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Research Article

EFFECT OF PHOSPHORUS SOURCES AND SULPHUR LEVELS ON NUTRIENT CONTENT, UPTAKE AND SOIL FERTILITY OF GREENGRAM (*VIGNA RADIATA*)

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Abstract: The field experiment was conducted at Instructional Farm, College of Agriculture, S K Rajasthan Agricultural University, Bikaner during kharif season of 2019. The experiment comprising five levels of phosphorus sources (Control, 16 kg P_2O_5/ha through DAP, 16 kg P_2O_5/ha through PROM, 32 kg P_2O_5/ha through DAP and 32 kg P_2O_5/ha through PROM) and three levels of sulphur (Control, 15 and 30 kg/ha) making 15 treatment combinations replicated three times in factorial randomized block design. Application of 32 kg P_2O_5/ha through PROM recorded significantly higher nitrogen, phosphorus, potassium and sulphur content in seed and straw as well as their uptake and also protein content in seed, organic carbon, available nitrogen and phosphorus and net returns (50440) with B:C ratio 2.93 as compared to 16 kg P_2O_5/ha through DAP, 16 kg P_2O_5/ha through PROM and 32 kg P_2O_5/ha through DAP. With regard to sulphur levels application of sulphur up to 30 kg/ha recorded significantly higher nitrogen, phosphorus, potassium and sulphur content in seed and straw as well as their uptake and also protein content in seed and net returns (46723) with B:C ratio 2.96 over control and 15 kg S/ha.

Keywords: *Greengram, Nitrogen, PROM, Sulphur*

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Introduction

Mungbean [*Vigna radiata* (L.) Wilczek] is an important pulse crop grown in entire Indian sub continent during kharif, rabi and spring seasons. It is a drought tolerant crop and can be successfully grown on well drained sandy loam to loamy soil in the areas receiving erratic rainfall. Being an efficient N- fixer, mungbean improve the soil fertility status and can thereby serve as a useful component in any viable cropping system in the country. This crop is primarily grown in rainy season but with the development of early maturing varieties, it has proved to be an ideal crop of spring and summer seasons. Phosphorus is an important nutrient after nitrogen. Indian soils are poor to medium in available phosphorus [1]. It plays a key role in energy metabolism of all plant cells particularly nitrogen fixation in leguminous crops. For meeting out the requirement of phosphorus for various pulses or mungbean crops different sources like, DAP, SSP, rock phosphate, gypsum, phosphorus rich organic manures are used. PROM has come out to be a better source of phosphorus. The Indian soils are deficient in organic carbon. Phosphorous Rich Organic Manure (PROM) is an organic alternative and indigenous source of phosphatic fertilizer. This substance is more efficient source for adding phosphorous to soil as compared to chemical fertilizers like, DAP, MAP, SSP etc. Besides, PROM also supplies the phosphorus to the succeeding crops as efficiently as it nourishes the crop to which it has been applied. The farmers are not much familiar with PROM and still use traditional fertilizers for their crops. This is very serious problem for all, these fertilizer harm the soil as well as environment, livestock, humans etc. Sulphur deficiency is reported from various areas of the country mainly due to increased crop yield coupled with intensive farming and a drastic shift from low analysis fertilizers to high analysis fertilizers containing little or no elemental S [2]. Its deficiency induced chlorosis in young leaves and decrease seed yield by 45 percent. Thus, the study of phosphorus & sulphur to legumes is more important than that of nitrogen as later is being fixed by symbiosis with rhizobium bacteria.

Materials and Methods

A field study was conducted during kharif season of 2019 at Instructional farm of College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner (28.01°N latitude and 73.22°E longitude at an altitude of 234.7m amsl). The experiment comprising five levels of phosphorus sources (Control, 16 kg P_2O_5/ha through DAP, 16 kg P_2O_5/ha through PROM, 32 kg P_2O_5/ha through DAP and 32 kg P_2O_5/ha through PROM) and three levels of sulphur (Control, 15 and 30 kg/ha) making 15 treatment combinations replicated three times in factorial randomized block design.

The soil of experimental site was loamy sand having 0.09% organic carbon, 8.2 pH, 115, 14 and 212 kg/ha available N, P and K, respectively. Greengram 'IPM 2-3' was sown on 23 July 2019 at 30 cm row spacing and was harvested on 30 September 2019. Phosphorus was applied through DAP and PROM fertilizer as per treatments as basal application in furrows.

