TITLE

Influence of Foliar application of zinc on growth and yield in different varieties of rice (*Oryza sativa L.)* and yield validation using SPSS model

Article type: *Original Research Article*

ABSTRACT

A field experiment was conducted during *Kharif* 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 Foliar application of zinc on growth and yield in different varieties of rice (*Oryza sativa L.)*. The treatments consist of Zinc 0.2%, 0.3%, 0.4% and the verities MTU-7029, BPT -5204, RNR15048. The soil of experimental plot was sandy loamy in texture, nearly neutral in soil reaction (pH 7.8), low in organic carbon (0.35%). Results revealed that the higher plant height (117.68 cm), higher number of Tillers/hill (13.64), higher plant dry weight (55.47 g/plant), higher number of panicles/hill (10.01), higher number of grains/panicle (141.37), higher 1000 seed weight (22.27 gm), higher grain yield (6.43 t/ha) and higher stove yield (12.11 t/ha) were significantly influenced with application of RNR-15048 + $ZnSo_4$ - 0.4%. Higher grossreturn (INR 1,52,860/ha), higher net return (INR 1,07,531/ha) and higher B:C ratio (2.37) were also recorded in treatment-9 (RNR-15048 + $ZnSo_4$ - 0.4%).

Keywords: *Rice, Varities, Zinc, growth parameters, yield attributes and Economics.*

INTRODUCTION

Rice (*Oryza sativa* L.) is the most crucial cereal food crop of India, which occupies about 24% of gross cropped area of the country. It contributes 42% of total food grain production and 45% of total cereal production of the country. India has a long history of rice cultivation and stands first in rice area and second in rice production, after China **(Yadav *et al*., 2010).**

Agriculture contributes to about 31% GDP and 25% of India's exports comes from agricultural products. Being the staple food for more than 65% of the people, our national food security hangs on the growth and stability of its production. India has the largest acreage under rice about 44.6 million hectares of land under four major eco-systems viz. irrigated, rain fed lowland, rain fed upland and flood prone which occupies 21,14, 6 and 3 million hectares respectively, with a production of about 90 million tones. **(Saha *et al*., 2017).**

Rice production and productivity became appreciably advanced with the advent and cultivation of semi-dwarf, fertilizer responsive, and non-inns immoderate yielding kinds with inside the early seventies most important to the "Green Revolution". **(Yatheesh et al., 2022).** Hybrids of rice possessed a prominent role in enhancing the production and quality of rice, which is used for feed and industrial purposes. Hybrid rice cultivation is economically viable if management level is above 60%. Hybrids are short duration with resistance to major pests and diseases, non-lodging, they adapt better to stress and different climatic conditions and has longer shelf-life Around 3 million hectares out of 43 million hectares under rice cultivation are hybrids **Sarkar SC (2016)**.Because the population is growing, there is an urgent need to provide high yielding of rice varieties, therefore, rice hybrids break yield barriers, yielding 15-20% more.

Globally, the percentage of farmed soils with minimal Zn concentration in periods with cereals is around 50% **(Prasad *et al.*, 2014)**. Reduced membrane integrity, increased susceptibility to thermal stress, and reduced production of carbohydrates, cytochromes, nucleotides, auxin, and chlorophyll are all symptoms of Zn deficiency in plants.

Alkaline phosphatase, carbonic anhydrase, Cu-Zn-superoxide dismutase, phospholipase, carboxypeptidase, and RNA polymerase are just a few of the Zn-containing enzymes that are blocked (**Marschner 1995).** More than 500 distinct proteins interact with zinc. Chelated zinc (EDTA) Zinc sulphate heptahydrate, used for foliar fertilization and soil application, raised Zn content in plant components like hull, bran, white rice kernels, and straw (**Stein et al., 2007**). Based on the rice crop's instant reaction to nutrient application, foliar fertilization has a greater impact on increasing Zn concentration in rice than soil application. With and without Zn application, the cereal and straw output of various rice types varied greatly. With soil + foliar and solely soil applications of Zn, respectively, grain yields of various rice types rose by 29% and 22% on average (**shah *et al* 2013**).

Keeping these points in view, the present study entitled "**Foliar application of zinc on growth and yield in different varieties of rice (*Oryza sativa L.)* and yield validation using SPSS model",** was conducted at Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh during *Kharif* season of 2022.

