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Response of green gram (*Vigna radiata* L.) to potassium fertilization in coarse textured soils of Southern Haryana, India

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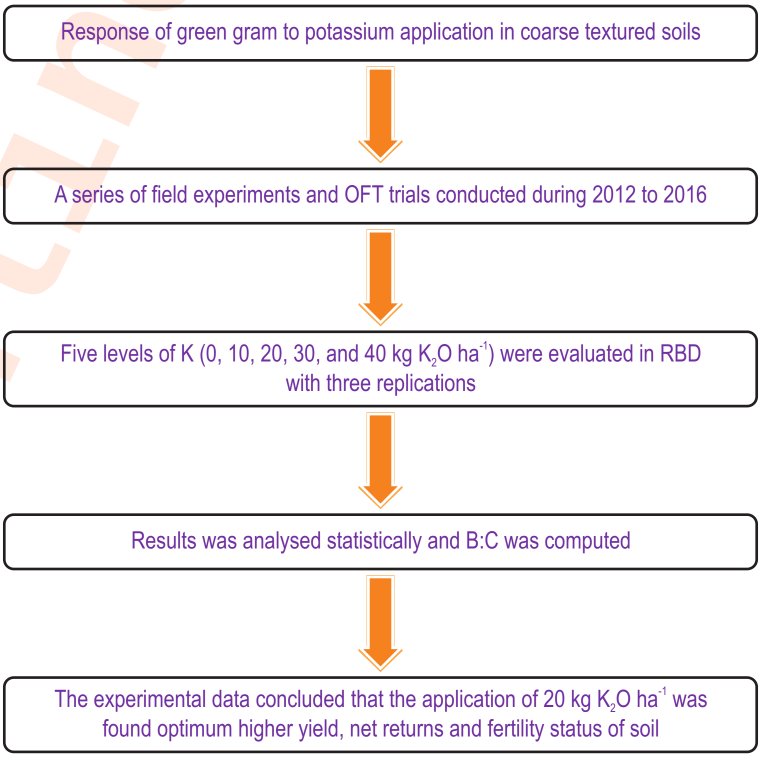
Abstract

Aim: To evaluate the optimum dose and potassium application on K uptake by green gram and its buildup/depletion in soil to overcome the production of pulses in South West part of Haryana.

Methodology: A series of field experiments and on farm trials were conducted during 2012 to 2016 at the Regional Research Station, CCS HAU, Bawal and at the farmers field to study the response of green gram to potassium fertilization in coarse textured medium K status soils of southern Haryana, India. Five levels of potassium (0, 10, 20, 30 and 40 kg K_2O ha^{-1}) were evaluated in randomized block design with three replications.

Results: The results of study revealed that green gram seed yield increased significantly with application of potassium at 20 kg K_2O ha^{-1}. Potassium fertilization also significantly increased total K uptake by green gram at each level of potassium application and helped in preventing the depletion of available soil K and enhanced its content in the soil. The mean K use efficiency varied from 38.30 to 54.15 per cent, being maximum with application of 20 kg K_2O ha^{-1} (54.15 %). The mean economic data analysis revealed that benefit cost ratio also increased with potassium fertilization.

Interpretation: On farm trials conducted on farmers field revealed that application of 20 kg K_2O ha^{-1} in coarse textured low to medium potash status soils is optimum for higher yield, returns and maintenance of available K status in soil.



Key words: Benefit cost ratio, Green gram, On farm trial, Potassium

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Introduction

India is one of the major pulse growing country of the world, accounting roughly one third of total world area under pulse cultivation and one fourth of total world production. Pulses occupy a key position in Indian diet and meet about 30 per cent of the daily protein requirement of human being. Green gram (*Vigna radiata* L.) commonly known as "mung" or "mung bean" is the most important crop of South-East Asia, particularly the Indian sub-continent (Krishan, 1995). It also plays an important role in maintaining and improving soil fertility through its ability to fix atmospheric nitrogen in the soil by root nodules (Raza *et al.,* 2012). Approximately, 5.79 million ha area is cultivated under green gram with annual production of 2.01 million tones and average productivity of 957 kg ha^{-1} (DAC, 2017-18).

