Original Research Article

Influence of Varieties and Foliar Spray of Zinc on Growth , Yield and Economics of Rice(*Oryza sativa*L.)

ABSTRACT

A field experiment was conducted during *Kharif*2022 at Crop Research Farm, Departmentof Agronomy,Sam Higginbottom University of Agriculture,Technology AndSciences,Prayagraj(U.P)to determinethe"Influence of Varieties and Foliar Spray of Zinc on Growth , Yield and Economics of Rice(*Oryza sativa* L.)". The results showed that treatment 9 [BPT5204+Zinc(2.5%)]recordedsignificantlyhigherplantheight(113.77cm),,maximumnumberoftillers/hill(12.80),higherplantdryweight() (54.13g),maximum number of effective tillers/hill (12.50) ,maximumnumberofpanicles/plant(10.20),maximum number of grains/panicle (104.70), higher test weight (18.70 g), higher grain yield (5.81 t/ha),Maximumstraw yield (5.92 t/ha) and higher harvest index (50.19 %) compare to other treatment.Themaximumgrossreturns(1,62,773.00INR/ha),maximumnetreturn(1,10,546.50INR/ha)and highest benefit cost ratio (2.12) was recorded in treatment 9 [BPT5204+Zinc(2.5%)] ascomparedtoothertreatments.

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Keywords:*Rice, Varieties,Zinc, Growth,YieldandEconomics.*

Introduction

Rice (Oryza sativa L.) is the most consumed cereal grain in the world, constituting the dietary staple food of more than half of the world population and referred to as "Global grain". The theme on rice as "Rice is life" was used for international year of rice- 2004, denoting its overwhelming importance as an item of food and commerce by the United Nations. Globally, 1.4 billion ha of cultivable land is available. In rice growing countries, India has thelargest area under rice in the world**(Kiran *et al.*2019)**.It is tropical plant,it flourishes comfortably in hot and humid climate. It is fundamentally a kharif crop in India. It demands temperature of around 25 degree Celsius and above and rainfall of more than 100cm. It is also grown through irrigation in those areas that receives comparatively less rainfall. In India, states located in the Eastern and Southern parts cultivate the majority of rice. West Bengal is the leading rice producer in India which is followed by Uttar Pradesh, Telangana, Andhra, Punjab, Orissa, Bihar, Chhattisgarh, Tamil Nadu, Assam and

Haryana**(Singh *et al.*2020)**.The starch content of the rice plant is generally low during the early growth stages and increases toward flowering. Generally, before flowering, the starch accumulates in the leaf sheath and culm, but after flowering, it accumulates in the panicle. Much of the starch accumulated in the leaf sheath and culm before flowering is translocated into the grains during ripening. Carbohydrates produced by photosynthetic tissues is either transported to other organs as soluble sugars, or accumulated in leaves as soluble sugars and starch during the different growth stages. Soluble carbohydrates and starch, which accumulates under normal conditions before the stress commonly, constitute the main resources for plants to supply energy during stress condition**(Debbarma and Abraham ,2015)**

Rice ranks first in area and second in terms of production after china and is grown in all most tropical and sub humid regions of different countries .Globally, rice covers an area about 878 Million hectares with production of 898 Million tonnes and the productivity of 3348 kg/ha**(USDA ,2022)**. In India , rice grown cover an area about 43.78 Million hectares with production of 118.43 Million tonnes and productivity of 2708 kg/ha under 2019-2020,During 2019-2020 total area coverage under rice in Uttar pradesh 5.74 lakh hectare with the production of 13.11 lakh tonnes and productivity of 2704kg/ha **(GOI ,2020).** According to government third advance estimates rice production in 2020-2021 is 121.46 Million tonnes**(GOI ,2021).**

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zinc is the most commonly deficient micronutrient in agricultural soils. Analysis of over 256,000 soil samples from all over India showed that about 50% of the soils were deficient in zinc and it causes leaf bronzing and poor tillering at the early growth stages, leading to delayed maturity and significant yield loss, its main cause of deficiency of plant available Zn in soil is the precipitation or adsorption of Zn with various soil components, depending on the pH and redox potential **(Zinzala and Narwade,2019).**Zinc is one of the most essential micronutrients required for the growth and development of plant and human beings. One-third of the human population, including children and women suffer from Zn deficiency related health problems such as growth retardation, lack of appetite, lack of immune function, hair loss, diarrhoea, vision, and skin lesions, weight loss, delayed healing of wounds, and mental lethargy ,The lack of micronutrients has become the major nutritional problem affecting more than two billion people in both developed and developing countries of Asia, Africa and Latin America. Micronutrient deficiencies or "hidden hunger" affects approximately 38% of pregnant women and 43% of preschool children worldwide and the most widespread among developing countries **(Jatav and Singh ,2018).**

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RNR 15048 (Telangana Sona) It is widely recognized for its super fine quality (short slender) of good cooking quality with grain yield of 6.5-7.0t/ha and high milling recovery (68-70%).

