AATCC Review

06 February 2024: Received
23 February 2024: Revised
07 March 2024: Accepted
22 March 2024: Available Online

www.aatcc.peerjournals.net

Research Article

Open Access

Enhancing Yield andNutrient Uptake of Summer Greengram (*Vigna radiata* L.) through Sulphur, Organic Manures and Biofertilizers

N. M. Chaudhari[1*], K. K. Patel[1], B. J. Chaudhary[2] and Krutika Subodh Patel[2]

[1]Department of Soil Science, Navsari Agricultural University, Navsari, India.
[2]Department of Agronomy, Navsari Agricultural University, Navsari, India.

ABSTRACT

The challenges in enhancing the yield and nutrient uptake of Summer Greengram include addressing widespread sulphur deficiency in Indian soils, which is crucial for protein synthesis, nodulation and overall plant growth. Integrating organic manures like farm yard manure (FYM) and vermicompost can improve soil fertility, structure and microbial activity, positively influencing crop growth and yield. Additionally, the application of biofertilizers containing Rhizobium for nitrogen fixation and phosphorus solubilizing microorganisms for improved phosphorus availability can play a vital role in overcoming nutrient limitations and enhancing the productivity of greengram crops. A field trial was conducted at the Soil and Water Management, Cotton Research Sub Station, Achhalia during the Summer season of 2021 to evaluate the effect of sulphur, organic manure and biofertilizers on the yield and nutrient uptake of Greengram. The experiment comprised with twelve different treatment combinations arranged in a factorial randomized block design with three replications. Sulphur was applied at three levels (20 kg S/ha, 30 kg S/ha, 40 kg S/ha) along with organic manure (FYM @ 5t/ha, Vermicompost @ 1 t/ha) and biofertilizers (control, PSB + Rhizobium inoculation). The findings revealed that the application of 40 kg/ha of sulphur significantly increased the seed yield, stover yield, and overall nutrient uptake, encompassing N, P, K, S, Fe, Mn, Zn, and Cu. The inclusion of organic manure, particularly FYM at 5 t/ha, led to improved nutrient uptake, specifically for N, P, K, and Cu in the Greengram crop. The introduction of biofertilizers containing PSB and rhizobium resulted in a notable improvement in seed yield, stover yield and total nutrient uptake. Additionally, the interactive effects showed a synergistic influence when combining sulphur, organic manure and biofertilizers, resulting in increased seed yield, stover yield, and total nutrient uptake for Greengram.

Keywords: *Greengram, sulphur, organic manures, biofertilizers, yield and nutrient uptake*

INTRODUCTION

Greengram (*Vigna radiata* L.) holds a significant position as a crucial pulse crop in India, known for its short growth period, substantial yield potential and outstanding nutritional value for both human consumption and use as livestock feed and forage. It covers approximately 34.37 lakh hectares nationwide, resulting in a total production of 17.83 lakh tonnes, with an average yield of 519 kg/ha. In Gujarat alone, it spans 0.90 lakh hectares, producing 0.55 lakh tonnes at an average productivity of 611 kg/ha in the 2019-20 period (Anonymous, 2020). Sulphur plays a pivotal role in the development of pulse crops, particularly in protein and vitamin synthesis, as well as in enhancing nodulation in legumes for improved nitrogen fixation. Throughout the growth cycle of Greengram, sulphur influences various aspects, ranging from plant height to grain yield. Sulphur is crucial for amino acids like cysteine, methionine and cystin, essential for protein synthesis in plants, contributing to the overall quality of pulses and oilseeds. The combination of nutrient application with organic manure, such as farmyard manure (FYM) and vermicompost, can function as a source of nutrients and complexing agents.

Corresponding Author:* ***N. M. Chaudhari*

DOI: https://doi.org/10.21276/AATCCReview.2024.12.01.312

These materials form stable complexes with native nutrients, preventing their loss and enhancing nutrient efficiency. Integrated Plant Nutrient Systems (IPNS) enhance fertilizer efficiency, supporting sustainable crop production. Microorganisms, including bacteria and fungi like *Bacillus*, *Pseudomonas*, *Aspergillus* and Penicillium, solubilize phosphorus, making it more accessible to plants (Sharma *et al.*, 2000). Some soil bacteria and fungi can transform insoluble phosphates into soluble forms by secreting organic acids, improving phosphorus absorption and surpassing the effectiveness of chemical fertilizers. The use of *Rhizobium* inoculation proves to be an economical and safe method for nitrogen provision in Greengram, promoting biological nitrogen fixation and increasing nitrogen availability.

