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Response of *Summer* Mungbean [*Vigna radiata* (L.) wilczek] to Foliar Potash Fertilization under Different Moisture Regimes

K. Shivashankar, Adesh Singh, Sanjeev Singh

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ABSTRACT

Background: Scheduling of irrigation is the major factor in producing higher yields of summer crops. Water stress during the sensitive stages will cause significant reduction in yield. Potassium (K+) is reported as an important element in reducing the ill effects of crop water stress. Foliar application of potassium increases the drought tolerance in mungbean. Keeping this in view, a field experiment was conducted to study the response of *summer* mungbean to foliar potassic fertilization under different moisture regimes during 2018 at SVPUAT, Meerut (U.P).

Methods: It included 12 treatment combinations comprised of 2 irrigation schedules (0.6 and 0.4 IW/CPE ratio) and 6 foliar potassium treatments (1% spray of K through KNO_3 and/or KCl at flowering, flowering and pod development stage including control), replicated thrice and were tested under a split-plot design.

Result: The results indicated that, the growth parameters, yield and yield attributes of mungbean were significantly higher under 0.6 IW/CPE ratio as compared to 0.4. The gross returns, net returns and B:C ratio were also found highest with 0.6 IW/CPE ratio. Among the foliar application of potassium treatments, the growth attributes, yield and yield attributes were significantly increased by foliar application of 1% K through KNO_3/KCl at flowering and pod development stage. The foliar application of 1% K through KNO_3 at flowering and pod development stage fetched significantly higher gross returns, net returns and B:C ratio, but remained *on par* with dual spray of 1% K through KCl. The interaction effect between irrigation regimes and potassium foliar levels was non-significant for most of the parameters.

Key words: Foliar spray, *Summer* mungbean, KCl, KNO_3, 0.4, 0.6 IW/CPE ratio.

INTRODUCTION

Pulses are wonderful gift of nature, can be grown on wide range of climatic condition and soils. They are rich in protein and considered as main protein source for vegetarians. Pulses are the second major constituent of Indian diet after cereals. Among the pulses greengram constitutes 24.20% of protein and superior as compared to others (Imran *et al*., 2015). Greengram [*Vigna radiata* (L.) Wilczek] is locally called as mungbean belongs to family fabaceae/ leguminaceae. It is annual in nature, generally short duration and drought resistant crop which can also be grown on low fertile soils. The symbiotic association was seen between roots of mungbean with Rhizobium bacteria and fixes the atmospheric nitrogen (58-109 kg ha^{-1}) into the soil (Ali, 1992). Mungbean is found rich in lysine, making its protein an exceptional supplement to rice in terms of balanced human nutrition (Yadav *et al*., 2009). Among the tools of crop production, irrigation turn out to be the most important factor in the changing global scenario. Day by day the requirement of water during summer months is increasing due to high temperature and higher evapotranspiration needs. Adequate water is required at all growth stages of mungbean, but it is very much susceptible to water stress during flowering and pod filling stage. Shortage of water during these sensitive stages will cause significant reduction in yield. Water stress negatively affects many plant processes including photosynthesis and transpiration (Ohashi *et al*., 2006) *etc*., which also cause substantial reduction in dry matter accumulation (Reddy *et al*., 2004). Scheduling of irrigation is the major factor which plays a key role in producing higher yields of summer crop. Foliar nutrition may be a useful option particularly for the areas where soil application of fertilizers often leads to locking or loss of nutrients. Potassium influences the water economy and crop growth through its effects on water uptake, root growth, maintenance of turgor, transpiration and stomatal regulation. Potassium is one of the macronutrients which plays a major role in plant growth and sustainable crop production. It involves in activation of more than 60 plant enzymes (Bushkh *et al*., 2011). It imparts resistance in plants against diseases and pests attack. It also helps in maintaining the turgor pressure of the cell which

Department of Agronomy, College of Agriculture, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut-250 110, Uttar Pradesh, India.

