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Effect of Organic and Inorganic Fertilizers on Soil Physical Properties & Nutrients Content and Uptake of Summer Green Gram

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The investigation was carried out during *summer* season to know the effect of different organic and inorganic fertilizers on physicochemical properties of soil & content and uptake of plants. The experiment was laid out in factorial randomized block design (FRBD) followed by twelve treatments with four replications. Water holding capacity, bulk density, porosity of soil was not significantly influenced by application of organic and inorganic fertilizers at harvest. Application of vermicompost @ 1.0 t ha^{-1} recorded significantly higher nitrogen content & uptake in seed and stover and

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potassium content in stover of green gram which was at par with incorporation of FYM @ 4 t ha^{-1} but phosphorus content & uptake was not significantly influenced by either incorporation of FYM or vermicompost or inorganic fertilizer. The use of 100% RDF (20 kg N + 40 kg P_2O_5 ha^{-1}) resulted in significantly higher uptake of nitrogen and potassium by seed, stover and total uptake by crop and were at par with the application of 75% RDF (15 kg N + 30 kg P_2O_5 ha^{-1}). Nitrogen, phosphorus and potassium content & uptake in seed, stover and total uptake of green gram was significantly higher recorded with the incorporation of FYM @ 4 t ha^{-1} which was at par with application of vermicompost @ 1 t ha^{-1}. Application of farm yard manure @ 4 t ha^{-1} or vermicompost @ 1 t ha^{-1} along with inorganic fertilizers @ 75% RDF (15 kg N + 30 kg P2O5 ha^{-1}) is best suited for improving physico-chemical properties of soil and nutrients content & uptake of green gram.

Keywords: Green gram; FYM; vermicompost; WHC; bulk density; porosity; RDF; nitrogen, phosphorus; potassium; content ; uptake.

1. INTRODUCTION

"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 3.51 million ha with total production of 2.25 million tonnes and productivity of 539 kg/ha" [1]. "It is grown principally for protein rich edible seeds which contain 24% crude protein, 56.7% carbohydrates, 1.3% fats, 3.5% minerals, 0.43% lysine, 0.1% methionine and 0.04% tryptophan" [2]. "In Gujarat, green gram is grown in the districts of Kutch, Banaskantha, Mehsana and Panchmahals in kharif season under inadequate and erratic rainfall. However, it is grown in very large area in summer season in Kheda, Vadodara and Panchmahals districts. The protein content of green gram is two to three times more than cereals. Being a legume, it adds nitrogen in the soil" [2].

"Organic materials hold great promise as a source of multiple nutrients and ability to improve soil characteristics" [2]. According to Sanchez [3], "60 to 80% of soil phosphorus is of organic origin. Thus, inadequate amount of organic matter in soil will show nutrient deficiencies. These deficiencies can be warded off by regular application of manures". "Soil fertility management plays a pivotal role in increasing green gram production. This involves adequate and balanced nutrient supply. Therefore, soil quality is determined by the efficient use of plant nutrients through judicially balanced and integrated use of all possible organic resources in conjunction with minimum chemical fertilizers. Even application of recommended dose of NPK fails to sustain soil quality and crop production" [4]. Using soil fertility management technologies is necessary to improve farm productivity, reduce poverty, and address challenges due to climate change [5,6]. Effective soil fertility management improves soil properties, including soil organic matter, which ensures the sustainability of soil functions that are critical in maintaining agricultural productivity [7].

"Optimum fertilizer application in the form of organic and inorganic fertilizers or bio-fertilizers is one of the well-established techniques for increasing crop production. Farm yard manure and vermicompost are the sources of primary, secondary and micro nutrients to the plant growth. They are the constant sources of energy for heterotrophic microorganisms, help in increasing the availability of nutrients, quality and quantity of crop produce. Integrated nutrient management involving organic manures, chemical and bio fertilizers all are used together to achieve sustained crop production and maintain soil health" [2].

This present study was conducted during summer season at Agronomy Farm, Bansilal Amrutlal College of Agriculture, Anand Agricultural university, Anand to evaluate the effect of organic manures and inorganic fertilizers on soil physico-chemical properties and nutrient content and uptake by green gram