*Kharif*Duration:110-120 days ,*Rabi* :125-130 days. It is said to be resistant to blast and tolerant to BPH nearly saving Rs. 2000 to 3000 per acre expenditure on plant protection.

KNM 118 (Kunaramsannalu) The rice culture, KNM 118 is a good alternate variety to mega rice variety, MTU 1010 as it exhibits high yield potential (7-8 t/ha) with good test weight, and is less prone to grain shattering and lodging at the time of harvest when compared to MTU 1010. Plant height:100-106 cm. Duration: *Kharif* :120-125 days ,*Rabi* :125-130 days. It is suitable for *kharif*, late *kharif* and *rabi*seasons. This culture has tolerance to leaf blast and neck blast.

BPT 5204 (Samba Masuri) The grain of samba masuri is of medium slender type and is semi dwarf variety suitable for rainfed shallow low lands of our country. Crop duration is 135-140 days and is suitable for *kharif* and *Rabi* seasons. The yield potential of BPT 5204 is 5.5 -6.0 t/ha. This variety is resistant to neck blast and tolerant to gall midge and is non-lodging and non-shattering type.

Zinc is an essential micro nutrient for crop plants. Zn is essential for several biochemical processes in rice plant, such as cytochrome and nucleotide synthesis, auxin metabolism, chlorophyll production, enzyme activation and membrane integrity. Zn- enrichment leads to more root surface area and the ability to change chemistry and biology of rhizosphere by releasing phytosiderophores from roots which ultimately increases Zn uptake by plants**(Suvarna *et al* .2015)**. zinc is major component and activator of several enzymes involved in metabolic activities , its deficiency continues to be one of the key factors in determining rice production in several parts of country **(Muthukumararaja and Sriramachandrasekharan 2012)** . Foliar application of zinc usually applied under emergencies to save the crops to symptoms of Zn appear ,single foliar application may not be adequate to severe deficiency symptoms , foliar application of 0.5% aqueous solution of $Znso_4$twice at 20 and30 days after transplanting **(Verma *et al.*2019)**. Keeping in view the above fact, the experiment was conducted to find out Influence of Varieties and Foliar spray of Zinc on Growth , Yield and Economics of Rice"(*Oryza sativa*L.)"

MATERIALSANDMETHODS:

Theexperimentwasconducteddur*ing Kharif*seasonof2022atCropResearchFarm,Department of Agronomy, Sam Higginbottom University of Agriculture, Technology AndSciences,Prayagraj(U.P).Thesoilofthefieldconstitutingapartofcentralgangeticalluviumisneutralanddeep.Thesoiloftheexperimentalfieldwassandyloamintexture,nearlyneutralinsoilreaction(pH7.8),lowleveloforganiccarbon(0.62%),availableN(225Kg/ha),P(38.2kg/ha) and K (240.7 kg/ha). The treatment consists of 3 different Zinc *viz.* (0.5%),(1.5%) and (2.5%) with combination of 3 Varieties *viz.* BPT5204, RNR15048, and KNM118. The experiment was laid out in RBD with 9 treatments eachreplicated thrice. The treatmentcombinations are Treatment 1[RNR 15048 + zinc (0.5%)],Treatment 2[RNR 15048 + zinc(1.5%)], Treatment 3[RNR 15048 + zinc (2.5%)], Treatment 4[KNM 118 + zinc (0.5%)], Treatment 5[KNM 118 +

zinc (1.5%)], Treatment 6[KNM 118 + zinc (2.5%)], Treatment 7[BPT 5204 + zinc (0.5%)], Treatment 8 [BPT 5204 + zinc (1.5%)], T [BPT 5204 + zinc (2.5%)]. Data recorded on different aspects of crop ,*viz*growth , yield attributes and yield were subjected to statistical analysis by analysis of variance method **(Gomez and Gomez , 1976)**

RESULTANDDISSCUSSION

Growth parametersPlantheight(cm):