Green gram contribution to national economy of India due to its wider adaptability, easy digestibility, better palatability and higher market price (Anjum *et al.,* 2006, Miah *et al.,* 2009 and Reddy *et al.,* 2009). The judicious use of fertilizers is found to be a factor of prime importance and application of major nutrients also affect the growth, development and yield of green gram (Asaduzzaman *et al.,* 2008, Ali *et al.,* 2010 and Singh *et al.,* 2013). The possibility of horizontal expansion or putting more area under cultivation is difficult, since future augmentation in quality have to be harnessed vertically through increase in productivity by judicious use of all input, especially management of nutrients.

Potassium is one of the major essential nutrients for plant growth and have vital role for sustaining high yield agriculture in this modern era. Green gram has higher requirement of potassium which not only improves the crop yield, but also the quality of the crop. Hence, potassium fertilization results in higher value product and better economic return to farmers. It is a prime factor for deciding the market price of green gram grown, which improve the income of farmers just by improving the quality of produce (Krishna, 1995).

Earlier, potassium did not receive much attention in Hrayana because of the general belief that soils have abundant potassium content. In fact, most of the pulse crop removal of potassium often equals or exceeds that of nitrogen. It is, therefore, required to maintain sufficiency in available potash for sustainable pulse production (Tikkoo *et al.,* 2015). The judicious use of potassium is necessary to maintain its proper level in soil. In light of the above, the present study was planned to determine the optimum dose of potassium for growth and yield performance of green gram in coarse textured soils of southern Haryana to get maximum economic returns.

Materials and Methods

The field experiments were conducted at Regional Research Station, CCS Haryana Agricultural University, Bawal, Haryana during *kharif* season of 2012 to 2014. The experimental site was situated at latitude 28.1° N, longitude 76.5° E, and an altitude of 266 m above mean sea-level. The initial experimental soil was loamy sand in texture, alkaline (pH 8.36) in nature having EC 0.19 dS m^{-1}, low in organic carbon 1.95 g kg^{-1} (Walkley and Black, 1965) and available nitrogen (alkaline $KMNO_4$, 110.90 kg ha^{-1}), medium in available phosphorous 10.95 kg ha^{-1} (Olsen *et al.* 1954:) and potassium (NH_4OAc, 169.5 kg ha^{-1}). The climatic zone of the site is characterized by hot summers and cold winters with an average annual rainfall of 604.6, 622.7 and 640.1 mm during the year 2012, 2013 and 2014, respectively.

These treatments were evaluated in randomized block design with four replications on green gram cv. MH-421 during *kharif* season of 2012 to 2014. Five graded levels of potassium *viz.,* 0, 10, 20, 30, and 40 kg K_2O ha^{-1} were applied through muriate of potash before sowing. The recommended dose of nitrogen and phosphorus @ 20 and 40 kg ha^{-1} were applied as di-ammonium phosphate. Seed, straw and soil samples were taken at harvest and analyzed for potassium concentration in seed and straw and available potassium content in soil with flame photometer (Richard, 1954).

On Farm Trials: Based on the results of field experiment conducted at research station on farm trials were conducted during 2015 and 2016 at farmer's field with control and 20 kg K_2O ha^{-1}. The soil of these field trials were sand to loamy sand in texture, alkaline in reaction, low in organic carbon and low to medium in available P and K. Full basal dose of N and P were applied at sowing time as per recommendations. The crop was raised with all the standard package of practices and harvested between September and October. Seed and straw yields were recorded. Soil, seed and straw samples were collected and analyzed for potassium content.

Statistical analyses : The experimental results were analyzed by the method of analysis of variance with the probability ($p= 0.05$) to drive ANOVA as applicable for randomized block design using a statistical software OPSTAT.

