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Response of Mungbean (*Vigna radiata* L.) To Different Levels of Phosphorus

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Abstract
Seed yield in green gram was increased progressively with phosphorus application up to 75 kg P_2O_5 ha^{-1}. The application of P_2O_5 more than 75 kg ha^{-1} depressed the yield and yield components. Maximum increase in seed yield, recorded at 75 kg P_2O_5 ha^{-1} was about 92% of control. Higher seed yield with phosphorus application was related to the higher number of pod bearing branches, number of pods per plant, number of seeds per pod and 1000-grain weight. Protein contents were also influenced significantly by phosphorus application, being maximum (27.01%) at phosphorus level of 75 kg ha^{-1}. Phosphorus application of 75 kg ha^{-1} seems to be the optimum level for harvesting higher yield in green gram.

Key words: Mungbean, *Vigna radiata*, phosphorus application, yield and yield components, protein contents

Introduction
Mungbean (*Vigna radiata* L.) is one of the important conventional pulses grown in Pakistan. Being rich in protein (Awan, 1995), it can provide a balanced human diet when taken in combination with cereals which contain low level of protein. Average grain yield of mungbean in Pakistan is 462 kg ha^{-1} (Anonymous, 1997) which is much lower than its potential yield. Efforts at both the breeder and agronomist level are needed to increase per hectare yield of this crop in Pakistan.

Phosphorus is considered the most important nutrient for increasing yield of mungbean (Siag *et al*. 1993). Studies have shown that phosphorus application to mungbean has increased plant height, number of branches, number of pods $plant^{-1}$, grains pod^{-1}, 1000 grain weight, biological yield and grain yield. Ashraf (1997) and Balachandran and Sasidhar (1991), reported that phosphorus application increased only number of pods $plant^{-1}$ but not the number of seeds pod^{-1} and 1000 seed weight.

The research work done on the effect of phosphorus on mungbean production in Pakistan is limited and there is a dire need to work out the most appropriate level of phosphorus under existing soil conditions. The present study was, therefore, planned to evaluate the effect of different levels of phosphorus at constant nitrogen level on mungbean genotype NM-95 under Faisalabad conditions.

Materials and Methods
The experiment was carried out to evaluate the effect of phosphorus on growth, yield and quality of mungbean at the Agronomic Research Area, University of Agriculture Faisalabad on a sandy clay loam soil having 0.058 percent N, 9.2 ppm available P and 134 ppm K. Experiment was laid out in a Randomized Complete Block Design with four replications. The net plot size was 2.4×8 m. Mungbean genotype NM-95 was sown in the 2nd week of March, 1996 in 40 cm apart rows with the help of single row hand drill. The experiment comprised 0, 25, 50, 75, 100 and 125 kg P_2O_5 ha^{-1}. Nitrogen was applied at the rate of 50 kg ha^{-1}. The whole quantity of N and P_2O_5 was side drilled at sowing time in the form of urea and single super phosphorus. All other agronomic practices were kept normal and uniform for all the treatments. Crop was harvested on June 22, 1996. For recording individual plant observation like plant height, number of pod bearing branches and number of pods per plant. Ten plants per plot were selected randomly and then average was calculated. For number of seeds pod^{-1} fifty pods were taken at random from ten already selected plants from each plot. Seeds of these pods were removed, counted and average were computed. Protein contents was measured by using Gunning and Hibbard's method of H_2SO_4 digestion and using micro Kjeldahl method for distillation (Jackson, 1962). Data collected were analyzed statistically using Fisher's analysis of variance technique and treatment's means were compared by using LSD test at 5% probability level (Steel and Torrie, 1984).

Results and Discussion
The data regarding various parameters recorded are given in Table 1. The application of 75 kg P_2O_5 ha^{-1} producted tallest plants (51.69 cm) but was not significantly different from 50 kg P_2O_5 ha^{-1}. The minimum plant height (43.80 cm) was recorded without phosphorus application. The results obtained by 25, 50, 100 and 125 kg P_2O_5 ha^{-1} were not statistically different with one another. The increase in height might be due to the better root growth and increased metabolic activity of the plant by the better combination of basal N ans P. The increase in plant height with P_2O_5 application has also been reported by Ghaffar (1990) and Ashraf (1997).

