

## Original Research Article

### EFFECT OF DIFFERENT ORGANIC SOURCES OF NUTRIENTS ON QUALITY OF SUMMER GREEN GRAM AND SOIL PROPERTIES

Comment [S1]: Effect of organic manure and bio-fertilizer on quality and productivity of summer green gram (*Vignaradiata* L) and soil Health

#### ABSTRACT

A field experiment entitled “An assessment of different organic sources of nutrients for organic summer green gram cultivation” was conducted during summer season of the year 2020-21 on organic certified plot A-7 at Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat. Different sources of organic manures were tested using randomized block design with four replications. The treatment T<sub>7</sub> recorded significantly higher available nitrogen content in soil and also same behaviour observed in available phosphorus content in soil. The treatment T<sub>9</sub> recorded significantly higher available phosphorus content in soil. Significantly higher value of EC of soil (0.18) was found in treatment T<sub>1</sub>, which was significantly higher EC of soil (0.11) which was recorded with treatment T<sub>9</sub>. Higher organic carbon (0.65%) of soil after harvest of green gram was observed in treatment T<sub>8</sub>. ~~Higher values can be discussed by chemical reactions inside the soil, which are influenced by combined applications of organic manures.~~ Significantly higher nitrogen content in seed of green gram was obtained with application of treatments T<sub>10</sub>. ~~Organic sources also influenced microbial activities in soil.~~ Treatment T<sub>2</sub> recorded significantly higher *Rhizobium* population in soil at harvest of green gram. Subsequent, treatment T<sub>6</sub> recorded significantly higher phosphorus solubilising bacteria (PSB) population in soil as compared to control. The maximum net realization of ` 63287/ha was obtained with application of treatment T<sub>10</sub> (50% N through NC + *Rhizobium* seed treatment) followed by treatment T<sub>7</sub> (50% N through FYM + *Rhizobium* seed treatment) with net realization of ` 54063/ha. With respect to benefit cost ratio, the highest 3.62 BCR was achieved with Treatment T<sub>7</sub>, which closely followed by treatment T<sub>2</sub> (*Rhizobium* seed treatment + 1.0 L/ha soil application) having BCR of 3.52.

Comment [S2]: Write treatment details

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Comment [S7]: Net return (INR/ha)

Comment [S8]: INR/ha

**KEY WORDS:** Green gram; Organic; FYM; *Rhizobium*; Neem cake; Soil properties; B:C

#### 1. INTRODUCTION

Green gram (*Vignaradiata* L.) belongs to the family Leguminosae and sub-family Papilionaceae and the earlier name of Green gram was *Phaseolus aureus* that has now been changed to *Vigna radiata*. It falls in the group of Asiatic Species of genus *Phaseolus*. Green

Comment [S9]: reference

gram in India is also known as Mungbean, Sonamung in Bengali, Mung in Hindi, Magum in Assam, Mung in Oriya, Pachalopayru in Tamil, Panchapesalu in Telugu, Cerupayarn in Malayalam, Mung in Marathi, Mag in Gujarati. Green gram is grown throughout the southern Asia including India, Australia, Pakistan, Turkey, Bangladesh, Sri Lanka, Thailand, Cambodia, Vietnam, Indonesia, Malaysia and China, etc. It is also grown in the parts of Africa and USA. The Green gram was domesticated in India, where its wild progenitor (*Vignaradiata* subspecies *sublobata*) occurs wild (Swamy, 2023).

Comment [S10]: reference

India is the World largest producer as well as consumer of Green gram. It produces about 1.5 to 2 million tons of Green gram annually from about 3 to 4 million ha of area. Green gram output accounts for about 10 per cent of the total pulse production in the country (Ministry of Agriculture, GOI, 2018).

Comment [S11]: add new data

Green gram is one of the important short season grain legumes in the conventional farming system of tropical and temperate regions. It can be grown on a variety of soil and climatic conditions, as it is tolerant to drought (Malik *et al.*, 2006).

Green gram is a healthful source of protein, fibres and rich in vitamins and minerals. It is an important legume crop that fixes the atmospheric nitrogen which enhances the fertility of the soil. After chickpea, mung bean is called as poor people diet owing to its protein nature and is meeting the major protein demand of the people (Pataczek *et al.*, 2018).

