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OPTIMISING ZINC APPLICATION IN RICE SOILS OF TAMIL NADU

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Zinc deficiency in flooded rice soils is considered as the most widespread and perhaps the vital yield limting factor in maximising rice production. This zinc deficiency is caused by continued rice culture with high yielding varieties using high analysis fertilizers and also dispensing with organic manuring. Nine field experiments were carried out to study the effect of zinc application at 0, 25, 50 and 75 kg $ZnSO_4$/ha on the grain yield and dry matter production in the representative rice soils viz., Entic Pellusterts, Entic Chromusterts, Typic Haplustalfs and Ultic Haplustalfs. The results clearly indicated that application of zinc at all levels significantly increased the grain and total dry matter production over control. Zinc at 25 kg $ZnSO_4$/ha registered higher grain and total dry matter yields. The economic optimum doses of zinc varied between 25.8 and 45.4 kg $ZnSO_4$/ha for the responsive soils (Entic Pellusterts and Entic Chromusterts) of old delta of Thanjavur district. A common economic dose of 35.4 kg $ZnSO_4$/ha has been arrived at as a recommendation wherever soils are deficient in soil available zinc (< 2.0 ppm DTPA-Zn).

Zinc deficiency is the most important and commonest micronutrient malady in flooded rice soils. Though the establishment of its essentiality to plant nutrition dates back to 1926 by Sommer and Lipman, the nutrient disorder due to this micronutrient was identified and reported for the first time on a field scale in rice soils only in 1966 by Nene of India. The Zn deficiency is considered as a vital yield limiting factor as indicated by the "preliminary estimates" that eight million hectares of rice soils are being adversely affected by this disorder (Katyal, 1975). The probable causes that might have led to the Zn deficiency and the resulting yield decline in rice soils can be enumerated as introduction of improved high yielding varieties; use of high analysis fertilisers; reduced use of organic manures and increasing the annual cropping intensity, besides the complex situation of submergence prevailing in rice soils. It has been clearly established by Mosi (1975) with extensive survey and intensive studies of macronutrients of rice soils, that N is the major yield limiting factor. Sub sequently it has also been proved through a systematic survey and study of micronutrients status of Tamil Nadu rice soils by Nagarajan *et al.* (1982) that Zn was second to none in contributing the productivity of rice crop. So much so, next to N, Zn deficiency can very well be emphasised as the most important nutritional factor that limits the growth and yield of wetland rice and hence this study was carried out.

MATERIALS AND METHODS

Nine field experiments were laidout in farmers' holdings in Thanjavur district. The details on the locations and their physico-chemical properties like texture, soil reaction, EC, organic carbon and available Zn are given in Table 1.

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The experiments were carried out during July-November, 1981 with ADT 31 as test crop using zinc sulphate at four levels (0, 25, 50 and 75 kg/ha) super imposing over a common dose of NPK in four replications adopting the randomised block design. The crop was harvested at maturity and yield of grain and straw were recorded and the data were subjected to statistical scrutiny. The grain yield data of the five responsive soils were fitted in a quadratic model $Y = a + bx - cx^2$ to arrive at the physical optimal dose of Zn $\left(\frac{dy}{dx} = b - 2cx = 0\right)$ and the economic optimal does of Zn $\left(\frac{dy}{dx} = b - 2cx = \frac{p}{q}\right)$ where Y = grain yield, X = added zinc sulphate, a, b, c are constants, p = cost per kg of zinc sulphate and q = cost price of per kg of rice grain.

RESULTS AND DISCUSSION

The results of grain yield of ADT 31 rice are presented in Table 2. It was observed from the data that the effect of added Zn on grain yield was significant with 25 kg $ZnSO_4$/ha level recording the highest yield. Further increase in the Zn level failed to produce any significant response while at 75 kg $ZnSO_4$/ha level, the grain yield started declining. A depressive effect on the uptake of Cu, Fe and N and a higher uptake of Zn at the above level might have caused a nutrient imbalance which inturn might be the cause for the reduction in yield (Nagarajan, 1984). The increased grain yield observed due to Zn application was in conformity with those of Gill and Singh (1978), Kumar *et al.* (1970) and Uddin *et al.* (1981). There was also significant variations in grain yield among the locations and this was expected, since the soils of the locations included in the present study varied widely in their physico-chemical properties. A significant interaction between the levels of Zn and soils was found to exist for grain yield The locations belonging to the old delta which were deficient in Zn (less than 2.0 ppm DTPA Zn; Nagarajan, 1984), showed marked responses for the applied Zn. The yield increases over NPK control were in the order of 9.4 to 14.4 per cent which corresponded to 3.76 to 5.49 quintal grain/ha. It is worth to mention that even low amount of Zn (25 kg $ZnSO_4$/ha) could produce substantial increase in grain yield which was advantageous to obtain maximum profit per unit area. The non-responsiveness observed in locations L2 and L9 which were having soil available Zn less than critical limit of 2.0 ppm DTPA Zn revealed the need for further refinement of critical limit of soil Zn in rice soils with specific physico-chemical properties.

