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INFLUENCE OF ZINC ON GROWTH, DRY MATTER PRODUCTION, NUTRIENT UPTAKE AND YIELD IN CERTAIN RICE VARIETIES

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A field experiment was conducted to study the response of rice varieties IET 3280, CO. 29 with 0, 12.5, 25.0 and kg/ha Zinc sulphate. The results indicated that the maximum shoot length and shoot dry weight was recorded at 25 kg/ha level in all the varieties. The root length and root weight showed only phenomenal increase to the applied zinc. Zinc application at 25 kg/ha improved the N, P and K uptake and a decrease trend was noticed at 50 kg/ha level. However, the content of zinc increased with increased level of zinc application upto 50 kg/ha level. But the maximum grain yield was recorded at 25 kg/ha level of zinc supplements.

Zinc deficiency occurs in many plants when the leaf concentration is less than 20 ppm in the dry matter and 1.5 ppm (DTPA) in the soil. In Tamil Nadu, an average of 36.7 per cent of the soil is zinc deficient. It was reported by Westfall *et al.* (1971) that reduction in yield up to 75 per cent was observed in zinc deficient soils. The effect of zinc on the growth of rice was reported by Tokuoka and Gyo (1939) and Pillai (1967). Zinc is known to alter not only the content of zinc but also the uptake of other nutrients namely N (Paramanandham, 1982), phosphorus (Singh, 1976) and potassium (Pathak *et al*., 1975). However, no study has been carried out to integrate the influence of zinc on the growth and nutrient uptake in rice varieties. So, the present investigation was, therefore undertaken to study the effect of zinc on the interrelationship between the growth, dry matter production, nutrient uptake and yield in different rice varieties.

MATERIALS AND METHODS

The experiment was laid out under field conditions in Tamil Nadu Agricultural University, Coimbatore during kharif season, 1980. The chosen varieties were Co.29, Co.39 and IET 3280. The pH, EC, organic carbon, DTPA extractable zinc, available N, P and K in the soil were 7.8, 0.3 m.mhos/cm, 0.085 per cent, 1.5 ppm (critical level), 239 kg/ha, 4 kg/ha and 494 kg/ha respectively. The treatments were consisting of four levels of zinc sulphate ($ZnSO_4 . 7H_2O$) namely 0, 12.5, 25.0 and 50 kg/ha apart from N:P:K

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TABLE 1 Effect of zinc on shoot length (cm) and shoot dry weight (g/hill)

Variety	Zinc dosage(kg/ha)	15 SH	15 SW	30 SH	30 SW	45 SH	45 SW	Flowering SH	Flowering SW	Harvest SH	Harvest SW
	0	21.9	0.37	39.6	1.66	45.2	3.28	68 7	17.91	73.9	19.8
	12.5	28.0	0.39	42.3	1.48	45.7	3.55	70.0	19.81	74.9	21.1
IET 3280	25	30.0	0.48	42.4	2.25	49.0	3.94	73.6	22.80	75.1	24.3
	50	31.0	0.44	41.9	2.05	46.8	3.28	70.0	16.91	75.0	20.1
	0	22.6	0.35	39.8	2.20	45.2	3.60	64.4	17.27	67.2	20.0
	12.5	25.7	0.38	42.6	2.23	45.7	4.20	66.1	20.07	67.8	22.6
CO 39	25	28.1	0.55	39.0	2.19	46.5	5.90	68.0	21.82	70.0	22.9
	50	27.9	0.54	36 3	1.57	41.7	3.40	67.1	21.76	68.7	23.4
	0	33.0	0.33	43.3	2.29	50.3	3.99	124.4	18.50	124.4	27.7
	12.5	33 0	0.41	45.2	2.45	57.1	4.76	125.4	22.09	125.4	31.4
CO 29	25	35.8	0.48	48 4	2.73	58.1	5.00	136.0	23.27	136.0	33.9
	50	36.9	0.61	50.2	2.68	59.6	4.93	122.8	17.88	122 8	28.7

