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Effects of Organic Manure and Recommended Dosage of Fertilizer on Nodulation, Chlorophyll Content of leaves, Availability of Nutrients and Soil Properties under Greengram [*Vigna radiata* (L.) Wilczek] Cultivation

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ABSTRACT

Background: The objective of the present study was to investigate the effects of different sources of organic manure on nodulation, chlorophyll content of leaves, availabilities of nutrients and soil chemical properties compared to the recommended dose of fertilizer (RDF).

Methods: The study was conducted during *kharif* and *rabi* seasons of 2022. The experiment laid out in randomized block design, replicated three times having nine treatments *i.e.*, T_1- Absolute control; T_2- Vermicompost 100% on N equivalent basis; T_3- Farmyard manure 100% on N equivalent basis; T_4- Vermicompost 50% + Farmyard manure 50%; T_5- Vermicompost 75%+Farmyard manure 25%; T_6- Vermicompost 25% + Farmyard manure 75%; T_7- RDF 100% inorganic; T_8- RDF 50% inorganic+Vermicompost 50%; T_9- RDF 50% inorganic + Farmyard manure 50%.

Result: The results indicated that application of vermicompost at 100% nitrogen equivalent basis increased root nodulation, chlorophyll content of leaves and improved soil properties. The application of 100% RDF also enhanced the nutrient availabilities and nutrient uptake in clay loam soil.

Key words: Farmyard manure, Greengram, Recommended dose of fertilizer, Vermicompost,

INTRODUCTION

In India, pulses are commonly known as food legumes and hold the second position in both production and consumption, after cereals. Greengram, being a vital pulse crop, is rich in carbohydrates-51%, vitamins-3% and minerals. It also provides a significant source of protein content of 25-26%. Being a resilient pulse crop, it contributes approximately 10-12% to the overall pulse production in the country. However low productivity of greengram can be attributed to its cultivation in marginal and sub-marginal soils with poor soil fertility in agro-managements (Saravanan *et al*., 2013). It is often cultivated as an intercrop and suited for dryland farming. Studies have reported that neglecting fertilizers can have a substantial negative impact on green gram yield (Singh and Sekhon, 2008). Further, the continuous depletion of nutrients poses a significant challenge in achieving sustainable production of crops and greengram is not an exception. In order to promote the growth and yield of greengram, the application of a starter dose of nitrogen is crucial along with bio-organics. Excessive and imbalanced nutrient use has led to nutrient depletion in the soil, decreased crop productivity and ultimately impair soil health (Sachan and Deeksha, 2021). By ensuring an adequate nitrogen supply, the plant's protein synthesis, chlorophyll production and enzymatic activities can be effectively supported, leading to improved growth and ultimately higher yields in greengram. Organic manures serve as an excellent medium for microbial growth and help sustain an optional nutrient balance, supporting a healthy and productive soil ecosystem (Shariff *et al*., 2016). Organic manures such as farmyard manure and vermicompost aid in enhancing soil structure, aeration and water retention capacity (Rambuatsaiha *et al*., 2017). Considering the above facts, the present study was undertaken to evaluate the usage of different organic manures and RDF in greengram for their effects on root nodules, chlorophyll content, availability of nutrients and their uptakes and soil chemical properties.

