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Research Paper

Production potential and economics of greengram (*Vigna radiata*) under differential substitution of nutrients through organics in subtropics of Jammu region

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ABSTRACT

A field experiment was conducted during the summer season of 2016 and 2017 at Chatha, Jammu and Kashmir, to study the effect of differential substitution of nutrients through organics on growth, yield and economics of greengram [*Vigna radiata* (L.) R. Wilczek]. Growth parameters (plant height and dry-matter accumulation at the time of harvesting); seeds/pod and seed yield of greengram were significantly highest in 100% recommended dose of fertilizer (RDF); however, these treatments were statistically at par with treatments wherein differential substitution of nutrients was done with organic sources, viz. 75% NPK + 25% N through vermicompost and farmyard manure (FYM) (1 : 1), 25% yearly replacement of RDF through vermicompost and FYM (1 : 1) on N basis, 75% NPK + 25% N through vermicompost, 25% yearly replacement of RDF through vermicompost on N basis, 75% NPK + 25% N through FYM and 25% yearly replacement of RDF through FYM with per cent increase during both the year of experimentation. The highest increase (16.85%) in seed yield of greengram during summer 2017 over summer 2016 was recorded in treatment 100% N through FYM, whereas the lowest increase in seed yield of greengram was recorded with treatment 100% recommended dose of fertilizer through in organics. Likewise, the maximum net returns (₹33.69 × 10^3/ha and ₹41.94 × 10^3/ha) were realized with 100% (RDF) followed by treatment 25% NPK + 75% N through vermicompost and FYM (1 : 1) with net returns (₹32.44 × 10^3/ha and ₹41.22 × 10^3/ha), whereas the minimum net returns (₹12.71×10^3/ha and ₹20.60 × 10^3/ha) were recorded with treatment 25% NPK +75 % N through vermicompost during both summer season of 2016 and 2017 respectively.

Key words **:** Economics, Growth, FYM, Substitution, Vermicompost, Yield

Among the pulses, greengram is one of the ancient and the third important conventional pulse crops cultivated throughout India and is adopted and acclimatized over wide range of agro-climatic zones of India for its multipurpose uses as vegetable, pulse, fodder and greenmanure crop with soil restorative characteristics. Greengram is considered as a substitute of animal protein and forms a balanced diet when used with cereals (Delice *et al.,* 2011). An important feature of the greengram crop is its ability to establish a symbiotic partnership with specific bacteria for setting up the biological nitrogen fixation in root nodules that supply the nitrogen to the plant. Being a legume crop, it fixes 40–42 kg nitrogen per hectare (Mahmood and Athar, 2008; Mandal *et al*, 2009). Soil health is an important factor for crop production. Use of inorganic fertilizers and organic manures helps in improving and maintaining of soil fertility for sustaining crop productivity. Farmyard manure and vermicompost, both contain both macro and micronutrients whose application in soil, results in improved soil physic-chemical and biological conditions by significantly increasing the level of N-fixation. Increased health consciousness among the masses has augmented the demand for safe and quality foods for which a comprehensive organic food-production technology needs to be developed with emphasis on quality enhancement and yield stability in comparison to the yield and quality aspects realized under conventional practices of crop production. The differential substitution of organic fertilizers with organic manures helps maintain soil productivity, ensure sustainable productivity, reduce the cost of inorganic fertilizers and prevents the environment from ill effects of inorganic fertilizers. Therefore, the present experiment was planned to assess the production and productivity of greengram with differential substitution of nutrients through organics under subtropics of Jammu region.

