Biological Forum – An International Journal **14(4): 824-827(2022)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Phosphorus Management through PROM and PSB in semi-*rabi* Green gram

Shivani Patel[1], J.C. Shroff [2], P.M. Parmar[3*], S.N. Shah[4] and P.V. Parmar[5]

[1]M.Sc. (Agronomy), Department of Agronomy, Anand Agricultural University, Anand (Gujarat), India.
[2]Associate Professor, Department of Agronomy, B.A. College of Agriculture, Anand Agricultural University, Anand (Gujarat), India.
[3]Ph.D. (Agri) Agronomy, Department of Agronomy, B.A. College of Agriculture, Anand Agricultural University, Anand (Gujarat), India.
[4]Associate Directorate of Research, Anand Agricultural University, Anand (Gujarat), India.
[5]Ph.D. Scholar, Department of Agronomy, B.A. College of Agriculture, Anand Agricultural University, Anand (Gujarat), India.

(Corresponding author: P.M. Parmar)*
(Received 03 September 2022, Accepted 29 October, 2022)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: A field experiment was carried out on loamy sand soil at Anand Agricultural University, Anand, Gujarat during semi-*rabi* season of 2021 under middle Gujarat condition to evaluate the effect of phosphorus management through PROM (Phosphate Rich Organic Manure) and PSB (Phosphorus solubilizing Bacteria) in semi-*rabi* green gram. The experiment was laid out in Factorial Randomized Block Design with three replications. The treatment combinations comprised three phosphorus levels *viz*., P_1: 30 kg P_2O_5/ha, P_2: 40 kg P_2O_5/ha and P_3: 50 kg P_2O_5/ha and five biofertilizer (PSB) treatments *viz*., B_0: Control, B_1: Seed treatment (5ml/kg seed), B_2: Drenching with PSB at 20 and 40 DAS(1 lit/ha), B_3: Seed treatment *fb* (Followed by) Drenching at 20 DAS, and B_4: Seed treatment *fb* Drenching at 20 and 40 DAS. The green gram was grown with standard package of practices. The results of the experiment revealed that significantly higher number of pods/plant (4.20), pod length (8.95 cm), seed yield (1176 kg/ha), stover yield (2262 kg/ha), test weight (51.96) and phosphorus content in seed (0.49 %) and stover (0.159 %) was found with application of 50 kg P_2O_5/ha (P_3) which was found at par with application 40 kg P_2O_5/ha (P_2). Nitrogen and phosphorus uptake in seed and stover also follows same trend. Under biofertilizer treatment, Seed treatment *fb* Drenching at 20 and 40 DAS(B_4) recorded higher yield attributes and yield of green gram *viz*., number of pods/plant (4.38), pod length (8.90 cm), seed yield (1207 kg/ha) and stover yield (2305 kg/ha). Quality parameters *viz*; phosphorus content in seed and stover as well as nitrogen and phosphorus uptake in seed and stover were also increased with application of treatment B_4 (Seed treatment *fb* Drenching at 20 and 40 DAS)followed by treatment B_3 (Seed treatment *fb* Drenching at 20 DAS).

Keywords: Green gram, Phosphorus, PROM, Biofertilizer, PSB, Yield, Quality.

INTRODUCTION

Pulses in India have long been considered as cheapest source of quality protein and amino acid especially for the vegetarian people. They are grown as main crop, inter crop and green manure crop due to their multipurpose utility. It can be incorporate in the crop rotation as a routine practice to preserve the soil health.

Green gram (*Vigna radiata* L.) is one of the most ancient and extensively grown leguminous crops of India also known as mungbean which is grown during *kharif* (July-October), semi *rabi* (September or October) as well as summer (March-June) seasons in arid and semi-arid regions of India. The cultivation of green gram mainly confined to the states of Orissa, Maharastra, Andhra Pradesh, Gujarat, Bihar, Karnataka, Uttar Pradesh and Tamil Nadu. It enhances the soil fertility through symbiotic association with rhizobium bacteria in the roots and then fixes atmospheric nitrogen for its growth and development and further uses as manure crop, green fodder and involves in multiple intercropping system. It is a short duration crop, it can fit in various multiple and intercropping systems. After harvesting, green gram plants may be used as green fodder or green manure. Besides these, it can also improves soil fertility by fixing atmospheric nitrogen.

