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EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON GROWTH AND YIELD OF GREEN GRAM (*Vigna radiata* L.)

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ABSTRACT

The experiment was conducted during *kharif* season of 2020-21 at Campus for Research and Advanced Studies Dhablan of G.S.S.D.G.S. Khalsa College, Patiala, Punjab. Field experiment was laid out in randomized block design with twelve treatment combinations and replicated three times. Integrated nutrient management significantly influenced the growth, yield and yield attributes of green gram crop. All the growth parameters like plant height (cm), number of branches plant^{-1}, number of leaves plant^{-1}and dry weight plant^{-1} (g) were significantly higher with the application of 75%RDF + FYM 5t ha $^{-1}$ + VC 2.5 t ha^{-1}+ *rhizobium* culture, which was followed by the application of 75% RDF+VC 2.5 t ha^{-1}. The yield, yield attributes and economic (*viz.,* gross return and net return) was significantly maximum with the application of 75% RDF + FYM 5 t ha $^{-1}$ + VC 2.5 t ha^{-1}+ *rhizobium* culture as compared to all other treatments combinations and it was statistically at par with the application of 75% RDF+VC 2.5 t ha^{-1}. The benefit: cost ratio (2:59) was recorded highest with the application of 75% RDF + FYM 5 t ha $^{-1}$ + VC 2.5 t ha^{-1}+ *rhizobium* culture.

(Key words: Green gram, growth, yield, nutrient management, B: C ratio)

INTRODUCTION

Green gram (*Vigna radiata* L.) is a most important pulse crop grown through-out India. It requires hot and humid growing season. It is primarily a rainy season crop but with the development of early maturing varieties, it has also proved to be an ideal crop for spring and summer seasons. It is generally grown as a summer and rainy season crop in northern India. Green gram is an excellent source of high quality protein. It contains about 25 per cent protein. It can also be used as a green manure crop. Its green plants are used as fodder after removing the mature pods. It also contains high quality of lysine (4600 mg g^{-1} N) and tryptophan (60 mg g^{-1} N) and consumed as whole grain as well as *dal* in variety of ways for table purposes. In Punjab, the total area under green gram was 1.06 million hectares with the annual production of 0.42 million tonnes and productivity of 396 kg ha^{-1}, which is very low as compared to its yield (658 kg ha^{-1}) obtained under National Demonstration Projects (Anonymous, 2019). Integrated use of chemical fertilizer with organic manure has been found to be quite promising not only in maintaining higher productivity but also in greater stability to crop production (Meena *et al.,* 2016). Among organic manures, FYM is rich in organic matter and is a good source of plant nutrients. It helps to buffer soils against rapid chemical changes. FYM also acts as a source of energy for the growth of soil microbes. Improvement in physical properties of soil, organic carbon and available nitrogen, phosphorus and potassium due to long term application of FYM and fertilizer has been well documented by Sahu *et al.* (2020). Poultry manure has been catching up as a very good alternative to existing organic source of nutrients in the agro climatic zone III in recent years. It improves soil structure by providing binding effect to soil aggregates and increases water holding capacity of soils. Vermicompost is sustainable compost regenerated from organic wastes using earthworms. Vermicompost is a rich source of N, P, K and micro nutrients. Inoculation of phosphate-solubilizing bacteria (PSB) plays fundamental roles in biogeochemical phosphorus cycling in agro-ecosystems. Phosphate-solubilizing microbes transform the insoluble phosphorus to soluble forms by acidification, chelation, exchange reactions, and polymeric substances formation (Almas Zaidi *et al.,* 2010). Bio-fertilizers are other organic source with play an important role in meeting the nutrient requirement of crops through biological nitrogen fixation (BNF), solubilization of insoluble phosphorus sources, stimulating plant growth and accelerating decomposition of plant residues. *Rhizobium* bacteria are important bio inoculants of legume seed, which have a symbiotic association to fix environmental nitrogen. Punse *et al.* (2018) inferred that application of 60 kg phosphorus ha^{-1} and 30 kg sulphur ha^{-1} yielded maximum for growth and growth attributes (plant height, number of branches plant^{-1} and plant dry matter accumulation, leaf area), yield and yield attributes (number of pod plant^{-1}, test weight, seed and straw