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MATERIAL AND METHODS

A field experiment was conducted at the Sher-e-Kashmir University of Agricultural Sciences and Technology-Jammu at main campus Chatha geographically situated at 32.65^{O} N and 74.88^{O} E and at an altitude of 300 m above from mean sea-level. The soil of the experimental site was sandy-clay loam in texture, with bulk density (1.44 g/cc), slightly alkaline (*p*H 7.81), low organic carbon (0.45%) and nutrient status of the soil at the beginning of greengram experiment was low in available nitrogen (249.88 kg/ha) and medium in available phosphorus (13.79 kg/ha) and available potassium (148.45 kg/ha) with electrical conductivity (0.20 ds/m). The experiment was laid out in randomized block design with 3 replications. Sixteen treatments comprising of $T_{1,}$ 100% NPK (recommended dose of fertilizer–RDF); T_2, 75% NPK + 25% N through vermicompost; T_3, 50% NPK + 50% N through vermicompost; T_4, 25% NPK + 75% N through vermicompost; T_5, 100% N through vermicompost; T_6, 25% yearly replacement of RDF through vermicompost; T_7, 75% NPK + 25% N through FYM; T_8, 50% NPK + 50% N through FYM; T_9, 25% NPK + 75% N through FYM; T_{10}, 100% N through FYM; T_{11}, 25% yearly replacement of RDF through FYM; T_{12}, 75% NPK + 25% N through vermicompost and FYM (1:1); T_{13}, 50% NPK + 50% N through vermicompost and FYM (1 : 1); T_{14}, 25% NPK + 75% N through vermicompost and FYM (1 : 1); T_{15}, 100% N through vermicompost and FYM (1 : 1); T_{16}, 25% yearly replacement of RDF through vermicompost and FYM (1 : 1). Greengram variety 'SML 668' was used in the experiment during both the years. The recommended dose of nutrient for 'SML 668' was nitrogen 16 kg/ha and phosphorus 40 kg/ha as per the package and practice. The inorganic fertilizers and organic manures (vermicompost and FYM) were applied to the crop as per the treatment.

The quantities of different sources of organics, as per the need of the treatments, were worked out on the basis of percent N content in each of these sources to meet the recommended nitrogen in greengram. The percent nitrogen content (1.61 and 1.62), phosphorus content (0.80 and 0.79) and potassium content (0.73 and 0.72) was present in vermicompost used in the experiment during 2016 and 2017 whereas in FYM used in the greengram crop the per cent nitrogen content was 0.62 and 0.57, phosphorus content 0.24 and 0.25 and potassium content 0.29 and 0.30 during both the years. Seed rate of 15 kg/ha of variety 'SML 668' was used in the experiment. Furrows were opened manually with the help of liner and greengram was sown at specified spacing of 30 cm × 10 cm. To maintain the healthy crop stand gap-filling at 8–9 days after sowing (DAS) and thinning at 15–16 DAS was done in greengram. Two irrigations were given to the crop during both the years. Weeds were controlled manually. Greengram sowing was done on same date 13 April during summer 2016 and 2017 and was harvested at its physiological maturity stage. This stage was recognized by uniform shedding of leaves and brown-black colour of pods with hard seed inside them. Hand-pickings of pods moist were done during morning hours to avoid pod shattering. Pods of each net plot on complete drying were threshed manually and finally winnowed to separate the chaff from the seeds plotwise and harvesting was done 79–82 DAS in different pickings during both the seasons. Plant height of all the 5 tagged plants of greengram was measured from each plot. All the above-ground biomass of the 3 random plants from the second row at harvest maturity was chopped into small pieces, sundried for 2–3 days and thereafter shifted in the oven to dry at a temperature of 65 ± 5^{O}C till a constant weight was achieved. The average dry-matter accumulation/plant was recorded and expressed as dry weight in g/plant. At the time of harvesting 3 spots each of 1 m^2 were randomly selected by throwing the 1 m^2 quadrant in the net plot. The number of plants from each of the randomly selected spot within the net plot were counted and averaged to express number of plants/m^2. The number of pods/plant on 5 random plants for the growth studies were counted and averaged to express the number of pods/plant. Ten randomly selected pods from bulk produce of greengram from each net plot were threshed and the seeds so obtained were counted and averaged to express number of seeds/pod. A random sample of seeds from the bulk of thrashed produce of each net plot was taken and 100 seeds of each net plot were counted and weighed. The weight was expressed as 100-seed weight of greengram in gram. Pods from each net plot were weighed separately and sundried for 3–4 days. After drying, pods were threshed and seeds were cleaned. The final seed weight was recorded and expressed in q/ha as per the conversion given below:

Seed yield, gross and monetary returns and benefit: cost ratio were calculated:

The data of 2 years were analysed as per the procedure given by Gomez and Gomez (1984). LSD values at (P=0.05) were used to determine the significance of difference between the treatments.

