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Influence of Differential Substitution of Nutrients through Organics on Growth, Yield and Nutrient Content of Green Gram (*Vigna radiata*) in Irrigated Sub-tropical Region of J and K

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ABSTRACT

Background: Green gram is the important pulse crop of India and grown under extensive agroclimatic condition in India for its versatile uses. Moreover, extreme and inappropriate use of inorganic nutrients deteriorated the soil quality by reducing the soil microbial population and also declined the quality of crops. Now a days, majority of population living in urban and rural area had demand for safe and healthy food for which inclusive food production technology needs to be developed with priority on quality enhancement and yield stability. In fact, it is not possible for farmers to directly shift from inorganic source of nutrients to organics in their crop production as it may lead to decrease in crop yields in the initial years. This may be possible due to substitution of organic sources of nutrients in place of inorganics to fulfil the crop nutrient requirement for accomplishing higher and stable crop yield of better quality with upgradation in soil health. Therefore, the present study was carried out to evaluate the influence of differential substitution of nutrients through organics on growth, yield and nutrient content of green gram (*Vigna radiata*) in irrigated sub-tropical region of J and K.

Methods: The experiment was conducted for two consecutive years in field during summer 2016 and 2017 at research farm of division of Agronomy located at latitude and longitude of 32°40′ N and 73°64′ E at SKUAST-Jammu. Experiment was laid out with 16 treatments and three replications. Green gram variety “SML-668” was grown as per their respective recommended packages of cultivation except for the nutrient-N and its organic sources which were applied as per the treatments. Nutrient content of green gram was worked out in the laboratory following standard procedures.

Result: The pooled result of the two-year study of green gram concluded that significantly highest growth parameters and yield of green gram were recorded with treatment 100% recommended dose of fertilizer whereas significantly lowest value of all these parameters were recorded with treatment 100% NPK through FYM. Numerically highest value of NPK content in seed and stover of green gram after two-year experiment was recorded with treatment 100% NPK through FYM whereas highest gross returns, net returns and B:C ratio were recorded with treatment 100% recommended dose of fertilizer when compared with other treatments.

Key words: Economics, Green gram, Growth, Nutrient content, Yield.

INTRODUCTION

Among the pulses, green gram [*Vigna radiata* (L.) Wilczek] is one of the ancient and the third important conventional pulse crop 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 green manure crop with soil restorative characteristics. Its seeds contain 24.7 per cent protein which is almost 2.5-3.0 times more than the cereals, 0.6 per cent fat, 0.9 per cent fibre and 3.7 per cent ash. It is a cheaper source of protein and designated as “Poor man’s meat” and “rich man’s vegetable” (Abbas *et al.,* 2011). An important feature of the moong bean 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 plant’s need for nitrogen (Mandal *et al.*, 2009). Reduction of land resources tied with increased demand for food to feed the escalating population has over exploited the cultivated lands and posed a serious challenge to the traditional resilience characteristics of these crop lands. Furthermore, imbalanced and inappropriate use of inorganic nutrients has not only worsened the soil resource base by reducing the population of beneficial micro-organisms and also deteriorated the quality of the crops. Increased health consciousness among the masses has augmented the demand for safe and quality foods for which a comprehensive food production technology needs to be developed with emphasises on quality

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enhancement and yield stability in comparison to the yield and quality aspects realized under conventional practices of crop production. In fact, it is not affordable for an average Indian farmer to jump immediately from inorganic source of nutrients to organics in their crop production programme as it may lead to unbearable drastic reduction in crop yields in the initial years. This may become possible through the differential substitution of nutrients through organics. Therefore, this research was framed to study the influence of differential substitution of nutrients through organics on growth, yield and nutrient content of green gram (*Vigna radiata*) in irrigated sub-tropical region of J and K.

