Response of phosphorus and biofertilizers on nutrient content and uptake by Mungbean (*Vigna radiata* L.).

ABSTRACT

A two-year field experiment conducted at Rama University's farm in Kanpur, Uttar Pradesh during the kharif seasons of 2022 and 2023 aimed to assess the impact of different nutrient management strategies on nutrient uptake. Phosphorus, a crucial nutrient, is deficient in insoluble forms, causing low yields in mungbeans. Biofertilizers offer a cost-effective, eco-friendly, and renewable alternative to chemical fertilizers. Inoculating pulse seeds with phosphorus-solubilizing agents boosts phosphorus availability for plant growth, enhancing mungbean productivity in the Central alluvial region of Uttar Pradesh. The study incorporated four varieties—PDM-139, IPM 2-3, Meha, and IPM 2-14—alongside varying levels of nutrient management practices. These practices involved N0 (Control), N1, N2, and N3, each with distinct combinations of nitrogen, phosphorus, zinc sulfate, seed treatment with rhizobium culture, and phosphate-solubilizing bacteria (PSB). The experiment followed a factorial randomized block design with three replications. Findings indicated that the application of 20 kg N + 40 kg P2O5 + 25 kg ZnSO4.H2O ha-1, coupled with seed treatment involving rhizobium culture and PSB at 2.5 kg ha-1 in soil, significantly enhanced nutrient uptake in the Central alluvial tract of Uttar Pradesh.

Keywords : Phosphorus levels, PSB, Greengram, Rhizobium inoculation, Nutrient content, Mungbean.

Introduction :

Green gram holds the position as the third most significant pulse crop across India due to its versatility. It serves various purposes as a vegetable, pulse, fodder, and green manure crop. Its significance lies in its high seed protein content and its ability to enhance soil fertility through symbiotic nitrogen fixation. Despite occupying substantial agricultural space and contributing significantly to production, the yield of green gram remains lower than the global average. This could be attributed to inadequate nutrient management practices. Farmers often refrain from using fertilizers and tend to cultivate green gram in less fertile, marginal soils, especially under rainfed conditions. Being a short-duration pulse crop, it can be grown as a catch crop during both the kharif and rabi seasons.

Phosphorus stands as a crucial nutrient, second only to nitrogen. Merely 25 to 30 percent of applied phosphorus is directly accessible to crops; the rest transforms into insoluble forms (Sharma and Khurana, 1997). Its deficiency stands as a primary factor causing low yields in mungbeans across various soil types. Phosphorus deficiency affects nodule stimulation, root development, growth, and accelerates maturity while enhancing the quality of crop yields. Biofertilizers, an integral part of balanced nutrient management, offer a cost-effective, eco-friendly, and renewable alternative to bulky, low-cost plant nutrient supplements in sustainable agricultural systems in India. Given the soaring costs of chemical fertilizers, the role of biofertilizers holds particular significance. Inoculating pulse seeds with phosphorus-solubilizing agents aims to increase their presence in the rhizosphere, substantially boosting phosphorus availability for plant growth. Phosphorus-solubilizing microorganisms—both bacteria and fungi—facilitate the release of phosphorus for plant uptake (Venkatarao et al., (2017). Consequently, this study was conducted to enhance mungbean productivity in the Central alluvial region of Uttar Pradesh.

Materials and methods :

The investigation took place at the experimental field of Rama University in Kanpur, Uttar Pradesh, during the kharif seasons of 2022 and 2023. Its aim was to assess how nutrient management and biofertilizers impacted the yield of mung bean (Vigna radiata L.) varieties. The region experiences a sub-tropical semi-arid climate. The experiment employed a Factorial Randomized Block Design, incorporating sixteen treatments replicated three times. These treatments comprised four mung bean varieties: C1: PDM-139, C2: IPM 2-3, C3: Meha, C4: IPM 2-14, and four levels of nutrient management:N0: Control, N1: 10 kg N + 20 kg P2O5 + 12.5 kg ZnSO4.H2O ha-1 + seed treated with rhizobium culture + PSB @ 2.5 kg ha-1 in soil, N2: 20 kg N + 40 kg P2O5 + 25 kg ZnSO4.H2O ha-1, N3: 20 kg N + 40 kg P2O5 + 25 kg ZnSO4.H2O ha-1 + seed treated with rhizobium culture + PSB @ 2.5 kg ha-1 in soil, The nutrient content of N, P, K was determined following the methodologies recommended by Snell and Snell (1955) for nitrogen, Jackson (1958) for phosphorus, and Muhr et al. (1963) for potassium.