Corresponding Author: K. Shivashankar, Department of Agronomy, College of Agriculture, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut-250 110, Uttar Pradesh, India. Email: ksshivu98@gmail.com

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is necessary for cell expansion. It also helps in osmo-regulation of plant cell, support in opening and closing mechanism of stomata (Yang *et al*., 2004). Taken as whole, potassium is an enzyme activator, helps in synthesis of starch and protein, helps in metabolism, plays major role in stomatal regulation, also takes part in chlorophyll formation and grain development. Potassium (K+) is reported as an important element in reducing the ill effects of soil water stress. Foliar application of potassium increases the drought tolerance in mungbean plant (Thalooth *et al*., 2006). Application of potassium at the time of flowering showed the beneficial effect on all the growth characters (Beg *et al*., 2013). Hence, relation between potassium and water stress became an important aspect of research in Meerut, (U.P) to avoid adverse effects of higher temperature during summer season. Keeping this in view the following study was formulated to study the “Response of *summer* mungbean to foliar potash fertilization under different moisture regimes”.

MATERIALS AND METHODS

The experiment was conducted at Technology Park, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) during 2018. The soil of the experimental field was well drained, sandy loam in texture and slightly alkaline in reaction (7.73). It was low in organic carbon (0.46%) and available nitrogen (176.3 kg ha^{-1}), medium in available phosphorus (16.4 kg ha^{-1}) and potassium (149.2 kg ha^{-1}). The treatments consisted of 2 levels of irrigation I_1 (0.6 IW/CPE) and I_2 (0.4 IW/CPE ratio) in main plots and six levels of foliar potassium application *viz.*, T_1-control, T_2-1% K by KCl at flowering stage, T_3-1% K by KNO_3 at flowering, T_4-1% K by (KCl + KNO_3) at flowering, T_5- 1% K by KCl at flowering and pod development stage, T_6-1% K by KNO_3 at flowering and pod development stage, were tested in split plot design replicated thrice. Seed rate of 25 kg ha^{-1} of Pant Mung-5 variety was used for sowing. Five cm deep furrows were opened at a row distance of 30 cm with the help of furrow opener, manually. Recommended dose of fertilizer was applied @ 20 kg N ha^{-1} and 40 kg P_2O_5 ha^{-1} to all the treatments. The whole amount of nitrogen and phosphorous were given through DAP (18% N and 46% P_2O_5) and urea (46% N) as basal dose *i.e.* at the time of sowing and foliar potassium fertilizers were given as per treatments to each plot. During crop period, the irrigations were given based on climatological approach, at IW/CPE ratio of 0.6 and 0.4, as per treatments. The evaporation was recorded every day from USWB (United States Weather Bureau) Class A open pan evaporimeter installed at IIFSR, Modipuram. In totality five irrigations were scheduled to the treatment with 0.6 IW/CPE (on 6th April, 22nd April, 2nd May, 19th May and 28th May) and 3 irrigations were scheduled to the treatment with 0.4 IW/CPE ratio (on 16th April, 2nd May and 24th May). The data recorded during the course of investigation were subjected to statistical analysis as per method of analysis of variance.

RESULTS AND DISCUSSION

Effect of irrigation regimes on growth and yield of mungbean

Growth parameters

The data pertaining to growth parameters indicated that plant height, number of leaves, drymatter accumulation plant^{-1} and branches plant^{-1} generally increased with increasing number of irrigations at all the stages of crop growth. Scheduling of irrigation at 0.6 IW/CPE ratio (I_1) recorded significantly taller plants (55.1 cm), higher leaf area index (3.77), Number of leaves plant^{-1} (5.36), Number of branches plant^{-1} (4.88), drymatter accumulation (12.4 g plant^{-1}) at harvest as compared to 0.4 IW/CPE ratio (I_2) (Table 1). This might be due to more availability of moisture and essential nutrients

Table 1: Effect of irrigation schedules and foliar potassium management on growth parameters of mungbean.

