Indian Journal of Agricultural Sciences **91** (3): 417–20, March 2021/Article
https://doi.org/10.56093/ijas.v91i3.112512

Enhance the productivity and nutrient use efficiency of greengram (*Vigna radiata*) through inorganic nutrients and biofertilizers

R K SINGH[1], S R K SINGH[1], UTTAM KUMAR TRIPATHI[2], VEENAPANI SRIVASTAV[2] and H K RAI[3]

Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh 482 004, India

Received: 11 September 2020; Accepted: 28 November 2020

ABSTRACT

Field experiment was conducted at the Instructional Farm of Krishi Vigyan Kendra, Chhatarpur during two consecutive *kharif* of 2017–18 and 2018–19 to evaluate the effect of different biofertilizers along with 75 % recommended dose of fertilizers on growth, yield, nutrient uptake, nutrient use efficiency and B:C ratio of greengram (*Vigna radiata* L.). Results revealed that application of 75 % recommended dose of NPK along with seed treatment with *Rhizobium* @ 10 g/kg seed and soil application of PSB and KSB @ 5 kg/ha (T_4) was found statistically at par with those obtained in T_3 (recommended dose of NPK along with seed inoculation by *Rhizobium* and PSB separately @ 10 g/kg seed) and significantly superior over other treatments in terms of above parameters. Study also indicated that application of biofertilizers have potential to improve the productivity, with curtail the cost of production in terms of inorganic fertilizers and greater net returns and nutrient use efficiency.

Keywords: Biofertilizers, Greengram, Growth, yield, Nutrients uptake

Greengram is the third important pulse crop cultivated across the India for its multipurpose uses (vegetable, pulse, fodder and green manure crop) due to high protein content and ability to improve soil fertility through symbiotic nitrogen fixation (Kumari *et al.* 2014). Despite occupying a greater position both in respect of area and production, the productivity of greengram is low compared to their yield potential mainly because of imbalanced and indiscriminate use of plant nutrients and lack of yellow mosaic virus (YMV) resistant varieties of greengram. Under traditional practices greengram crop is being cultivated on marginal land without use of fertilizers in rainfed conditions. Whereas, excessive use of chemical fertilizer in current intensive crop cultivation system results in environmental and ground water pollution, deteriorating soil quality, higher production cost and poor quality production for livelihood. Being leguminous crop greengram has potential to fix atmospheric nitrogen through root nodulating symbiotic bacteria (*Rhizobium*). Therefore, optimization of productivity and nutrient use efficiency could be achieved through use of improved variety and balanced fertilization along with integration of biofertilizers (Kumawat *et al.* 2010). Exitence of low cost and eco-friendly input biofertilizers have tremendous potential for supplying nutrients and can curtail the need of chemical fertilizer to the extent of 50 percent in integrated nutrient management supply system (Mohammadi and Sohrabi 2012). In addition to symbiotic N-fixation other rhizospheric bacteria are able to secrete different types of organic acid that consequently solubilized the bound forms of phosphate and potassium. There is a need to develop a suitable production system which requires lower nutrition input with higher nutrient use efficiency. Therefore, the current trend needs to explore the possibility of supplementing chemical fertilizers with organics particularly bio fertilizers. In light of above facts present study was framed to evaluate the effect of integrated use of bio and inorganic fertilizers on performance of improved YMV resistant variety of greengram in terms of growth, yield, nutrient uptake, nutrient use efficiency and B:C ratio under Bundelkhand region.

MATERIALS AND METHODS

Field experiment was conducted at the Instructional Farm of Krishi Vigyan Kendra, Chhatarpur (25.035307' N latitude and 79.505258' E longitude), Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh during two consecutive *kharif* 2017–18 and 2018–19 and *kharif* 2017–18 to 2018–19 with improved YMV resistant variety of greengram (var. Sikha). Experiment consisted of five treatments including T_0 (control), T_1 (recommended dose of $N:P_2O_5:K_2O$ as 20:60:20 kg/ha), T_2 (recommended dose of NPK + seed inoculation by *Rhizobium* @ 10 g/kg seed), T_3 (recommended dose of NPK + seed inoculation by *Rhizobium* and PSB separately @ 10 g/kg seed) and T_4

[1]ATARI Zone IX Jabalpur; [2]KVK, Chhatarpur; [3]JNKVV Jabalpur. Corresponding author: Scientist, Agronomy rajiv_kvk@rediffmail.com.