Content of N in seed and stover samples were determined colourimetrically by developing colour through Nessler's reagent as described by Snell and Snell (1955). Phosphorus was determined colourimetrically by the chlorostannous reduced phosphomolybdenum blue method in H2SO4 system as described by Jackson (1958) Content of potash was determined on Flame photometer model II as described by Muhr et al.,(1963)

Results and Discussion:

The data in Table-1 show nitrogen, phosphorus, and potassium content (%) in both the seed and stover of greengram. Surprisingly, the application of phosphorus didn't significantly impact these content levels. However, numerically, the N3 level of nutrient management—receiving 20 kg N + 40 kg P2O5 + 25 kg ZnSO4.H2O ha-1 alongside seed treated with rhizobium culture + PSB @ 2.5 kg ha-1 in soil—yielded the highest NPK content in both seed and stover of greengram. These findings echo those of Chaudhari et al. (2022) and Niraj et al. (2014). Interestingly, the highest nitrogen uptake by seed and stover occurred with the application of 20 kg N + 40 kg P2O5 + 25 kg ZnSO4.H2O ha-1, along with seed treated with rhizobium culture + PSB @ 2.5 kg ha-1 in soil, followed by the N2 treatment: 20 kg N + 40 kg P2O5 + 25 kg ZnSO4.H2O ha-1, with the lowest uptake observed under the control (N0). The variety Meha exhibited the highest nitrogen uptake, followed by PDM-139, while the lowest values were noted in IPM 2-14 during the observed years (Table-2). Regarding phosphorus uptake by seed and stover, cv. Meha displayed significantly higher uptake with the application of 20 kg N + 40 kg P2O5 + 25 kg ZnSO4.H2O ha-1, coupled with seed treated with rhizobium culture + PSB @ 2.5 kg ha-1 in soil. This trend was observed across both years, aligning with the findings of Rani et al. (2016) and Murari et al. (2013). Moreover, the highest potassium uptake was recorded under the N3 level of nutrient management. Similar observations were reported by Mandal et al. (2005) and Bairwa et al. (2014).

Conclusion :

On the basis of results of the experiment, it can be inferred that among mungbean cultivars cv. Meha with application of 20 kg N + 40 kg P_2O_5 + 25 kg $ZnSO_4.H_2O$ ha^{-1} + seed treated with rhizobium culture + PSB @ 2.5 kg ha^{-1} incorporated in the soil excelled overall and have shownsignificant effect in improving the soil health as well as uptake of nutrients in central alluvial tract of Uttar Pradesh.

References :

Bairwa, R.K., Nepalia, V., Balai, C.M., Jalwania, R. and Meena, H.P. (2014). Yield and nutrient uptake of summer green gram (*Vigna radiata* L.) under different levels of phosphorus and sulphur fertilizations. *SAARC Journal of Agriculture*, 12(1):162-172.

Chaudhari, G.I., Patel, N.I., Patel, D.M. and Nisarata, N.V. (2022). Effect of phosphorus and sulphur on nutrient content and uptake by greengram (*Vigna radiata* L.). *The Pharma Innovation Journal* , 11(3):1432-1435.

Jackson, M.L.(1958). Soil Chemical Analysis. Prentice Hall Inc. England Cliffs N.J., U.S.A.

Muhr, G.R., Datt, N.P., Shankra, Subramaney, M., Lieley, V.K. and Donahue, R.L. (1963). Soil Testing in India, USDA Handbook-60.

