of Allahabad on the right side of the river Yamuna on the South of Rewa Road at a distance of about 6 Km from Allahabad city. It is situated at 25°24 23’N latitude, 81°50 38’ E longitude and at the altitude of 98 meter above the sea level (Table 2).

Climate condition in the experimental area

The area of Allahabad 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 ranged between 20 to 94 percent. The average rainfall in this area is around 1100 mm annually.

The source of nitrogen, phosphorus, neem cake and biofertilizers are as urea, SSP, neem cake, Rhizobium culture respectively. The Neem cake applied to some day of before sowing because well decomposed and not direct contact to seed. Basal dose of fertilizer was applied in respective plots according to treatment allocation unifurrows opened by about 5cm. depth before sowing seeds in soil at the same time sowing seeds was sown on well prepared beds in shallow furrows, at the depth of 5cm, row to row distance was maintained at 30 cm and plant to plant distance was 10 cm, during the course of experiment, observations were recorded as mean values of the data.

Results and Discussion

Table 3 shows the interaction effects of N P K, Neem cake and Rhizobium are generally influenced physical and chemical properties of post-harvest soil.

Physical properties

The interaction effects of N P K, Neem cake and Rhizobium on bulk density (Mg m\(^{-3}\)), particle density (Mg m\(^{-3}\)), % Pore space and Water holding capacity was significant. The maximum bulk density, particle density of after crop harvest soil was recorded as 1.40 Mg m\(^{-3}\), 2.51Mg m\(^{-3}\) respectively in T\(_0\) (I\(_0\)+N\(_0\)+R\(_0\)) @ 0%N P K ha\(^{-1}\) + @ 0% Neem cake @ ha\(^{-1}\) + @0% Rhizobium ha\(^{-1}\) and minimum bulk density 1.11 Mg m\(^{-3}\), particle density 2.33 Mg m\(^{-1}\) respectively in @ T\(_{11}\)-(I\(_2\)+N\(_1\)+R\(_1\)) @100%N P K ha\(^{-1}\) + @ 100% Neem cake + 100% @ Rhizobium. The
highest Pore space and Water holding capacity of soil was recorded 56.62 in @ T11- (I2+N1+R1) @100% N P K ha⁻¹ + @ Neem cake 0.5 t ha⁻¹ + Rhizobium @ 20 g/ Kg seed.

Chemical properties of post soil

During the course of study, it was observed that the highest pH was recorded in 7.41T0 (I₀+N₀+R₀) @ 0% N P K ha⁻¹ + @ 0% Neem cake ha⁻¹ + @ Rhizobium ha⁻¹ and the lowest of 6.97 was recorded with the application of treatment T₁₁ (I₂+N₁+R₁) @100% N P K ha⁻¹ + @ 100% Neem cake ha⁻¹ + @ 100% Rhizobium. If we compare the pH of pre sowing soil sample which was 7.44 with that of after crop harvest soil, there was decrease in pH after crop harvest. Increasing dose of N P K and Neem cake lightly decrease pH of the post-harvest soil. The decrease in pH might be due to higher growth of crops as respiration is more. Respiration evolves carbon dioxide and reacts with water to form carbonic acid in soil.

Organic carbon (%), available nitrogen, phosphorus and potassium (kg ha⁻¹) were increased in soil after crop harvests. The chemical properties were significantly affected by different treatment combination of N P K, Neem cake and Rhizobium.