MATERIALS AND METHODS

A field trial was conducted during the *Summer* season of 2021 at the Soil and Water Management, Cotton Research Sub Station, Achhalia, situated in the South Gujarat Agro Climatic Zone-II. The aim was to evaluate the impact of varying levels of sulphur, organic manure and biofertilizers on the yield and nutrient uptake of Greengram. The experimental field had clay-textured soil, medium levels of available nitrogen and phosphorus, and high levels of available potassium. The study employed a factorial randomized block design with twelve different treatment combinations and three replications. Sulphur was applied at three different rates (20 kg/ha, 30 kg/ha, 40 kg/ha) in combination with organic manure (FYM @ 5t/ha, Vermicompost @ 1 t/ha) and biofertilizers (control, PSB + *Rhizobium* inoculation). Greengram variety GM-6 was sown with a furrow spacing of 30 cm x 10 cm. Fertilizers were manually applied before sowing, and biofertilizer was applied through seed inoculation (10 ml/kg). Standard cultural practices and plant protection measures were adhered to throughout the experimental period. Statistical analysis following the procedures outlined by Panse and Sukhatme (1985) was performed to assess the significant effects of treatments on yield and nutrient uptake.

RESULTS AND DISCUSSION

Effect of Sulphur

Examination of the data elucidated that both seed yield and stover yield, along with the augmented total nutrient uptake encompassing nitrogen, phosphorus, potassium, sulphur, iron, manganese, zinc and copper were significantly influenced by the application of sulphur (Table 1).

The application of sulphur @ 40 kg/ha resulted in a noteworthy augmentation in both seed and stover yields, as well as an amplification in the overall uptake of nutrients (N, P, K, S, Fe, Mn, Zn, and Cu) in comparison to alternative sulphur levels. The heightened growth and development of the crop plants, as observed in this study, can be ascribed to elevated metabolic activities and an increased photosynthetic rate. These factors collectively contributed to improved assimilation of dry matter during diverse growth stages and at the point of maturity.

Furthermore, sulphur application manifested an apparent enhancement in nutrient concentration within the plants, likely serving as the primary determinant for the observed escalation in nutrient uptake following sulphur application. The outcomes of the current investigation align with the findings of Meena *et al.* (2013) and Dheri *et al.* (2021).

Effect of Organic Manure

The utilization of Farm Yard Manure (FYM) @ 5 t/ha resulted in a marked enhancement in the uptake of essential nutrients, namely nitrogen, phosphorus, potassium and copper in comparison to the application of Vermicompost @ 1 t/ha (Table 1). The augmented nutrient uptake observed with FYM can be attributed to an increased accessibility of nutrients to the plants. Furthermore, the application of FYM positively influenced the soil environment, fostering an environment conducive to robust root system development. This, in turn, facilitated improved absorption of both moisture and nutrients, consequently leading to heightened biomass production. Similar results were reported by Singh *et al.* (2013).

Conversely, seed yield, stover yield, and total nutrients (S, Fe, Mn and Zn) uptake did not exhibit significant differences as a result of the organic manure treatments. These parameters remained relatively consistent and were not significantly affected by the application of organic manures.

Effect of Biofertilizer

Examination of the data elucidated a significant impact of biofertilizer inoculation on both seed yield and stover yield, concurrently leading to heightened total nutrient uptake, *viz.* N, P, K, S, Fe, Mn, Zn and Cu (table 1).

When Greengram seeds were treated with both PSB and *Rhizobium*@ 10 ml/kg of seed, a significant boost in seed and stover yield was observed. The increased yield was attributed to the positive role of *Rhizobium* in enhancing root nodulation, leading to improved root development and increased nutrient availability. Simultaneously, the presence of *Pseudomonas* in the co-inoculation contributed to sustained nutrient availability, supporting robust plant growth and higher dry matter production. This enhanced vegetative growth, in turn, resulted in improved flowering and pod formation, ultimately leading to a positive impact on seed yield. Similar results were reported by Kumar *et al*. (2009) and Kumawat *et al*. (2010). However, the application of PSB and *Rhizobium* inoculation @ 10 ml/kg of seed resulted in significantly higher total nutrient uptake by Greengram, including N, P, K, S, Fe, Mn, Zn, and Cu, compared to non-inoculated plants. The increased nutrient uptake with biofertilizer application may be attributed to the heightened activity of symbiotic N-fixers and P solubilizers, promoting nodulation by enhancing nitrogenase activity and resulting in higher nutrient uptake in both seeds and stover. Additionally, it was noted that the application of biofertilizers improved chlorophyll content in plants, regulating photosynthesis and enhancing the accumulation of food in plants, as indicated by Singh *et al*. (2021).

