

Integrated nutrient management on semi *rabi* green gram

ABSTRACT

An experiment was conducted to study the response of organic sources on the growth, yield, and quality of semi-rabi green gram. The experiment was conducted during semi rabi season 2021, at Agronomy Farm, B.A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, comprising one chemical treatment with nine integrated nutrient management and bio-fertilizer treatments i.e. total 10 integrated organic manures treatments impose in semi rabi green gram. The layout of experiment was done according to Randomized complete block design with three replications. Growth attributes like plant height, number of branches, dry matter accumulation plant⁻¹ and dry weight of nodules plant⁻¹ of green gram as influenced by an application of 75% N through vermicompost + ST (5ml kg seed⁻¹) of Rhizobium + Bio NPK consortium 1 L ha⁻¹. Significantly higher green gram yield attributing character and biological yield was observed significantly higher where application done by 75% N through vermicompost + ST (5ml kg seed⁻¹) of Rhizobium + Bio NPK consortium 1 L ha⁻¹. Quality parameter and content is most important factors for green gram, an application of 75% N through vermicompost + ST (5ml kg seed⁻¹) of Rhizobium + Bio NPK consortium 1 L ha⁻¹ treatment reported significantly higher seed and straw NPK content and uptake.

Keywords: biofertilizer consortium, castor cake, farmyard manure, green gram, organic sources, seed, stover yield and vermicompost

Introduction

India is a largest producer of Pulses (Joshi *et al.*, 2016 and Kavaya *et al.*, 2021) and its universally utilized as food legumes, which come in second position in terms of produce and

utilization after cereals. Being an essential component of the food of the great majority of vegetarians and the foundation of sustainable agricultural production. For livelihood activities, about 65-70 % of the population depend on agricultural and its relative activities. Nearly agricultural contribute 17% of domestic growth. Pulses have a rich in protein (25-26%), vitamins (3%), fibres, carbohydrate (51 %) and minerals and nutritional like iron, zinc, magnesium and also having essential amino acids, which play a vital role in human health (Yadav *et al.*, 2017). Due to its many uses, Green gram is a major pulse crop in India, where it is growing under a different agroclimatic conditions. (Banotra *et al.*, 2022).

Pulses, which are high in protein and play an active part in human food, are the second most significant section of Indian agriculture after grains. (Chaudhary *et al.*, 2018). In India, pulse farming is important role in agriculture (Kundal *et al.*, 2023). These crops are grown for domestic human consumption, mainly vegetarian peoples are used due to ani nutritional factors. Pulses have capacity to fix atmospheric nitrogen (average 30-50 kg ha⁻¹) into soi and ultimately to improve soil fertility so, it's called as mini natural fertilizer factory (Makwana *et al.*, 2020). Pulses are called “Marvel of Nature”. Pulse are the fundamental sources of protein and having around 14% of the total protein in the typical Indian diet is provided by pulses. Pulses are cultivated in *kharif*, *rabi* as well as summer season. As a third important pulse crops, its utilized vegetable, pulse, fodder as well as green manuring in the India (Saravanan *et al.*, 2013). Its seed is more palatable, nutritive, digestible and not flatulent than other pulse grown in country (Angmo *et al.*, 2022). In current Agriculture system, based on chemical is not sustainable become of soil erosion, associated plant nutrient losses, surface, and ground water pollution from agro-chemical and sediment impending shortage of non-renewable resources so low farm income from higher cost (Joshi *et al.*, 2016). One of the most essential agronomic practises for boosting

crop output and preserving soil fertility is nutrient management (Patel *et al.*, 2019). A sustainable farming system must have pulse. They improve soil health and fix nitrogen into the soil, which reduces the requirement for water (Dubey *et al.*, 2023).

