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Critical limits of zinc in soil and plant for rice grown in eastern Maharashtra

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Rice is the major crop grown in Bhandara, Chandrapur and Gadchiroli districts of eastern Maharashtra. Zinc deficiency and response of rice to zinc in Inceptisols (Ingle *et al.* 1997) and Vertisols (Kadamdhad *et al.* 1996) of eastern Maharashtra have been reported due to high cropping intensity, cultivation of high yielding varieties and use of zinc free complex fertilizers. Information is lacking on the critical level of DTPA extractable zinc for rice grown on soils of the eastern Maharashtra and more particularly of Chandrapur district. In the present investigation, critical limit of available zinc and concentration of zinc in index leaf were determined based on the response of rice to applied zinc under greenhouse conditions.

Seventeen surface soil samples (0-0.15 m) belonging to the order Inceptisol were collected in bulk from Sindewahi, Chandrapur. The processed soils were analysed for important characteristics (Table 1) by following standard procedures. The pH of the soil ranged from 5.40 to 8.07, organic C from 0.33 to 0.98%, $KMnO_4$–N from 144 to 314 kg ha^{-1}, Olsen's P from 15.2 to 18.0 kg P_2O_5 ha^{-1}, NH_4OAc–K from 220 to 420 kg K_2O ha^{-1} and DTPA extractable zinc from 0.32–1.14 mg kg^{-1} (Table 1). In this study, earthern pots (25 cm dia.) lined with ploythene sheet were filled with 5 kg air dried soil. Treatments consist of 0, 2.5 and 5 mg Zn kg^{-1} soil as $ZnSO_4.7H_2O$ alongwith 50, 25, 25 mg N, P and K kg^{-1} soil through urea, single superphosphate and muriate of potash, respectively. Each treatment was replicated thrice.

Twenty three days old six seedlings of rice (cv. Sye–75) were transplanted in each pot and irrigated with deionised water. Two plants from each pot were collected at tillering stage (52 DAS) and 3rd leaf from apex was analysed for zinc content after digestion in a tri-acid mixture of nitric, perchloric and sulphuric acid (9:3:1) using AAS. This stage is designed for nutrient diagnosis and efficient nutrient management for economic optimum yield. After harvesting, the grain yield was recorded. Maximum yield amongst the two levels of zinc i.e. 2.5 mg and 5 mg kg^{-1} was considered as an optimum yield for calculation of Bray's per cent yield. The Bray's per cent yield was calculated as per the formula.

$$\text{Bray's per cent yield} = \frac{\text{Yield without zinc}}{\text{Optimum yield with zinc}} \times 100$$

Table 1: Soil properties of Sindewahi area

Soil No.	pH	Organic carbon (%)	Available nutrients (Kg ha^{-1})			Available zinc (ppm)
			N	P_2O_5	K_2O	
1.	5.40	0.73	276	16.2	270	0.85
2.	7.78	0.46	204	15.5	360	0.40
3.	6.82	0.80	182	15.1	230	0.58
4.	5.69	0.76	223	16.0	220	0.73
5.	6.23	0.33	144	15.8	350	0.32
6.	6.64	0.62	216	16.0	380	0.52
7.	5.70	0.52	197	16.7	360	0.61
8.	8.07	0.46	166	17.2	400	0.35
9.	6.40	0.98	314	16.3	420	0.56
10.	5.57	0.67	270	15.2	380	0.74
11.	5.85	0.88	301	16.9	340	0.65
12.	5.80	0.55	223	17.2	250	0.62
13.	5.43	0.56	257	17.1	360	0.98
14.	5.77	0.62	245	16.3	380	0.69
15.	6.54	0.64	216	18.0	370	0.46
16.	5.40	0.63	285	16.3	380	1.09
17.	5.45	0.65	305	17.4	385	1.14

For establishment of critical limit of available DTPA extractable zinc, the graphical method of Cate and Nelson (1965) was used.

The soils selected belonged to three groups i.e. zinc deficient (<0.50 mg Zn kg^{-1}), marginal (0.50-0.75 mg Zn kg^{-1}) and adequate (>0.75 mg Zn kg^{-1}). The paddy grain yield varied from 17.2 g/pot in Zn-deficient to 61.37 g/pot in Zn adequate soils (Table 2) and Bray's yield based on grain, varied from 48-112 per cent.

