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Effect of Sulphur, Zinc and Insecticides on yield and uptake of nutrients in 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 eighteen treatment combinations were tested comprising three levels of each sulphur0, 30 and 60 kgha^{-1}, zinc 0, 3 and 5 kgha^{-1} and two insecticides (Phorate and Carbofuran).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 content and uptake of nutrients (NPKS) by grain and straw. Use of zinc upto 5 kgha^{-1} significantly increased the content and uptake of nutrients(NPKZn).
Keywords: *Sulphur, Zinc, Phorate and Carbofuran.*

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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 principal 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 is usually 6-7 percent when milled. Rice production in India is an important part of the national economy. India is one of the world largest producer of rice. Rice is India's prominent crop, and is the staple food of the people of the eastern and southern part of the country.Uttar Pradesh is largest rice growing state next to West Bengal in the country. In U.P., rice is grown on an area of 5.95 million ha with total production of 13.53 million tons annually with 23.58 q/ha average productivity during 2011-12. In the country, U.P. is very important state in respect to total production but its productivity is low (agricoop.nic.in). 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]. Insecticide may have ability to enhance nutrient use efficiency by providing insect free and suitable atmosphere in rhizosphere of the crop [3]. Some insecticides have N and P in his chemical structure and that N and P may contribute as nutrient source besides insecticides role in crop production.

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 $155Kgha^{-1}$, $CaCl_2$ 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, $5kgha^{-1}$ and two insecticides namely Phorate and Carbofuran were tested using rice 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 [4], available N by Subbiah and Asija [5] and available phosphorus by Olsen *et al.* [6]. Available potassium with N-HN_4OAC solution was determined by flame photometerically as explained by Jackson [7], available sulphur extracted by using 0.15% $CaCl_2$ and was determined by turbidimetric procedure [8], available zinc extracted with DTPA and analysed by AAS as described by Lindsay and Norvell [9]. NPKS and Zn content in grain & straw were determined by standard procedure. Grain and straw yields were recorded after harvesting and threshing of crop.

Table1. Effect of sulphur, zinc and insecticides on yield and uptake of nutrients of rice (Mean of two years)

Treatment	Yield (Q/ha)		Uptake(Kg/ha)									
			Nitrogen		Phosphorus		Potassium		Sulphur		Zinc(g/ha)	
	G	S	G	S	G	S	G	S	G	S	G	S
S_0	46.42	65.13	52.53	14.94	14.45	5.28	14.17	60.28	6.74	6.85	167.06	84.06
S_{30}	48.47	68.27	59.95	17.82	16.94	6.49	16.57	68.05	9.09	8.31	176.67	89.52
S_{60}	51.18	72.15	69.04	22.1	20.45	7.95	19.59	77.84	12.29	10.47	189.3	97.42
CD (P=0.05)	0.821	2.111	1.640	0.778	0.691	0.389	0.617	1.987	0.698	0.407	5.655	4.441
Zn_0	47.77	67.11	57.42	16.92	16.11	5.96	15.71	65.32	8.91	8.1	161.86	67.82
Zn_3	48.8	68.53	60.66	18.07	17.42	6.6	16.8	68.76	9.34	8.38	177.92	88.3
Zn_5	49.49	69.9	63.41	19.86	18.43	7.15	17.8	72.09	9.34	9.15	193.25	114.88
CD (P=0.05)	0.821	2.111	1.640	0.778	0.691	0.389	0.617	1.987	0.443	0.407	5.655	4.441
Ip	48.52	68.29	60	18.02	17.13	6.5	16.61	68.29	9.28	8.44	176.3	89.26
Ic	48.84	68.75	61.01	18.55	17.52	6.64	16.94	69.16	9.46	8.64	179.06	91.4
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

G : Grain and S : Straw

RESULTS AND DISCUSSION

Application of sulphur and zinc significantly increased grain and straw yield of rice. Grainand straw yield of rice increased significantly due to application of sulphur upto 60 $kgha^{-1}$and zinc upto 5 $kgha^{-1}$. 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. Sulphur is an essential plant nutrients and involved in physiological process of plants are well pronounced, therefore increase 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 and value of available of the experimental field was less than the critical limit of 10 $mgkg^{-1}$. These results are in line with those reported by Singh and

Singh [10], Chandel *et al.* [11] and Sriramchandrashekharan *et al.* [12]. 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. Yields of grain and straw were always considerably increased due to application of zinc also. Since zinc application had caused pronounced in yield contributory characters and the latter were found to be positively correlated with the yield and beneficial effect of zinc on the grain and straw yield was very much expected. The increased yield may be because of metabolic activity of plant due to zinc application. Higher yield responses and better yield attributes with the use of Zn were also reported by Kulandaivel *et al.* [13], Singh and Singh [10], Tripathi and Tripathi [14] and Darade and Bankar [15].

The amount of NPKS and Zn absorbed by grain and straw of the rice is directly correlated with yield and contents of these nutrients in grain and straw both. Application of sulphur upto 60 kg ha^{-1} significantly increased NPKS and Zn uptake. Similarly use of zinc upto 5 $kgha^{-1}$ significantly increased uptake of NPK and Zn. Use of zinc upto 5 $kgha^{-1}$ increased significantly the uptake of sulphur by rice grain and straw. The increase in nutrient uptake is attributed to application of zinc to plants which is turn provide vigorous growth resulting in greater absorption of nutrients from the soil. Insecticide always considerably increased uptake of NPKS and Zn in grain and straw. The significant increase in uptake of nutrients by S and Zn application could be attributed to profuse vegetative growth and root growth, thereby activating absorption of nutrients. The uptake of N, P, K, S and Zn by grain and straw were increased which might be due to the enhanced availability of nutrients in soil due to application of S and Zn as soil was deficient in S and DTPA extractable Zn, which in turn, increased the concentration of nutrients and dry matter accumulation. It seemed that grain and straw yields were more deciding factors for uptake of these nutrients. The increase in uptake of these nutrients by the crop under the influence of S and Zn seems partly due to increased contents of these nutrients in grain and straw of rice, which had increased dry matter production. Similar results are also reported by Mukhi and Shukla [16], Singh *et al.*[17] and Kumar *et al.*[18].

CONCLUSION

On the basis of present research it is found that application of sulphur, zinc and insecticides increase grain and straw yield, uptake of N, P, K, S and Zn in grain and straw of rice. Application of 60 kg S, 5 kg Zn ha^{-1} and insecticides gave the highest value of grain and straw yield, uptake of NPKS and zinc by grain and straw.However sulphur 60 kg ha^{-1}, zinc 5 kg ha^{-1} along with soil insecticide like Carbofuran 3G with recommended dose of NPK is suitable for obtaining maximum rice yield and uptake of nutrients.

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