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Response of Sulphur and Zinc on yield, nutrients content and Quality of Rice (*Oryza sativa* L.)

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ABSTRACT
A field experiment was conducted for two years (2014 & 2015) at student research farm C.S.A. University of Agriculture and Technology kanpur-208002. There are nine treatment combinations were tested comprising three levels of each sulphur0, 30 and 60 kgha^{-1} and zinc 0, 3 and 5 kgha^{-1}.Application of graded doses of S upto 60 kgha^{-1} and Zn upto 5 kgha^{-1} significantly increased grain and straw yield. Application of 60kg S ha^{-1} gave 476.00 (10.25%) and 702.00 (10.77%) kg ha^{-1} higher grain and straw yield respectively over no use of sulphur. Similarly use of 5 kg Zn ha^{-1} resulted 172.00 (3.60%) and 279.00 (4.15%) kg ha^{-1} extra grain and straw yield respectively over no use of zinc.Application of sulphur upto 60 kgha^{-1} significantly increased the sulphur and zinc content in grain and straw. Zinc content in grain and straw increased significantly with the use of 60kg S ha^{-1}. Use of zinc upto 5 kgha^{-1} significantly increased the nutrient content in grain and straw. Application of sulphur upto 60kgha^{-1} and zinc upto 5 kgha^{-1} significantly increased maximum protein content 8.43 % and 8.00 % in grain and 1.90 %& 1.74 % in straw respectively. Use of 60 kg S ha^{-1} significantly increased kernal elongation and L/B ratio of rice grain.
***Keywords**: Sulphur, Zinc Protein, Kernal elongation and L/B ratio.*

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INTRODUCTION

Rice (*Oryza sativa* L.) is most stable and important crop of the country. It is staple food of over half of the world's population. It is principle food and cereal crop of the South-Eastern Asia and about 90 percent of all rice grown in the world is produced and consumed by Asian countries. It is one of the cereal crop of the world providing 22 percent of calories and 17 percent of protein. In Asia, over two billion people obtain 60-70 percent of their energy intake from rice and its products. The protein content of rice usually 6-7 percent when milled. Rice is important cereal crop in tropical and semitropical regions and needs hot and humid climate conditions for best growth and development. The best condition for cultivation is high humidity, prolonged sunshine duration and assured irrigation facility. The average temperature throughout the period of the rice crop ranges from 21-37^{0}C and at the time of tillering the crop requires high temperature. It is capable of growing in diverse groups of soil including saline and sodic soils having plenty of water holding capacity, rich in organic matter and clay content. In the coastal area of country, it is grown in all the three seasons (*Rabi, Kharif* and *Zaid*). In U.P. it is grown mainly in *Kharif* season. In West Bengal, it is grown in three seasons, autumn, winter and summer. The crop may be grown in submerged condition of water depth having from 10-30 cm. Fertilizers play a crucial role in increasing crop productivity through their judicious application by increasing the supply

of deficient plant nutrient in the soil. Farmers, in general are applying generalized quantities of Nitrogen, Phosphorus and some extent Potassium with the result, deficiency of other nutrients particularly S & Zn are spreading in space & time. With increasing level of soil nutrient depletion and higher demand of food grain production in future the nutrient use will have to be increased at higher level. Sulphur is a secondary major nutrient. It is now recognized as the fourth major nutrients in addition to nitrogen, phosphorus and potash. Sulphur improves growth, crop yield, seed formation and oil percentage in oil seed plant, protein, cereal quality for milling and baking [1]. Zinc aids synthesis of plant growth substances and enzyme systems and is essential for promoting certain metabolic reaction. It is necessary for production of chlorophyll and carbohydrate. Its play an important role in increasing the yield of rice crop [2]. However on above facts the present investigation are planned.

MATERIALS AND METHODS

A field experiment was conducted at Student Research Farm of C.S. Azad University of Agriculture and Technology, Kanpur-208002, during *Kharif* seasons of 2014 and 2015. The soil of the experimental site was sandy loam in texture and had pH 7.8, EC 0.30 dSm^{-1}, OC 0.38%, alkaline $KMnO_4$ extractable N 164 Kg ha^{-1}, Olsen P 6.20 $Kgha^{-1}$ and NH_4OAC extractable K 155$Kgha^{-1}$, $CaCl_2$ extractable S 5.90 $Kgha^{-1}$ and DTPA extractable Zn 0.41 $mgkg^{-1}$. Three levels of each sulphur i.e. 0, 30, 60 $kgha^{-1}$ and zinc i.e. 0, 3, 5$kgha^{-1}$were tested using rice variety Pant-12 as a test crop. Nitrogen, phosphorus, potassium, sulphur and zinc were applied through urea, DAP, MOP, gypsum and zinc oxide, respectively. Full dose of P,K, S, Zn and half dose of N was applied as basal dose as per treatment details. Remaining $^1/_2$dose of N was applied in equal two splits at tillering and panicle initiation stages. All the necessary agronomical practices were followed as and when required to raise good crops.

The organic carbon was determined by Walkley and Black's rapid titration method as described by Piper [3], available N by Subbiah and Asija [4] and available phosphorus by Olsen *et al.* [5]. Available potassium with N-HN_4OAC solution was determined by flame photometerically as explained by Jackson [6], available sulphur extracted by using 0.15% $CaCl_2$ and was determined by turbidimetric procedure [7], available zinc extracted with DTPA and analysed by AAS as described by Lindsay and Norvell [8]. S and Zn content in grain & straw were determined by digesting samples in diacid mixture & extract of sulphur & zinc determined by same as in case of soil analysis.