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yield ha^{-1}) . Economics of green gram also improved by the same treatment in green gram. Similarly, Marbaniang (2020) revealed that combined application of 30 kg phosphorus ha^{-1} and 20 kg sulphur ha^{-1} recorded highly significant growth parameters (plant height, number of leaves $plant^{-1}$ and nodulation), yield and yield parameters (number of pods $plant^{-1}$, number of seeds pod, seed and stover yield) in green gram. The chemical fertilizers, no doubt, are the important source which can meet the nutrient requirement but their imbalance and continuous use lead to environmental pollution and deterioration of soil health. Karhale *et al.* (2021) showed that growth attributes of soybean *viz.,* plant height, number of branches $plant^{-1}$, number of leaves $plant^{-1}$ and dry matter accumulation were found significantly maximum combined application of FYM @ 5.0 t ha^{-1} + 30 kg N ha^{-1} + biofertilizer. Karhale *et al.* (2021) observed that gross monetary returns was found to be maximum with the INM treatment of FYM @ 5.0 t ha^{-1} + 30 kg N ha^{-1} + biofertilizer.

MATERIALS AND METHODS

The field experiment was conducted during *kharif* season of the year 2020-2021 at Campus for Research and Advanced studies, Dhablan of G.S.S.D.G.S. Khalsa College, Patiala. The experimental field is situated at 24-46^0 North latitude and 76-24^0 East longitude and at an altitude of 250 meter above the mean sea level. The soil of experimental field was clayey in texture slightly basic in reaction (pH 7.6). The soil was low in available nitrogen (248 kg ha^{-1}), medium in available phosphorus (19.50 kg ha^{-1}), low in available potassium (130.80 kg ha^{-1}) and moderate in organic carbon (0.60 %). The experiment was laid out in randomized block design with three replications. There were 12 treatment combinations *viz.,* T_1 (control), T_2 (100% RDF), T_3 (*rhizobium* culture), T_4 (FYM 7 t ha^{-1}), T_5 (VC 3 t ha^{-1}), T_6 (PM 3 t ha^{-1}), (T_7 75% RDF+ FYM 5 t ha^{-1}), T_8 (75% RDF+ VC 2.5 t ha^{-1}), T_9 (75% RDF+ PM 2.5 t ha^{-1}), T_{10} (75% RDF + *rhizobium* culture), T_{11} (75% RDF+ FYM 5 t ha^{-1} + *rhizobium* culture), T_{12} (75% RDF + FYM 5t ha^{-1} + VC 2.5 t ha^{-1} + r*hizobium* culture). Green gram cultivar 'SML-832' was sown in lines of 30 cm x 10 cm apart during last week of March in each experimental unit. All the recommended package of practices was followed to raise the crop. The crop was harvested during second week of May, 2021. Five plants were tagged at random and data on plant height (cm), number of leaves $plant^{-1}$ and number of branches $plant^{-1}$ were measured from each experimental plots at 20, 40 DAS and at harvest. Dry weight was noted by taking mean weight of five dried plants. To note down dry weight of tagged plant by dried in oven for 48 hours. Yield and yield attributes (*viz.,* pods $plant^{-1}$, seed pod^{-1} and test weight) were noted from tagged plants after harvesting of crop. The economics of different treatment was worked out from mean value of the yield. Gross return was worked out by multiplying grain and straw yield with their prevailing market prices and expressed in rupees $hectare^{-1}$. Net return was calculated by subtracting cost of cultivation from gross return and B:C ratio was calculated from net return and cost of cultivation. The data were analyzed as per the standard procedure for "Analysis of Variance" (ANOVA) as described by Gomez and Gomez (1984). The significance of treatments was tested by 'F' test (Variance ratio). Standard error of mean was computed in all cases. The difference in the treatment mean was tested by using Critical Difference (CD) at 5% level of probability.

