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Effect of Differential Substitution of Nutrients through Organics on Growth, Quality, Nutrient Uptake and Economics of Green Gram (*Vigna radiata*) in Shiwalik Foothill Region

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ABSTRACT

Background: Green gram is one of the ancient and third important conventional pulse crop cultivated throughout India and acclimatized over wide range of agro-climatic zones for its multipurpose uses. Furthermore, imbalanced and inappropriate use of inorganic nutrients 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 enhancement and yield stability. 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 as it may lead to unbearable drastic reduction in crop yields in the initial years. This may become possible through the progressive substitution of organic sources of nutrients in place of in organics to meet crop nutrient requirement for attaining higher and stable crop yield of better quality with an improvement in soil health. Therefore, the present study was carried out to evaluate the effects of differential substitution of nutrients through organics on growth, yield, quality, nutrient uptake and economics of green gram in Shiwalik foothill region.

Methods: In this field experiment conducted during summer 2016 and 2017, at SKUAST-Jammu, Main Campus Chatha with green gram variety SML-668 on sandy clay loam soil. The experiment was laid out in randomized block design with sixteen treatments during both the years using recommended package and practices.

Result: The result of the study concluded that RDF 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 where as highest crop quality traits were realized where in 100% N was substituted through FYM followed by Vermicompost and Vermicompost and FYM (1:1). Treatment 100% N was substituted through FYM was adjudged as the best treatment in improving crop quality traits and soil properties. Further, for substitution of nutrients, 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.

Key words: Economics, FYM, Growth, Protein, Vermicompost, 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 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). Furthermore, imbalanced and inappropriate use of inorganic nutrients devoid of requisite quantity of organics has not only worsened the soil resource base by reducing the population of beneficial micro-organisms and the factor productivity of most of the crop lands but also deteriorated the quality of the crops (Kumar *et al.*, 2016). 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 enhancement and yield stability in comparison to the yield and quality aspects realized under conventional practices

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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 progressive substitution of organic sources of nutrients in place of in organics to meet crop nutrient requirement for attaining higher and stable crop yield of better quality with an improvement in soil health. Therefore, the present study was carried out to evaluate the effects of differential substitution of nutrients through organics on growth, yield, quality, nutrient uptake and economics of green gram (*Vigna radiata*) in Shiwalik foothill region.

MATERIALS AND METHODS

A field experiment was conducted during summer 2016 and 2017 at Research Farm of Division of Agronomy, Shere-Kashmir University of Agricultural sciences and Technology-Jammu, Main Campus Chatha. Initially, experimental soil was sandy clay loam in texture with pH (7.81). It was moderately fertile with low organic carbon (0.45%), available N (249.88 kg/ha), available P (13.79 kg/ha) and available K (148.55 kg/ha). The rainfall data of green gram revealed that a total of 102.00 mm and 251.40 mm were received during summer 2016 and 2017.The average maximum temperature recorded for green gram during summer 2016 was 37.4°C, whereas during summer 2017, the average maximum temperature was 36.8°C. The average minimum temperature recorded for green gram during summer 2016 was 21.3°C, whereas during summer 2017,the average minimum temperature was 20.5°C .The experiment was laid out in randomized block design with sixteen treatments during both the years. The sixteen treatments include 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 recommended dose of fertilizer during both the years for green gram was nitrogen 16 kg/ha and phosphorus 40 kg/ha. The source of fertilizer was Urea and Diammonium phosphate whereas source of organics was Vermicompost and FYM alone and in 1:1 ratio as per the treatments. The application of fertilizer including organic manures was done on the basis of nutrient recommended for summer moong cultivation in Shiwalik hill region. Whole application of nutrients whether through organic or inorganic in green gram was done as basal. The nutrient composition of organic manures during both the crop growing season *i.e.* summer 2016 and 2017 was given in Table 1.

