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Response of zinc in transplanted rice under integrated nutrient management in New Alluvial Zone of West Bengal

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ABSTRACT

Field experiments were conducted during wet seasons of 2004 and 2005 to study the effect of Zn in combination with FYM and/or recommended dose (RD) of NPK on transplanted rice. Application of 10 kg Zn (5.0 + 2.5 + 2.5 kg ha^{-1}) in three splits in combination with RD of NPK (60:13:25 kg ha^{-1}) recorded significantly higher growth, yield attributes, grain (42.5 t ha^{-1}) and straw (46.6 t ha^{-1}) yield and showed additional net return of Rs 1,967 ha^{-1}. However, the benefit : cost ratio was highest (1.72) for the treatment RD of NPK in combination with Zn (2.5 + 2.5 kg ha^{-1}) in two equal splits.

Key words: *Zinc, integrated nutrient management, transplanted rice, inceptisol*

Agriculture, particularly in West Bengal rice-based cropping system, experiencing stagnation or decline in productivity (Bhandari *et al.*, 2002) due to low organic matter as well as micronutrient content of soils. Zinc deficiency is one of the micro-nutrient deficiencies in rice soil. Continuous use of high analysis fertilizers without application of organic manures in soil manifest the occurrence of wide spread Zinc deficiency. Khanda *et al*. (1997) reported that zinc deficiency in rice soils exists since long time, hence blanket soil application of 5-20 kg ha^{-1} of $ZnSO_4$ has been recommended for most of the field crops to correct the deficiency. However, the residual response of applied $ZnSO_4$ persists for two or more years depending on soil characteristics and rate of application. The present investigation was undertaken to assess the response of Zinc with integrated nutrient management on growth and yield attributes, yield and benefit : cost ratio of transplanted rice.

MATERIALS AND METHODS

A field experiments were conducted during wet seasons of 2004 and 2005 at Kalyani, West Bengal in sandy clay loam soil having pH 7.7, organic carbon 0.67%, extractable Zn (0.44 mg kg^{-1}), total N 0.067%, P 18.50 kg ha^{-1} and available K 186.0 kg ha^{-1}. Ten treatments comprising of Recommended dose (RD) of N, P_2O_5 and K_2O at 60:13:25 kg ha^{-1} (Control), RD of NPK + FYM at 5 t ha^{-1}, RD of NPK + FYM at 5 t ha^{-1} + Zn at 5 kg ha^{-1} (basal), RD of NPK + Zn at 5 kg ha^{-1} (basal), RD of NPK + Zn at 10 kg ha^{-1} (basal), RD of NPK + Zn at 5 kg ha^{-1} (½ basal + ½ active tillering stage), RD of NPK + Zn at 10 kg ha^{-1} (½ basal + ½ active tillering stage), RD of NPK + Zn at 10 kg ha^{-1} (½ basal + ¼ active tillering stage + ¼ panicle initiation stage), RD of NPK + one spray of $ZnSO_4$ 0.5% solution at active tillering stage, RD of NPK + two spray with 0.5% $ZnSO_4$ solution at active tillering stage and panicle initiation stage replicated thrice in randomized block design. Rice variety 'Satabdi' (IET-4786) was sown in 3rd week of June and transplanted in the 2nd week of July and subsequently the harvesting was done in the 3rd week of October during both the years. The crop received the rainfall of 1346.5 mm and 1311 mm during 2004 and 2005, respectively. The full dose of P and K and ¼ of N was applied as basal at the time of transplanting and remaining ½ and ¼ of N were applied in two splits during tillering and panicle initiation stage. Well decomposed FYM was applied during final puddling. However, $ZnSO_4$ was used as a source of Zn applied in field as per treatment schedule.

