Original Research Article

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 ofAgriculture, Technology and Sciences, Prayagraj (U.P.) India. To study the Response ofSulphur and zinc on growth and yield of Pearl millet. The treatments consist of Sulphur20,30,40 kg/ha and zinc 5, 10, 15 kg/ha. There were 9 treatments each replicated thrice.

Thesoilofexperimentalplotwassandyloamyintexture,nearlyneutralinsoilreaction(pH7.8),low in organic carbon (0.35%) available N (163.42 kg/ha), available P (21.96 kg/ha) andavailable K (256.48 kg/ha). Results revealed that the higher plant height (198.06 cm), plantdry weight (75.83 g/plant), crop growth rate (47.70 g/m^2 /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 higherstoveryield(40.95q/ha)weresignificantlyinfluencedwithapplicationofSulphur40kg/ha +Zinc15kg/ha.Highergrossreturns(INR92145.00/ha),highernetreturns(INR62365.00/ha)andhigherB:Cratio(2.09)werealsorecordedintreatment-9(Sulphur40kg/ha +Zinc15kg/ha).

Keywords:*Pearlmillet,Sulphur,zinc,growthparametersandyieldattributes.*

INTRODUCTION

PearlmilletiscommonlyknowninIndiaas*Bajri*or*Bajra*.Pearlmillet(*Pennisetumglaucum*L.)isalsoknownas'bullrushmillet',originatedintropicalwesternAfrica,wherethegreatestnumber 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 cropin arid and semi-arid regions of India. The realized productivity of pearl millet is below itspotential. The main reasons of poor crop yield are low moisture availability to crop duringgrowing season and lack of proper nutrient management (**Choudhary *et al.* 2016)**. The foodgrain demand of

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

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(142millionha),theimprovedperunitareaproductivitycouldtriggeroverallincreaseinfoodgrainproduction**(Reddy*etal*.,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**(VinaySingh*etal*.,2015)**.Sulphurperformsimportantfunctionsinpearlmillet.Itisthebestknown 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 Singh*etal*., 2015).**

Keeping these points in view, the present investigation entitled **''Effect of SulphurandZinconGrowthandYieldofpearlmillet(*Pennisetumglaucum*L.)''**wasconductedduring*Zaid*-2022, atcrop researchfarm,SHUATS,Prayagraj (U.P).

MATERIALSANDMETHODS

Afieldexperimentwasconductedduring*Zaid*seasonof2021-22attheCropResearchFarm,Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University ofAgricultureTechnologyandSciences(SHUATS),Prayagraj(U.P.)India.Thesoilofexperimentalplotwassandyloamyintexture,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,Sulphur30kg/ha+zinc10kg/ha,Sulphur30kg/ha+zinc15kg/ha,Sulphur40kg/ha+ zinc5kg/ha,Sulphur40kg/ha+zinc10kg/ha,Sulphur40kg/ha+zinc15kg/ha.Theexperiment

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waslaidoutinRandomizedBlockDesign,with9treatmentsreplicatedthrice.Theobservationswererecordedforplantheight,plantdryweight,CropGrowthRate(g/m^2/day),Relative Growth Rate (g/g/day), Ear head length (cm), Grains/ear head (g), Test weight (g),Grainyield(kg/ha)andStoveryield(kg/ha).Thedataweresubjectedtostatisticalanalysisbyanalysis of variancemethod**(GomezandGomez, 1976).**

RESULTAND DISCUSSION

GROWTHPARAMETERS

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 withtreatment- 9 (Sulphur 40 kg/ha + Zinc 15 kg/ha). The significantly higher plant height wasobserved with the Application Sulphur 40 kg/ha. This increase may be due to involvementof Sulphur in bio synthesis of Indole 3 acetic acid. And also, Sulphur plays an importantrole in growth and development of crops. It owing an important role in the formation of S-containingaminoacidslikecystine(27%S),Cysteine(26%S),methionine(21%S),whichact as building blocks in the synthesis of proteins. Similar results find out by **Chauhan *etal.*, (2017).** Further increase of plant height is might be due to application of zinc 15 kg/ha,due to the role of zinc as a "catalyst" in most physiological, metabolic, and tryptophanesynthesis processes. Certain protein elements are required to produce growth hormones(auxins)includingIAA.Thereweresimilarfindingsdescribed by**Reddy*etal.*(2022**).

