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Effect of Integrated nutrient management on growth, yield and economics of summer green gram (*Vigna radiata* L.) Under south Gujarat condition

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Abstract
A field trial was conducted at the College Farm, Navsari Agricultural University, Navsari during the years 2019 and 2020 in summer seasons. The soil of the experimental field was clayey in texture, low in organic carbon (0.40%) and available nitrogen (213.42 kg/ha), medium in available phosphorus (37.55 kg/ha) and high in available potassium (318.27 kg/ha). The soil was slightly alkaline in reaction (pH-7.96). The treatment consisted of integrated nutrient management *viz*., T_1 - Absolute control, T_2 - 100% RDF (20-40-00 NPK kg/ha), T_3 – 100% RDF + bio-compost @ 2.5 t/ha, T_4 – 100% RDF + bio-compost @ 2.5 t/ha + PSB (soil application @ 2.5 l/ha), T_5 – 50% RDF + bio-compost @ 2.5 t/ha, T_6 – 50% RDF + bio-compost @ 2.5 t/ha + PSB (soil application @ 2.5 l/ha) to green gram in summer season. These treatments were replicated four times in randomized block design. Treatments T_4 as 100% RDF + bio-compost @ 2.5 t/ha + PSB (soil application @ 2.5 t/ha) performed good and recorded significantly higher growth attributes, yield attributes, yield and economics of summer green gram.

Keywords: Green gram, economics, bio-compost, integrated nutrient management, growth, yield

Introduction
Pulses are a very important crop for India. They are an important source of protein, grow quickly, generate good profits for farmers and contribute to agricultural and environmental sustainability. The UN Food and Agricultural Organization had declared year 2016 as the "International Year of Pulses." Pulses are an important source of protein for human but have low productivity mainly because their cultivation is limited to marginal and sub-marginal conditions with almost no or low-input management. Efficient and balanced fertilization can help in achieving desired productivity in pulses. Apart from the human diet, pulses form an important fraction of cattle feed and fodder as hay, green fodder and concentrates. Due to their short duration, they can be grown as main, intercrop, catch and green manure crop. Pulses also improve the soil fertility by fixing atmospheric nitrogen and adding residues.

Green gram is an important pulse crop of India as it is the third rank among pulse crops. It is grown on an area of 3.44 million ha with total production of 1.4 million tonnes and productivity of 407 kg/ha (Anon., 2017a) [1]. In Gujarat, it is cultivated in about 2.3 lakh hectares with an annual production of 1.21 lakh tonnes and average productivity of 526 kg/ha (Anon., 2017b) [2]. Green gram (*Vigna radiata* L.) is an important pulse crop having high nutritive value. It not only plays an important role in human diet but also in improving the soil fertility by fixing the atmospheric nitrogen. Due to short duration nature, it is an excellent crop to fit in intercropping system with different major crops. It is also grown as a green manure crop. Being a close growing and spreading crop, it helps in reducing soil erosion and also checks weed growth. Being a legume, it adds nitrogen in the soil. Also, there is a possibility to intensify the system through introduction of green gram as a catch crop during summer, which is helpful in improving soil nutrient status (Venkatesh *et al*., 2015) [5].

Integrated nutrient management facilitates better utilization of resources. In this process, organic sources of nutrients are applied based on economic consideration and the balance required for the crop is supplemented with inorganic fertilizers. Bio-compost is very useful in INM as it is a cost effective and good source of nutrients and also has other benefits like enhancing microbial population in the soil, acting as an absorbent material to hold moisture and soluble minerals etc. Biofertilizers are also important ingredients in INM. Biofertilizer application increases the availability of nutrients to the crops due to enhanced mineralization.

