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Effect of phosphorus and iron on nutrient uptake and yield of green gram (*Vigna radiata* L.)

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Abstract
A field experiment was carried out during *Kharif* 2024 at the Research Farm of Vivekananda Global University, Jaipur, to evaluate Effect of phosphorus and iron on nutrient uptake and yeild of greengram (*Vigna radiata* L.). The study employed a factorial randomized block design with 16 treatment combinations, involving four phosphorus levels (0, 20, 40, and 60 kg/ha) and four iron treatments (control, 15 kg/ha basal application, 1.0% foliar spray at 25 and 40 DAS, and 1.0% foliar spray at 25, 40, and 55 DAS), each replicated thrice. The results demonstrated significant improvements in growth attributes, yield components, seed yield, nutrient uptake, and protein content with increasing phosphorus and iron levels. Notably, the combined application of 60 kg P/ha with three foliar sprays of iron resulted in the highest values for plant height, dry matter accumulation, pod number, seed yield, and protein content. Nutrient uptake of N, P, and Fe was also maximized under this treatment. From an economic perspective, this combination yielded the highest net return and benefit-cost ratio. The findings underscore the importance of integrated phosphorus and iron management for improving greengram productivity and nutritional quality under semi-arid conditions.

Keywords: Greengram, nutrient uptake, yield, phosphorus, iron

Introduction
Green gram (*Vigna radiata* L.) also known as mung bean, is one of the most important pulse crops cultivated in tropical and subtropical regions of the world. It holds a significant position in sustainable agriculture due to its short duration, ability to fix atmospheric nitrogen through symbiosis with Rhizobium, and high nutritional value. It is a self-pollinated leguminous crop, which is grown during kharif as well as summer season in arid and semi-arid regions of India. It is tolerant to drought and be grown successfully on drained loamy to sandy loam soil in areas of erratic rainfall. It is mainly a rainy season crop and raised without irrigation but with the development of early maturing varieties, it has also proved to be an ideal crop for spring and summer season under irrigated conditions. Being a short duration crop, it suits well in various multiple and intercropping system. After picking of pods, greengram plants may be used as green fodder or green manure. It is also cultivated for its edible seeds and its seed is more palatable, nutritive, digestible and non-flatulent then other pulses grown in country. Phosphorus is an important nutrient next to nitrogen for plants. Indian soils are poor to medium in available phosphorus. At present 5% of the Indian soils have adequate available P, 49.3% are under low category, 48.8% under medium and 1.9% under high category. The P input in Indian agriculture comes from fertilizers, organic manures and to a very small extent from crop residues. The overall uptake of phosphorus in cereals, pulses, oil seeds and tubers varies between 2 and 24 mg kg^{-1}. For the targeted food grains production of 3.01 mt by the year 2020, at least 45 mt of plant need to be added to the Indian soils, out of which P use will be 5.6 to 8.8 mt. Several workers observed a steady decline in available P status with continuous cropping without P application. Only 25% to 30% of the applied P is available to crops and remaining P is converted into insoluble. In recent years, soil and foliar tests indicates a wide spread deficiency of iron particularly in light texture soils, low in organic carbon and alkaline in reaction. Deficiency of iron is a major reason of lower crop yield in some soils. Iron is an essential plant nutrient play a

vital role in metabolic activities of the plant. Iron performs different functions in plant bodies such as production of carbohydrates, cell respiration and chlorophyll synthesis. A big part of proteins of enzymes and proteins is made up of iron. Iron has an important role in the transfer of energy between the different parts of plant. The availability of zinc and iron increase using foliar application and reduce the drought effect. Iron is a structural component of porphyrin molecules, hematein, hemes, ferrichromes, and leghemoglobin involved in oxidation reduction in respiration or in root nodules. Iron is also an important component of nitrogenase, which is essential for nitrogen fixation through nitrating bacteria. Iron is taken part in the formation of chlorophyll even though it is not it's constituent. Iron in chloroplast show the presence of cytochromes for performing various photosynthesis reduction processes (Nasar and Shah, 2017). Foliar application of iron has been generally more effective in correcting Fe chlorosis than soil application. Iron foliar fertilization had a superior effect on dry matter, concentration and uptake of elements by plants as compared with Fe soil application.