Treatment	Growth parameters				
	Plant height (cm)	LAI	No. of Branches plant^{-1}	Drymatter accumulation (g plant^{-1})	No. of trifoliate leaves plant^{-1}
A. Irrigation schedules (IW/CPE)					
I_1 (0.6)	55.1	3.77	4.88	12.4	5.36
I_2 (0.4)	47.7	2.91	3.77	10.6	4.40
S.Em. (±)	0.7	0.08	0.11	0.3	0.15
C.D. (P=0.05)	4.7	0.49	0.74	1.7	0.95
B. Foliar potassium management					
T_1-Water spray	44.4	3.05	3.90	10.0	4.05
T_2-1% K by KCl at flowering	50.4	3.28	4.23	11.1	4.77
T_3-1% K by KNO_3 at flowering	51.6	3.30	4.32	11.3	4.87
T_4-1% K by (KCl+KNO_3) at flowering	52.0	3.35	4.30	11.5	4.95
T_5-1% K by KCl at flowering and pod development	53.9	3.52	4.55	12.4	5.27
T_6-1% K by KNO_3 at flowering and pod development	56.0	3.55	4.65	12.7	5.37
S.Em. (±)	1.3	0.06	0.13	0.4	0.16
C.D. (P=0.05)	4.0	0.19	0.38	1.0	0.47

under frequently irrigated conditions, maintenance of higher water status in plants, which resulted into more absorption of PAR, higher rate of photosynthesis, cell division and cell enlargement that helps in the formation of taller, thicker stem and root system, which ultimately increased the number of branches plant^{-1} and drymatter accumulation. Similar results were also found by Patel *et al*. (2011) and Chaudhary *et al.* (2015) in mungbean.

Yield and yield attributes

Irrigation scheduled at 0.6 IW/CPE ratio (I_1) recorded significantly higher number of pods plant^{-1} (16.8), grains pod^{-1} (8.2), test weight (34.2 g), grain yield plant^{-1} (4.3 g), grain yield (1100 kg ha^{-1}) and straw yield (2381 kg ha^{-1}) over 0.4 IW/CPE ratio (I_2) (Table 2). The probable reason for increase in these yield attributing characters was due to frequent water supply that resulted in increasing uptake of water and nutrients. This helped in keeping larger photosynthetic green surface and provided the longer reproductive phase which in turn improved storage and translocation capacity to attain higher allocation of drymatter in grains. The highest grain and straw yield at 0.6 IW/CPE ratio (I_1) were mainly due to sufficient moisture supply during the entire growth period, increased the soil moisture status which resulted into higher leaf water potential, higher photosynthesis, consequently increased the drymatter production and yield attributes, which ultimately increased grain yield and straw yield of mungbean. Similar observations were also made by Yadav and Singh (2014) and Patel *et al*. (2016) in mungbean.

Table 2: Effect of irrigation schedules and foliar potassium management on yield attributes, yield and harvest index (%) of mungbean.

Treatment	Yield attributes				Yield (kg ha^{-1})		Harvest index (%)
	Pods plant^{-1}	Grains pod^{-1}	Test weight (g)	Grain yield plant^{-1} (g)	Grain	Straw	
A. Irrigation schedules (IW/CPE)							
I_1 (0.6)	16.8	8.2	34.2	4.3	1100	2381	31.5
I_2 (0.4)	15.0	7.3	32.7	3.2	878	2183	28.7
S.Em. (±)	0.2	0.1	0.1	0.2	19	26	0.1
C.D. (P=0.05)	1.4	0.4	0.8	1.0	122	169	0.8
B. Foliar potassium management							
T_1-Water spray	14.4	7.2	33.1	3.1	805	1917	29.2
T_2-1% K by KCl at flowering	15.3	7.5	33.4	3.4	932	2209	29.6
T_3-1% K by KNO_3 at flowering	15.6	7.6	33.5	3.6	957	2246	29.8
T_4-1% K by ($KCl+KNO_3$) at flowering	15.9	7.7	33.4	3.7	990	2299	30.0
T_5-1% K by KCl at flowering and pod development	16.8	8.1	33.7	4.2	1098	2478	30.6
T_6-1% K by KNO_3 at flowering and pod development	17.2	8.3	33.7	4.4	1152	2544	31.1
S.Em. (±)	0.4	0.1	0.9	0.1	35	51	0.7
C.D. (P=0.05)	1.3	0.2	NS	0.4	103	153	NS