Table 2. Available zinc, tissue concentration of Zn at tillering stage and yield with and without zinc and Bray's per cent yield

Soil No.	Avai. zinc (ppm)	Tissue concentration of Zn at tillering stage (ppm)	Control yield (g pot^{-1})	Optimum yield (g pot^{-1})	Bray's % yield
1.	0.32	20	17.20	33.07	52
2	0.35	24	20.20	33.66	60
3	0.40	28	25.20	46.66	54
4	0.46	26	26.70	55.22	48
5	0.52	25	29.20	47.09	62
6	0.56	26	30.10	51.89	58
7	0.58	29	32.10	53.50	60
8	0.61	31	35.80	52.64	68
9	0.62	32	38.20	58.76	65
10	0.65	42	44.45	52.03	85
11.	0.69	44	46.08	56.20	82
12	0.73	52	49.59	52.20	95
13.	0.74	54	50.27	51.80	98
14.	0.85	69	61.37	54.80	112
15.	0.98	75	57.01	54.30	105
16.	1.09	80	50.57	53.20	95
17.	1.14	89	47.61	52.90	90

Out of the 17 soils tested, 64.7 per cent soils responded to zinc fertilization. The Zn concentration of the index leaf varied with initial zinc status of the soil and ranged from 20 mg kg^{-1} to 89 mg kg^{-1}. The variations in zinc concentration of index leaf and the yield of rice in different soils were due to difference in ability of soils to supply zinc to the crop. This is confirmed by the significant correlation of DTPA extractable Zn with zinc concentration of index leaf (r=0.94)** and yield of rice (r=0.84)**.

Scatter diagram by graphical method of Cate and Nelson (1965) showing relationship between Bray's per cent yield and index leaf concentration (Fig 1) and DTPA extractable zinc in soil (Fig 2) indicated 32.3 mg Zn kg^{-1} in plants and 0.62 mg Zn kg^{-1} in soil as a critical limits of zinc below which rice may respond to zinc application.

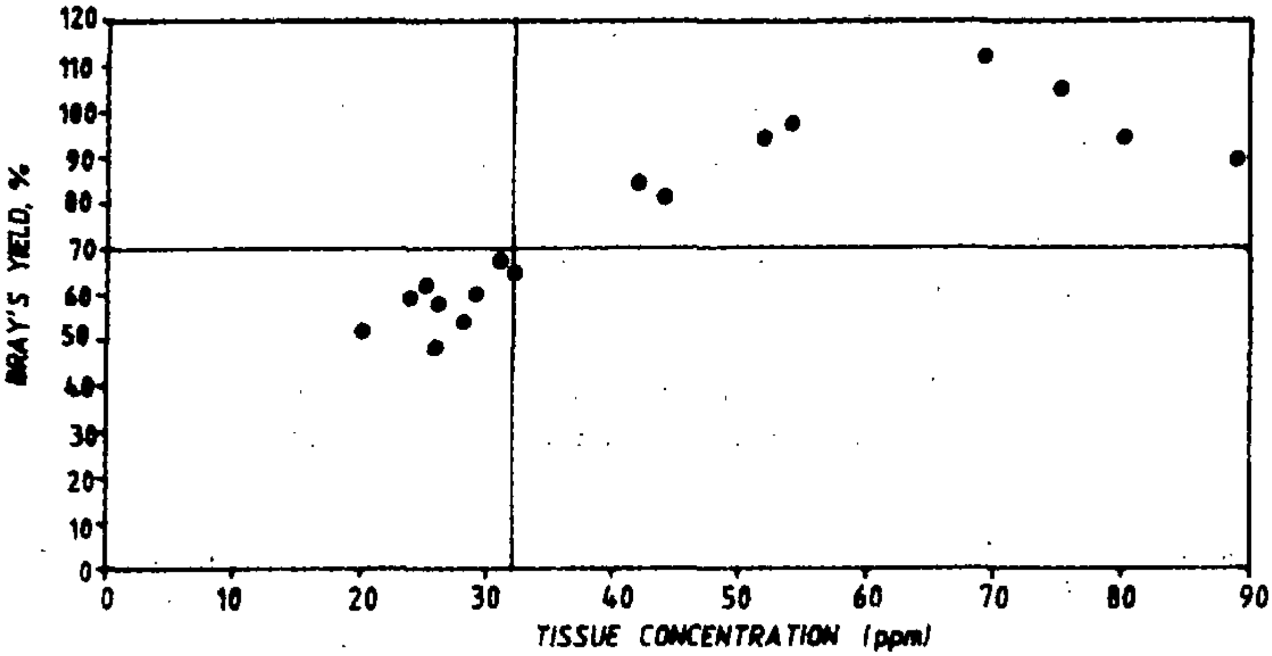

Fig. 1. Scatter diagram showing relationship between Bray's percent yield and tissue zinc concentration in rice.