MATERIALS AND METHODS

The experimental study was conducted at research farm of division of Agronomy at SKUAST-Jammu, Main campus Chatha for consecutive 2 years *i.e* during summer 2016 and summer 2017. The experimental site was located at a latitude of 32°40′ N and longitude of 73°64′ E at an elevation of 293 meters above mean sea level in irrigated sub-tropical region of J and K. The meteorological data with regard to rainfall, temperature and relative humidity acquired from the meteorological observatory located in the vicinity of experimental site at Research Farm, Chatha of SKUAST-Jammu. The experimental site was sandy clay loam in texture with sand (62.52%), Silt (11.73%) and Clay (27.75%) by Bouyoucos hydrometer method (Piper, 1966). The investigation of the initial soil sample of the experimental field revealed that soil of the field had bulk density (1.44 g/cc), porosity (45.66%) and cation exchange capacity [11.09C(mol (p+)/kg]. Soil of the experimental site was medium in available phosphorus (13.79 kg/ha) and potassium (148.45 kg/ha) but low in available nitrogen (249.88 kg/ha). Experiment was laid out in randomized block design with sixteen treatments and three replications during summer 2016 and 2017. The sixteen treatments included 100% NPK(Recommended dose of fertilizer)-T_1; 75% NPK+25% N through vermicompost -T_2; 50% NPK+50% N through vermicompost -T_3; 25% NPK+75% N through vermicompost -T_4;100% N through vermicompost -T_5; 25% yearly replacement of RDF through vermicompost on N basis -T_6; 75% NPK+ 25% N through Fym -T_7 ; 50% NPK+50% N through Fym -T_8; 25% NPK+75% N through Fym -T_9; 100% N through Fym -T_{10}; 25% yearly replacement of RDF through Fym on N basis-T_{11}; 75% NPK+25% N through vermicompost and Fym (1:1)-T_{12}; 50% NPK+50% N through Vermicompost and Fym (1:1)-T_{13}; 25% NPK+75% N through vermicompost and Fym (1:1) -T_{14}; 100% N through vermicompost and Fym (1:1)-T_{15}; 25% yearly replacement of RDF through vermicompost and Fym (1:1) on N basis -T_{16}. The green gram variety SML-668 was taken in experiment during both the years. The gross plot size of each plot was 16.2 m^2. Spacing of green gram during summer 2016 and 2017 was 30 cm (row-row) × 10 cm (plant-plant). To eliminate the border effect, net plot area (10.92 m^2) was worked out by after exclusion of two outermost rows on each side of the plot length wise and from both sides of the plot width wise. Green gram was sown on 13th April during both the years manually. The recommended dose of fertilizer, nitrogen 16 kg/ha and phosphorus 40 kg/ha were applied to crop during both the years. Source of Inorganic fertilizer was Urea and DAP whereas source of organic manures was FYM and Vermicompost. Urea top dressed manually only in plots wherein inorganic fertilizers were to be used. Plant height of green gram was taken with the help of meter scale from the ground surface to the tip of apex of leaf from each plot from 5 tagged plants in each net plot. All the above ground biomass of the three randomly selected plants from the second row at harvest maturity was chopped in to small pieces, sundried for 2-3 days and thereafter shifted in the oven to dry at a temperature of 65±5°C till a constant weight was achieved. The average dry matter accumulation per plant was recorded and expressed as dry weight in g/plant. Crop was harvested manually from net plot area of 10.92 m^2 when nearly 80% of the pods turned black in colour manually with the help of sickles. Seed and straw yields were recorded separately from net plot of each treatment. Treatment wise samples of seed and stover of green gram taken after harvest were washed first with tap water and then with distil water. These samples were sun dried for 2-3 days and then in oven dried at 65±5°C for 24 hours, dried samples were ground in to 40 mesh size and analysis was done as per the standard procedure given for nitrogen per cent by Modified Kjeldhal's method given by (Jackson, 1967), phosphours by vanadomolybdo phosphoric acid yellow colour given by (Jackson, 1967) and potassium by Ammonium acetate method (Hanway and Heidel, 1952). The total cost of cultivation (Rs/ha) of each treatment calculated on per hectare basis. The wages of labour, amount spent on mechanical power for different operations and cost of inputs such as seed, fertilizers, organic manures (Vermicompost and Farmyard manure), *etc.* were calculated on the basis of the then prevailing, respective, market rates of different operations/input used. Gross returns (Rs/ha) were worked out by multiplying the saleable products seed yield of green gram by their then prevailing respective, sale rates and then were presented on per hectare basis as per the treatments. Net returns (Rs/ha) were computed by deducting the total cost of cultivation from the gross returns as per the treatments. Benefit cost ratio was calculated by dividing the net returns with cost of cultivation for different treatments. The data recorded for various characters were subjected to statistical analysis according to procedure outlined by Cochran and Cox (1963). Data of summer 2016 and summer 2017 were than pooled to calculate the various parameters of green gram.

