

Influence of Sulphur and Zinc on Growth and Yield of Pearl millet. (*Pennisetum glaucum* L.)

ABSTRACT

A field experiment was conducted during *Zaid* season of 2022 at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) India. To study the Response of Sulphur and zinc on growth and yield of Pearl millet. The treatments consist of Sulphur 20, 30, 40 kg/ha and zinc 5, 10, 15 kg/ha. There were 9 treatments each replicated thrice.

The soil of experimental plot was sandy loamy in texture, nearly neutral in soil reaction (pH 7.8), low in organic carbon (0.35%) available N (163.42 kg/ha), available P (21.96 kg/ha) and available K (256.48 kg/ha). Results revealed that the higher plant height (198.06 cm), plant dry weight (75.83 g/plant), crop growth rate (47.70 g/m²/day), ear head length (25.2 cm), grains/ear head (2006.0), test weight (8.57 gm), higher grain yield (40.95 q/ha) and higher straw yield (40.95 q/ha) were significantly influenced with application of Sulphur 40 kg/ha + Zinc 15 kg/ha. Higher gross returns (INR 92145.00/ha), higher net returns (INR 62365.00/ha) and higher B:C ratio (2.09) were also recorded in treatment-9 (Sulphur 40 kg/ha + Zinc 15 kg/ha).

Keywords: Pearl millet, Sulphur, zinc, growth parameters and yield attributes.

INTRODUCTION

Pearl millet is commonly known in India as *Bajr* or *Bajra*. Pearl millet (*Pennisetum glaucum* L.) is also known as 'bullrush millet', originated in tropical western Africa, where the greatest number of both wild ancestors and cultivated forms occur. It belongs to family Gramineae (Poaceae). Pearl millet is a staple diet of rural population and also an important fodder crop in arid and semi-arid regions of India. The realized productivity of pearl millet is below its potential. The main reasons of poor crop yield are low moisture availability to crop during growing season and lack of proper nutrient management (Choudhary *et al.* 2016). The food grain demand of

India will increase to about 291m ton by 2025 and to 377 m ton by 2050(Amarasingheetal.,2010).Since,thereislimitedscopetoincreasethenetcultivatedarea

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(142millionha),theimprovedperunitareaproductivitycouldtriggeroverallincreaseinfoodgrainp
roduction(**Reddyetal.,2022**).Pearlmilletisaheavynutrientfeederandleadstolargewithdrawal of
plant nutrients from soil. This depletion will result in decline in yield of thecrop.

Among various nutrients, sulphur and zinc play a crucial role in pearl millet
production(**VinaySinghetal.,2015**).Sulphurperformsimportantfunctionsinpearlmillet.Itistheb
estknown for its role in the synthesis of proteins, oils and vitamins in pearl millet. Sulphur
isassociated with the production of crops for superior nutritional and market quality
produce(**Chaudhary et al., 2014**). Sulphur plays an important role in formation of S-
containingamino-acids, which act as building blocks in the synthesis of proteins. it has to
play inincreasing chlorophyll formation and aiding photosynthesis in pearl millet (**Pandey
et al.,2018**).

Zinc plays a key role as a structural constituent or regulatory cofactors of wide range
ofdifferent enzymes and protein in many important biochemical pathways. These are
mainlyconcerned with carbohydrate metabolism, both in the conversion of sugars to starch,
proteinmetabolism, auxin (growth regulator) metabolism, pollen formation the maintenance
of theintegrity of biological membranes, the resistance to infection by certain pathogens.
Zincdeficiencyisacommonphenomenonincereals,particularincoarsetreatment,soilsemi-
aridregions. Balanced fertilization is the key to achieve higher productivity and nutrient
useefficiency (**Vinay Singhetal., 2015**).

Keeping these points in view, the present investigation entitled “**Effect of
SulphurandZinconGrowthandYieldofpearlmillet(*PennisetumglaucumL.*)**”wasconducte
dduringZaid-2022, atcrop researchfarm,SHUATS,Prayagraj (U.P).

MATERIALSANDMETHODS

AfieldexperimentwasconducteddduringZaidseasonof2021-

22attheCropResearchFarm,Department of Agronomy, Naini Agricultural Institute, Sam
Higginbottom University
ofAgricultureTechnologyandSciences(SHUATS),Prayagraj(U.P.)India.Thesoilofexperiment
alplotwassandyloamyintexture,nearlyneutralinsoilreaction(pH7.8),lowinorganic carbon
(0.35%), The treatments consist of Sulphur 20 kg/ha + zinc 5 kg/ha,
Sulphur20kg/ha+zinc10kg/ha,Sulphur20kg/ha+zinc15kg/ha,Sulphur30kg/ha+zinc5kg/ha,Su
lphur30kg/ha+zinc10kg/ha,Sulphur30kg/ha+zinc15kg/ha,Sulphur40kg/ha+
zinc5kg/ha,Sulphur40kg/ha+zinc10kg/ha,Sulphur40kg/ha+zinc15kg/ha.Theexperiment