Materials and Methods

A field trial was conducted at the College Farm, Navsari Agricultural University, Navsari during the year 2019 and 2020. The soil of the experimental field was clayey in texture, low in organic carbon (0.40%) and available nitrogen (213.42 kg/ha), medium in available phosphorus (37.55 kg/ha) and high in available potassium (318.27 kg/ha). The soil was slightly alkaline in reaction (pH-7.96). The treatment consisted of integrated nutrient management *viz*., T_1 - Absolute control, T_2 - 100% RDF (20-40-00 NPK kg/ha), T_3 – 100% RDF + bio-compost @ 2.5 t/ha, T_4 – 100% RDF + bio-compost @ 2.5 t/ha + PSB (soil application @ 2.5 l/ha), T_5 – 50% RDF + bio-compost @ 2.5 t/ha, T_6 – 50% RDF + bio-compost @ 2.5 t/ha + PSB (soil application @ 2.5 l/ha) to green gram in summer season, replicated four times in randomized block design. Nitrogen nutrient was applied through urea whereas phosphorus was applied through SSP as basal application. The desired quantity of bio-compost was worked out as per treatments and bio fertilizer was thoroughly mixed with bio-compost. It was then uniformly spread and mixed in particular plots before sowing. The biometric observations were recorded on five randomly selected plants from the net plot. Samples for the observations that required destructive sampling were collected from the ring line and take from the net plot area. The mean values of all observations were utilized for statistical analysis by using statistical procedures as described by Panse and Sukhatme (1985) [4]. The treatment effects on all the characters under study were compared by employing 'F' – test and the data was analysed in randomised block design.

Results and Discussion

Effect on growth parameters

Growth parameters like periodical plant height, number of branches per plant, root nodules per plant and dry matter accumulation at harvest were significantly influenced by integrated nutrient management as use of organic and inorganic sources with biofertilizers. Application of 100% RDF with bio-compost @ 2.5 t/ha with PSB (soil application @ 2.5 l/ha) – T_4 recorded significantly higher values of all growth parameters which was mostly at par with treatment T_3 as 100% RDF with bio-compost @ 2.5 t/ha in majority of all growth parameters. Increasing plant height and better plant growth observed in treatment T_4 probably due to improvement in soil conditions under organic matter addition. Conjunctive use of organic manure and inorganic fertilizers increases the availability of nutrients over a longer period of crop duration owing to their slow release. Thus, better availability of nutrients from an early stage was reflected in improved growth of crop. Here the treatment of organic sources provided enough amount of nutrients and also influenced the soil environment in positive ways for plant growth. The favorable soil condition finally resulted into higher growth parameter of green gram. addition of bio-compost and Phosphate Solubilizing Bacteria (PSB) enhanced the availability of soil phosphorus which otherwise remains mostly fixed in the soil. Phosphorus other than being an important constituent of cell's energy currency (ATP), also bio-compost might be improving physical and biological properties of soil, improving soil aeration and provided food and oxygen to microbes which aids in root nodulation in leguminous crops which in turn results in nitrogen fixation which fulfill nitrogen requirement at later growth stages. The results lend support to the earlier finding of Tyagi *et al.* (2014) [7], Patel *et al.* (2018) [6], Barkha *et al.* (2020) [3] and Patel *et al.* (2020) [8].

Effect on yield parameters and yield

Yield parameters like number of pods per plant, number of seeds per pod, pod length, seed yield and stover yield were significantly influenced by different treatments of integrated nutrient management. Application of 100% RDF with bio-compost @ 2.5 t/ha with PSB (soil application @ 2.5 l/ha) – T_4 recorded significantly higher with all yield parameters, seed yield and stover yield which was mostly at par with treatment T_3 as 100% RDF with bio-compost @ 2.5 t/ha in majority of all growth parameters and followed by T_2 (100% RDF) and T_6 (50% RDF + bio-compost @ 2.5 t/ha with PSB @ 2.5 l/ha through soil application). The increased availability of nutrients due to combined application of organics and inorganics resulted in better absorption, translocation and assimilation of nutrients. Better partitioning of photosynthates between source and sink led to greater assimilation of dry matter in the reproductive or fruiting parts which resulted on improvement of yield attributing characters and ultimately yield. The beneficial effects of integration of organic manures and chemical fertilizers on yield attributes were also reported by Patel (2012) [10], Tyagi *et al.* (2014) [7], Joshi *et al.* (2016) [9], Patel *et al.* (2018) [6] and Barkha *et al.* (2020) [3].