RESULTS AND DISCUSSION

Weather parameters

The crop growing period of green gram lied between 15th-26th SMW in both the seasons *i.e.* summer 2016 and 2017. The rainfall data of the green gram for the both seasons

presented in Fig 1 and 2 revealed that a total of 102.00 mm and 251.40 mm of rainfall was received during summer 2016 2017, respectively. A large variation was recorded in the total rainfall received by green gram in both the seasons, wherein summer season of 2017 recorded higher rainfall than summer 2016. Green gram grown during summer 2016 received 25.11 per cent less rainfall than the seasonal normal rainfall (136.20), whereas green gram during summer 2017 received 84.58 per cent more rainfall than the seasonal normal rainfall (136.20 mm) during their respective crop growing periods.

Green gram during summer 2016 and 2017 recorded a maximum temperature of 40.9°C in the 20th Standard meteorological week (SMW) and 39.9°C in the 19th and 23rd Standard meteorological week (SMW) and minimum temperature of 13.9°C and 11.9°C at sowing in the 15th Standard meteorological week (SMW) during both the summer seasons, respectively. The average maximum temperature recorded for summer moong during summer 2016 was 37.4°C which was above the average normal maximum temperature (37.1°C) and the extent of variation from the normal values was to the tune of (+0.3°C) , whereas during summer 2017, the average maximum temperature was 36.8°C which was below the average normal maximum temperature (37.1°C) and the extent of variation from the normal values was to the tune of -0.35°C. The average minimum temperature recorded for summer moong during summer 2016 was 21.3°C which was below the average normal minimum temperature (21.59°C) and the extent of variation from the normal values was to the tune of -0.3°C, whereas during summer 2017,the average minimum temperature was 20.5°C which was below the average normal minimum temperature (21.6°C) and the extent of variation from the normal values was to the tune of -1.1°C. Meteorological data on relative humidity for green gram during 2016 revealed that, mean weekly maximum (morning) and minimum (after noon) relative humidity ranged from 77 to 89 per cent and 39 to 69 per cent whereas during *rabi* 2017, mean weekly maximum (morning) and minimum (after noon) relative humidity ranged from 76 to 86 per cent and 41 to 58 per cent, respectively.

The average maximum relative humidity recorded for green gram during summer 2016 was 61.42 per cent which was above the average normal maximum relative humidity (59.39 per cent) and the extent of variation from the normal values was to the tune of +2.03, whereas during summer 2017, the average maximum relative humidity was 63.17 per cent which was above the average normal maximum relative humidity (59.39 per cent) and the extent of variation from the normal values was to the tune of +3.78. The average minimum relative humidity recorded for green gram during summer 2016 was 35.48 per cent which was above the average normal minimum relative humidity (33.01 per cent) and the extent of variation from the normal values was to the tune of +2.47, whereas during summer 2017, the average minimum relative humidity was 34.92 per cent which was

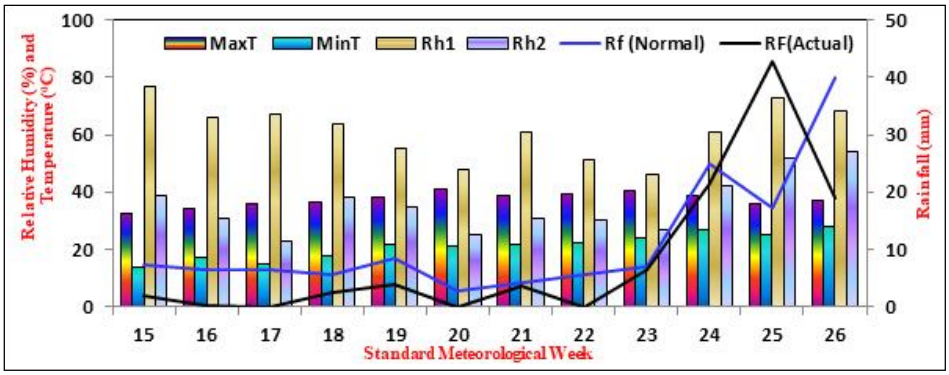

Fig 1: Graphical representation of meteorological data of green gram during summer 2016.