The use of organic manures and biofertilizers instead of synthetic chemical fertilizer are shown to improve plant growth through the supply of plant nutrients and may help to sustain environmental health and soil productivity (O'connell, 1992). The danger of leaching synthetic fertilizers is harmful to soil and groundwater (Naeem *et al.*, 2006). Thus, it is necessary to supply the plant nutrient requirement through proper on-farm management practices. Organic materials are intrinsic and essential components of all soils and it makes a living dynamic system in the soil that supports all life residing in soil. Organic matter plays a vital role in improving soil health and the quality of soils. Besides this, organic manure improves soil structure by providing binding effect to soil aggregates, increases water holding capacity and improves buffering capacity of soils.

Comment [S12]: write details of organic manure to improve soil health with data and references

Phosphorus is the second most important nutrient next to nitrogen. Its deficiency is usually the most important single factor which is responsible for a poor yield of pulses on all soils. It is a major constituent of protein and nucleic acids. Phosphorus plays a key role in the formation of energy-rich bound phosphates (ADP and ATP). It has a beneficial effect on

nodulation, stimulation, root development, and growth, hastens the maturity of crops as well as improves quality traits. Indian soils have poor to medium status in available phosphorus (Syers *et al.*, 2008).

Several bacteria belonging to the genera *Pseudomonas* and *Bacillus* can solubilize inorganic P from insoluble sources. The microorganisms can grow on insoluble forms such as tricalcium phosphate, rock phosphate and bone meal and convert them into soluble forms. The solubilization of phosphorus by these microorganisms is attributed to the secretion of organic acids like citric, glutamic, succinic, lactic, oxalic, glycoxalic, maleic, fumaric, tartaric and alfa ketobutyric acid (Raju *et al.*, 2005). Thus, in legumes, it is more important than nitrogen as later is fixed by symbiosis with *Rhizobium* bacteria.

Significant progress has been achieved in the use of biofertilizers during the last few years. Biofertilizer plays an important role in the increasing availability of soil mineral nutrients. They increase the biological fixation of atmospheric nitrogen and also enhance phosphorus availability to the crop by solubilizing fixed phosphorus of soil. Therefore, the application of the efficient strain of *Rhizobium* in the soil may be helpful in nitrogen fixation and consequently production can be boosted through seed inoculation with *Rhizobium* and by usage of phosphorus solubilizing bacteria (Dhakal *et al.*, 2016).

**Comment [S13]:** write about VC, FYM, Oil cake and Bio fertilizers

## 1. MATERIALS AND METHODS

### 2.1 Experimental Site

The investigation “An assessment of different organic sources of nutrients for organic summer green gram cultivation” was carried out during the summer season of the year 2021 at Certified Organic Farm A-7, College Agronomy Farm, BACA, Anand Agricultural University, Anand (Gujarat).

### 2.2 Experimental Details

#### 2.2.1 Details of treatments

Ten treatments comprising different organic sources were included in the experiment. The details of the treatments and NPK content in different inputs are given in Table 1.

**Table 1: Description of the given treatment**

Treatment No.	Treatment details
T <sub>1</sub>	No manures (Control)
T <sub>2</sub>	<i>Rhizobium</i> (5.0 mL/kg seed treatment and 1.0 L/ha soil application)
T <sub>3</sub>	100 % N through FYM
T <sub>4</sub>	100 % N through vermicompost
T <sub>5</sub>	100 % N through castor cake

T <sub>6</sub>	100 % N through neem cake
T <sub>7</sub>	50 % N through FYM followed by Seed treatment of <i>Rhizobium</i>
T <sub>8</sub>	50 % N through vermicompost followed by Seed treatment of <i>Rhizobium</i>
T <sub>9</sub>	50 % N through castor cake followed by Seed treatment of <i>Rhizobium</i>
T <sub>10</sub>	50 % N through neem cake followed by Seed treatment of <i>Rhizobium</i>

**Note:**

1. All the organic manures were applied 10 days before sowing in the respective treatment
2. *Rhizobium* was applied at 5.0 mL/kg as a seed treatment in the respective treatment while PSB 1.0 L/ha applied as a common soil application except for treatment T<sub>1</sub>.

