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Use of phosphorus for maximization of *Summer* Mungbean [*Vigna radiata* (L.) Wilszeck] productivity under sub-humid condition of Rajasthan, India

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Abstract

Pulses occupy unique place in Indian diet with supplying of vegetable protein to primarily starchy diet and provide an essential supplement for balance diet. Therefore, it is essential to increase the sustainable productivity with more appropriate management of nutrient utilization of plants so that with same area, we can increase pulses sustainable production. In future sustainable pulse production will greatly depend on soil health because of heavy doses of chemical fertilizers, extensive removal of phosphorus by the crops under intensive cultivation and degraded soil condition day by day will be chief in concern for decreasing sustainability in production and environment. In this regard, a field experiment was conducted at Instructional Farm Rajasthan College of Agriculture, Udaipur with four levels of phosphorus (0, 20, 40 and 60 kg P_2O_5/ha) in greengram. Results workout in quadratic equation with four levels of phosphorus found that 48.62 kg P_2O_5/ha is proved to be the best dose for optimum input responsive yield (1384.85 kg/ha.).

Keywords: Phosphorus, Optimum dose, greengram, Seed yield

1. Introduction

Pulses have an important place in order to mitigate the protein requirement of increasing population of country. Greengram as 'Moongbean' or 'Moong' contains 24.5 per cent protein, rich in carbohydrates and also contains small quantities of riboflavin and thiamine and fairly rich in phosphorus and iron. It mainly grown as sole crop, mixed crop and intercrop in *kharif* and in summer season where adequate water availability are available (Bhatt *et al.*, 2013) [1].
Total pulse area in India is 233.09 lakh hectare and the production is 171.91 lakh tones. *Summer* mungbean stands third after chickpea and pigeon pea among pulses (Tamang *et al.*, 2015) [11]. It occupies 30.53 lakh hectare area and contributes 15.09 lakh tones in pulse production in the country (Statistical year book India, 2016) [10]. *Summer* mungbean is cultivated in states of Madhya Pradesh, Punjab, Haryana, Maharashtra, Rajasthan, Karnataka, Andhra Pradesh and Tamil Nadu. Pulses are grown in about 32.07 lakh ha area in Rajasthan of which 21.33 lakh ha area comes under kharif pulses and 10.74 lakh per hectare area under Rabi pulses. Area and production of *Summer* mungbean is 8.93 lakh hectares and 4.61 lakh tones, respectively with the productivity of 515 kg ha^{-1}, while area, production and productivity of *Summer* mungbean in Udaipur and Bhilwara region together is 14618 hectares, 5241 tones and 359 kg ha^{-1} respectively (Government of Rajasthan 2015-16) [2]. Declining productivity of *Summer* mungbean is mainly due to the cultivation in degraded or less fertile soil with less adoption of suitable management technology while, with availability of high yielding short duration cultivars and the suitability of growing them round the year, give a vast opportunity to fulfill the protein requirement by increasing productivity (Singh *et al.*, 1994) [8].
To exploit the full genetic potential of improved *Summer* mungbean variety is may be possible through development of best management practices and improved crop management techniques. In addition to all appropriate cultivation practices application of balanced amount or optimum dose of nutrients, particularly phosphorus can become important element apart from NPK in all the greengram cultivation The incorporation of vermicompost in the soil and the addition of arbuscular mycorrhizal fungi, PSB are promotes soil fertility and plant growth by increasing the nutrient availability and nutrient absorption, especially in reference to P a nutrient that is found in low levels in tropical soils (Tripura, *et al.*, 2016) [13]. Increasing the number of such microorganisms and accelerate microbial process to augment to extent of the availability of the nutrient in a form, which can easily assimilated by plant. Pulses have relatively more requirement of P among the field crops. However, techniques involving optimization of fertilizer inputs (Phosphorus dose) with aim to enhance the productivity and economics of cultivating *Summer* mungbean.

Hence the present study was carried out in greengram to found the effect of optimum fertilization through soil on the yield of greengram.

2. Materials and Methods

The experiment was carried out at the Instructional farm, Rajasthan College of Agriculture Udaipur is situated at South-Eastern part of Rajasthan at an altitude of 582.17 meter above mean sea level and at 24º 35′ N latitude and 73º 42′ E longitude. The region falls under Agro-climatic Zone IV a (Sub- humid Southern Plain and Aravalli Hills) of Rajasthan. during *Summer* season of 2016. The mean annual rainfall of Udaipur is 610.2 mm, and zone IV a range between 582-620 mm, most of which is contributed by south west monsoon. This zone possesses typical sub-tropical climatic conditions characterized by mild winters and moderate *Summer* associated with high temperature and low relative humidity during the months of March to July. The soil of experimental site was clay loam in texture, slightly alkaline in reaction. The soil was medium in available nitrogen and phosphorus while high in potassium, and sufficient in DTPA extractable micronutrients.