2. MATERIALS AND METHODS

The field experiment was carried out at College Agronomy Farm, Bansilal Amrutlal College of Agriculture, Anand Agricultural University, Anand during summer season. The experiment was laid out Randomized Block Design (Factorial) with no. of treatments 12 & four replication. Among Organic manure, treatments of M_3: Vermicompost @ 1 t ha^{-1} and M_2: FYM @ 4 t ha^{-1} compared with M_1: Control. In the inorganic fertilizer's treatments F1: Control, F2: 50% RDF, F3: 75% RDF, F4: 100% RDF. Recommended dose of fertilizers 20 kg N: 40 kg P_2O_5: 0 K_2O ha^{-1}. The soil is representative of the region and is locally known as "Goradu" soil. "The texture of

the soil is sandy loam. The soil is very deep and fairly moisture retentive. It responds well to manuring and suitable to various crops of tropical and sub-tropical regions. The physico-chemical properties of experimental plot were determined by drawing representative soil samples from 0-15 cm depth and analyzed for physical and chemical properties of soil described" by Bhuriya et al. [8]. Soil samples was collected at harvest from the surface soil (0-15) using pipe auger and collected in polyethylene bags. Water holding capacity and bulk density of soil were determined by using standard methods from soil at 1 DAS and at harvest. Nitrogen from plant sample was determined after cutting and recorded in percentage using Kjeldahls method. Phosphorus and potassium contents were estimated by using Vando-Molybdo phosphoric acid yellow color method in HNO3 and flame photometric method as described by Jackson [9], respectively. The nutrient uptake was worked out by employing the following formula,

Nutrient uptake = [Dry matter yield (q ha-1) x Nutrient content (%)]/100

3. RESULTS AND DISCUSSION

3.1 Effect of Organic Manures & Inorganic Fertilizers on Water Holding Capacity of Soil

Water holding capacity of soil was influenced by application of organic manures at harvest. The water holding capacity of soil found higher under the application of vermicompost @ 1 t ha^{-1} (M3) *followed by* application of farm yard manure @ 4 t ha^{-1} (M2) (Table 1). Water holding capacity of soil was ot significantly influenced by either application of FYM or vermicompost at harvest. The results are in close conformity with the findings of Damor et al. (2020). They observed increased in water holding capacity of soil with the application of vermicompost. The result (Table 1) revealed that the application of inorganic fertilizers was found to be non-significant with respect to water holding capacity of soil at harvest. Interaction effect of organic manures and inorganic fertilizes with respect to water holding capacity of soil at harvest was found to be non-significant.

3.2 Effect of Organic Manures and Inorganic Fertilizers on Bulk Density (g cc^{-1}) of Soil

The results (Table 1) revealed that there were non-significant differences in bulk density of soil under various applications of organic manures at harvest of the crop. However, bulk density of soil was slightly lower recorded in soil under the application of FYM as well as in the application of vermicompost. Similar results were also obtained by Damor et al. [10]. They found slight decrease in the bulk density where vermicompost or farm yard manure was amended in soil over inorganic fertilizers. The data presented in Table 1 showed that the differences in bulk density of soil among the treatments of inorganic fertilizers at harvest were found to be non-significant. However slightly higher bulk density was found under the treatments of inorganic fertilizers as compared to control in soil samples collected at the time of harvest. The interactive effect of organic manures and inorganic fertilizers on soil bulk density determinate at harvest was found to be non-significant.

Table. 1 Effect of organic manures & inorganic fertilizers on physical properties of soil

Treatments	WHC (%)	Bulk density (g cc^{-1})	Porosity (%)
Organic Manures (M)			
$M_{1:}$ control (No manure)	39.99	1.35	45.53
$M_{2:}$ FYM @ 4 t ha^{-1}	40.27	1.33	46.99
M_3: Vermicompost @ 1 ha^{-1}	40.64	1.34	45.98
S.Em. ±	0.49	0.008	0.76
C.D. at 5%	NS	NS	NS
Inorganic Fertilizers (F)			
F_1: Control (No Fertilizers)	39.49	1.33	46.72
F_2: 50% RDF	39.98	1.34	47.30
F_3: 75% RDF	40.67	1.36	46.16
F_4: 100% RDF	41.07	1.35	44.48
S.Em. ±	0.57	0.009	0.88
C.D. at 5%	NS	NS	NS
Interaction (M x F)	NS	NS	NS
C V %	4.90	2.56	6.61

Table 2. Effect of integrated nutrients management on NPK content (%) and uptake of plant