Table 3: Effect of irrigation schedules and foliar potassium management on economics (Gross, net returns and B:C ratio), water use efficiency and water productivity of mungbean.

Treatments	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	B:C ratio	Water use efficiency (kg ha-mm^{-1})	Water productivity (kg grains m^{-3} water)
A. Irrigation schedules (IW/CPE)					
I_1 (0.6)	66163	41897	2.73	2.17	1.47
I_2 (0.4)	53135	30398	2.33	1.81	1.70
S.Em. (±)	1069	1069	0.04	0.04	0.03
C.D. (P=0.05)	6503	6503	0.27	0.23	0.17
B. Foliar potassium management					
T_1-Water spray	48628	25344	2.10	1.62	1.28
T_2-1% K by KCl at flowering	56268	32966	2.42	1.88	1.49
T_3-1% K by KNO_3 at flowering	57751	34320	2.45	1.93	1.53
T_4-1% K by ($KCl+KNO_3$) at flowering	59948	36581	2.57	1.99	1.59
T_5-1% K by KCl at flowering and pod development	66262	42578	2.80	2.21	1.76
T_6-1% K by KNO_3 at flowering and pod development	69038	45096	2.87	2.32	1.85
S.Em. (±)	1986	1986	0.09	0.07	0.05
C.D. (P=0.05)	5859	5859	0.25	0.20	0.15

Effect of foliar potassium nutrition on growth and yield of mungbean

Growth parameter

The significantly higher values of growth parameters like plant height (56.0), LAI (3.55), No. of branches plant^{-1} (4.65), Drymatter accumulation (12.7 g plant^{-1}) and no. of leaves plant^{-1} (5.37) were recorded under foliar applied 1% K through KNO_3 at flowering and pod development stage (T_6) and remained on par with 1% K spray through KCl at flowering and pod development stage (T_5) and the lowest was recorded under control treatment (T_1) (Table 1). This might be due to the involvement of potassium in cell division and cell expansion as well as the positive influence of potassium on water and nutrient uptake, thus creating the cell turgor necessary for growth, resulting in higher plant height, LAI, no. of branches and leaves plant^{-1} and higher drymatter accumulation. These results are in close conformity with those of Govind and Thirumurugan (2000) in mungbean, Goud *et al.* (2014) in chickpea and Sanjay (2015) in mungbean.

Yield and yield attributes

The higher values of yield attributes *viz*., namely number of pods plant^{-1} (17.2), number of grains pod^{-1} (8.3), test weight (33.7), grain yield plant^{-1} (4.4), grain yield (1152 kg ha^{-1}) and straw yield (2544 kg ha^{-1}) were recorded with the foliar application of 1% K through KNO_3 at flowering and pod development stage (T_6) followed by 1% K by KCl sprayed at flowering and pod development stage (T_5) than the control (T_1) (Table 2). This increase in number of pods plant^{-1} and number of grains pod^{-1} might be due to the increase in the fruit setting, diversion of energy towards sink followed by efficient transfer of metabolites and subsequent accumulation of these metabolites in the grains, which results in increase in the size and weight of individual grain. The increase in number of pods plant^{-1}, grains pod^{-1} and test weight resulted into higher grain yield plant^{-1}. Increase in yield attributes finally resulted into higher grain and straw yields. These results are in close proximity with the findings of Govindan and Thirumurugan (2000) in mungbean, Beg *et al.* (2013) in black gram and Lakshmi *et al.* (2018) in urdbean.