Green gram is a staple meal that is high in protein. It has a protein content of roughly 25%, which is about three times that of grains (Sengupta and Tamang, 2015). Overall, the area planted with pulses has grown over time, however the productivity level is not very satisfying because of continuous cropping and negligence about inorganic fertilizers. The crop is often grown using only conventional fertilizers, without the use of bio-fertilizers or any other supplemental sources of nutrients (Pushpa *et al.*, 2022). Integrated plant nutrition management promotes economic yield as well as the physico chemical aspects of the soil. (Tripathi and Tiwari, 2022). When crop residues are applied along with chemical fertilizers, the chemical characteristics, specifically the organic carbon content and nutrient availability, improve. The use of fertilizer, organic manures, and biofertilizers in tandem, also known as integrated nutrient management, is the most effective technique for satisfying plant nutrient demands, resolving the issue of nutrient mining, and preserving soil health. (Tripathi and Tiwari, 2022). The important component of enhanced yield is nutrient balance. Excessive and unbalanced fertilizer usage has resulted in soil mining, which has reduced agricultural output and, ultimately soil health (Mishra *et al.*, 2023).

Organic manure involves both micro and macro nutrients, and it enhances soil fertility, soil physical, chemical, and biological qualities; it also maintains soil microbial population balance. Reduce soil erosion and increase plant nutrient availability through the mineralization process. (Kishor *et al.*, 2021 and Kumar *et al.*, 2011). It is widely acknowledged that the combination of organic manures and biofertilizers plays a critical role in boosting soil

production. (Kishor *et al.*, 2021). Biofertilizers made from microalgae have been found to be an excellent alternative to toxic chemical fertilizers in the agriculture sector (Dineshkumar *et al.*, 2020). Biofertilizers are primarily responsible for boosting nutrient availability by using various microorganisms; they are also beneficial in enhancing atmospheric nitrogen fixation in soil and for increasing the availability of nutrients in soil that are easily accessible to plants. The use of organic manures and biofertilizer is crucial for soil structure and nutrient management. They improve nutrient availability and soil health by converting a fixed form of nutrient into a soluble form, increasing soil fertility and productivity (Perli *et al.*, 2022).

The need for an inexpensive alternative to inorganic fertilizer has grown significantly in popularity due to the high price of inorganic fertilizer, growing environmental awareness, and the energy crisis. Given this, the current study on integrated nutrient management is more beneficial for enhancing the physical, chemical, and biological aspects of the soil as well as the production of healthy foods, increasing income, and lowering cultivation costs.

Organic manures and biofertilizer have the ability to promote development and provide immunity in the plant system by lowering the soil microbial population. Excessive and inefficient application of inorganic fertilizers reduced crop quality and harmed the soil. As a result, total yields increase. This may be accomplished by substituting different nutrients using organic methods. As a result, this research was designed to examine how integrated nutrient management affects the development, production, quality, and economics of green gramme under semi-rabi conditions.

METHODOLOGY

The present research investigation was carried out in the semi *rabi* season (2021) at the Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India. The experimental site is located at 22°-35' N latitude 72°-55' longitude and an altitude of