RESULTS AND DISCUSSION

The effect of levels of Zn in respect of FYM and recommended dose of NPK significantly influenced all the growth attributes of rice (Table 1). Plant height and volume of roots increased with the age and recorded maximum value till last observations i.e. 90 days after transplanting (DAT). The application of Zn in split doses proved to be significantly superior than the application of same amount of Zn as basal which might be due to split application increased the Zn use efficiency. Plant height as well as volume of roots increased with increasing the levels of Zn from 5 kg ha^{-1} to 10 kg ha^{-1} might be due to greater availability of Zn to the plant. Application of 5 kg Zn ha^{-1} as basal along with RD of NPK and FYM (5 t ha^{-1}) and application of 5 kg Zn ha^{-1} in two equal splits along with RD of NPK did not show any significant difference might be due to better availability of Zn in both the cases. The increase plant height with increasing levels of Zn was also reported by Ullah *et al.* (2001) and Ghatak *et al.* (2005).

The maximum leaf area indices (LAI) and crop growth rate (CGR) were recorded at 70 DAT and 50-70 DAT respectively and thereafter both are declined. The basal applied Zn in respect of number of splits and doses along with RD of NPK was recorded more or less similar growth attributes among themselves but better than other treatments. This could possibly due to lower inherent Zn status of the soil under study. The results confirm with the findings of Samui and Mandal (2003). However, among the treatments, significantly higher growth attributes were recorded when Zn applied in three splits along with RD of NPK followed by Zn in two equal splits along with RD of NPK combinations irrespective of dates of observations except leaf area indices at 50 DAT.

The levels of zinc in combination with FYM and recommended dose of NPK significantly influenced the yield attributes, grain and straw yield and harvest index of rice (Table 2) except test weight. All yield attributes, grain and straw yield and harvest index increased irrespective of levels of Zn in combination with FYM and RD of NPK. The higher dose of Zn when splited and in combination with RD of NPK and FYM produced higher yield attributes, yield of grain and straw and harvest index over control. The maximum yield attributes, grain and straw yield and harvest index were recorded when Zn was applied in three splits along with RD of NPK treatment followed by zinc in two equal splits along with RD of NPK treatment and they were statistically at par. Application of registered 33.5

Table 1. Effect of levels of Zn in combination with FYM and recommended dose of NPK on growth attributes of rice (Pooled data 2004 and 2005

Treatments	Plant height (cm)				Leaf area index				Crop growth rate (gm^{-2} $days^{-1}$)			Volume of roots ($cc\ m^{-2}$)			
	30 DAT	50 DAT	70 DAT	90 DAT	30 DAT	50 DAT	70 DAT	90 DAT	30-50 DAT	50-70 DAT	70-90 DAT	30 DAT	50 DAT	70 DAT	90 DAT
RD (Control)	37.9	67.1	77.1	87.2	2.4	3.2	3.7	1.7	7.9	13.7	7.2	294.6	341.8	363.0	382
RD + FYM (5 t ha^{-1})	40.5	71.4	81.0	91.1	2.5	3.4	4.1	2.1	8.4	14.5	7.9	301	354.7	378.2	395
RD + FYM (5 t ha^{-1}) + Zn (5 kg ha^{-1})	43.6	74.5	83.8	94.5	2.6	3.7	4.3	2.3	9.3	15.2	8.1	310.2	363.3	389.3	406
RD + Zn (5 kg ha^{-1})	42.9	72.4	82.1	91.7	2.6	3.5	4.1	2.2	8.3	14.6	8.0	309.2	356.6	381.7	399
RD + Zn (10 kg ha^{-1})	46	76.4	85.3	95.2	2.7	3.8	4.5	2.4	8.9	15.2	8.1	318.0	368.7	392.4	409
RD + Zn (2.5+2.5 kg ha^{-1})	43.1	74.3	84.0	93.6	2.6	3.7	4.4	2.4	9.1	14.2	8.1	307.8	362.3	387.2	406
RD + Zn (5.0+5.0 kg ha^{-1})	48.9	78.3	86.6	97.0	2.9	4.0	4.7	2.6	8.9	15.5	8.2	331.5	374.0	398.4	415
RD + Zn (5.0+2.5+2.5 kg ha^{-1})	48.4	79.7	88.1	98.0	2.8	4.0	4.8	2.6	10.4	15.5	8.4	325.4	378.6	402.5	419.7
RD + 0.5% $ZnSO_4$ spraying (once)	38.1	69.2	78.9	89.1	2.4	3.3	4.9	1.9	8.4	14.0	7.3	296.6	347.9	369.2	387.7
RD + 0.5% $ZnSO_4$ spraying (Twice)	37.4	69.2	79.4	89.3	2.4	3.3	4.0	1.9	8.3	14.3	7.5	295.5	348.2	371.3	389.9
CD (P=0.05)	3.41	2.62	2.15	2.28	0.22	0.24	0.23	0.18	0.27	0.15	0.32	8.94	7.58	7.38	7.53