RESULTS AND DISCUSSION

Data regarding effect of integrated nutrient management on plant height (cm), number of leaves $plant^{-1}$, number of branches $plant^{-1}$ and dry weight $plant^{-1}$ (g) are presented in Table 1, revealed that significantly maximum plant height (cm), number of leaves $plant^{-1}$, number of branches $plant^{-1}$ and dry weight $plant^{-1}$ (g) was observed with the application of 75% RDF + FYM 5t ha^{-1} + VC 2.5 t ha^{-1} + r*hizobium* culture at 20, 40 DAS and at harvest followed by the application of 75% RDF + VC 2.5t ha^{-1}. However, plant height (cm) was statistically at par with the application of 75% RDF + VC 2.5t ha^{-1} at 20 DAS and number of branches $plant^{-1}$ and dry weight $plant^{-1}$ were also at par with the application of 75% RDF + VC 2.5t ha^{-1} at all growth stages (*viz.,* 20, 40 DAS and at Harvest). Significantly lower plant height (cm), number of leaves $plant^{-1}$, number of branches $plant^{-1}$ and dry weight $plant^{-1}$ (g) were found with the application of the treatment T_1 (control). This was due to nutrients play important role to increase growth of plants, hence effect of integrated nutrient management significantly increased all growth parameters and rapid development of the crop plant. The effect of integrated nutrient management significantly increased with the increasing fertilizer dose. Similar results were found by Pandey *et al.* (2019). They observed that plant height (cm), number of leaves $plant^{-1}$, pod formation and number of branches $plant^{-1}$ were found maximum in treatment T_3 (75% NPK +5t FYM ha^{-1} + biofertilizer (PSB+*Rhizobium*) followed by treatment T_4 (50% NPK+5t FYM ha^{-1}+ Bio-fertilizer) than T_2 (100% NPK) in green gram. Similarly Singh *et al.* (2017) also found that application of RDF+VC 5 t ha^{-1} registered maximum growth attributes (*viz.,* number of nodules and nodules dry weight) in green gram crop. Asefa and Waguri (2021) showed that highest plant height, productive branches, pods number $plant^{-1}$ and biomass yield (5102.30 kg ha^{-1}) were recorded by the application of 75 kg NPS ha^{-1} + 2.5 t VC ha^{-1} with Dhidhessa variety of soybean crop.

Table 1. Effect of integrated nutrient management on plant height (cm), number of leaves plant^{-1}, number of branches plant^{-1} and dry weight plant^{-1} of green gram

Treatments	Plant height (cm)			Number of leaves plant^{-1}			Number of branches plant^{-1}			Dry weight plant^{-1} (g)		
	20 DAS	40 DAS	At harvest	20 DAS	40 DAS	At harvest	20 DAS	40 DAS	At harvest	20 DAS	40 DAS	At harvest
T_1: Control	9.60	28.57	38.52	10.31	31.20	30.20	3.87	10.87	10.98	6.73	31.23	37.13
T_2:100% RDF	14.60	37.77	44.72	15.93	36.40	35.97	5.66	16.07	16.22	11.93	36.80	42.17
T_3:*Rhizobium*culture	11.57	33.37	41.72	12.43	32.63	31.80	4.57	13.10	13.25	8.97	33.13	41.70
T_4:FYM7tha^{-1}	11.23	32.27	40.62	11.33	31.53	30.70	3.47	12.00	12.15	7.87	32.03	40.60
T_5:VC3tha^{-1}	12.60	34.47	43.08	13.53	33.87	33.20	5.67	14.27	14.42	10.13	34.13	40.03
T_6:PM3tha^{-1}	11.93	33.77	42.30	13.77	34.17	33.03	5.80	14.10	14.75	9.13	34.67	43013
T_7:75%RDF+ FYM5tha^{-1}	11.43	34.0	42.48	13.33	33.53	32.70	5.47	14.03	14.25	8.77	34.03	42.60
T_8:75%RDF +VC 2.5tha^{-1}	15.53	39.57	48.28	18.10	38.83	38.00	5.77	19.30	19.45	15.77	39.33	45.90
T_9:75%RDF+PM 2.5tha^{-1}	13.10	36.27	44.62	15.33	35.53	34.70	5.43	16.03	16.25	10.77	36.03	44.60
T_{10}:75%RDF+ *Rhizobium*culture	11.50	34.47	42.82	13.53	33.73	32.90	5.40	14.40	14.45	8.97	34.23	42.80
T_{11}:75% RDF+ FYM 5t ha^{-1}+ *Rhizobium*culture	13.23	36.37	44.72	15.43	36.63	35.80	5.57	16.13	16.35	10.87	37.13	46.70
T_{12}:75%RDF + FYM 5t ha^{-1} + VC2.5tha^{-1} +*Rhizobium* culture	16.67	42.47	51.22	19.90	41.03	40.37	6.67	20.87	20.52	16.90	40.80	47.67
SE (d) ±	0.72	0.50	0.64	0.64	0.78	0.86	0.63	0.87	0.83	1.08	0.82	2.14
CD(0.05)	1.64	1.12	1.45	1.44	1.75	1.95	1.43	1.96	1.87	2.44	1.86	4.84