Interaction Effect

The interaction effects between sulphur and organic matter exhibited noteworthy impacts on phosphorus and sulfur uptake. Notably, the treatment combination S_3O_1, characterized by the application of 40 kg S/ha and 5 t/ha of FYM, demonstrated significantly elevated levels of total P and S uptake as compared to the other treatment combinations (Table 2).

The interaction effects between sulphur and biofertilizer had noteworthy impacts on the overall nitrogen and phosphorus uptake in Greengram, as depicted in Figure 1 and Figure 2, respectively. Notably, the combination labelled as S_3B_1, which included the application of 40 kg S/ha and the inoculation of PSB + *Rhizobium* (each @ 10 ml/kg of seed), exhibited significantly higher levels of both total nitrogen uptake and total phosphorus uptake as compared to the other treatment combinations.

However, when examining the interaction effects of sulphur, organic matter and biofertilizers, a noteworthy influence was observed on seed yield, stover yield and the overall uptake of nutrients such as nitrogen, phosphorus, potassium, sulphur, iron, manganese, zinc and copper (Table 3). Specifically, in the context of the S×O×B interaction, the combination $S_3O_1B_1$, involving the application of 40 kg S/ha, FYM @ 5 t/ha, along with PSB + *Rhizobium* inoculation, demonstrated significantly increased seed yield, stover yield and total nutrient uptake, including N, P, K, S, Mn, Zn, and Cu. The simultaneous use of organic, inorganic and biofertilizers contributed to enhanced plant growth, potentially due to improved nutrient availability, leading to better yield development and improved soil physical properties. These positive outcomes in nutrient uptake by Greengram are consistent with the findings of Kumpawat (2010).

CONCLUSION

The study outcomes emphasize the considerable positive effect of sulphur application, particularly when combined with organic manures and biofertilizers, on both the yield of Greengram and its nutrient absorption. These results highlight the promise of integrated nutrient management approaches, such as utilizing 40 kg S/ha, incorporating 5 t FYM/ha and administering PSB + *Rhizobium* inoculation. Such strategies have the potential to boost Greengram productivity and enhance the overall nutrient uptake by the crop.

Table 1: Yield and total nutrient uptake of Greengram as influenced by sulphur, organic manures and biofertilizers.

Treatments	Seed Yield (kg/ha)	Stover Yield (kg/ha)	Total Nutrient Uptake							
			N (kg/ha)	P (kg/ha)	K (kg/ha)	S (kg/ha)	Fe (g/ha)	Mn (g/ha)	Zn (g/ha)	Cu (g/ha)
Sulphur(S)										
S_1-20 kg S/ha	920.8	1871.6	42.34	13.50	52.36	4.95	312.3	131.6	75.46	15.68
S_2-30 kg S/ha	997.8	2030.0	48.05	15.28	65.16	5.99	343.8	143.1	82.94	17.16
S_3-40 kg S/ha	1163.5	2334.5	59.94	20.07	81.63	7.64	407.2	167.5	97.37	20.40
S.Em.±	36.1	57.8	1.51	0.42	1.81	0.18	10.9	4.1	2.53	0.43
CD at 5%	105.8	169.6	4.43	1.24	5.30	0.52	31.9	11.9	7.42	1.27
Organic-manures(O)										
O_1-FYM 5 t/ha	1067.1	2118.0	52.47	16.84	68.68	6.30	363.2	151.3	87.89	18.46
O_2-Vermicompost 1 t/ha	987.7	2039.4	47.75	15.72	64.10	6.09	345.6	143.5	82.62	17.04
S.Em.±	29.4	47.2	1.23	0.35	1.48	0.14	8.9	3.3	2.07	0.35
CD at 5%	NS	NS	3.62	1.01	4.33	NS	NS	NS	NS	1.04
Bio-fertilizer(B)										
B_0-No inoculation	959.7	1947.9	44.43	14.15	56.19	5.33	330.2	137.5	79.31	16.65
B_1-PSB+*Rhizobium* inoculation	1095.1	2209.5	55.79	18.42	76.58	7.06	378.7	157.3	91.21	18.84
S.Em.±	29.4	47.2	1.23	0.35	1.48	0.14	8.9	3.3	2.07	0.35
CD at 5%	86.4	138.4	3.62	1.01	4.33	0.42	26.0	9.7	6.06	1.04
Interaction										
S × O										
S.Em.±	51.0	81.8	2.14	0.60	2.56	0.25	15.4	5.7	3.58	0.61
CD at 5%	NS	NS	NS	1.75	NS	0.73	NS	NS	NS	NS
S × B										
S.Em.±	51.0	81.8	2.14	0.60	2.56	0.25	15.4	5.7	3.58	0.61
CD at 5%	NS	NS	6.26	1.75	NS	NS	NS	NS	NS	NS
O × B										
S.Em.±	41.6	66.8	1.74	0.49	2.09	0.20	12.5	4.7	2.92	0.50
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S × O × B										
S.Em.±	72.1	115.6	3.02	0.85	3.61	0.35	21.7	8.1	5.06	0.87
CD at 5%	**211.5**	**339.1**	**8.86**	**2.48**	**10.60**	**1.03**	NS	**23.8**	**14.85**	**2.54**
CV (%)	12.2	9.6	10.44	9.00	9.43	9.84	10.61	9.52	10.29	8.47