RESULTS AND DISCUSSION

Growth parameters

Plant height and dry-matter accumulation at maturity in greengram were significantly influenced by differential substitution of nutrients through organics (Table 1). Among all the treatments, significantly highest growth parameters of greengram were recorded with treatment 100% recommended dose of fertilizer than all the other treatments. Treatment of 100% recommended dose of fertilizer was

found statistically at par with treatments 75% NPK + 25% N through vermicompost and FYM (1 : 1), 25% yearly replacement of RDF with vermicompost and FYM (1 : 1) on N basis, 75% NPK + 25% N through vermicompost, 25% yearly replacement of RDF with vermicompost on N basis, 75% NPK + 25% N through FYM, 25% yearly replacement of RDF with FYM on N basis in plant height and dry-matter accumulation of greengram both the years. Significantly lowest plant height and dry-matter accumulation at harvesting during both the years was recorded with treatment in which 100% N was substituted through FYM which was found statistically at par with treatment 100% N through vermicompost, 100% N through vermicompost and FYM (1 : 1), 25% NPK + 75% N through FYM, 25% NPK + 75% N through vermicompost and 25% NPK + 75% N through vermicompost and FYM (1 : 1). The highest increase (7.53%) in plant height was recorded in summer 2017 over 2016 with treatment 100% N through FYM where increase in plant height with treatment of 100recommended dose of fertilizer was 3.70%. This might be because combined application of inorganic and organic to greengram increased the availability of major nutrients to the plants which might have enhanced early root growth and cell multiplication leading to more absorption of nutrients from deeper layers of soil, resulting in increased dry-matter accumulation. Our results conformity with findings of Borse *et al.* (2002) and Kohler *et al*. (2008).

Table 1. Effect of differential substitution of nutrients through organics on growth parameters of greengram during summer 2016 and 2017

Treatment	Plant height (cm)		Dry-matter accumulation (g/plant)	
	SY_1	SY_2	SY_1	SY_2
T_1	56.7	58.8	12.3	13.5
T_2	55.7	57.3	12.1	13.4
T_3	45.2	47.5	10.5	11.8
T_4	37.9	40.5	9.3	10.2
T_5	37.5	40.2	9.12	10.0
T_6	53.4	56.2	12.0	13.4
T_7	52.9	55.6	11.9	13.3
T_8	44.9	47.4	10.6	11.7
T_9	37.8	40.5	9.2	10.2
T_{10}	37.2	40.0	9.0	9.7
T_{11}	52.8	55.7	11.9	13.3
T_{12}	56.3	58.6	12.3	13.5
T_{13}	45.7	48.1	10.6	11.9
T_{14}	38.0	40.8	9.3	10.3
T_{15}	37.7	40.3	9.1	10.1
T_{16}	56.0	57.5	12.2	13.4
SEm±	2.2	2.4	0.4	0.5
CD (P=0.05)	6.5	6.9	1.2	1.4

SY_1, Summer 2016; SY_2, Summer 2017
Details of treatments are given under Materials and Methods

Yield and yield attributes

Seed yield of crop is the result of different combinations

Table 2. Effect of differential substitution of nutrients through organics on yield attributes and yield of greengram during summer 2016 and 2017

Treatment	Plants/m^2		Pods/plant		Seeds/pod		100-seed weight (g)		Seed yield (q/ha)	
	SY_1	SY_2	SY_1	SY_2	SY_1	SY_2	SY_1	SY_2	SY_1	SY_2
T_1	31.8	32.0	9.5	11.2	9.0	9.0	4.4	4.4	9.6	10.4
T_2	31.2	31.4	9.7	11.6	8.8	8.9	4.4	4.4	9.3	10.3
T_3	28.8	29.4	11.6	13.4	6.9	7.0	4.2	4.3	7.7	8.6
T_4	27.6	28.0	13.4	15.5	5.3	5.4	4.1	4.1	6.2	7.2
T_5	27.0	27.2	14.0	16.0	5.1	5.2	4.0	4.1	6.1	7.2
T_6	31.0	31.2	9.8	11.6	8.7	8.7	4.3	4.4	9.3	10.2
T_7	30.8	31.0	9.8	11.7	8.6	8.7	4.3	4.3	9.3	10.2
T_8	28.6	29.2	11.7	13.5	6.7	6.7	4.2	4.2	7.7	8.6
T_9	27.4	27.8	13.6	15.7	5.3	5.4	4.1	4.1	6.2	7.2
T_{10}	26.9	27.0	14.2	16.2	5.0	5.1	4.0	4.0	6.1	7.1
T_{11}	30.6	30.8	9.9	11.8	8.5	8.6	4.3	4.3	9.2	10.2
T_{12}	31.6	31.8	9.6	11.4	8.9	9.0	4.4	4.4	9.4	10.4
T_{13}	29.0	29.6	11.4	13.4	7.3	7.3	4.2	4.3	7.7	8.6
T_{14}	27.8	28.2	13.3	15.0	5.4	5.6	4.1	4.2	6.2	7.3
T_{15}	27.2	27.4	13.8	15.9	5.2	5.2	4.0	4.1	6.2	7.2
T_{16}	31.4	31.6	9.6	11.47	8.8	8.9	4.4	4.4	9.4	10.4
SEm±	1.3	1.78	0.5	0.5	0.4	0.4	0.3	0.6	0.5	0.4
CD (P=0.05)	N.S	N.S	1.45	1.48	1.26	1.13	N.S	N.S	1.36	1.28