was laid out in Randomized Block Design, with 9 treatments replicated thrice. The observations were recorded for plant height, plant dry weight, Crop Growth Rate ($\text{g/m}^2/\text{day}$), Relative Growth Rate (g/g/day), Ear head length (cm), Grains/ear head (g), Test weight (g), Grain yield (kg/ha) and Stover yield (kg/ha). The data were subjected to statistical analysis by analysis of variance method (Gomez and Gomez, 1976).

RESULT AND DISCUSSION

GROWTH PARAMETERS

Plant height (cm)- At 80 DAS, the significantly higher plant height (198.06 cm) [Table-1] was observed in treatment-9 (Sulphur 40 kg/ha + Zinc 15 kg/ha). However, treatment-8 (Sulphur 40 kg/ha + zinc 10 kg/ha) was found to be statistically at par with treatment-9 (Sulphur 40 kg/ha + Zinc 15 kg/ha). The significantly higher plant height was observed with the application of Sulphur 40 kg/ha. This increase may be due to the involvement of Sulphur in the bio-synthesis of Indole 3 acetic acid. And also, Sulphur plays an important role in growth and development of crops. It plays an important role in the formation of S-containing amino acids like cysteine (27% S), Cysteine (26% S), methionine (21% S), which act as building blocks in the synthesis of proteins. Similar results were found out by Chauhan *et al.*, (2017). Further increase of plant height might be due to the application of zinc 15 kg/ha, due to the role of zinc as a "catalyst" in most physiological, metabolic, and tryptophan synthesis processes. Certain protein elements are required to produce growth hormones (auxins) including IAA. There were similar findings described by Reddy *et al.* (2022).

Plant dry weight (g/plant) - At 80 DAS, the significantly higher plant dry weight (75.83 g/plant) [Table-1] was observed in treatment-9 (Sulphur 40 kg/ha + Zinc 15 kg/ha). However, treatment-8 (Sulphur 40 kg/ha + zinc 10 kg/ha) was found to be statistically at par with treatment-9 (Sulphur 40 kg/ha + Zinc 15 kg/ha). The significantly higher plant dry weight (75.83 g) was observed with the application of Sulphur 40 kg/ha. It has a role in play in increasing chlorophyll formation and aiding photosynthesis. Sulphur plays a role in the activation of enzymes, nucleic acids and forms parts of biotin and thiamine. Further increase in the dry weight might be due to the application of zinc at 15 kg/ha. Zinc is essential for promoting certain metabolic reactions. It is necessary for the production of chlorophyll and carbohydrates. Zinc is directly or indirectly required by several enzymes, auxin and protein synthesis. The nutrients applied in one crop are not fully utilized which leads to their residual effect on

succeeding crop. Similar results conformity with **kaushal and vinay(2021)**.

Crop growth rate (g/m²/day) - At 60-80 DAS, the significantly higher crop growth rate (47.70g/m²/day) [Table-1] was observed in treatment-9 (Sulphur 40kg/ha + Zinc 15 kg/ha) However, treatment-8 (Sulphur 40 kg/ha + zinc 10 kg/ha) was found to be statistically at par with treatment- 9 (Sulphur 40 kg/ha + Zinc 15 kg/ha). the significantly higher crop growth rate was observed with the Sulphur application 40kg/ha, may be due to the increase in plant height with an increase in Sulphur level might be due to the beneficial effect of Sulphur on the various metabolic activities and also because of its important role in cell division, photosynthetic process and formation of chlorophyll in the leaf. Therefore, it shows positive reaction on crop growth rate. Similar results in accordance with **Dadhichand Gupta (2003)**.

YIELD ATTRIBUTES

Ear head length (cm) - The significant and higher ear head length (25.2 cm) [Table-2] was observed in treatment-9 with (Sulphur 40 kg/ha + Zinc 15 kg/ha), which was significantly superior over rest of the treatments. However, treatment-8 (Sulphur 40kg/ha + Zinc 10 kg/ha), was found to be statistically at par with treatment-9 (Sulphur 40kg/ha + Zinc 15 kg/ha). The significant and higher ear head length was observed with the application of zinc 15 kg/ha. Zn are involved in cell division, enzyme activation and with their increased supply, their availability, acquisition, mobilization and influx into the plant tissue increased and thus improved growth attributes and yield components. Similar results in accordance with **vinay and mamta(2018)**.

