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Effect of integrated nutrient management on kharif green gram (*Vigna radiata* L.) in red soils of the north-western zone of Tamil Nadu

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Abstract
The pot experiment entitled, "Effect of Integrated nutrient management on Kharif green gram (*Vigna radiata* L.) In red soils of north western zone of Tamil Nadu" was carried out at PGP College Agricultural Sciences, Namakkal, India, during Kharif, 2020. The pot experiment was laid out in completely randomized design with eight treatments of nutrient management and three replication. Growth attributes significantly influence by different nutrient management treatments. The growth attributes at harvest *viz*., plant height (65.4 cm) significantly superior with application of 100% RDF based on STCR (28.05:12.35:11.36 NPK kg ha^{-1}) + Vermicompost @ 6.25 t/ha^{-1} + Seed treatment with rhizobium and phosphorous solubilizing bacteria, which was remained on par with application of T_7-75% RDF + Vermicompost 6.25 t ha^{-1} + Seed treatment with rhizobium and phosphate solubilizing bacteria, 100% RDF based on STCR (28.05:12.35:11.36 NPK kg ha^{-1}) + Vermicompost @ 6.25 t/ha^{-1} and significantly superior over T_2-100% RDF based on STCR (28. 05:12.35:11.36 NPK kg ha^{-1}), T_8-Vermicompost @ 6.25 t/ha^{-1} + Seed treatment with rhizobium and phosphorous solubilizing bacteria, 75% RDF based on STCR (28. 05:12.35:11.36 NPK kg ha^{-1}) and T_1 - Control.
The yield contributing characters like number of pods $plant^{-1}$ (21. 04), length of pod (8.42 cm), weight of pod $plant^{-1}$ (14.38 g), number of grains pod^{-1} (10.2), grain yield $plant^{-1}$ (5.81g) were significantly more with the integrated application of 100% RDF based on STCR (28. 05:12.35:11.36 NPK kg ha^{-1}) + Vermicompost @ 6.25 t/ha^{-1} + Seed treatment with rhizobium and phosphorous solubilizing bacteria and which was remained on par with application of T_7 - 75% RDF + Vermicompost 6.25 t ha^{-1} + Seed treatment with rhizobium and phosphate solubilizing bacteria, 100% RDF based on STCR (28.05:12.35:11.36 NPK kg ha^{-1}) + Vermicompost @ 6.25 t/ha^{-1}, T_3 -100% RDF based on STCR (28.05:12.35:11.36 NPK kg ha^{-1}) + Vermicompost @ 6.25 t/ha^{-1}, T_6, T_8, T_5 and T_1. However, 1000 grains weight (47.49 g) and harvest index (31.61%) futile to reach the level of significance.
On the basis of the result of the pot experiment, it may be inferred that the application of T_4-100% RDF + Vermicompost @ 6.25 t/ha^{-1} + Seed treatment with Rhizobium and Phosphorus solubilizing bacteria had a remarkable effect on the Physio-chemical properties, Growth and Yield attributes of Greengram CO8. It is an effective practice for augmenting higher growth and yield in greengram.

Keywords: Vermicompost, NPK, rhizobium and phosphorous solubilizing bacteria

1. Introduction
In India, total pulses were cultivated during 2017-18 under an area of 293.62 lakh ha with a production of 245.06 lakh tons. India is the major producer of green gram in the world and has grown in almost all the states. It contributes 10% to the entire output of pulses and is cultivated on around 4.5 million hectares, producing 2.5 million tons with a yield of 548 kg/ha. According to the third advance projections from the Indian government, 2.64 million tons of green gram would be produced in 2020–21. (Anonymous, 2020) [1]. Integrated use of inorganic sources of nutrients with organic sources of nutrients helps not solely in maintaining higher productivity but conjointly in providing bigger stability in crop production. The application of organic amendments might increase the availability of macro and micronutrients to plants and will mobilize out-of-stock nutrients to obtainable forms. As an additive impact, nutrient uptake is above artificial fertilizers (Sharma *et al.* 2008) [11].
Despite being a widely adapted crop in India, its productivity is very low. Maximum productivity of crops could be achieved with the maximum use of agrochemicals. The impressive gains in food production were achieved due to the green revolution but due to the intensive use of agrochemicals soil health are being affected.

