Biological Forum – An International Journal **13(1): 92-97(2021)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Impact of Potassium and Sulphur Levels on Pearl millet (*Pennisetum glaucum* L.)

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(Received 12 December 2020, Accepted 01 March, 2021)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: The field experiment was conducted during *Kharif* 2020 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P.). The soil of trial plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low organic carbon (0.36%), medium availability N (171.48 kg ha^{-1}), lower availability P (15.2 kg ha^{-1}) and medium availability K (232.5 kg ha^{-1}). The research was laid out in Randomized Block Design (RBD) which consist of ten treatments which are replicated thrice to Study the different levels of potassium and sulphur on growth and yield of Pearl millet. The results showed that higher plant height (150.43 cm), maximum number of leaves per plant (9.13) and highest dry weight per plant (19.55 g) were obtained significantly with the application of 50 kg ha^{-1} of K+20 kg ha^{-1} of S as compared to all other treatments. The higher grain yield (3.97 t/ha) and stover yield (7.68 t/ha) and were significantly recorded with the application of 50 kg ha^{-1} of potassium +20 kg ha^{-1} of sulphur as compared to all other treatments. The higher grain yield (3.97 t/ha) and stover yield (7.68 t/ha) and were significantly recorded with the application of 50 kg ha^{-1} of potassium + 20 kg ha^{-1} of sulphur over the rest of treatments. Therefore, application of potassium 50 kg ha^{-1} + sulphur 20 kg ha^{-1} was best among all other treatments.

Keywords: Pearl millet, Potassium, Sulphur, yield.

INTRODUCTION

Pearl millet is the fifth most important cereal crop in the world after rice, wheat, maize and sorghum. It is widely grown in rainfed cereal crop in the arid and semi-arid regions of Africa and Southern Asia, and can be grown in areas where rainfall is not enough (200 ta 600 mm/yr) for cultivation of maize and sorghum (Reddy *et al.,* 2016). In India Pearl millet occupies 4th position among cereals crops next to rice, wheat and sorghum. Pearl millet may be an alternative crop that exhibits excessive valuable in physiological characteristics when compared to other cereals as it is resistant to drought, low fertility, high salinity and high temperature tolerance (Chaudhary *et al.,* 2014). It is nutritionally better than many cereals as it is a good basis of protein (12.6%), minerals particularly iron (2.8%) and fat (5%). It is high fibre (1.2 g/100 g) and α-amylase activity when compared with other grains. Pearl millet is gluten free and retains its alkaline properties after being cooked which is ideal for gluten allergic people. It is rich source of vitamins like thiamine, riboflavin, niacin and minerals (2.3 mg/ 100 g) like potassium, phosphorus, magnesium, iron, zinc, copper and manganese. It is a rich source of unsaturated fatty acids (75%). It has tall percentage of slowly digestible starch (SDS) and resistant starch (RS) contributing to low glycemic index (GI) which is required for transforming diets and food habits (Choudhary *et al.,* 2019).

Pearl millet occupies 6.93 million ha with the production of 8.61 million tonnes and the productivity of 1243 ka/ha (Anonymous, 2018-19). Rajasthan occupied 42.49 lakh ha area with the total production of 50.59 lakh tonnes and average productivity of 1190 kg ha^{-1} (Anonymous, 2019-20). Potassium is one of the chief plant nutrients for the growth and development of plants. In pearl millet potassium plays vital role in enzyme activities, water and energy metabolism, translocation of assimilates photosynthesis, protein and starch synthesis (Mengel *et al.,* 1996). Potassium involves in water uptake and efficiency and also impart resistant against drought, pest and diseases of pearl millet (Chaudhary *et al.,* 2014). Huge percentage of entire K in soil is unreachable to plants as it happens as physical component of soil minerals. Plants can use only the transferrable K found on the surface of soil particles and K dissolved in soil water and this often constitutes the small fraction of whole soil K. The dynamics of K in soils depends on the magnitude of equilibrium among several forms and thus, information on supply of K fractions in soil demonstrates to the finest approach in understanding and handling of the applied K fertilizers (Jat *et al.,* 2014).