The yield of straw are given in Table 3. The treatmental influence of Zn and its interaction with locations were found non-significant, due to the micro-climatic variations in the cultivators. fields. With respect to locations, as expected, the variation in the yield of straw was quite marked because of the considerable variations in the physico-chemical properties of the soils of the different locations.

In order to make the results more of practical utility and to get the maxi mum returns, economic appraisal of the data of grain production was done for five locations of old deltaic soils of Entic Pellusterts and Entic Chromusterts

Table 1. Physico-chemical properties of the soils used

Location No.	Name of the location	Soil sub group	soil texture	pH	EC	OC	Available zinc (ppm)
		(A) New delta of Thanjavur district					
L_1	Aladikumulai	Ultic Haplustalfs	Sandy loam	5.8	0.1	1.0	6.0
L_2	Pattukkottai	Typic Haplustalfs	Sandy loam	6.6	0.1	0.9	1.9
		(B) Old delta of Thanjavur district					
L_3	Aduthurai	Entic Pellusterts	Clayey	6.4	0.2	0.7	1.0
L_4	Nannilam	"	Clay loam	6.9	0.1	0.7	3.3
L_5	Marudhanallur	"	Clayey	6.9	0.1	0.7	1.0
L_6	Sakkottai	Entic Chromusterts	Loamy	6.5	0.1	0.8	1.2
L_7	Koonanchery	"	Clay loam	6.5	0.1	0.8	0.3
L_8	Thiruppalanam	Typic Haplustalfs	Clayey	7.2	0.2	0.8	1.1
L_9	Kadiramangalam	"	Clayey	7.2	0.2	0.4	1.8

Table 2. Effect of zinc application on grain yield of rice (quintal/ha)

Location No.	Name of the Location	Treatment (kg $ZnSO_4$/ha) 0	5	50	75	Mean
L_1	Aladikumulai	44.4	44.6	44.9	42.7	44.1
L_2	Pattukkottai	43.4	42.9	43.5	44.1	43.5
L_3	Aduthurai	40.0	41 7	42.1	39.8	41.3
L_4	Nannilam	40.0	38.7	39.3	39.7	39.5
L_5	Marudhanallur	32.3	35.7	36.9	34.6	34.9
L_6	Sakkottai	41.2	43.7	46.7	40.9	48 1
L_7	Koonanchery	38.2	43.0	38.4	39.4	39.8
L_8	Thiruppalanam	36.1	39.5	41.1	40.4	39 3
L_9	Kadiramangalam	38.4	39.5	36.2	36.9	37.8
	Mean	39.3	41.2	41.0	39.8	

	T	L	L X T
SE	0.4	0.6	1.2
CD	1.1	1.7	3.3

(P=0.05)

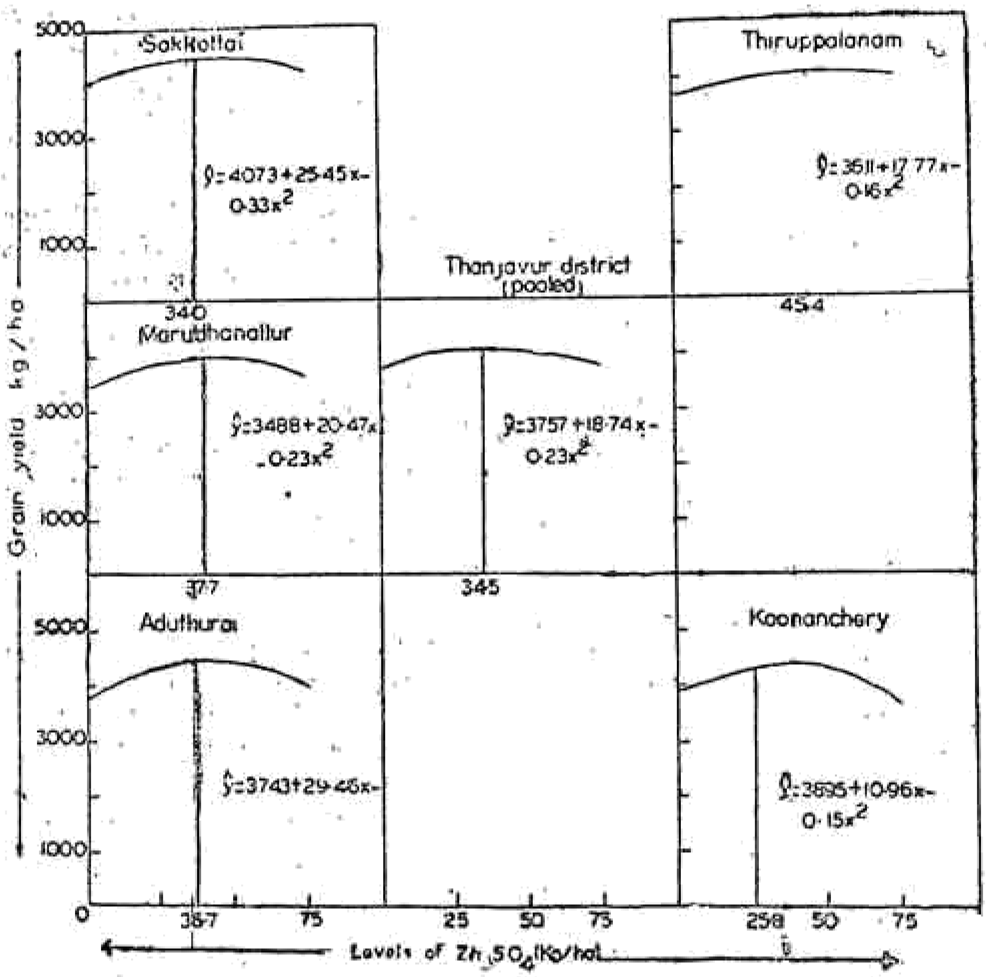
Table 3. Effect of zinc application on straw yield of rice (quintal/ha)

