Original Research Article

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

ABSTRACT

A field experiment entitled "An assessment of different organic sources of nutrients for organic summer green gram cultivation" was conducted during summerseason of the year 2020-21 on organic certified plot A-7 at Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand. Different sources of organic manures were tested using randomized block design with four replications. The treatment T_7 recorded significantly higher available nitrogen content in soil and also same behaviour observed in available phosphorus content in soil. The treatment T_9 recorded significantly higher available phosphorus content in soil. Significantly higher value of EC of soil (0.18) was found in treatment T_1, which was significantly higher EC of soil (0.11) which was recorded with treatment T_9. Higher organic carbon (0.65%) of soil after harvest of green gram was observed in treatment T_8. 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_{10}. Organic sources also influenced microbial activities in soil. Treatment T_2 recorded significantly higher *Rhizobium* population in soil at harvest of green gram. Subsequent, treatment T_6 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 $T_{10}$ (50% N through NC + *Rhizobium* seed treatment) followed by treatment $T_7$ (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_7, which closely followed by treatment T_2 (*Rhizobium* seed treatment + 1.0 L/ha soil application) having BCR of 3.52.

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 gram in India is also known as Mungbean, Sonamung in Bengali, Mung in Hindi, Magum in Assam, Mung in Oria, 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).

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).

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.

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).

1. MATERIALS AND METHODS

2.1Experimental Site

The investigation "An assessment of different organic sources of nutrients for organic summer green gram cultivation" was carried out during the summerseason 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_1	No manures (Control)
T_2	*Rhizobium* (5.0 mL/kg seed treatment and 1.0 L/ha soil application)
T_3	100 % N through FYM
T_4	100 % N through vermicompost
T_5	100 % N through castor cake

T_6	100 % N through neem cake
T_7	50 % N through FYM followed by Seed treatment of *Rhizobium*
T_8	50 % N through vermicompost followed by Seed treatment of *Rhizobium*
T_9	50 % N through castor cake followed by Seed treatment of *Rhizobium*
T_{10}	50 % N through neem cake followed by Seed treatment of *Rhizobium*

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_1.

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)

2.3Sample Collection and Processing

2.3.1Soil 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.

2.3.2Plant 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.

2.4Quality parameter

2.4.1Protein 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)

2.5Methods of analysis

2.5.1Soil 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_2O_5 were determined as per the standard methods (Table 2).

Table 2: Methods used for soil and plant analysis

Sr. No.	Parameters	Extraction method	References
A.	**Soil analysis**		
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 $KMnO_4$(0.32%) method	Subbaiah (1956)
5.	Available P_2O_5	0.5 M $NaHCO_3$, pH 8.5, Spectrophotometry	Olsen (1954)
B.	**Plant analysis**		
1.	Nitrogen	Kjeldahl's Method	Jackson (1973)
2.	Phosphorus	Vanadomolybdo phosphoric acid yellow color method	Jackson (1973)
3	Potassium	Flame photometry	Jackson (1973)

2.5.2Plant analysis

Dried plant samples (straw and grain) were ground in a stainless-steel grinder and digested in the di-acid mixture (HNO_3: $HClO_4$ - 4:1) and the volume was made with double distilled water (Lindsay & Norvell, 1978). The extract was filtered through Whattman 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:

Net return (`/ha) = Gross return (`/ha) - Cost of cultivation (`/ha)

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

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_1: No manure (Control)	21.67±0.28
T_2:*Rhizobium* seed treatment + 1.0 L/ha soil application	21.45±0.03
T_3: 100% N through FYM	21.47±0.08
T_4: 100% N through vermicompost (VC)	21.70±0.31
T_5: 100% N through castor cake (CC)	21.55±0.06
T_6: 100% N through neem cake (NC)	21.55±0.11
T_7: 50% N through FYM + *Rhizobium*seed treatment	21.75±0.20
T_8: 50% N through VC + *Rhizobium* seed treatment	21.78±0.27
T_9: 50% N through CC + *Rhizobium*seed treatment	21.81±0.09
T_{10}: 50% N through NC + *Rhizobium* seed treatment	21.83±0.30
SEm ±	0.10
CD (P=0.05)	NS
CV (%)	0.96

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_2O_5

Data presented in Table 4 showed that the significantly higher value of EC (0.18dS/m) was found in treatment T_1 [No manure (Control)], whereas the lowest value (0.09dS/m) of EC was found in treatment T_4, which was remained at par (0.11) with treatment T_9.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_4 (100% N through VC) and T_6 (100% N through NC).