The weighed quantity of DAP and PROM was broadcasted uniformly in earmarked plots and thoroughly mixed in soil before sowing. The weighted quantity of gypsum was broadcasted uniformly in earmarked plots and thoroughly mixed in soil before sowing.

Results and Discussion

Nutrient uptake

PROM application with 32 kg P_2O_5/ha proved the most effective in increasing N, P, K and S content in seed and straw as well as their uptake and also protein content in seed [Table-1 and 2] over 16 kg P_2O_5/ha through DAP, 16 P_2O_5/ha through PROM and 32 kg P_2O_5/ha through DAP. However, 16 kg P_2O_5/ha through DAP and 16 kg P_2O_5/ha through PROM remained at par with each other. Addition of PROM in soil improved the physico-chemical properties, nutritional status, and microbial population which resulted in the increased availability of these major nutrients and thus their uptake by crop.

Table-1 *Effect of phosphorus sources and sulphur levels on nutrient content of greengram*

Treatment	N content (%)		P content (%)		K content (%)		S content (%)		Protein content in seed (%)
	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw	
Sources of phosphorus (kg/ha)									
Control	3.33	1.27	0.31	0.15	0.50	2.10	0.549	0.348	20.81
16 kg P through DAP	3.46	1.40	0.35	0.18	0.62	2.26	0.590	0.361	21.60
16 kg P through PROM	3.50	1.45	0.37	0.19	0.67	2.32	0.612	0.413	21.86
32 kg P through DAP	3.62	1.54	0.42	0.22	0.74	2.40	0.650	0.484	22.62
32 kg P through PROM	3.70	1.63	0.46	0.24	0.82	2.47	0.680	0.543	23.10
SEm±	0.02	0.02	0.011	0.006	0.02	0.03	0.019	0.013	0.11
CD (P= 0.05)	0.05	0.06	0.031	0.017	0.06	0.07	0.056	0.038	0.31
Levels of sulphur (kg/ha)									
Control	3.45	1.34	0.34	0.17	0.56	2.19	0.529	0.336	21.57
15	3.53	1.48	0.39	0.20	0.69	2.33	0.635	0.453	22.03
30	3.58	1.55	0.42	0.22	0.75	2.41	0.685	0.501	22.39
SEm±	0.01	0.02	0.008	0.005	0.02	0.02	0.015	0.010	0.08
CD (P= 0.05)	0.04	0.05	0.024	0.013	0.05	0.06	0.044	0.029	0.24

Table-2 *Effect of phosphorus sources and sulphur levels on nutrient uptake by greengram*

Treatment	N uptake (kg/ha)		P uptake (kg/ha)		K uptake (kg/ha)		S uptake (kg/ha)	
	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw
Sources of phosphorus (kg/ha)								
Control	25.60	21.80	2.39	2.65	3.96	35.89	4.22	5.94
16 kg P through DAP	29.49	26.80	2.98	3.42	5.45	42.75	5.10	7.10
16 kg P through PROM	32.64	29.82	3.54	4.01	6.18	47.07	5.81	8.45
32 kg P through DAP	36.33	34.13	4.32	4.92	7.57	53.11	6.61	10.95
32 kg P through PROM	41.25	38.76	5.08	5.67	9.13	58.59	7.49	12.76
SEm±	0.61	0.76	0.13	0.16	0.23	0.94	0.22	0.42
CD (P= 0.05)	1.77	2.21	0.38	0.48	0.67	2.72	0.64	1.21
Levels of sulphur (kg/ha)								
Control	28.69	24.97	2.81	3.17	4.92	40.29	4.40	6.33
15	33.68	31.20	3.84	4.24	6.72	48.40	6.09	9.54
30	36.82	34.61	4.34	5.00	7.72	53.76	7.05	11.25
SEm±	0.47	0.59	0.10	0.13	0.18	0.73	0.17	0.32
CD (P= 0.05)	1.37	1.71	0.30	0.37	0.52	2.11	0.50	0.93