Table 2: S x O interaction effect on total P uptake, total S uptake as well as available N and available S in soil

Treatments	Total Nutrient Uptake	
	P (kg/ha)	S (kg/ha)
S_1O_1	12.37	4.76
S_1O_2	14.63	5.14
S_2O_1	12.23	6
S_2O_2	18.32	5.99
S_3O_1	17.84	8.14
S_3O_2	22.3	7.15
S.Em ±	**0.60**	**0.25**
CD at 5%	**1.75**	**0.73**

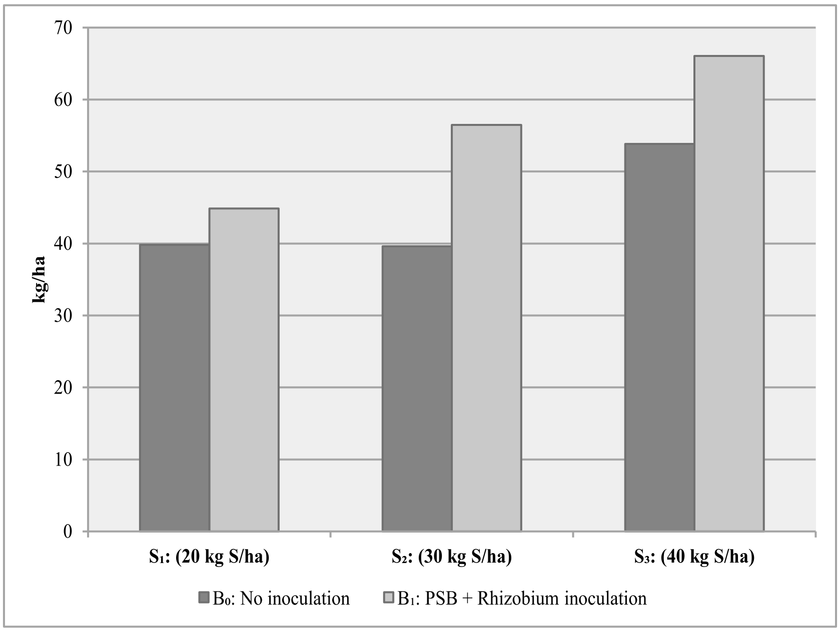

Fig. 1: Total N uptake by Greengram as influenced by S× B interaction

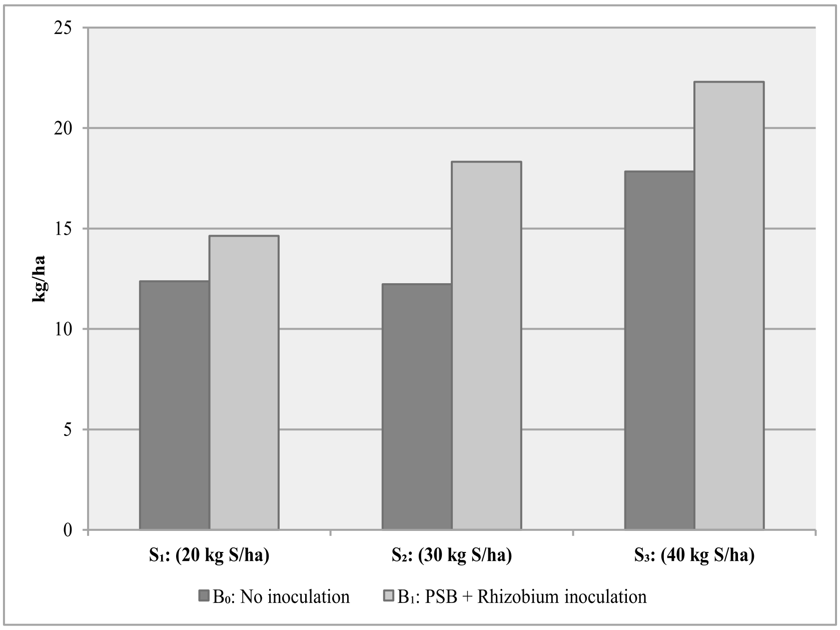

Fig. 2: Total P uptake by Greengram as influenced by S× B interaction

Table 3: S x O x B interaction effect on seed yield, stover yield, total nutrient uptake and available S in soil