Data in Table 2 shows the significant effect of integrated nutrient management on yield attributes of green gram. Significantly maximum number of pods plant^{-1}, number of seeds plant^{-1}, test weight (g) were found with the application of 75% RDF + FYM 5t ha^{-1} + VC 2.5t ha^{-1} + *rhizobium* culture followed by application of 75% RDF + VC 2.5t ha^{-1}. However, number of pods plant^{-1}, number of seeds plant^{-1}, test weight (g) were statistically at par with the application of 75% RDF + VC 2.5t ha^{-1}. Significantly minimum number of pods plant^{-1}, number of seeds plant^{-1}, test weight (g) were found with the application of treatment T_1 (control).

Application of integrated nutrient increased all yield contributing parameters because it provide proper and adequate plant nutrients which is responsible for better development and growth of plant. This similar finding of INM in case of test weight was reported by Pandey *et al.* (2019), they observed that application of NPK through inorganic source with FYM and vermicompost significantly increased the yield attributes at all levels of fertilizer. Thus, integrated application of inorganic and organic source (Vermicompost + FYM) maximized yield of green gram. Similar finding was also found by Barkha *et al.* (2020). They observed that application of treatments T_3 (100% RDF + biocompost @ 5 t ha^{-1}), T_4 (100% RDF + biocompost @ 5 t ha^{-1} + PSB @ 2.5 l h^{-1}) and T_6 (50% RDF + biocompost @ 2.5 t ha^{-1} + PSB @ 2.5 l ha^{-1}) performed equally good and recorded significantly higher growth attributes, yield attributes, seed and stover yield. Meena *et al.* (2016) also found that yield of green gram was maximum in treatment $N_{20}P_{40}K_{40}$+ FYM @10 t ha^{-1} and *rhizobium*. Total seed yield of 12.10 q ha^{-1} was found to be significant over all other treatments. Adequate plant nutrient supply holds the key for improving the growth and food grain production of crop.

Data regarding effect of integrated nutrient management on grain yield (q ha^{-1}), stover yield (q ha^{-1}) and biological yield (q ha^{-1}) are presented in Table 2. Maximum grain yield (q ha^{-1}), stover yield (q ha^{-1}) and biological yield (q ha^{-1}) were recorded with the application of 75% RDF + FYM 5t ha^{-1} + VC 2.5t ha^{-1} + r*hizobium* culture, which was significantly superior than all other treatments, followed by application of 75% RDF + VC 2.5t ha^{-1}. Whereas, minimum grain yield (q ha^{-1}), stover yield (q ha^{-1}) and biological yield (q ha^{-1}) was recorded with the application of treatment T_1 (control). This is due to significantly higher total number of branches plant^{-1} and number of pods plant^{-1} with the use of recommended dose of nutrients through integrated nutrient management. Increased number of branches plant^{-1} along with increased number of pods plant^{-1}, higher seed weight plant^{-1} and higher 1000 seed weight showed their additive effect in influencing the seed yield, stover yield and biological yield with the use of recommended dose i.e. 75% RDF + FYM 5 t ha^{-1} + VC 2.5 t ha^{-1} + r*hizobium* culture sources of nutrients. Similar observations have also been reported by Sahu *et al.* (2020), they resulted that application of r*hizobium* culture @ 25 g kg^{-1} of seed along with Vermicompost @ 2.5 t ha^{-1}; FYM @ 5 t ha^{-1} and 100% RDF was found to be responsible for higher grain yield (11.41 q ha^{-1}) and straw yield (27.45 q ha^{-1}) as compared to other combinations and control in green gram. Similar results were also found by Singh *et al.* (2019), they found that among all the treatments, application of 75% RDF + PSB + 2.5 t ha^{-1} vermicompost + r*hizobium* gave maximum yield attributes *viz.,* number of pods plant^{-1}, number of grains pod^{-1}, test weight and grain and straw yield as well as maximum gross returns and net returns from moong bean.