Materials and Methods

The experiment was conducted during *Kharif* of 2022, Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh. Which is located at 25.24' 42'' N latitude, 81.50' 56" E longitude and 98m altitude above the mean sea level (SL). The experiment was conducted in Randomized Block Design with 10 treatments each replicated thrice. The plot size of each treatment was 3m x 3m. Factors are three levels of Zinc [ZnSo4 -0.2% (30,60 DAS), ZnSo4 -0.3% (30,60 DAS), ZnSo4 -0.4% (30,60 DAS)], and three different rice verities (MTU-7029, BPT-5204, RNR-150480). The different levels of zinc supplied during 30 and 60 DAS. The Rice varieties were sown on 26 June 2022 by maintaining a spacing of 22.5 cm × 10 cm. Harvesting was done taking 1m^2 area from each plot. And from it five plants were randomly selected for recording growth and yield parameters. The treatment details are as follows, T_1 -(MTU-7029 + ZnSo4- 0.2%), T_2 -(MTU-7029 + ZnSo4- 0.3%), T_3 – (MTU-7029 + ZnSo4- 0.4%), T_4 -(BPT -5204 + ZnSo4- 0.2%), T_5 -(BPT -5204 + ZnSo4- 0.3%), T_6 -(BPT -5204 + ZnSo4- 0.4%), T_7 -(RNR15048 + ZnSo4- 0.2%), T_8 -(RNR15048 + ZnSo4- 0.3%), T_9 -(RNR15048 + ZnSo4- 0.4%), T_{10}-(N 120 Kg/ha + P 60 kg/ha +k 60 kg/ha) Control. The observations were recorded for plant height, dry weight, Number of tillers/hill, Crop growth rate, number of panicles/hill, number of grains/panicle, test weight, grain yield and straw yield. The data were subjected to statistical analysis by analysis of variance method **(Gomez and Gomez, 1976).**

Results and Discussion

Growth parameters:

Plant height – At 100 DAS, the significantly higher plant height (117.68 cm) was observed in treatment-9 (RNR-15048 + ZnSo4 - 0.4%). However, treatment-8 (RNR-15048 + ZnSo4- 0.3%) was statistically at par with treatment- 9 (RNR-15048 + ZnSo4 - 0.4%). Plant height, an important growth index was significantly influenced by different zinc levels over control. Significantly taller plants were recorded at 0.4% as compared to the other treatments. As a result of high photosynthetic and hormonal activity, the meristematic growth in the apical region resulted in the sufficient elongation of the plants due to Zn application. **Ghatak *et al.* (2005),** Genetic makeup of the variety is a huge contributing factor which have also been reported by **Haque *et al.* (2015).** Increase in plant height may also be due to synchronized availability of all the essential plant nutrients especially nitrogen for a longer period during growth stages (**Singh *et al.*, 2019).**

Number of tillers/hill – The significantly higher number of tiller/hill (13.64) was observed in treatment-9 (RNR-15048 + ZnSo4 - 0.4%). However, treatment-8 (RNR-15048 + ZnSo4- 0.3%) was statistically at par with treatment- 9 (RNR-15048 + ZnSo4 - 0.4%). The significantly higher number of tillers per hill might be due to with the application of Zinc. Zinc enriched urea and Zn-FYM incubated might also have favorably altered the Zn dynamics in soil to prolong its availability for better rice growth and tillering. Superiority of Zn-EDTA. **Gangloff *et al*., 2002.** And also, the probable reason for high yielding varieties having high tillering capacity. Similar findings are also reported by **Yadav *et al.* (2004). Wang *et al.* (2016)** reported that the unequal distribution of photo- synthetic active radiation (PAR) was the source of heterogeneity in individual tiller yields, in that early emerging superior tillers pre-empted the uppermost light source, and shaded the late emerging tillers under limited light conditions.

Dry weight/plant- the significantly higher plant dry weight (55.47 gm) was observed in treatment-9 (RNR-15048 + ZnSo4 - 0.4%). However, treatment-8 (RNR-15048 + ZnSo4- 0.3%) was statistically at par with treatment-9 (RNR-15048 + ZnSo4 - 0.4%). Severe zinc deficiency in rice causes chlorosis, a decrease in, or complete lack of, tillering, a slower rate of crop maturity, and increased spikelet sterility. In lowland rice producing areas, zinc deficiency is associated with calcareous soils and is accentuated by prolonged flooding. Positive dry matter production response to Zn application has been reported by **Slaton *et al.* (2005).** and also, the probable reason for maximum dry matter accumulation depends upon the photosynthesis and respiration rate, which finally increases the plant growth with respect to increased plant height, leaf area and tillers/hill etc. Thus, the treatment which attained maximum growth, also accumulated higher dry matter similar result have also been reported by **Kumar (2016).**

