The Andhra Agric. J 61(1): 41-43, 2014

Effect of Soil Application and Foliar Nutrition of Zinc on Yield and Grain Fortification of Rice

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ABSTRACT

A field experiment was conducted at the agricultural college farm, Bapatla on a clay loam soil during *kharif* season of 2011-12 to study the effect of different zinc treatments in improving zinc concentration in rice grain. The findings of the experiment revealed that combined application of soil as well as foliar sprays at MT, PI & flowering stages is more beneficial for realizing higher grain yields and enhancing nutrient content of rice grain.

Key words : Foliar spray, Grain fortification, Soil application, Yield, Zinc.

Rice is the staple food crop for more than half of the world's population which supplies adequate energy in the form of calories and is a good source of thiamine, riboflavin, and niacin (Stalin *et al*., 20 11). But, it is a poor source of many essential mineral nutrients, especially Zn and Fe, which are specially required for human nutrition. Undoubtedly, with the introduction of high yielding varieties of cereals and their continuous cultivation, deficiency of secondary and micronutrients in time and space, are the reasons for yield stagnation (Gill and Singh, 2009).

Although Zn deficiency to some extent can be cured by Zn supplementation and improvement in dietary composition, it is better to increase the Zn content in cereals, the staple food in India and as a matter of fact in the entire south and Southeast Asia. This can be achieved by biofortification of food grains either by developing crop cultivars with high concentration of Zn in grains or by adequate Zn fertilization of crops grown on Zn-deficient soils (Rajendraprasad, 2010). Hence, it is proposed to explore the possibility of ferti-fortification for enhancing the nutrient content of rice grain either by adding fertilizer to soil or by applying zinc fertilizer to the crop foliage at an appropriate time during its growth.

MATERIAL AND METHODS

A field experiment was conducted during *kharif* season of 2011-12 at the Agricultural college farm, Bapatla. The soil was clay loam (sand 28 %, silt 24 %, clay 48 %) with pH 7.9, organic carbon 0.4% and 210, 20, 362 kg ha^{-1} and 0.6 ppm available N, P_2O_5, K_2O and Zn respectively. Thirty five days old seedlings of BPT-2270 (Bhavapuri sannalu) were transplanted with a spacing of 20 cm ×15 cm. The experiment was laid out in Randomized Block Design with three replications. The experiment consisted of nine treatments viz., Soil application @ 50 kg $ZnSO_4$ ha^{-1} (T_1), T_1 + foliar application @ 0.5% $ZnSO_4$ at maximum tillering (MT) stage (T_2), T_1 + foliar application @ 0.5% $ZnSO_4$ at panicle intiation (PI) stage (T_3), T_1 + foliar application @ 0.5% $ZnSO_4$ at flowering stage (T_4), T_1 + foliar application @ 0.5% $ZnSO_4$ at MT + flowering stages (T_5), T_1 + foliar application @ 0.5% $ZnSO_4$ at PI + flowering stages (T_6), T_1 + foliar application @ 0.5% $ZnSO_4$ at MT + PI stages (T_7), T_1 + foliar application @ 0.5% $ZnSO_4$ at MT + PI + flowering stages (T_8), Control *i.e*., no zinc application (T_9). A recommended dose of 160 kg N, 60 kg P_2O_5, and 40 kg K_2O ha^{-1} was applied through urea, single superphosphate and muriate of potash respectively. Entire quantity of phosphorus and half of potassium and one third of the N were applied at the time of final land preparation just before transplanting. The remaining nitrogen was applied in two equal splits at active tillering and panicle initiation stages. The remaining half of K was applied at PI stage. Zinc sulphate @ 50 kg ha^{-1} was applied to soil 3 days after N, P and K application as per the treatments. For foliar application of Zn, sprays of $ZnSO_4$ (0.5 %) were given (500 L ha^{-1}) with hand sprayer during morning hours between 8 A.M. and 9 A.M. However, no

Table 1. Grain yield, Straw yield, Harvest index ,Zinc content (ppm) in grain of rice as influenced by different zinc treatments.