There is now tremendous scope for growers to use an integrated nutrient management approach to increase productivity and sustain soil health. The organic amendment offers an alternative or supplementing control tactic to increase production (Meena, 2015) [9].

In this context, it is of paramount importance to evolve the strategies for integrated nutrient management. Considering the miserably low amount of organic matter, low fertility status of these soils, low purchasing power of the dryland farmers for fertilizers, a study was undertaken with specific objectives of identifying appropriate integrated nutrient management treatments, to sustain greengram yields and soil productivity.

2. Materials and Methods

2.1 Experimental site

Pot experiment was conducted to June, 2022 at PGP college of Agricultural sciences, Namakkal. The pot experiments were conducted in red soils for studying the influences of combined application of organic and inorganic sources of nutrients in red soils of north western zone of Tamil Nadu and its impact on growth and yield attributes of green gram.

2.2 Pot preparation

Before sowing the seeds the pots were prepared by filling the pots with soil and vermicompost in three replicates. A pot experiment with green gram (CO 8) as a test crop was laid out in a randomized block design and eight treatments.

- T_1: Control
- T_2: 100% RDF
- T_3: 100% RDF + Vermicompost @ 6.25 t/ha
- T_4: 100% RDF + Vermicompost @ 6.25 t/ha + Seed Treatment with Rhizobium and PSB
- T_5: 75% RDF
- T_6: 75% RDF + Vermicompost @6.25 t/ha
- T_7: 75% RDF + Vermicompost @6.25 t/ ha + Seed Treatment with Rhizobium and PSB
- T_8: Vermicompost @6.25 t/ ha + Seed Treatment with Rhizobium and PSB at PGP college of Agricultural sciences, Namakkal. The experimented soils were represented Alfisol soil order (Typic Haplustalfs), with pH slightly acidic to neutral (6.8) and EC (0.49 dSm^{-1}). The soils were low in available nitrogen (118 kg ha^{-1}), available phosphorous (5.7 kg ha^{-1}) and available potassium (101 kg ha^{-1}). The initial organic content of the soils was 0.49%. The details of fertilizers used in the treatment are given below.

Table 1: Details of fertilizer used in this experiment

S. No.	Particulars	Pot experiment
1.	RDF	25:50:25 NPK kg ha^{-1}
2.	RDF Based on STCR Approach	28.05:12.35:11.36 kg of N, P_2O_5 & K_2O
3.	Targeted yield	0.8 t ha^{-1}
4.	Vermicompost	6.25 t ha^{-1}
5.	Nutrient composition (%)	1.50:0.30:0.56 NPK
10.	Time of application	All the treatments received an equal amount of recommended dose of fertilizer. Entire dose of phosphorus was applied as basal and the remaining N & K were applied as the split application respectively. However, vermicompost was applied three days before sowing as per treatment.

The biometric observations were recorded on five randomly selected plants from the pot. These plants were labelled with proper notations and used for recording the observations. Samples for the observations that required destructive sampling were collected from the pot.

2.3 Statistical analysis

The dataset was subjected to statistical analysis following the method of variance described by Gomez and Gomez (1984). At 5% level, least significant difference (LSD) at 5% level was calculated to find significant differences between treatments.

