Biological Forum – An International Journal **(SI-AAEBSSD-2021) 13(3b): 291-294(2021)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Assessment of different doses of Zinc on Growth and yield of different Rice (*Orysa sativa*) cultivars

Rina Sisodiya[1], H.K. Rai[1], Megha Dubey[3], Usha Waskle[4], Nidhi Verma[4] and Anjum Ahmed[5]
[1]M.Sc. Scholar, J.N.K.V.V, Jabalpur (Madhya Pradesh), India.
[2] Senior Scientist Pi, AICRP on MSPE, (Madhya Pradesh), India.
[3]Scientist , Krishi Vigyan Kendra, Betul, J.N.K.V.V, Jabalpur, (Madhya Pradesh), India.
[4]FEO, College of Agriculture, Powerkheda, (Madhya Pradesh), India.
[5]Scientist, Krishi Vigyan Kendra, Narsinghpur, (Madhya Pradesh), India.
[6]Technical Assistant, BTC, College of Agriculture and Research Station, (Chhatisgarh), India.

(Corresponding author: Dr. Megha Dubey)*
(Received 01 July 2021, Accepted 30 September, 2021)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: A field trial was carried to find out the efficacy of different doses of zinc on growth, yield attributes and nutrient uptake in rice during the years 2017 at the Breeder Seed Production Unit (Soybean) of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh. The experiment consists of three main treatments as different rice varieties and five sub treatments of different concentration of Zn which were replicated three times in a split plot design.. The main treatment consist of V_1: Kranti,V_2: MTU1010 and V_3: PS 5 and sub plot 5 treatments consist of T_1: 100% NPK + No Zn (control), T_2: 100% NPK + 0.25% $ZnSO_4$ ha^{-1} (foliar spray) at 30 and 60 DAT, T_3: 100% NPK + 0.50% $ZnSO_4$ ha^{-1} (foliar spray) at 30 and 60 DAT, T_4 :100% NPK + 0.75% $ZnSO_4$ ha^{-1} (foliar spray) at 30 and 60 DAT, T_5 :100% NPK + 25 kg $ZnSO_4$ ha^{-1} (soil application). All the growth attributing characters such as (plant height, dry matter accumulation in shoot and root and number of tillers $hill^{-1}$) were studied at 35, 55, 75 DAT and at harvest of the crop which were significantly influenced by rice varieties and different levels of Zn applied at various days intervals. It was reported that maximum plant height, dry matter accumulation in shoot, root and number of tillers $hill^{-1}$ was obtained in rice variety Kranti with soil application of $ZnSO_4$ @ 25.0 kg ha^{-1}. The rice varieties and levels of Zn application significantly influenced the growth and yield attributing characters, yield and uptake of Zn, N, P and K in shoot, root, grain and straw. The rice variety Kranti and soil application of $ZnSO_4$ @ 25.0 kg ha^{-1} or foliar spray of 0.75 % $ZnSO_4$ at 30 and 60 days after transplanting was found to be the best for potential production of rice. It was also concluded that effect of rice varieties and levels of Zn application on pH, EC, OC and $CaCO_3$ was not significant. However, available Zn, N, P and K in soil were significantly altered by rice varieties and levels of Zn application.

Keywords: Zinc, Soil Organic Carbon, Zinc uptake, Gain yield, Straw yield, Nutrient uptake