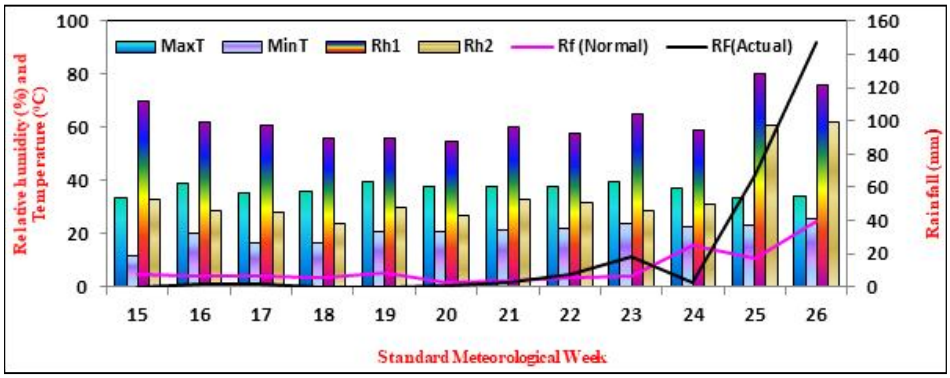

Fig 2: Graphical representation of meteorological data of green gram during summer 2017.

below the average normal minimum relative humidity (33.01 per cent) and the extent of variation from the normal values was to the tune of +1.91. The analysis of weather parameters of green gram for the two years exhibit that there is a considerable variation in the amount of rainfall and relative humidity, whereas a marginal variation in temperature was recorded between the crops in both the crop growing seasons. Variation in amount in rainfall and its distribution influenced the vegetative growth of the green gram and indirectly its yield attributing characters. In nut shell, it can be deducted that of these two important weather parameters of rainfall and humidity, the impact of rainfall is quite considerate to influence the growth and yield.

Growth parameters

The pooled data of growth parameters of green gram presented in Table 1 revealed that plant height (cm) and dry matter accumulation (g/plant) in green gram at maturity was significantly affected by differential substitution of nutrients through organics. Significantly highest plant height (57.79 cm) and dry matter accumulation (12.93 g/plant) in green gram was recorded with treatment recommended dose of fertilizer which was found statistically at par with treatments 25% yearly replacement of RDF through vermicompost and Fym (1:1) on N basis with plant height and dry matter accumulation (56.81 cm and 12.85 g/plant), 75% NPK+25% N through vermicompost and Fym (1:1) (57.49 cm and12.91 g/plant), 75% NPK+25% N through vermicompost (56.55cm and 12.78 g/plant), 25% yearly replacement of RDF through vermicompost on N basis (54.83 cm and 12.74 g/plant), 25% yearly replacement of RDF through Fym on N basis (54.30 cm and 12.65 g/plant) and 75% NPK+25% N through Fym (54.27 cm and 12.67 g/plant) at harvest in descending order whereas significantly lowest plant height (38.60 cm) and dry matter accumulation (9.43 g/plant) at harvest was recorded with treatments 100% N through Fym which was found statistically at par with treatments 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) and with plant heights 38.89 cm, 39.07 cm, 39.15 cm, 39.25 cm and dry matter accumulation 9.56 g/plant, 9.67 g/plant, 9.74 g/plant, 9.80 g/plant in the increasing order respectively. Treatments 50% NPK+50% N through vermicompost and Fym (1:1), 50% NPK+50% N through vermicompost and 50% NPK+50% N through Fym with plant height and dry matter accumulation (46.94 cm and 11.29 g/plant), (46.39 cm and 11.23 g/plant) and (46.19 cm and 11.20 g/plant) at harvest were found significantly different from all other treatments in these growth parameters. The highest growth parameters with treatment T_1, T_{12}, T_{16}, T_2, T_6, T_7 and T_{11} was might be due to reason that initially application of more quantity of inorganic fertilizers improved availability of nutrients to green gram plants and in later phases by organic manures contributed for increase in plant height with these treatments. Increased in plant height might increase number of leaves in green gram which bring about more accumulation of photosynthates resulting in increase in dry matter accumulation in green gram. These results were in conformity with findings of Kohler *et al.* (2008) and Mannivannan *et al.* (2009).