The effect of various treatments of organic sources significantly showed statistical differences concerning organic carbon of soil after harvest of green gram crop as theexperiment was conducted in a certified organic plot. Higher organic carbon (0.65%) of soil after harvest of green gram was observed in treatment T_8 (50% N through VC + *Rhizobium* seed treatment). but it was statistically at par (0.60) with treatment T_9. While lower (0.51%) with treatment T_1, which was at par (0.53%) with treatment T_2.

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_7 (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_{10}, T_8, T_9 and T_5. While significantly lower nitrogen content (194 kg/ha) was recorded with treatment T_1 (Control) after harvest of the green gram crop.

The treatment T_9 (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_{10}, T_3, T_7, T_5 and T_6, respectively, while significantly lower phosphorus content (30.21 kg/ha) was recorded with treatment T_1(No manure control) at the harvest of green gram crop.

3.2.2Soil 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_2 (*Rhizobium* seed treatment + 1.0 L/ha soil application) recorded a significantly higher *Rhizobium* population in soil (2.9×10^7 CFU/g) after harvest of green gram. However, it remained at par (8.7×10^6 CFU/g,7.62×10^6 CFU/g,3.9×10^6 CFU/gand 2.19×10^6 CFU/g, respectively) with treatment T_8, T_7 and T_{10}. While significantly the lowest. *Rhizobium* population (4.4×10^3 CFU/g) was recorded with treatment T_1(No manure control). Further,

Table 4: Initial and at harvest soil status of EC, pH, OC (%), available N, and P_2O_5as influenced by different organic sources of nutriens

Treatment	**EC (dS/m)***	**pH**	**OC (%)**	**Available N (kg/ha)**	**Available P_2O_5 (kg/ha)**
Initial	**0.26**	**7.5**	**0.51**	**192**	**33.19**
T_1: No manure (Control)	0.18±0.03	7.43±0.17	0.51±0.00	194.75±4.86	30.21±0.04
T_2:*Rhizobium* 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
T_3: 100% N through FYM	0.14±0.05	7.55±0.06	0.58±0.03	196.50±2.38	35.50±0.40
T_4: 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
T_5: 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
T_6: 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
T_7: 50% N through FYM + *Rhizobium*seed treatment	0.13±0.01	7.55±0.10	0.58±0.02	212.00±4.97	35.38±1.23
T_8: 50% N through VC + *Rhizobium* seed treatment	0.13±0.01	7.55±0.06	0.65±0.03	208.75±10.34	33.69±3.06
T_9: 50% N through CC + *Rhizobium*seed treatment	0.11±0.01	7.55±0.13	0.60±0.08	207.25±9.60	36.41±3.55
T_{10}: 50% N through NC + *Rhizobium* seed treatment	0.13±0.03	7.50±0.08	0.61±0.07	210.25±10.87	35.83±1.83
SEm ±	**0.01**	**0.05**	**0.02**	**3.10**	**0.64**
CD (P=0.05)	**0.02**	**NS**	**0.058**	**9.02**	**1.86**
CV (%)	**15.58**	**1.57**	**7.03**	**3.06**	**3.72**