The experiment was laid out in randomized block design with three replications, having four levels of phosphorus (P_0, P_{20}, P_{40} and P_{60} kg ha^{-1}). Full quantity of phosphorus (SSP) was applied at the time of sowing as per P_2O_5 receiving treatments. The crop was equally fertilized with 25kg N $ha^{-1}$with urea as basal dose to each treatment. Seed of cv. SML-668 (suitable for *Summer* seasons which matures uniformly within 60-65 days) were sown at 3 to 4 cm depth with 30 cm spacing at 1st week of April, 2016. All the recommended cultural and plant protection measures were followed throughout the experimentation.

3. Results and Discussion

The data presented in table 1 and fig 1 a critical examination of the data revealed that grain yield of *Summer* mungbean was significantly improved due to successive increase in level of phosphorus up to 40 kg P_2O_5/ha. It provide the grain yield of 1309 kg/ha and further application of phosphorus up to 60 kg P_2O_5/ha produced the highest grain yield of 1381 kg/ha. However, response of grain yield to varying levels of phosphorus was worked out and found to be the quadratic. The functional form of yield response to phosphorus showed that the economic optimum dose of phosphorus worked out through production function came out 48.62 kg P_2O_5/ha corresponding with grain yield response of 1384.85 kg/ha. This indicates that application of phosphorus up to 60 kg/ha was not economic responsive to increase yield of greengram, if we apply P_2O_5 at 48.62 kg/ha, it gives maximum grain yield which of highly input responsive and further increase in phosphorus dose increases yield with declining rate. For the support of these results, Kumar and Singh, 1993 [4] was found 22.9 kg P2O5 ha^{-1} optimum for grain yield. Khan *et al.,* (1999) [3] also recorded that application of phosphorus from 60-90 kg ha^{-1} was optimum for getting better yield of green gram. Sadeghipour *et al.,* (2010) [6] further recorded that application of 120 kg $P_2O_5ha^{-1}$ was optimum for fetching the highest yield of green gram.

Correlation coefficients and regression equations were worked out between grain yield of *Summer* mungbean and dry matter accumulation at harvest, total and effective nodules/plant, fresh and dry weight of nodules/plant, number of pods/plant, number of grains/pod, test weight and total uptake of nitrogen, phosphorus and potassium. The values worked out are presented in table 2. Results of the correlation coefficients indicated that grain yield was significantly and positively correlated with total and effective nodules/plant (r = 0.990 and 0.967), number of pods/plant (r = 0.979), number of seeds/pod (r = 0. 956), test weight (r = 0.975), total N uptake (r = 0.981), total P uptake (r = 0.999) and total K uptake (r = 1.000). The regression equations (Table 2) showed that every unit increase in total and effective nodules/plant, number of pods/plant, number of seeds/pod, test weight and total uptake of N, P and K increased the grain yield of *Summer* mungbean by 14.39, 46.23, 34.82, 16.94, 25.02, 22.39, 175.32, 70.46, 8.23, 82.98 and 11.64 kg/ha, respectively. Sarkar *et al.,* (2002) [7] also recorded as like results. Interesting result from this experiment was found the significant grain yield and yield attributing variables. The original reason was that optimum levels of phosphorus would be associated with high N2 fixation rates. These results imply that concentrations of P and bio-organics in the soil alter the crop physiology so that of nitrogen is increased such that the accumulation of dry matter is actually increased. The active loading of dry matter into the phloem for support this energy transfer to whole parts of plants. Phosphorus not only plays important role in root development and proliferation but also improves nodulation and N fixation by supplying assimilates to the roots. Increased availability of phosphorus owing to its application in soluble form to the soil which was otherwise deficient in P concentration might have led to significant improvement in the concentration and uptake of this nutrient which in turn helped in early root development and ramification, thereby leading to better growth in terms of plant height, branches/plant and dry matter accumulation. The increased uptake of phosphorus as well as N and K due to synergistic effect thereby increasing the sink in terms of flowering and grain setting. These reasons are in close conformity with the findings of Tanwar *et al.,* (2003) [12] and Owla *et al.,* (2007) [5] in *Summer* mungbean and Singh and Agarwal (2001) [9] in urdbean.