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most prominent staple food for more than 60 per cent of the world population and it contribute about 45 per cent to the total food grain production in India. In India, rice occupies an area of about 43.39 M ha with average annual production of 104.32 million tonnes and productivity of 2404 kg ha^{-1}. In Madhya Pradesh rice is grown in about 2.02 M ha with production of 3.58 million tonnes and average productivity of 1768 kg ha^{-1}. In India, Zn is considered as the fourth important yield limiting nutrient in rice after N, P and K, respectively. The critical limit of available zinc in soil suitable for rice growth is 0.6 mg kg^{-1}. The plant available zinc in Indian soils extracted with DTPA is less than 1% of total zinc. The analysis of DTPA extractable Zn in soils has shown that 40% of soil samples were potentially zinc deficient. It has been postulated that the zinc deficiency is likely to increase from 49-63% by the year 2025 as most of the marginal soils brought under cultivation are showing the symptoms of zinc deficiency (Arunachalam *et al.,* 2013). In India 36.7% and MP 57.1% of the soils has been found to be deficient in Zn (Shukla and Tiwari, 2013). Almost 50% of the world soils used for cereal crops production are Zn deficient (Gibbson, 2006). Increasing the Zn concentration in crop plants for better crop productivity and improved human health is an important global challenge. In rice soils, Phosphorous fertilization decreased Zn uptake by plant. If the soil is slightly deficient in P or Zn, adding one of the nutrients result in the deficiency of the other one, which can be compensated by fertilizing both nutrients (Barben *et al.*, 2010). The increase in total N, K and Zn uptake has been attributed to synergistic effect between Zn and N and due to the positive interaction of K and Zn, respectively (Keram *et al.*, 2012). Application of Zn fertilizers in the soil increases the production of dry matter, grain yield and Zn concentration in grain (Fageria *et al.*, 2011). While, minimizing the use of inputs especially nutrients is one of the key for any agricultural production system. In spite of balanced application of macronutrients, productivity and quality of rice has been diminishing mainly because of spreading of micronutrients deficiency (Fageria *et al.*, 2002). Zinc fertilizers are used in the prevention of Zn deficiency and in the bio fortification of cereal grains (Alloway, 2009). Crop utilizes very low amount of fertilizer Zn but very high doses of fertilizer Zn are often applied to correct zinc deficiencies in crop due to high fixation of applied Zn in the soil. Zn use efficiency is hardly 1 to 5%. Transformation of zinc in to different chemical pools governs the availability of Zn to plants. Researches on Zn fertilizer have proved that application of Zn fertilizers effects the growth, yield and quality characters of rice (Patnaik *et al.*, 2011). Under Zn deficient condition the crops are likely to respond more to application of zinc the yield of rice grain and straw increased significantly due to application of 10 mg kg^{-1} zinc in deficient category by 56.6% and 13.8%, respectively. Whereas 28.5% and 9.6% response was observed in zinc sufficient soils. Apply zinc fertilizers is required for maintaining sufficient amount of available zinc in soil solution, maintaining

adequate availability to seeds and ultimately increases in the crop yield. Zinc application in soils can be done through different practices like soil application, foliar spray, seed treatment, fertigation etc.

MATERIAL AND METHOD

The present investigation entitled "Assessment of different doses of zinc on growth and yield of different Rice (*Orysa sativa*) cultivars was conducted during *kharif* season of 2017 at Breeder Seed Production farm (soybean) of JNKVV, Jabalpur. The soil of the experimental field was medium black clayey (Vertisols). Composite soil sample of 0-15 cm was collected from the experimental field with the help of soil auger following standard procedure to determine the initial properties of soil. Soil sample was air dried in shade and ground by wooden pastle and mortar, thereafter sieved through 2.0 mm sieve and stored in the cloth bag. The mean annual rainfall of Jabalpur was 1350 mm, mostly received during the month of June to September with a little and occasional rainfall in remaining part of year. The mean monthly temperature goes down to the limit of 4 $^{\circ}$C during winter while the maximum temperature reaches as high as 45 $^{\circ}$C during the summer. Generally, relative humidity remains very low during summer (15 to 30%), moderate during winter (60 to 75%) and it attains higher value (80 to 95%) during rainy season. It is evident from the data that weather conditions were almost favorable for the growth and development of rice. The monsoon commenced in the first week of July and terminated in the second week of October. The total rainfall received during the crop season was 949.1 mm, which was equally distributed in 42 rainy days from first week of July to last week of December. Minimum and maximum mean temperature ranged from 3.9 to 24.6 $^{\circ}$C and 26.7 to 33.8 $^{\circ}$C respectively. The relative humidity ranged from 82 to 93 % in morning and 21 to 81 % in evening. The mean sunshine hour remained between 1.4 to 9.3 hours per day. The main treatment details are V_1: Kranti,V_2: MTU1010 and V_3: PS 5 and sub plot 5 treatments as T_1: 100% NPK + No Zn (control), T_2: 100% NPK + 0.25% $ZnSO_4$ ha^{-1} (foliar spray) at 30 and 60 DAT**,** T_3: 100% NPK + 0.50% $ZnSO_4$ ha^{-1} (foliar spray) at 30 and 60 DAT**,** T_4: 100% NPK + 0.75% $ZnSO_4$ ha^{-1} (foliar spray) at 30 and 60 DAT, T_5 :100% NPK + 25 kg $ZnSO_4$ ha^{-1} (soil application).

