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Effect of INM on nodulation, yield, quality and available nutrient status in soil after harvest of greengram

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ABSTRACT

A field experiment was carried out at Varanasi (Uttar Pradesh) during *kharif* season of 2013 to study the influence of integrated nutrient management on greengram [*Vigna radiata* (L.) Wilczek].Three sources of nutrients *viz.* inorganic, organic and bio-fertilizers were used in twelve combinations with randomized block design. Among different combinations, significant improvement in number of nodules/plant (80.97), dry weight of nodules (32.89 mg/plant), yield attributes, seed yield (12.34 qt/ha), harvest index (28.32%), nutrient content, available NPK and organic carbon after harvest in soil were recorded with application of nutrients through 75% RDF + 2.5 t/ha vermicompost + *rhizobium* + Phosphate solubilizing bacteria (PSB) as compared to other combinations and control, but it was at par with 100% RDF + 2.5 t/ha vermicompost and 100% RDF + *rhizobium* + PSB.

Key words: Greengram, PSB, *Rhizobium*, Vermicompost, Yield.

INTRODUCTION

Greengram [*Vigna radiata* (L.) Wilczek] is one of the most ancient and extensively grown leguminous crops of India. 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. Greengram is an excellent source of high quality protein. It can be boiled or eaten whole and contains about 25 per cent protein. It also contains high quality of lysine (4600 mg/g N) and tryptophan (60 mg/g N) and consumed as whole grain or as well as in the form of dal for table purposes. Greengram is supposed to be easily digestible, hence, is preferred by patients. The sprouted seeds of greengram are rich in ascorbic acid (vitamin C), riboflavin and thiamine (Choudhary *et al.*, 2003).

In spite of being widely adapted crop in India, its productivity is very low. Crop productivity could be achieved with the help of agrochemicals. The green revolution brought impressive gains in food production but due to intensive use of agro-chemicals soil biodiversity is being affected. There is now tremendous pressure on growers to use integrated nutrient management approach to increase productivity and sustain soil health. Organic amendment offers an alternative or supplementing control tactic to increase production (Meena, 2015). During the last several years, considerable progress has been made in the utilization of vermicompost and seed inoculation with *rhizobium* and PSB for integrated nutrient management approach. Organic sources of nutrients like vermicompost are extensively used in various crops. These organic additives can be used to promote the development of beneficial organisms in the soil. Several workers used organic additives to enhance the growth, yield and quality of crops (Meena, 2013; Mujahid and Gupta 2010). Organic amendments also increase the efficiency of bio-fertilizers. Such bio-fertilizers are cheaper, eco-friendly and based on renewable energy sources has gained momentum in recent years to supplement the parts of chemical fertilizers (Meena *et al.*, 2015a). The rhizosphere is inhabited by actively growing microbial population that immensely affects the root and plant metabolic activities. *rhizobium* and PSB are beneficial for root nodule formation collectively known as rhizobia, as potential microbial inoculants have been convincingly emphasized in recent years for its nitrogen and phosphorus fixing ability (Meena *et al.*, 2015b). Hence, the present investigation was carried out to find out appropriate integrated nutrient management option for greengram productivity and to find out available NPK and organic carbon status in soil after harvest of greengram in eastern Uttar Pradesh region.

MATERIALS AND METHODS

An attempt was made to study the response of greengram to integrated nutrient management. Field experiment was conducted during *kharif* season of 2013 at Agronomy Farm, Institute of Agricultural Sciences, BHU, Varanasi (UP). The soil was sandy clay loam with pH 7.32, available N 160.13 kg/ha (Subbiah and Asija, 1956), P 22.64