Treatments	N content (%)		N Uptake (kg ha^{-1})		Total N uptake (kg ha^{-1})	P content (%)		P Uptake (kg ha^{-1})		Total P uptake (kg ha^{-1})	K content (%)		P Uptake (kg ha^{-1})	Total K uptake (kg ha^{-1})	
	Seed	Stover	Seed	Stover		Seed	Stover	Seed	Stover		Seed	Stover	Seed	Stover	
Organic Manures (M)															
M_1 : Control	3.45	0.75	23.09	9.56	32.65	0.35	0.15	2.29	1.98	4.26	0.62	1.42	4.11	18.29	22.39
M_2 : FYM @ 4 t ha^{-1}	3.57	0.81	26.79	12.04	38.83	0.37	0.16	2.80	2.45	5.25	0.69	1.52	5.18	22.60	27.78
M_3: Vermicompost @ 1 ha^{-1}	3.87	0.82	28.71	11.67	40.38	0.37	0.17	2.76	2.27	5.03	0.68	1.54	5.01	21.72	26.71
S.Em. ±	0.09	0.02	1.27	0.47	1.52	0.01	0.005	0.15	0.12	0.24	0.01	0.04	0.19	0.92	0.99
C.D. at 5 %	0.26	0.06	3.65	1.34	4.37	NS	NS	0.41	0.34	0.69	0.05	0.13	0.53	2.63	2.85
Inorganic fertilizer (F)															
F_1 : Control (No fertilizers)	3.59	0.76	24.48	10.46	34.94	0.35	0.15	2.41	2.09	4.50	0.65	1.46	4.58	19.15	23.72
F_2 : 50 % RDF	3.64	0.79	25.19	10.26	35.46	0.35	0.15	2.51	2.12	4.63	0.66	1.47	4.46	19.76	24.23
F_3 :75 % RDF	3.64	0.80	26.01	11.15	37.16	0.36	0.16	2.58	2.21	4.80	0.66	1.50	4.67	21.24	25.90
F_4 : 100 % RDF	3.66	0.81	29.09	12.47	41.56	0.37	0.16	2.94	2.49	5.44	0.67	1.52	5.34	23.33	28.66
S.Em. ±	0.10	0.02	1.46	0.54	1.75	0.001	0.006	0.17	0.14	0.27	0.02	0.05	0.22	1.05	1.45
C.D. at 5 %	NS	NS	4.36	1.55	5.04	NS	NS	NS	NS	NS	NS	NS	0.60	3.04	3.29
Interaction (M x F)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C. V. %	10.25	10.10	14.39	10.88	10.29	13.36	14.10	11.83	11.35	10.80	10.27	11.15	10.31	11.49	10.46

3.3 Effect of Organic Manures and Inorganic Fertilizers on Porosity (%) of Soil

Data presented in Table 1 revealed that porosity (%) of soil was influenced by application of organic manures at harvest. The porosity of soil found the higher under the application of vermicompost @ 1 t ha^{-1} *fb* application of farm yard manure @ 4 t ha^{-1}. Porosity of soil was not significantly influenced by either application of FYM or vermicompost at harvest. The results are in close conformity with the findings of Sharma et al. [11] and Manivannan et al. [12]. They observed that soil porosity with the application of vermicompost was improved. Data presented in Table 1 revealed that application of inorganic fertilizers was found to be non-significant with respect to porosity of soil at harvest. This result is in agreement with the findings of Maji and Mandal [13] who reported changing in soil porosity due to long term application of 100% NPK for ten years in paddy-oat and paddy berseem cropping system. The interaction effect of organic manures and inorganic fertilizes with respect to porosity of soil at harvest was found to be non-significant (Table 1).

3.4 Effect of Organic Manures and Inorganic Fertilizers on N Content (%) and Uptake from Plant

A perusal of data given in Table 2 revealed that the influence of organic manures was found significant for nitrogen content in green gram Seed and Stover at harvest. Application of vermicompost @ 1.0 t ha^{-1} recorded significantly the higher nitrogen content in green gram seed (3.87%) and Stover (0.82%) at harvest which was at par with the application of FYM @ 4 t ha^{-1}. These results are in agreement with the findings of Purkayastha and Menon [14]. An analysis of the data on nitrogen uptake by green gram seed and stover as well as total uptake by crop as influenced by organic manures showed their significant effect. Application of vermicompost @ 1 t ha^{-1} registered significantly the higher nitrogen uptake by grain and total uptake by crop which was at par with application of FYM @ 4 t ha^{-1}. While uptake of nitrogen by stover of green gram was significantly higher in application of FYM @ 4 t ha^{-1} which was at par with application of vermicompost @ 1 t ha^{-1}. This indicated more availability of nitrogen in soil at vegetative growth stage in application of FYM or vermicompost as compare to control. Growth of green gram was influenced by organic manures which increased uptake of nitrogen by plants. Significantly the lowest nitrogen uptake was noticed under no manure (control) treatment in seed and stover of green gram. These results are in agreement with the findings of Sutaria et al. [15] who reported higher uptake of nitrogen by green gram crop with the application of organic manures as compared to control at Targhadia (Gujarat).