RESULT AND DISCUSSION

Growth attributing characters like plant height, plant dry matter and number of tillers $hill^{-1}$ in various rice varieties at different DAT were observed. The effect of different rice varieties and various levels of zinc application effect on plant height at 35, 55, 75 DAT and at harvest was significant. Maximum plant height was recorded under Kranti followed by MTU 1010 and lowest in PS 5 variety. It was also found that plant height increased progressively with the increase in levels of zinc application and significantly higher plant height was obtained under soil application of $ZnSO_4$ @ 25.0 kg ha^{-1} treatment which was statistically at par with those obtained in foliar spray of 0.75 % $ZnSO_4$ at 30 and 60 DAT treatments. It might be attributed to adequate supply of zinc under these treatments which accelerates the activity of enzymes and auxins metabolism in plants resulted in higher plant height. The results pertaining to effect of rice varieties and levels of zinc application on dry matter accumulation (shoot and root) at different days after transplanting was significant. It was found that dry matter accumulation in shoot and roots increased progressively from 35 DAT till harvest of the crop. Dry matter accumulation in shoot and root was significantly higher in Kranti over MTU 1010 and PS-5 and PS-5 varieties. It might be due to faster biomass accumulation ability of Kranti variety over others. Dry matter accumulation increased by 0.75 % $ZnSO_4$ foliar application over lower doses of zinc application. Result pertaining to effect of rice varieties and levels of zinc application on number of tillers $hill^{-1}$ showed that maximum and significantly higher number of tillers $hill^{-1}$ was obtained in Kranti variety under soil application of 25 kg ha^{-1} zinc sulphate treatment as compared to other varieties.

It is clearly evident from the result that effect of rice varieties and levels of zinc application directly influenced the available N, P and K contents in soil at 55 DAT and after harvest of the crop and significantly higher available N, P and K in soil was obtained under PS 5 followed by MTU 1010 over Kranti. It might be because of lower withdrawal of nutrients from soil by PS-5 and MTU 1010 as compared to Kranti variety. Results further showed a significantly higher content of available N, P and K in soil under control as compared to higher levels of Zn application. It may be due to poor growth and yield under control caused by sub-optimal supply of zinc resulted less uptake of N, P and K from soil. Kranti variety was more than those in MTU 1010 and PS-5 varieties. It might be because of higher shoot and root biomass production at different intervals in Kranti as compared to MTU 1010 and PS-5 varieties. Results further revealed that highest uptake of N, P and K in shoot and root was found in soil application of 25 kg $ZnSO_4$ ha^{-1} treatment followed by foliar spray of 0.75 % $ZnSO_4$ at 30 and 60 DAT treatment and lowest in control. The increase N and K uptake could be attributed to synergistic effect between N and Zn and due to the positive interaction of K and Zn, respectively.

Table 1: Effect of zinc application in rice varieties on number of tillers at different intervals.

Main plot treatments (Rice varieties)	Number of tillers $hill^{-1}$			
	35 DAT	55 DAT	75 DAT	At harvest
Kranti	14.0	16.7	16.9	15.3
MTU 1010	11.0	12.9	13.4	13.1
PS 5	9.1	10.7	11.6	10.4
SEm±	**0.38**	**0.43**	**0.61**	**0.56**
CD (*p=0.05*)	**1.11**	**1.20**	**1.79**	**1.63**
Sub-plot treatments (Zn levels)				
Control (No Zn)	8.0	9.9	9.2	7.9
Foliar sprays of 0.25 % $ZnSO_4$ at 30 and 60 DAT	9.9	10.7	10.0	9.7
Foliar sprays of 0.50 % $ZnSO_4$ at 30 and 60 DAT	10.8	12.1	11.3	10.5
Foliar sprays of 0.75 % $ZnSO_4$ at 30 and 60 DAT	12.9	14.6	13.8	13.4
Soil application of $ZnSO_4$ @ 25.0 kg ha^{-1}	14.7	16.1	15.0	14.5
SEm ±	**0.64**	**0.53**	**0.48**	**0.39**
CD (*p=0.05*)	**1.82**	**1.56**	**1.41**	**1.15**
Rice Varieties X Zn levels	**NS**	**NS**	**NS**	**NS**

It is clearly evident from the result that effect of rice varieties and levels of Zn application directly influenced the concentration of available Zn in soil and a significantly higher available Zn in soil was obtained under PS 5 followed by MTU 1010 over Kranti variety may be due to less biomass production and lower uptake of Zn from soil. Results further showed significantly higher available Zn in soil under higher levels of Zn application and maximum available Zn in soil was obtained under 25.0 kg $ZnSO_4$ ha^{-1} treatment and minimum in control. It might be because of zinc application and accumulation of residual Zn left after crop harvest. Highest Zn-uptake in grain and straw was obtained in Kranti followed by MTU 1010 and PS-5 varieties. Results further showed a progressive and significant increase in Zn-uptake due to increase in levels of Zn application and maximum Zn-uptake in grain and straw was obtained under 25.0 kg $ZnSO_4$ ha^{-1} treatment and minimum in control. Increase in Zn-uptake in grain and straw with zinc levels could be ascribed to the variation in the availability of applied Zn in the root zone and their role in the growth and development which was well supported by the findings of Muthukumararaja and Sriramachandrasekharan (2012).