Effect of irrigation regimes on economics, water use efficiency and water productivity of mungbean

Economics

The irrigation scheduled at 0.6 IW/CPE ratio (I_1) fetched significantly higher gross returns (Rs 66163 ha^{-1}), net returns (Rs 41897 ha^{-1}) and B:C ratio (2.7) as compared to 0.4 IW/CPE ratio (I_2) (Table 3). The higher values of these parameters under 0.6 IW/CPE ratio irrigation schedule were mainly due to higher grain yield and straw yield under 0.6 IW/CPE ratio and only marginal increase in cost of cultivation. Similar results were also reported by Patel *et al.* (2016) in mungbean and Deewan *et al.* (2017) in cluster bean.

Water use efficiency

Significantly higher value of water use efficiency (2.17 kg ha-mm^{-1}) was obtained under I_1 (0.6 IW/CPE) irrigation schedule but significantly higher water productivity was obtained under 0.4 IW/CPE ratio (I_2) (Table 3). Higher moisture availability, increased growth, yield attributes and yield that might be responsible for increased WUE in mungbean under I_1 irrigation schedule (0.6 IW/CPE ratio).

Effect of foliar potassium nutrition on economics, water use efficiency and water productivity of mungbean

Economics

The results revealed that the foliar application of 1% K through KNO_3 at flowering and pod development stage (T_6) incurred higher gross returns (Rs 69,038 ha^{-1}), net returns (Rs 45,096 ha^{-1}) and B:C ratio (2.87) than control (T_1) (Table 3). The higher values of these parameters under T_6 treatment was mainly due to higher grain yield and straw yield and only marginal variation in cost of cultivation. Similar results were also reported by Goud *et al.* (2014) in chickpea.

Water use efficiency

Significantly higher WUE and water productivity were recorded under foliar application of 1% K through KNO_3 at flowering and pod development stage (T_6), followed by 1% K through KCl at flowering and pod development stage (T_5) than control. In general, potassium is considered to be a better osmoticum, which favors maintenance of internal water balance, cell turgidity, inducing drought tolerance and helping in transport of carbohydrates which might be the reason for higher WUE and water productivity (Lugg and Sinclair, 1979). Achitov (1961) suggested that K increased water uptake and improved water use efficiency.

CONCLUSION

From the obtained results, it may be concluded that foliar application of 1% K through KNO_3 or KCl at flowering and pod development stages under 0.6 IW/CPE ratio irrigation schedule gave best results in terms of growth parameters, yield attributes and yield, and also proved to be beneficial for *summer* mungbean in terms of gross returns, net returns and B:C ratio.

REFERENCES

Achitov, M. (1961). Review of Literature on the Interaction between Potash and Water in Plants. In: Potash Review 15th Suite International Potash Institute, Berne, (Switzerland).

Ali, M. (1992). Weeds are a great threat to *kharif* pulses. Indian Farming. 42: 29-30.

Beg, M.Z., Ahmad, S. and Srivastava, D.K. (2013). Foliar application of potassium on urd bean. Indian Journal of Life Science. 2(2): 67-70.

Bukhsh, M.A.A.H.A., Ahmad, R., Malik, A.U., Hussain, S. and Ishaque, M. (2011). Profitability of three maize hybrids as influenced by varying plant density and potassium application. Journal of Animal and Plant Science. 21(1): 42-47.

Chaudhary, A.N., Vihol, K.J., Chaudhary, J.H., Mor, V.B. and Desai, L.J. (2015). Influence of spacing and scheduling of irrigation on growth, yield, yield attributes and economics of *summer* greengram (*Vigna radiata* L.). Ecology, Environment Conservation. 21(December Suppl.): S357-S361.