(75% of recommended NPK+ seed inoculation by *Rhizobium* @ 10 g/kg seed + soil application of PSB and KSB each @ 5 kg/ha) which were replicated thrice in randomized block design. All biofertilizers were procured a fresh from the microbes research and production centre department of soil science and agriculture chemistry of JNKVV, Jabalpur. The soil of the experimental field was sandy loam, *Typic Ustochrept* having pH 6.9, EC 0.13 dS/m, organic carbon 4.73 g/kg and available N, P and K as 205.1, 17.3 and 210 kg/ha, respectively. The seed of greengram was treated by biofertilizers *Rhizobium* and PSB @10 g/kg seed and PSB and KSB @ 5 kg/ha were applied in soil at the time of sowing as per the treatments. Seed was sown at row and plant spacing of 45 cm × 22 cm. Recommended dose of nutrients (N-20, P_2O_5-60 and K_2O-20 kg/ha were applied in the soil at the time of field preparation through urea, single super phosphate and muriate of potash, respectively. Standard recommended agronomic practices other than those under treatments were followed to grow the greengram crop. Three randomly selected plants per plot were carefully uprooted to study the nodulation characteristics at 30, 45 and 60 days after sowing (DAS). Plant roots were cleaned under tap water and nodules were carefully detached from the roots, collected in icebox and brought to the laboratory then nodules were kept over filter paper for soaking of excess adhered moisture. At the maturity three randomly selected plants from each plot were harvested separately to study the growth and yield attributing parameters. The crop was harvested, threshed and cleaned manually and seed and stover yield per plot have been recorded. Seed and stover samples were taken separately from each plot and dried at 75°C for 48 h then grind in a mechanical grinder. Grind sample was passed through a 2.0 mm sieve and stored for biochemical analysis. In seed and stover samples nitrogen, phosphorus and potassium were estimated by modified Kjeldahl, Vanadomolybdo phosphoric acid yellow colour and flame photometric methods, respectively. Protein content was calculated by nitrogen percentage × 6.25 (Jackson 1962). The uptake of nutrient (N, P and K) was calculated from concentration of nutrient in grain and straw × their yield. Nutrient use efficiency was calculated by the procedure suggested by (Singh *et al.* 2007). Statistical analysis of data was carried out by "Analysis of Variance" method (Panse and Sukhatme 1967). The data were analyzed statistically using ANOVA and treatment comparison was made at 5% level of significance.

RESULTS AND DISCUSSION

Growth and development: The results pertaining to growth (plant height and number branches/plant) and development (days to 50% flowering and maturity) of greengram has been presented in (Table 1). The data explained that highest plant height (65.5 cm) and number of branches/plant (4.5) were recorded under T_4 (75% of recommended NPK+ seed inoculation by *Rhizobium*@ 10 g/kg seed + soil application of PSB and KSB each @ 5 kg/ha) treatment, whereas these parameters statistically at par with T_3 and significantly superior over remaining treatments. The superiority of the treatment may be attributed to interactive effect of symbiotic N-fixation by *Rhizobium* and growth promoting substances produced by Phosphorus and Potassium solubilizers. It has been reported that inoculation of pulses with PSB, KSB and *Rhizobium* along with application of inorganic nutrients enhances the plant height and branching in plants through promoting the translocation of photosynthates (Kumari *et al.* 2014).