Results and Discussion

The perusal of data on grain and straw yield of green gram (Table 1) revealed that on applying potassium @ 20 kg ha^{-1} significantly increased the grain and straw yield of green gram. However, the seed yield of green gram was recorded statistically at par with the application of potassium @ 20, 30 and 40 kg K_2O ha^{-1}. The mean seed yield recorded was 9.88, 10.46,11.49, 11.78 and 12.09 q ha^{-1} whereas the mean straw yield recorded was 11.87, 12.63,13.87, 14.25 and 14.65 q ha^{-1} under the treatment receiving 10, 20, 30 and 40 kg K_2O ha^{-1}, respectively. The percent increment in mean seed yield was 5.87, 16.29, 19.23 and 22.36, while it was 6.40, 16.84, 20.05 and 23.42 in straw yield on applying 10, 20, 30 and 40 kg K_2O ha^{-1}, respectively over control. This might be due to improved nutritional environment in the rhizosphere as well as in the plant system leading to enhanced translocation of nutrients in different plant parts (Ilavarasi *et al.,* 2007; Pandya and Bhatt, 2007).

As potassium application is directly related to growth, roots, plant biomass, seed quality and yield in crops, the results of the present study are in agreement with Ali *et al*., (1996). The highest seed yield (12.09 q ha^{-1}) was obtained from treatment receiving 40 kg K2O ha^{-1} due to the higher pods per plant and number of seeds per pod (Samiullah, 2003).

The perusal of data on K-uptake presented in Table 2 revealed that the higher uptake of K in plant was observed significantly due to application of K fertilizers in graded levels. Potassium uptake increased significantly with the increased levels of K upto 20 kg K_2O ha^{-1}. Potassium uptake by green gram increased from 22.21 to 38.78 kg ha^{-1}, respectively, with increasing levels of potassium from 0 to 40 kg K_2O ha^{-1}. The progressive increase in the supply of potassium to crop resulted in higher availability of this nutrient, resulting in higher biomass yield. The impact of higher uptake of plant nutrients under these treatments reflected in the growth and yield performance of the crop. No definite trend was observed regarding potassium use efficiency, which was recorded highest (54.15 %) with the treatment receiving 20 kg K_2O ha^{-1}. However, the KUE decreased to 46.27 and 41.37 percent under the treatment receiving 30 and 40 kg K_2O ha^{-1}. The increased supply of nutrients and good response by the plants resulted in enhanced translocation of nutrients and build-up of available K content in the soil which improves potassium use efficiency. Similar trends were reported by Geetha and Velayutham (2009) and Hussain *et al*. (2011).

The application of potassium in graded levels significantly influenced the availability of K in soil. The available potassium was recorded significantly higher with the application of 40 kg K_2O ha^{-1} with its respective value of 171.57 kg ha^{-1} over that of control. The initial mean available K status was 169.50 kg K ha^{-1} whereas it was 166.40, 167.25, 169.35, 170.48 and 171.57 kg ha^{-1} at 0, 10, 20, 30 and 40 kg K_2O ha^{-1}, respectively. Increasing levels of potassic fertilizer from 0 to 40 kg K_2O ha^{-1} significantly improved available potassium in soil after harvesting of crop (Table 3). The

Table 1 : Effect of potassium application on seed and straw yield of green gram

Potassium levels (kg ha^{-1})	**Seed yield (q ha^{-1})**				**Straw yield (q ha^{-1})**			
	2012	**2013**	**2014**	**Mean**	**2012**	**2013**	**2014**	**Mean**
K_0	10.51	9.47	9.65	9.88	12.72	11.55	11.35	11.87
K_{10}	11.24	10.10	10.05	10.46	13.60	12.25	12.05	12.63
K_{20}	11.80	11.27	11.42	11.49	14.28	13.65	13.70	13.87
K_{30}	12.04	11.60	11.70	11.78	14.80	13.90	14.05	14.25
K_{40}	12.41	11.88	12.05	12.09	15.26	14.25	14.45	14.65
CD (05)	0.97	0.86	0.89	0.87	1.05	1.02	1.10	1.02