SY_1, Summer 2016; SY_2, Summer 2017
Details of treatments are given under Materials and Methods

of physiological process based on the environment under which crop was grown. Final yield of the crop is a function of all the components of source and sink operating at different phenophases of the plant. Significant effect of differential substitution of nutrients through organics was observed on number of seeds/pod and seed yield of green gram.

Significantly highest number of seeds/pod and seed yield were recorded with 100% recommended dose of fertilizer among all the treatments. Treatment of 100% recommended dose of fertilizer was found statistically at par with treatments in which 25% NPK + 75% N through vermicompost and FYM (1:1), 25% NPK + 75% N through vermicompost, 25% NPK + 75% N through FYM during both the years. Significantly lowest yield and yield attributes were recorded with treatment in which 100% N was substituted through FYM. Treatment in which 100% N was substituted through organics either through vermicompost, FYM and vermicompost and FYM in (1 : 1) combination were also found statistically at par with each other for yield and yield attributes of greengram during both the years. The highest increase (16.85%) in seed yield of during summer 2017 over summer 2016 was recorded in treatment T_{10}, (100% N through FYM) followed by treatments $T_{14,}$ $T_{15,}$ $T_{5,}$ $T_{9,}$ $T_{4,}$ $T_{8,}$ $T_{13,}$ $T_{3,}$ $T_{2,}$ $T_{12,}$ $T_{16,}$ $T_{11,}$ $T_{6,}$ T_{7} and T_{1} with per cent increase in seed yield to the tune of 16.83, 16.6, 16.57, 16.57, 16.48, 12.00, 11.92, 11.91, 10.69, 10.65, 10.48, 10.09, 9.75, 9.59 and 9.20% in the decreasing order respectively. This was due to reason that balanced nutrition in greengram with recommended dose of fertilizer. Also, highest yield and yield attributes were recorded in treatments in which 75% inorganic + 25% N was substituted through organics (vermicompost, FYM and vermicompost and FYM (1 : 1) because of the efficacy of inorganic fertilizers is much pronounced when it is combined with vermicompost and FYM. These results confirm the findings of Munirathnam *et al*, (2004).

Economics

The maximum cost of cultivation of greengram was recorded with treatment in which 100 % N was substituted through vermicompost (₹19.92 × 10^3/ha and ₹19.87 × 10^3/ha), whereas the minimum in treatment in which 100% N was substituted through farmyard manure (Table 3) during summers of 2016 and 2017. The highset cost of cultivation in these in treatment was due high per kg cost of vermicompost associated with this treatment, whereas the lowest in treatment 100% N through FYM was due to low per kg cost of FYM associated with these treatment during both the years. The maximum gross returns (₹49.95 × 10^3/ha and ₹58.20 × 10^3/ha) and net returns (₹33.69 × 10^3/ha and ₹41.94 × 10^3/ha) were recorded with treatment recommended dose of fertilizer followed by treatment 75% NPK + 25% N through vermicompost and FYM (1 : 1) with gross returns and net returns during summer 2016 and summer 2017. The highest benefit cost ratio (2.07 and 2.58) of greengram during summers of 2016 and 2017 was also recorded with recommended dose of fertilizer. Difference in net returns and benefit: cost ratio might be due to cumulative effects of yield and price of greengram under these

Table 3. Effect of differential substitution of nutrients through organics on economics of green gram during summer 2016 and 2017