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MATERIALS AND METHODS

The field experiment was conducted during *rabi* and *kharif* (2022- 23) at the south farm field No. R15, Karunya Institute of Technology and Sciences, Coimbatore. The farm is situated in Western Agro-Climatic zone of Tamil Nadu (10° 56′N and 76°44′E) at an elevation of 474 m above mean sea level. The Greengram variety 'CO 8' with a seed rate of 25 kg ha^{-1} was sown at a 30 cm × 10 cm spacing following pre-sowing irrigation. The experiment was laid out in randomized block design with three replications having nine treatments *i.e.*, T_1: Absolute control, T_2: Vermicompost 100% on N equivalent basis (4 t ha^{-1}), T_3: Farmyard manure 100% on N equivalent basis (12.5 t ha^{-1}), T_4: Vermicompost 50% (2 t ha^{-1})+Farmyard manure 50% (6.25 t ha^{-1}), T_5: Vermicompost 75% (3 t ha^{-1})+Farmyard manure 25% (3.125 t ha^{-1}), T_6: Vermicompost 25% (1 t ha^{-1}) + Farmyard manure 75% (9.375 t ha^{-1}), T_7: RDF 100% (inorganic) (25:50:25 of N, P_2O_5 and K_2O kg ha^{-1}), T_8: RDF 50% (inorganic) (12.5:25:12.5 of N, P_2O_5 and K_2O kg ha^{-1}) + Vermicompost 50% (4 t ha^{-1}), T_9: RDF 50% (inorganic) (12.5:25:12.5 of N, P_2O_5 and K_2O kg ha^{-1})+Farmyard manure 50% (6.25 t ha^{-1}). Organic manures and RDF were applied as basal in soil (Sand 43.20%, Clay 38.10% and Clay 18.17%). The root nodulation was recorded at 30 and 45 DAS. The total chlorophyll content of leaves was estimated by SPAD chlorophyll meter at 30, 40 and 50 DAS using physiologically active leaves randomly selected from five plants. The estimation of soil pH and EC at 25°C (1:2.5) was estimated by the potentiometric method by Jackson (1973). The pH of the experimental field was 7.6, EC 0.40 dSm^{-1} and the organic carbon content was 7.96%. The wet o xidation method by Walkley and Black (1934) was used to estimate the organic carbon. The soil available nitrogen was estimated by the Alkaline Permanganate method as outlined by Subbiah and Asija (1956). The soil available phosphorus was estimated by the method proposed by Olsen *et al.* (1954). The available potassium content was determined by neutral ammonium acetate extraction method using flame photometer by Stanford and English (1949). The online computer program "OPSTAT," created by Sheoran *et al.* (1998) was employed for statistical analysis.

RESULTS AND DISCUSSION

Impact of different sources of organic manures and RDF on nutrient uptake of greengram at harvest

The recommended dose of fertilizer (T_7) had the highest uptake of N,P and K and the least was registered in absolute control (Table 1). Treatment T_7 was at par with T_2 and T_8 and was significantly superior over other treatments for the uptake of nitrogen and potassium. In the case of phosphorous uptake, the treatment T_7 was at par with T_2, T_4 and T_8 and was significantly superior over other treatments. In general, a balanced uptake of NPK nutrients leads to higher plant height, better nodulation, improved growth and yield characteristics and higher-quality greengram harvests (Meena and Varma, 2016).

Impact of different sources of organic manures and RDF on chlorophyll content of leaves

Application of vermicompost 100% on N equivalent basis (T_2) significantly improved the chlorophyll content of the leaf (Table 2). The chlorophyll content of the leaves showed a progressive increase from 30 DAS to 50 DAS during both seasons. During the *Kharif* season chlorophyll content in T_2 was significantly superior over all the other treatments at 30, 40 and 50 DAS, which was on par with T_4, T_5, T_6 and T_8. During *rabi* season, T_2 recorded higher chlorophyll content at all the stages. At 30 DAS, T_2 was at par with T_3, T_4 and T_5. At 40 and 50 DAS T_2 was at par with T_3, T_4, T_5, T_6 and T_8 treatments. Prasad and Ram (1984) observed that even basal doses of recommendation of fertilizers and seed inoculation with single or multiple strains of rhizobia increased the chlorophyll content of green gram. It is widely accepted that vermicompost enhances the physical, chemical and biological properties of the soil, besides

Table 1: Impact of different sources of organic manures and RDF on nutrient uptake in greengram at harvest.

Treatments	Available nutrients (Kg ha^{-1})		
	N	P	K
T_1: Absolute control	34.5	3.66	29.1
T_2: Vermicompost 100% on N equivalent basis	64.3	7.87	52.2
T_3: Farmyard manure 100% on N equivalent basis	40.2	4.82	31.2
T_4: Vermicompost 50% + Farmyard manure 50%	58.1	7.52	46.3
T_5: Vermicompost 75% + Farmyard manure 25%	56.2	7.10	43.2
T_6: Vermicompost 25% + Farmyard manure 75%	45.3	5.32	34.2
T_7: RDF 100% inorganic	69.8	8.82	55.1
T_8: RDF 50% inorganic + Vermicompost 50%	61.2	7.82	49.6
T_9: RDF 50% inorganic + Farmyard manure 50%	51.2	6.23	38.8
S.E.(d)±	5.0	0.62	4.0
C.D. at 5%	10.4	1.30	8.4

RDF- Recommended dose of fertilizer; *Significant at P 0.05; NS- Non significant at P>0.05.

supplying nearly all the necessary nutrients for plant growth and development. Similar results were also reported (Sitaram *et al*., 2014; Vaithiyanathan and Sundaramoorthy, 2016).

