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Response of Zinc Application on Aerobic Rice in Inceptisols of Raigarh District in Chhattisgarh Plains

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Abstract: ***Field experiments was conducted in kharif 2016 at the Instructional Farm of Krishi Vigyan Kendra, Raigarh (C.G.), to find out the effect of different levels of zinc (0, 5, 10, 15, 20, 25 and 30 kg Zn SO4 ha-1) on yield, economics and Zn uptake by rice. The results revealed that the rice responded significantly to graded doses of zinc application. The highest grain (4.85 t ha-1) and straw yield (6.58 t ha-1) was recorded at 25 kg ZnSO4 ha-1 which was 50.62 % and 20.73 % greater than control, respectively. The highest zinc concentration (22.50 mg kg-1, 46.40 mg kg-1) and uptake (109.12 g ha-1, 305.97 g ha-1) in grain and straw were recorded at 25 kg ZnSO4 ha-1. The highest apparent zinc recovery(2.48 %) was recorded at lower level of zinc application. However. increasing levels of Zn increased available Zn (1.42 mg kg-1) in post harvest soil was noted at 30 kg Zn SO4 ha-1. All growth and yield parameters were performed better under 25 kg Zn SO4 ha-1. Net returns (Rs.38065.00 ha-1) and B: C ratios (2.10) were recorded highest with 25 kg Zn SO4 ha-1.***

Keywords: Zinc response, yield, zinc uptake, zinc use efficiency, residual zinc, and rice.

1. Introduction

Zinc is one of micro essential elements necessary for the normal growth and development of plants. It is among eight micronutrients essential for plants, Zn is ranked as the fourth most deficient element in Indian soils after N, P and K. Shukla and Behera (2011) reported that 49% of the Indian soils are deficient in Zn. However, Zinc deficiency in plants retards photosynthesis and nitrogen metabolism, reduces flowering and fruit development, prolongs growth periods (resulting in delayed maturity), decreases yield and quality, and results in sub-optimal nutrient-use efficiency. Rice is the stable food for more than half of the world population and it provides 21% and 15% per capita of dietary energy and protein, respectively (Maclean et al., 2002). Being the single major source of Agricultural GDP, rice plays a significant role in the state economy. Considering the intensive cultivation of high yielding rice varieties and inceptisols in the rice growing areas of Chhattisgarh, the response of rice to applied Zn is the subject deserving investigation. In Chhattisgarh, most of the cultivable land especially rice growing soils are showing Zn deficiency and information in relation to Zn fertilizer management is inadequate. However, response to zinc application was observed in zinc deficient areas, but an optimum level of zinc had not been determined and in relation to agro climatic conditions of State. Therefore, this study was conducted with an objective to find out a suitable level of zinc fertilizer to supply the zinc requirement to increase the yield and productivity of rice in Inceptisols of Raigarh District in Chhattisgarh Plains.

2. Materials and Methods

Field experiments was conducted in kharif 2016 at Instructional Farm of Krishi Vigyan Kendra, Raigarh (C.G.). The physico-chemical characteristics of the soil were sandy clay loam in texture, pH 6.5, EC 0.85 dSm-1, organic carbon 0.55 %, available N 285 kgha-1, available P 13.70 kgha-1, available K 284 kgha-1 and available Zn 0.78 mgkg-1. The experiment consisted of six levels of ZnSO4 (0, 5, 10, 15, 20 ,25 and 30 Kg ha-1) which corresponds to 0, 1.05, 2.1, 3.15, 4.2, 5.25, and 6.3 Kg Zn ha-1 in a randomised block design with three replications. Recently release rice variety IGKV R-1 (Rajeshwary) twenty two days old seedlings were transplanted with three plants per hill at a spacing of 20x20 cm surrounded by 30 cm wide bunds. Recommended dose of N, P and K through Urea, SSP, and MOP were applied @ 80kg N + 50 kg P2O5 + 30 kg K2O ha-1 along with 2t ha-1 farm yard manure (FYM) as broadcast and incorporated into the soil by puddling just before transplanting. Application of urea in three splits viz. at basal (50 %), maximum tillering (25 %) and panicle initiation stage(25 %). Plant growth parameters was measured by taking plant height, total tillers, effective tillers, filled grain, saffy grain and thousand grain weight. Grain and straw yields were recorded of harvested rice at maturity. Analysis of zinc content in dried grain and straw samples were digested in diacid mixture and determined in Atomic Absorption spectrophotometer. Zinc uptake was calculated by multiplying factor in grain and straw yield with respective zinc content. Zinc use efficiency (kg grain kg-1 Zn) and apparent zinc recovery (%) of rice grains were recorded.