Materials and Methods

The experiment on "Effect of Phosphorus and Iron on Yield of Green Gram (*Vigna radiata* L.)" was conducted during Kharif 2024 at Research Farm, Vivekananda Global University, Jaipur (26°51′N, 75°47′E, 390 m AMSL), in Agro-Climatic Zone IIIa. The soil was loamy sand, alkaline, low in nitrogen and zinc, medium in phosphorus and potassium. It was laid out in a factorial randomized block design with 16 treatment combinations: four phosphorus levels (0, 20, 40, 60 kg/ha through DAP) and four iron treatments (control, 15 kg/ha basal, 1% foliar spray at 25 & 40 DAS, and at 25, 40 & 55 DAS) using ferrous sulphate (20% Fe). Each treatment was replicated thrice. Mungbean variety RMG-268 was sown on 13th July 2024 at 20 kg/ha by pora method, with row spacing of 30 cm. One irrigation was applied. Seeds were treated with bavistin (3 g/kg), and methyl parathion (25 kg/ha) was used for insect control. Standard intercultural operations were done. Harvesting was on 28th September 2024.Observations included plant height, dry matter, pods per plant, seeds per pod, test weight, grain and biological yield, harvest index, protein content, and nutrient uptake. Economics (net return, B:C ratio) and statistical analysis were done using standard methods.

Table 4.7: Effect of phosphorous and iron on N, P and K uptake in seed and straw of greengram

Treatments	Nitrogen uptake (kg/ha)		Phosphorus uptake (kg/ha)		Potassium uptake(g/ha)	
Phosphorous levels (kg/ha)	**Seed**	**Straw**	**Seed**	**Straw**	**Seed**	**Straw**
Control	19.95	14.49	2.87	2.23	9.06	7.49
20	29.97	21.14	3.76	2.85	12.41	9.95
40	36.05	25.20	4.16	3.12	13.94	11.08
60	38.80	27.04	4.24	3.17	14.65	11.61
S.Em+	1.58	1.07	0.19	0.14	0.64	0.50
CD (P = 0.05)	4.56	3.08	0.55	0.39	1.86	1.45
Iron						
Control	20.92	15.11	2.25	1.96	9.57	7.87
15 kg/ha (basal application)	32.33	22.73	4.01	2.96	12.84	10.27
1.0% foliar spray at 25 and 40 DAS	31.54	22.19	3.92	2.90	12.86	10.29
1.0% foliar spray at 25, 40 and 55 DAS	39.98	27.86	4.84	3.54	14.78	11.70
S.Em+	1.58	1.07	0.19	0.14	0.64	0.50
CD (P = 0.05)	4.56	3.08	0.55	0.39	1.86	1.45

Table 4.5: Effect of phosphorous and iron on yield and harvest index of greengram

Treatments				
Phosphorous levels (kg/ha)	**Seed yield (kg/ha)**	**Straw yield (kg/ha)**	**Biological yield (kg/ha)**	**Harvest index (%)**
Control	622	1223	1845	35.64
20	840	1601	2442	35.97
40	935	1767	2702	36.13
60	976	1838	2814	36.17
S.Em+	25	45	70	0.15
CD (P = 0.05)	73	129	201	NS
Iron				
Control	656	1282	1938	35.97
15 kg/ha (basal application)	868	1650	2518	35.67
1.0% foliar spray at 25 and 40 DAS	864	1642	2506	36.07
1.0% foliar spray at 25, 40 and 55 DAS	986	1855	2841	36.20
S.Em+	25	45	70	0.15
CD (P = 0.05)	73	129	201	NS

*NS = Non significant

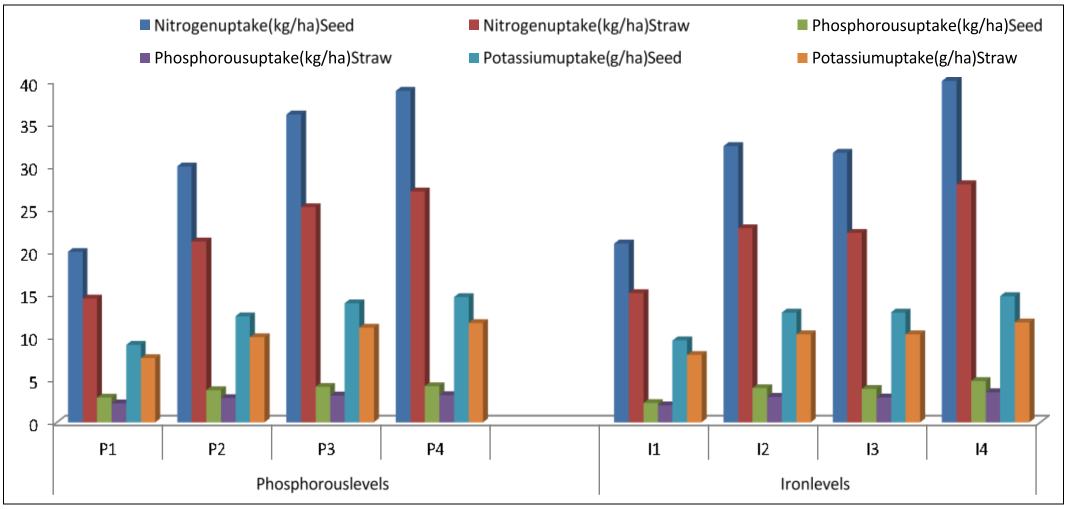

Fig: 4.4: Effect of phosphorous and iron on nutrient uptake by grain and straw of greengram

