ISSN 1023-1072

Pak. J. Agri., Agril. Engg., Vet. Sci., 2015, 31 (2): 203-210

GROWTH AND YIELD RESPONSE OF MUNGBEAN VARIETIES TO VARIOUS POTASSIUM LEVELS

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ABSTRACT

Growth and yield response of two mungbean (Mung-06 and NM-92) varieties to different application rates of potassium was evaluated under field condition. Plants were fertilized with five K (00, 50, 75, 100 and 125 kg ha^{-1}) levels. The data obtained from the study indicated that there was significant effect of potassium levels on growth, yield and yield components of both varieties. Compared to Mung-06, the variety NM-92 performed well by displaying maximum seed germination, taller plants with more branches, pods, seeds and biological yield. In addition to the recommended rates of nitrogen and phosphorus, the K applied @ 125 kg ha^{-1} significantly increased seed germination, plant height, number of branches per plant, number of pods, seed index and biological yield (kg ha^{-1}) as well. The difference between 125 and 100 kg K ha^{-1} rates for mjority of the growth and yield parameters under study remained non-significant. However, the plants given 75, 50 and 00 kg K ha^{-1} ranked 3rd, 4th and 5th, respectively for all the recorded yield parameters. It is, therefore, concluded that 100 kg K ha^{-1} can be the effective rate for achieving economically higher mungbean yield.

Keywords: Growth, K fertilizer, mungbean, yield.

INTRODUCTION

Mungbean (*Vigna radiate*) also known as green gram, is a member of Fabaceae family and domesticated in the Indo-Pak sub-continent. Mungbean as a pulse and legume crop is of prime importance, because of its excellent flavor, easy digestibility, well palatability, good market price as well as its capability for biological nitrogen fixation (Mandal *et al.,* 2009). Several factors have long been reported for low mungbean production. Particularly, the selection of varieties, and poor crop management, like improper fertilizer application are the major

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constraint for low productivity (Jackson, 2001). Excessive consumption of macro and micro nutrients on the agricultural lands due to extensive cultivation of crops is an indicator of the importance of paying attention to the nutrients (Malakouti, 2004). Hence, deficiency of these nutrients in soil creates physiological and metabolic disturbances within plant (Babaeian *et al*., 2011). Potassium maintains cell's turgor pressure, that ultimately improves cell growth by adding to regulation of osmotic pressure in plant cell, helps in stomatal conductance and plays a vital role in photosynthesis, synthesis of proteins and disease resistance. In Pakistan extensive cultivation and utilization of high yielding cultivars cause a substantial drain of nutrients especially K, therefore most of the crops become responsive to K fertilization (Malik *et al.,* 1989; Tariq *et al.,* 2001).

Mungbean needs P, K and few trace elements for satisfactory growth and production. Ali *et al*. (1996) stated that 125 kg K ha^{-1} is an effectitve and economical rate for healthy growth and maximum yield of mungbean. Chanda *et al.* (2002) noted a prominent response of growth, yield and protein content of soybean against 90 kg K ha^{-1}. Fadhel (2011) got highest yield (1.52 t ha^{-1}) by adding 80 kg K ha^{-1}. It is also evident from the report of Naeem *et al.* (2006) that the application of 25-50-50 kg NPK ha^{-1}, 3.5 t ha^{-1} poultry manure, 5 t ha^{-1} FYM and 8g kg^{-1} seed bio-fertilizer gave higher yield. Similarly, Tariq *et al.* (2001) found increment in pod bearing branches and seed yield of mungbean due to application of K, whereas, varietal difference was significant in studied parameters. This paper reports the results of the study conducted to identify the optimum rate of potassium fertilizer application for obtaining comprehensible output.

MATERIALS AND METHODS

A field experiment was conducted to evaluate the growth and yield of mungbean varieties to different K application rates. The experiment was designed with three replications using Randomized Complete Block Design (RCBD) with plot size of 3 × 5m (15 m^2). Five potassium levels (0, 50, 75, 100 and 125 Kg K ha^{-1}) and two mungbean varieties (Mung-06 and NM-92) were included in the study.