45.1 meters above mean sea level in the Anand district of Gujarat. Metrological data are presented in Fig. 1. The soil of top 15 cm depth of experimental site was loamy sand in texture, low in organic carbon (0.30%) and available nitrogen (210 kg ha^{-1}), medium in available phosphorus (40 kg ha^{-1}) and available potash (285 kg ha^{-1}) with 8.05 soil ph. The details of the ten treatments viz., (T₁) 100% RDF(20:40:0 kg NPK ha^{-1}), (T₂) 100% N through FYM, (T₃) 100% N through vermicompost, (T₄) 100% N through castor cake, (T₅) 75% N through FYM + ST (5 ml kg^{-1} seed) of *Rhizobium* + Bio NPK consortium 1 L ha^{-1} , (T₆) 75% N through vermicompost + ST (5 ml kg^{-1} seed) of *Rhizobium* + Bio NPK consortium 1 L ha^{-1} , (T₇) 75% N through castor cake + ST (5 ml kg^{-1} seed) of *Rhizobium* + Bio NPK consortium 1 L ha^{-1} , (T₈) 50% N through FYM + ST (5 ml kg^{-1} seed) of *Rhizobium* + Bio NPK consortium 1 L ha^{-1} , (T₉) 50% N through vermicompost + ST (5 ml kg^{-1} seed) of *Rhizobium* + Bio NPK consortium 1 L ha^{-1} and (T₁₀) 50% N through castor cake + ST (5 ml kg^{-1} seed) of *Rhizobium* + Bio NPK consortium 1 L ha^{-1} . The inputs nutrient was analyzed before sowing (FYM, vermicompost, Castor cake containing 0.32, 1.21 and 3.24 % N, respectively) while initial microbial count $117.60 \times 10^7 \text{ cfu/g}$ observed in soil. Tested organic manures were applied 10 days before planting and integrated into the soil, Rhizobium was used as a seed treatment, and Bio NPK Consortium was applied by soaking and irrigation. At the maturity five randomly selected plants from each plot were harvested separately to study the growth and yield attributing parameters. The crop was harvested, threshed and cleaned manually and seed and stover yield per plot have been recorded. The results from the field experiment were statistically analyzed to compare treatments using analysis of variance techniques (ANOVA) for RBD design and the result were interpreted at 5% level of significance (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Response on growth attributes

Perusal of data depicted in Table 1 indicated that response of integrated nutrient management treatment on green gram was found to be significant. Application of 75% N through vermicompost + seed treatment (5ml kg^{-1} seed) of *Rhizobium* + Bio NPK consortium 1L ha^{-1} (T_6) reported significantly higher plant height (52.32 and 54.33 cm at 60 DAS and at harvest, respectively) as well as higher number of branched per plant (5.20) at harvest as compared to treatments. Manure treatment may have encouraged improved root proliferation, increased phosphorous solubility, and hence enhanced biological nitrogen fixation, nutrient absorption, and during the plant growth nutrient availability of all nutrients during the growth phase. As a result, the plant grew taller. (Verma *et al.*,2022). Vermicompost and FYM has improved nutrient availability due to speedy mineralization and improved nutrient availability to plants, advancing plant growth and development. By using organic manures and biofertilizers, which enhanced growth of green gram. The maximum number of branches per plant might be due to synergistic result, it is well recognized that organic manures increase chlorophyll concentration, cell division, shoot growth, and photosynthetic rate (Priyadharshini *et al.*,2021). According to the findings, Adding manure to the soil increased nutrient availability over time and had a positive effect on plant height. A more balanced diet might have resulted in faster development and growth. Nitrogen is one of the most significant components influencing the leaf area index, which may have aided in agricultural photosynthesis and productivity. The response of organic manures on leaf area index might be due to (Rajeshwari,2011 and Prajapati, 2014) supply of macro and micronutrients, vitamins, and growth hormones like as gibberellins, which increased leaf area and hence photo assimilates. Another reason might be due to the practice of keeping soil fertility and plant nutrient delivery at an optimal level in order to sustain goal productivity by

optimizing the benefits from all viable organic and biological components except inorganic is referred to as integrated organic nutrient management (Pandey *et al.*, 2019 and Das 2018).

Presented Table-1 indicated that application organic manures with biofertilizer combination reported its significant response on dry matter accumulation and dry weight of root nodules per plant. Higher dry matter accumulation (31.87 g plant⁻¹) and dry weight of root nodules per plant at 45 DAS (45.67 g) were observed higher in treatment T₆ (75% N through vermicompost + seed treatment (5ml kg⁻¹ seed) of *Rhizobium* + Bio NPK consortium 1L ha⁻¹) than other treatments. Organic manure application may have increased organic matter content and microbial activity and ultimately improved soil conditions for nutrient availability, whereas the addition of biofertilizers may have enhanced the biochemical processes of nitrogen fixation and phosphorus solubilization, boosting nutrient availability and promoting crop development. Nutrient availability improved due to higher microbial availability, and activities ultimately improved by using biofertilizers. Biofertilizers have improved soil nutrient availability by improving microbial activity and releasing nutrients from soil, which aids in adequate nutrient absorption and utilization by plants (Gohain and Kikon 2017; Kaur 2016). In general, proper provision of plant nutrients as per crop requirement via solubilization of insoluble phosphorus and potassium, as well as favorable environmental conditions in the rhizosphere, which supported the crop's longer vegetative and reproductive phases. (Singh *et al.*, 2021).