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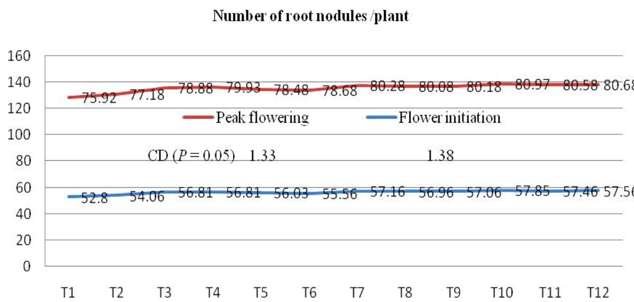
kg/ha (Olsen *et al.*, 1954), K 211.41 kg/ha (Stanford and English, 1949) and 0.36% organic carbon (Jackson, 1973). The twelve treatments comprised one control, three levels of inorganic sources (75, 50 and 100 % NPK of recommended dose) and other eight in combination *viz.* 50% RDF+ *rhizobium* + PSB, 50% RDF + 2.5 t/ha vermicompost, 50% RDF+2.5 t/ha vermicompost/ha + *rhizobium* + PSB, 75% RDF+ *rhizobium* + PSB, 75% RDF + 2.5 t/ha vermicompost,75% RDF + 2.5 t/ha vermicompost + *rhizobium* +PSB, 100%RDF+ *rhizobium*+ PSB and100% RDF+2.5 t/ha vermicompost were laid out in randomized block design with three replications. Recommended dose of fertilizers 20: 40: 20 kg /ha (N_2:P_2O_5:K_2O) were applied as per treatments as basal dose at the time of sowing in furrows at 30 cm apart in at the depth of 10 cm. The required quantity of *rhizobium* cultures, *i.e*. @ 200 g culture per 10 kg seed was mixed to 10% sugar solution to form slurry. The culture of PSB 200 g per 12 kg fine soil was well mixed with the help of hand and then applies to as per treatment details. Five representative homogenous vermicompost samples were taken and analyzed for pH (7.5), available nitrogen (1.4%), phosphorus (0.81%) and potassium (1.03%) and also for important micronutrients. Vermicompost was applied as per treatment. Greengram variety HUM 12 (Maliviya Jenchetna) was sown at 15 kg/ha in line at 30 cm at a depth of 5 cm on 6 August. Surface soil samples (0-30 cm depth) were collected from each plot after the crop harvest and composite samples were analyzed for organic carbon, available nitrogen, phosphorus and potassium as per standard procedures. All the data obtained were statistically analyzed using the *F*-test (Gomez and Gomez, 1984). Critical difference (CD) values at *P*=0.05 were used for determine the significance of differences between mean values of treatments.

RESULTS AND DISCUSSION

Nodulation: The maximum number of root nodules /plant at flower initiation and peak flowering stages were recorded in the treatment of 75% RDF+ vermicompost + bio-fertilizers + *rhizobium* +PSB (57.85, 80.97) and it was found to be at par with treatments of other combinations. The minimum number of root nodules /plant at both the stages was recorded under the control (52.80, 75.92) respectively (Fig 1). Such positive benefits of nutrient combination have also been reported elsewhere (Gupta, 2006). This fact is also supported with better nodulation pattern and nodulation rating with 75% RDF + 2.5 t/ha vermicompost + *rhizobium* + PSB as



T_1= Control, T_2=50%RDF, T_3=75%RDF, T_4=100%RDF, T_5=50%RDF+Rh+PSB, T_6=50%RDF+2.5 t /ha VC, T_7=50%RDF+2.5t /haVC+ Rh+ PSB, T_8=75%RDF+Rh+PSB, $T_9$75%RDF+2.5t /ha VC, T_{10} 75%RDF+2.5t /ha VC+Rh+PSB, T_{11} 100%RDF+Rh+PSB, T_{12}100%RDF+2.5t /ha VC

Fig 1: Effect of integrated nutrient management on number of nodules of greengram

Table 1: Effect of integrated nutrient management on nodulation and yield attributes of greengram

Treatment	Dry weight of root nodules (mg/plant)		Yield attributes			
	Flower initiation	Peak flowering	Length of pod (cm)	No. of pods /plant	No. of seeds /pod	Seed index (g)
Control	27.84	22.10	4.16	25.68	8.01	3.03
50%RDF	29.10	23.36	5.41	28.03	9.27	3.21
75%RDF	30.80	25.06	7.11	30.04	10.97	3.45
100%RDF	31.85	26.11	8.16	31.08	12.02	3.60
50%RDF+Rh+PSB	30.40	24.66	6.71	29.12	10.57	3.42
50%RDF+2.5 t /ha VC	30.60	24.86	6.91	29.65	10.77	3.49
50%RDF+2.5t /haVC+Rh+PSB	32.20	26.46	8.80	31.48	12.61	3.66
75%RDF+Rh+PSB	32.00	26.26	8.31	31.30	12.17	3.61
75%RDF+2.5t /ha VC	32.10	26.36	8.77	31.44	12.57	3.63
75%RDF+2.5t /ha VC+Rh+PSB	32.89	27.15	9.20	32.49	13.06	3.71
100%RDF+Rh+PSB	32.50	26.76	8.82	31.72	12.67	3.68
100%RDF+2.5t /ha VC	32.60	26.86	8.91	32.18	12.77	3.70
S.Em±	0.40	0.42	0.36	0.43	0.36	0.04
CD (*P* = 0.05)	1.19	1.23	1.04	1.26	1.05	0.10