Murari, A.K., Mathur, H.S., Meena, R.L. and Solanki, R.L. (2013). Effect of phosphorus and sulphur on yield quality and nutrient uptake by chickpea (*Cicer arietinum* L.). *Environment and Ecology*, 31(1A):325-327.

Niraj,V.P.S. and Prakash, V. (2014). Effect of phosphorus and sulphur on growth and yield and quality of blackgram (*Phaseolus mungo* L.). *Asian Journalof Soil Science*, 9(1):117-120.

Rani, M., Prakash, V.and Khan, K.(2016). Response of mungbean (*Vigna radiata* L.) to phosphorus, sulphur and PSB during summer season. *Agriculture Science Digest*, 36(2):146-148.

Sharma, M.P. and Khurana, A.S. (1997). Biofertilizers, Farmer and Parliament. *Indian Journal of Agricultural Sciences*, 38:17-18.

Shelke, A.V., Sonani, V.V., Gaikwad, V.P., Raskar, S.S. and Sawant, V.B. (2012). Effect of different fertility and biofertilizer levels on yield and economics of summer greengram. *International Journal of Forestry and Crop Improvement*, 3(2):162-164.

Singh, H. and Singh, G.,(2014). Response of mungbean varieties to sowing time and planting geometry. *Journal of Food Legumes*, 27(4): 347-349.

Sharma, M.P. and Khurana, A.S. (1997). Biofertilizers, Farmer and Parliament. *Indian Journal of Agricultural Sciences*, 38:17-18.

Snell, F.D. and Snell, T.C. (1955). Ammonia " Colorimetric Method of Analysis", Vol. II, Inorganic D. Van Norstrand Co-Inc. Princeton, New Jersey, New York, 808-819.

Tarafder, S., Rahman, M.A., Hossain, M.A., Chowdhury, M.A.H. (2020).Yield of *Vigna radiata* L. and post-harvest soil fertility in response to integrated nutrient management. *Agricultural and Biological Sciences* , 6(1):32-43.

Thakur, R., Sawarkar, S.D., Vaishya, U.K., Singh, M.(2011). Impact of Continuous use of Inorganic.Fertilizers and Organic Manure on soil Properties and Productivity under Soybean-wheat Intensive Cropping of Vertisol. *Indian Society of Soil Science.*; 59(1):74-81

Tondon, H.L.S.(1984). Methods of Analysis of Soils, Plants and Fertilizers (ed.). Fertilizer Development and Consultation Organization, New Delhi.

Venkatarao, C.V., Naga, S.R., Yadav, B.L., Koli, D.K. and Rao, I.J. (2017). Effect of phosphorus and biofertlizers on growth and yield of mungbean (*Vigna radiata* L.). *Indian Journal of Current Microbiology and Applied Sciences*, 6(7):3992-3997.

Table-1: Effect of nutrient management on nitrogen, phosphorus and potassium content in seed and stover of mung bean cultivars