Table 1: Response of treatments on growth parameters of semi *rabi* green gram

| Treatment | Plant height (cm) | | Branches/plant | Dry matter accumulation/plant (g plant ⁻¹) | Dry weight of root nodules/plant |
|----------------|-------------------|------------|----------------|--|----------------------------------|
| | 60 DAS | At harvest | At harvest | | 45 DAS |
| T ₁ | 48.87 | 51.15 | 4.90 | 28.33 | 23.00 |
| T ₂ | 44.67 | 46.78 | 3.73 | 24.67 | 29.73 |
| T ₃ | 45.60 | 47.74 | 3.93 | 25.67 | 32.20 |
| T ₄ | 39.52 | 41.35 | 2.40 | 24.33 | 23.77 |

| | | | | | |
|-----------------------|-------------|-------------|-------------|-------------|-------------|
| T₅ | 50.27 | 52.62 | 5.13 | 30.33 | 44.40 |
| T₆ | 52.32 | 54.33 | 5.20 | 31.87 | 45.67 |
| T₇ | 49.33 | 51.65 | 4.93 | 29.27 | 44.13 |
| T₈ | 47.04 | 49.23 | 4.33 | 26.33 | 43.40 |
| T₉ | 47.93 | 50.18 | 4.53 | 27.50 | 43.87 |
| T₁₀ | 46.57 | 48.74 | 4.13 | 26.00 | 42.20 |
| SEm ± | 1.98 | 2.06 | 0.35 | 1.29 | 1.54 |
| CD (p=0.05) | 5.89 | 6.12 | 1.03 | 3.83 | 4.56 |

Effect of treatment on yield attributes and yield

The yields varied significantly because of diverse organic nutrient sources and their combinations. (Table 2 & Fig.1). Dry matter accumulation and dry weight of root nodules per plant of green gram as affected by different organic manure treatments depicted in Table 2. An application of 75% N through vermicompost + ST (5ml kg⁻¹ seed) of *Rhizobium* + Bio NPK consortium 1L ha⁻¹ (T₆) reported significantly higher pods per plant (33.20) and length of pod (8.60 cm) it was found to be significantly superior over all the treatments. Significantly maximum seed (1481 kg ha⁻¹) and straw (2008 kg ha⁻¹) yield than rest of treatments (Fig.1). As compared to RDF treatment (T₁), treatment T₆ (75% N through vermicompost + seed treatment (5ml kg⁻¹ seed) of *Rhizobium* + Bio NPK consortium 1L ha⁻¹) reported 12.48 % higher seed yield. The improved seed yield and yield-attributing characteristics of green gram due to organic soil application may be increased nutrient availability to plants, in addition to increased water holding capacity and other physical properties, which may be due to the formation of more root nodules, vigorous root development, and better nitrogen fixation. (Shete *et al.*, 2010) and better development of plant growth leading to higher photosynthesis activity and translocation of photosynthesis to the sing which is turn resulted in better development of yield attributes and finally higher seed yield (Ravikumar *et al.*, 2012). Another explanation for increased economic output might be the reaction of yield-attributing variables such as number of pods per plant, length of pods, number of seeds per pod, and test weight to improved yield resulted in a greater

economic yield. Nutrient availability may also have increased photosynthate synthesis and improved translocation within plants led in enhanced growth of photosynthate sink source ratio. Improvement in higher biological yields recorded could be attributed to better plant growth and dry matter accumulation as recorded under these treatments (Gohain and Kikon 2017).