Treatment	Cost of cultivation (× 10^3 ₹/ha)		Gross returns (× 10^3₹ /ha)		Net returns (× 10^3₹ /ha)		Benefit: cost ratio	
	SY_1	SY_2	SY_1	SY_2	SY_1	SY_2	SY_1	SY_2
T1	16.26	16.26	49.95	58.20	33.69	41.94	2.07	2.58
T2	17.41	17.40	48.80	57.65	31.39	40.25	1.80	2.31
T3	18.54	18.52	40.18	48.00	21.64	29.48	1.17	1.59
T4	19.69	19.65	32.40	40.25	12.71	20.60	0.65	1.05
T5	19.92	19.87	34.94	42.90	15.03	23.03	0.75	1.16
T6	17.41	18.52	48.54	56.87	31.13	38.35	1.79	2.07
T7	16.07	16.12	48.49	56.70	32.42	40.57	2.02	2.52
T8	15.86	15.97	40.13	47.95	24.27	31.97	1.53	2.00
T9	15.86	15.83	32.24	40.08	16.38	24.26	1.03	1.53
T10	14.55	14.77	34.77	42.78	20.22	28.01	1.39	1.90
T11	16.07	15.97	48.17	56.59	32.11	40.62	2.00	2.54
T12	16.68	16.76	49.12	57.98	32.44	41.22	1.94	2.46
T13	17.20	17.24	40.28	48.11	23.08	30.87	1.34	1.79
T14	17.67	17.74	32.50	40.53	14.83	22.79	0.84	1.28
T15	17.23	17.32	35.06	43.02	17.82	25.70	1.03	1.48
T16	16.68	17.24	49.01	57.76	32.33	40.51	1.94	2.35

SY_1, Summer 2016; SY_2, Summer 2017
Details of treatments are given under Materials and Method

treatments during the respective years. These are in agreement with the findings of Yakadri *et al.* (2004).

Thus recommended dose of fertilizer in greengram (16 N : 40 P_2O_5 kg/ha) and 75% NPK + 25% N through vermicompost and FYM (1 : 1) were adjudged as the best treatments with regard to crop-growth parameters, yield and yield attributes, net returns, and benefit: cost ratio during summers of 2016 and 2017, whereas amongst the different organic soil nutrition treatments, 100% N through vermicompost and FYM (1 : 1) proved as the best treatment in realizing growth, yield and yield attributes and net returns of the 'SML 668' during both the years. Further, for substitution of nutrients, in greengram, for immediate shifting from inorganics to organics combination of vermicompost and FYM (1 : 1) can be the best option for early realization of yield at par with recommended dose of fertilizer.

REFERENCES

Borse, P.A., Pawar, V.S. and Tumbare, A.D. 2002. Response of mung bean (*Phaseolus radiatus*) to irrigation schedule and fertilizer levels. *Indian Journal of Agricultural Sciences* **72**(7): 418–420.

Delice D., Stajkovic-Sibrinovic O., Kuzmanovic, D., Rasulic, N., Mrvic, V., Andjelovic, S. and Knezevic-Vukcevic, J. 2011. Effects of bradyrhizobial inoculation on growth and seed yield of mung bean in Fluvisol and Humoflovisol. *African Journal of Microbiology Research*. **5**(23): 3,946–3,957.

Gomez, K.A. and Gomez, A.A. 1984. *Statistical Procedure for Agricultural Research*, edn 2, An international Rice Research Institute Book. Wiley-Inter Science Publication, John Wiley & Sons, New York.

Kohler, J., Hernandez, J.A., Caravaca, F. and Roldan, A. 2008. Plant growth promoting *rhizobacteria* and arbuscular mycorrhizal fungi modify alleviation biochemical mechanisms in water stress plants. *Functional Plant Biology* **35**: 141–151.

Munirathram, P., Reddy, B.S. and Sawadhakar, S.M. 2004. Conjuctive use of organic, inorganic and biofertilizers for cost effective production of foxtail millet (*Seteria italica*). *National Symposium on Resources Conservation and Agricultural Productivity*, 22–25 November 2004, Ludhiana Punjab.

Mahmood, A. and Athar, M. 2008. Cross inoculation studies: Response of *Vigna mungo* to inoculation with rhizobia from tree legumes growing under arid environment. *International Journal of Environmental Sciences and Technology* **5**: 135–139.

Mandal, S., Mandal, M., Das, A., Pati, B. and Ghosh, A. 2009. Stimulation of indoleacetic acid production in a *Rhizobium* isolate of *Vigna mungo* by root nodule phenolic acids. *Archives of Microbiology* **4**: 389–393.

Yadkari, M., Ramesh, T. and Latchanna, A. 2004. Dry matter production and nutrient uptake of mung bean [*Vigna radiata* (L.) Wilczek] as influenced by nitrogen and phosphorus application during wet season. *Legume Research* **27**(1): 58–61.