**2.2.2 Design and Layout**

1. Experimental design: Randomized Block Design
2. Number of Replications : 04 (Four)
3. Number of Treatments : 10 (Ten)
4. Total number of plots : 40 (Forty)

**2.3 Sample Collection and Processing**

**2.3.1 Soil sampling**

Representative soil samples at 0-15 cm depth were collected initially from the entire experimental site and each plot after the harvest of green grams. The soil samples were prepared by mixing the soil collected from four spots randomly. The soil samples were air-dried and ground to pass through a 2 mm sieve. The samples were stored in polythene-lined cotton bags for further analysis.

**2.3.2 Plant sampling for chemical analysis**

After the harvest of the crop green gram grain and straw samples were taken for analysis. The samples were dried in paper bags at 70 °C till constant weight in a hot air oven and preserved for further analysis. These samples were ground in a stainless-steel grinder to avoid contamination of micronutrients. The processed samples were preserved in airtight polyethylene bags for further analysis.

**2.4 Quality parameter**

**2.4.1 Protein content in seeds (%)**

The protein content in seeds was calculated by multiplying the nitrogen content of seeds (%) with the conversion factor of 6.25 as reported by Gupta *et al.* (1972)

**2.5 Methods of analysis**

**2.5.1 Soil analysis**

The processed soil samples were analyzed for important soil properties *viz.* pH, EC (1:2.5; soil: water ratio), organic carbon (O.C. %) and available nutrients *viz.*, N, P<sub>2</sub>O<sub>5</sub> were determined as per the standard methods (Table 2).

**Table 2: Methods used for soil and plant analysis**

Sr. No.	Parameters	Extraction method	References
<b>A. Soil analysis</b>			
1.	pH (1:2.5 soil: water)	Potentiometric	Jackson (1973)
2.	EC (1:2.5 soil: water)	Conductometric	Jackson (1973)
3.	Organic carbon (OC)	Walkley Black's wet digestion method	Jackson (1973)
4.	Available N	Alkaline KMnO <sub>4</sub> (0.32%) method	Subbaiah (1956)
5.	Available P <sub>2</sub> O <sub>5</sub>	0.5 M NaHCO <sub>3</sub> , pH 8.5, Spectrophotometry	Olsen (1954)
<b>B. Plant analysis</b>			
1.	Nitrogen	Kjeldahl's Method	Jackson (1973)
2.	Phosphorus	Vanadomolybdo phosphoric acid yellow color method	Jackson (1973)
3.	Potassium	Flame photometry	Jackson (1973)

**2.5.2 Plant analysis**

Dried plant samples (straw and grain) were ground in a stainless-steel grinder and digested in the di-acid mixture (HNO<sub>3</sub>: HClO<sub>4</sub> - 4:1) and the volume was made with double distilled water (Lindsay & Norvell, 1978). The extract was filtered through Whatman filter paper No. 42. The filtrate of plant samples was used for the analysis of nutrients on the Atomic Absorption Spectrophotometer (AAS Model: PE 3110).

**2.6 Statistical analysis**

The statistical analysis of the data of various characters studied in the investigation was carried out through the procedure appropriate to the design of the experiment as described by Panse & Sukhatme (1967).

**2.7 Economics**

The cost of cultivation was worked out by taking into consideration all the expenses incurred. Gross return was worked out by multiplying the seed yield of the crop with their prevailing market prices. Calculations were made as per normal rates prevalent at the Agricultural Research Farm, AAU, Anand. The cost of manure, biofertilizers and seed, etc. was taken as per prevailing market prices. Net return (₹/ha) and the benefit-cost ratio was calculated with the help of the following formula:

$$\text{Net return (₹/ha)} = \text{Gross return (₹/ha)} - \text{Cost of cultivation (₹/ha)}$$

Comment [S14]: INR/ha

$$B : C \text{ Ratio} = \frac{\text{Gross realisation (₹/ha)}}{\text{Total cost of cultivation (₹/ha)}}$$

### 3. RESULTS AND DISSCUSION

#### 3.1 Effect on Quality Parameters

##### Protein content of seed (%)

The results presented in Table 3 showed that different organic sources remained at par with protein (%) content and they had no significant influence on protein (%) content.