Impact of different organic manures and RDF on root nodules

The nodule number per plant was significantly influenced by the treatments at 30 and 40 DAS in both seasons. The highest number of nodules per plant were observed in T_2 (19.89 and 19.72 nodules per plant at 30 DAS during *rabi* and *kharif* season respectively) which received vermicompost 100% on an N equivalent basis. At 45 DAS, T_2 had about 22.88 (*rabi*) and 22.71 (*kharif*) nodules per plant (Table 3). The use of vermicompost enhanced the production of metabolites and enzymes which might have favored root nodulation. The phosphorus supply from vermicompost and FYM increased root development and increased root nodulation. Singh *et al*. (2017) and Singh *et al*. (2022) reported similar findings.

Impact of various sources of organic manures and RDF on soil pH, EC and organic carbon

The application of various combinations of vermicompost, farmyard manure and RDF did not influence the soil pH and EC at harvest during *kharif* and *rabi* seasons of 2022 (Table 4). The highest soil pH was under absolute control in both the seasons. The pH was generally low in all the organic treatments though not significantly.

The retention of soil pH in plots receiving vermicompost might be attributed to the soil's improved buffering capacity by the organic matter. In the present study, adding organic manures alone or in combination with the fertilizers brought the pH closer to neutral, but use of organic fertilizers slightly increased soil pH. These results are supported by Kharadi and Bhuriya (2020).

Vermicompost 100% on N equivalent basis (T_2) recorded higher soil organic carbon in both seasons (Table 4) followed by T_5. The treatment T_2 was at par with T_4, T_5 and T_6 in both the seasons. The absolute control had the lowest soil organic carbon. The addition of vermicompost alone

Table 2: Impact of different sources of organic manures on chlorophyll content (μ mol m^{-2}).

Treatments	*Kharif* 2022			*Rabi* 2022		
	30 DAS	40 DAS	50 DAS	30 DAS	40 DAS	50 DAS
T_1: Absolute control	24.8	25.0	25.1	25.1	25.3	25.4
T_2: Vermicompost 100% on N equivalent basis	34.1	35.1	35.6	34.4	35.4	35.9
T_3: Farmyard manure 100% on N equivalent basis	31.7	32.1	33.7	31.9	32.4	34.0
T_4: Vermicompost 50% + Farmyard manure 50%	31.3	31.7	33.1	31.4	32.3	33.5
T_5: Vermicompost 75% + Farmyard manure 25%	29.0	31.2	32.0	30.4	31.8	32.5
T_6: Vermicompost 25% + Farmyard manure 75%	28.5	30.8	31.7	30.2	31.5	32.0
T_7: RDF 100% inorganic	25.9	27.2	28.1	26.1	27.8	28.6
T_8: RDF 50% inorganic + Vermicompost 50%	27.1	30.0	31.3	27.5	30.5	31.6
T_9: RDF 50% inorganic + Farmyard manure 50%	26.4	28.3	28.6	27.1	28.9	29.1
S.E.(d)±	2.50	2.63	2.70	2.53	2.66	2.73
C.D. at 5%	5.23	5.49	5.64	2.26	2.56	5.70

RDF- Recommended dose of fertilizer; *Significant at P 0.05; NS- Non significant at P>0.05.

Table 3: Impact of different organic manures and RDF on number of root nodules.

Treatments	*Kharif* 2022		*Rabi* 2022	
	30 DAS	45 DAS	30 DAS	45 DAS
T_1: Absolute control	13.09	13.40	13.38	13.8
T_2: Vermicompost 100% on N equivalent basis	19.72	22.71	19.89	22.88
T_3: Farmyard manure 100% on N equivalent basis	18.55	20.00	18.69	20.16
T_4: Vermicompost 50% + Farmyard manure 50%	17.22	19.53	17.41	19.69
T_5: Vermicompost 75% + Farmyard manure 25%	16.73	19.24	16.95	19.38
T_6: Vermicompost 25% + Farmyard manure 75%	16.54	18.69	16.79	18.84
T_7: RDF 100% inorganic	14.21	15.39	14.49	15.59
T_8: RDF 50% inorganic + Vermicompost 50%	15.52	17.69	15.72	17.95
T_9: RDF 50% inorganic + Farmyard manure 50%	15.03	16.92	15.17	17.00
S.E.(d)±	0.50	0.51	0.51	0.52
C.D. at 5%	1.05	1.06	1.07	1.09

RDF- Recommended dose of fertilizer; *Significant at P 0.05; NS- Non significant at P>0.05.