Stages (Days after transplanting). SH=Shoot height ; SW=Shoot dry weight

SED	2.508	0.018	1.220	0.020	1.639	0.050	2.005	0.048	0.650	4.034
CD	5.521**	0.040**	2.686**	0 044**	3.609**	0.111**	4.415**	0.106**	1.432**	8.879NS

TABLE 2 Effect of zinc on root length (cm) and root weight (g/hill)

Variety	Zinc dosage(kg/ha)	15 RH	15 RW	30 RH	30 RW	45 RH	45 RW	Flowering RH	Flowering RW	Harvest RH	Harvest RW
	0	8.9	0.16	13.8	0.49	15.9	0.82	18.9	2.59	19.0	2.42
	12.5	9.8	0.16	14.2	0.54	16.0	0.73	18.9	2.79	19.6	2.52
IET 3280	25.0	9.8	0.19	14.8	0.63	16.3	0.68	19.2	3.00	20.1	2.77
	50.0	10.2	0.20	15.3	0.58	16 8	0.86	19.0	2.71	20.0	2.29
	0	8.5	0.17	14.7	0.78	15.3	0.86	16.2	2.83	19.4	2.50
	12 5	8.7	0.17	15.3	0.77	16 8	1.03	17.7	3.95	18.2	2.39
CO 39	25.0	9.5	0.22	16.7	0.71	16.8	1.00	17.3	2.80	18 8	2.41
	50.0	10.2	0.19	16.9	0.50	17.8	0.78	18.3	2.80	20.2	2.30
	0	9.7	0.13	15.0	0.71	16.1	0.77	17.2	2.64	19 2	2.72
	12.5	11.9	0.18	16.0	0.76	16.7	0.90	19 2	2.91	19.7	3.08
CO 29	25.0	12 4	0.17	17.0	0.72	18.3	0.78	20.8	2.95	21.5	2.95
	50.0	11.8	0.17	15.8	0.72	18 0	0.77	20.4	2.06	20 4	2.34

Stages (Days after transplanting). RH=Root height RW=Root dry weight

SED	0.694	3.838	0.913	0.014	0.853	0.014	1.218	0 054	0 901	0.058
CD	1.527NS	8.450NS	2.010**	0.031**	1.870NS	0.031**	2.682**	0.119**	1.983NS	0.129**

at the rate of 100:50:50 kg/ha. The design adopted was factorial RBD with three replications. Samples were, drawn at 15, 30 days after transplanting, at flowering and harvest stages. The dry weight was recorded through oven drying The N was analysed by micro-kjeldahl method (Humphries, 1956), phosphorus by colorimetrically (Jackson, 1967) and zinc by Atomic absorption Spectrophotometer (Yoshida *et al.*, 1973).

RESULTS AND DISCUSSION

1. Growth and Dry Matter Production

Data on shoot length, shoot weight, root length and root weight were presented (Table 1, 2). They were increased as time trend in all the varieties and treatments. As regards shoot length and weight, significant difference could be noticed in all the stages except shoot weight at harvest stage. In the case of root length 30th day and flowering stages were found to be significant whereas root weight showed significant at all stages except on 30th day. In all the varieties, maximum shoot length was recorded at 25 kg/ha level in all the stages. This may be due to the involvement of auxin action for cellular enlargement (Skoog, 1940; Tusi, 1940). Similar to shoot length, shoot weight was also found to be maximum at 25 kg/ha level. The increase in shoot dry weight by the application of zinc was also confirmed by Bear and Sakhon (1179), Halder and Mandel (1981) and Chatterjee and Mandal (1983). The effect of zinc supplements as to that matter, the varietal differences themselves were not phenomenol as regards root length. But in terms of root weight, the effect of zinc supplement was discernible. These results were in agreement with the reports of Forno *et al.* (1975).