Soil analyses

Soil texture was determined through Bouyoucos Hydrometer method (Kanwar and Chopra, 1959), electrical conductivity of saturation extract (Ece dS m^{-1}) was determined with the help of portable conductivity meter (Hana Model-8733, Germany) using the standard reference solution (Rowell, 1994), pH of soil water extract was determined by portable digital pH meter (Orion (ISE) Model-SA-720 USA) using buffers of pH 4.0 and 9.0 as standards (Rowell, 1994), Walkely-Black method was adopted for the determinations of organic matter (%) in soil (Jackson, 1958a), total soil nitrogen (%) was measured through Kjeldahl's method (Jackson, 1958b), AB-DTPA phosphorous (mg kg^{-1}) was determined using Spectrophotometer (Model Specord-200 PC. Analytik Jen, Germany) (Soltanpour and Schwab, 1977) and extractable potassium (mg kg^{-1}) was determined with the help of Flame photometer- Jenway UK Model No. PFP-7 (Soltanpour and Schwab, 1977).

Experimental soil

The texture of the experimental soil was clay loam. The soil had no problem of salinity (EC 0.14 to 0.68 dS m^{-1}), it was slightly alkaline in pH (pH 7.25 to 7.76), calcareous ($CaCO_3$ 9.5%) in nature and deficient in organic matter (0.64 -0.88%), total nitrogen (03-0.06%) and available phosphorus (6.8-9.2 mg kg^{-1}) contents. However, the soil contained 60-110 mg kg^{-1} extractable K. All the cultural operations were carried out before sowing of crop. Along with different potassium levels, the experimental crop was given a uniform dose of nitrogen and phosphorus (75-50 kg NP ha^{-1}). The nitrogen was applied in the form Urea, whereas the phosphorus was applied through Single Super Phosphate (SSP). Muriate of potash (MOP) was used as the source of K. Irrigations through canal water were applied as per crop requirement. The space between rows was 75 cm and plants was 30 cm. All the other cultural practices were followed as per recommended production technology of the crop. Majority of the traits were recorded in the field; except the number of seeds, weight of 100 seeds and per hectare seed yield, which were obtained and calculated after harvesting and threshing of crop.

Statistical analysis

The data obtained from the study were processed and analyzed through ANOVA using MSTATC Software. The mean values were compared through LSD, following by 5% probability level (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The soils are going to be deficient in potassium day by day due to extensive cropping and cultivation of high yielding heavy feeder crop species and varieties. There is no natural source to replenish it. Therefore, soil application of inorganic fertilizer became necessary. Otherwise potassium deficiency in soils will have negative effects on yield and quality of the crop (Mian *et al.,* 1998). This field study was conducted to evaluate the growth and yield response of two mungbean varieties to various K application rates.

Seed germination

The seed germination in variety NM-92 was significantly higher (11.9 m^2) than variety Mung-06; while the crop receiving higher K levels of 125 or 100 kg ha^{-1} resulted in higher seed germination of 13.3 and 12.5 m^2, respectively. The reduction in K levels up to 75 and 50 kg ha^{-1} showed a simultaneous decrease in germination up to 11.50 and 10.50 m^2, respectively. The minimum seed germination (9.5 m^2) was noted in plots where mungbean was kept without K and supplied only with N-P fertilizers (control). The interactive effect of 125 kg K ha^{-1}× variety NM-92 resulted in maximum seed germination (Table 1).

Table 1. Agronomical traits of mungbean varieties as influenced by various potassium levels.

Potassium levels (Kg ha^{-1})	Seed germination (m^2)			Plant height (cm)			Branches (plant^{-1})		
	Mung-06	NM-92	Mean	Mung-06	NM-92	Mean	Mung-06	NM-92	Mean
K_1=(Control)	9.0	10.0	9.5 c	38.0	40.6	39.3 d	10.6	11.4	11.0 b
K_2= 50	10.0	11.0	10.5 b	40.3	43.3	41.8 c	11.3	12.1	11.7 b
K_3=75	11.0	12.0	11.5 b	41.6	44.6	43.1 b	12.2	13.1	12.6 a
K_4=100	12.0	13.0	12.5 a	43.3	46.3	44.8 a	12.8	13.7	13.2 a
K_5=125	13.0	13.6	13.3 a	44.0	47.0	45.5 a	12.6	13.5	13.2 a
Mean	11.0 b	11.9a	-	41.4 b	44.4 a	-	11.9 a	12.7 a	-
LSD 5%	0.7096		1.1219	0.7003		1.1073	0.5972		0.9442

Mean value with same letters do not differ significantly at 0.05 probability level.

Table 2. Yield and yield components of mungbean varieties as influenced by various potassium levels.