Table 4: Impact of different sources of organic manures on pH, EC and organic carbon.

Treatments	*Kharif* 2022			*Rabi* 2022		
	pH	EC (dSm^{-1})	OC (%)	pH	EC (dSm^{-1})	OC (%)
T_1: Absolute control	7.96	0.42	0.46	7.96	0.42	0.46
T_2: Vermicompost 100% on N equivalent basis	7.58	0.40	1.16	7.57	0.39	1.20
T_3: Farmyard manure 100% on N equivalent basis	7.56	0.41	0.51	7.56	0.41	0.52
T_4: Vermicompost 50% + Farmyard manure 50%	7.55	0.41	1.07	7.54	0.41	1.12
T_5: Vermicompost 75% + Farmyard manure 25%	7.54	0.40	1.10	7.54	0.41	1.17
T_6: Vermicompost 25% + Farmyard manure 75%	7.54	0.39	1.07	7.53	0.38	1.10
T_7: RDF 100% inorganic	7.62	0.42	0.49	7.61	0.42	0.50
T_8: RDF 50% inorganic + Vermicompost 50%	7.57	0.41	0.51	7.58	0.41	0.52
T_9: RDF 50% inorganic + Farmyard manure 50%	7.58	0.40	0.50	7.58	0.40	0.51
S.E.(d)±	0.65	0.03	0.07	0.65	0.03	0.07
C.D. at 5%	NS	NS	0.15	NS	NS	0.15

RDF- Recommended dose of fertilizer; *Significant at P 0.05; NS- Non significant at P>0.05.

Table 5: Effect of vermicompost, FYM and RDF on soil available nutrients (kg ha^{-1}) at harvest.

Treatments	Soil available nutrients (kg ha^{-1}) at harvest		
	N	P	K
T_1: Absolute control	211	13.47	402
T_2: Vermicompost 100% on N equivalent basis	265	17.30	492
T_3: Farmyard manure 100% on N equivalent basis	223	14.27	427
T_4: Vermicompost 50% + Farmyard manure 50%	238	15.60	478
T_5: Vermicompost 75% + Farmyard manure 25%	239	15.15	469
T_6: Vermicompost 25% + Farmyard manure 75%	232	14.63	435
T_7: RDF 100% inorganic	287	19.21	505
T_8: RDF 50% inorganic + Vermicompost 50%	251	16.43	485
T_9: RDF 50% inorganic + Farmyard manure 50%	235	14.77	452
S.E.(d)±	21.34	1.39	40.57
C.D. at 5%	44.59	2.91	84.74

RDF- Recommended dose of fertilizer; *Significant at P 0.05; NS- Non significant at P>0.05.

or in combination with farmyard manure contributed to the improved organic carbon content of soil.

Impact of vermicompost, FYM and RDF on soil available nutrients (kg ha^{-1}) at harvest stage of greengram

At harvest, an improved nutritional status was observed in RDF 100% (inorganic) treated plots. Available N, P_2O_5 and K_2O were highest in T_7 (RDF 100% inorganic). In the case of K_2O, T_7 was at par with other treatments barring T_1. The highest nitrogen content (287 kg ha^{-1}) in the soil after the experiment was observed in T_7 was at par with T_2 and T_8 (Table 5). The highest P_2O_5 content (19.21kg ha^{-1}) was observed with T_7 which was at par with T_2 and T_8. The highest available potassium (505 kg ha^{-1}) was observed in T_7 which was at par with other treatments except the absolute control (T_1). Kharadi and Bhuriya (2020) reported comparable results in their study.

CONCLUSION

A significant increase in the uptake of N, P and K and availability of soil N, P and K after harvest were observed with 100% RDF treatment followed by T_2 (vermicompost 100% on N equivalent basis). The application of vermicompost 100% on N equivalent basis (T_2) enhanced the root nodulation, chlorophyll content and soil organic carbon. However, the treatments could not significantly alter the electrical conductivity and pH of the soil.

Conflict of interest

I hereby certify that none of the authors of the manuscript have any conflicts of interest.

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