Economics

The relative economics of summer green gram as influenced by different treatments of INM have been worked out and presented in Table 3. Maximum net returns of ₹ 51682/ha with 2.40 B:C ratio was recorded under treatment T_4 (100% RDF + bio-compost 2.5 t/ha with PSB through soil application 2.5 l/ha), followed by treatment T_2 (100 RDF%, ₹ 44277/ha) with BCR of 2.35 and treatment T_3 (100% RDF + bio-compost 2.5 t/ha) net return ₹ 46345/ha with BCR of 2.26. While lowest net return ₹ 27545/ha was observed in treatment T_1 (control) with B:C ratio 1.92. percent increase in net returns over the control was the tune of 87.81, 68.25, 60.74, 39.61 and 33.18% with treatments T_4, T_3, T_2, T_6 and T_5, respectively.

Table 1: Plant height, number of branches per plant, root nodules per plant and dry matter accumulation per plant in green gram as influenced by different treatments (Pooled values)

Treatments	Plant height (cm)		Number of branches per plant (At harvest)	Root nodules per plant	Dry matter accumulation (g/plant)
	60 DAS	At harvest			
T_1: Absolute control	34.56	42.72	3.06	16.74	12.04
T_2: 100% RDF	42.76	52.54	3.65	20.93	14.54
T_3: 100% RDF + Bio- compost @ 2.5 t/ha	43.50	53.50	3.98	21.94	14.69
T_4: 100% RDF + Bio- compost @ 2.5 t/ha + PSB (soil application @ 2.5 l/ha)	44.04	54.90	4.36	22.70	16.79
T_5: 50% RDF + Bio- compost @ 2.5 t/ha	38.88	47.87	3.54	19.87	13.48
T_6: 50% RDF + Bio- compost @ 2.5 t/ha + PSB	40.70	50.03	3.60	20.83	14.39

(soil application @ 2.5 l/ha)					
S.Em ±	1.21	1.70	0.15	0.76	0.53
CD (P=0.05)	3.50	4.63	0.43	2.20	1.52
CV (%)	8.41	9.15	11.47	10.53	10.42
Interaction (Y x T)	NS		NS	NS	NS

Table 2: Number of pods per plant, number of seeds per pod, pod length, seed yield, stover yield and economics of green gram as influenced by different treatments (Pooled values)

Treatments	Number of pods per plant	Number of seeds per pod	Pod length (cm)	Seed yield (kg/ha)	Stover yield (kg/ha)	Gross return	Net return	B:C ratio
T_1: Absolute control	11.40	6.48	6.91	730	1809	57407	27545	1.92
T_2: 100% RDF	13.30	7.85	7.83	988	2234	76970	44277	2.35
T_3: 100% RDF + Bio- compost @ 2.5 t/ha	13.87	8.20	7.91	1069	2378	83144	46345	2.26
T_4: 100% RDF + Bio- compost @ 2.5 t/ha + PSB (soil application @ 2.5 l/ha)	14.59	8.59	8.31	1141	2539	88731	51682	2.40
T_5: 50% RDF + Bio- compost @ 2.5 t/ha	12.71	7.48	7.43	930	2103	72427	36687	2.03
T_6: 50% RDF + Bio- compost @ 2.5 t/ha + PSB (soil application @ 2.5 l/ha)	13.16	7.58	7.74	952	2231	74447	38457	2.07
S.Em ±	0.75	0.24	0.16	46.92	88.8	-	-	-
CD (P=0.05)	2.18	0.71	0.48	136	257	-	-	-
CV (%)	13.09	9.10	6.18	13.70	11.34	-	-	-
Interaction (Y x T)	NS	NS	NS	NS	NS	-	-	-

Conclusion

On the basis of experimental results, it can be concluded that for getting higher yield and economic returns, summer green gram crop should be nourished with 100% RDF + bio-compost @ 2.5 t/ha + PSB (soil application @ 2.5 l/ha) (RDF: 20-40-00 N-P2O5-K2O kg/ha) under south Gujarat condition.

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