**Table 3: Protein content (%) of green gram as influenced by different organic sources of nutrients**

Treatment	Protein content (%)
T <sub>1</sub> : No manure (Control)	21.67±0.28
T <sub>2</sub> : <i>Rhizobium</i> seed treatment + 1.0 L/ha soil application	21.45±0.03
T <sub>3</sub> : 100% N through FYM	21.47±0.08
T <sub>4</sub> : 100% N through vermicompost (VC)	21.70±0.31
T <sub>5</sub> : 100% N through castor cake (CC)	21.55±0.06
T <sub>6</sub> : 100% N through neem cake (NC)	21.55±0.11
T <sub>7</sub> : 50% N through FYM + <i>Rhizobium</i> seed treatment	21.75±0.20
T <sub>8</sub> : 50% N through VC + <i>Rhizobium</i> seed treatment	21.78±0.27
T <sub>9</sub> : 50% N through CC + <i>Rhizobium</i> seed treatment	21.81±0.09
T <sub>10</sub> : 50% N through NC + <i>Rhizobium</i> seed treatment	21.83±0.30
SEm ±	0.10
CD (P=0.05)	NS
CV (%)	0.96

Comment [S15]: Write symbol only T1, T2.....T10

#### 3.2 Effect on Chemical Parameters, Available Nutrient Status, And Soil Microbial Count After Harvest

##### 3.2.1 EC, pH, OC (%), available N and P<sub>2</sub>O<sub>5</sub>

Data presented in Table 4 showed that the significantly higher value of EC (0.18 dS/m) was found in treatment T<sub>1</sub> [No manure (Control)], whereas the lowest value (0.09 dS/m) of EC was found in treatment T<sub>4</sub>, which was remained at par (0.11) with treatment T<sub>9</sub>. The close examination of data given in Table 6 indicated that the effect of various treatments of organic sources did not show any statistical differences concerning the pH of soil. Though the higher pH (7.58) of soil after harvest of green gram was observed in treatments T<sub>4</sub> (100% N through VC) and T<sub>6</sub> (100% N through NC).

Comment [S16]: Effect of Organic manure and Bio fertilizer on soil chemical and biological properties of soil after Harvest green gram..

The effect of various treatments of organic sources significantly showed statistical differences concerning organic carbon of soil after harvest of green gram crop as the experiment was conducted in a certified organic plot. Higher organic carbon (0.65%) of soil after harvest of green gram was observed in treatment T<sub>8</sub> (50% N through VC + *Rhizobium* seed treatment). but it was statistically at par (0.60) with treatment T<sub>9</sub>. While lower (0.51%) with treatment T<sub>1</sub>, which was at par (0.53%) with treatment T<sub>2</sub>.

The availability of nitrogen, phosphorus, potassium, and organic carbon status of the soil improved with the organic manure which enhanced the use of organic sources for higher production and stable soil health. Organic manure released nutrients more slowly than mineral nutrients and contributed to the residual pool of organic nitrogen, phosphorus and potassium in the soil, and reduces nutrient loss from the soil by improving soil organic matter and increasing organic carbon content in the soil. Similar results were also noticed by Sharma & Dayal (2005) and Chaudhary *et al.* (2015) in green gram and groundnut, respectively.

The treatment T<sub>7</sub> (50% N through FYM + *Rhizobium* seed treatment) recorded significantly higher available nitrogen content in soil (212 kg/ha) after harvest of a green gram but it was at par statistically (210.25 kg/ha, 208.75 kg/ha, 207.25 kg/ha and 204.75 kg/ha, respectively) with treatments T<sub>10</sub>, T<sub>8</sub>, T<sub>9</sub> and T<sub>5</sub>. While significantly lower nitrogen content (194 kg/ha) was recorded with treatment T<sub>1</sub> (Control) after harvest of the green gram crop.