Sulphur performs important functions in pearl millet. It is the best known for its role in the synthesis of proteins, oils and vitamins in pearl millet. Sulphur is associated with the production of crops for superior nutritional and market quality produce (Chaudhary *et al.,* 2014).

Sulphur has to play in increasing chlorophyll formation and aiding photosynthesis in pearl millet (Pandey *et al.,* 2018). Under U.P. condition of soil was deficient in micro and macro nutrient which reduce the yield. For more positive results adding of potassium and sulphur to increase the yield. Keeping this point in view the present experiment to find out 'Impact of potassium and sulphur levels on pearl millet' was conducted.

MATERIALS AND METHODS

The experiment was conducted during the *Kharif* season 2020, at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P.) which is located at 25°39″42″ N latitude, 81°67″56″ E longitude and 98 m altitude above the mean sea level (MSL). Pearl millet hybrid "NBH 5767" was planted at 45 cm × 15 cm spacing. The experiment consisting of ten treatments, in which are T_1: Potassium (K) 25 kg ha^{-1} + Sulphur (S) 10 kg ha^{-1}, T_2: Potassium (K) 25 kg ha^{-1} + Sulphur (S) 20 kg ha^{-1}, T_3: Potassium (K) 25 kg ha^{-1} + Sulphur (S) 40 kg ha^{-1}, T_4: Potassium (K) 45 kg ha^{-1} + Sulphur (S) 10 kg ha^{-1}, T_5: Potassium (K) 45 kg ha^{-1} + Sulphur (S) 20 kg ha^{-1}, T_6: Potassium (K) 45 kg ha^{-1} + Sulphur (S) 40 kg ha^{-1}, T_7: Potassium (K) 50 kg ha^{-1} + Sulphur (S) 10 kg ha^{-1}, T_8: Potassium (K) 50 kg ha^{-1} + Sulphur (S) 20 kg ha^{-1}, T_9: Potassium (K) 50 kg ha^{-1} + Sulphur (S) 40 kg ha^{-1} and T_{10}: Farmers practice 80:40:40 N:P:K kg ha^{-1} which is known as control were tried in Randomized Block Design replicated thrice to Study the different levels of potassium and sulphur on growth and yield of Pearl millet. The soil of investigational plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.36%), medium available N (171.48 kg ha^{-1}), lower available P **(**15.2 kg ha^{-1}) and medium available K (232.5 kg ha^{-1}). The nutrient sources used in research plot were Urea, DAP and MoP to fulfil the requirements of nitrogen, phosphorus and potassium. The recommended dose of 80 kg ha^{-1} nitrogen, 40 kg ha^{-1} phosphorus was applied according to the treatment details. Half dose nitrogen, whole dose of phosphorus, potassium and sulphur was applied as a basal dose at the time of sowing. The remaining dose of nitrogen was applied as top dressed at 30 DAS and 60 DAS depending upon the occurrence of rains. Irrigation was based on the necessity and as per the time of sowing. Gap filling was done at 7-10 DAS whereas thinning was done at 15 DAS to maintain the plant population according to treatment in order to attain recommended plant population for proper growth and yield of crop. First, all border plants were harvested and then the net plot area of each treatment was harvested by cutting of plants closely to the ground.

Fig. 1. Secondary tillage of land with tractor drawn cultivator at CRF (Crop Research Farm) SHUATS, Prayagraj, *Kharif* 2020.

Fig. 2. Making of bunds by the labour in the part of layout preparation at CRF (Crop Research Farm) SHUATS, Prayagraj, *Kharif* 2020.

Fig. 3. Making of furrows for seed dropping, Weeding and Thinning at 20 DAS 5 & Inspection of field by Dr. Umesha C. (Advisor).