Table 2. Effect of levels of Zn in combination with FYM and recommended dose of NPK on yield attributes and yield of rice (Pooled data 2004 and 2005)

Treatment	No. of panicle (m^{-2})	% filled grains	Test weight (g)	Grain yield t ha^{-1}	Straw yield t ha^{-1}	Harvest Index	Additional profit (Rs ha^{-1}) over control	Benefit : Cost ratio
RD (Control)	315	68.1	20.7	3.19	3.85	45.3		
RD + FYM (5 t ha^{-1})	327	70.4	20.9	3.53	4.95	46.3	(-) 368.00	0.85
RD + FYM (5 t ha^{-1}) + Zn (5 kg ha^{-1})	335	72.5	21.4	3.85	4.37	46.9	(-) 650.00	0.86
RD + Zn (5 kg ha^{-1})	330	70.8	20.9	3.62	4.17	46.5	446.00	1.20
RD + Zn (10 kg ha^{-1})	337	73.1	21.7	3.95	4.42	47.2	286.00	1.07
RD + Zn (2.5+2.5 kg ha^{-1})	337	72.1	21.4	3.82	4.34	46.8	1577.50	1.72
RD + Zn (5.0+5.0 kg ha^{-1})	343	74.4	22.1	4.15	4.61	47.4	1465.50	1.34
RD + Zn (5.0+2.5+2.5 kg ha^{-1})	346	75.5	22.1	4.25	4.66	47.7	1967.00	1.45
RD + 0.5% $ZnSO_4$ spraying (once)	321	69.2	21.6	3.35	4.03	45.3	372.00	1.62
RD + 0.5% $ZnSO_4$ spraying (Twice)	322	69.5	22.0	3.41	4.06	45.6	233.00	1.22
CD (P=0.05)	5.79	1.88	N.S.	0.17	0.21	0.43		

and 22.8 per cent grain and straw yield over control treatment. The over-all improvement in growth and yield attributes due to combine use of NPK and Zn was reflected in the increased grain and straw yield. The results confirmed with the findings of Chaphale and Badole (1999). The increased yield attributes might be due to role of Zn in biosynthesis of Indole acetic acid (IAA) and specially due to its role in initiation of primodial reproductive parts and partitioning of photosynthates towards them (Wear and Haghler, 1968). The favourable influence of applied Zn on yield may be explain to its catalytic or stimulatory effect on most of the physiological and metabolic process of plants.

The highest additional net returns (Rs 1,967 ha^{-1}) (Table 3) was obtained when Zn was applied in three splits along with RD of NPK treatment followed by Zn in two equal splits along with RD of NPK (Rs 1577.5 ha^{-1}). However, the highest Benefit : Cost ratio (1.72) was recorded with RD + Zn (2.5+2.5 kg ha^{-1}) might be due to lesser additional treatment cost as compared to others.

Thus, it may be concluded that under new alluvial zone of West Bengal, application of Zn in three splits (5.0 + 2.5 + 2.5 kg ha^{-1}) along with recommended dose of NPK was advantageous for sustaining the particularly of rice crop and higher additional net returns.

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