Green gram was sown at row to row spacing of 30 cm and plant to plant spacing of 10 cm during both the years. The gross plot size of green gram was 5.40 m × 3.0 m where as net plot size was 4.20 m × 2.60 m during both the years. Green gram variety “SML-668” was sown @ 15 kg/ha during both the years. The crop was sown on 13th April during summer 2016 and 2017 and harvested on 1st July during summer 2016 and 30th June during summer 2017. Plant height at all stages was recorded with the help of meter scale from the ground surface to the tip of apex of leaf. The dry matter accumulation was recorded from the second row in each plot and was chopped in to small pieces, sundried for 2-3 days and thereafter shifted in oven to dry at a temperature of 65+ 5°C till a constant weight is achieved. The average dry matter accumulation per plant was recorded and expressed as dry weight in g/plant. Pods from each net plot were weighed separately and sundried for 3-4 days. After drying, pods were threshed and seeds were cleaned. The seed yield was recorded by the formula given below:

$$\text{Seed yield (q/ha)} = \frac{\text{Yield obtained from net plot (kg)}}{\text{Area of net plot (m}^2\text{)} \times 100} \times 10{,}000$$

The weight of the dried stover was recorded from each net plot and converted in to quintal per hectare by multiplying the same conversion factor employed for seed yield of green gram

$$\text{Stover yield (q/ha)} = \frac{\text{Stover yield obtained from net plot (kg)}}{\text{Area of net plot (m}^2\text{)} \times 100} \times 10{,}000$$

The individual treatment wise seed samples of green gram were subjected to per cent crude protein content analysis by multiplying the nitrogen percent in seeds of green gram with the factor 6.25 and expressed in percentage A.O.A.C. (1960). Treatment wise samples of seed and stover of green gram were washed first with tap water and then with distil water. These samples were sundried for 2-3 days and then oven dried at 65+5°C for 24 hours, dried sample

Table 1: Nutrient composition of organic manures.

Organic sources	N (%)		P (%)		K (%)	
	2016	2017	2016	2017	2016	2017
Vermicompost	1.61	1.62	0.80	0.79	0.73	0.72
FYM	0.62	0.57	0.24	0.25	0.29	0.30

were ground into 40 mesh size. The nutrient uptakes in green gram were calculated by the formula:

Nutrient Uptake (kg/ha) =

$$\frac{\text{Nutrient content (\%)} \times \text{dry matter accumulation (kg/ha)}}{100}$$

The collected data was analysed statistically by using Analysis of Variance for randomized block design as per the procedure described by Rangaswamy (2006). The treatments means were compared at 5% level of significance and relative economics of green gram was calculated on the prevailing market prices for inputs and outputs during both the years.

RESULTS AND DISCUSSION

Growth

Plant height of green gram as recorded at different growing periods presented in Table 2, revealed a linear increase in plant height with the advancement in plant age from 15 DAS to maturity of the crop. The height of the green gram rapidly increased up to 60 DAS. During summer 2016 and summer 2017, significantly maximum plant height of green gram was recorded with treatment 100% NPK (RDF) which was found statistically at par with treatment T_{12}, T_{16}, T_2, T_6, T_7 and T_{11} at maximum branching stage, flowering emergence and at maturity. Significantly highest plant heights of green gram with T_1, T_{12}, T_{16}, T_2, T_6, T_7 and T_{11} was might be attributed to better growth of green gram plants due to increased availability of nitrogen and phosphorus to the plant initially through chemical fertilizers and then through nutrient release by vermicompost and FYM in the later stages in the cropping seasons .

The maximum plant height of green gram was also might be due to higher number of leaves in T_1, T_{12}, T_{16}, T_2, T_6, T_7 and T_{11} which produced higher food material for the growth of the plant. The large sized leaves were responsible for the preparing more photosynthates which increased cell division and resulted in better growth of the plant. At the latter stages the growth of the green gram became slow which was might be due to the fact that plant started entering from vegetative to reproductive stage of life cycle. Similar results were also reported by Kohler *et al.* (2008).