Among different levels of fertilizers, nitrogen content in seed and stover were increased with increasing levels of fertilizers. Higher nitrogen content in seed and stover were observed with 100% RDF application to the green gram. Nitrogen uptake by seed and stover as well as total uptake of nitrogen by green gram crop were significantly higher recorded with the 100% RDF which was at par with RDF applied @ 75%. Plant growth of green gram was influenced by application of fertilizers applied @ 75 and 100% RDF which increased the uptake of nitrogen. These results are in agreement with the finding of Kumawat et al. [16] who reported maximum uptake of nitrogen by seed and stover of green gram with application of 20 kg N + 30 kg P_2O_5 ha^{-1}. Data presented in Table2 revealed that interaction effect of organic manures and inorganic fertilizers was found to be non-significant with respect to nitrogen content in seed and stover of green gram and uptake of nitrogen by seed and stover as well as total uptake of nitrogen by crop at harvest.

3.5 Effect of Organic Manures and Inorganic Fertilizers on P Content (%) and Uptake from Plant

Application of vermicompost @ 1 t ha^{-1} recorded higher phosphorus content in seed (0.37%) and stover (0.17%) of green gram fb the application of FYM @ 4 t ha^{-1} at harvest. An analysis of the data on phosphorus uptake by seed and stover of green gram and total uptake by crop as influenced by organic manures showed their significant effect. Incorporation of FYM @ 4 t ha^{-1} registered significantly higher phosphorus uptake by seed and stover as well as total uptake by crop which was at par with application of vermicompost @ 1 t ha^{-1}. Application of FYM and vermicompost increased phosphorous content in soil which showed beneficial effect on phosphorous content of green gram as compared to control (no manure). seed and stover yield of green gram was higher in application of FYM @ 4 t ha^{-1} therefore, uptake of phosphorous found higher as compared to application of vermicompost. Plant growth was also influenced by application of organic

manures. These results are in agreement with the findings of Das et al. [17] who also reported higher phosphorus uptake by green gram crop with incorporation of vermicompost and Jat et al. [18] reported higher phosphorus uptake by seed and stover of green gram by application of FYM @ 5 t ha^{-1} (Table 2).

The data presented in Table 2 indicated that phosphorous content in seed and stover of green gram were not significantly affected by application of inorganic fertilizers. Phosphorus content in seed and stover of green gram as well as uptake of phosphorus by seed and stover and total uptake of phosphorus by green gram crop is increased with increasing levels of fertilizers and higher found with 100% RDF application. The results are in close agreement with the finding of Kumawat et al. [16] who reported higher phosphorus uptake in seed and stover with the application of 100% RDF (20 kg N + 30 kg P_2O_5 ha^{-1}) *fb* 50% RDF in green gram grown on loamy sand soil. Data presented in Table. 2 indicate that interaction effect of organic and inorganic fertilizers on phosphorus content & uptake by seed and stover of green gram was found non-significant.

3.6 Effect of Organic Manures and Inorganic Fertilizers on K Content (%) and Uptake from Plant

Data relating to potassium content in seed and stover of green gram and uptake of potassium by green gram (Table 2) revealed that significantly the higher potassium content in seed of green gram were recorded in the incorporation of FYM @ 4 t ha^{-1} which was at par with application of vermicompost @ 1 t ha^{-1} while in stover, phosphorus content was higher with application of vermicompost @ 1 t ha^{-1} and was at par with incorporation of FYM @ 4 t ha^{-1}. Significantly higher potassium uptake by seed and stover as well as total uptake by green gram crop at harvest were recorded with incorporation of FYM @ 4 t ha^{-1} which was at par with application of vermicompost @ 1 t ha^{-1}. Plant growth is greatly influenced by application of organic manures which directly influenced the uptake of nutrients by crop. These results are in agreement with the findings of Ghanshyam et al. [19] and Jat et al. [18].

The results revealed that potassium content in seed and stover of green gram analyzed at harvest was not significantly influenced by application of inorganic fertilizers. Potassium content in seed and stover were increased with increasing levels of fertilizers and higher potassium content found with 100% RDF application to the green gram. In the case of uptake of potassium by seed and stover of green gram and total uptake of potassium by crop was found significantly due to application of inorganic fertilizers. Significantly higher uptake of potassium by seed and stover as well as total uptake of potassium by crop were recorded with 100% RDF which was at par with application of 75% RDF. Application of nitrogen and phosphorus influencing plant growth due to better nutrient in soil and provided balance nutrient to the crop hence uptake was higher with 100% RDF applied to the crop. This results are in conformity with the finding of Ram and Dixit [20] and singh et al. [21]. Data presented in Table. 2 revealed that interaction effect of organic and inorganic fertilizers on potassium content & uptake by seed and stover of green gram was found non-significant.

4. CONCLUSION

On the basis of present study, it was concluded that combined application of organic and inorganic fertilizers improved the growth of green gram. Application of vermicompost and farm yard manure (FYM) in combination with recommended dose of fertilizer (RDF) increased the physico-chemical properties and nutrients content & uptake of green gram as compared to control treatment. Thus, use of organic manures and inorganic fertilizers should be included in integrated crop management for sustainable agriculture.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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