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Response of mungbean (*Vigna radiata* L.) varieties as influenced by nutrient management on harvest index and economics in Central alluvial tract of Uttar Pradesh

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Abstract
A field experiment was carried out on mungbean at Farm of Rama University, Uttar Pradesh, Kanpur during *kharif* 2022. The soil of the experimental field may be characterized as sandy loam in texture. The treatment comprising four varieties of mungbean *viz.* C_1: PDM-139, C_2: IPM 2-3, C_3: Meha, C_4: IPM 2-14. Four levels of nutrient management *viz.* N_0: Control, 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, N_2: 20 kg N + 40 kg P_2O_5 +25 kg $ZnSO_4.H_2O$ ha^{-1} and 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 with 3 replication in factorial RBD. Based on the results of the field experimentation it can be inferred that potential seed yield and economic nutrient management can be achieved in greengram by 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} in soil in *kharif* of greengram in Central alluvial soils of Uttar Pradesh.

Keywords: Greengram, phosphorus solubilizing bacteria, harvest index, vermicompost

Introduction
Pulses are the important crops of our country and are the main sources of vegetable protein as far as an Indian dietary is concerned. The lysine rich protein of pulses is considered to the supplement of the deficiency of this amino acid in cereal dietaries and brings at par with milk's protein in the term of biological efficiency. Pulses are major sources of vitamins like riboflavin, thiamine, niacin and iron. Medical considerations encourage the presence of certain quantity of fibre in the human diet. The average protein content in the pulses varies from 18 to 24 per cent. Pulses also contains calcium and phosphorus. Nutrient balance is the key component to increase crop yields. Excess and imbalanced use of nutrients has caused nutrient mining from the soil, deteriorated crop productivity and ultimately soil health. Replenishment of these nutrients through organic and combination with organic and inorganic has a direct impact on soil health and crop productivity (Meena *et al.*, 2016) [9].

Among different production practices, nutrient management is one of the important practices for increasing crop yield and maintaining soil fertility. Growth and development of crops depend largely on the development of root system. Phosphorus (P) is one of the most important elements among three macronutrients that plants must require for the better growth and development. Most of the soils throughout the world are P deficient. Patel *et al.*, (2017) [12]. After nitrogen, phosphorus is the second primary macronutrient required in large amounts for plant growth. Phosphorus solubilizing bacteria and plant growth promoting rhizobacteria are highlighted to use phosphorus fixed in soil layers. Inoculation techniques with PSB are the initial step for accomplishing the better quality and high mungbean yields. Application of Zn to soil is the satisfactory way to cure zinc deficiency. Debnath *et al.*, (2018) [2]. Keeping in view all the factors related to soil fertility and productivity fertilizers are applied to soil to maintain soil status and crop productivity. Mungbean is highly responsive to fertilizer application. Thus, the present investigation have been undertaken in Central alluvial tract of Uttar Pradesh.

Materials and Methods

Field experiment was conducted in *kharif* season of 2022 at the Farm of Rama University, Uttar Pradesh, Kanpur. Total 16 treatment combinations comprising of four mungbean varieties *viz.* C_1: PDM-139, C_2: IPM 2-3, C_3: Meha, C_4: IPM 2-14 and four levels of nutrient management *viz.* N_0: Control, 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, N_2: 20 kg N + 40 kg P_2O_5 +25 kg $ZnSO_4.H_2O$ ha^{-1}, 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, were evaluated in factorial randomized block design with three replications. The soil of the experimental field was sandy loam in the texture having soil pH 7.6, EC 0.46 dSm^{-1}, organic carbon 0.38%, total nitrogen 0.037%, available P_2O_5 17.8 kg ha^{-1} and available K_2O 169.5 kg ha^{-1}. Sowing was done on 2nd August 2022 by using seed rate of 15 kg ha^{-1}. Required quantity of mungbean varieties was inoculated with rhizobium+PSB biofertilizers before sowing. The entire dose of fertilizer was applied as per the treatments through urea, DAP and zinc sulphate. All other operations were performed as per recommendations of the crop. The data on seed and stover yields were recorded under different treatments after harvest of crop. The benefit cost ratio was calculated using the following formula:

Benefit Cost Ratio = Gross return (Rs ha^{-1})/Total cost of cultivation (Rs ha^{-1}).