Deewan, P., Regar, K.L., Jajoriya, M., Meena, M. and Verma, R. (2017). Influence of irrigation scheduling (IW/CPE ratios) and plant growth regulators on quality, yield and economics of *summer* clusterbean (*Cyamopsis tetragonoloba* L.) under middle Gujarat conditions. International Journal of Chemical Studies. 5(5): 467-471.

Goud, V.V., Konde, N.M., Mohod, P.V. and Kharche, V.K. (2014). Response of chickpea to potassium fertilization on yield, quality, soil fertility and economics in vertisols. Legume Research. 37(3): 311-315.

Govindan, K. and Thirumurugan, V. (2000). Response of greengram to foliar nutrition of potassium. Journal of Maharashtra Agricultural Universities. 25: 302-303.

Imran, Hussain, I., Khattak, I., Rrehman, A.U., Ahamd, F., Zada, H. and Naveed, S. (2015). Roots nodulation, yield and yield contributing parameters of mungbean cultivars as influenced by different Phosphorous level in Swat-Pakistan. Pure and Applied Biology. 4: 557-567.

Lakshmi, K.V., Sree, S.P., Lakshmi, N.V., Vani, P.M. and Chandrasekhar, K. (2018). Effects of irrigation and foliar nutrition on growth, yield and nutrient uptake of blackgram (*Vigna mungo* L.). International Journal of Current Microbiology and Applied Sciences. 7(6): 2425-2432.

Lugg, D.G. and Sinclair, T.R. (1979). Variation in stomatal density with leaf position in field grown soybean. Crop Science. 19: 407-409.

Ohashi, Y., Nakayama, N., Saneoka, H. and Fujita, K. (2006). Effects of drought stress on photosynthetic gas exchange, chlorophyll fluorescence and stem diameter of soybean plants. Journal of Biology Plant. 50: 138-141.

Patel, A.P., Patel, D.B., Chaudhary, M.M., Parmar, P.N. and Patel, H.K. (2016). Influence of irrigation scheduling based on IW: CPE ratio and levels of sulphur on growth and yield of *rabi* greengram [*Vigna radiata* (L.) Mills]. Journal of Pure and Applied Microbiology. 10(1): 1-5.

Patel, D.M., Shah, K.A. and Sadhu, A.C. (2011). Response of *summer* clusterbean [*Cyamopsis tetragonoloba* (L.) Taub.] to irrigation scheduling and integrated nutrient management. International Journal of Forestry and Crop Improvement. 2(1): 8-11.

Reddy, A.R., Chaitanya, K.V. and Vivekanandan, M. (2004). Drought induced responses of photosynthesis and antioxidant metabolism in higher plants. Journal of Plant Physiology. 161: 1189-1202.

Sanjay, S.S. (2015). Response of *summer* greengram to potash levels and foliar nutrition. Thesis submitted to the Mahatma Phule Krishi Vidyapeeth Rahuri, Maharashtra. 71.

Thalooth, A.T., Tawfik, M.M. and Mohamed, H.M. (2006). A comparative study on the effect of foliar application of zinc, potassium and magnesium on growth, yield and some chemical constituents of mungbean plants grown under water stress conditions. World Journal of Agricultural Sciences. 2(1): 37-46.

Yadav, N., Sarika, M.A., Iquebal and Akram, M. (2009). In-silico analysis and homology modelling of coat-protein of mungbean YMV. Journal of Food Legumes. 24(2): 138-141.

Yadav, S. and Singh, B.N. (2014). Effect of irrigation schedules and planting methods on growth, productivity and WUE of greengram (*Phaseolus radiata* L.) under rice-wheat-greengram cropping system. Plant Archives. 14: 211-13.

Yang, X.E., Wang, W.M. and He, Z.L. (2004). Physiological and genetic characteristics of nutrient efficiency of plants in acid soils. 78-83.