The application of conventional phosphatic fertilizer such as DAP and SSP is quite popular. However, some drawback is the application of DAP and SSP as a phosphatic fertilizers. These fertilizers contain P2O5 in water soluble form because of which plants can take up P readily. After application P is fixed in soil and become unavailable in presence of Fe, Al and Mn ions in acidic soils (pH below 5.5) and Ca and Mg ions in alkaline soils (pH below 7.0). The most favorable range of soil pH is 5.5 to 7.0 (Brady and Weil 1983). Further scarcity and high cost of these phosphatic fertilizers has restricted their use by the farming community to a great extent. Hence the country demands research for an

alternative to SSP/DAP. Thus, the use of indigenous rock phosphate has thereby become imperative. With the development of technology to produce Phosphate Rich Organic Manure (PROM) has been increased in many folds and has made cheap, ecofriendly, and equally effective as water soluble sources of phosphorus, irrespective of soil types. Phosphate Rich Organic Manure (PROM) is a value-added product prepared from co-compositing of high-grade rock phosphate (34/74) with organic matter collected from various sources such as FYM, straw of paddy or wheat, press mud, karanj cake or waste from fruit industries and distillery etc. To enhancing the microbial activity and improve the efficiency of PROM, Phosphate Solubilizing Bacteria (PSB) and nitrogen fixing bacteria are added. The organic matter releases organic acids, which converts unavailable phosphate into available phosphate (Kumawat *et al.,* 2013). It is better source of 100% water soluble phosphatic fertilizers. It is noted that PROM works as efficiently as DAP and further shows equal residual effect that is it works for the second subsequent crop also (Mihir and Jagadeesh 2017). The inoculation of phosphate solubilizing bacteria also has an important role in phosphorus cycling and in the uptake of phosphorus by plant. Inoculation of PSB which helps in conversion of unavailable phosphorus to available form of phosphorus, which increases the yield of crop by 10-30 % (Tilak and Annpurna 1993). Phosphate solubilizing bacteria improved nodulation (Ghosh and Poi 1998) through increased phosphate solubilization and hence, increase symbiotic nitrogen fixation (Dametario *et al.* 1972). It also, enhanced photosynthesis, production of photosynthates and their partitioning between vegetative and reproductive structure might have helped in improving the yield attributes.

In general, seed production in *kharif* season get damaged due to continuous rains at the time of harvesting and availability of quality seed become the constrains. Sometimes due to aberrant weather conditions farmers could not get economic produce in the *kharif* crop. To overcome such situation semi *rabi* green gram cultivation is best answer and it will give remunerative income to farmers.

MATERIALS AND METHODS

A field experiment was conducted during semi-*rabi* season of 2021at the College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand to assess the effect of "Phosphorus management through PROM and PSB in semi-*rabi* green gram". The experimental soil was low in organic carbon (0.41%) and available nitrogen (210 kg/ha) and medium in available phosphorous (37.00 kg/ha) and high in available potassium (285 kg/ha). The experiment having 15 treatment combinations was laid out in factorial randomized block design with three replications. The main plot was comprised of three phosphorus levels (PROM)*viz*.,P_1 : 30 kg P_2O_5/ha, P_2 : 40 kg P_2O_5/ha and P_3 : 50 kg P_2O_5/ha and five biofertilizer (PSB) treatments *viz.*,B_0: Control, B_1: Seed treatment(5ml/kg seed), B_2: Drenching with PSB at 20 and 40 DAS(1 lit/ha), B_3: Seed treatment *fb* Drenching at 20 DAS, and B_4: Seed treatment *fb* Drenching at 20 and 40 DAS with gross and net plot sizes of 3.0 m × 4.0 m and 2.4 m × 3.0 m, respectively. The green gram was grown by adopting standard package of practices as suggested by the competent authority of Department of Agronomy, Anand Agricultural University, Anand.