Harvesting done at their physiological maturity. After harvesting plants were bundled and allowed for sun drying for 2-3 days. After complete drying threshing, winnowing and cleaning for separation of grains. Two weeding's done manual with Khurpi at 20 DAS and 40 DAS. The growth parameters *viz.,* plant height (20 DAS, 40 DAS, 60 DAS, 80 DAS, at harvest) dry weight per plant (20 DAS, 40 DAS, 60 DAS, 80 DAS at harvest), crop growth rate (20-40 DAS, 40-60 DAS, 60-80 DAS, 80 DAS-at harvest) and relative growth rate (20-40 DAS, 40-60 DAS, 60-80 DAS, 80 DAS-at harvest) were recorded at different growth intervals. The yield parameters grains yield, stover yield were recorded. The data were statistically analysed using analysis of variance (ANOVA) as applicable to Randomized Block Design (Gomez and Gomez 2010).

RESULTS AND DISCUSSION

A. Impact of potassium and sulphur on plant height of pearl millet

Data presented in Table 1, tabulated with parameter plant height (cm) of pearl millet and there was increasing in crop age plant height was progressively increased with the advancement of the experimentation. The plant height was significantly higher in all different growth intervals with the levels of potassium (K) and sulphur (S). Plant height at 20 DAS (18.61 cm), 40 DAS (73.60 cm), 60 DAS (112.67 cm), 80 DAS (136.71 cm) and at harvest, maximum plant height (150.43 cm) was recorded with the application of potassium (K) 50 kg ha^{-1} + sulphur (S) 20 kg ha^{-1} which was significantly superior over all other treatments. The probable reason for increases plant height might due to the potassium in that application plays crucial role in meristematic growth through its effects on the synthesis of Phytoharmones, among various plant harmones, cytokinin plays an important role in growth of the plant. Similar, results observed by Yadav *et al.,* (2012) and Chauhan *et al.,* (2017). Sulphur plays an important role in bio synthesis of Indole 3 acetic acid, these increase in growth attributes reported by Singh *et al.,* (2014). Beneficial effect of sulphur on various metabolic activities and also because of its important role in cell division. Therefore, an increase in plant height due to application of sulphur was also observed by Degra *et al.,* (2008).

B. Impact of potassium and sulphur on dry weight (g/plant) of pearl millet

Data pertaining to dry weight (g/plant) in the Table 1 and there was dry weight had consecutively increased from 20 DAS to at harvest. Dry weight at 20DAS (1.81 g) 40DAS (5.94 g), 60 DAS (12.33 g), 80 DAS (18.44 g) and at harvest, maximum dry weight (19.55 g/plant) was recorded with the application of potassium (K) 50 kg ha^{-1} + sulphur (S) 20 kg ha^{-1}. At harvest, application of potassium (K) 45 kg ha^{-1} + sulphur (S) 40 kg ha^{-1} and potassium (K) 50 kg ha^{-1} + sulphur (S) 20 kg ha^{-1} which were statistically at to the application of potassium (K) 50 kg ha^{-1} + sulphur (S) 20 kg ha^{-1}. The probable reason for increase in dry weight might due to the potassium in that application plays a crucial role in meristematic growth through its effect on the synthesis of phytoharmones. Similar results reported by Chauhan *et al.,* (2017). Sulphur in that application plays plant metabolic activity, which may lead to the increase in photosynthesis. The similar results were observed by Lunde *et al.,* (2008).

C. Impact of potassium and sulphur on CGR and RGR of pearl millet

Data presented in Table 2, Fig. 1 and Fig. 2, tabulated the crop growth rate (CGR) and relative growth rate (RGR) was recorded at different growth intervals and found to be non-significant. At 80 DAS-at harvest, the height crop growth rate (1.32 g/m^2/day) was recorded with the application of potassium (K) 25 kg ha^{-1} + sulphur (S) 40 kg ha^{-1} and potassium (K) 45 kg ha^{-1} + sulphur (S) 10 kg ha^{-1}. At 80 DAS-at harvest, the height relative growth rate (0.005 g/g/day) was recorded with the application of potassium (K) 25 kg ha^{-1} + sulphur (S) 20 kg ha^{-1}, potassium (K) 25 kg ha^{-1} + sulphur (S) 40 kg ha^{-1}, potassium (K) 45 kg ha^{-1} + sulphur (S) 10 kg ha^{-1} and potassium (K) 45 kg ha^{-1} + sulphur (S) 20 kg ha^{-1}.