Like plant height significant changes in dry matter accumulation of green gram was also recorded at all the three stages as revealed in Table 2. Significantly highest dry matter accumulation in green gram during summer 2016 and 2017 was recorded with treatment T_1- 100% NPK (RDF)

Table 2: Growth of green gram as influenced by differential substitution of nutrients through Organics.

Treatment	Plant height (cm)						Dry matter accumulation (g/plant)					
	Maximum branching		Flowering emergence		At Maturity		Maximum branching		Flowering emergence		At Maturity	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
T_1	32.42	36.34	51.27	53.90	56.71	58.87	5.66	6.39	9.55	9.95	12.32	13.53
T_2	30.10	35.35	49.20	52.00	55.75	57.35	5.44	6.24	9.15	9.76	12.13	13.42
T_3	25.89	29.52	40.30	43.13	45.26	47.52	4.29	4.82	7.72	8.22	10.59	11.87
T_4	21.14	25.16	31.40	35.40	37.92	40.57	2.97	3.59	6.32	6.66	9.31	10.28
T_5	18.60	23.39	29.60	34.10	37.57	40.21	2.54	3.42	6.00	6.37	9.12	10.00
T_6	29.86	34.03	48.00	50.76	53.43	56.23	5.39	6.19	9.09	9.72	12.07	13.40
T_7	29.73	33.86	47.80	50.35	52.92	55.62	5.38	6.17	8.99	9.67	11.99	13.34
T_8	25.58	29.49	39.00	42.51	44.92	47.46	4.09	4.80	7.68	8.15	10.64	11.76
T_9	21.10	25.15	31.00	35.00	37.80	40.50	2.72	3.53	6.18	6.54	9.27	10.21
T_{10}	18.15	23.22	29.40	34.00	37.20	40.00	2.41	3.37	5.90	6.00	9.09	9.76
T_{11}	29.67	33.80	47.20	50.20	52.89	55.71	5.32	6.10	8.97	9.64	11.96	13.33
T_{12}	30.76	35.97	51.06	53.00	56.32	58.66	5.50	6.34	9.35	9.87	12.31	13.51
T_{13}	26.00	29.79	41.00	43.44	45.73	48.15	4.37	4.89	7.79	8.34	10.65	11.93
T_{14}	21.58	25.73	32.60	36.40	38.05	40.83	3.10	3.61	6.55	6.75	9.35	10.35
T_{15}	18.80	23.77	30.00	34.30	37.77	40.37	2.68	3.49	6.10	6.44	9.18	10.15
T_{16}	30.40	35.40	49.63	52.53	56.03	57.58	5.48	6.28	9.22	9.81	12.26	13.44
SEm (±)	1.19	1.28	2.03	2.11	2.28	2.40	0.29	0.31	0.36	0.39	0.43	0.50
LSD(p=0.05)	3.45	3.70	5.86	6.09	6.58	6.94	0.83	0.91	1.03	1.13	1.25	1.45

T_1 -100% NPK (Recommended dose of fertilizer); 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).

which was found statistically at par with dry matter accumulation of green gram recorded with treatments$T_{12,}$ $T_{16,}$ $T_{2,}$ $T_{6,}$ T_7 andT_{11} at all the three stages and significantly superior than rest of the treatments. The highest dry matter accumulation in these treatments was might be due to combined application of inorganic and organics to the green gram which increased the availability of major nutrients as it might has enhanced early root growth and cell multiplication leading to more absorption of nutrients from the deeper layers of soil resulting in increased dry matter accumulation. Similar results were also reported by Borse *et al,* (2002) and Mannivannan *et al.* (2009).