Table 1: Effect of differential substitution of nutrients through organics on plant height (cm) and dry matter (g plant) of green gram (pooled data of 2 years).

Treatments	Plant height (cm)	Drymatter accumulation (g/plant)
T_1	57.79	12.93
T_2	56.55	12.78
T_3	46.39	11.23
T_4	39.25	9.80
T_5	38.89	9.56
T_6	54.83	12.74
T_7	54.27	12.67
T_8	46.19	11.20
T_9	39.15	9.74
T_{10}	38.60	9.43
T_{11}	54.30	12.65
T_{12}	57.49	12.91
T_{13}	46.94	11.29
T_{14}	39.44	9.85
T_{15}	39.07	9.67
T_{16}	56.81	12.85
S.E.m (±)	2.34	0.47
CD (5%)	6.76	1.35

*Detail of treatments were given material and methods.

Yield

It is evident from the pooled data of yield of green gram depicted in Table 2 that seed and stover yield of green gram were significantly affected with differential substitution of nutrients through organics. Significantly highest seed yield (10.00 q/ha) and stover yield (41.10 q/ha) of green gram was recorded with treatment 100% recommended dose of fertilizer which was found statistically at par with treatments 75% NPK+25% N through vermicompost and 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 on N basis with seed and stover yields (9.90 q/ha and 40.93 q/ha), (9.87 q/ha and 40.70 q/ha), (9.84 q/ha and 40.47 q/ha), (9.74 q/ha and 40.31 q/ha), (9.72 q/ha and 40.02 q/ha), (9.69 q/ha and 39.36 q/ha) in the descending order whereas significantly lowest (6.61 q/ha and 23.97 q/ha) seed and stover yield of green gram was recorded with treatment T_{10} which was also found statistically at par with treatments100% 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) with seed and stover yields (6.64 q/ha and 25.41 q/ha),(6.66 q/ha and 26.11 q/ha), (6.68 q/ha and 26.47 q/ha),(6.71 q/ha and 26.67 q/ha) and (6.74 q/ha and 27.17 q/ha) in the ascending order respectively. Highest seed yield in green gram with recommended dose of fertilizer was might be due to higher yield attributes which eventually amplified the seed yield of green gram whereas significantly maximum straw yields in treatments T_1, T_{12}, T_{16}, T_2, T_6, T_7 and T_{11} was might be due to dynamic vegetative growth and maximum dry matter accumulation (g/plant) in these treatments. These results were in line with the findings of Meena *et al.* (2015).

Table 2: Effect of differential substitution of nutrients through organics on seed yield and stover yield (q/ha) (Pooled data of 2 years).

Treatments	Seed yield (q/ha)	Stover yield (q/ha)
T_1	10.0	41.10
T_2	9.84	40.47
T_3	8.15	33.66
T_4	6.71	26.67
T_5	6.64	25.41
T_6	9.74	40.31
T_7	9.72	40.02
T_8	8.14	33.14
T_9	6.68	26.47
T_{10}	6.61	23.97
T_{11}	9.69	39.96
T_{12}	9.9	40.93
T_{13}	8.17	34.08
T_{14}	6.74	27.17
T_{15}	6.66	26.11
T_{16}	9.87	40.7
S.E.m (±)	0.32	1.36
CD (5%)	0.91	3.86

Nutrient content

The pooled data of nutrient content in presented in Table 3 depicts that highest nitrogen content (4.640 per cent and 2.098 per cent), phosphorus content (0.487 per cent and 0.262 per cent) and potassium content (1.400 per cent and 1.218 per cent) in seed and stover of green gram whereas lowest nitrogen content (4.640 per cent and 2.098 per cent), phosphorus content (0.487 per cent and 0.262 per cent) and potassium content (1.400 per cent and 1.218 per cent) in seed and stover of green gram was recorded with treatment 100% recommended dose of fertilizer followed by treatments T_{12}, T_{16}, T_2, T_6, T_7, T_{11}, T_{13}, T_3, T_8, T_{14}, T_4, T_9, T_{15} and T_5 in nitrogen content, phosphorus content and potassium content in seed and stover of green gram the ascending order.