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Table 2: Response of treatments on yield attributes and yield of semi *rabi* green gram

| Treatment | Pods/plant | Pod length (cm) | Test weight (g) | Protein content in seed (%) | Net return (₹/ha) | B:C ratio |
|-----------------|-------------|-----------------|-----------------|-----------------------------|-------------------|-----------|
| T ₁ | 29.60 | 7.60 | 45.25 | 21.42 | 40583 | 2.46 |
| T ₂ | 27.60 | 5.80 | 44.61 | 20.38 | 27367 | 1.87 |
| T ₃ | 29.27 | 6.00 | 44.88 | 20.60 | 27134 | 1.77 |
| T ₄ | 22.80 | 5.47 | 44.17 | 20.17 | 19932 | 1.61 |
| T ₅ | 31.40 | 8.00 | 45.36 | 21.77 | 50613 | 2.66 |
| T ₆ | 33.20 | 8.60 | 45.41 | 22.48 | 51231 | 2.54 |
| T ₇ | 30.40 | 7.80 | 45.32 | 21.52 | 45802 | 2.46 |
| T ₈ | 28.60 | 7.20 | 45.11 | 21.10 | 40307 | 2.39 |
| T ₉ | 29.20 | 7.40 | 45.17 | 21.23 | 41878 | 2.36 |
| T ₁₀ | 28.20 | 7.00 | 44.95 | 20.94 | 35944 | 2.22 |
| SEm ± | 1.34 | 0.33 | 0.92 | 0.27 | - | - |
| CD (p=0.05) | 3.99 | 0.99 | NS | 0.80 | - | - |

Selling price of green gram: Seed @ ₹ 50/kg for RDF, @ ₹ 55/kg seed from organic sources, and straw @ ₹ 1.5/kg