Data further revealed that application of biofertilizers (*Rhizobium* + PSB + KSB) significantly enhanced the duration of vegetative and reproductive stages of the crop over control. It was also found that maximum days required to 50% flowering (47 days) and maturity (80 days) stages were significantly higher over T_0 (41.0 and 71.0 days), T_1 (42.0 and 72.0 days), T_2 (43.0 and 75.0 days) and T_3 (45.0 and 76.0 days), respectively. It might be due to proper supply of plant nutrients as per demand of crop through solubilization of insoluble phosphorus and potassium and provide favorable environmental condition in rhizosphere which favoured the prolonged vegetative and reproductive

Table 1 Effect of integrated use of biofertilizers and inorganic fertilizers on growth, development and nodulation characteristics of greengram

Treatment	Plant height (cm)	Number of branches/ plant	Days to 50% flowering	Days to maturity	Number of nodules/ plant at different DAS			Nodule diameter (mm) at different DAS			Nodule weight (mg/plant) at different DAS					
											Fresh weight			Dry weight		
					30	45	60	30	45	60	30	45	60	30	45	60
T_0	55.5	2.5	41.0	71.0	11.8	14.3	8.3	2.2	2.3	1.0	47.2	88.7	26.5	26.0	58.6	12.5
T_1	58.6	2.9	42.0	72.0	15.0	17.0	11.3	2.5	3.0	1.5	60.0	105.5	36.2	33.0	69.7	17.0
T_2	59.4	3.8	43.0	75.0	15.9	19.3	12.7	2.8	3.3	1.6	63.6	119.7	40.6	35.0	79.1	18.5
T_3	63.3	4.2	45.0	76.0	16.8	24.0	12.3	3.1	3.5	1.7	67.2	148.7	39.3	37.0	98.4	18.8
T_4	65.5	4.5	47.0	80.0	20.2	26.3	14.3	3.3	5.8	2.0	82.0	163.1	45.7	45.1	107.8	21.5
SEM±	0.91	0.13	0.58	0.97	0.09	0.2	0.10	0.09	0.07	0.03	0.78	0.72	0.55	0.64	0.91	0.64
CD at 5%	2.61	0.35	1.63	2.81	0.31	0.72	0.34	0.30	0.21	0.08	2.55	2.4	1.79	2.08	2.9	2.1

*DAS- Days after sowing.

Table 2 Effect of integrated use of biofertilizers and inorganic fertilizers on yield and yield attributes and nutrient uptake and protein yield of greengram

Treatment	Number of pods/ plant	Number of seeds/ pod	Seed test weight (g)	Seed yield (q/ ha)	Stover yield (q/ha)	Increase yield (%)	N-uptake (kg/ha)		P- uptake (kg/ha)		K-uptake (kg/ha)		Protein content in seed (%)	Protein yield (kg/ ha)
							Grain	Straw	Grain	Straw	Grain	Straw		
T_0	12.0	6.0	39.3	6.8	21.6	-	21.08	25.92	2.2	3.2	5.3	25.9	19.4	131.8
T_1	17.3	6.0	41.7	7.4	23.5	8.8	24.42	32.9	2.7	4.0	6.7	32.9	20.6	152.6
T_2	18.3	6.5	42.3	8.9	28.3	28.4	30.26	42.45	3.6	5.1	9.8	39.6	21.3	189.1
T_3	20.3	7.0	44.3	9.4	29.9	29.2	31.96	44.85	3.9	5.4	11.3	44.9	21.3	199.8
T_4	22.0	8.0	46.7	10.6	33.7	40.4	38.16	57.29	4.9	8.1	14.8	53.9	22.5	238.5
SEm ±	0.29	0.36	0.14	0.13	0.58		0.53	0.98	0.083	0.28	0.05	0.09	0.23	0.96
CD(P=0.05)	0.84	1.03	0.41	0.36	1.71		1.58	2.86	0.24	0.80	0.15	0.26	0.66	2.77

phases of the crop as also stated by Ghosh *et al.* (2010).

