Annals of Plant and Soil Research 22(1): 96-99 (2020)

Sulphur fertilization for enhancing the productivity of pearl millet (*Penniretum glaucum*) and soil fertility in alluvial soil

RANJEET SINGH, U.N. SINGH[2], TAHIR MOHD. CHAUHAN[3] AND VINAY SINGH

Department of Agricultural Chemistry and Soil Sceience, Raja Balwant Singh College, Bichpuri, Agra (U.P.)-283105

Received: November, 2019; Revised accepted: January, 2020

ABSTRACT

A field experiment was conducted at Sandhan village of Agra district (U.P.) during kharif season of 2017 and 2018 to study the effect of sulphur fertilization on growth and yield of pearl millet (Pennisetum glaucum L. RBR emend Stunt) and soil fertility in an alluvial soil. Five levels of S (0, 10, 20, 30 and 40 kg ha^{-1}) were evaluated in randomized block design with four replications. The results revealed that the plant height, yield attributes (ears/m^2, length and width of ear and test weight), grain and stover yields of pearl millet were significantly improved with the increase in the levels of sulphur and maximum grain (3.97t ha^{-1}) and stover (9.37t ha^{-1}) yields were recorded with 30 kg S ha^{-1}. Application of 30 kg S ha^{-1} resulted in 34.5% higher grain and 30.0% stover yield than the yield obtained in the control (2.95 and 7.20t ha^{-1}). However, the grain yield obtained with 30 kg S ha^{-1} was statistically at par with 20 kg S ha^{-1}. Sulphur application significantly increased the content and yield of protein in pearl millet crop over control and maximum values were recorded with 30 kg S ha^{-1}. The maximum uptake of N, P, K by pearl millet crop was recorded with 30 kg S ha^{-1}. While significantly highest uptake of S was recorded with 40 kg S ha^{-1}. Application of 40 kg S ha^{-1} significantly recorded the highest content of organic carbon, available nitrogen, phosphorus and potassium in soil compared to other levels of S. However these values were at par with 20 kg S ha^{-1}. In respect of available S, significantly highest content was obtained with 40 kg S ha^{-1}.

Keywords: Pearl millet, nutrient uptake, soil fertility, sulphur yield.

INTRODUCTION

Pearl millet (*Pennisetum glaucum* (L) R B Remend Stuntz) is the fourth most important cereal and widely grown in India because of its tolerance to drought high temperature and soil fertility. The productivity of this crop is very low mainly because of its cultivation on marginal land under reduced rate of fertilizer. Among the several constraints, improper nutritional management is an important impediment for increasing the productivity of pearl millet. A cereal crop like pearl millet has a high sulphur (Singh *et al.* 2014) requirement due to its many functions in plant growth. There is stagnation in productivity of pearl millet because sulphur deficiency is very common in alluvial soils of Agra (Singh 2015). Sulphur deficiency in crop plants has been recognized as a limiting factor not only for crop production but also for poor quality of products, because sulphur is aconstituent of several essential compounds such as cysteine, methionine, cystine, coenzymes thioredoxine and sulfolipids etc. It has role to play in increasing chlorophyll formation and aiding photosynthesis. So far, inadequate information is available regarding the effect of sulphur on pearl millet in Agra condition. This study was therefore, conducted to evaluate the effect of sulphur fertilization on yield and nutrient uptake in pearl millet.

MATERALS AND METHODS

A field experiment was conducted on sandy loam soil at Sandhan village of Agra district (U.P.) with pearl millet for two consecutive kharif season of 2017 and 2018. The soil of the experimental field had pH 7.8, organic carbon 2.9 g kg^{-1}, available N 155 kg ha^{-1}, available P 8 kg ha^{-1}, available K 110 kg ha^{-1} and available S 8.8 kg ha^{-1}. The experiment was laid out in randomized block design with four replications. The treatments consisted of five levels of sulphur (0, 10, 20, 30 and 40 kg ha^{-1}). A basal dose of 80 kg N, 40 kg P_2O_5 and 40 kg K_2O ha^{-1} was applied at the time of sowing through urea, diannonium phosphate and muriate of potash, respectively. Sulphur was applied at the time of final land preparation through elemental sulphur, well matured pearl millet plants were harvested and yield data were

[2]*Department of Agricultural Statistics, R.B.S.College, Bichpuri, Agra*
[3]*Guest Lecturer, Faculty of Agriculture, Aligarh Muslim University, Aligarh*

recorded. Dried grain and stover samples were digesred in di-acid mixture and the aliquots were used for analysis of phosphorus content by vanadomolybdate yellow colour method (Jackson 1973), potassium by flame photometer and sulphur content by turbidimetric method (Chesnin and Yien 1951). Nitrogen content in grain and stover was determined by modified Kjeldahl method (Jeckson 1973). The nutrient uptake was calculated by multiplying the concentration values with respective grain and stover yield data. Soil samples were collected after harvest of the crop and analysed for organic carbon (Walkley and Black, 1934), available N by alkaline permanganate method (Subbiah and Asija, 1956), available P (Olsen *et al.* 1954), available K by neutral normal ammonium acetate (Hanway and Heidel, 1952) and 0.15% calcium chloride extractable S (Chesnin and Yien, 1951). The data generated for both the growing seasons were pooled and statistically analyzed (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Yield attributes and yield