Plant dry weight(g/plant) - At 80 DAS, the significantly higher plant dryweight(75.83gm/plant)[Table-1]wasobservedintreatment-9(Sulphur40kg/ha+Zinc15 kg/ha) However, treatment-8 (Sulphur 40 kg/ha + zinc 10 kg/ha) was found to bestatisticallyatparwithtreatment-9(Sulphur40kg/ha+Zinc15kg/ha).Thesignificantly higher plant dry weight (75.83 gm) was observed with the application ofSulphur 40 kg/ha. It has a role in play in increasing chlorophyll formation and aidingphotosynthesis.Sulphurplaysaroleintheactivationofenzymesnucleicacidsandforms parts of biotin and thiamine. Further increase in the dry weight might be due to theapplication of zinc at 15 kg/ha. Zinc isessentialforpromoting certain metabolicreactions. It is necessary for the production of chlorophyll and carbohydrates. Zinc isdirectly or indirectly required by several enzymes, auxin and protein synthesis. Thenutrientsappliedinonecroparenotfullyutilizedwhichleadstotheirresidualeffecton

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succeeding crop. Similar results conformity with**kaushalyadav and vinaysingh(2021).**

Comment [Ma1]: Give in scientific format i.e. Yadav and Singh 2021

Crop growth rate (g/m^2/day) - At 60-80 DAS, the significantly higher cropgrowthrate(47.70g/m^2/day)[Table-1]wasobservedintreatment-9(Sulphur40kg/ha + Zinc 15 kg/ha) However, treatment-8 (Sulphur 40 kg//ha + zinc 10 kg/ha) was foundto be statistically at par with treatment- 9 (Sulphur 40 kg//ha + Zinc 15 kg/ha). thesignificantly higher crop growth rate was observed with the Sulphur application 40kg/ha,maybeduetotheIncreaseinplantheightwithanincreaseinSulphurlevelmightbe due to the beneficial effect of Sulphur on the various metabolic activities and alsobecause of its important role in cell division, photosynthetic process and formation ofchlorophyllintheleaf.Therefore,itshowspositivereactiononcropgrowthrate.Similarresults accordancewith**Dadhichand Gupta (2003).**

YIELDATTRIBUTES

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), whichwas 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 theapplication of zinc 15 kg/ha. Zn are involved in cell division, enzyme activation and withtheirincreasedsupply,theiravailability,acquisition,mobilizationandinfluxintotheplanttissueincreasedandthusimprovedgrowthattributesandyieldcomponents.Similarresultsinaccordancewith**vinaysingh andmamtapandey(2018).**

Comment [Ma2]: Same as above

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), whichwas 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+Zinc15kg/ha).ThesignificantandhigherGrains/earheadwasobservedmightbeduetoSulphurapplication.BecauseSulphurisapartofaminoacid(Cystine)whichhelpsinchlorophyllformation,photosyntheticprocess,activationofenzymesandseedformation.Similar resultswereobserved by**Degraet al. (2008).**

Test Weight - The significantly higher Test weight (8.57 gm) [Table-2]

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wasobservedintreatment-9with(Sulphur40kg/ha+Zinc15kg/hatreatments.However,

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treatment-8 (Sulphur 40 kg/ha + Zinc 10 kg/ha), was found to be statistically at par withtreatment-9 (Sulphur 40 kg/ha + Zinc 15 kg/ha). The significant and higher test weightwas recorded with the application of Zinc (15kg/ha), might be due to the application ofzinc might have increased the photosynthetic efficiency due to improved enzymaticactivity and thus might have increased thousand grains weight. similar results are inconformitywith thefindingsof**Arshad*etal.* (2016).**