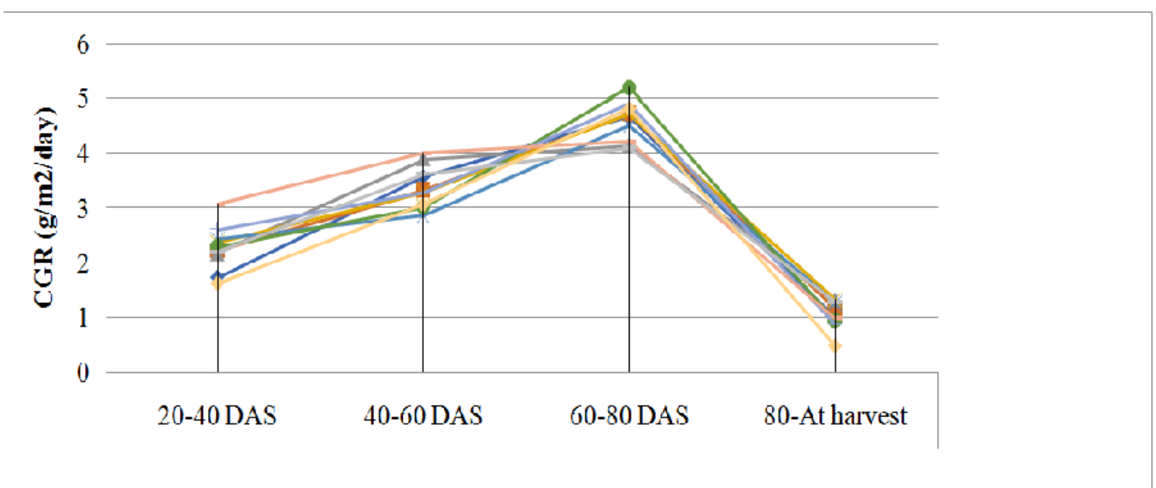

Fig. 1. Impact of potassium and sulphur on CGR of pearl millet.

Table 1: Impact of potassium and sulphur levels on growth parameters of pearl millet at harvest.

S. No.	Treatments	Plant height (cm)					Dry weight (g/plant)				
		20 DAS	40 DAS	60 DAS	80 DAS	At harvest	20 DAS	40 DAS	60 DAS	80 DAS	At harvest
1.	25 kg ha^{-1} K + 10 kg ha^{-1} S	14.09	56.87	88.05	121.64	131.57	1.25	3.58	8.95	15.24	16.58
2.	25 kg ha^{-1} K + 20 kg ha^{-1} S	14.76	61.13	94.53	125.41	134.67	1.27	4.27	9.01	15.37	16.96
3.	25 kg ha^{-1} K + 40 kg ha^{-1} S	15.93	67.53	93.94	128.59	138.40	1.43	4.36	10.43	16.01	17.79
4.	45 kg ha^{-1} K + 10 kg ha^{-1} S	15.19	66.53	96.89	127.91	137.44	1.36	4.56	9.63	15.99	17.77
5.	45 kg ha^{-1} K + 20 kg ha^{-1} S	16.12	66.20	100.98	130.81	139.59	1.34	4.61	9.29	15.35	17.05
6.	45 kg ha^{-1} K + 40 kg ha^{-1} S	18.11	72.67	108.24	134.76	145.28	1.63	4.71	9.99	17.01	18.27
7.	50 kg ha^{-1} K + 10 kg ha^{-1} S	17.27	72.00	105.65	133.19	141.89	1.61	5.13	10.11	16.72	17.91
8.	50 kg ha^{-1} K + 20 kg ha^{-1} S	18.61	73.60	112.67	136.71	150.43	1.81	5.94	12.33	18.44	19.55
9.	50 kg ha^{-1} K + 40 kg ha^{-1} S	16.17	71.00	100.63	131.49	140.72	1.81	4.77	11.01	16.53	18.02
10.	Control	12.71	52.41	77.74	111.75	123.11	1.18	3.37	7.83	14.32	14.91
	SEm (±)	0.83	2.57	4.02	1.89	1.16	0.10	0.17	0.64	0.58	0.54
	CD (5%)	2.45	7.64	11.93	5.61	3.45	0.28	-	-	-	1.60