2. Nutrient uptake

Data on nitrogen, phosphorus and potassium uptake were presented in Table 3. These were found to increase as time trend in all the three varieties and treatments upto harvest stage. With respect to Nitrogen, considering the harvest stage alone, maxmium uptake was noticed at 25 kg/ha level in all the three verieties. This may be attributed to the fact that optimum zinc influenced mobilisation of nitrogen to the grain for improving crop productivity (Ozanne, 1955). Maximum P uptake was noticed at 25 kg/ha in all the three varieties. The reduction of P uptake at 50 kg/ha level may be attributed to the fact that zinc might block the absorption of phosphorus at higher levels, in the root cells (Stoyonor and Mokhamad, 1983). The data on the uptake revealed that it incaeased as time trend. However, a big jump in K uptake was noticed between 45 days after transplanting and flowering stage and it was coincided with high physiological activity of the rice plant (Beringer and Haeder, 1981). Similar to N and P, K was found to be maximum at 25 kg/ha level. Tiwari and Pathak (1976) also observed similar results in rice varieties.

TABLE 3 Effect zinc on nitrogen, posphorus and Potassium uptake (mg/hill) at harvest

Vareity	Zinc dosage (kg/na)	Nitrogen	Phosphorus	Potassium
	0	277.7	102.7	409.8
	12.5	350.6	112.3	462.5
IET 3280	25.0	374.9	131.1	600.7
	50.0	358.9	113.6	387.6
	0	283.5	93.8	390.5
	12.5	364.9	108.6	460.2
CO 39	25.0	397.2	112.7	528.2
	50.0	304.1	103.8	450.1
	0	325.0	126.9	479.0
	12.5	374.0	143.4	562.9
CO 29	25.0	419.3	150.6	612.0
	50.0	313.4	114.1	425.6

TABLE 4 Effect of zinc supplement (kg/ha) on zinc content (ppm) of three rice varieties as time trend

variety	Zinc dosage (kg/ha)	Stages (Days after transplanting) 15 Shoot	15 Root	30 Shoot	30 Root	45 Shoot	45 Root	Flowering Shoot	Flowering Root	Harvest Shoot	Harvest Root	Harvest Grain
	0	50.2	95.0	42.0	72.0	36.4	125.0	29.0	135.0	25.5	124.5	19.2
	12.5	65.4	94.2	51.6	148.2	49.0	170.2	32.5	181.2	29.0	160.2	21.2
IET 3280	25.0	75.0	119.0	62.8	173.4	50.8	192.4	37.5	270.4	27.3	192.6	22.7
	50.0	80.2	123.5	66.7	201.5	48.7	275.0	35.8	240.1	31.2	220.4	20.0
	0	58.1	70.0	45.0	89.0	38.3	129.2	32.6	148.4	28.9	118.4	18.3
	12.5	74.5	110.0	52.1	140.2	41.5	148.0	35.3	160.2	27.4	128.6	19.2
CO 38	25.0	85.2	135.0	63.7	172.6	60.0	194.5	41.0	220.4	26.4	190.4	20.0
	50.0	100.0	121.9	75.8	198.4	62.0	220.0	48.2	248.3	30.0	240.0	21.4
	0	65.2	69.7	52.3	98.0	39.5	140.0	32.0	170.1	29.3	154.3	18.2
	12.5	74.7	102.4	63.4	128.5	43.5	190.5	34.3	202.4	30.4	172.8	19.3
CO 29	25.0	84.4	140.5	62.3	184.3	43.5	209.5	34.4	220.3	30.4	180.8	20.0
	50.0	80.4	162.2	70.8	192.0	55.6	220.0	36.2	237.1	33.4	222.0	17.9

TABLE 5. Effect of zinc on grain yield

Variety	Zinc dosage (kg/ha)			
	0	125	25	50
IET 3280	10.2	10.7	11.9	10.8
CO 39	10.5	10.8	11.5	11.0
CO 29	10.0	10.6	11.6	10.0

	Variety	Treatment	V x T
SED	0.043	0.050	0.087
CD	0.096**	0.111**	0.193**

The data on zinc content (Table 4) revealed that zinc application enhanced the zinc content as well as uptake. The decreased zinc content from seedling stage to harvest may be attributed to the dilution effect. Rai *et al.* (1983) were of the opinion that zinc in rice decreased with progressive growth of the crop possibly due to the dilution effect.

3. Yield of grair

With regard to yield, all the three varieties showed maximum yield 25.0 (kg/ha) level. Their differences were found to be statistically significant. For instances, the yield decreased from 25 to 50 kg/ha level but zinc uptake continuously increased indicating luxury consumption. Gill and Singh (1978) also found that the increased grain yield up to 20 kg/ha level of zinc sulphate.