Table 1: Seed yield (Y) as a function of phosphorus (P_2O_5) ($Y = b_0+b_1 X + b_2 X^2$)

Study parameters	Values
1. Partial regression coefficients	
b_0	735.80
b_1	25.565**
b_2	-0.2512*
2. Coefficients of	
(i) Determination (R^2)	0.981**
(ii) Multiple correlation (R)	0.990**
3. Optimum level P2O5 kg ha^{-1}	48.62
4. Yield at optimum level (kg ha^{-1})	1384.85
5. Response of optimum level (kg ha^{-1})	649.05

Note:- The yield, P levels, responses and intercepts are given in kg ha^{-1}

* Significant at 1% level of significance

** Significant at 5% level of significance

Table 2: Correlation coefficients and linear regression equations showing relationship between seed yield of mung bean (kg/ha) and independent variables (X)

S. No.	independent variables (X)	Correlation coefficients (r)	Regression equations ($Y = a + b_{yx}.X$)
1.	Total nodules per plant	0.990**	$Y = -1745.021+95.650\ X_1$
2.	Effective nodules	0.967**	$Y = -989.883+97.624\ X_2$
3.	Number of pods per plant	0.979**	$Y = -216.045+37.036\ X_3$
4.	Number of seeds per pod	0.956**	$Y = -343.812+142.297\ X_4$
5.	Test weight (g)	0.975**	$Y = -2844.878+112.543\ X_4$
5.	Total N uptake by crop (kg/ha)	0.981**	$Y = 342.016+10.009\ X_5$
6.	Total P uptake by crop (kg/ha)	0.999**	$Y = 328.928+72.944\ X_6$
7.	Total K uptake by crop (kg/ha)	1.000**	$Y = 266.582+38.119\ X_7$

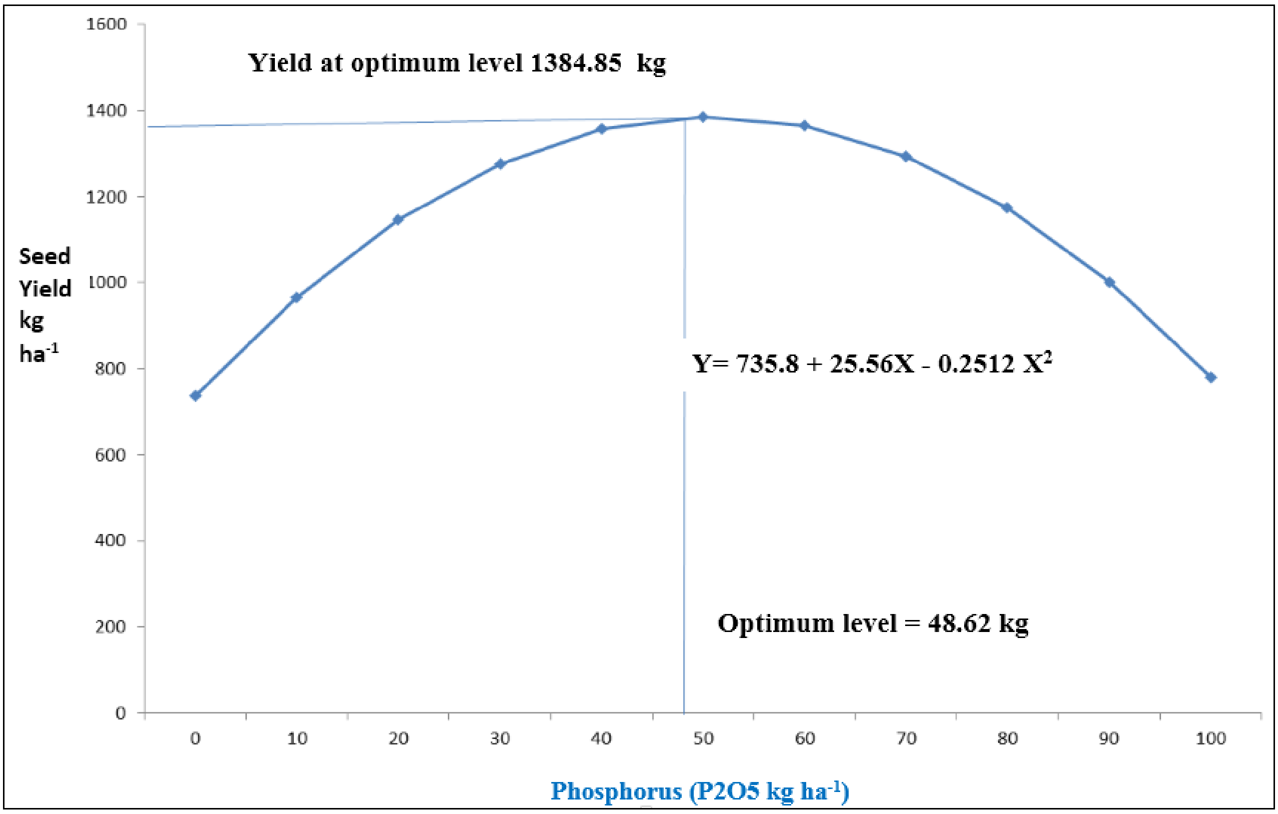

Fig 1: Seed yield (Y) as a function of phosphorus ($Y = b_0 + b_1 \cdot X + b_2 .X^2$)

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