*Decisiemens per meter

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	***Rhizobium* population at harvest (CFU/g of soil)**	**PSBpopulation at harvest (CFU/g of soil)**
Initial	**3.18 (1.4 × 10^3)**	**4.17 (2.4 × 10^4)**
T_1: No manure (Control)	3.61 (4.4 ×10^3)	4.41 (3.4 × 10^4)
T_2:*Rhizobium* seed treatment + 1.0 L/ha soil application	7.48 (2.9 × 10^7)	7.65 (4.4 × 10^7)
T_3: 100% N through FYM	5.61 (4.5 × 10^5)	7.69 (5.2 × 10^7)
T_4: 100% N through vermicompost (VC)	5.99 (8.2 × 10^5)	7.67 (5.6 × 10^7)
T_5: 100% N through castor cake (CC)	5.96 (5.9 × 10^5)	7.17 (5.0 × 10^7)
T_6: 100% N through neem cake (NC)	5.24 (2.2 × 10^5)	7.92 (5.9 × 10^7)
T_7: 50% N through FYM + *Rhizobium*seed treatment	6.92 (3.9 × 10^6)	7.13 (4.9 × 10^7)
T_8: 50% N through VC + *Rhizobium* seed treatment	6.97 (7.62 × 10^6)	7.82 (6.09× 10^7)
T_9: 50% N through CC + *Rhizobium*seed treatment	6.98 (8.7 × 10^6)	7.88 (6.9 × 10^7)
T_{10}: 50% N through NC + *Rhizobium* seed treatment	6.82 (2.19 × 10^6)	7.73 (4.90 × 10^7)
SEm ±	**0.25**	**0.34**
CD (P=0.05)	**0.62**	**0.69**

CFU:colony forming unit

treatment T_6 (100% N through NC) recorded a significantly higher PSB population in soil (6.9×10^7 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_{10}(50% N through NC + *Rhizobium* seed treatment), T_9 (50% N through CC + *Rhizobium* seed treatment) and T_8 (50% N through VC + *Rhizobium* seed treatment) and it was remained at par (3.48, 3.47 and 3.45) with treatments T_1, T_4, T_5 and T_6. 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_2 (*Rhizobium* seed treatment + 1.0 L/ha soil application), T_3 (100% N through FYM), and T_5 (100% N through CC).

Table 6: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_1: No manure (Control)	3.47±0.05	1.04±0.02
T_2:*Rhizobium* seed treatment + 1.0 L/ha soil application	3.43±0.00	1.03±0.02
T_3: 100% N through FYM	3.44±0.01	1.03±0.02
T_4: 100% N through vermicompost (VC)	3.47±0.05	1.04±0.02
T_5: 100% N through castor cake (CC)	3.45±0.01	1.03±0.01
T_6: 100% N through neem cake (NC)	3.45±0.02	1.05±0.02
T_7: 50% N through FYM + *Rhizobium*seed treatment	3.48±0.03	1.04±0.02
T_8: 50% N through VC + *Rhizobium* seed treatment	3.49±0.04	1.05±0.02
T_9: 50% N through CC + *Rhizobium*seed treatment	3.49±0.01	1.04±0.02
T_{10}: 50% N through NC + *Rhizobium* 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**

3.4 Economics

Data presented in Table 7 revealed that a maximum net realization of `63287/ha was recorded under the application of treatment $T_{10}$ (50% N through NC + *Rhizobium* seed treatment) which was followed by treatment $T_7$ with the net realization of `54063/ha. The lowest net realization of `26222/ha was obtained under treatment T_4 (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_7) which was closely followed by treatment T_2 (3.52). Application of 100% N through NC (T_6) registered the lowest benefit-cost ratio of 1.94.

Table 7:Economics as influenced by the application of different organic sources of nutrientsin green gram

Treatment	Seed yield (kg/ha)	Gross realization (`/ha)	Cost of cultivation (`/ha)	Net realization (`/ha)	BCR
T_1	**868**	47740	18609	29131	2.57
T_2	**1248**	68640	19473	49167	3.52
T_3	**906**	49830	21871	27959	2.28
T_4	**972**	53460	27238	26222	1.96
T_5	**1096**	60280	24657	35623	2.44
T_6	**1115**	61325	31692	29633	1.94
T_7	**1358**	74690	20627	54063	3.62
T_8	**1208**	66440	23311	43129	2.85
T_9	**1351**	74305	22021	52284	3.37
T_{10}	**1615**	88825	25538	63287	3.48

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_{10} (50% N through NC + *Rhizobium* seed treatment), T_9 (50% N through CC + *Rhizobium* seed treatment), T_8 (50% N through VC + *Rhizobium* seed treatment), T_7(50% N through FYM + *Rhizobium* seed treatment) and T_2(*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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