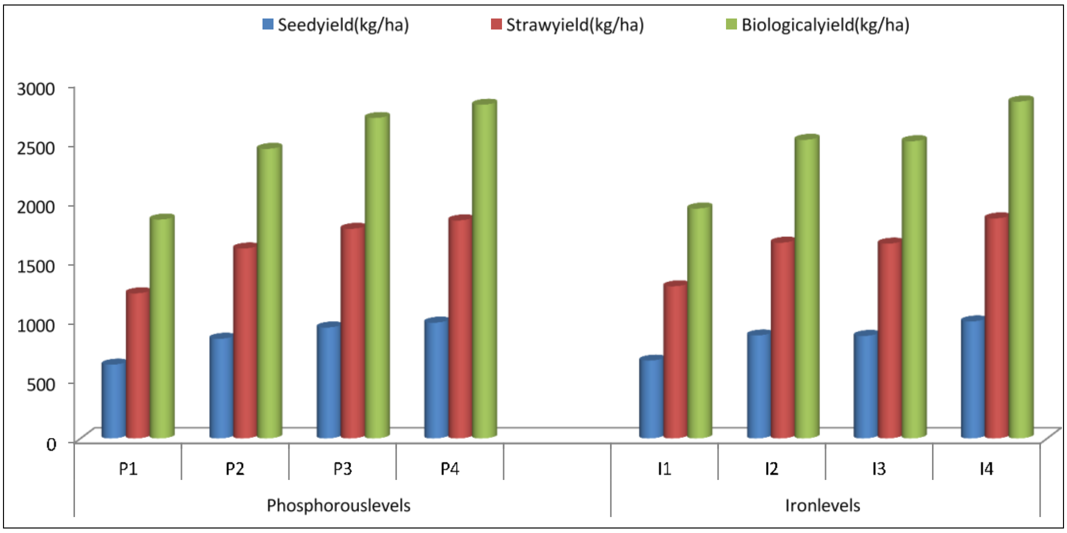

Fig: 4.3: Effect of phosphorous and iron on yield and harvest index of greengram

Results

Application of phosphorus and iron significantly influenced nutrient content and uptake in greengram seed and straw. Maximum nitrogen content in seed (3.95%) and straw (2.42%) was recorded with foliar spray of 1.0% Fe at 25, 40, and 55 DAS, followed by 3.89% and 2.36% under 60 kg P/ha, respectively. Phosphorus content was highest in seed (0.47%) and straw (0.38%) with 1.0% Fe spray at three stages, and 0.46% and 0.37% with 60 kg P/ha. Maximum potassium content in seed (1.67%) and straw (1.41%) was observed under 60 kg P/ha, while iron content in grain (178.2 ppm) and straw (116.8 ppm) was highest under foliar Fe at 25, 40, and 55 DAS.

In terms of nutrient uptake, the highest nitrogen uptake was 39.98 kg/ha in seed and 27.86 kg/ha in straw with triple foliar Fe spray, followed by 38.37 kg/ha and 26.89 kg/ha under 60 kg P/ha. Phosphorus uptake was also maximum under triple Fe spray: 4.84 kg/ha (seed) and 3.54 kg/ha (straw). Potassium uptake reached 14.78 kg/ha (seed) and 11.70 kg/ha (straw) under the same treatment. Iron uptake was highest with triple Fe spray, recording 128.9 g/ha in seed and 85.1 g/ha in straw. Protein content in seed was also influenced, with the highest value of 24.48% under 1.0% Fe spray at 25, 40, and 55 DAS, and 22.85% under 40 kg P/ha application.

Discussion

Improved nutrient content and uptake with phosphorus application might be due to enhanced root growth and increased nutrient solubility in the soil. Similar results were reported by Erman, who observed that phosphorus increased N, P, and K uptake in greengram due to better rhizosphere activity. Rathour *et al.* (2015) [7] also reported that phosphorus supports leaf development and nutrient translocation, leading to higher uptake and content in seed and straw.

Foliar application of iron at 25, 40, and 55 DAS significantly improved nitrogen, phosphorus, potassium, and iron content and uptake. This could be attributed to iron's role in photosynthesis, enzyme activation, and nitrate reduction, as noted by Jain (2007) [6]. confirmed that iron enhances nitrogen metabolism and protein formation, which is supported by the higher protein content observed in the present study.

Higher iron uptake under foliar application treatments was due to increased availability and direct absorption through leaf surfaces. Choudhary (2006) [8] observed similar improvements in iron uptake due to foliar feeding, which increased photosynthetic efficiency and nutrient mobility. The present findings are in close agreement with those of Chavan *et al.* (2013) [9] and Upadhyay and Singh (2016) [10], who found that foliar iron sprays improved nutrient uptake and quality parameters in greengram.

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