From the study, it was concluded that the yield increase in rice was the integral of the shoot dry matter accumulation and nutrient uptake. The higher yield at 25kg/ha was achieved through the higher activity of these two paramater than compared to other treatments.

REFERENCES

BERINGER, H. and H. E. HAEDER. 1981. Influence of potassium nutrition in starch synthesis in barley grains. *In*: Potassium workshop (p) Nigeria. p. 57.

BRAR, M. S. and G. S. Sekhon. 1979. Effect of applied zinc and iron on growth of rice *IL RISO*, *28* : 125-132.

CHATTERJEE, A. K. and L. N. Mandal. 1983. Interaction of zinc and phosphorus in relation to micronutrient nutrition of rice, *Micron. News 3* : 5400.

FORNO, D. A., C. J. ASHER and S. YOSHIDA, 1975. II. Studies on two varieties differing in susceptibility to zinc deficiency. *Plant* and *Soil*. *42* : 551-563.

GILL, R. S. and N. SINGH. 1978. Effect of zinc sulphate on growth and yield performances of tall and dwarf varieties of rice. *Indian J. Agron.*, *23* : 375-376.

HALDER, M. and L. N. MANDAL. 1981. Effect of phosphorus and zinc on the growth, phophorus, zinc, copper, iron and manganese nutrition of rice. *Plant and Soil*, *59* : 415-425.

HUMPHRIES, E. C. 1956. Mineral components and analysis. *In* : Modern methods of plant analysis. (Paech, K and Tracey, M. O. ed.) *1* : 502.

JACKSON, M. L. 1969. Soil chemical Analysis Prentice Hall of India Pvt. Ltd., New Delhi.

OZANNE, P. G. 1955. The effect of nitrogen on the zinc deficiency in subterranean clover *Aust. J. Biol. Sci.*, *8* : 47-55.

PATHAK, A. N., K. N. TIWARI and K. SINGH, 1975. Zinc-phosphorus interrelationship in rice. *J. Indian Soc. Soil Sci.* *23*: 475-483.

PARAMANANDHAM, P. 1982. Investigations on the effect of zinc and gypsum application in the yield and uptake of various, nutrients by rice. cv. IR 20 in Sodic soils, M. Sc. (Ag.) thesis (Unpublished). T.N.A.U, Coimbatore-3.

PILLAI, K. M. 1967. Response of paddy to application of micronutrients. *Indian J. Agron.* *12*: 151-155.

RAI, M. M., K. P. SINGH, R. S. SINHA and V. PRASAD. 1983 Effect of zinc on yield and zinc content of rice varieties on calcareous soils. *Micron News.3*: 5006.

SKOOG, F. 1940. Relationships between zinc and auxin in the growth of higher plants. *Am. J. Bot.* *27* : 939-951.

SINGH, Y. 1976. Phosphorus and zinc interaction in maize nutrition. *Indian J. agric Sci.* *21* : 480-482.

STOYONOV, D. and Y. MOHAMED. 1983. Diagnosis of the zinc regime of maize growth in highly calcareous soil. *Micron News.* *3* : 5283.

TIWARI, K. N. and A. M. PATHAK. 1978. Direct, residual and cumulative effect of applied zinc on yiled, chemical composition and iron uptake by rice and wheat in a fixed rotation under field conditions. *Fert. News.* *21* : 31-33.

TOKUOKA, M. and O. GYO. 1939. The effect of zinc on the growth of rice. *Chem. Abstr.*, *33* : 5444.

TUSI, C. 1948. The role of zinc in the auxin synthesis in tomato plant. *Am. J. Bot.*, *35* : 172

WESTFALL, D. G., W. B. ANDERSON anb R. J. HODGES. 1971. Iron and zinc responses to chlorotic rice grown in calcareous soils. *Agron. J.* *63* : 602-605.

YOSHIDA, S., J. S. AHN. and D. A. FORNO. 1970. Laboratory manual for physiological studies. IRRI. Philippines.