No. of Grains/ear head - The significant and higher Grains/ear head (2006.0) [Table-2] was observed in treatment-9 with (Sulphur 40 kg/ha + Zinc 15 kg/ha), which was significantly superior over rest of the treatments. However, treatment-8 (Sulphur 40kg/ha + Zinc 10 kg/ha), was found to be statistically at par with treatment-9 (Sulphur 40kg/ha + Zinc 15kg/ha). The significant and higher Grains/ear head was observed might be due to Sulphur application. Because Sulphur is a part of amino acid (Cystine) which helps in chlorophyll formation, photosynthetic process, activation of enzymes and seed formation. Similar results were observed by **Degraet al. (2008)**.

Test Weight - The significantly higher Test weight (8.57 gm) [Table-2] was observed in treatment-9 with (Sulphur 40kg/ha + Zinc 15kg/ha) treatments. However,

treatment-8 (Sulphur 40 kg/ha + Zinc 10 kg/ha), was found to be statistically at par with treatment-9 (Sulphur 40 kg/ha + Zinc 15 kg/ha). The significant and higher test weight was recorded with the application of Zinc (15kg/ha), might be due to the application of zinc might have increased the photosynthetic efficiency due to improved enzymatic activity and thus might have increased thousand grains weight. similar results are in conformity with the findings of **Arshad et al. (2016)**.

Grain yield - The significantly Maximum Grain yield (40.95 q/ha) [Table-2] was observed in treatment-9 with (Sulphur 40 kg/ha + Zinc 15 kg/ha), which was significantly superior over rest of the treatments. However, treatment-8 (Sulphur 40 kg/ha + Zinc 10 kg/ha), was found to be statistically at par with treatment-9 (Sulphur 40 kg/ha + Zinc 15 kg/ha). The significant and higher Grain yield was observed with increasing the Sulphur application level. And also, it 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**). Further, with the application of Zinc (15 kg/ha), might be due to the greater photosynthesis efficiency or more nutrients availability due to increasing decomposition rate of organic matter or improved individual plant performance might be the possible reasons for higher grain yield in zinc applied plots compared to other plots. These results are in conformity with the findings of **Arshad et al. (2016)**, **Norwood (1992)** and **Jan et al. (2013)**.

Stover yield - The significantly Maximum stover yield (65.33 q/ha) [Table-2] was observed in treatment-9 with (Sulphur 40 kg/ha + Zinc 15 kg/ha), which was significantly superior over rest of the treatments. However, treatment-8 (Sulphur 40 kg/ha + Zinc 10 kg/ha), was found to be statistically at par with treatment-9 (Sulphur 40 kg/ha + Zinc 15 kg/ha). The significant and higher stover yield was observed by the application of Sulphur 40 kg/ha. Sulphur plays a vital role in proving vegetative structure for nutrient absorption, increasing sink strength through development of reproductive structures by production of assimilates to fill economically important sink (**CHOUDHARY et al., 2016**). Further increase of stover yield may be due to application of zinc 15 kg/ha. Zinc is critical to the growth and development of tryptophan, a necessary amino acid for plant growth and development. Similar results were in conformity with **Reddy et al. (2022)**.

CONCLUSION

It was concluded that with the application of Sulphur 40 kg/ha along with the zinc 15 kg/ha (Treatment-9), has performs positively and improves growth and yield parameters. Maximum grain yield, gross returns, net returns and benefit cost ratio were also recorded with application of Sulphur 40 kg/ha along with the zinc 15 kg/ha (Treatment-9). These findings are based on one season therefore; further trials may be required for further confirmation.

REFERENCES

- Amarasinghe UA, Shah T, Singh OP (2010). Changing consumption patterns: Implications on food and water demand in India, International Water Management Institute, Colombo, Sri Lanka. *IWMIResearchReport.*;119:43.
- Anonymous(2011). Area and production of pearl millet in India. Agricultural Statistics, Directorate of Economics & Statistics, Govt. of India.
- Arshad, Muhammad & Adnan, Muhammad & Ahmed, Sher & Khan, Abdul & Ali, Irshad & Ali, Muhammad & Ali, Azaz & Khan, Azam & Kamal, Muhammad & Gul, Farhana & Khan, Muhammad. (2016). Integrated Effect of Phosphorus and Zinc on Wheat Crop. *American-Eurasian J. Agric. & Environ. Sci.*, **16**:455-459.
- Chaudhary, N.N., Khaif, H.R., Raj, A.D., Yadav, V. and Yadav, P. (2014). Effect of nutrients (K and S) on growth, yield and economics of pearl millet [*Pennisetum glaucum* (L.)]. *International Journal of Forestry and Crop Improvements*, **5**(1):9-12.
- Dadhich, L. K. and Gupta, A. K. (2003). Productivity and economics of pearl millet fodder as influenced by sulphur, zinc and planting pattern. *Forage Research*. **28**(4):207-209.
- Gomez, K.A., Gomez, A. A., (1976) Three or more factor experiment. (In:) *Statistical Procedure for Agricultural Research 2nd ed.*, 1976, pp.139-141.
- Kaushal and Vinay(2021). Effect of sulphur and zinc management on yield, quality and nutrient uptake in pearl millet (*Pennisetum glaucum*) – lentil (*Lens culinaris*) crop sequence. *Annals of Plant and Soil Research* **23**(2):135-139.
- Mukesh C., K.S. Rana, D.S. Rana and R.S. Bana (2016). Tillage and crop residue effects in rainfed pearl millet (*Pennisetum glaucum*) in conjunction with sulphur fertilization under pearl millet – Indian mustard. *Indian Journal of Agronomy* **61** (1):1519.