Treatment	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)	Zinc content (ppm)		
				Brown rice	Polished rice	Whole rice
T_1 : Soil application @ 50 kg $ZnSO_4$ ha^{-1}	5251	5945	46.9	31.9	24.6	29.0
T_2 :T_1 + foliar application @ 0.5% $ZnSO_4$ at maximum tillering (MT) stage	5276	6306	45.5	34.0	26.0	31.2
T_3 :T_1 + foliar application @ 0.5% $ZnSO_4$ at panicle intiation (PI) stage	5290	6363	45.3	34.5	26.4	32.6
T_4 :T_1 + foliar application @ 0.5% $ZnSO_4$ at flowering stage	5356	6616	44.7	37.0	27.6	33.2
T_5 :T_1 + foliar application @ 0.5% $ZnSO_4$ at MT + flowering stages	5486	7013	43.8	39.7	29.9	36.1
T_6 :T_1 + foliar application @ 0.5% $ZnSO_4$ at PI + flowering stages	5666	7197	44.4	40.4	30.6	37.2
T_7 :T_1 + foliar application @ 0.5% $ZnSO_4$ at MT + PI stages	5771	7471	43.5	41.3	32.6	37.7
T_8 : T_1 + foliar application @ 0.5% $ZnSO_4$ at MT + PI + flowering stages	5961	7604	43.9	42.7	34.4	40.0
T_9 : Control (No Zinc)	4232	5501	43.5	26.8	14.4	22.8
SEm±	176	213	0.9	1.4	1.6	1.4
CD (P= 0.05)	529	637	NS	4.0	4.7	4.1
CV (%)	7.8	6.9	2.8	6.4	9.8	6.2

measurable foliar burning or precipitation was recorded within 24 hours of foliar treatments.

Plant samples at harvesting stage from different treatments were utilized for chemical analysis after grinding into fine powder. Zinc content in the grain samples was determined by Atomic absorption Spectrophotometer method (Lindsay and Norvell, 1978).

RESULTS AND DISCUSSION

The highest grain yield (5961 kg ha^{-1}) and straw yield (7604 kg ha^{-1}) were recorded with soil application @ 50 kg $ZnSO_4$ ha^{-1} + foliar application @ 0.5% $ZnSO_4$ at MT + PI + flowering stages (T_8) which was on a par with T_5, T_6 followed by T_7 but significantly superior to rest of the treatments (Table 1). All the treatments resulted in significantly higher grain yield over control. The increased yield with Zn foliar spray might be attributed to enhanced yield components, decreased spikelet sterility and faster grain filling and also due to biochemical utilization of zinc in the shoot. Similar results were also reported by Ram *et al*. (1995). The significant increase in straw yield in rest of the treatments over T_9 (No zinc) due to better supply of Zn, which plays specific role in various metabolic activities. Further, Stalin *et al.* (2011) also observed that the supply of micronutrient zinc through foliar spraying resulted in better absorption of this nutrient, thereby helping in photosynthetic activity and effective translocation to storage organs, thus, contributed to the increased yield.

The highest zinc content in grain (40.0 ppm) was recorded with the treatment that received soil application @ 50 kg $ZnSO_4$ ha^{-1} + foliar application @ 0.5% $ZnSO_4$ at MT + PI + flowering stages (T_8) which was on a par with T_7 (37.7), T_6 (37.2) followed by T_5 (36.1) but proved to be significantly superior to rest of the treatments, and all these treatments remained at a par among themselves

(Table 2). Similar trend was also noticed in respect of zinc content in brown rice as well as in polished rice as that was observed with Zn content in grain. The increased zinc content in whole grain might be due to direct application of zinc at critical growth stages, which might have helped in increased absorption in the grain during ripening and also due to its direct absorption in plant tissue resulted in increased grain content of zinc. Similar findings were also reported by Dhaliwal *et al*., 2010.

From the present investigation, it can be concluded that under clay loam soils of Bapatla, integration of soil application @ 50 kg $ZnSO_4$ ha^{-1} and foliar application of 0.5% $ZnSO_4$ at MT + PI + flowering stages (T_8) was found to be better as this treatment has resulted in higher productivity and higher zinc fortification in grain.

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(Received on 11.06.2012 and revised on 30.09.2012)