3. Result and Discussion

3.1 Plant height

The data pertaining to mean plant height of greengram recorded at 30, 45 DAS and at harvest as pretentious by different nutrient management treatments are presented in Table 2. From the data, it could be seen that the plant height of greengram increased with the advancement of crop age and reached to its maximum at harvest. The treatment T_4 (100% RDF + Vermicompost 2.5 t ha^{-1} + Seed treatment with *Rhizobium* and phosphorous solubilizing bacteria) recorded taller plant height at all growth stages *viz*., 30, 45 DAS and at harvest (14.9, 40.0 and 65.4 cm). At 45 DAS onwards, treatment T_4 recorded on par with treatment T_7 (75% RDF + Vermicompost 2.5 t ha^{-1} + Seed treatment with *Rhizobium* and phosphorous solubilizing bacteria) (14.8,39.2 and 64.9), T_3 (100% RDF + Vermicompost 2.5 t ha^{-1}) (13.6,37.4 and 63.7) and T6 (75% RDF + Vermicompost 2.5 t ha^{-1}) (13.6,37.0 and 62.8) and it was found significantly superior over the rest of treatments T_2(13.6,35.9 and 59.7), T_8(13.6,35.8 and 58.7), T_5(13.4, 35.2 and 57.9) and T_1(12.6, 31.7 and 51.5). It might be due to highest combined application of nutrient boosted the plant height. However, the significantly smaller plant height was noticed in treatment T_1 (Control) (12.6, 31.7 and 51.5). Similar results have been reported by Arsalan *et al.* (2016) [2], Singh *et al.* (2019) [12], Tyagi and Singh (2019) [13] and also Pandey *et al.* (2019) [10] reported similar results of black gram.

Table 2: Effect of treatments on plant height at different stage of green gram (CO 8) (Mean of three replications)

Treatments	30 DAS (cm)	45 DAS (cm)	At harvest (cm)
T_1- Control	12.6	31.7	51.5
T_2- 100% RDF based on STCR (28. 05:12.35:11.36 NPK kg ha^{-1})	13.6	35.9	59.7
T_3- 100% RDF based on STCR (28. 05:12.35:11.36 NPK kg ha^{-1}) + Vermicompost @ 6.25 t/ha^{-1}	13.6	37.4	63.7
T_4- 100% RDF based on STCR (28. 05:12.35:11.36 NPK kg ha^{-1}) + Vermicompost @ 6.25 t/ha^{-1} + Seed	14.9	40.0	65.4

treatment with rhizobium and phosphorous solubilizing bacteria			
T_5- 75% RDF based on STCR (28. 05:12.35:11.36 NPK kg ha^{-1})	13.4	35.2	57.9
T_6- 75% RDF based on STCR (28. 05:12.35:11.36 NPK kg ha^{-1}) + Vermicompost @ 6.25 t/ha^{-1}	13.6	37.0	62.8
T_7- 75% RDF based on STCR (28. 05:12.35:11.36 NPK kg ha^{-1}) + Vermicompost @ 6.25 t/ha^{-1} + Seed treatment with rhizobium and phosphorous solubilizing bacteria	14.8	39.2	64.9
T_8- Vermicompost @ 6.25 t/ha^{-1} + Seed treatment with rhizobium and phosphorous solubilizing bacteria	13.6	35.8	58.7
CD (P=0.05)	0.273	1.214	2.482
S.Em ±	0.090	0.401	0.821
CV (%)	1.137	1.904	2.347

3.2 Yield Attributing Characters of *Kharif* Green gram

Data regarding yield contributing characters *viz*. number of pods plant^{-1}, mean length of pod (cm), number of grains pod^{-1}, grain yield plant^{-1}, weight of pods plant^{-1} and mean 100 grains weight (g) as affected by various treatments are recorded, analysed and tabulated in Table 3.

Table 3: Effect of treatments on the yield attributing characters of green gram (CO 8) (Mean of three replications)