The data revealed that significantlyhighest plant height (113.77 cm) was recordedinthetreatment9[BPT5204+ (Zinc2.5%)] (Table 1) . Significant and higher plantheight was recorded with the variety (BPT5204) might be due to variation in growth characters of varieties to genetic makeup, its adaptation to the environment.Similar results were reported by **Kiran*etal*. (2019)**. Further, in higher plantheight with application of zinc (2.5%) may duetoadequatesupplyofzincwhichcontributedtoaccelerateenzymaticactivityandauxinmetabolism inplants. Similar results Were reported by **Khan *et al* .(2007).**

Numberoftillers/hill:

The resultsrevealedthatsignificantandMaximumnumberof tillers/hill (12.80)wasrecordedinthetreatment9[BPT5204 + Zinc(2.5%)].However, treatment 4 [KNM118 + (Zinc 0.5%)] was found to be statisticallyatparwithtreatment 9 [BPT5204 + (Zinc 2.5%)](Table 1). The significant and Maximum number oftillers / hill was observed with the variety (BPT5204) might be due to geneticcharacter, Thedifferenceingrowthattributesindicatethatallricevarietiesresponddifferentlytotheappliednutrients uchasnutrientuptakeandnutrientuseefficiency. similar results were reported by **Pratap*etal*.(2020**).Further, increased in tiller/hill with application of zinc (2.5%) may due to its application attributed to its role in various enzymatic activity and auxin metabolism which control growth of plant. Similar results were reported by **Singh*etal*. (2020).**

Plant dry weight (g):

Data found that significant and higher plant dry weight (54.13 g) was recorded

inthetreatment5[KNM 118 +(Zinc 1.5%].However, treatment 8 [BPT 5204+(Zinc 1.5%)] was found to be statistically at par with treatment 5 [KNM 118 +(Zinc 1.5%)](Table 1). The Significant and higher plant dryweightwas observed with the variety KNM118 might be due to their genetic potential, capacity towards uptake of nutrients by varieties, competition of variety for space, light, nutrients and differential plant height. Similar results was also reported by **Patil *et al*. (2022)**. Further increased in plant dry weight with the application of zinc (2.5%) may due to important role of zinc for the activation of various types of enzymes , such as hose required for the Co_2 assimilation pathway and chlorophyll biosynthesis .Similar results were reported by **Suvarna *et al*.(2015).**

CropGrowth Rate(g/m^2/day):

The data recorded that significant and higher crop growth rate (7.95 g/m^2/day) wasrecorded in treatment 7 [BPT5204 +(Zinc 0.5%)].However,treatment 4 [KNM 118 +(Zinc 0.5%)] wasfoundtobestatisticallyatparwithtreatment 9 [BPT5204 +(Zinc 2.5%)] (Table1) .The significant and higher crop growth rate was recorded with application of zinc (2.5%) might be due to it is function of combined effects of genetic make up of plant, soil nutrient status ,seedling vigor and environmental conditions under which it is grown, resulted increased in crop growth rate of the plant. Similar results were reported by **Mustafa*etal*(2011).**

Yield Attributes &Yield

Number of effective tillers/hill :

The data showed that Significant and maximum number of effective tillers/hill (12.50) was recorded in the treatment 9 [BPT5204 + zinc (2.5%)] However ,treatment 4 [KNM118 + (zinc 0.5%] was found to be statistically to be statistically at par with treatment 9[BPT5204 + (zinc 2.5%)] (Table 2) . The significant and Maximum number of effective tillers/hill was recorded with the variety (BPT5204) might be due to varietal character and adequate availability of photosynthates under transplanted system of cultivation, good maintenance of source sink relationship due to longer reproductive phase. Similar results were also reported by **Manira*jetal* .(2022).** Further, increased in effective tillers/hill with application of zinc (2.5%) mayduetobetterutilizationofappliedzincowingtodevelopedrootsystem.Withthesufficientnutritionofzincgrowthpromotingsubstancelikeauxininplantisproducedandthatmayincreasetheoverallgrowthoftheplant.Similarresults were reported by **Sardar *et al.(2020)*.**

Numberofpanicles/plant:

The data recorded that significant and Maximum number of panicles/plant (10.20) wasrecorded in the treatment9 [BPT5204 + zinc (2.5%)]However , treatment 8 [BPT5204 + (zinc 1.5%)] was found to be statistically at par with treatment 9 [BPT5204 +(zinc 2.5)] (Table 2).The significant and maximum number of panicles/plant was recorded with the variety (BPT5204) might be due to increased accumulation of photosynthetic from the source to the sink and the differences in growth characters due to genotypes may be attributed to their inherent characteristics, resulted increased in panicles/ plant. Similar results were reported by **Dangi *et al.* (2017)**. Further increased in panicles/plant with application of zinc (2.5%) may due to Participation of Zn in biosynthesis of indole acetic acid (IAA) and its role in initiation of primordial reproductive parts and partitioning of photosynthates towards them are responsible for increased in panicles/plant. Similar results were reported by **Ram *et al* .(2013).**