The increase in N content in plant may be due to the well-developed root system which increased the availability of phosphorus to soil microbes. Thus, leads to increase in multiplication of Rhizobium bacteria and resulted in increased atmospheric biological nitrogen fixation through better utilization of soil N [3]. The increased availability of phosphorus in soil increased both macro and micro nutrient content with P fertilization might be attributed to balanced nutrient status of the soil which was found deficient in N and P whereas medium in K and S. The greater availability of nutrients improved the plant root system which resulted in greater K accumulation in the crop. Uptake of N, P, K and S is a function of content of these nutrients in seed and straw and their yields. Thus, increase in content of these nutrients in seeds and straw and in yields have been resulted to increased uptake of N, P, K and S by crop. Increase in the protein content of seed attributed to the increased availability of nitrogen may be due to proper establishment of Rhizobia on roots thus increasing the N uptake by crop. PROM is also recognized to improve the physical condition of soil which improved the nutrient uptake and thus protein content. These results are in the conformity with findings of Yadav *et al*. (2017) [4] and Bairwa *et al*. (2019) [5].

Successive increase in sulphur level up to 30 kg/ha significantly increased the N, P, K and S content in seed and straw as well as their uptake and also protein content in seed [Table-1 and 2] over control and 15 kg S/ha. The positive influence of sulphur fertilization on N, P, K and S content of crop might be due to the improved nutritional availability in rhizosphere and plant system. The increased availability of nutrients in root zone and metabolic activity at cellular level might have increased the nutrient uptake and their accumulation in vegetative plant parts. Increased in accumulation of nutrients like N, P, K and S in vegetative parts concomitant with the improved metabolism led to greater translocation of these nutrients to reproductive structures of the crop thus, N, P, K and S content in seed and straw significantly increased due to sulphur fertilization. The increased photosynthetic efficiency, which favoured the dry matter accumulation and nutrient content in plant, may be the major reason responsible for higher nutrient uptake with the influence of sulphur fertilization.

The potential role of sulphur fertilization brings out the greater availability of sulphur as well as other nutrients which are considered as important for growth and development of plants. The nitrogen and sulphur are main elements of protein and increase in their availability increases the utilization of nitrogen for protein synthesis [6]. Sulphur also plays an important role in synthesis of sulphur containing amino acids like cystine, cystenine and methionine and thus its application resulted increase in protein content which is in accordance with the findings of Dharwe *et al*. (2019) [7] and Italia *et al*. (2019) [8] in green gram.

Soil fertility

The results [Table-2] showed that PROM application with 32 kg P_2O_5/ha significantly increased the organic carbon, available N and available P in soil after harvest of crop as compared to 16 kg P_2O_5/ha through DAP, 16 P_2O_5/ha through PROM and 32 kg P_2O_5/ha through DAP. However, there was no significant variation was found in available K content due to sources of phosphorus. PROM is prepared from organic matter and high graded rock phosphate. The organic matter released the organic acids, which converted the unavailable phosphate into the available phosphate [9] and thus significantly increased the available P content in soil over DAP. The organic acids released by PROM increased the activity of alkaline phosphatase, dehydrogenase and microbial biomass in the soil after harvest of crop. It provides essential substances for growth and activity of microbes, which is responsible for increase in soil microbial biomass. The phosphorus addition in higher level might have influenced metabolism of microorganism which is highly responsible for higher level of soil microbial population. Similar rise in the soil microbial population was also suggested by Santhy *et al*. (2004) [10], Majumdar *et al*. (2007) [11] and Mahanta and Rai (2008) [12]. Singh *et al*. (2015) observed that application of PROM improved the organic carbon in soil after harvest of crop as it contains large quantity of organic manures that provides a huge quantity of organic carbon. Aechra *et al*. (2017) [13] also observed that available P content in soil after harvest influenced by the sources of phosphorus. Significantly higher organic carbon, available N, P and K content in soil after harvest of green gram crop with the application of PROM was also reported by Yadav *et al*. (2017) and Bairwa *et al*. (2019).