Potassium levels (Kg ha^{-1})	Pods (plant^{-1})			Seeds (plant^{-1})			Seed index (1000 seed weight, g)		
	Mung-06	NM-92	Mean	Mung-06	NM-92	Mean	Mung-06	NM-92	Mean
K_1=(Control)	41.4	44.3	42.8 d	230.0	257.6	243.8 e	30.4	33.1	31.8 d
K_2= 50	43.9	47.2	45.6 c	242.6	271.7	257.2 d	30.9	33.7	32.3 c
K_3=75	45.7	48.6	47.0 b	251.6	281.8	266.7 c	33.8	36.9	35.4 b
K_4=100	47.2	50.5	48.8 a	258.0	288.9	273.4 b	37.5	40.9	39.2 a
K_5=125	47.9	51.2	49.6 a	274.0	306.8	290.4 a	37.5	40.9	39.2 a
Mean	45.2b	48.4a	-	251.2b	281.4a	-	34.0b	37.1a	-
LSD 5%	0.7633		1.2069	2.7618		4.3668	0.8353		1.3207

Mean value with same letters do not differ significantly at 0.05 probability level.

Table 3. Yield and yield components of mungbean varieties as influenced by various potassium levels.

Potassium levels (Kg ha^{-1})	Seed yield (kg ha^{-1})			Biological yield (kg ha^{-1})			Harvest index (%)		
	Mung-06	NM-92	Mean	Mung-06	NM-92	Mean	Mung-06	NM-92	Mean
K_1=(Control)	1525.3	1601.6	1563.5d	3744.4	3784.6	3764.5 c	40.3	42.7	41.5 a
K_2= 50	1677.9	1761.8	1719.8 c	4138.7	4212.4	4175.5 b	39.8	42.5	41.2 a
K_3=75	1750.7	1838.2	1794.4 b	4246.7	4275.6	4261.1 b	40.9	43.2	42.1 a
K_4=100	1804.7	1894.9	1849.8 a	4668.3	4795.0	4731.7 a	37.7	40.5	39.1 b
K_5=125	1829.0	1910.9	1869.9 a	4862.10	4790.8	4826.4 a	38.1	39.2	38.7 b
Mean	1717.5b	1801.5a		4332.04	4371.68	-	39.4 b	41.7a	-
LSD 5%	27.995		25.643	96.820		153.09	0.8333		1.3175

Mean value with same letters do not differ significantly at 0.05 probability level.

Plant height (cm)

Results for height of mungbean plants as affected by K levels revealed a statistically significant difference among varieties. The maximum plant height (44.4 cm) was recorded in variety NM-92, while minimum plant height (41.4 cm) was observed in variety Mung-06. The effect of K levels showed that the mungbean plants receiving higher K levels of 125 or 100 kg ha^{-1} grew taller i.e. 45.5 and 44.8 cm, respectively as compared to lower K levels (Table 1). This increase in plant height under higher K levels was mainly associated with adequacy of nutrients in soil after K application. Fatima *et al*. (2001) also reported that the application of potassium fertilizer improves length of stem, branches, pods, seed weight and seed yield.

Branches per plant

The results clearly indicated variation among varieties in terms of producing number of branches per plant. The maximum number of branches per plant (12.79) was recorded in mungbean variety NM-92, while minimum branches per plant (11.9) were noted in variety Mung-06 (Table 1). With the application of K, the plants grew vigorously to produce more branches per plant. However, the LSD test indicates that the differences in branches per plant under 75, 100 and 125 kg K ha^{-1} were statistically non-significant, which suggests that application of 75 and 100 kg K ha^{-1} is an optimum level for mungbean.

Number of pods per plant

The data for pods per plant are presented in Table 2. Results showed that the difference between varieties was clear and significant. Variety NM-92 produced more pods (48.4) than the variety Mung-06. However, some other workers indictaed no difference among genotypes. That was possibly due to difference in genetic makeusp or change in climatic conditions for crop. Maximum number of pods per plant (49.6) was noted when K was applied @ 125 Kg ha^{-1}. Fwewer pods per plant (42.8) were recorded from the plots, which received no potassium fertilizer. Similar results have also been reported by Ali *et al*. (1996) who investigated the effect of different potassium application rates on the yield and quality of mungbean produce and stated that the number of pods per plant as well as number of seeds per pod were significantly influenced by potassium application. The pattern and extent of pulse crop response to K fertilizer depend on yield potential, soil K status, genotype, and supply of critical inputs such as irrigation and other nutrients. The study reported higher K responses in mungbean and postulated that well branched root systems of cereal and oilseed crops might exploit soil K more efficiently than pulse crop root systems. Generally, improved varieties can be expected to be more responsive to K application due to their larger yield potential and K requirement at critical growth stages (Srinivasarao *et al*., 2003).