Table 2 : Effect of potassium on total K uptake and available potassium in green gram

Potassium levels (kg ha^{-1})	**Total K uptake (kg ha^{-1})**				**KUE (%)**	**Available K (kg ha^{-1})**			
	2012	**2013**	**2014**	**Mean**		**2012**	**2013**	**2014**	**Mean**
K_0	23.05	22.36	21.22	22.21	-	166.10	166.05	167.05	166.40
K_{10}	28.23	25.63	24.25	26.04	38.30	167.30	167.50	167.25	167.25
K_{20}	34.68	32.75	31.70	33.04	54.15	169.70	169.85	168.50	169.35
K_{30}	35.72	36.55	36.02	36.09	46.27	170.30	170.50	170.65	170.48
K_{40}	36.99	40.08	39.26	38.78	41.37	171.40	171.55	171.75	171.57
CD(P=0.05)	2.15	2.53	3.01	1.50	-	2.72	3.15	3.48	2.92

Table 3 : Effect of potassium application on economic and returns in green gram

Potassium levels (kg ha^{-1})	**Cost of cultivation (Rs. ha^{-1})**	**Gross returns (Rs. ha^{-1})**	**Net returns (Rs. ha^{-1})**	**B:C**	**Additional returns per Rs. invested on K**
K_0	45840	50587	4747	1.10	-
K_{10}	46112	53563	7451	1.16	10.94
K_{20}	46368	58837	12469	1.27	15.63
K_{30}	46640	60325	13685	1.29	12.17
K_{40}	46912	61915	15003	1.32	10.72

highest value of available K was observed with the treatment reviving 40 kg ha^{-1} which is significantly superior over control and treatment receiving 10 kg K_2 ha^{-1}. The application of potassic fertilizers improved the post-harvest buildup of soil available K compared to control in green gram crop. Similar trend for available K in soil was observed by (Kabir *et al.,* 2004) after harvest of crop.

It is evident from the data that gross returns and net returns of green gram increased with increasing levels of K at 10, 20, 30 and 40 kg K_2O ha^{-1}, respectively which might be due to increase in seed and straw yield with increasing potassium levels .The minimum and maximum gross return of Rs. 50587 and Rs. 61915 were recorded with control and application of 40 kg K_2O ha^{-1}, respectively (Table 3). Data also indicated that the total cost of cultivation followed the similar trend. The highest net return (Rs. 15003) was recorded from the potassium application of 40 kg $ha^{-1,}$ while minimum net return obtained with 0 kg K_2O ha^{-1} (Rs 4747) (Vekaria *et al.,* 2013; Kumar *et al.,* 2014).

The mean economic data analysis revealed that benefit cost ratio also increased with application of potassium. Whereas, the additional returns per rupee invested on potassium @10, 20, 30 and 40 kg K_2O ha^{-1} was Rs. 10.94, 15.63, 12.17 and 10.72, respectively. The highest additional return per rupee invested on potassium (15.63) was obtained with application of 20 kg K_2O ha^{-1}, owing to higher seed and grain yield (Table 4).

The results of OFT trials at farmer's field also indicated that application of potassium @ 20 kg K_2O ha^{-1} increased the mean seed yield of green gram by 11.85 per cent over control (Table 4). The analysis of available potassium before sowing and after harvest of green gram revealed that there was a slight depletion and buildup of potash in the soil (Table 5). The mean initial soil available potassium status of the field was 169.50 kg K ha^{-1} whereas after the harvest of green gram, the mean available potassium status was 165.9 and 168.91 kg K ha^{-1} @ 0 and 20 kg K_2O ha^{-1}, respectively.