All the growth and yield attributes were affected significantly with the different levels of S (Table 1). The significantly taller plants (192 cm), higher number of ears (23.9 m^{-2}), length of ear (16.6 cm), width (8.8 cm) and test weight (10.1 g) were recorded at 30 kg S ha^{-1}. However, application of 30 kg S ha^{-1} was statistically at par with 20 kg S ha^{-1}. The increase in plant height may be due to involvement of S in biosynthesis of indole-3-acetic acid. The maximum values of yield attributes with sulphur application may be attributed to increased growth of plants with S application which later on get converted in to reproductive phase (Singh *et al.* 2014). Grain and stover yield of pearl millet increased significantly with sulphur application (Table 1). Significantly highest grain and stover yield was recorded with 30 kg S ha^{-1} which was found at par with 20 kg S ha^{-1}. The increases in grain and stover yield with 30 kg S ha^{-1} over control were 34.5 and 30.0 per cent, respectively. This increase in yield might be due to better availability of available nutrients which ultimately led to effective assimilate partitioning of photosynthates from source to sink in post flowering stage and resulted in higher grain and stover yield. Singh *et al.* (2016) also reported similar results.

Quality

Increasing levels of S significantly increased the protein content in pearl millet grain from 9.13 to 10.18% with 30 kg S ha^{-1}.The increase in protein content owing to S addition might be attributed to its involvement in amino acid synthesis. Singh *et al.* (2014) and Singh and Pandey (2018) also reported an increase in protein content in pearl millet with S application. Corresponding application of sulphur also had significantly beneficial effect on protein yield of pearl millet grain over control. Protein yield increased from 274.6 at control to 376.6 kg ha^{-1} with 30 kg S ha^{-1}. Protein yield is the function of protein content and grain yield. Since variation in protein content has genetic and biochemical limitation, the protein yield is more influenced by grain yield and thus followed almost trend similar to grain yield. Similar results were reported by Singh *et al.* (2014).

Table 1: Effect of sulphur levels on growth yield attributes and yield of pearl millet (mean of 2 years)

Sulphur (kg ha^{-1})	Plant height (cm)	Length of ear (cm)	Ears (m^2)	Width ear (cm)	Protein	Test weight (g)	Yield (t ha^{-1})	
							Grain	Stover
0	181	14.3	19.6	8.2	9.31	9.3	2.95	7.20
10	185	15.0	21.0	8.5	9.68	9.7	3.10	7.65
20	192	16.0	23.9	8.8	10.00	10.1	3.75	8.38
30	194	17.0	24.3	9.0	10.18	10.4	3.97	9.37
40	189	16.6	23.6	8.6	10.12	10.0	3.70	8.75
SEm±	0.59	0.15	0.19	0.07	0.044	0.10	0.08	0.22
CD (P=0.05)	2.02	0.51	0.65	0.24	0.150	0.35	0.28	0.59

Nutrient uptake

Application of sulphur significantly increased the uptake of N by pearl millet crop over the control (Table 2). It was observed that the uptake of N by grain and stover of pearl millet showed a significant increase up to 30 kg S ha^{-1}. The increase in N uptake might be attributed to the efficient utilization of N through the well developed root system with a concomitant increase in yield and concentration of N in pearl millet grain and straw due to application of sulphur. Similar result was observed by Pandey *et al.* (2018) in pearl millet.

Table2: Effect of sulphur fertilization on the uptake of nutrients (kg ha^{-1}) by pearl millet (mean of 2 years)

Sulphur (kg ha^{-1})	Nitrogen		Phosphorus		Potassium		Sulphur	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
0	42.4	30.2	5.3	6.5	16.2	140.4	5.0	7.9
10	48.0	32.9	5.9	7.6	17.4	149.9	5.9	9.2
20	60.0	37.7	7.9	10.0	21.4	165.9	7.5	11.7
30	64.7	44.0	9.1	12.2	22.6	186.4	8.7	14.0
40	59.9	41.1	8.9	13.1	20.7	173.2	8.5	14.9
SEm±	1.58	0.94	0.06	0.11	0.42	1.94	0.14	0.24
CD (P=0.05)	4.25	2.66	0.17	0.31	1.15	5.52	0.40	0.68

The phosphorus uptake by pearl millet grain and straw tended to increase with sulphur application over control. This increase is apparently the result of favourable effect of S on P absorption coupled with greater pearl millet grain and stover production. Similar results were reported by Chauhan *et al.* (2017) and Pandey *et al.* (2018). The addition of S also increased K uptake by grain and stover from 16.2 to 22.6 kg ha^{-1} and 140.4 to 186.4 kg ha^{-1} as the dose of S was increased from 0 to 30 kg ha^{-1}. Higher uptake of K might be due to higher grain and stover yield (Pandey *et al.* 2018). It is explicit from the data (Table 2) that application of 40 kg S ha^{-1} recorded significantly highest uptake of sulphur by the crop over other treatments. This might be attributed to increased sulphur availability from applied sulphur with a concomitant increase in S concentration and grain and stover yield of pearl millet. Results corroborate the findings of Singh *et al.* (2016) and Singh and Pandey (2018).