The harvest index (%) is calculated by the empirical formula given below:
Harvest Index = Economic yield/ Biological yield × 100

Where, economic yield = Total seed yield (t ha^{-1}).
The results were analysed statistically to draw suitable inference as per the standard ANOVA techniques suggested by Gomez and Gomez (1984) [5]

Results and Discussion

The data with respect to seed yield, stover yield and harvest index as influenced by crop cultivars and nutrient management have been presented in Table-1. The significantly maximum seed, stover yield and harvest index were recorded with cv. C_3: Meha followed by cv. PDM-139 and minimum under cv. IPM 2-14. It is evident from the results that there was a significant difference in seed and stover yields of greengram due to different cultivars. This might be due to difference in its genetical built up of the cultivars. These findings are in agreement with earlier work of Shelke *et al.*, (2012) [13], Patel *et al.*, (2016) [11] and Dash and Rautaray (2017) [1].
It is clear from the results that there was a significant difference in seed, stover yield and harvest index due to different nutrient management practices. Significantly highest values were registered in 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 in respect to seed, stover and harvest index followed by N_2: 20 kg N + 40 kg P_2O_5 +25 kg $ZnSO_4.H_2O$ ha^{-1} were applied, and lowest values were recorded under control. This might be due to combined inoculation of rhizobium + PSB with fertilizers enhanced the yield of greengram. Such positive benefits of nutrient combination have also been reported by Kartik *et al.*, (2020) [7], Masih *et al.*, (2020) [8] and Patel *et al.*, (2013) [10].

Table 1: Effect of nutrient management on seed yield, stover yield and harvest index of Mungbean during *kharif*, 2022

S. No.	Treatments	Symbol	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	Harvest Index (%)
	Crop cultivars				
(i)	PDM-139	C_1	10.69	25.78	29.17
(ii)	IPM 2-3	C_2	9.37	23.00	28.75
(iii)	Meha	C_3	13.52	31.51	29.88
(iv)	IPM 2-14	C_4	8.84	21.97	28.51
	SE (d)		0.66	1.02	0.25
	CD (P=0.05)		1.35	2.08	0.51
	Nutrient Management				
(i)	Control	N_0	6.66	17.14	27.90
(ii)	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	N_1	10.67	26.03	28.99
(iii)	20 kg N + 40 kg P_2O_5 +25 kg $ZnSO_4.H_2O$ ha^{-1}	N_2	11.51	27.47	29.45
(iv)	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	N_3	13.57	31.61	29.97
	S.E(d)		0.66	1.02	0.25
	CD (P=0.05)		1.35	2.08	0.51

Economics

The results of economic analysis of greengram production (Table-2) revealed that gross, net return and B:C ratio in var Meha recorded highest realization of Rs 122177 and Rs 68180 ha^{-1} and 2.26, respectively, followed by var PDM-139 and lowest under var IPM-2-14 during the experimentation. This might be due to highest seed and stover yields under the same var Meha as compared to rest of the varieties. The results confirm the findings of Shelke *et al.*, (2012) [13], Tarafder *et al.*, (2020) [14] and Masih *et al.*, (2020) [8].
Highest net return of Rs 66533 with B:C ratio of 1:2.19 was recorded with application of N_3 level of nutrient management which received 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 and lowest under control. These observations are in accordance with those of Dwivedi *et al.*, (2018) [4] and Kartik *et al.*, (2020) [7].

Table 2: Effect of nutrient management of mungbean cultivars on economics of different treatments during *kharif*, 2022.

Treatments	Symbol	Cost of cultivation (Rs ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	Benefit: Cost ratio
Crop cultivars					
PDM-139	C_1	53997	97081	43084	1:1.80
IPM 2-3	C_2	53997	85316	31319	1:1.58
Meha	C_3	53997	122177	68180	1:2.26
IPM 2-14	C_4	53997	80637	26640	1:1.49
Nutrient Management					
Control	N_0	50760	61115	10355	1:1.20
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	N_1	54410	97103	42693	1:1.78
20 kg N + 40 kg P_2O_5 +25 kg $ZnSO_4.H_2O$ ha^{-1}	N_2	54750	104390	49640	1:1.91
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	N_3	56070	122603	66533	1:2.19

Conclusion

Mungbean crop responded well to the application of nutrients as the soils of the experimental field was average in nutrient status *viz.* low in organic carbon (0.38%), low in available nitrogen (168.2 kg ha^{-1}), medium in available P_2O_5 (17.8 kg ha^{-1}) and medium in available K_2O (169.5 kg ha^{-1}). Among mungbean varieties C_3: Meha showed significantly highest seed (13.52 Q ha^{-1}), stover (31.52 Q ha^{-1}) and harvest index (29.88%). Apart from this, 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} in soil have recorded maximum seed yield, stover yield, and harvest index and gave maximum values of gross return, net return and benefit: cost ratio, hence this treatment can be recommended for higher yield and may be opted for getting higher benefit cost ratio.

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