YIELD

Number of panicles/hill- The significant and higher number of panicles/hill (10.01) were observed in treatment-9 with (RNR-15048 + ZnSo4 - 0.4%), which was significantly superior over rest of the treatments. However, treatment-8 (RNR-15048 + ZnSo4 - 0.3%), was found to be statistically at par with treatment-9 (RNR-15048 + ZnSo4 - 0.4%). The increase in the number of panicles/hill might be attributed to adequate Zn supply which may have increased the supply of other nutrients and stimulated the overall plant growth. Increase in number of panicles m-2 has also been reported by many earlier workers **Veeranagappa, 2010.** And also, the favourable reason might be that hybrid rice produces long roots and broad leaves that enable them to take up more nutrients and produce more grains. It is suited to existing climatic condition of the place especially during the grain-filling stage of the panicle development. Similar results have also been reported by **Bhuiyan *et al.*(2014).** **Number of seeds/pod -** The significant and higher number of seeds/pod (1.94) were observed in treatment-9 with (RDP 40 kg/ha+ Sulphur 30 kg/ha), which was significantly superior over rest of the treatments. However, treatment-8 (RDP 40 kg/ha+ Sulphur 20 kg/ha), was found to be statistical at par with treatment-9 (RDP 40 kg/ha+ Sulphur 30 kg/ha). Significant higher number of seed/pod might be due to increase in phosphorus fertilization in ensuring availability of other plant nutrients which increased carbohydrate accumulation and their re-mobilization to reproductive parts of the plant, being the closest sink. Phosphorus is known to encourage flowering and fruiting which might have stimulated the plants to produce more pods per plant and also enables development of a greater number of seeds per pod. Similar findings were reported by **Shah *et al.* (2000).**

Number of grains/panicle - The significant and higher number of grains/panicles (141.37) were observed in treatment-9 with (RNR-15048 + ZnSo4 - 0.4%), which was significantly superior over rest of the treatments. However, treatment-8 (RNR-15048 + ZnSo4 - 0.3%), was found to be statistically at par with treatment-9 (RNR-15048 + ZnSo4 - 0.4%). The increase in the number of grains panicle-1 might have been due to its enhancing effect on the physiological activities, photosynthesis and translocation and assimilation of photosynthetic and formation of higher number of spikelet's during the spikelet initiation process which ultimately resulted in higher number of grains /panicle these findings are in line with those of **Muhammad *et al.* (2002).**

Test Weight (gm) - The significant and higher test weight (22.27 gm) was observed in treatment-9 with (RNR-15048 + ZnSo4 - 0.4%), which was significantly superior over rest of the treatments. However, treatment-8 (RNR-15048 + ZnSo4 - 0.3%), was found to be statistically at par with treatment-9 (RNR-15048 + ZnSo4 - 0.4%). Higher photosynthetic rates and translocation rate of assimilates in the post flowering period might have resulted in increased number of grains panicle-1 and enhanced panicle weight and 1000 grain weight. These results corroborate the findings of **Naik and Das (2008).**

Grain Yield (t/ha) - The significant and higher grain yield (6.43 t/ha) was observed in treatment-9 with (RNR-15048 + ZnSo4 - 0.4%), which was significantly superior over rest of the treatments. However, treatment-8 (RNR-15048 + ZnSo4 - 0.3%), was found to be statistically at par with treatment-9 (RNR-15048 + ZnSo4 - 0.4%). The significantly higher grain yield might be due to with Zinc. Zn applications to the increased grain yield of rice might have been due to the initiation of the early emergence of panicles, which might have allowed greater storage of assimilates in rice grains. **Khan *et al.* (2012).** And also, due to the extended yield attributes are probably because of extended boom and improvement parameters which in the long run ended in extended grain. These effects with inside the conformity with **Yatheesh Kumar *et al.* (2022).**

Straw Yield (t/ha) - The significant and higher stover yield (12.11 t/ha) was observed in treatment-9 with (RNR-15048 + ZnSo4 - 0.4%), which was significantly superior over rest of the treatments. However, treatment-8 (RNR-15048 + ZnSo4 - 0.3%), was found to be statistically at par with treatment-9 (RNR-15048 + ZnSo4 - 0.4%). Application of Zn resulted in an improved vegetative growth which was reflected in higher dry matter accumulation and grain yield production per pot. This might have been due to the role of Zn in enzymatic, hormonal and photosynthetic functions. Stimulation of vegetative growth resulted in higher straw yield. **Ghatak *et al.* (2005).** And also, according to the findings by **Padmavathi, 1997** supports that the capability of hybrid rice to utilize more nitrogen through the expression of better growth brought by the beneficial effect on nutrient uptake and physiological growth increase the straw yield.

Economic Analysis

Gross returns (INR/ha) - Highest gross return (1,55,870.00 INR/ha) was obtained in treatment-9 (RNR-15048 + ZnSo4 - 0.4%) as compared to other treatments.

Net Returns

Net return (1,10,542.00 INR /ha) was found to be highest in treatment-9 (RNR-15048 + ZnSo4 - 0.4%) as compared to other treatments.

Benefit Cost Ration

Benefit Cost ratio (2.44) was found to be highest in treatment-9 with (RNR-15048 + ZnSo4 - 0.4%) as compared to other treatments.