The treatment T<sub>9</sub> (50% N through CC + *Rhizobium* seed treatment) recorded significantly higher available phosphorus content in soil (36.41 kg/ha) after harvest of green gram, however, it remained at par (35.83 kg/ha, 35.50 kg/ha, 35.44 kg/ha, 35.38 kg/ha, 34.97 kg/ha and 34.66 kg/ha, respectively) with treatment T<sub>10</sub>, T<sub>3</sub>, T<sub>7</sub>, T<sub>5</sub> and T<sub>6</sub>, respectively, while significantly lower phosphorus content (30.21 kg/ha) was recorded with treatment T<sub>1</sub>(No manure control) at the harvest of green gram crop.

### **3.2.2 Soil microbial count after harvest**

The data in Table 5 revealed that microbial count after harvest of the crop was significantly influenced due to the application of different organic sources of nutrients in green gram. The treatment T<sub>2</sub> (*Rhizobium* seed treatment + 1.0 L/ha soil application) recorded a significantly higher *Rhizobium* population in soil ( $2.9 \times 10^7$  CFU/g) after harvest of green gram. However, it remained at par ( $8.7 \times 10^6$  CFU/g,  $7.62 \times 10^6$  CFU/g,  $3.9 \times 10^6$  CFU/g and  $2.19 \times 10^6$  CFU/g, respectively) with treatment T<sub>8</sub>, T<sub>7</sub> and T<sub>10</sub>. While significantly the lowest. *Rhizobium* population ( $4.4 \times 10^3$  CFU/g) was recorded with treatment T<sub>1</sub>(No manure control). Further,

**Table 4: Initial and at harvest soil status of EC, pH, OC (%), available N, and P<sub>2</sub>O<sub>5</sub> as influenced by different organic sources of nutrients**

Treatment	EC (dS/m)*	pH	OC (%)	Available N (kg/ha)	Available P <sub>2</sub> O <sub>5</sub> (kg/ha)
<b>Initial</b>	<b>0.26</b>	<b>7.5</b>	<b>0.51</b>	<b>192</b>	<b>33.19</b>
<b>T<sub>1</sub></b> : No manure (Control)	0.18±0.03	7.43±0.17	0.51±0.00	194.75±4.86	30.21±0.04
<b>T<sub>2</sub></b> : <i>Rhizobium</i> seed treatment + 1.0 L/ha soil application	0.14±0.02	7.60±0.08	0.53±0.01	196.25±3.10	32.45±2.00
<b>T<sub>3</sub></b> : 100% N through FYM	0.14±0.05	7.55±0.06	0.58±0.03	196.50±2.38	35.50±0.40
<b>T<sub>4</sub></b> : 100% N through vermicompost (VC)	0.09±0.01	7.58±0.05	0.56±0.03	197.00±2.83	34.97±1.67
<b>T<sub>5</sub></b> : 100% N through castor cake (CC)	0.12±0.02	7.53±0.10	0.58±0.04	204.75±0.96	34.66±1.77
<b>T<sub>6</sub></b> : 100% N through neem cake (NC)	0.13±0.02	7.58±0.15	0.56±0.03	202.50±12.23	35.44±1.85
<b>T<sub>7</sub></b> : 50% N through FYM + <i>Rhizobium</i> seed treatment	0.13±0.01	7.55±0.10	0.58±0.02	212.00±4.97	35.38±1.23
<b>T<sub>8</sub></b> : 50% N through VC + <i>Rhizobium</i> seed treatment	0.13±0.01	7.55±0.06	0.65±0.03	208.75±10.34	33.69±3.06
<b>T<sub>9</sub></b> : 50% N through CC + <i>Rhizobium</i> seed treatment	0.11±0.01	7.55±0.13	0.60±0.08	207.25±9.60	36.41±3.55
<b>T<sub>10</sub></b> : 50% N through NC + <i>Rhizobium</i> seed treatment	0.13±0.03	7.50±0.08	0.61±0.07	210.25±10.87	35.83±1.83
<b>SEm ±</b>	<b>0.01</b>	<b>0.05</b>	<b>0.02</b>	<b>3.10</b>	<b>0.64</b>
<b>CD (P=0.05)</b>	<b>0.02</b>	<b>NS</b>	<b>0.058</b>	<b>9.02</b>	<b>1.86</b>
<b>CV (%)</b>	<b>15.58</b>	<b>1.57</b>	<b>7.03</b>	<b>3.06</b>	<b>3.72</b>