With the present findings it can be inferred that yield of green gram increased significantly with the application of potassium @ 20 kg K_2O ha^{-1} over control, while it was statistically at par with the application of 30 and 40 K_2O ha^{-1}. The results of on Farm Trials showed that application of 20 kg K_2O ha^{-1} increased the green gram yield over control. This might be due to improved nutritional environment in the rhizosphere as well as in the plant system leading to enhanced translocation of nutrients in plant parts. These results are in close conformity with the findings of (Ali *et al.,* 1996 and Ilavarasi *et al.,* 2007). Potassium application not only enhanced the availability of other nutrient but also increased the photosynthetic activity (Samiullah, 2003) and transportation of photosynthates from source to sink might be the main reason for increase yield of crop (Ali *et al.,* 1996).

It is concluded that based on the results of research trials and OFTs conducted on coarse textured medium K status soil, the application of 20 kg K_2O ha^{-1} was found optimum for green gram in terms of crop yield, maintaining availability of K in soil and highest addition returns per rupee invested on potassium fertilization.

Table 4 : Effect of potassium application on green gram seed yield in OFT trials

Name of farmer/Fathers name	Village	Seed yield (q ha^{-1})	
		K_0	K_{20}
Sh. Rajesh Kumar S/o Sh. Mange Ram	Jholri (Rewari)	10.00	11.25
Sh. Suraj Bhan S/o Sh. Nand Ram	Jholri (Rewari)	9.75	10.63
Sh. Dharmender S/o Sh. Dayanand	Manethi (Rewari)	8.75	10.00
Sh. Sahadi Ram S/o Sh. Mangal Singh	Manethi (Rewari)	8.13	9.13
Sh. Kapil S/o Sh. Pyare Lal	Manethi (Rewari)	8.50	9.50
Mean	9.03	10.10	
Per cent increase in yield	-	11.85	

Table 5 : Effect of potassium application on available potassium in OFT trials

Name of farmer/Father's name	Initial available potassium (kg ha^{-1})	Available potassium at harvest (kg ha^{-1})	
		K_0	K_{20}
Sh. Rajesh Kumar S/o Sh. Mange Ram	164.5	160.6	163.9
Sh. Suraj Bhan S/o Sh. Nandram.	172.4	168.9	172.0
Sh. Dharmender S/o Sh. Dayanand	165.3	162.3	164.9
Sh. Sahadi Ram S/o Sh. Mangal Singh	168.9	164.8	167.8
Sh. Kapil S/o Sh. Pyare Lal	176.4	172.8	176.0
Mean	169.5	165.9	168.9

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References

Ali, M.A., G.Q. Abbas, K. Mohyuddin, G. Ullah, Abbas and Aslam: Response of green gram (*Vigna radiata*) to phosphatic fertilizer under arid climate. *J. Anim. Plant Sci.,* **20,** 83-86 (2010).

Ali, M.A., M.A. Malik, R. Ahmad and T.S. Atif: Response of green gram to potassium fertilizer. *Pak. J. Agri. Sci.,* **33,** 44-45 (1996).

Anjum, M.S, Z.I. Ahmed and C.A. Rauf: Effect of rhizobium inoculation and nitrogen fertilizer on yield and yield components of green gram. *Int. J. Agric. Biol.*, **8**, 238-240 (2006).

Asaduzzaman, M.F., J. Karim, M. Ullah and Hasanuzzaman: Response of green gram (*Vigna radiata* L.) to nitrogen and irrigation management. *Am. Eurasian J. Sci. Res.,* **3**, 40-43 (2008).

Bukhsh, M.A.A.H., R. Ahmad, J. Iqbal, M.M. Maqbool, A. Ali, M. Ishaque and S. Hussain: Nutritional and physiological significance of potassium application in maize hybrid crop production. *Pak. J. Nutr.,* **11**, 187-202 (2012).

Epstein, E.: Mineral Nutrition of Plants: Principles and perspectives. New York: Wiley, USA (1972).