Treatments	Seed Yield (kg/ha)	Stover Yield (kg/ha)	Total Nutrient Uptake							Available S (mg/kg)
			N (kg/ha)	P (kg/ha)	K (kg/ha)	S (kg/ha)	Mn (g/ha)	Zn (g/ha)	Cu (g/ha)	
$S_1O_1B_0$	961.6	1930.6	45.49	13.14	49.17	4.59	135	79.44	16.54	13.84
$S_1O_1B_1$	889.4	1768.1	40.14	13.09	52.79	4.93	126.3	70.38	15.06	12.15
$S_1O_2B_0$	827.3	1689.4	34.16	11.59	42.86	4.15	120	67.81	14.34	7.48
$S_1O_2B_1$	1005.1	2098.6	49.55	16.17	64.64	6.13	145	84.22	16.77	9.49
$S_2O_1B_0$	859.3	1724.1	36.01	11.64	50.93	4.67	123.6	70.88	15.23	16.98
$S_2O_1B_1$	1204.6	2433.3	64.44	20.58	86.33	7.33	168.8	100.29	20.65	19.15
$S_2O_2B_0$	951.9	1871.8	43.26	12.83	54.49	5.37	132.5	77.23	16.03	9.01
$S_2O_2B_1$	975.5	2090.7	48.49	16.05	68.9	6.61	147.4	83.36	16.72	10.46
$S_3O_1B_0$	1145.8	2372.2	57.18	18.85	73.33	6.78	167.6	95.41	19.46	21.97
$S_3O_1B_1$	1341.7	2479.6	71.55	23.74	99.5	9.5	186.4	110.93	23.79	23.74
$S_3O_2B_0$	1012.5	2099.5	50.47	16.83	66.36	6.43	146.2	85.06	18.32	17.62
$S_3O_2B_1$	1154.2	2386.6	60.57	20.86	87.33	7.87	169.6	98.06	20.04	18.59
S.Em ±	**72.1**	**115.6**	**3.02**	**0.85**	**3.61**	**0.35**	**8.1**	**5.06**	**0.87**	**1.37**
CD at 5%	**211.5**	**339.1**	**8.86**	**2.48**	**10.60**	**1.03**	**23.8**	**14.85**	**2.54**	**5.37**

REFERENCES

1. Anonymous (2020). Kharif Pulses Prospects-2020-21 DPD, Bhopal

2. Dheri, G S, Saini, S, Brar, B S and Sandhu, O S 2021. Response of soybean (*Glycinemax*) to different sources and levels of sulphur application. *Indian Journal of Agricultural Sciences*, 91(8): 1242-1246.

3. Kumar, R P, Singh, O N, Singh, Y, Dwivedi, S and Singh, J P 2009. Effect of integrated nutrient management on growth, yield, nutrient uptake and ecnomics of french bean (*Phaseolus vulgaris*). *Indian Journal of Agricultural Sciences*, 79(2): 122-128.

4. 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): 655-657.

5. Kumpawat, 2010. Integrated nutrient management in blackgram (*Vigna mungo*) and its residual effect on succeeding mustard (*Brassica juncea*) crop. *Indian Journal of Agricultural Sciences*, 80(1): 76–79.

6. Meena, K K, Meena, R S and Kumawat S M 2013. Effect of sulphur and iron fertilization on yield attributes, yield and nutrient uptake of mungbean (*Vigna radiata*). *Indian Journal of Agricultural Sciences*, 83(4): 472-476.

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

8. Sharma, N P, Bali, S V and Gupta, D K 2000. Crop yield and properties of Inceptisol as influenced by residue management under rice-wheat sequence. *J. Indian Soc. Soil Sci.*, 48(3): 506-509.

9. Singh, R K, Singh, S R K, Tripathi, U K, Srivastav, V and Rai, H K 2021. Enhance the productivity and nutrient use efficiency of greengram (*Vigna radiata*) through inorganic nutrients and biofertilizers.*Indian Journal of Agricultural Sciences*, 91(3): 417-420.

10. Singh, V, Singh, S P, Singh, S and Shivay, Y S 2013. Growth, yield and nutrient uptake by wheat (*Triticum aestivum*) as affected by biofertilizers, FYM and nitrogen. *Indian Journal of Agricultural Sciences*, 83(3): 331-334.