\*Decisiemens per meter

Comment [S17]: Write symbol only T1.....T10

**Table 5: Initial and at harvest soil microbial count (CFU/g of soil) of green gram as influenced by different organic sources of nutrients**

Treatment	<i>Rhizobium</i> population at harvest (CFU/g of soil)	PSB population at harvest (CFU/g of soil)
<b>Initial</b>	<b>3.18 (1.4 × 10<sup>3</sup>)</b>	<b>4.17 (2.4 × 10<sup>4</sup>)</b>
<b>T<sub>1</sub></b> : No manure (Control)	3.61 (4.4 × 10 <sup>3</sup> )	4.41 (3.4 × 10 <sup>4</sup> )
<b>T<sub>2</sub></b> : <i>Rhizobium</i> seed treatment + 1.0 L/ha soil application	7.48 (2.9 × 10 <sup>7</sup> )	7.65 (4.4 × 10 <sup>7</sup> )
<b>T<sub>3</sub></b> : 100% N through FYM	5.61 (4.5 × 10 <sup>3</sup> )	7.69 (5.2 × 10 <sup>7</sup> )
<b>T<sub>4</sub></b> : 100% N through vermicompost (VC)	5.99 (8.2 × 10 <sup>3</sup> )	7.67 (5.6 × 10 <sup>7</sup> )
<b>T<sub>5</sub></b> : 100% N through castor cake (CC)	5.96 (5.9 × 10 <sup>3</sup> )	7.17 (5.0 × 10 <sup>7</sup> )
<b>T<sub>6</sub></b> : 100% N through neem cake (NC)	5.24 (2.2 × 10 <sup>3</sup> )	7.92 (5.9 × 10 <sup>7</sup> )
<b>T<sub>7</sub></b> : 50% N through FYM + <i>Rhizobium</i> seed treatment	6.92 (3.9 × 10 <sup>6</sup> )	7.13 (4.9 × 10 <sup>7</sup> )
<b>T<sub>8</sub></b> : 50% N through VC + <i>Rhizobium</i> seed treatment	6.97 (7.62 × 10 <sup>6</sup> )	7.82 (6.09 × 10 <sup>7</sup> )
<b>T<sub>9</sub></b> : 50% N through CC + <i>Rhizobium</i> seed treatment	6.98 (8.7 × 10 <sup>6</sup> )	7.88 (6.9 × 10 <sup>7</sup> )
<b>T<sub>10</sub></b> : 50% N through NC + <i>Rhizobium</i> seed treatment	6.82 (2.19 × 10 <sup>6</sup> )	7.73 (4.90 × 10 <sup>7</sup> )
<b>SEm ±</b>	<b>0.25</b>	<b>0.34</b>
<b>CD (P=0.05)</b>	<b>0.62</b>	<b>0.69</b>

Comment [S18]: Write symbol only

CFU: colony forming unit

treatment T<sub>6</sub> (100% N through NC) recorded a significantly higher PSB population in soil ( $6.9 \times 10^7$  CFU/g) after harvest of green gram as compared to control.

The higher microbial count might be due to the availability of abundant organic matter and effective microbial activities because of a sufficient supply of feeding material for the microorganism in the form of humus. The results are in close proximity to the tune reported by Ghosh *et al.* (2013).

### 3.3 Effect on Nutrient Content in Plant

#### Nitrogen content in green gram seed and haulm

The data tabulated in Table 6 indicated that significantly higher nitrogen content in seed (3.49%) of green gram was obtained with the application of treatments T<sub>10</sub>(50% N through NC + *Rhizobium* seed treatment), T<sub>9</sub> (50% N through CC + *Rhizobium* seed treatment) and T<sub>8</sub> (50% N through VC + *Rhizobium* seed treatment) and it was remained at par (3.48, 3.47 and 3.45) with treatments T<sub>1</sub>, T<sub>4</sub>, T<sub>5</sub> and T<sub>6</sub>. These results are in close agreement with the findings of Sardar *et al.* (2016).

It was observed from Table 6 data that Nitrogen (%) content in haulm did not exert any significant differences among varied treatments of effects of different organic sources of nutrients. However, the numerically highest response (1.03) was collected from treatments T<sub>2</sub> (*Rhizobium* seed treatment + 1.0 L/ha soil application), T<sub>3</sub> (100% N through FYM), and T<sub>5</sub> (100% N through CC).