Table 2: Impact of potassium and sulphur on crop growth rate (CGR) and relative growth rate (RGR) of pearl millet.

S. No.	Treatments	CGR ($g/day/m^2$)				RGR (g/g/day)			
		20-40 DAS	40-60 DAS	60-80 DAS	80-At harvest	20-40 DAS	40-60 DAS	60-80 DAS	80-At harvest
1.	25 kg ha^{-1} K + 10 kg ha^{-1} S	1.73	3.56	4.66	1.00	0.05	0.05	0.03	0.005
2.	25 kg ha^{-1} K + 20 kg ha^{-1} S	2.22	3.32	4.71	1.17	0.05	0.04	0.03	0.005
3.	25 kg ha^{-1} K + 40 kg ha^{-1} S	2.17	3.89	4.13	1.32	0.06	0.04	0.02	0.005
4.	45 kg ha^{-1} K + 10 kg ha^{-1} S	2.37	3.28	4.71	1.32	0.06	0.04	0.03	0.005
5.	45 kg ha^{-1} K + 20 kg ha^{-1} S	2.43	2.86	4.49	1.26	0.06	0.04	0.03	0.005
6.	45 kg ha^{-1} K + 40 kg ha^{-1} S	2.28	3.01	5.20	0.93	0.05	0.04	0.03	0.004
7.	50 kg ha^{-1} K + 10 kg ha^{-1} S	2.61	3.29	4.90	0.88	0.06	0.03	0.03	0.004
8.	50 kg ha^{-1} K + 20 kg ha^{-1} S	3.06	4.00	4.21	0.97	0.06	0.04	0.02	0.004
9.	50 kg ha^{-1} K + 40 kg ha^{-1} S	2.20	3.62	4.09	1.28	0.05	0.04	0.02	0.004
10.	Control	1.62	3.06	4.81	0.48	0.05	0.04	0.03	0.004
	SEm (±)	0.15	0.73	0.70	0.23	0.01	0.01	0.01	0.001
	CD (5%)	-	-	-	-	-	-	-	-

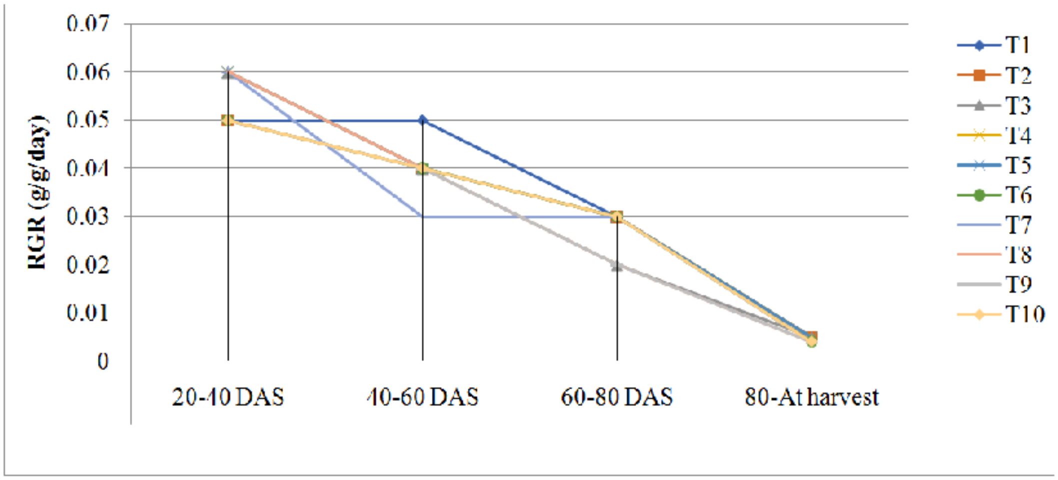

Fig. 2. Impact of potassium and sulphur levels on RGR of pearl millet.