The highest N content concentration in treatment 100% N through Fym was might be due to increase in nitrate reductase which is a primary component of amino acids which aids in the synthesis of protein in grain. These results were comparable with the results of Dadhich *et al.* (2001) whereas organic residue decomposition and also solubilise the fixed form of N and P in soil resulting in increased uptake of N and P by the crop. These results were in conformity with the findings of (Dhakal 2016).

Economics

The practicability and usefulness of a treatment is judged in terms of net returns. As it is evident from pooled data of cost of cultivation of green gram presented in Table 4 that highest cost of cultivation (Rs.19891/ha) of green gram was recorded with treatment 100% N through vermicompost

Table 3: Effect of differential substitution of nutrients through organics on nutrient content (%) in seed and stover of green gram (Pooled data of 2 years).

Treatments	Nitrogen (%)		Phosphorus (%)		Potassium (%)	
	Seed	Stover	Seed	Stover	Seed	Stover
T_1	3.105	1.551	0.369	0.207	1.030	0.909
T_2	3.156	2.062	0.445	0.224	1.361	1.181
T_3	3.850	2.075	0.467	0.243	1.378	1.202
T_4	4.544	2.087	0.482	0.255	1.393	1.212
T_5	4.600	2.092	0.484	0.259	1.399	1.217
T_6	3.171	2.063	0.447	0.226	1.362	1.182
T_7	3.172	2.064	0.448	0.227	1.364	1.184
T_8	3.912	2.076	0.469	0.245	1.379	1.203
T_9	4.556	2.089	0.483	0.256	1.396	1.214
T_{10}	4.640	2.098	0.487	0.262	1.400	1.218
T_{11}	3.182	2.066	0.451	0.229	1.365	1.186
T_{12}	3.136	2.059	0.439	0.220	1.357	1.178
T_{13}	3.806	2.074	0.466	0.241	1.376	1.201
T_{14}	4.536	2.086	0.481	0.255	1.392	1.211
T_{15}	4.571	2.090	0.482	0.258	1.397	1.215
T_{16}	3.152	2.060	0.442	0.223	1.360	1.180

Table 4: Effect of differential substitution of nutrients through organics on relative economics of green gram (Pooled data of 2 years).

Treatments	Cost of cultivation (Rs/ha)(A)	Gross returns (Rs/ha)(B)	Net returns (Rs/ha) C= B-A	B:C ratio D=C/A
T_1	16262	54077	37815	2.33
T_2	17403	53224	35820	2.06
T_3	18531	44091	25560	1.38
T_4	19667	36323	16656	0.85
T_5	19891	38921	19029	0.96
T_6	17964	52703	34739	1.93
T_7	16095	52593	36498	2.27
T_8	15915	44037	28122	1.77
T_9	15843	36161	20318	1.28
T_{10}	14660	38775	24115	1.64
T_{11}	16019	52380	36361	2.27
T_{12}	16719	53548	36828	2.20
T_{13}	17222	44199	26976	1.57
T_{14}	17705	36515	18810	1.06
T_{15}	17276	39038	21762	1.26
T_{16}	16961	53384	36423	2.15

*Detail of treatments were given in material and methods.

whereas lowest cost of cultivation (Rs.14460/ha) was recorded with treatment 100% N through FYM. Variation in cost of cultivation in treatments was might be due to variation in cost of organic manures associated with these treatments. The pooled highest gross returns (Rs. 54077/ha), net returns (Rs.37815/ha) and benefit cost ratio (2.33) was recorded with treatment 100% recommended dose of fertilizers whereas lowest gross returns (Rs. 36161/ha) was recorded with treatment 25% NPK+75% N through Fym whereas lowest net returns (Rs.16656/ha) and benefit cost ratio (0.85) in green gram after two years was recorded with treatments 25% NPK+75% N through vermicompost. Difference in net returns and benefit ratio was might be due to collective effects of yield and price of green gram under these treatments. These results were in agreement with the findings of Yadav *et al*. (2004).

CONCLUSION

Based on two-year study on green gram it was concluded that green gram (100% recommended dose of fertilizer) and 75% NPK +25% N through Vermicompost and FYM (1:1) were adjudged as the best treatments with regard to crop growth, yield, net returns and benefit cost ratio. Further, for substitution of nutrients, in green gram, for immediate shifting from in organics 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.

Conflict of interest: None.

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