Pandey, M., Abidi, A. B. and Singh, R. P. (2010). Effect of sulphur and phosphorus on yield and quality of pearl millet (*Pennisetum glaucum* L.). *Annals of Plant and Soil Research*, **20**(3):272-275.

Chauhan T. M., Ram Lakhan and Vinay Singh (2017). Effect of potassium and sulphur on yield and nutrient uptake by pearl millet (*Pennisetum glaucum*) in alluvial soil. *Annals of Plant and Soil Research* **19**(4):434-437.

Vangala S, Rajesh and Chandu (2022). Effect of phosphorus and zinc on growth and yield of pearl millet (*Pennisetum glaucum* L.). *The Pharma Innovation Journal*; **11**(4):542-545.

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

Vinay, Harvendra, Seema, Javed and Jagpal (2015). Balanced use of nutrients for sustaining higher production of pearl millet in alluvial soil. *Annals of Plant and Soil Research* **17**(4):346-349.

Table-1.Effectofsulphurandzincongrowthofpearlmillet.

S. No.	Treatmentcombinations	Planheight(cm)	Dry weight(g/plant)	Cropgrowthrate(g/m ² /day)
1.	Sulphur20kg/ha+Zinc5 kg/ha	180.38	62.90	36.73
2.	Sulphur20kg/ha+Zinc10 kg/ha	183.53	64.22	37.31
3.	Sulphur20kg/ha+Zinc15 kg/ha	184.62	65.87	36.65
4.	Sulphur30kg/ha+Zinc5 kg/ha	186.38	67.64	39.20
5.	Sulphur30kg/ha+Zinc10 kg/ha	188.94	68.22	40.22
6.	Sulphur30kg/ha+Zinc15 kg/ha	189.96	68.95	38.93
7.	Sulphur40kg/ha+Zinc5 kg/ha	192.27	71.20	41.65
8.	Sulphur40kg/ha+Zinc10 kg/ha	195.05	73.87	42.90
9.	Sulphur40kg/ha+Zinc15 kg/ha	198.06	75.83	47.70
	Ftest	S	S	S
	SEm.(±)	1.12	0.84	1.71
	CD (p=0.05)	3.37	2.53	5.12

Table-2. Effect of sulphur and zinc on yield of pearl millet.

S. No.	Treatment combinations	Ear head length (cm)	No. of Grains/earhead	Test weight (g)	Grain yield (q/ha)	Stover yield (q/ha)	Harvest index (%)
1.	Sulphur 20kg/ha + Zinc 5 kg/ha	19.8	1837.1	6.75	32.29	47.55	40.44
2.	Sulphur 20kg/ha + Zinc 10 kg/ha	20.8	1876.0	6.81	33.94	48.20	41.32
3.	Sulphur 20kg/ha + Zinc 15 kg/ha	21.5	1902.4	7.19	34.61	49.11	41.34
4.	Sulphur 30kg/ha + Zinc 5 kg/ha	21.3	1911.1	7.45	35.24	50.99	40.87
5.	Sulphur 30kg/ha + Zinc 10 kg/ha	22.4	1929.6	7.81	36.16	54.03	40.10
6.	Sulphur 30kg/ha + Zinc 15 kg/ha	22.7	1938.4	7.99	37.03	58.36	38.83
7.	Sulphur 40kg/ha + Zinc 5 kg/ha	23.5	1965.3	8.10	37.82	59.33	38.93
8.	Sulphur 40kg/ha + Zinc 10 kg/ha	24.5	1981.1	8.31	39.03	63.32	38.14
9.	Sulphur 40kg/ha + Zinc 15 kg/ha	25.2	2006.0	8.57	40.95	65.33	38.53
	F _{test}	S	S	S	S	S	S
	Sem(±)	0.27	6.07	0.13	0.40	0.65	0.41
	CD(P=0.05)	0.81	18.19	0.40	1.21	1.94	1.23