RDF: Recommended dose of fertilizer, VC: Vermicompost, Rh*: Rhizobium,* PSB: Phosphorus solublizing Bacteria, DAS: Days after sowing, NS: Non significant compared to other combinations. PGPR inoculation alone also significantly increased nodule number, nodule dry weight and nodule effectively by 34.4, 33.2 and 15.1 %, respectively over control (Table 1), This fact is also supported with better nodulation pattern and nodulation rating with Mesorhizobium inoculation as compared to control. Other combinations also significantly increased nodule dry weight. The maximum dry weight of root nodules /plant at flower initiation and peak flowering stages obtained in combination of 75% RDF + 2.5 t/ha vermicompost + *rhizobium* + PSB (32.89, 27.15 mg). These results were in conformity of the findings (Gan *et al.*, 2005; Meena *et al.*, 2015b).

Yield attributes and yield: Amongst combinations, significant improvement in number of pods/plant (32.49), seeds/pod (13.06), hundred seed weight (3.71 g) was observed in 75%RDF+2.5 t/ha VC+ *rhizobium* + PSB as compare to other combinations and control (Table1). Similar pattern were observed in straw yield (31.15qt/ha), biological yield (43.49 q/ha) and harvest index (28.32%), protein (24.72%), nutrient content and uptake (Table 2) of greengram followed by 100% RDF + 2.5 t/ha vermicompost and 100% RDF + *rhizobium* + PSB. The combined inoculation of *rhizobium* + PSB with fertilizers enhanced the yield attributes of greengram (Yadav *et al*., 2007). Seed yield increased significantly with the combine application of inorganic, organic and bio-fertilizer nutrients over control, respectively. The highest seed yield of greengram was obtained with the application of recommended dose of 75% RDF + 2.5 t/ha vermicompost + *rhizobium* + PSB (12.34 q /ha) followed by treatments 100% RDF + 2.5 t/ha vermicompost (12.05 q /ha) and 100% RDF + *rhizobium* + PSB (11.95 q /ha). This may due to increased availability of major nutrients to plant which enhanced early root growth and cell multiplication leading to more absorption of other nutrients from deeper layers of soil ultimately resulting increased growth parameters, grain, straw, biological yields and harvest index. Similar results by various workers have been reported at different places Patel *et al.* (2003); Rajkhowa *et al.* (2000).

Quality parameters: Treatment combination of 75% RDF + 2.5 t/ha vermicompost + *rhizobium* + PSB significantly increased in protein content (24.72%), NPK content in seed and straw (Nitrogen 3.96, 2.00%, Phosphorus 0.483,0.0284% and potassium 1.534,1.307 %, respectively) than other combinations and control(Table 2), followed by 100% RDF + 2.5 t/ha vermicompost and 100% RDF + *rhizobium* + PSB. The combined inoculation of *rhizobium* and PSB with vermicompost has proved one of the most efficient approach to in increasing in protein per cent and nutrient content. Dual inoculation might have contributed something towards enhanced plant growth and increased nitrogen or soluble phosphorus. Increased nutrient content with dual inoculation with *rhizobium* and PSB were observed in greengram by Sharma *et al*. (2006); Singh *et al*. (2013).