RESULTS AND DISCUSSION

Grain and straw yield of rice increased significantly due to application of sulphur and zinc. Application of sulphur upto 60 $kgha^{-1}$ and zinc upto 5 $kgha^{-1}$increased significantly grainand straw yield of rice. On an average the grain yield of rice at S_0, S_{30} and S_{60} levels of sulphur use were 46.42, 48.47 and 51.18 Qha^{-1} and straw yield were 65.13, 68.27 and 72.15 Qha^{-1} respectively.

Table 1.Response of sulphur and zinc on yield, nutrients content and quality of rice (Mean of two years)

Treatment	Yield(Q/ha)		Nutrient content				Quality			
			Sulphur(%)		Zinc($mgkg^{-1}$)		Protein content (%)		Kernal elongation (mm)	L/B ratio
	G	S	G	S	G	S	G	S	G	G
S_0	46.42	65.13	0.15	0.11	35.96	12.86	7.11	1.42	6.49	3.34
S_{30}	48.47	68.27	0.19	0.12	36.44	13.09	7.74	1.64	6.52	3.35
S_{60}	51.18	72.15	0.24	0.15	36.96	13.45	8.43	1.90	6.54	3.36
CD (P=0.05)	0.821	2.111	0.014	0.010	0.708	0.337	0.045	0.030	0.039	0.021
Zn_0	47.77	67.11	0.19	0.12	33.88	10.10	7.53	1.56	6.51	3.35
Zn_3	48.80	68.53	0.19	0.12	36.45	12.88	7.75	1.65	6.52	3.35
Zn_5	49.49	69.90	0.20	0.13	39.02	16.42	8.00	1.74	6.52	3.35
CD (P=0.05)	0.821	2.111	NS	NS	0.841	0.517	0.045	0.030	NS	NS

G: Grain and S: Straw

Sulphur improves growth, crop yield, seed formation and oil percentage in oil seed plant, protein, cereal quality for milling and baking [9].Since sulphur is an essential plant nutrients and involved in physiological process of plants are well pronounced,therefore increased yield of grain and straw both due to use of sulphur is quite expected. The marked response in yield due to sulphur application may be attributed to the fact that soils of experimental plot were deficient in available sulphur in its values were less than the critical limit of 10 $mgkg^{-1}$. These results are in line with those reported by Singh and Singh [10], and Sriramchandra shekharan *et al.* [11]. Grain and straw yield were always considerably increased due to application of zinc also. On an average the grain yield of rice at Zn_o , Zn_3 and Zn_5 levels of zinc use were 47.77, 48.80 and 49.49 Qha^{-1} and straw were 67.11, 68.53 and 69.90 Qha^{-1} respectively. The significant increase of yield attributing characters due to application of zinc could be attributed to its great importance in growth and development of crop as it involves in various enzyme system as prosthetic group and metallic constituents, in biosynthesis of photosynthetic pigments and auxin which in turn enabled the plant to grow taller and produce more dry matter yield of rice due to zinc application. Higher yield responses and better yield attributes with the use of Zn were also reported by Kulandaivel *et al.* [12], Singh and Singh [10], Tripathi and Tripathi [13] and Darade and Bankar [14].

Increasing dose of sulphur upto 60 kg ha^{-1} significantly increased sulphur content in grain and straw. The significant increase in nutrient content by S application could be attributed to profuse vegetative growth, root growth and release more nutrients from the soil & transport to the plant. thereby activating absorption of nutrients. Similar results are also reported by Poongothai *et al.* [15], Wani and Refique [16], Sarfraz *et al.* [17] and Sudha and Chandini [18].

Increasing dose of zinc upto 5 kg ha^{-1} significantly increased zinc content in grain and straw. The beneficial effect of zinc addition on nutrient content observed in the present study could be attributed to higher uptake of all the nutrients on account of correction of deficiencies like Zn resulting in elimination of factor, which was limiting the growth and nutrient contents in the control. Sulphur content in grain and straw were statistically non significance with the use of zinc. These finding is also supported by Dixit and Patro [19], Prasad *et al.* [20], Patil and Meisheri [21] and Khan *et al.* [22].

Application of sulphur upto 60 kg ha^{-1}stimulate protein content and significantly increased percent protein content in grain and straw. Sulphur is involved in amino acid synthesis and, therefore, considerable increased protein content in grain and straw is quite expected. Kernal elongation and L/B ratio were also significantly increased with use of sulphur upto 60 kg ha^{-1} . Zinc application upto 5 kg ha^{-1} significantly increased percent protein content in grain and straw. Similar results are also reported by Singh *et al.* [24], Khanna *et al.* [23], Khan *et al.* [22] and Tripathi and Tripathi [13].

CONCLUSION

On the basis of present research it is found that application of sulphur and zinc increase grain and straw yield, uptake of S and Zn in grain and straw of rice, percent protein content in grain & straw, kernel elongation and L/B ratio of rice grain. Application of S upto 60 $kgha^{-1}$ and Zn upto 5 $kgha^{-1}$ gave the highest value of grain and straw yield, S and zinc content in grain and straw,percent protein content in grain & straw, kernel elongation and L/B ratio of rice grain. However sulphur 60 kg ha^{-1}, zinc 5 kg $ha^{-1}$with recommended dose of NPK is optimum for obtaining maximum yield ofquality rice with rich in sulpur and zinc content.

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