Yield

Seed yield is more important in green gram which is the result of the different combinations of many physiological processes based on the environment under which crop is grown. The synthesis, accumulation and translocation of photosynthates depend upon the source sink relationship and also on the green gram growth during early stage of crop growth. Final yield is a function of all components of source and sink operating at different phenophases during the life cycle of green gram. Seed yield and stover yield of green gram were significantly influenced by differential substitution of nutrients through organics as presented in Table 3 during summer 2016 and 2017. Significantly highest seed yield (9.56 q/ha and 10.44 q/ha) and stover yield (39.16 q/ha and 43.03 q/ha) of green gram were recorded with treatment T_1 *i.e.*100% NPK (RDF) 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, 25% yearly replacement of RDF through FYM on N-basis and significantly superior than rest of the treatments in seed and stover yield during both the crop growing seasons. The highest seed yield of green gram was might be due to cumulative effect of yield attributes of green gram on account of increased growth which was due to higher biomass accumulation during vegetative phase leading to increased bearing capacity which ultimately increased the seed yield of green gram during summer 2016 and 2017 where as highest dry matter accumulation in these treatments results in highest stover yield in these treatments. Similar findings were also reported by of Aslam *et al*. (2010) and Meena *et al.* (2015).

Quality

Data regarding per cent crude protein content of green gram presented in Table 3 revealed that crude protein content in green gram were significantly influenced by differential substitution of nutrients through organics during summer 2016 and 2017. Significantly highest crude protein content

Table 3: Yield and quality of green gram as influenced by differential substitution of nutrients through Organics.

Treatment	Seed yield (q/ha)		Stover yield (q/ha)		Crude Protein (%)	
	2016	2017	2016	2017	2016	2017
T_1	9.56	10.44	39.16	43.03	19.05	19.76
T_2	9.34	10.34	38.33	42.61	19.27	20.18
T_3	7.69	8.61	31.98	35.33	23.51	24.61
T_4	6.20	7.22	25.00	28.33	27.81	28.99
T_5	6.13	7.15	23.58	27.23	28.11	29.38
T_6	9.29	10.20	38.14	42.47	19.30	20.34
T_7	9.28	10.17	37.88	42.15	19.31	20.33
T_8	7.68	8.60	31.16	35.12	23.88	25.02
T_9	6.17	7.19	24.66	28.27	27.87	29.08
T_{10}	6.10	7.13	21.79	26.15	28.35	29.65
T_{11}	9.22	10.15	37.80	42.12	19.36	20.41
T_{12}	9.40	10.40	38.91	42.95	19.15	20.05
T_{13}	7.71	8.63	32.15	36.00	23.23	24.34
T_{14}	6.22	7.27	25.42	28.91	27.73	28.96
T_{15}	6.15	7.17	24.21	28.00	27.92	29.21
T_{16}	9.38	10.36	38.73	42.66	19.26	20.14
SEm ($\pm$)	0.47	0.44	1.73	2.11	1.30	1.34
LSD(p=0.05)	1.36	1.28	5.00	6.08	3.75	3.87

T_1 -100% NPK (Recommended dose of fertilizer); 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).

in green gram was recorded with treatment 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 significantly superior than remaining treatments. The highest per cent crude protein content in seeds of green gram with FYM and Vermicompost was might be due to more availability of nitrogen. They improved nutritional environment in the rhizosphere as well as its utilization in the plant system. The highest crude protein content in seeds of green gram was due to more nitrogen fixation by the bacteria which in turn help in better absorption and utilization of nitrogen and increased the activity of nitrate reductase that play very significant role in the synthesis of protein in seeds.