Nodulation characteristics: In the present study nodulation characteristics (number of nodules/plant, nodule diameter, fresh and dry weight of nodule) of greengram were recorded at 30, 45 and 60 days after sowing (DAS) and the data given in (Table 1). Data clearly indicated that number of nodules/plant, nodule diameter, fresh and dry weight of nodule was significantly affected by different treatments at temporal level. Irrespective of the treatments the number of nodules/plant, nodule diameter, fresh and dry weight of nodule were increased up to 45 DAS and thereafter the values decreased might be because of potential translocation of photosynthates towards reproductive parts resulted less availability of photosynthates to root nodulating bacteria and cessation of and decaying of nodules as suggested by Mohammadi and Sohrabi (2012), Kumawat *et al.* (2013). Overall the nodulation characteristics were significantly superior under T_4 (75 % of recommended NPK+ seed inoculation by *Rhizobium* @ 10 g/kg seed + soil application of PSB and KSB each @ 5 kg/ha) as compared to remaining treatments. Similar finding was also reported by Dhakal *et al.* (2016).

Yield attributes and yield: Data pertaining to yield attributes and yield of greengram (Table 2), which clearly showed that integrated application of inorganic fertilizers and biofertilizers had significant effect. Data further revealed that significantly higher yield attributes (number of pods/plant, number of seeds/pod and seed test weight) and yield (seed and stover) were obtained under T_4 (75% of recommended NPK+ seed inoculation by *Rhizobium* @ 10 g/kg seed + soil application of PSB and KSB each @ 5 kg/ha) treatment over other treatments. Improvement in yield attributes and yield under T_4 treatment was may be attributed to the increased vegetative growth due to effective utilization of nutrients provided by rhizobacteria (N-fixer, P and K solubilizers) and potential production and partitioning of photosynthates as also stated by Kumawat *et al.* (2010) and Bhavya *et al.* (2018).

Nutrients uptake and protein yield: Data (Table 2) clearly revealed that uptake of nitrogen, phosphorus and potassium by greengram and protein yield was significantly affected by different treatments of integrated application of inorganic and biofertilizers with highest values under T_4 followed by T_3 treatment and lowest value in control. Higher uptake of N, P, K and protein yield in T_4 treatment could be attributed to optimal availability of nitrogen, phosphorus and potassium due to more activity of symbiotic N-fixers, P and K solubilizers, which promoting the nodulation by improving nitrogenase activity thus resulted in higher uptake of nutrients in seed and stover. It also improve the chlorophyll content in plants that regulates the photosynthesis and accumulation of food in plant as stated by (Singh and Sharma 2011). Protein content (22.5%) and yield (238.5 kg/ha) was also found maximum with T_4 (75% of recommended NPK+ seed inoculation by *Rhizobium*@ 10 g/kg seed + soil application of PSB and KSB each @ 5 kg/ ha) treatment might be due to more N-uptake as suggested by (Bhavya *et al*. 2018).

Fertilizer use efficiency and production economics: Maximum agronomic, chemical and economic use efficiency of nitrogen, phosphorus and potassium was recorded in T_4 followed by T_3 and lowest under T_1 (recommended dose of $N:P_2O_5:K_2O$ as 20:60:20 kg/ha) treatment (Table 3). More uptake of NPK due to synergetic relations between each other in combined application of inorganic and biofertilizers resulted in improved nutritional environment in the rhizosphere as well as its utilization in the plant system that leads to better partitioning and translocation of food towards sink caused higher use efficiency of nutrients as also reported by Kumar *et al*. (2014), Rani *et al.* (2016).

Maximum net monetary returns (₹ 28237/ ha) and B:C ratio (2.4) were recorded under T_4 (75% of recommended NPK+ seed inoculation by *Rhizobium*@ 10 g/kg seed + soil application of PSB and KSB each @ 5 kg/ha) treatment followed by T_3 (recommended dose of NPK + seed inoculation by *Rhizobium* and PSB separately @ 10 g/kg seed) treatment (₹23428/ha) and B:C ratio (2.2) and lowest values obtained under control (₹14616/ ha) and B:C ratio (1.9). These above results are in the conformity with the findings reported by (Rani *et al.* 2016) from an integrated nutrients management in greengram.