3. Results and Discussion

Yield: Grain and straw yield of rice responded significantly to zinc application (Table 1). Increasing levels of Zn increased gradually grain and straw yield.. All the treatments produced significantly different grain and straw yield. The grain yield ranged from 3.22 t ha-1 to 4.85 t ha-1 and straw yield from 5.45 t ha-1 to 6.58 t ha-1 due to Zinc application. The highest grain (4.85 t ha-1) and straw yield (6.58 t ha-1) was found in the treatment receiving 25 kg ZnSO4 ha-1 which was significantly higher than all other treatments. Zinc application increase in grain yield among the treatments varied from 10.24 to 50.62 percent over control, while in straw yield, increase varied from 04.03 to 20.73

percent. Similar zn application increase dry matter and grain yields in different crops have also been reported by Kumar et al (2011). The grain and straw yield increase with application of zinc may be 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 findings were also reported by Muthukumaraja et al. (2013).

Content and uptake of Zinc: The Zn application increased gradually Zn content and zn uptake in grain and straw with increase in Zinc level up to 25 kg ZnSO4 ha-1 and decreased at 30 kg ZnSO4 ha-1(Table 2). It was observed that maximum Zn concentration 22.50 and 46.50 zn mg kg-1 and uptake of 109.12 g ha-1 and 305.97 g ha-1 was recorded with 25 kg ZnSO4 ha-1 in grain and straw, respectively which was statistically higher than the treatment receiving 30 kg ZnSO4 ha-1. Dwivedi and Tiwari (1992) also reported that zinc concentration and uptake in grain and straw increased with Zinc rate particularly in zinc deficient soils.

Efficiency indices: Higher levels of Zn decreased significantly apparent Zn recovery (Table 2). It was observed that due to inverse relationship often with between utilization and rate of application. The maximum values of apparent Zn recovery (2.48 %) was recorded at 5 kg ZnSO4 ha-1. However, increasing levels of Zn decrease apparent Zn recovery (0.72 %) was noted at 30 kg ZnSO4 ha-1. The available Zn content of soil was depleted under control. The available Zn status of initial soil which was 0.55 mg kg-1 decreased to 0.50 mg kg-1 after harvest of rice crop. The zinc status of soil varied from 0.55 mg kg-1 at control to 1.42 mg kg-1 at 30 kg Zn SO4 ha-1. Similar results were also reported by Singh (2009).

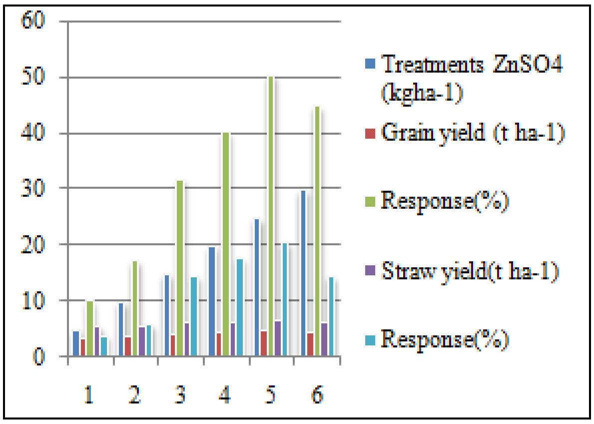
Economics: Economic analysis of experiment revealed that the highest cost of cultivation (Rs.34600.00 ha-1) was recorded in 30 kg ZnSO4 ha-1. The gross return (Rs.72265.00 ha-1), net Return (Rs.38065.00 ha-1) and B: C ratio (2.10) were recorded highest with 25 kg ZnSO4 ha-1. This might be due to higher yield obtained in this treatment compared to all other levels of Zn. It was economically observed that lowest net returns (Rs. 15478.00 ha-1) and B:C ratio (1.47) were recorded under control due to lower yields of rice. The present study was concluded that application of 25 kg ZnSO4 ha-1 proved significantly beneficial in respect of yield and economics of rice grown in Inceptions of Raigarh District In Chhattisgarh Plains.