Treatments	No. of pods per plant	Weight of pods per plant (g)	Length of pod (cm)	No. of grains per pod	Grain yield per plant (g)	Test weight (g)
T_1- Control	13.91	9.91	6.44	6.67	3.04	41.3
T_2- 100% RDF based on STCR (28. 05:12.35:11.36 NPK kg ha^{-1})	18.04	12.52	7.5	8.47	4.67	43.56
T_3- 100% RDF based on STCR (28. 05:12.35:11.36 NPK kg ha^{-1}) + Vermicompost @ 6.25 t/ha^{-1}	19.38	13.39	7.96	9.34	5.41	44.86
T_4- 100% RDF based on STCR (28. 05:12.35:11.36 NPK kg ha^{-1}) + Vermicompost @ 6.25 t/ha^{-1} + Seed treatment with rhizobium and phosphorous solubilizing bacteria	21.04	14.38	8.42	10.2	5.81	46.16
T_5- 75% RDF based on STCR (28. 05:12.35:11.36 NPK kg ha^{-1})	16.84	11.89	6.94	8.27	4.17	42.35
T_6- 75% RDF based on STCR (28. 05:12.35:11.36 NPK kg ha^{-1}) + Vermicompost @ 6.25 t/ha^{-1}	18.44	13.06	7.8	9.14	4.97	44.04
T_7- 75% RDF based on STCR (28. 05:12.35:11.36 NPK kg ha^{-1}) + Vermicompost @ 6.25 t/ha^{-1} + Seed treatment with rhizobium and phosphorous solubilizing bacteria	20.18	13.77	8.21	9.6	5.64	45.73
T_8- Vermicompost @ 6.25 t/ha^{-1} + Seed treatment with rhizobium and phosphorous solubilizing bacteria	17.38	12.13	7.17	8.4	4.47	42.81
CD (P=0.05)	0.849	0.374	0.304	0.478	0.269	1.633
S.Em ±	0.281	0.124	0.101	0.158	0.089	0.540
CV (%)	2.680	1.696	2.307	3.122	3.227	2.133

3.2.1 Number of Pods Plant^{-1}

The mean number of pods plant^{-1} recorded at harvest which was significantly influenced by different nutrient management treatments. The maximum number of pods plant^{-1} (21.04) were found under the treatment of T_4 (100% RDF + Vermicompost 2.5 t ha^{-1} + Seed treatment with *Rhizobium* and phosphorus solubilizing bacteria which was on par with T_7 (75% RDF + Vermicompost 2.5 t ha^{-1} + Seed treatment with *Rhizobium* and phosphorus solubilizing bacteria) (20.18), T_3 (100% RDF + Vermicompost 2.5 t ha^{-1}) and T_6 (75% RDF + Vermicompost 2.5 t ha^{-1}) treatments and it was found significantly superior over the rest of treatments *viz*., T_2, T_5, T_8 and T_1 treatment. In control treatment (T_1) due to unavailability of sufficient nutrients, significantly less mean number of pods plant^{-1} (13.91) were recorded. These results are in line with those findings reported by Kalaiyarasi *et al.* (2019) [5] and Arsalan *et al.* (2016) [2] on green gram, Chaudhary *et al*. (2016) [3] on black gram, Verma *et al.* (2017) [14] and Konthoujam *et al.* (2013) [7] on soybean.

3.2.2 Weight of pods Plant^{-1} (g)

Data presented in Table 3 reveals that the weight of pods plant^{-1} was significantly influenced by various nutrient management treatments to *Kharif* greengram. Crop fertilized with 100% RDF + Vermicompost 2.5 t ha^{-1} + Seed treatment with *Rhizobium* and phosphorus solubilizing bacteria (T_4) recorded highest mean weight of pods plant^{-1} (14.38 g) at harvest and found statistically on par with T_7 (75% RDF + Vermicompost 2.5 t ha^{-1} + Seed treatment with *Rhizobium* and phosphorus solubilizing bacteria) (13.77 g), T_3 (100% RDF + Vermicompost 2.5 t ha^{-1}) and T_6 (75% RDF + Vermicompost 2.5 t ha^{-1}) treatments, where it was found significantly superior over the treatments T_2, T_8, T_5 and T_1. Among this all treatments, T_1 (Control) recorded significantly lowest weight of pods plant^{-1} (9.91 g).

3.2.3 Length of Pod (cm)

The data regarding to pod length of *Kharif* greengram as affected by different nutrient management treatments are mentioned in Table 8 was indicates that the significant effect on mean length of pod. Integrated application of 100% RDF + Vermicompost 2.5 t ha^{-1} + Seed treatment with *Rhizobium* and phosphorus solubilizing bacteria (T_4) resulted in longest length of pod (8.42 cm), it was observed significantly superior over the treatments T_2, T_8, T_5 and T_1. However, it was found on par with treatment T_7 (75% RDF + Vermicompost 2.5 t ha^{-1} + Seed treatment with *Rhizobium* and phosphorus solubilizing bacteria), T_3 (100% RDF + Vermicompost 2.5 t ha^{-1}) and T_6 75% RDF + Vermicompost 2.5 t ha^{-1}). Similar results also were reported earlier by Mandal *et al.* (2019) [8] on cowpea and Kale (2017) [6] in green gram.