The findings of the present study concludes that integration of biofertilizers along with inorganic fertilizers had positive and significant effect on the performance

Table 3 Effect of integrated use of biofertilizers and inorganic fertilizers on fertilizer use efficiency and production economics of greengram

Treatment	Fertilizers use efficiency							Production economics			
	Agronomic (kg/ kg^{-1})			Chemical (%)			Economic (%)	Cost of production (₹/ ha)	Gross return (₹/ha)	Net return (₹/ha)	B:C ratio
	N	P	K	N	P	K					
T_o	-	-	-	-	-	-	187.0	16800	31416	14616	1.9
T_1	4.0	1.3	4.0	140.5	4.9	35.3	189.9	18000	34188	16188	1.9
T_2	14.0	4.7	14.0	162.8	6.0	44.7	216.4	19000	41118	22118	2.2
T_3	17.3	5.8	17.3	201.7	8.0	65.3	217.1	20000	43428	23428	2.2
T_4	25.3	8.4	25.3	213.1	8.7	75.3	236.2	20735	48972	28237	2.4

of greengram in terms of growth, development, yield attributes, yield, nutrient uptake, nutrients use efficiency and economics. It has been also concluded that application of 75% of recommended NPK + seed inoculation by *Rhizobium* @ 10 g/kg seed + soil application of PSB and KSB each @ 5 kg/ha treatment was best for sustainability and higher net returns from greengram in Bundelkhand region.

ACKNOWLEDGEMENTS

We are grateful to Dr A K Upadhya, JNKVV Jabalpur and Dr A K Rai, KVK Panchmahal (CIAH, Gujarat) for providing to technical help.

REFERENCES

Bhavya G, Chandra S K, Jayasree G and Reddy M. 2018. Effect of integrated use of phosphorus, biofertilizers and organic manures on soil available nutrient status and yield of greengram (*Vigna radiata* L.) *An Asian Journal of Soil Science* **13**(1): 45–49.

Dhakal Y, Meena R S and Kumar S. 2016. Effect of INM on nodulation, yield, quality and available nutrient status in soil after harvest of greengram. *Legume Research* **39**(4): 590–94.

Ghosh P K, Das A, Saha R, Kharkrang E, Tripathi A K, Munda G and Ngachan S V. 2010. Conservation agriculture towards achieving food security in north-east India. *Current Science* **99**(7): 915–21.

Jackson M L.1962. Nitrogen determination from soils and plant tissues. In: *Soil chemical Analysis*. Constable & Co. Ltd, London, pp 183-04.

Kumar S, Tomar S and Tomar T S. 2014.Integrated phosphorus management in black gram (V*igna mungo*) in western Uttar Pradesh during summer season. *Annals Agriculture Research* **35** (3): 290–97.

Kumari A, Singh O N and Kumar R. 2014. Root growth, crop productivity, nutrient uptake and economics of dwarf pea (*Pisum sativum*) as influenced by integrated nutrient management. *Indian Journal of Agricultural Sciences* **84**(11): 1347–51.

Kumawat A, Pareek B L and Yadav R S. 2010.Response of greengram (*Vigna radiata*) to biofertilizers under different fertility levels. *Indian Journal of Agricultural Sciences* **80**(7): 655–57.

Kumawat P K, Tiwari R C, Golada S L, Godara A S, Garhwal R S and Choudhary R. 2013. Effect of phosphorus sources, levels and biofertilizers on yield attributes, yield and economics of blackgram. *Legume Research* **36**(1): 70–73.

Mohammadi K and Sohrabi Y. 2012. Bacterial Biofertilizers for sustainable crop production: A review. *Journal of Agricultural and Biological Science* **7**: 307–16.

Panse V G and Sukhatme P V. 1967. *Statistical Methods for Agricultural Workers*. ICAR Publication New Delhi.

Rani M, Prakash V and Khan K. 2016. Response of mungbean (*Vignaradiata* L.) to phosphorus and sulphur and PSB during summer season. *Agriculture Science Digest* **36**(2): 146–48.

Singh R K, De N, Singh T K and Rai M. 2007. Sulphur improves the factor productivity in pea. *Vegetable Science* **34**(2): 200–01.

Singh Y P and Sharma A. 2011. Effect of sources of phosphorus and microbial inoculation on productivity,nutrient availability in soil and uptake of nutrients by chickpea (*Cicer arietinum*) grown on sandy loam soil. *Indian Journal of Agricultural Sciences* **81**(9): 834–37.