Number of seeds per plant

The differences among varieties for number of seeds per plant were significant (Table 2). The variety NM-92 produced higher number of seeds per plant (281.4) than Mung-06 (251.2). Number of seeds per plant was also affected significantly by various K levels. Seeds per plant is mungbean crop increased (290.4) with the application of K @ 125 Kg ha^{-1}. The seeds per plant decreased to 266.77 and

257.23 when the mungbean crop was fertilized with K @ 75 and 50 kg ha^{-1}, respectively. The maximum number of seeds per plant (306.8) was recorded in NM-92 fertilized with 125 Kg K ha^{-1}. The minimum number of seeds per plant (230.0) was observed in Mung-06 in control (0.0 Kg K ha^{-1}). It could also be concluded that increase in seeds per plant was mainly associated with increased plant height and branches per plant. The significant increase in number of seeds per plant can possibly be due to the influence of K on the availability and uptake of other essential elements, transportation of photosynthates from source to sink as well as protein synthesis.

Seed index (1000 seed weight)

The seed index value of mungbean varieties under different K levels was examined and the results are shown in Table 2. The results showed that among both varieties, the seed index value was highest (37.1 g) in variety NM-92 and minimum (34.07 g) in variety Mung-06. Whereas, with each increased level of K fertilizer, the seed index of mungbean was concurrently improved. The LSD test suggested that the differences in seed index value between 125 and 100 kg K ha^{-1} were non-significant (P>0.05) and significant in other treatments.

Seed yield (kg ha^{-1})

The highest seed yield (1801.50 kg ha^{-1}) was produced by mungbean variety NM-92, while the lowest seed yield (1717.50 kg ha^{-1}) was produced by variety Mung-06. The seed yield was decreased considerably from 1869.90 and 1849.80 kg ha^{-1} to 1794.40 and 1719.80 kg ha^{-1}, when the mungbean crop was fertilized with 75 and 50 kg K ha^{-1} from 125 and 100 kg K ha^{-1}, respectively (Table 3). Chanda *et al.* (2002) also investigated that the 120 kg K ha^{-1} application increases grain yield. Fadhel (2011) harvested 1.52 t ha^{-1} of mungbean seed with the application of 80 kg K ha^{-1}. These findings are in contradiction to our results (Chavan *et al.* 2012). Rose *et al*. (2008) reported that for achieving the highest grain yield in canola, getting enough potassium application is important at early flowering stage. Nasri *et al.* (2011) studied the effect of potassium on quantity and quality of bean and found that it has an important role in increasing grain yield through its effect on number of pods and number of grains per pod.

Biological yield (kg ha^{-1})

The biological yield was higher (4371.68 kg ha^{-1}) in case of mungbean variety NM-92 as compared to variety Mung-06 (4332.04 kg ha^{-1}). In case of K levels, the biological yield was higher (4826.4 and 4731.7 kg ha^{-1}) in plots receiving higher K levels of 125 and 100 kg ha^{-1}, respectively. The biological yield declined to 4261.1 and 4175.5 kg ha^{-1}, when the mungbean crop was fertilized with 75 and 50 kg K ha^{-1}, respectively. However, the lowest biological yield (3764.50 kg ha^{-1}) was noted in control (without K) plots, where K was not applied (Table 3).

Harvest index (%)

The harvest index was highest in mungbean variety NM-92 (41.7%) and lowest (39.4%) in case of variety Mung-06. The effect of K levels showed that the harvest index was highest (42.12%) in plots receiving K @ 75 kg ha^{-1}, followed by control (without K) and plots given K @ 50 kg ha^{-1} with average harvest index of 41.53 and 41.22%, respectively. The harvest index was relatively lower i.e. 39.15 and 38.74% in plots given K @ 100 and 125 kg ha^{-1}, respectively (Table 3).

CONCLUSION

Almost all the growth and yield traits were markedly affected by K application rates. The K applied at the rate of 125 kg ha^{-1} gave maximum yield, followed by 100 kg K ha^{-1}. The difference between 125 and 100 kg K ha^{-1} for growth and yield was slight and non-significant (P>0.05). Therefore, 100 kg K ha^{-1} can be considered as an economical rate for obtaining maximum seed yield. The varietal effect on various growth and yield components of munbean was statistically significant (P<0.05), where variety NM-92 is ranked 1st.

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(Accepted: February 04, 2015)