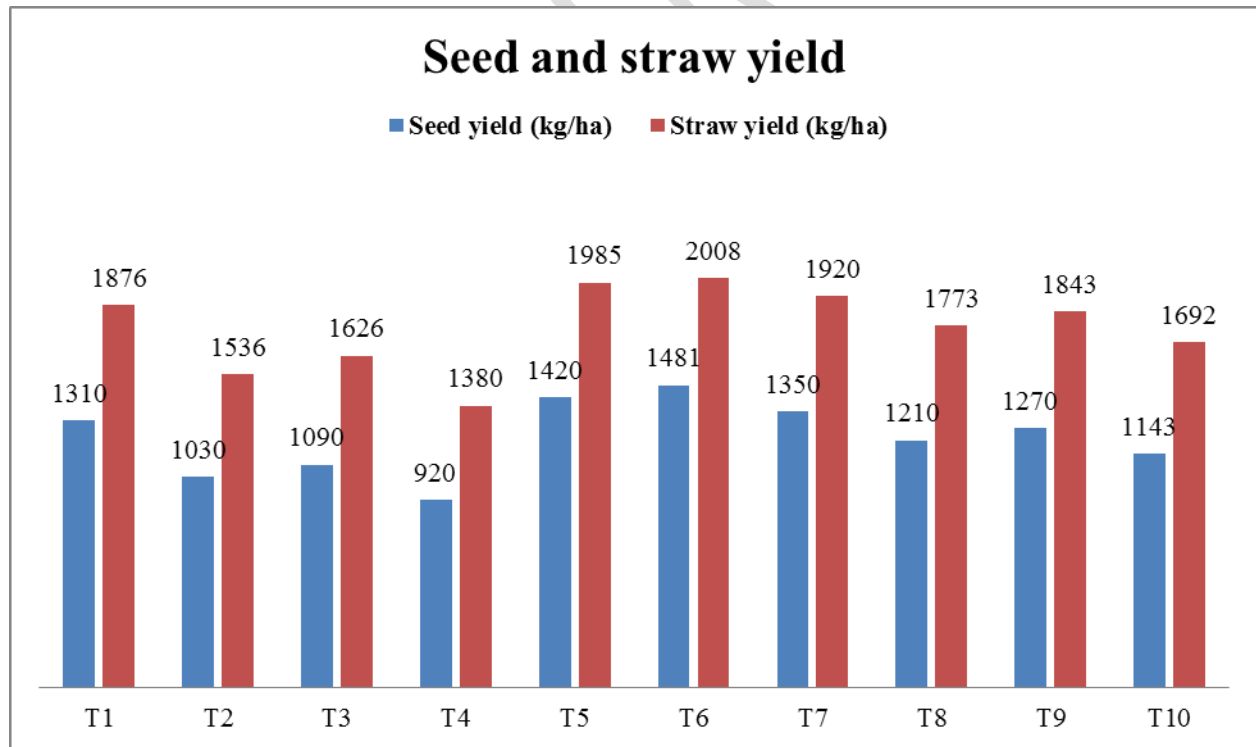


Fig 1: Effect of integrated organic manures treatments on seed and straw yield

QUALITY PARAMETERS

NPK content, uptake and protein content

The evaluation of seed quality criteria of the resulting seed crop is a critical component in determining the planting value and the performance of seeds as a result of treatments. The use of organic manures in conjunction with biofertilizers altered seed nutrient content, absorption, and protein content of green gram.

Different organic manures on nutrient content and uptake by seed and straw were found to be significant (Fig 2). Application of 75% N through vermicompost + seed treatment (5ml kg⁻¹ seed) of *Rhizobium* + Bio NPK consortium 1L ha⁻¹ (T₆) reported higher nitrogen content in seed and straw (3.6 and 0.65 %, respectively) but it remains statistically at par with treatment T₅ (75% N through FYM + ST (5ml kg⁻¹ seed) of *Rhizobium* + Bio NPK consortium 1L ha⁻¹). An application of 75% N through vermicompost + ST (5ml kg⁻¹ seed) of *Rhizobium* + Bio NPK consortium 1L ha⁻¹ (T₆) reported higher NPK uptake by seed (53.27, 7.38 and 9.08 NPK kg ha⁻¹) and straw (12.91, 3.16 and 32.78 NPK kg ha⁻¹). Data presented in Table 2 revealed that green gram seed protein content (22.48%) reported higher by application of 75% N through vermicompost + ST (5ml kg⁻¹ seed) of *Rhizobium* + Bio NPK consortium 1L ha⁻¹ (T₆). Higher nitrogen concentration in biological products might be attributed to organic manure, which contains all macro and trace nutrients and is gradually and slowly released, helping to crop nutrition balance. It also improves the soil environment for root development and proliferation. As a result, plants will absorb more nutrients. resulted in higher nutrient content in seed and stover in green gram (Shariff *et al.* (2017) and Singh *et al.* (2017). In general, The use of organic manure alone or combinations with rhizobium and PSB, was found to improve NPK absorption by both seed and stover, with the combined treatment resulting in a greater uptake (Fig. 2).

ascribed to improved soil fertility and greater nutrient availability and higher nutrient absorption by crop might to due to combined application of organic manures and biofertilizers (Gohain and Kikon, 2017). Significantly higher protein content by application of integrated organic manures treatment. It might be due to the fact that nitrogen from organic manures was continuously available to the crop at all stages of the crop growth, due to slow release of nitrogen through organic sources. Then, resulting later stage nitrogen availability through increased protein content in seed.