3.2.4 Number of Grains Pod^{-1}

The data on mean number of grains pod^{-1} was tabulated in Table 3 shows that the differences in number of grains pod^{-1} was succeeded to reach the level of significance under different nutrient management treatments.

The treatment T_4 of 100% RDF + Vermicompost 2.5 t ha^{-1} + Seed treatment with *Rhizobium* and phosphorus solubilizing bacteria (10.2) was found at par with comparatively good treatment T_7 (75% RDF + Vermicompost 2.5 t ha^{-1} + Seed treatment with *Rhizobium* and phosphorus solubilizing bacteria), T_3 (100% RDF + Vermicompost 2.5 t ha^{-1}), T_6 (75% RDF + Vermicompost 2.5 t ha^{-1}) and T_2 (100% RDF). However, it was recorded significantly superior number of grains pod^{-1} over the treatments T_2, T_8, T_5 and T_1. The minimum number of grains pod^{-1} (6.67) noticed in control treatment (T_1), which was found significantly inferior over the all treatments.

These results are similar with those findings reported earlier by Kalaiyarasi *et al.* (2019) [5] and Arsalan *et al.* (2016) [2] on greengram, Chaudhary *et al.* (2016) [3] on black gram, Verma *et al.* (2017) [14] and Konthoujam *et al.* (2013) [7] on soybean.

3.2.5 Grains Yield Plant^{-1}

The data on mean grains yield $plant^{-1}$ was tabulated in table 3 shows that the differences mean grains yield $plant^{-1}$ was reached the level of significance under different nutrient management treatments.

The application of T_4-100% RDF + Vermicompost 2.5 t ha^{-1} + Seed treatment with *Rhizobium* and phosphorus solubilizing bacteria was resulted in highest grain yield $plant^{-1}$ (5.81 g) and it was found at par with comparatively good treatment T_7 [75% RDF + Vermicompost 2.5 t ha^{-1} + Seed treatment with *Rhizobium* and phosphorus solubilizing bacteria], T_3 (100% RDF + Vermicompost 2.5 t ha^{-1}), T_6 (75% RDF + Vermicompost 2.5 t ha^{-1}) and T_2 (100% RDF) except treatments T_2, T_8, T_5 and T_1. Which was found significantly inferior. The minimum mean number of grains yield $plant^{-1}$ (3.04 g) noticed in control treatment (T_1), which was found significantly inferior over the all treatments.

Almost all yield attributing characters of *Kharif* greengram increased with combined application of organic and inorganic fertilizer. Highest yield characters recorded due to increased vegetative growth and balanced C: N ratio which leads to greater carbohydrate synthesis. Also greater portioning of plant metabolites and adequate nutrient supply from combined source (organic and inorganic) resulted in improved yield characters.

3.2.6 Test Weight (g)

The data furnished in Table. 3 indicated that differences in test weight of *Kharif* green gram was failed to reach the level of significance under different treatments of nutrient management because of generally less influence of biotic and abiotic factors on *Kharif* green gram. Numerically higher test weight (46.16 g) was recorded in treatment T_4 due to integration of 100% RDF + Vermicompost 2.5 t ha^{-1} + Seed treatment with *Rhizobium* and phosphorus solubilizing bacteria, whereas, numerically lowest test weight (41.3 g) was recorded in control treatment (T_1). Similar results also was reported Konthoujam *et al*. (2013) [7] on soybean.

4. Conclusion

On the basis of the result of the pot experiment, it may be inferred that the application of T_4-100% RDF + Vermicompost @ 6.25 t/ha^{-1} + Seed treatment with Rhizobium and Phosphorus solubilizing bacteria had a remarkable effect on the Physio- chemical properties, Growth and Yield attributes of Greengram CO8. It is an effective practice for augmenting higher growth and yield in greengram.

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