Table 2. Effect of integrated nutrient management on yield and yield attributes of green gram

Treatments	Pods plant^{-1}	Seeds pod^{-1}	Test weight (g)	Yield (q ha^{-1})		
				Grain Yield (q ha^{-1})	Stover Yield (q ha^{-1})	Biological yield (q ha^{-1})
T_1:Control	30.94	5.30	31.81	6.93	17.30	24.23
T_2:100% RDF	36.70	6.17	35.43	12.37	29.00	41.37
T_3:*Rhizobium*culture	32.83	5.07	32.33	8.70	23.67	32.37
T_4:FYM7tha^{-1}	31.73	4.90	32.03	10.53	27.57	38.10
T_5:VC3tha^{-1}	33.90	7.10	33.70	14.85	32.03	46.88
T_6:PM3tha^{-1}	34.03	4.10	33.63	12.60	28.27	40.87
T_7:75%RDF+ FYM5tha^{-1}	33.73	6.39	32.97	12.10	34.57	46.67
T_8:75%RDF +VC 2.5tha^{-1}	39.03	6.90	37.33	17.83	39.97	57.80
T_9:75%RDF+PM 2.5tha^{-1}	35.73	6.13	35.23	12.93	32.57	45.50
T_{10}:75%RDF+ *Rhizobium*culture	33.93	6.50	33.43	12.30	27.77	40.07
T_{11}:75% RDF+ FYM 5t ha^{-1} + *Rhizobium*culture	36.83	5.57	36.33	14.20	32.67	46.87
T_{12}:75%RDF + FYM 5t ha^{-1} + VC2.5tha^{-1} +*Rhizobium* culture	40.47	7.53	37.83	22.13	47.83	69.96
SE (d) ±	0.80	0.73	0.40	0.39	0.79	1.02
CD(0.05)	1.80	1.65	0.91	0.89	1.66	2.32

The relative economics of different treatment were worked out on the basis of the grain yield and stover yield and cost of inputs. The lowest gross return (Rs.55466.67 ha^{-1}), net return (Rs. 29466.67 ha^{-1}) were recorded in control plot. Among the other treatment combinations the highest gross return (Rs.177066.67), net return (Rs.122, 702, 67ha^{-1}) were recorded with the application of 75% RDF + FYM 5 t ha^{-1} + VC 2.5t ha^{-1} + r*hizobium* culture. The lowest was recorded in control plot. The highest benefit : cost ratio was obtained with the application of 75% RDF + FYM 5 t ha^{-1} + VC 2.5 t ha^{-1} + *rhizobium* culture (2.59) which was followed by treatment T_8 (75% RDF + PM 2.5 t ha^{-1}) (2.56). Among other treatment combinations the lowest benefit cost ratio was recorded (1.13) with the application of treatment T_1 (control). Similar results were also found by Singh *et al.* (2017), they found that among all the treatments, application of 75% RDF + PSB + 2.5 t ha^{-1} vermicompost + r*hizobium* gave maximum gross returns and net returns from moong bean.

Table 3. Effect of integrated nutrient management on economics of green gram

Treatments	Economics		
	Gross return (Rs. ha^{-1})	Net Return (Rs. ha^{-1})	B:C ratio
T_1: Control	55466.67	29466.67	1.13
T_2:100% RDF	98933.33	68848.33	2.29
T_3:*Rhizobium*culture	69600.00	43300.00	1.65
T_4:FYM7tha^{-1}	84266.67	51266.67	1.55
T_5:VC3tha^{-1}	118800.00	68,800.00	1.70
T_6:PM3tha^{-1}	100800.00	68800.00	2.15
T_7:75%RDF+ FYM5tha^{-1}	96800.00	62736.00	1.84
T_8:75%RDF +VC 2.5tha^{-1}	142666.67	93602.67	1.91
T_9:75%RDF+PM 2.5tha^{-1}	103466.67	69402.67	2.56
T_{10}:75%RDF+*Rhizobium*culture	98400.00	69036.00	2.35
T_{11}:75% RDF+ FYM 5t ha^{-1}+ *Rhizobium*culture	113600.00	79236.00	2.31
T_{12}:75%RDF + FYM 5t ha^{-1}+ VC2.5tha^{-1} +*Rhizobium* culture	177066.67	122,702.67	2.59
SE (d) ±	**3982.76**	**3982.76**	**0.11**
CD(0.05)	**9001.03**	**9001.03**	**0.24**

Hence, it is inferred from the investigation that with the application of 75% RDF + FYM 5t ha^{-1} + VC 2.5 t ha^{-1} + *Rhizobium* culture gave maximum growth and yield parameters. In case of economics such as gross returns, net returns and B:C ratio also recorded maximum with the same treatment (75% RDF + FYM 5 t ha^{-1} + VC 2.5 t ha^{-1} + *Rhizobium* culture).

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