Conclusion:

It was concluded that with the application of Zinc 0.4% on the variety of RNR-15048 (Treatment-9), has performed positively and improved growth and yield parameters. Maximum grain yield, gross returns, net returns and benefit cost ratio were also recorded with application of Zinc 0.4% on the variety of RNR-15048 (Treatment-9). These findings are based on one season therefore; further trials may be required for further confirmation.

Table 1. Influence of foliar application of zinc on growth parameters of different rice varieties.

S. No.	Treatment combinations	Plant height	Number of tillers/hill	Plant Dry weight
1.	MTU-7029 + ZnSo4- 0.2%	108.88	14.25	47.58
2.	MTU-7029 + ZnSo4- 0.3%	109.37	14.51	48.48
3.	MTU-7029 + ZnSo4- 0.4%	111.73	15.17	49.55
4.	BPT -5204 + ZnSo4- 0.2%	111.23	15.54	51.30
5.	BPT -5204 + ZnSo4 - 0.3%	113.27	15.55	52.13
6.	BPT -5204 + Znso4 - 0.4%	116.41	16.27	53.88
7.	RNR15048 + ZnSo4- 0.2%	115.99	14.60	54.21
8.	RNR-15048 + ZnSo4- 0.3%	116.91	15.48	54.97
9.	RNR-15048 + ZnSo4 - 0.4%	117.68	16.72	55.47
	F test	S	S	S
	S Em.(±)	0.29	0.25	0.33
	CD (P=0.05)	0.88	0.76	0.99

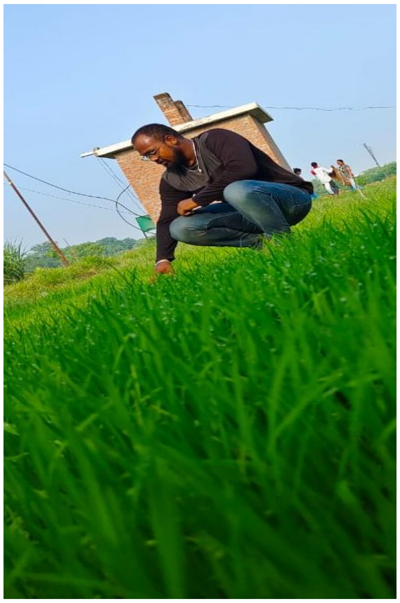
Table 2. Influence of foliar application of zinc on yield and yield attributes of different rice varieties.

S. No. TREATMENTS PREDICTED YIELD THROUGH SPSS MODEL(t/ha) OBTAINED YIELD IN EXPERIMENT(t/ha) PERCENTAGE INCREASE OVER PREDICTED YIELD(%)

S. No.	Treatment combinations	No. of Panicles/hill	No. of Grains/panicle	Test weight	Grain yield (t/ha)	Straw yield (t/ha)
1.	MTU-7029 + ZnSo4- 0.2%	7.55	120.56	19.08	5.06	9.67
2.	MTU-7029 + ZnSo4- 0.3%	8.36	126.20	19.67	5.31	9.90
3.	MTU-7029 + ZnSo4- 0.4%	8.57	131.78	20.02	5.56	10.09
4.	BPT -5204 + ZnSo4- 0.2%	7.72	127.65	19.66	5.30	9.83
5.	BPT -5204 + ZnSo4 - 0.3%	8.67	132.04	20.29	5.76	10.29
6.	BPT -5204 + Znso4 - 0.4%	9.08	135.72	21.06	6.16	11.06
7.	RNR15048 + ZnSo4- 0.2%	7.89	132.00	21.42	5.84	10.19
8.	RNR-15048 + ZnSo4- 0.3%	9.37	136.32	22.03	6.19	11.57
9.	RNR-15048 + ZnSo4 - 0.4%	10.01	141.37	22.27	6.43	12.11
	F test	S	S	S	S	S
	S Em (±)	0.23	1.98	0.21	0.07	0.22
	CD (P=0.05)	0.68	5.92	0.62	0.24	0.67

1.	MTU-7029 + ZnSo4- 0.2%	2.88	5.06	43.08
2.	MTU-7029 + ZnSo4- 0.3%	2.88	5.31	45.76
3.	MTU-7029 + ZnSo4- 0.4%	2.88	5.56	48.20
4.	BPT -5204 + ZnSo4- 0.2%	2.88	5.30	45.20
5.	BPT -5204 + ZnSo4 - 0.3%	2.88	5.79	50.26
6.	BPT -5204 + Znso4 - 0.4%	2.88	6.16	53.25
7.	RNR15048 + ZnSo4- 0.2%	2.88	5.84	50.68
8.	RNR-15048 + ZnSo4- 0.3%	2.88	6.19	53.47
9.	RNR-15048 + ZnSo4 - 0.4%	2.88	6.43	55.21

Table 3. Yield validation using SPSS model

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