Table.1 Treatment combination of green gram

| Treatment | Description | Symbol |
|-----------|-------------|--------|
| T₀        | @ N₀P₀K₀ Kg ha⁻¹ + Neem cake @ 0 t ha⁻¹ + Rhizobium @ 0 g/ Kg seed | I₀N₀R₀ |
| T₁        | @ N₀P₀K₀ Kg ha⁻¹ + Neem cake @ 0 t ha⁻¹ + Rhizobium @ 20 g/ Kg seed | I₀N₀R₁ |
| T₂        | @ N₀P₀K₀ Kg ha⁻¹ + Neem cake @ 0.5 t ha⁻¹ + Rhizobium @ 0 g/ Kg seed | I₀N₁R₀ |
| T₃        | @ N₀P₀K₀ Kg ha⁻¹ + Neem cake @ 0.5 t ha⁻¹ + Rhizobium @ 20 g/ Kg seed | I₀N₁R₁ |
| T₄        | @ N₁₀P₂₀K₀ Kg ha⁻¹ + Neem cake @ 0 t ha⁻¹ + Rhizobium @ 0 g/ Kg seed | I₁N₀R₀ |
| T₅        | @ N₁₀P₂₀K₀ Kg ha⁻¹ + Neem cake @ 0 t ha⁻¹ + Rhizobium @ 20 g/ Kg seed | I₁N₀R₁ |
| T₆        | @ N₁₀P₂₀K₀ Kg ha⁻¹ + Neem cake @ 0.5 t ha⁻¹ + Rhizobium @ 0 g/ Kg seed | I₁N₁R₀ |
| T₇        | @ N₁₀P₂₀K₀ Kg ha⁻¹ + Neem cake @ 0.5 t ha⁻¹ + Rhizobium @ 20 g/ Kg seed | I₁N₁R₁ |
| T₈        | @ N₂₀P₃₀K₀ Kg ha⁻¹ + Neem cake @ 0 t ha⁻¹ + Rhizobium @ 0 g/ Kg seed | I₂N₀R₀ |
| T₉        | @ N₂₀P₃₀K₀ Kg ha⁻¹ + Neem cake @ 0 t ha⁻¹ + Rhizobium @ 20 g/ Kg seed | I₂N₀R₁ |
| T₁₀       | @ N₂₀P₃₀K₀ Kg ha⁻¹ + Neem cake @ 0.5 t ha⁻¹ + Rhizobium @ 0 g/ Kg seed | I₂N₁R₀ |
| T₁₁       | @ N₂₀P₃₀K₀ Kg ha⁻¹ + Neem cake @ 0.5 t ha⁻¹ + Rhizobium @ 20 g/ Kg seed | I₂N₁R₁ |

Table.2 Mechanical analysis of pre experimental soil

| Particulars             | Method employed |            |
|-------------------------|-----------------|------------|
| Sand (%)                | (Bouyoucos,1927)| 61.21      |
| Silt (%)                |                 | 25.36      |
| Clay (%)                |                 | 13.43      |
| Textural class          |                 | Sandy loam |
| Soil Colour             | (Mussel,1908)   | Pale brown |
| Dry Soil                |                 | Olive brown|
| Wet Soil                |                 |            |
| Bulk density (Mg m⁻³)   | (Muthuaval,1992)| 1.32       |
| Particle density (Mg m⁻³)| (Muthuaval, 1992)| 2.48       |
| Pore Space (%)          | (Black, 1965)   | 46.42      |
Table 3 Chemical analysis of pre experimental soil

| Parameters                        | Method employed | Value |
|-----------------------------------|-----------------|-------|
| Soil pH (1:2)                     | (Jackson, 1958) | 7.33  |
| Soil EC (dS m⁻¹)                  | (Wilcox, 1950)  | 0.30  |
| Organic Carbon (%)                | (Walleye and Black, 1947) | 0.55  |
| Available Nitrogen (Kg ha⁻¹)      | (Sabbath and Asija, 1956) | 287.08 |
| Available Phosphorus (Kg ha⁻¹)    | (Olsen et al., 1950) | 23.11 |
| Available Potassium (Kg ha⁻¹)     | (Toth and Prince, 1949) | 163.60 |

Table 4 Effect of different levels of N P K Neem cake and Rhizobium on post-harvest soil properties of Green gram