Table 2: Effect of zinc application in rice varieties on yield attributes.

Main plot treatments (Rice varieties)	Yield attributes			Yield (kg ha^{-1})	
	Panicles $hill^{-1}$	Grains $panicle^{-1}$	1000-grains weight (g)	Grain	Straw
Kranti	13.8	107.9	25.3	4011	5670
MTU 1010	11.2	92.7	24.4	3487	5006
PS 5	9.5	78.5	24.1	3190	4630
SEm±	**0.79**	**4.96**	**0.31**	**103.5**	**193.8**
CD (*p=0.05*)	**2.35**	**14.76**	**0.88**	**298.3**	**569.2**
Sub-plot treatments (Zn levels)					
Control (No Zn)	6.3	79.9	24.6	2947	4294
Foliar sprays of 0.25 % $ZnSO_4$ at 30 and 60 DAT	8.1	84.7	23.8	3179	4385
Foliar sprays of 0.50 % $ZnSO_4$ at 30 and 60 DAT	9.3	88.9	25.2	3285	4700
Foliar sprays of 0.75 % $ZnSO_4$ at 30 and 60 DAT	11.5	97.6	25.5	3627	5039
Soil application of $ZnSO_4$ @ 25.0 kg ha^{-1}	12.4	105.3	25.6	3746	5213
SEm ±	**0.54**	**5.20**	**0.32**	**117.6**	**189.4**
CD (*p=0.05*)	**1.59**	**9.14**	**0.93**	**339.8**	**547.9**
Rice Varieties X Zn levels	**NS**	**NS**	**NS**	**NS**	**NS**

Table 3: Effect of zinc application in rice varieties at different intervals.

Main plot treatments (Rice varieties)	Soil Organic Carbon (g kg^{-1})		Calcium Carbonate (%)		Available N (kg ha^{-1})		Available P (kg ha^{-1})		Available K (kg ha^{-1})		Available Zinc (mg kg^{-1})	
	55 DAT	After harvest	55 DAT	After harvest	55 DAT	55 DAT	After Harvest	After Harvest	55 DAT	After Harvest	55 DAT	After Harvest
Kranti	6.21	6.33	6.32	6.52	176.5	160.7	13.6	11.4	219.3	210.2	0.63	0.61
MTU 1010	6.25	6.29	6.53	6.67	181.4	169.2	14.5	11.9	226.5	212.9	0.66	0.63
PS 5	6.44	6.50	6.79	6.59	182.6	174.8	15.7	13.2	231.8	219.6	0.67	0.65
SEm±	**0.164**	**0.284**	0.134	0.138	**1.53**	**1.74**	**0.113**	**0.129**	**6.92**	**7.76**	**0.008**	**0.012**
CD(*p=0.05*)	**NS**	**NS**	**NS**	**NS**	**4.43**	**4.93**	**0.326**	**0.381**	**NS**	**NS**	**0.022**	**0.034**
Sub-plot treatments (Zn levels)												
Control (No Zn)	6.10	6.18	6.27	6.50	191.4	179.3	15.9	13.9	246.4	235.8	0.69	0.65
Foliar sprays of 0.25 % $ZnSO_4$ at 30 and 60 DAT	6.18	6.20	6.48	6.52	180.0	167.6	14.3	12.8	233.7	224.5	0.64	0.62
Foliar sprays of 0.50 % $ZnSO_4$ at 30 and 60 DAT	6.31	6.33	6.48	6.54	178.1	161.7	13.6	11.5	218.9	210.4	0.68	0.64
Foliar sprays of 0.75 % $ZnSO_4$ at 30 and 60 DAT	6.35	6.52	6.78	6.69	173.3	156.7	13.2	10.9	212.6	207.6	0.67	0.63
Soil application of $ZnSO_4$ @ 25.0 kg ha^{-1}	6.46	6.60	6.72	6.66	174.1	159.4	13.6	11.3	216.8	209.8	0.72	0.68
SEm ±	**0.230**	**0.212**	0.273	0.214	**3.25**	**3.11**	**0.117**	**0.108**	**8.45**	**7.86**	**0.016**	**0.011**
CD(*p=0.05*)	**NS**	**NS**	**NS**	**NS**	**9.17**	**8.84**	**0.345**	**0.296**	**14.89**	**21.82**	**0.045**	**0.031**
Zn levels X Rice Varieties	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Initial value	**6.45**		**6.70**		**178.6**		**11.8**		**261.8**		**0.71**	