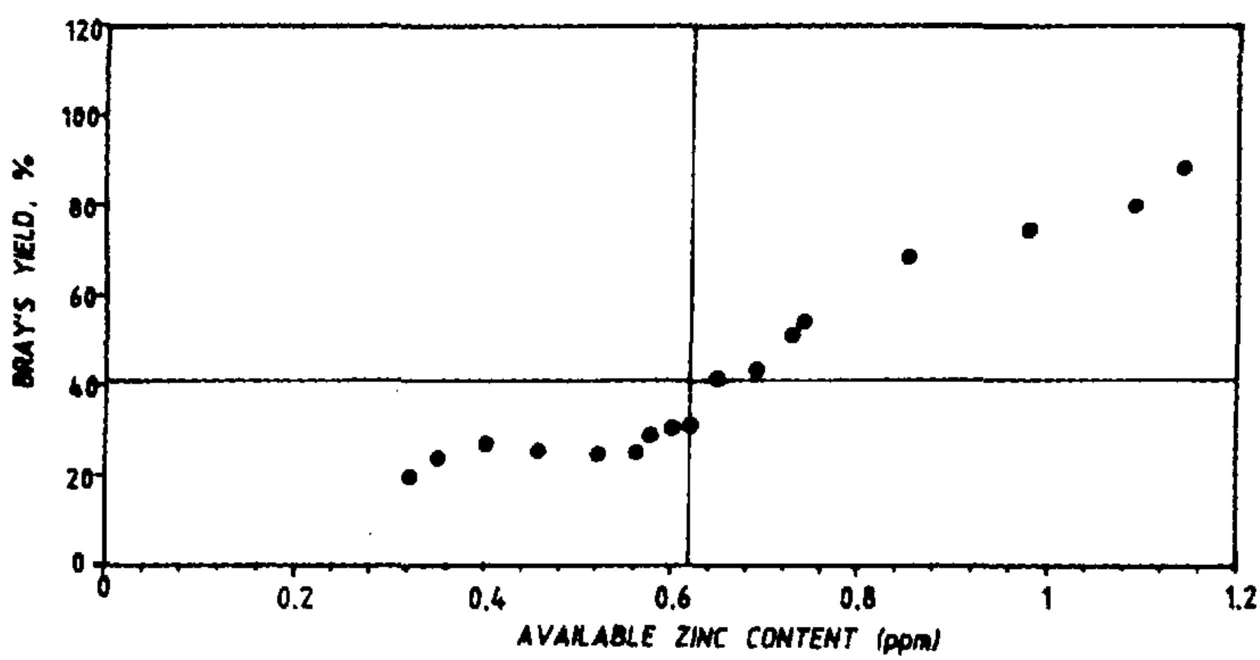

Fig. 2. Scatter diagram showing relationship between Bray's percent yield and available zinc concentration in soil.

References

Cate, R. B. Jr., and Nelson, L. A. (1965). A rapid method for correlation of soil test analysis with plant respond data. Soil Testing Series. Tech. Bull No. 1, North Carolina State University, Releigh, W. C.

Ingle, S. N., Borkar, D. K., Chaphale, S. D., and Thakre, S. K. (1997). Effect of source and levels of zinc on yield and nutrient uptake by rice (*Oryza sativa* L.). *Journal of Soils and Crops* **7**, 157-159..

Kadamdhad, G. R., Babulkâr, V. P., and Babhulkar, P. S. (1996). Response of soybean (*Glycine max,*) to sulphur and zinc in Vertisol. *Annals of Plant Physiology* **10**, 153-156.

Lindsay, W. L. and Norvell, W. A. (1978). Development of DTPA micronutrients soil test for Zn, Fe, Mn and Cu. *Soil Science Society of America Proceedings* **42**, 421-428.

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