**Table 6: Effect of Organic manure and Bio fertilizer on Nitrogen (%) content in seed and haulm of green gram as influenced by different organic sources of nutrients**

Treatment	Nitrogen (%) of seed	Nitrogen (%) of haulm
T <sub>1</sub> : No manure (Control)	3.47±0.05	1.04±0.02
T <sub>2</sub> : <i>Rhizobium</i> seed treatment + 1.0 L/ha soil application	3.43±0.00	1.03±0.02
T <sub>3</sub> : 100% N through FYM	3.44±0.01	1.03±0.02
T <sub>4</sub> : 100% N through vermicompost (VC)	3.47±0.05	1.04±0.02
T <sub>5</sub> : 100% N through castor cake (CC)	3.45±0.01	1.03±0.01
T <sub>6</sub> : 100% N through neem cake (NC)	3.45±0.02	1.05±0.02
T <sub>7</sub> : 50% N through FYM + <i>Rhizobium</i> seed treatment	3.48±0.03	1.04±0.02
T <sub>8</sub> : 50% N through VC + <i>Rhizobium</i> seed treatment	3.49±0.04	1.05±0.02
T <sub>9</sub> : 50% N through CC + <i>Rhizobium</i> seed treatment	3.49±0.01	1.04±0.02
T <sub>10</sub> : 50% N through NC + <i>Rhizobium</i> seed treatment	3.49±0.05	1.04±0.02
SEm ±	0.01	0.01
CD (P=0.05)	0.04	NS
CV (%)	0.82	1.32

Comment [S19]: Symbol only

### 3.4 Economics

Data presented in Table 7 revealed that a maximum net realization of ₹63287/ha was recorded under the application of treatment T<sub>10</sub> (50% N through NC + *Rhizobium* seed treatment) which was followed by treatment T<sub>7</sub> with the net realization of ₹54063/ha. The lowest net realization of ₹26222/ha was obtained under treatment T<sub>4</sub> (100% N through VC).

In the case of benefit-cost ratio, the highest benefit-cost ratio of 3.62 was recorded under the application of 50% N through FYM + *Rhizobium* seed treatment(T<sub>7</sub>) which was closely followed by treatment T<sub>2</sub> (3.52). Application of 100% N through NC (T<sub>6</sub>) registered the lowest benefit-cost ratio of 1.94.

**Table 7: Economics as influenced by the application of different organic sources of nutrients in green gram**

Treatment	Seed yield (kg/ha)	Gross realization (₹/ha)	Cost of cultivation (₹/ha)	Net realization (₹/ha)	BCR
T <sub>1</sub>	868	47740	18609	29131	2.57
T <sub>2</sub>	1248	68640	19473	49167	3.52
T <sub>3</sub>	906	49830	21871	27959	2.28
T <sub>4</sub>	972	53460	27238	26222	1.96
T <sub>5</sub>	1096	60280	24657	35623	2.44
T <sub>6</sub>	1115	61325	31692	29633	1.94
T <sub>7</sub>	1358	74690	20627	54063	3.62
T <sub>8</sub>	1208	66440	23311	43129	2.85
T <sub>9</sub>	1351	74305	22021	52284	3.37
T <sub>10</sub>	1615	88825	25538	63287	3.48

Comment [S20]: INR/ha

Haulm to be incorporated into the field. The selling price of green gram has been computed as ₹55.

### 4. CONCLUSION

It can be concluded that treatments T<sub>10</sub> (50% N through NC + *Rhizobium* seed treatment), T<sub>9</sub> (50% N through CC + *Rhizobium* seed treatment), T<sub>8</sub> (50% N through VC + *Rhizobium* seed treatment), T<sub>7</sub> (50% N through FYM + *Rhizobium* seed treatment) and T<sub>2</sub> (*Rhizobium* seed treatment + 1.0 L/ha soil application) are superior among the other treatments in case of net realization, higher available phosphorus content in soil, higher organic carbon, higher available nitrogen content in soil and higher *Rhizobium* population in soil, respectively.

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**Comment [S21]:** Write references as a journal standard style