| Treatment combination | Bd (Mg m⁻³) | Pd (Mg m⁻³) | WHC (%) | pH (1:2w/v) | Ec (dSm⁻¹) | O.C (%) | N (kg ha⁻¹) | P₂O₅ (kg ha⁻¹) | K₂O (kg ha⁻¹) |
|-----------------------|-------------|-------------|---------|-------------|------------|---------|-------------|----------------|---------------|
| (I₀+N₀+R₀)            | 1.40        | 2.51        | 48.13   | 7.41        | 0.33       | 0.54    | 287.13      | 23.35          | 168.85        |
| (I₀+N₀+R₁)            | 1.33        | 2.47        | 50.89   | 7.29        | 0.32       | 0.56    | 290.21      | 24.53          | 169.65        |
| (I₀+N₁+R₀)            | 1.31        | 2.46        | 51.33   | 7.21        | 0.31       | 0.59    | 289.26      | 25.17          | 174.47        |
| (I₀+N₁+R₁)            | 1.23        | 2.41        | 53.47   | 7.13        | 0.29       | 0.63    | 298.50      | 25.49          | 175.55        |
| (I₁+N₀+R₀)            | 1.35        | 2.47        | 51.22   | 7.27        | 0.32       | 0.58    | 295.51      | 26.19          | 170.24        |
| (I₁+N₀+R₁)            | 1.29        | 2.45        | 52.85   | 7.23        | 0.31       | 0.60    | 303.61      | 27.20          | 173.51        |
| (I₁+N₁+R₀)            | 1.25        | 2.43        | 54.38   | 7.17        | 0.30       | 0.63    | 302.71      | 27.36          | 176.45        |
| (I₁+N₁+R₁)            | 1.17        | 2.38        | 56.28   | 7.03        | 0.29       | 0.70    | 307.07      | 28.25          | 176.42        |
| (I₂+N₀+R₀)            | 1.38        | 2.50        | 53.25   | 7.22        | 0.31       | 0.61    | 312.24      | 30.51          | 173.74        |
| (I₂+N₀+R₁)            | 1.19        | 2.40        | 56.11   | 7.08        | 0.30       | 0.68    | 313.87      | 31.54          | 175.51        |
| (I₂+N₁+R₀)            | 1.15        | 2.36        | 56.45   | 7.02        | 0.29       | 0.71    | 314.07      | 32.48          | 179.05        |
| (I₂+N₁+R₁)            | 1.11        | 2.33        | 56.62   | 6.97        | 0.28       | 0.74    | 314.84      | 33.45          | 181.05        |

F-test | S | S | S | NS | NS | S | S | S | NS |
S. Me (±) | 0.008 | 0.010 | 0.04 | 0.11 | 0.032 | 0.012 | 0.81 | 0.05 | 224.37 |
C. D. at 5% | 0.017 | 0.019 | 0.07 | 0.22 | 0.065 | 0.024 | 1.65 | 0.09 | 455.93 |

Fig. 1 Effect of different levels of N P K Neem cake and Rhizobium on Bd (Mg m⁻³) and Pd (Mg m⁻³) post-harvest soil properties of Green gram
The effect of N P K fertilizer on organic carbon (%), available nitrogen, phosphorus, potassium (kg ha\(^{-1}\)), electric conductivity (dS m\(^{-1}\)) is significant. The maximum chemical properties of after crop harvest soil was recorded electric conductivity (dS m\(^{-1}\)), organic carbon (%), available nitrogen, phosphorus, potassium (kg ha\(^{-1}\)) 0.330, 0.74, 314.84, 33.45, 181. respectively available Potassium (kg ha\(^{-1}\)), Electric conductivity (ds m\(^{-1}\)) and pH was found non-significant and Organic carbon (%), Nitrogen (kg ha\(^{-1}\)), Potassium (kg ha\(^{-1}\)) and Phosphorus (kg ha\(^{-1}\)) found to be significant.

It was concluded from trial that the various level of N P K + Neem cake and Rhizobium used from in the experiment, the treatment combination T\(_{11}(I_2+N_2+R_i) \@ 100\% \ N \ P \ K\ ha^{-1} + @ 100\% \ Neem \ cake \ 0.5 \ t \ ha^{-1} + @ 100\% \ Rhizobium \ 20 \ g/ Kg \ seed \ was \ found \ to \ be \ the \ best \ treatment \ gave \ highest \ benefit \ of \ ₹58651 with highest cost benefit ratio 1:2.73 for Green gram it could be recommended for profitable production of Green gram (\textit{Vigna radiata} L.) var. Samrat, it improve soil physical and chemical properties. Integrated nutrient management is better for soil health and Green gram production (Table 4; Figs 1 and 3).

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