RESULTS AND DISCUSSION

A. Effect of Phosphorus Levels (PROM)

Yield attributes and yield of green gram. The growth, yield attributes and yield as influenced by different treatments recorded during the experiment are presented in Table 1-2. Among the different growth, yield attributes and yield, significantly the higher plant height at 40 DAS and at harvest, plant dry biomass, root dry biomass, dry weight of root nodules, number of pods/plant, pod length, seed yield, stover yield and test weight.Treatment P_3 having 50 kg P_2O_5/ha recorded significantly higher growth, yield attributes as well as yield, followed by application of 40 kg P_2O_5/ha (P_2). Harvest index was remained unaffected due to corresponding increase in both seed and stover yield. Increased growth attributes due to the sufficient supply of plant nutrient through appropriate nutrient sources and solar radiation to each plant required for its growth and development. An appropriate phosphorus supply which indirectly helps in providing nitrogen supply and its availability helped plants to attain more vigour in terms of plant growth attributes. Higher yield attributes are due to higher vigour and strength attained by the plants as a result of better photosynthetic activities with sufficient availability of light, and supply of nutrients in balanced quantity of plants at growing stages. Similarly, increased yield might be result of excess assimilates stored in the leaves and later trans located into seed at the time of senescence. These results are in conformity with the findings of Parmar *et al*. (2014); Gajera *et al*. (2014); Chaudhari *et al*. (2015); Yadav *et al.* (2017).

Quality, nutrient content and uptake of green gram. The quality parameters, nutrient content and uptake as influenced by different treatments recorded at harvest are presented in Table 2. A glance of data presented in Table 2 revealed that protein and nitrogen content of green gram were not significantly influenced due to various phosphorus levels (PROM). However, phosphorus content, as well as nitrogen and phosphorus uptake were significantly influenced by various phosphorus levels (PROM) and highest values of all the parameters were found with treatment P_3 having 50 kg P_2O_5/ha which was found at par with application of 40 kg P_2O_5/ha (P_2). Significantly higher phosphorus content in seed and stover as well as nitrogen and phosphorus uptake was recorded under phosphorus level P_3(50 kg P_2O_5/ha). This might be due to increased phosphorus level, which improved nutritional level in rhizosphere as well as in plant system and led to higher concentration of phosphorus in seed and stover which ultimately increased its content and uptake in both seed and stover of green gram. These results are in close agreement with results reported by Singh *et al.* (2015); Meena *et al.* (2021).

B. Effect of Biofertilizer (PSB)

Yield attributes and yield of green gram. The data pertaining to the effect of different biofertilizer (PSB) treatments on yield attributes and yield are presented in Table 1Biofertilizer (PSB) application had significant influence on number of pods/plant and pod length. Seed treatment of PSB followed by drenching of PSB at 20 and 40 days after sowing (B_4) produced highest yield attributes as well as yield followed by treatment B_3: seed treatment *fb* drenching at 20 DAS. The yield of crop is the cumulative effect of growth and yield attributing characters. The significant increase in yield may be because of application of biofertilizer, phosphate solubilizing bacteria treatments which enhanced the metabolic activities in plant parts and translocation of photosynthates resulting in higher growth and development, yield attributing characters and ultimately produced higher seed yield. This result is in line with Kumawat *et al.* (2009); Bahadur and Tiwari (2014); Parmar *et al.* (2014); Verma *et al.* (2017); Mandale *et al.* (2020).