Grain yield - The significantly Maximum Grain yield (40.95 q/ha) [Table-2] wasobserved in treatment-9 with (Sulphur 40 kg/ha + Zinc 15 kg/ha), which was significantlysuperioroverrestofthetreatments.However,treatment-8(Sulphur40kg/ha+Zinc10kg/ha),was found to be statistically at par with treatment-9 (Sulphur 40 kg/ha + Zinc 15 kg/ha). Thesignificant and higher Grain yield was observed with increasing the Sulphur application level.Andalso,itperformsimportantfunctionsinpearl millet.Itisthebestknownforitsroleinthesynthesisofproteins,oilsandvitaminsinpearlmillet.Sulphurisassociatedwiththeproductionofcropsforsuperiornutritionalandmarketqualityproduce**(Chaudhary*etal*.,2014).**Further,with the application of Zinc (15 kg/ha), might be due to the greater photosynthesis efficiencyor more nutrients availability due to increasing decomposition rate of organic matter orimprovedindividualplantperformancemightthepossiblereasonsforhighergrainyieldinzincapplied plots compared to other plots. These results are in conformity with the findings of**Arshad*etal.* (2016), Norwood(1992)andJan*etal.* (2013).**

Stover yield - The significantly Maximum stover yield (65.33 q/ha) [Table-2]wasobserved in treatment-9 with (Sulphur 40 kg/ha + Zinc 15 kg/ha), which was significantlysuperioroverrestofthetreatments.However,treatment-8(Sulphur40kg/ha+Zinc10kg/ha),was found to be statistically at par with treatment-9 (Sulphur 40 kg/ha + Zinc 15 kg/ha). Thesignificant 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, increasingsink strength through development of reproductive structures by production of assimilates tofilleconomicallyimportantsink**(CHOUDHARY*etal*.,2016).**Furtherincreaseofstoveryieldmay be due to application of zinc 15 kg/ha. Zinc is critical to the growth and development oftryptophane, a necessary amino acid for plant growth and development. Similar results wereconformitywith**Reddy *etal.* (2022**).

CONCLUSION

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The significantly maximum grain yield was found in treatment (T9) with the application ofSulphur40kg/haalongwiththezinc15kg/ha.However,treatment-8(Sulphur40kg/ha+Zinc10 kg/ha), was found to be statistically at par with treatment-9 (Sulphur 40 kg/ha + Zinc 15kg/ha). These findings are based on one season therefore; further trials may be required forfurtherconfirmation.

Comment [Ma3]: Don't provide data. Just give what you find with the application of S and Zinc

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Comment [Ma4]: Singh and Pandey 2018 should be there

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Table-1.Effectofsulphurandzincongrowthofpearlmillet.

S. No.	Treatmentcombinations	Plantheight (cm)	Dry weight(g/ plant)	Cropgrowthrate(g/m2/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

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Table-2.Effectofsulphurandzinc onyield ofpearlmillet.

S. No.	Treatmentcombinations	Ear headlength (cm)	No.ofGrains/ earhead	Test weight(g)	Grainyield (q/ha)	Stoveryield(q/ha)	Harvestindex(%)
1.	Sulphur20kg/ha+Zinc5 kg/ha	19.8	1837.1	6.75	32.29	47.55	40.44
2.	Sulphur20kg/ha+Zinc10 kg/ha	20.8	1876.0	6.81	33.94	48.20	41.32
3.	Sulphur20kg/ha+Zinc15 kg/ha	21.5	1902.4	7.19	34.61	49.11	41.34
4.	Sulphur30kg/ha+Zinc5 kg/ha	21.3	1911.1	7.45	35.24	50.99	40.87
5.	Sulphur30kg/ha+Zinc10 kg/ha	22.4	1929.6	7.81	36.16	54.03	40.10
6.	Sulphur30kg/ha+Zinc15 kg/ha	22.7	1938.4	7.99	37.03	58.36	38.83
7.	Sulphur40kg/ha+Zinc5 kg/ha	23.5	1965.3	8.10	37.82	59.33	38.93
8.	Sulphur40kg/ha+Zinc10 kg/ha	24.5	1981.1	8.31	39.03	63.32	38.14
9.	Sulphur40kg/ha+Zinc15 kg/ha	25.2	2006.0	8.57	40.95	65.33	38.53
	Ftest	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

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