Garg, B.K., U. Burmin and S. Kathju: Physical aspects of drought tolerance in cluster bean and strategies for yield improvement under arid conditions. *J. Arid. Legum.,* **2**, 61-66 (2005).

Geetha, P. and A. Velayutham: Refinement of nutrient management techniques for growth, yield and nutrient uptake of rice fallow black gram. *Madras Agric. J.,* **96**, 163-166 (2009).

Hussain, F., A.U. Malik, M.A. Haji and A.L. Malghani: Growth and yield response of two cultivars of mungbean (*Vigna radiata* L.) to different potassium levels. *J. Ani. Plant Sci.,* **21**, 622-625 (2011).

Ilavarasi, K., S. Anuja, A. Shakila and A. Angayakanni: Effect of phosphorus and potassium application on soil NPK availability, their uptake and pod yield of cowpea. *Adv. Pla. Sci.,* **20**, 205-206 (2007).

Kabir, M.E., M.A. Karim and M.A.K. Azad: Effect of potassium on salinity tolerance of mungbean (*Vigna radiata* L.). *J. Bio. Sci.,* **4***,* 103-110 (2004).

Krishna, S.: Mineral nutrition of plants "Principles and perspectives". *Better Crop.,* **82,** 155-160 (1995).

Kumar, P., P. Kumar, T. Singh, A.K. Singh and R.A. Yadav: Effect of different potassium levels on mungbean under custard apple based agri-horti system. *Afr. J. Agric. Res.,* **9,** 728-734 (2014).

Miah, M.A., K. Anwar, M.P. Begum, M.A.S. Juraimi and M.A. Islam: Influence of sowing date on growth and yield of summer green gram varieties. *J. Agric. Soc. Sci.*, **5,** 73-76 (2009).

Pandya, C.B. and V.R. Bhatt: Effect of different nutrient levels on yield and nutrient content of fodder cowpea. *Legu. Res.,* **30**, 218-220 (2007).

Raza, M.H, G.U. Sadozai, M.S. Baloch, E.A. Khan, I. Din and K. Wasim: Effect of irrigation levels on growth and yield of green gram. *Pak. J. Nutr.,* **11**, 876-879 (2012).

Reddy, A.A.: Pulses production technology "Status and Way Forward". *Eco. Polt. Weekly,* **44,** 73-80 (2009).

Richard, L.A.: Diagnosis and improvement of saline and alkaline soils. USDA Hand Book No. 60 (1954).

Samiullah, Khan N.A.: Physiological investigation on interactive effect of P and K on growth and yield of chickpea. *Indian J. Plant Physiol.*, **8,** 165-170 (2003).

Singh, A.K, M.K. Meena, R.C. Bharati and R.M. Gade: Effect of sulphur and zinc management on yield, nutrient uptake, changes in soil fertility and economics in rice (*Oryza sativa*) –lentil (*Lens culinaris*) cropping system. *Indian J. Agril. Sci.,* **83**, 344-348 (2013).

Tikkoo, A., S.S. Yadav, J.P. Singh and P.K. Yadav: Potassium fertilization in pearl- millet, Cluster bean and Indian mustard crops of Southern Haryana. *Environ. Eco.,* **33,** 1258-1261 (2015).

Olsen, S.R., C.V. Cole, F.S. Watanable and L.A. Dean: Estimation of available phosphorus in soils by extraction with sodium bicarbonate. US Deptt Agric No. 9391954 (1954).

Vekaria, G.B., M.M. Talpada, G.S. Sutaria and K.N. Akbari: Effect of foliar nutrition of potassium nitrate on the growth and yield of green gram. *Legu. Res.,* **36**, 162-164 (2013).

Walkley, A. and C.A. Black: An examination of different methods for determining soil organic matter and a proposed modification of the chromic acid titration method. *Soil Sci.*, **37,** 29 (1965).

Wang, W. and X. Yang: Physiological and genetic characteristics of nutrient efficiency of plants in acid. *Chin. J Soil Sci.,* **35**, 78-83 (2004).