Numberofgrains/panicle:

The data showed that significantly highest number of grains /panicle (104.70) wasrecorded in the treatment 9 [BPT5204 + zinc (2.5%)] (Table2). The significant and Maximum number of grains/panicle was recorded with the variety (BPT5204) might be due to Efficient utilization of growth resources, less intra species competition coupled with higher availability of nutrients among the widely spaced crop plants may be ascribed the reason for superiority in increasing of grains/panicle. Similar results were reported by **Rahem and Marzoka , (2020).** Further increased in number of grains/panicle with application of zinc (2.5%) may due to it is synthesizer of protein and carbohydrate resulted into bolder seeds and increased more number of grains/panicle. Similar results were reported by **Singh *et al*.(2018).**

Testweight(g):

Significantandhighertestweight(18.70g)wasrecordedinthetreatment9[BPT5204 + zinc (2.5%)]However , treatment 7 [BPT5204+ (zinc 0.5%)] was found to be statistically at par with treatment 9 [BPT5204+(Zinc2.5%)] (Table 2). The significant and higher test weight was recordedwiththevariety (BPT5204) might be due to better growth and translocation of photosynthates to reproductive parts, which might have increased grain weight of the plant. Similar results were reported by **Singh *et al* (2017).**Further increased in test weight (g) with application of zinc (2.5 %) may be due to it is involved in several physiological processes including protein synthesis, enzyme activation, carbohydrates metabolism, auxins, lipids, and nucleic acids , resulted increased in test weight . Similar results were reported by **Sayed *et al*.**

(2022).

GrainYield(t/ha):

Thedatarevealedthatsignificantly highestgrainyield(5.81 t/ha)wasrecordedinthe treatment9 [BPT5204 + zinc (2.5%)] (Table2).The significant and higher grain yield was recorded with the variety (BPT5204) might be due to greater vegetative growth and better light interception and higher dry matter portioning towards economic part, yield variability among rice cultivars also attributed to genetic characters and environmental effects . Similar results were reported by **Kumar*et al.* (2017).** Further increased in grain yield with application of zinc (2.5%) may due to fertilization is attributed to its involvement in many metallic enzyme system, regulatory functions and auxin production enhanced synthesis of carbohydrates and their transport to the site of grain production.Similar results were reported by **Muthukumararaja*et al* (2012).**

StrawYield (t/ha):

The data showed that significantly Maximum straw yield (5.92 t/ha) was recorded in thetreatment9[BPT5204 + zinc (2.5%)](Table 2). The significant and Maximum straw yieldwas recorded with the variety (BPT5204) might be due to higher photosynthetic rate as a result of enhanced LAI, which in turn boosted dry matter formation ,resulting in higher grain yield and straw yields. Similar results were reported by **Maurya *et al.* (2021)** . Further increased in straw yield with application of zinc (2.5%) may due to it is attributed to adequate supply of zinc that might have increased the availability and uptake of other essential nutrients resulting in improvement in metabolic activities and also due to the effect of zinc on the proliferation of roots. Similar results were reported by **Zinzala*et al.* (2019).**

HarvestIndex(%):

Data recorded that significant and higher harvest index (50.19 %) was recorded intreatment9[BPT5204 + zinc (2.5)].However , treatment 6 [KNM118 + (zinc 2.5%)] was found to be statistically at par with treatment 9 [BPT5204 +(zinc 2.5%)](Table 2). The significant and higherharvest index was recorded with the variety (BPT5204) might be due to adequate and available water at reproductive stages where irrigation system is flooded until ripening stage, resulted increased in harvest index . Similar results were reported by **Soriano *et al*.(2017).** Further increased in harvest index with application of zinc (2.5) may be due to it is indicated the greater translocation of photosynthates from source to sink and better portioning towards reproductive growth. Similar results were reported by **Saikh*et al.* (2022).**

ECONOMIC ANALYSIS

Economics:

The resultshowedthatmaximum gross returns (1,63,120.00INR/ha),Maximumnetreturn(1,10,893.50INR/ha)andhighestbenefitcostratio(2.12)wasrecordedintreatment9[BPT5204 + zinc (2.5%)].Ascomparedtoothertreatments(Table3). Maximum gross returns, net returns and benefit cost ratio was recorded with the application of zinc (2.5%) might be due to it is essential plant nutrient and its involvement in the physiological process is well pronounced , therefore increase in both grain and straw yield and ultimately increased benefit cost ratio. Similar results were reported by **Bareddy*et al*.(2020)**

CONCLUSION:

Basedonabovefindingsitcanbeconcludedthatcombinationof BPT5204alongwithZinc(2.5%) has performed better in growth parameters and yield attributes of rice and also proven profitable .