Table 3: Effect of sulphur levels on fertility status of soil (mean of 2 years)

Sulphur (kg ha^{-1})	pH (1: 2.5)	Org. Carbon (g kg^{-1})	Available nutrients (kg ha^{-1})			
			Nitrogen	Phosphorus	Potassium	Sulphur
0	8.0	2.9	137	8.0	98	8.5
10	8.0	2.3	142	8.4	100	10.6
20	7.9	2.5	148	9.6	103	13.0
30	7.9	2.8	151	10.0	106	15.0
40	7.8	2.9	152	10.0	106	17.5
SEm±	0.11	0.08	1.00	0.09	0.81	0.58
CD (P=0.05)	NS	0.29	3.45	0.31	2.77	2.01

Soil fertility

Application of graded doses of S had a negative effect on soil pH and minimum value (pH 7.8) was recorded with 40 kg S ha^{-1}. Application of S significantly increased organic carbon content over control. This increase might be due to addition of S and NPK fertilizer resulting in improvement in root and shoot growth and thus higher production of biomass might have increased the organic carbon content.The significant increase in available N content was recorded with 30 kg S ha^{-1}. However, maximum amount was recorded under 40 kg S ha^{-1}. This increase may be attributed to stimulating activity of microorganism leading to mineralization of N at increased organic carbon. Similar trend was also observed in case of available P. The highest available P was observed with 30 kg S ha^{-1} but it was significantly at par with 20 kg S ha^{-1}. This increase in available P may be attributed to solubilization of native source and mobilizing soil P in available form and thus available P increased. Available K content increased significantly with S application over control. Available S increased significantly with increasing levels of S and maximum value (17.5 kg ha^{-1}) was recorded with 40 kg S ha^{-1}. Application of 40 kg S ha^{-1} resulted in an improvement of 9 kg S ha^{-1} over control while it was depleted under control. This improvement may be attributed to relatively less absorption of S by crop than its supply while depletion may be due to removal of S from soil by the crop. Singh *et al.* (2016) also reported similar results.

REFERENCES

Chauhan, T.M., Lakhan, R. and Singh, V. (2017) Effect of potassium and sulphur on yield of and nutrient uptake by pearl millet (*Pennisetum glaucum*) in alluvial soil. *Annals of Plant and Soil Research* **19** (4): 434-435.

Chesnin, L. and Yien, C.H. (1951) Turbidimetric determination of available sulphate.*Soil Science Society of America Proceeding***15**: 149-151.

Hanway, J.J. and Heidel, H. (1952) Soil analysis methods as used in Iowa State College, Soil Testing Laboratory, Iowa State College Bulletin **57**: 1-131.

Jackson, M.L. (1973) *Soil chemical Analysis* Prentice Hall of India Private Limited, New Delhi.

Olsen, S.R., Cole, C.V., Watanabe, F.,S. and Dean, L.A. (1954) Estimation of available phosphorus by extraction with sodium bicarbonate. United States Department of Agriculture circular **939.**

Pandey,M.,Abidi, A.B. and Singh, R.P. (2018) Effect of sulphur and phosphorus on yield and quality of pearl millet (*Pennisetum glaucum*). *Annals of Plant and Soil Research***20** (3): 272-275.

Singh, H.,Kumar, B., Sharma, R.K., Sharma, G.K.. and Gautam, R.K. (2014) Direct and residual effect of sulphur in pearl millet-wheat crop sequence. *Annals of Plant and Soil Research* **16** (3): 257-260.

Singh, S. (2015) Forms of sulphur in relation to soil properties under pearl millet cultivation in soils of Agra, Uttar Pradesh. *Annals of Plant and Soil Research* **17** (4): 362-365.

Singh, S., Singh, J.P., Khan, M.H., Pal, A.K. and Kumar, S. (2016) Effect of sulphur on yield, nutrient uptake and economics of pearl millet (*Pennisetum glaucum*) and lentil (*Lens culinaris*) grown in sequence on an alluvial soil. *Indian Journal of Agricultural Sciences* **86** (12): 1581-1585.

Singh, V. and Pandey, M. (2018) Direct effect of sulphur and zinc on productivity, quality and nutrient uptake by pearl millet (*Pennisetum glaucum*) and residual effect on succeeding wheat (*Triticum aestivum*) in pearl millet-wheat crop sequence. *Annals of Plant and Soil Research***20** (3): 233-238.

Walkley, A. and Black, L.A. (1934) An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic and titration method. Soil Science **37**: 29-38.