4. Conclusion

The present study of zinc application revealed that the rice responded significantly to graded doses of zinc application. The highest grain and straw yield was recorded at 25 kg ZnSO4 ha-1 which was greater than control, respectively. The highest zinc concentration and uptake in grain and straw were recorded at 25 kg ZnSO4 ha-1. The highest apparent zinc recovery was recorded at lower level of zinc application. However, Increasing levels of Zn increased available Zn in post harvest soil was noted at 30 kg Zn SO4 ha-1. Economic analysis of different treatments revealed that gross return, net returns and B: C ratios were recorded highest with 25 kg Zn SO4 ha-1. The study was concluded that application of 25 kg ZnSO4 ha-1 proved significantly beneficial in respect of yield and economics of rice.

Table 1: Effect of Zinc on grain and straw yield and economics.

Treatments ZnSO4 (kgha-1)	Grain yield (t ha-1)	Response (%)	Straw yield (t ha-1)	Response (%)	Gross Return (Rs.ha-1)	Net Return (Rs.ha-1)	B:C Ratio
0	3.22	-	5.45	-	47978.00	15478.00	1.47
5	3.55	10.24	5.67	04.03	52895.00	20045.00	1.61
10	3.78	17.39	5.78	06.05	56322.00	23122.00	1.69
15	4.25	31.98	6.25	14.67	63325.00	29775.00	1.88
20	4.52	40.37	6.43	17.98	67348.00	33448.00	1.98
25	4.85	50.62	6.58	20.73	72265.00	38065.00	2.10
30	4.67	45.03	6.25	14.67	69583.00	34983.00	2.01
S.Em	0.63		1.22	-	-	-	-
CD (0.05%)	1.48		2.64	-	-	-	-



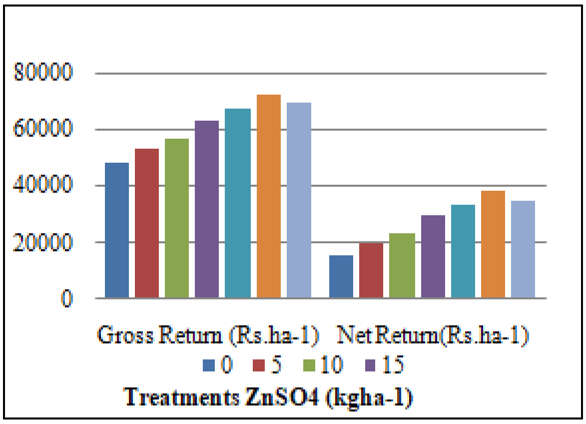


Table 2: Effect of zinc on Zn contents, Zn uptake, apparent Zn recovery and available Zn

Treatments ZnSO4 (kgha-1)	Zinc content (mg kg-1)		Zinc uptake(g ha-1)		Apparent Zn Recovery (%)	Available Zn (mg Kg-1)
	Grain	Straw	Grain	Straw		
0	16.20	30.65	52.16	167.04	-	0.55
5	19.25	34.70	68.33	196.74	2.48	0.82
10	17.80	41.57	67.28	240.27	0.93	0.95
15	18.40	43.30	78.20	270.62	0.95	1.10
20	21.20	40.20	95.82	258.48	0.98	1.30
25	22.50	46.50	109.12	305.97	1.05	1.35
30	21.60	46.30	100.82	289.37	0.72	1.42
S.Em	0.47	1.43	3.63	8.36	-	0.10
CD (0.05%)	1.04	3.21	7.87	18.17	-	0.21

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