SUMMARY

All the growth and yield attributing characters like (plant height, dry matter accumulation in shoot and root and number of tillers $hill^{-1}$) studied at 35, 55, 75 DAT and at harvest of the crop were significantly influenced by rice varieties and levels of Zn application at different days intervals. Maximum plant height, dry matter accumulation in shoot and root and number of tillers $hill^{-1}$ was obtained in Kranti variety under at soil application of $ZnSO_4$ @ 25.0 kg ha^{-1} treatment and minimum in control. The rice varieties and levels of Zn application significantly influenced the growth and yield attributing characters, yield and uptake of Zn, N, P and K in shoot, root, grain and straw. Kranti variety and soil application of $ZnSO_4$ @ 25.0 kg ha^{-1} or foliar spray of 0.75 % $ZnSO_4$ at 30 and 60 days after transplanting was found best for potential production of rice. It was also concluded that effect

of rice varieties and levels of Zn application on pH, EC, OC and $CaCO_3$ was not significant. However, available Zn, N, P and K in soil were significantly altered by rice varieties and levels of Zn application.

FUTURE SCOPE

Rice is one of the most important crop in MP and zinc is the most deficient element in soils of MP .Therefore, if the study continues we will be able to rectify the correct and right method of its application and use to get maximum profit. The losses due to zinc deficiency will be checked by this type of studies.

Acknowledgement. I would like to thank my Guide for his valuable guidance and support for this study and help in analysis of my result. I would like to thank Dr. Megha Dubey for helping me in preparing this paper.

Conflict of Interest. Zinc has its own role in increasing the yield of cereal crops. Such types studies will help in reducing its excess application and will maintain balance in the soils.

REFERENCES

Alloway, B. J. (2009). Soil factors associated with zinc deficiency in crops and humans. *Environmental Geochemistry and Health*, *31*(5): 537-548.

Arunachalam, P., Kannan, P., Prabukumar, G. and Govindaraj, M. (2013). Zinc deficiency in Indian soils with special focus to enrich zinc in peanut. *African Journal of Agricultural Research*, *8*(50): 6681-6688.

Barben, S.B., Hopkins, V., Jolley, B. and Nichols, B. (2010). Phosphorus and zinc interactions in chelat buffered solution grown russet burbank potato. *Journal of Plant Nutrition*, *33*: 587-601.

Fageria, N.K., Baligar, V.C. and Clark, R.B. (2002). Micronutrients in crop production. *Advances in Agronomy*, *77*: 185-268.

Fageria, N. K., Dosantos, A. B. and Cobucci, T. (2011). Zinc nutrition of lowland rice. *Communication in Soil Science and Plant Analysis*, *42*: 1719-1727.

Gibbson, R. S. (2006). Zinc the missing link in combating micronutrient malnutrition in developing countries. *Proceedings of the Nutrition Society*, *University of East Anglia*, *Norwich*, 28 June-1 July, 2005.

Keram, K. S., Sharma, B. L., Sawarkar, S. D. (2012). Impact of Zn application on yield, Quality, Nutrients uptake and Soil fertility in a medium deep black soil (Vertisol). *International Journal of Science, Environment and Technology*, *1*(5): 563–571.

Muthukumararaja, T. M. and Sriramachandrasekharan, M. V. (2012). Effect of zinc on yield, zinc nutrition and zinc use efficiency of lowland rice. *Journal of Agricultural Technology*, *8*(2): 551-561.

Patnaik, M. C., Raju, A. C. and Bhupal, R. G. (2011). Zinc requirement of hybrid rice –Bhendi and its influence on zinc fractions in an Alfisol of Hyderabad. *Journals of Indian Society of Soil Science, 9:* 368-375.

Shukla, A. K. and Tiwari, P. K. (2013). Micro and secondary nutrients and pollutant elements research in India. IISS Bhopal, *20*: 14-28.