Nutrient uptake

It is evident from the data depicted in Table 4 that uptake of N, P and K in green gram during summer 2016 and 2017 were significantly influenced by differential substitution of nutrients through organics in both the crop growing seasons. Uptake of nutrient is the function of nutrient content in crop component and dry matter yield (seed and stover). During summer 2016 significantly highest total N uptake in green gram was recorded with treatment T_{12}-75% NPK +25% N through Vermicompost and FYM which was found statistically at par with total N uptake recorded with treatments T_{16}, T_2, T_6, T_7 and T_{11} where as during summer 2017 significantly highest total N uptake in green gram was recorded with treatment T_7-75% NPK +25% N through FYM. This might be due to the reason that nitrogen content in seed and straw of green gram were enhanced with the application of vermicompost and FYM. Increase in nutrient content in green gram is ascribed to the beneficial role of FYM, vermicompost and vermicompost and FYM (1:1) in mineralization of native as well as nutrients in soil through added fertilizers in addition of its own nutrient content which enhanced the available nutrient pool of the soil. The higher N content concentration in FYM was might be due to nitrate reductase in the synthesis of protein in grain because it is a primary component of amino acids which are building blocks of protein molecules (Kumar *et al.* 2014). These results were similar to the findings of Devidyal *et al.* (1999) and Dadhich *et al*. (2001).

Among the different treatment during summer 2016 and 2017 significantly highest total P uptake in green gram was recorded with treatment T_{11}-25 % yearly replacement of RDF through FYM on N-basis where as significantly highest total K uptake in green gram during summer 2016 and 2017 was recorded with treatment T_{12} -75%NPK +25% N through

Table 4: Total Nutrient uptake of summer moong as influenced by differential substitution of nutrients through Organics.

Treatment	Total Uptake (kg/ha)					
	Nitrogen		Phosphorus		Potassium	
	2016	2017	2016	2017	2016	2017
T_1	89.80	99.84	11.48	12.89	45.27	50.02
T_2	107.72	121.33	12.53	14.37	57.81	64.53
T_3	95.19	107.31	11.11	12.85	48.85	54.49
T_4	79.67	92.73	9.11	10.96	38.75	44.61
T_5	76.85	90.61	8.84	10.78	37.09	43.31
T_6	107.29	120.88	12.53	14.38	57.61	64.22
T_7	106.78	130.16	12.51	14.34	57.34	63.91
T_8	93.94	107.45	10.99	12.92	47.92	54.28
T_9	78.93	92.61	9.05	10.97	38.33	44.54
T_{10}	73.34	88.73	8.45	10.57	34.91	42.01
T_{11}	106.58	120.26	12.57	14.44	57.21	63.99
T_{12}	108.80	121.88	12.40	14.33	58.38	64.89
T_{13}	95.24	108.37	11.12	12.94	49.04	55.28
T_{14}	80.52	94.07	9.26	11.10	39.25	45.34
T_{15}	78.00	92.13	8.94	10.96	37.85	44.22
T_{16}	108.55	121.40	12.53	14.33	58.28	64.57
SEm ($\pm$)	4.40	5.08	0.51	0.61	2.29	2.70
LSD(p=0.05)	12.71	14.68	1.47	1.75	6.61	7.81

T_1 -100% NPK (Recommended dose of fertilizer); 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).

Vermicompost and FYM which was found statistically at par with total K uptake recorded with treatment T_{16}, T_2, T_6, T_7 and T_{11} in total K uptake during summer 2016 and 2017. The increase in NPK uptake was might be due to improved in the physico-chemical and biological properties in the root environment wherever organics and in organics were applied together. Another reason was might be that legume crop (green gram) add large amount of organic residues through leaf fall and produced intermediate acids during 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 Henri *et al*., 2008 and Dhakal 2016.

Economics

The data of relative economics presented in Table 5, showed that cost of cultivation of green gram was significantly influenced by differential substitution of nutrients through organics.