Symbol	Treatment	Content of nitrogen (%)				Content of phosphorus (%)				Content of potassium (%)			
		Seed		Stover		Seed		Stover		Seed		Stover	
		2022	2023	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
	Cultivars												
C_1	PDM-139	3.34	3.32	1.23	1.18	0.47	0.46	0.25	0.23	1.15	1.15	1.78	1.72
C_2	IPM 2-3	3.27	3.24	1.20	1.17	0.46	0.45	0.23	0.22	1.14	1.14	1.76	1.71
C_3	Meha	3.46	3.37	1.26	1.23	0.48	0.47	0.26	0.23	1.16	1.15	1.80	1.74
C_4	IPM 2-14	3.24	3.22	1.18	1.16	0.46	0.45	0.23	0.22	1.15	1.14	1.75	1.71
	SE (d)	0.30	0.27	0.08	0.07	0.04	0.03	0.01	0.02	0.06	0.05	0.11	0.10
	CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Nutrient management												
N_0	Control	3.00	2.98	1.12	1.08	0.42	0.42	0.21	0.20	1.14	1.13	1.75	1.70
N_1	10 kg N + 20 kg P_2O_5 + 12.5 kg $ZnSO_4.H_2O$ ha^{-1}+ seed treated with rhizobium culture + PSB @ 2.5 kg ha^{-1} in soil	3.38	3.34	1.24	1.20	0.47	0.46	0.24	0.22	1.15	1.14	1.77	1.72
N_2	20 kg N + 40 kg P_2O_5 +25 kg $ZnSO_4.H_2O$ ha^{-1}	3.44	3.38	1.25	1.22	0.48	0.47	0.25	0.23	1.15	1.15	1.78	1.72
N_3	20 kg N + 40 kg P_2O_5 + 25 kg $ZnSO_4.H_2O$ ha^{-1} + seed treated with rhizobium culture + PSB @ 2.5 kg ha^{-1} in soil	3.49	3.45	1.26	1.24	0.49	0.48	0.27	0.24	1.16	1.15	1.79	1.73
	SE (d)	0.30	0.27	0.08	0.07	0.04	0.03	0.01	0.02	0.06	0.05	0.11	0.10
	CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table-2 : : Effect of nutrient management on nitrogen, phosphorus and potassium uptake by seed and stover of mung bean cultivars

Symbol	Treatment	Nitrogen uptake (kg ha^{-1})				Phosphorus uptake (kg ha^{-1})				Potassium uptake (kg ha^{-1})			
		By seed		By stover		By seed		By stover		By seed		By stover	
		2022	2022	2022	2022	2022	2023	2022	2023	2022	2023	2022	2023
	Cultivars												
C_1	PDM-139	33.24	30.34	27.71	24.15	4.70	4.14	5.67	4.71	11.36	10.27	39.77	34.85
C_2	IPM 2-3	28.53	25.74	23.93	21.15	3.99	3.57	4.64	3.99	9.81	8.96	35.00	30.64
C_3	Meha	38.48	34.78	31.64	28.24	5.36	4.83	6.57	5.28	12.79	11.75	44.91	39.69
C_4	IPM 2-14	27.03	23.53	22.74	19.96	3.81	3.29	4.46	3.79	9.45	8.25	33.45	29.26
	SE (d)	1.72	1.63	1.03	0.99	0.48	0.33	0.38	0.28	0.50	0.63	1.59	1.57
	CD (P = 0.05)	3.51	3.32	2.10	2.02	0.99	0.67	0.78	0.57	1.02	1.28	3.25	3.21
	Nutrient management												
N_0	Control	18.41	17.54	17.40	16.18	2.57	2.48	3.23	3.03	6.96	6.64	27.08	25.48
N_1	10 kg N + 20 kg P_2O_5 + 12.5 kg $ZnSO_4.H_2O$ ha^{-1}+ seed treated with rhizobium culture + PSB @ 2.5 kg ha^{-1} in soil	31.96	29.08	27.28	23.46	4.45	3.92	5.23	4.36	10.85	9.79	38.89	33.56
N_2	20 kg N + 40 kg P_2O_5 +25 kg $ZnSO_4.H_2O$ ha^{-1}	35.06	31.06	28.91	25.19	4.92	4.29	5.85	4.78	11.69	10.54	41.16	35.50
N_3	20 kg N + 40 kg P_2O_5 + 25 kg $ZnSO_4.H_2O$ ha^{-1} + seed treated with rhizobium culture + PSB @ 2.5 kg ha^{-1} in soil	41.85	36.70	32.42	28.66	5.92	5.16	7.03	5.60	13.91	12.27	46.00	39.90
	SE (d)	1.72	1.63	1.03	0.99	0.48	0.33	0.38	0.28	0.50	0.63	1.59	1.57
	CD (P = 0.05)	3.51	3.32	2.10	2.02	0.99	0.67	0.78	0.57	1.02	1.28	3.25	3.21