The plot receiving 25, 50 and 75 kg P_2O_5 ha^{-1} remaining at par with one another gave significantly higher number of pod bearing branches per plant than 0, 100 and 125 kg P_2O_5 ha^{-1}. The difference between 100 and 125 kg P_2O_5 ha^{-1} was not significant. The maximum (5.65) and minimum (3.80) number of pod bearing branches per plant were obtained with application of 50 kg P_2O_5 ha^{-1} and control respectively. The increase in number of pod bearing branches per plant beyond 50 kg ha^{-1} might be due to nutritional imbalance. These results are in conformity with those of Hussein (1989), Ghaffar (1990) and Ashraf (1997). The application of P_2O_5 at the rate of 75 kg ha^{-1} remaining at par with 50 and 100 kg P_2O_5 ha^{-1} gave significantly higher number of pods per plant than 0, 25 and

Table 1: Growth and yield of mungbean as influenced by different levels of phosphorus

	P_2O_5 applied kg ha^{-1}					
	0	25	50	75	100	125
Plant height (cm)	43.80c	45.64bc	48.34ab	51.69a	47.22bc	47.15bc
No. of pods bearing branches $plant^{-1}$	3.80c	5.20a	5.65a	5.47a	4.40bc	4.53b
No. of pods $plant^{-1}$	10.35c	12.05bc	13.45ab	16.40a	13.60ab	12.75
No. of seeds per pod	5.90d	6.22cd	6.93b	7.53	6.89b	6.49c
1000-grain weight (g)	55.40d	56.60c	59.53b	60.47a	59.88ab	59.85ab
Seed yield (t ha^{-1})	0.59d	0.79c	0.99ab	1.13a	1.01ab	0.98b
Protein contents of grain (%)	24.35d	25.10c	26.05b	27.01a	25.99b	25.84b

Any two means, not sharing a letter in column, differ significantly ($p<0.05$)

125 P_2O_5 ha^{-1}. The minimum number of pods (10.35) $plant^{-1}$ were recorded in control. Application of phosphorus beyond 75 kg P_2O_5 ha^{-1} decreased the number of pods per plant. The sink capacity of plants (number of pods) has genetic limitation that is why the number of pods per plant were decreased at higher phosphorus levels. Patel *et al*. (1984), Samiullah *et al*. (1987), Balachandran and Sasidhar (1991) and Ashraf (1997) have also reported and increase in number of pods per plant with phosphorus application in mungbean.

The application of 75 kg P_2O_5 ha^{-1} produced significantly higher number of seeds per pod (7.53). Phosphorus levels of 50 and 100 kg ha^{-1} were statistically at par when compared with each other but gave significantly higher number of seeds per pod than 0, 25 and 125 kg P_2O_5 ha^{-1}. The increase in the number of seed per pod might be due to the positive response of phosphorus on flower setting and ultimately increased the seeds. Similar results have been reported by Hussein (1989), Samiullah *et al*. (1987) and Ashraf (1997).

Phosphorus levels of 75, 100 and 125 kg ha^{-1} produced almost similar 1000-grain weight but significantly higher than 25 kg P_2O_5 ha^{-1} and control. The minimum (55.40 g) and maximum (60.47 g) 1000-grain weight was observed in control and pods receiving 75 kg P_2O_5 ha^{-1}. These results indicate that phosphorus application has influenced the physiological processes such as photosynthesis that ultimately resulted in the fully filled grains. Similar results have also been reported by Hussein (1989), Ghaffar (1990) and Ashraf (1997).

All P_2O_5 levels gave significantly higher seed yield over control. The 75 kg P_2O_5 ha^{-1} did not differ significantly from 50 and 100 kg P_2O_5 ha^{-1} but gave significantly higher seed yield than 25 and 125 P_2O_5 ha^{-1}. The highest (1.13 t ha^{-1}) and lowest (0.59 t ha^{-1}) seed yield were obtained by the application of 75 kg P_2O_5 ha^{-1} and control, respectively. The increase in seed yield with P_2O_5 application has been due to higher number of pods per plant, seeds per pod and 1000-grain weight. The decrease in seed yield beyond 75 kg P_2O_5 ha^{-1} might be due to genetic inability of the cultivar to get more phosphorus or due to some nutritional imbalance. These findings are also in line with those of Samiullah *et al*. (1987) and Ghaffar (1990).

The treatment 75 kg P_2O_5 ha^{-1} gave significantly higher protein contents than other treatments. The treatments receicing 50, 100 and 125 kg P_2O_5 ha^{-1} were not significantly different with one another. The maximum (27.01%) and minimum (24.35%) protein contents were obtained in plots receiving 75 kg P_2O_5 ha^{-1} and control, respectively. The results indicated that the phosphorus application has improved the amino acids synthesis in the seed. Similar results have been reported by Ghafoor (1985). From the results of this study it can be concluded that for achieving high seed yield and protein contents, the phosphorus application level of 75 kg ha^{-1} is the optimum one.

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