Quality, nutrient content and uptake of green gram. The data pertaining to the effect of different biofertilizer (PSB) treatments quality parameters are presented in Table 2. Quality of green gram in terms of protein and nitrogen content was remained unaffected. The experiment results showed that the higher nitrogen and phosphorus uptake by seed and stover was recorded under treatment B_4 in which seed treatment with PSB followed by drenching of PSB at 20 and 40 DAS was done which was found at par with treatment B_3 (Seed treatment *fb* drenching at 20 DAS). Significantly the lowest nutrient uptake in seeds were noted with control. The improved availability of nitrogen and phosphorus in root zone combined with improved metabolic activity at cellular level might have enhanced nutrient uptake. Results are in accord with Rekha *et al.* (2018); Venkatarao *et al.* (2018).

Table 1: Effect of different treatments on yield attributes and yield of green gram.

Treatments	Number of pods/plant	Pod length (cm)	Test weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest index %
Phosphorus levels (PROM)						
P1	28.55	8.22	49.41	1093	2010	35.21
P2	32.67	8.68	51.30	1159	2144	35.10
P3	33.80	8.95	51.96	1176	2262	34.27
S.Em±	0.61	0.10	0.63	23.15	46.02	0.52
CD(P=0.05)	1.79	0.30	1.85	67	133	NS
Biofertilizer (PSB)						
B0	28.41	8.15	48.90	1034	1965	34.48
B1	29.67	8.39	50.57	1115	2035	35.52
B2	32.11	8.81	51.51	1175	2181	35.03
B3	33.33	8.83	51.68	1182	2208	34.91
B_4	34.83	8.90	51.79	1207	2305	34.41
S.Em±	0.79	0.13	0.82	29.89	59.41	0.67
CD(P=0.05)	2.31	0.38	NS	86	172	NS
P×B	NS	NS	NS	NS	NS	NS
CV %	7.57	6.23	4.86	7.84	8.33	5.81

Table 2: Effect of different treatments on quality and nutrient content and uptake of green gram.

Treatments	Protein content (%)	N content (%)		P content (%)		N uptake (kg/ha)		P uptake (kg/ha)	
		Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover
Phosphorus levels (PROM)									
P1	21.36	3.29	0.50	0.44	0.152	36.00	10.06	5.00	3.09
P2	21.55	3.31	0.51	0.48	0.155	38.44	11.01	5.63	3.34
P3	21.60	3.33	0.52	0.49	0.159	39.01	11.76	5.83	3.61
S.Em±	0.25	0.039	0.010	0.0078	0.00149	0.81	0.31	0.134	0.08
CD(P=0.05)	NS	NS	NS	0.02	0.004	2.37	0.91	0.389	0.23
Biofertilizer (PSB)									
B0	21.18	3.26	0.50	0.43	0.153	33.72	10.12	4.76	3.04
B1	21.30	3.28	0.51	0.47	0.154	36.53	10.45	5.32	3.12
B2	21.42	3.30	0.51	0.48	0.154	38.68	10.96	5.61	3.34
B3	21.74	3.34	0.51	0.48	0.155	39.47	11.29	5.78	3.44
B_4	21.87	3.36	0.52	0.49	0.161	40.69	11.90	5.96	3.79
S.Em±	0.33	0.051	0.012	0.010	0.0019	1.05	0.40	0.173	0.104
CD(P=0.05)	NS	NS	NS	0.03	0.006	3.06	1.17	0.502	0.302
P×B	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV %	4.67	4.67	7.21	6.46	3.71	8.39	11.13	9.49	9.35

CONCLUSION

On the basis of the results obtained from the present investigation, it is indicated that for accruing higher yield and quality in green gram variety GAM 5 should be cultivated in semi rabi season with the application of 40 kg P_2O_5/ha through PROM (387 kg/ha) and seed treatment with PSB followed by drenching of PSB at 20 DAS.

Acknowledgement. Financial support for the research was provided by Anand Agricultural University, Anand, Gujarat under the masters research project during the research carried out in the university as a part of master's degree programme.
Conflict of Interest. None.

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How to cite this article: Shivani Patel, J.C. Shroff, P.M. Parmar, S.N. Shah and P.V. Parmar (2022). Phosphorus Management through PROM and PSB in semi-*rabi* Green gram. *Biological Forum – An International Journal*, *14*(4): 824-827.