Location No.	Name of the location	Treatment (kg $ZnSO_4$/ha)				Mean
		0	25	50	75	
L_1	Aladikumulai	63.0	65.7	67.0	65.8	65.3
L_2	Pattukkottai	57.5	59.5	59.0	62.5	59.6
L_3	Aduthurai	48.0	53.5	52.0	47.6	50.3
L_4	Nannilam	64.6	64.5	60.7	65.0	63.7
L_5	Marudhanallur	41.1	39.7	39.8	39.9	40.1
L_6	Sakkottai	53.1	51.4	50.1	54.4	52.2
L_7	Koonanchery	63.0	65.5	63.3	66.0	64.4
L_8	Thiruppalanam	63.5	65.2	70.3	74.0	68.5
L_9	Kadiramangalam	56.2	56.3	52.4	50.8	53.9
	Mean	56.6	57.9	57.3	58.4	

	T	L	L x T
SE	NS	1.8	NS
CD (P=0.05)		5.0	

Table 4. Response functions, physical and economic optimum doses of zinc for different rice soil

Location No.	Name of the location	Response function	Physical optimum dose (kg $ZnSO_4$/ha)	Economic optimum dose (kg $ZnSO_4$/ha)
L_3	Aduthurai	$Y = 3743 + 29.46X - 0.36 X^2$	40.9	36.7
L_5	Marudhanallur	$Y = 3488 + 20.47X - 0.23 X^2$	44.5	37.7
L_6	Sakkottai	$Y = 4073 + 25.45X - 0.33 X^2$	38.6	34.0
L_7	Koonanchery	$Y = 3895 + 10.96X - 0.15 X^2$	36.3	25.8
L_8	Thiruppalanam	$Y = 3611 + 17.77X - 0.16 X^2$	55.2	45.5
	Pooled	$Y = 3757 + 18.74X - 0.23 X^2$	41.5	34.5



which responded favourably to Zn application. The response functions and the economic and physical optimal doses of zinc sulphate obtained during the investigations are presented in Table 4 and Figure 1. The economic optimum dose of Zn varied between 25.8 and 45.5 kg $ZnSO_4$/ha. Among the soils, the response was higher in location of Entic Pellusterts, Aduthurai (L3), resulting in an overall increase of 5.98 quintal grain per hectare indicating an increased production of 16.3 kg grain per kg of $ZnSO_4$ applied which works out to 4.1 kg of grain per kilogram of Zn on nutrient basis. It is also worth to mention that the rate of return was the highest (Rs. 5.43) in this location indicating the beneficial effect of Zn in rice production

The physical optimal doses computed for the locations which will tap the maximum potential of rice yield ranged from 36.3 to 55.2 kg $ZnSO_4$/ha. Here too the Aduthurai (L3) location surpassed the rest indicating the highest response.

When the entire district is considered as a single unit, application of 41.5 kg $ZnSO_4$/ha could result in maximum yield and 34.5 kg $ZnSO_4$/ha would result in the highest return in the rice soils of Thanjavur. From the results, it can be stated that for maximum profit, the economic dose (34.5 kg $ZnSO_4$/ha) would be preferred. When there is a keen demand for food grain the physical optimum dose of 41.5 kg $ZnSO_4$/ha, the maximum yield per unit area, may be adopted to exploit the maximum grain yield from the rice crop.

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CORRELATION AND PATH-COEFFICIENT ANALYSIS IN FORAGE MAIZE (*Zea mays L.*)*

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Correlation coefficients and path coefficient analysis were computed for yield components in parents and hybrids of forage maize. The results revealed that plant height, stem girth, leaf length, leaf breadth and leaf number were highly associated with fodder yield, both in parents and hybrids. Path coefficient analysis indicated differential influence in parents and hybrids. The stem girth followed by Plant height had made direct effect in parents, while leaf breadth followed by stem girth had highest direct effect in hybrids on fodder yield. The results indicated that stem girth and plant height in parents, leaf breadth and stem girth in hybrids should be given importance for breeding for forage production in maize.

There are limited reports on correlation and path analysis of important fodder traits in forage maize and the knowledge of which is so important for initiating any plant improvement programme. The present investigation was, therefore, undertaken to study the extent of association and the magni-

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