Research Article

Growth and Yield Response of Five Elite Grass Pea (*Lathyrus sativus* L.) Genotypes to Varying Levels of Potassium

Umed Ali Laghari[1], Ahmed Naqi Shah[1], Muhammad Nawaz Kandhro[1*], Zia-ul-Hassan[2], Ghulam Murtaza Jamro[2] and Khalid Hussain Talpur[2]

[1]Department of Agronomy; [2]Department of Soil Science, Sindh Agriculture University, Tandojam, Pakistan.

Abstract | Adequate potassium (K) nutrition is known to increase crop yields, including legumes. However, very little is known about the K requirements of crops in Pakistan, especially grass pea (*Lathyrus sativus* L.). We evaluated K requirements of five elite grass pea genotypes in a field experiment. The experiment was organized in factorial block design with three replications. The study involved five commonly grown grass pea genotypes (Sel-B 111, Sel-449, Sel-190, Sel-1785 and Sel-945) and three K doses (0, 10 and 20 kg K ha^{-1}). The results revealed that K nutrition and genotypic variation significantly ($p<0.05$) determined the yield of grass pea. However, their interaction remained non-significant for all the traits of grass pea under study. As expected, the increasing rate of K significantly ($p<0.05$) increased various growth traits and yield of grass pea genotypes. The crop supplied with 20 kg K_2O ha^{-1} produced maximum branches per plant (5.2), pods per plant (32.3), seeds per pod (4.7), seed index (82.7 g) and seed yield (2589 kg ha^{-1}) when compared with 0.0 and 10 kg K_2O ha^{-1}.Interestingly, Sel-449 was the most responsive genotype to K nutrition which resulted in higher branches per plant (5.3), pods per plant (29.7), seeds per pod (4.5), seed index (87.3 g) and seed yield (2504 kg ha^{-1}) as compared to its counterparts. The genotype Sel-1785 was much closer to Sel-449 for its growth and yield traits. We conclude from the results of this study that a dose of 20 kg K_2O ha^{-1} proved to be the most beneficial. Moreover, the grass pea genotype Sel-449 was more responsive to potassium nutrition as compared to other genotypes. Hence, we recommend growing of Sel-449 at 20 kg K_2O ha^{-1} for obtaining maximum yield of grass pea.

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Correspondence | Muhammad Nawaz Kandhro, Department of Agronomy, Sindh Agriculture University, Tandojam, Pakistan; **Eamil:** kandhromn@gmail.com
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Introduction

Pulses are considered as one of the most important sources of vegetable protein for the human life and animals and consumed by people of all ages and all levels. In Pakistan, pulses occupy about 5% area under cultivations. Owing to rapid increase in population and the importance of pulses in human diet and health, the interest for growing pulses is increasing day by day (FAO, 2016). Pea is a highly nutritious crop which is globally grown as a winter crop (Ali et al., 2002), such as in tropics and subtropics including Ethiopia, Burma, Morocco, India, Ecuador, Peru, Columbia and Pakistan (Javaid et al., 2002). Its cultivation ranks fourth after soybean, groundnut and beans (Ashraf et al., 2011) and is known to maintain soil fertility through biological nitrogen fixation along with symbiotic rhizobium prevalent in its root nodules (Negi et al., 2006). Hence, it has been considered a valuable crop in the grass rotations and a biological

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source for nitrogen fixation in soil, nitrogen fixation varies from -100 kg N ha^{-1} (Alam et al., 2010). In Pakistan, grass pea (*Lathyrus sativus* L.) is grown as a leguminous Rabi crop on both the irrigated and non-irrigated land and ranked as third significant grain vegetable (Aslam et al., 2000; Kazmi et al., 2002), containing 20-22% protein with lysine in its different cultivars (Jabeen et al., 1988). Its yield in Pakistan is very low due to improper irrigation, imbalance fertilization, poor weed management, coupled with diseases and insect-pest infestation (Khan et al., 2013). Balanced fertilization especially plays a very significant role in N_2-fixation by legumes (Vasileva et al., 2007). Among various plant nutrients, potassium (K) plays a vital role in the growth and development of pea plants (Ashraf et al., 2011). Modern, high yielding crop varieties require high amount of K (Malik et al., 1989), however, it has been very rarely evaluated in Pakistan. The role of adequate K-nutrition on K deficient soils is now globally recognized for the sustainable production of legumes, *e.g.* K deficiencies are reported to limit the production of common bean (Baijukya and Mzanda, 2015). Adequate K supply, particularly during flowering and pod setting stages (Zahran et al., 1998), not only increases N_2-fixation but it also enhances protein availability in grain legumes (Srinivasarao et al., 2003). Application of 30 kg K ha^{-1} reportedly increased crop yield by 24% compared to no K (Tiwari and Nigam, 1985). The study was conducted to evaluate the influence of K on growth and yield of five elite grass pea genotypes and to determine K requirement for obtaining their maximum seed yield.