Nutrient status: The treatment of 75 % NPK RDF, 2.5 t/ha vermicompost and bio-fertilizer inoculations increased organic carbon (0.487%), nitrogen (204.03kg/ha), phosphorus (25.76kg/ha) and potassium (218.63kg/ha) recorded in soil after harvest of the greengram, over other combinations and control (Table 3). As per analysis vermicompost contains appreciable amount of nutrients with in the most suitable pH range that might have resulted in

Table 2: Effect of integrated nutrient management on yields and nutrient content of greengram

Treatment	Yield (q /ha)			Harvest index	Nitrogen (%)	content (%)	Protein content seed (%)	Phosphorus incontent (%)		Potassium content (%)	
	Seed	Straw	Biological		Seed	Straw		Seed	Straw	Seed	Straw
Control	7.29	24.74	32.04	22.74	3.27	1.22	20.45	0.350	0.141	0.860	1.108
50%RDF	8.55	27.09	35.64	23.99	3.46	1.54	21.60	0.368	0.169	1.043	1.184
75%RDF	10.25	28.78	39.03	26.25	3.69	1.77	23.05	0.373	0.187	1.267	1.205
100%RDF	11.30	29.83	41.13	27.45	3.85	1.89	24.08	0.419	0.212	1.432	1.213
50%RDF+Rh+PSB	9.85	28.38	38.23	25.76	3.66	1.75	22.90	0.385	0.198	1.243	1.197
50%RDF+2.5 t /ha VC	10.05	28.59	38.64	26.02	3.73	1.81	23.30	0.356	0.188	1.308	1.228
50%RDF+2.5t /haVC+ Rh+ PSB	11.65	30.40	42.05	27.70	3.92	1.96	24.50	0.428	0.227	1.485	1.270
75%RDF+Rh+PSB	11.45	29.98	41.43	27.63	3.87	1.89	24.17	0.422	0.215	1.447	1.217
75%RDF+2.5t /ha VC	11.55	30.23	41.78	27.63	3.91	1.92	24.44	0.425	0.220	1.475	1.252
75%RDF+2.5t /ha VC+Rh+PSB	12.34	31.15	43.49	28.32	3.96	2.00	24.72	0.483	0.284	1.534	1.307
100%RDF+Rh+PSB	11.95	30.48	42.43	28.16	3.92	1.97	24.53	0.442	0.239	1.511	1.276
100%RDF+2.5t /ha VC	12.05	30.58	42.63	28.26	3.94	1.99	24.62	0.454	0.242	1.519	1.303
S.Em±	0.37	0.40	0.73	0.54	0.039	0.080	0.242	0.026	0.016	0.036	0.0266
CD (P = 0.05)	1.09	1.16	2.13	1.60	0.114	0.236	0.711	0.075	0.047	0.105	0.0780

RDF: Recommended dose of fertilizer, VC: Vermicompost, Rh: *Rhizobium*, PSB: Phosphorus solublizing Bacteria

Table 3 : Effect of integrated nutrient management on organic carbon and available nutrients in soil after the harvest of greengram

Treatment	Organic carbon (%)	Available nutrients (kg /ha)		
		Nitrogen	Phosphorus	Potassium
Control	0.344	180.59	19.18	200.30
50%RDF	0.356	187.89	21.10	208.70
75%RDF	0.382	190.16	22.73	210.10
100%RDF	0.390	191.33	24.00	212.53
50%RDF+Rh+PSB	0.377	189.82	22.85	210.53
50%RDF+2.5 t /ha VC	0.382	190.33	22.42	211.29
50%RDF+2.5t /ha VC+ Rh + PSB	0.428	196.94	24.97	213.13
75%RDF+Rh+PSB	0.399	192.43	24.26	212.68
75%RDF+2.5t /ha VC	0.426	194.64	24.58	213.03
75%RDF+2.5t /ha VC + Rh + PSB	0.487	204.03	25.76	218.63
100%RDF+Rh+PSB	0.442	199.24	25.17	213.43
100%RDF+2.5t /ha VC	0.448	200.21	25.25	213.62
S.Em±	0.023	2.656	0.592	1.914
CD (P = 0.05)	0.066	7.788	1.737	5.613

RDF: Recommended dose of fertilizer, VC: Vermicompost, Rh: *Rhizobium,* PSB: Phosphorus solublizing Bacteria

making their increased status in soil after the harvest of the greengram. Uma and Malathi, 2009 also indicated a positive effect of vermicompost on the soil properties and mineralization of nitrogen, phosphorus and potassium in soil, due to the production of organic acids. Legume crops add large amount of organic residues through leaf fall and rhizodeposition and the intermediate acids produced during organic residue decomposition also solubilise fixed forms of nitrogen and phosphorus in soil resulting in increased available nitrogen and phosphorus (Henri *et al.*, 2008).

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