D. Impact of potassium and sulphur on Yield of pearl millet

The data pertaining to yield are presented in Table 3, the higher grain yield (3.97 t/ha) and stover yield (7.68 t/ha) was recorded significantly with the application of potassium (K) 50 kg ha^{-1} + sulphur (S) 20 kg ha^{-1} compared to all other treatments. In yield parameters *viz.*, grain yield and stover yield, however the applications of potassium (K) 45 kg ha^{-1} + sulphur (S) 20 kg ha^{-1}, potassium (K) 45 kg ha^{-1} + sulphur (S) 40 kg ha^{-1}, potassium (K) 50 kg ha^{-1} + sulphur (S) 10 kg ha^{-1}, potassium (K) 50 kg ha^{-1} + sulphur (S) 10 kg ha^{-1} which are statistically at par to the application of potassium (K) 50 kg ha^{-1} + sulphur (S) 20 kg ha^{-1}. The higher grain yield and stover yield could be due to potassium in that application stimulates the cumulative effect improvement in yield attributes *viz.*, ear head length, number of grains/ear head, test weight and enhances the development of strong cell walls and therefore stiffer straw which might be resulted into profuse tillering (Kacha *et al.*, 2011) and increased availability, absorption and translocation of K nutrient (Jat *et al.*, 2014). Sulphur accelerated nutrient uptake which helped the plants to put optimum growth. Similar, results observed by Yadav and Nand (2004).

Table 3: Impact of Potassium and Sulphur levels on yield of Pearl millet.

S. No.	Treatments	Grain yield (t/ha)	Stover yield (t/ha)
1.	25 kg ha^{-1} K + 10 kg ha^{-1} S	2.88	6.61
2.	25 kg ha^{-1} K + 20 kg ha^{-1} S	6.82	6.82
3.	25 kg ha^{-1} K + 40 kg ha^{-1} S	6.96	6.96
4.	45 kg ha^{-1} K + 10 kg ha^{-1} S	6.71	6.71
5.	45 kg ha^{-1} K + 20 kg ha^{-1} S	7.39	7.39
6.	45 kg ha^{-1} K + 40 kg ha^{-1} S	7.52	7.52
7.	50 kg ha^{-1} K + 10 kg ha^{-1} S	7.43	7.43
8.	50 kg ha^{-1} K + 20 kg ha^{-1} S	7.68	7.68
9.	50 kg ha^{-1} K + 40 kg ha^{-1} S	7.40	7.40
10.	Control	6.32	6.32
	Sem (±)	0.13	0.25
	CD (5%)	0.40	0.45

CONCLUSION

Study suggests that to achieve maximum plant height (150.3 cm), dry weight/plant (19.55 g), grain yield (3.97 t/ha) and stover yield (7.68 t/ha) was significantly recorded with the application of potassium (K) 50 kg ha^{-1} + sulphur (S) 20 kg ha^{-1}. Hence, the application of Potassium (K) 50 kg ha^{-1} + Sulphur (S) 20 kg ha^{-1} is beneficial for pearl millet production under eastern Uttar Pradesh condition.

ACKNOWLEDGEMENT

The authors are thankful to Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj – 211007, Uttar Pradesh, India for providing use necessary facilities to undertake the studies.

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How to cite this article: Reddy, Kunduru Manikanteswara, Umesha, C. and Meshram, M.R. (2021). Impact of Potassium and Sulphur levels on Pearl millet (*Pennisetum glaucum* L.). *Biological Forum – An International Journal*, **13**(1): 92-97.