Materials and Methods

Field experiment was carried out following factorial (two-factor) randomized complete block design with three replications. The plot size kept for of each experimental unit was 5× 3 m^2. Five grass pea genotypes (Sel-B 111, Sel-449, Sel-190, Sel-1785 and Sel-945) were grown at three K doses (0, 10 and 20 kg K_2O ha^{-1}). All the plots were plowed before the commencement of planting season of peas. Clod crushing was done with the help of rotavator. Irrigation channels were prepared to irrigate each plot independently. Sowing of crop was done on 14th November, 2014 with the help of single row hand-drill at a seed rate of 25 kg ha^{-1}. Spacing was managed to 10 cm between plants and 30 cm between rows. The recommended doses of nitrogen (10 kg ha^{-1}) and phosphorus (20 kg ha^{-1}) were applied in the form of urea (46% N) and DAP (18% N and 46% P_2O_5). The K was applied in the form of muriate of potash (50% K_2O). Full recommended dose of phosphorus, K and ½ of nitrogen (N) was applied at sowing time. The remaining N was applied in two equal splits, *i.e.* at first and second irrigations. First irrigation was applied at 30 days after sowing and 2nd irrigation at 45 days interval. Inter culturing and hoeing continued till crop maturity. The data were collected on branches per plant, pods per plant, seeds per pod, seed index (1000-seed weight, g) and seed yield (kg ha^{-1}). Statistical analysis was performed through computer software Statistix version 8.1 (Statistix, 2006). The differences among treatment means were compared by LSD test at alpha 0.05.

Results and Discussion

Branches per Plant

The number of branches per plant responded significantly ($p<0.05$) different to the increasing dose of potassium, and genotypic variation was obvious. However, their interaction remained non-significant (Table 1). Application of 20 kg K_2O ha^{-1} produced maximum branches per plant (5.2) which were significantly more as compared to number of branches produced where 10 kg K_2O ha^{-1} was given (4.7 per plant) and where no K was applied (4.3 per plant). In an elegant study, Mazed et al. (2015) also reported that K nutrition significantly increased number of branches per plant in mungbean. The variation among grass pea genotypes was observed for producing number of branches per plant in order of Sel-449>Sel-1785>Sel-B111>Sel-190=Sel-945 (Table 1). The number of branches per plant produced by Sel-449 was significantly more (5.3) when compared to Sel-1785 (5.0), Sel-B 111 (4.8), Sel-190 (4.4) and Sel-945 (4.3). Earlier, Sharar et al. (2003) also reported such genotypic variation among various cultivars of masoor for producing number of branches per plant as a result of receiving nitrogen and phosphorus in different combination.

Pods per Plant

Significant differences ($p<0.05$) were noted in pods per plant produced by the grass pea genotypes due to genotypic variation and K nutrition. However, their interaction was non-significant (Table 1). The plots fertilized with K at 20 kg K_2O ha^{-1} produced highest number of pods (32.3 per plant) when compared to the application of 10 or 0 kg K_2O ha^{-1} with 28.2 and 23.6 pods per plant. Biswash et al. (2014) reported

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Table 1: *Branches and pods per plant of grass pea genotypes as affected by genotypic variation and K nutrition*

Genotypes	Branches per plant				Pods per plant			
	K levels (kg K_2O ha^{-1})				K levels (kg K_2O ha^{-1})			
	0	10	20	Mean	0	10	20	Mean
Sel-B 111	4.2	4.8	5.3	4.8 BC	22.9	27.4	30.7	27.0 B
Sel-449	4.7	5.1	6.1	5.3 A	25.0	30.1	34.0	29.7 A
Sel-190	4.3	4.4	4.6	4.4 CD	22.7	27.1	31.8	27.2 B
Sel-1785	4.4	4.9	5.6	5.0 AB	24.1	28.6	32.8	28.5 AB
Sel-945	4.1	4.3	4.3	4.3 D	23.1	27.8	32.1	27.7 B
Mean	**4.3 C**	**4.7 B**	**5.2 A**	--	**23.6 C**	**28.2 B**	**32.3 A**	--
	Potassium (K)	**Genotype (V)**		**K x V**	**Potassium (K)**	**Genotype (V)**		**K x V**
SE ±	0.1724	0.2226		--	0.7375	0.9521		--
$LSD_{0.05}$	0.3532	0.4559		--	1.5107	1.9503		--

Table 2: *Seeds per pod and seed index of grass pea genotypes as affected by genotypic variation and K nutrition*

Genotypes	Seeds per pod				Seed index (g)			
	K levels (kg K_2O ha^{-1})				K levels (kg K_2O ha^{-1})			
	0	10	20	Mean	0	10	20	Mean
Sel-B 111	3.7	4.2	4.6	4.2	72.0	75.0	77.3	74.8 D
Sel-449	4.0	4.4	5.0	4.5	84.0	88.0	90.0	87.3 A
Sel-190	3.4	4.1	4.4	4.0	70.3	74.0	77.3	73.9 D
Sel-1785	3.9	4.2	4.7	4.3	80.7	83.3	85.7	83.2 B
Sel-945	3.8	4.1	4.6	4.2	76.3	80.3	83.0	79.9 C
Mean	**3.8 B**	**4.2 B**	**4.7 A**	--	**76.7 C**	**80.1 B**	**82.7 A**	--
	Potassium (K)	**Genotype (V)**		**K x V**	**Potassium (K)**	**Genotype (V)**		**K x V**
SE ±	0.1700	--		--	1.0293	1.3288		--
$LSD_{0.05}$	0.3482	--		--	2.1084	2.7220		--

a significant influence of K nutrition in producing pod per plant of mung bean. Genotypic variation also played significant role in producing pods per plant (Table 1). However, the impact was meager as compared to one observed in case of number of branches. The highest number of pods (29.7 per plant) was noted in case of Sel-449 as compared to other genotypes. All other genotypes were statistically at par in producing number of pods per plant. The existence of such variation for number of pods per plant among various lentil varieties was also witnessed by early workers (Mohammadjanloo et al., 2009).