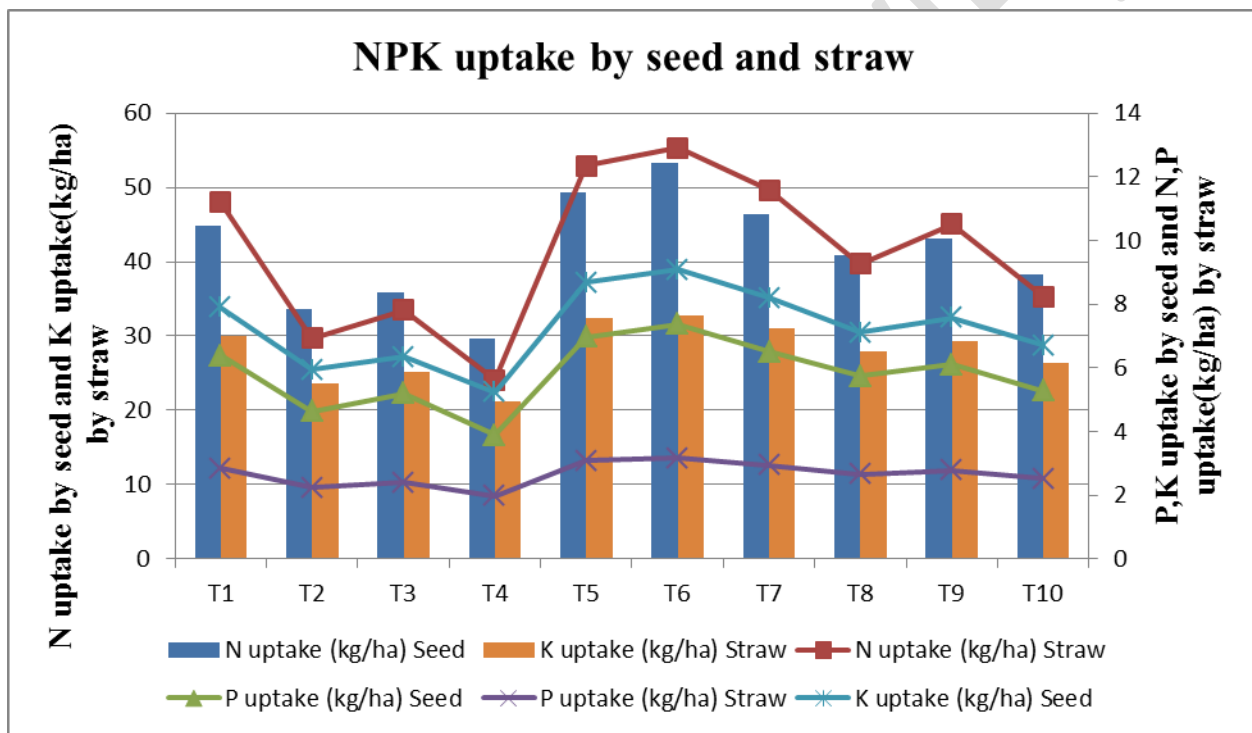


Fig 2: Effect of different organic sources on NPK uptake by seed and straw

ECONOMICS

The Perusal of data show in Table 2 indicated that net returns in green gram were influenced significantly due to various treatments of organic manures. Results presented in Table-2 indicated that the higher net return (₹ 51231/ha) and B:C ratio (2.66) were obtained with application of 75% N through vermicompost + ST (5ml kg⁻¹ seed) of *Rhizobium* + Bio NPK consortium 1L ha⁻¹ and 75% N through FYM + ST (5ml kg⁻¹ seed) of *Rhizobium* + Bio NPK

consortium 1L ha⁻¹ respectively which could be due to the higher seed yield during the growing season, higher selling price of organic treated seed and low cost of FYM. The lowest B:C ratio of 1.61 was recorded under 100% N through castor cake.

CONCLUSION

In order to increase seed yield and quality of green gram as well as maintain soil health, use of the organic sources for fulfilling nutrient requirement to sustain crop productivity and safeguard soil human-environment health is recommended. Thus, it can be concluded that the application of 75% N through vermicompost + ST (5ml kg⁻¹ seed) of *Rhizobium* + Bio NPK consortium 1L ha⁻¹ gave significantly, higher seed yield (1480 kg ha⁻¹), net return (₹ 51231/ha) and B:C ratio (2.66) with the application of 75% N through FYM + ST (5ml kg⁻¹ seed) of *Rhizobium* + Bio NPK consortium 1L ha⁻¹.

ETHICAL APPROVAL: This article does not contain any studies of human participants or animals performed by any of the authors.

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