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Table1.Influence of Varieties and Foliar spray of Zinc onongrowthparametersofrice.

Sl. No.	Treatments	Plant heights(cm) AT 100 DAT	Number oftillers/hill AT 100 DAT	Plant dry weight(g) AT 100 DAT	Cropgrowth Rate ($g/m^2/day$) 80 – 100 DAT	Relative growth rate(g/g/day) 80 – 100 DAT
1	RNR15048+Zinc 0.5%	106.07	11.50	47.95	6.05	0.0017
2	RNR15048+Zinc 1.5%	106.17	10.80	49.06	7.27	0.0020
3	RNR15048+Zinc 2.5%	106.97	11.20	48.69	7.78	0.0021
4	KNM118+Zinc 0.5%	104.20	12.23	50.51	6.77	0.0018
5	KNM118 +Zinc1.5%	103.77	11.60	54.13	2.63	0.0006
6	KNM118 +Zinc2.5%	107.83	12.30	50.03	6.73	0.0018
7	BPT 5204+Zinc0.5%	108.70	12.12	49.30	7.95	0.0022
8	BPT 5204+Zinc1.5%	110.77	12.56	53.51	6.17	0.0015
9	BPT 5204+Zinc2.5%	113.77	12.80	53.14	5.12	0.0012
	Ftest	S	S	S	S	S
	SE(m)±	0.85	0.80	0.07	0.16	0.0038
	CD (p=0.05)	2.54	1.18	0.22	0.50	0.0012

Table2.Influence of Varieties and Foliar spray of Zinc on yield attributes and yield ofrice.

SlNo.	Treatments	Number of effective tillers/hill	Number ofpanicles/plant	Number ofgrains/panicle	Testweight (g)	Grain yield(t/ha)	Straw yield(t/ha)	HarvestIndex(%)
1	RNR15048+Zinc 0.5%	11.0	8.00	96.50	13.77	4.46	5.34	45.48
2	RNR15048+Zinc 1.5%	10.29	8.67	97.50	13.60	4.56	5.44	45.63
3	RNR15048+Zinc 2.5%	10.12	8.67	96.17	13.73	5.11	5.47	48.30
4	KNM118+Zinc 0.5%	11.54	7.67	94.73	15.30	4.85	5.49	46.94
5	KNM118 +Zinc1.5%	11.27	8.67	98.70	15.57	5.52	5.52	49.98
6	KNM118 +Zinc2.5%	10.57	8.33	98.47	15.60	5.59	5.65	49.73
7	BPT 5204+Zinc0.5%	11.58	8.78	99.10	18.60	5.67	5.63	49.55
8	BPT 5204+Zinc1.5%	12.0	9.34	101.8	18.63	5.69	5.67	50.10
9	BPT 5204+Zinc2.5%	12.50	10.20	104.70	18.70	5.81	5.92	50.19
	Ftest	S	S	S	S	S	S	S
	SE(m)±	0.45	0.36	0.26	0.14	0.07	0.14	0.27
	CD (p=0.05)	1.08	1.06	0.78	0.40	0.24	0.13	0.79

Table3. Influence of Varieties and Foliar spray of Zinc ontheeconomicsofrice.

Sl.NO	Treatment combinations	Economics			
		Costof cultivation	Grossreturn	Netreturn	B:CRatio
1.	RNR15048+Zinc 0.5%	51,727.50	1,24,787	73,059	1.41
2.	RNR15048+Zinc 1.5%	51,727.50	1,27,773	76,046	1.47
3.	RNR15048+Zinc 2.5%	51,977.50	1,43,080	91,353	1.77
4.	KNM118 +Zinc0.5%	51,977.50	1,35,893	83,916	1.61
5.	KNM118 +Zinc1.5%	51,977.50	1,54,467	1,02,489	1.97
6.	KNM118 +Zinc2.5%	52,227.50	1,56,520	1,04,543	2.01
7.	BPT 5204+Zinc0.5%	52,227.50	1,58,760	1,06,533	2.04
8.	BPT 5204+Zinc1.5%	52,227.50	1,59,320	1,07,093	2.05
9.	BPT 5204+Zinc2.5%	51,707.50	1,62,773	1,10,546	2.12