Seeds per Pod

Potassium nutrition significantly ($p<0.05$) affected seeds per pod, while genotypic variation, individually or by interacting with K nutrition, did not play any role (Table 2). The application of 20 and 10 kg K_2O ha^{-1} was statistically at par in producing maximum seeds (4.7 and 4.2 per pod) as against 3.8 seeds per pod observed in control where no K was applied. Significant differences in number of seeds per pod due to adequate potassium nutrition have also been reported elsewhere (Amjad et al., 2004; Ashraf et al., 2011). Surprisingly, grass pea genotypes behaved similarly and were statistically at par for the production of seeds per pod. Contrarily, some studies reported significant genotypic variation in different varieties of lentil for production of seeds per pod (Hussain et al., 2002; Sharar et al., 2003).

Seed Index

Potassium nutrition and genotypic variation significantly ($p<0.05$) affected seed index of grass pea genotypes but their interaction was non-significant (Table 2). The application of 20 kg K_2O ha^{-1} produced maximum seeds index (82.7 g) followed by the K application of 10 kg K_2O ha^{-1} with seed index of 80.1 g. Earlier, it has been documented that K nutrition, with a balanced nitrogen and phosphorus supply increased seed index of groundnut (Channaveerswami, 2005), pea (Amjad et al., 2004) and green gram (Rajkhowa et al., 2002). Moreover, the genotype Sel-449 produced maximum seed index (87.3 g) followed by Sel-1785 (83.2 g), Sel-945 (79.9 g), Sel-B111 (74.8 g) and 17-18% higher than genotypes and Sel-190 (73.9 g), respectively. Such genotypic variation has been reported for lentil genotypes (Sharar et al., 2003).

Seed Yield

Potassium nutrition and genotypic variation significantly ($p<0.05$) affected seed yield of grass pea genotypes however their interaction was found non-significant (Table 3). The application of 20 kg K_2O ha^{-1} produced maximum seeds yield (2589 kg ha-1) followed by the K application of 10 kg K_2O ha^{-1} (2303 kg ha^{-1}) as against seed yield (1977 kg ha^{-1}) recorded in control where no K was applied. Significant increase in seed yield due to K application has been reported in mungbean (Biswash et al., 2014; Mazed et al., 2015), pea (Alam et al., 2010; Ashraf et al., 2011), lentil (Mohammadjanloo et al., 2009), groundnut (Channaveerswami, 2005) and green gram (Rajkhowa et al., 2002). Likewise, the genotype Sel-449 and Sel-1785 were statistically at par in producing maximum seed yield (2504 and 2449 kg ha^{-1}, respectively). Genotypes Sel-945, Sel-B 111 and Sel-190 produced respective seed yield of 2286, 2150 and 2058 kg ha^{-1}. Such genotypic variation for seed yield has been reported for lentil genotypes (Hussain et al., 2002; Sharar et al., 2003).

Table 3: *Seed yield of grass pea genotypes as affected by genotypic variation and K nutrition*

Genotypes	K levels (kg K_2O ha^{-1})			
	0	10	20	Mean
Sel-B 111	1947	2183	2320	2150 BC
Sel-449	1788	2732	2992	2504 A
Sel-190	1880	2000	2294	2058 C
Sel-1785	2288	2465	2595	2449 AB
Sel-945	1981	2135	2742	2286 ABC
Mean	**1977 C**	**2303 B**	**2589 A**	--
	Potassium (K)	**Genotype(V)**	**K x V**	
SE ±	136.29	175.96	--	
$LSD_{0.05}$	279.19	360.43	--	

Conclusions

It is concluded from the findings of experimental results that a dose of 20 kg K_2O ha^{-1} is sufficient for better production of grass pea. However, the grass pea genotype Sel-449 was more responsive to potassium nutrition as compared to other genotypes. Therefore, genotype Sel-449 at 20 kg K_2O ha^{-1} is recommended for obtaining maximum yield of grass pea and dose of K_2O ha^{-1} should be increased for other genotypes.

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Authors Contribution

ANS conceived the idea; ANS and UAL planned study; UAL launched experiment and collected data; ANS, MNK and ZH supervised study; UAL, ANS, MNK and ZH analyzed data and interpreted results; UAL, ANS, MNK, ZH, GMJ and KHT prepared initial draft; MNK and ZH finalized the draft, MNK formatted and submitted the manuscript, while MNK and ZH revised its final version.

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