Table-3 *Effect of phosphorus sources and sulphur levels on soil fertility and economics of greengram*

Treatment	Organic carbon (%)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)	Net Returns (₹/ha)	B:C ratio
Sources of phosphorus (kg/ha)						
Control	0.087	116.6	15.72	214.0	31435	2.48
16 kg P through DAP	0.090	120.7	16.81	216.4	35488	2.53
16 kg P through PROM	0.091	122.0	17.78	217.8	39082	2.56
32 kg P through DAP	0.094	123.6	18.86	219.9	45221	2.91
32 kg P through PROM	0.107	126.9	19.67	222.2	50440	2.93
SEm±	0.004	1.5	0.25	2.62	1146	0.05
CD (P= 0.05)	0.012	4.4	0.72	NS	3320	0.14
Levels of sulphur (kg/ha)						
Control	0.090	120.7	17.40	216.1	33156	2.38
15	0.095	122.4	17.87	218.0	41120	2.71
30	0.097	122.7	18.03	220.2	46723	2.96
SEm±	0.003	1.2	0.19	2.03	888	0.04
CD (P= 0.05)	NS	NS	NS	NS	2572	0.11

Increasing levels of sulphur to the soil did not affect the organic carbon, available N, available P and available K in soil after harvest of crop.

Economics

Results showed [Table-2] that significantly higher net returns (Rs 50440/ha) were fetched when mungbean crop fertilized with 32 kg P_2O_5/ha through PROM compared to 16 kg P_2O_5/ha through DAP, 16 kg P_2O_5/ha through PROM and 32 kg P_2O_5/ha through DAP. As net returns are calculated by multiplying the seed and straw yields by their sale prices and subtracting the cost of cultivation including treatment cost. As the price of PROM is very low in comparison to the DAP, hence application of PROM was found profitable over DAP, therefore, led to the maximum returns as it provided a B:C ratio of 2.93. Results further showed that an appreciable increase in net realization was observed due to different levels of sulphur. The highest net return of 46723/ha with B:C ratio of 2.96 was recorded with the application of S @ 30 kg/ha followed by application of sulphur @ 15 kg/ha which realized net return of 41120/ha and B: C ratio of 2.71. This was due to comparatively better increase in yield over other treatments.

Application of research: Through the research work, application of 32 kg phosphorus through PROM and 30 kg/ha S is remunerative in maximizing the nutrient content and uptake of green gram on loamy sand soils of Agro-climatic zone I-C (Hyper Arid Partially Irrigated Western Plain Zone). These treatments significantly provided the higher net returns (50440 and 46723/ha).

Research Category: Agronomy

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Study area / Sample Collection: College of Agriculture, Bikaner, 334006

Cultivar / Variety / Breed name: Mungbean [*Vigna radiata* (L.)

Conflict of Interest: None declared

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References

[1] Singh K., Manohar R.S., Choudhary R., Yadav A.K. and Sangwan A. (2015) *Legume Research*, 35(4), 263-268.
[2] Krishna D., Sachan H.K. and Chaudhary N.K. (2020) *Legume Research*, 43(6), 832-837.
[3] Tondon H.L.S. (1991) *Fertilizer News*, 36, 69-79.
[4] Yadav K.R., Manohar R.S., Kumawat S.R. and Yadav V.K. (2017) *Chemical Science Review and Letters*, 6(22), 1152-1155.
[5] Bairwa P.C., Sammauria R. and Gupta K.C. (2019) *Journal of Soil Salinity and Water Quality*, 11(1), 84-89.
[6] Finalayson J., Christ C.M. and Downey R.K. (1970) *Canadian Journal of Plant Science*, 50, 705-9.
[7] Dharwe D.S, Dixit H.C., Dotaniya C.K., Khandagle A., Mohbe S. and Doutaniya R.K. (2019) *International Journal of Chemical Studies*, 7(2), 01-05.
[8] Italia J.H., Jadav N.J., Rathod S.V. and Viradiya M.B. (2019) International Journal of Chemical Studies, 7(3), 364-368.
[9] Kumawat P.K., Tiwari R.C., Golada S.L., Godara A.S., Garhwal R.S. and Choudhary R. (2013) *Legume Research*, 36(1), 70-73.
[10] Santhy P., Vijila K., Selvi D. and Dhakshinamoorthy M. (2004) *Annals of Agricultural Research*, 25, 38-42.
[11] Majumdar B., Venkatish M.S., Kumar K. and Patiram (2007) *Journal of the Indian Society of Soil Science*, 45 (1), 19-23.
[12] Mahanta D. and Rai A.K. (2008) *Indian Journal of Agronomy*, 53, 279-284.
[13] Aechra S., Yadav B.L., Ghosalya B.D. and Bamboriya J.S. (2017) *Journal of Pharmacognosy and Phytochemistry*, 6(4), 1691-1695.