During summer 2016 highest cost of cultivation (Rs 19916.00/ha) was recorded with treatment 100% N through Vermicompost where as lowest cost of cultivation (Rs 14546.40/ha) was recorded with treatment 100% N through FYM. Treatment 100% N through Vermicompost was followed by treatments $T_4 > T_3 > T_{14} > T_2 = T_6 > T_{15} > T_{13} > T_{12} = T_{16} > T_1 > T_7 = T_{11} > T_9 > T_8 > T_{10}$ in cost of cultivation. During summer 2017 highest cost of cultivation (Rs 19866.96/ha) of green gram was also recorded with treatment 100% N through Vermicompost followed by treatments $T_4 > T_3 = T_6 > T_{14} > T_2 > T_{15} > T_{13} = T_{16} > T_{12} > T_1 > T_7 > T_8 = T_{11} > T_9$ and T_{10} with lowest cost of cultivation (Rs 14772.78/ha) with treatment 100 % N through FYM. The highest cost of cultivation in treatment 100 % N through Vermicompost was might be due to highest per kg cost of vermicompost associated with treatment. During summer 2016 and 2017 highest gross returns (Rs 49951.00/ha and Rs 58203.00/ha), net returns (Rs 33689.38/ha and Rs 41941.38/ha) and B:C ratio (2.07 and 2.58) were recorded with treatment T_1-100% NPK (Recommended dose of fertilizer) where as lowest gross returns (Rs 32238.25/ha and Rs 40084.25/ha)were recorded with treatment 25%NPK+75% N through FYM , lowest net returns (Rs 12709.62/ha and Rs 20602.92/ha) were recorded with treatment 25% NPK+75% N through Vermicompost and lowest B:C ratio (0.65 and 1.05) were recorded with treatment 100% N through Vermicompost during both crop growing seasons. The highest gross returns in T_1 were might be due to difference in yield of green gram between the treatments during the respective years. Difference in net returns and B:C ratio was might be due to cumulative effects of yield and price of green gram under these treatments. These results were in agreement with the findings of Yakadri *et al.* (2004) and Yadav *et al*. (2014).

Table 5: Economics of green gram as influenced by differential substitution of nutrients through Organics.

Treatment	Cost of cultivation (Rs/ha) (A)		Gross returns (Rs/ha) (B)		Net returns (Rs/ha) C=B-A		B:C ratio D = C/A	
	2016	2017	2016	2017	2016	2017	2016	2017
T_1	16261.62	16261.62	49951.00	58203.00	33689.38	41941.38	2.07	2.58
T_2	17409.14	17396.98	48801.50	57645.50	31392.36	40248.52	1.80	2.31
T_3	18542.82	18518.42	40180.25	48000.75	21637.43	29482.33	1.17	1.59
T_4	19685.38	19648.58	32395.00	40251.50	12709.62	20602.92	0.65	1.05
T_5	19916.00	19866.96	34941.00	42900.00	15025.00	23033.04	0.75	1.16
T_6	17409.14	18518.42	48540.25	56865.00	31131.11	38346.58	1.79	2.07
T_7	16066.78	16123.51	48488.00	56697.75	32421.22	40574.24	2.02	2.52
T_8	15858.02	15971.20	40128.00	47945.00	24269.98	31973.80	1.53	2.00
T_9	15858.14	15827.92	32238.25	40084.25	16380.11	24256.33	1.03	1.53
T_{10}	14546.40	14772.78	34770.00	42780.00	20223.60	28007.22	1.39	1.90
T_{11}	16066.78	15971.20	48174.50	56586.25	32107.72	40615.05	2.00	2.54
T_{12}	16677.96	16760.53	49115.00	57980.00	32437.04	41219.47	1.94	2.46
T_{13}	17200.38	17244.43	40284.75	48112.25	23084.37	30867.82	1.34	1.79
T_{14}	17671.76	17738.25	32499.50	40530.25	14827.74	22792.00	0.84	1.28
T_{15}	17231.20	17319.82	35055.00	43020.00	17823.80	25700.18	1.03	1.48
T_{16}	16677.96	17244.43	49010.50	57757.00	32332.54	40512.57	1.94	2.35

T_1-100% NPK (Recommended dose of fertilizer); T_2-7% 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).

CONCLUSION

Based on the two years study, it is concluded that, recommended dose of fertilizer of green gram *i.e.* 16 kg 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 net returns, where as highest crop quality traits were realized where in 100% N was substituted through FYM followed by Vermicompost and Vermicompost and FYM (1:1).

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