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CONSEQUENCE OF ZINC SULPHATE ON GROWTH AND YIELD OF RICE

Agricultural Science

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ABSTRACT

Studies on the consequence of zinc sulphate on growth and yield of rice in two soils was carried out during the year 2010-11 in a pot experiment in a net house of Department of Soil Science and Agricultural Chemistry, Faculty of Agriculture, Annamalai University.The plant height, DMP and yield of rice significantly improved on addition of graded dose of zinc in both Vertisol and Entisol. The result of experiment revealed that highest grain yield (32.04, 43.02 g pot^{-1}) and straw yield (37.45, 59.84 g pot^{-1}) noticed with 5.0 mg Zn kg^{-1} in Vertisol and Entisol respectively. Similarly, the plant height and DMP maximum with 5.0 mg Zn kg^{-1} and declined at 7.5 mg Zn kg^{-1}.

KEYWORDS

Rice yield, Zinc, plant height, DMP

INTRODUCTION

Zn plays a fundamental role in various metabolic processes in plants. It is a component of series of enzymes such as dehydrogenases, proteinases, peptiodases, phosphohydrolases, carbonic anhydrases and superoxide dismutases. Zinc is an essential components of over 300 enzymes (Fox and Guerimot, 1998). Zinc plays an important role in many biochemical functions within plants. Zinc plays an important role in auxin production, preferential accumulation of chlorophyll, protein synthesis and starch metabolism. Therefore,deficiency of zinc in soil adversely affect the growth and development of plants (Rashid and Ryan, 2004). In Tamil Nadu, 53 per cent of soils are found deficient in Zn (Tandon, 1995). Katyal and Rattan (1993) reported that Zn deficiency in South Indian soils most commonly seen in soils under Vertisol and Alfisol. Zinc plays an important role in the nutrition of rice. It was subsequently found to be widespread phenomenon in lowland rice areas of Asia, next to N and P deficiencies. Zinc deficiency in rice appears right from seedling stage in nursery and three weeks after transplanting in mainfield. Zinc deficiency is considered the most widespread disorder in lowland rice.

MATERIALS AND METHODS

With a view to study the consequence of zinc sulphate on growth and yield of rice in two soils was carried out during the year 2010-11 in a pot experiment in a net house of Department of Soil Science and Agricultural Chemistry, Faculty of Agriculture, Annamalai University. Bulk surface soil samples (0-15 cm) from two soil series (Kondal and Padugai) were collected air dried, powdered with wooden mallet. The processed soil samples used for pot experiment. The experimental soil was clay loam and sandy clay loam in texture with pH 7.63;7.30, EC 0.70;0.81dS m^{-1}, organic carbon 5.70;8.20 g kg^{-1} (low), medium in $KMnO_4$-N 281;284 kg ha^{-1}, high in Olsen-P 23.2;26.5 kg ha^{-1}, high in NH_4OAc-K 306;318 kg ha^{-1} and low in available DTPA-Zn 0.75;0.70 mg kg^{-1} .The experiment was laid out in FCRD with three replication. The experiment consisted of two factors viz., Factor A – Zinc levels (mg kg^{-1}) Zn_0 - Control (no zinc),Zn_1- 2.5,Zn_2- 5.0 and Zn_3- 7.5 and Factor B – Soil S_1 – Kondal series (Typic Haplusterts) – Vertisol: S_2 – Padugai series (Typic Ustifluvents) – Entisol. Before planting and application of fertilizers, the soil in all the pots were well puddled. All the pots were treated with basal dose of RDF (150:50:50 N, P_2O_5, K_2O kg ha^{-1}) in the form of urea, SSP and MOP and mixed with the soil. Zinc was applied as $ZnSO_4.7H_2O$ in the form of solution which was mixed thoroughly with soil. Three seedling of rice variety ADT 43 was planted pot^{-1}. The soils in the pots were kept at submergence throughout the crop period. At each stage,plant samples were collected from 24 pots (8x3). At harvest, grain and straw yields were recorded and expressed as g pot^{-1}.

RESULTS AND DISCUSSION

Plant height

The effect of different dose of zinc, soils and their interaction significantly improved plant height at all stages of rice growth over control (Table 1). The shortest plant at all stages of rice growth was noticed in control (no zinc) and the tallest plant at all stages of rice growth in 5.0 mg Zn kg^{-1}. The plant height was slightly decreased at 7.5 mg Zn kg^{-1} which was comparable with 5.0 mg Zn kg^{-1}. It is evidently noticed from the table that per cent improvement in plant height due to Zn levels was more distinct at tillering stage (11.9 to 22.6) and gradually decreased with stages of crop growth *viz*., 8.1 to 18.9 (panicle initiation) and 6.5 to 13.8 (harvest stage). With respect to soils, taller plants was noticed in Entisol than Vertisol. It was significantly higher at tillering stage, but was comparable at panicle initiation and harvest stages. Increase in plant height due to zinc levels could be ascribed to increase in zinc concentration in the plant. Zinc is known for precursor of growth as they play greater and crucial role during early phase of the plant life. Zinc is precursor of tryptophan, which is supposed to play a decisive role in the synthesis of auxin, the main factor behind apical dominance, growth and development, which is involved in cell division and internode elongation (Shanmugam and Veeraputhiran, 2000). The result obtained in the present study was confirmed by the significant positive correlation between plant height with DTPA-Zn (r=0.972**), zinc concentration (r=0.992**) and Zn uptake (r=0.987**).

Dry matter production (DMP)

Perusal of data on dry matter production (DMP) in Table 2 showed a significant impact of zinc levels, soil and their interaction over control at all stages of crop growth. Irrespective of the treatments, DMP progressively increased with stages of crop growth. Irrespective of the stages, DMP was found to be highest at 5.0 mg Zn kg^{-1} (12.98, 40.93 and 87.23 g pot^{-1}) which was comparable with 7.5 mg Zn kg^{-1}. At all stages of crop growth, DMP was higher in Entisol (13.15, 40.42 and 89.55 g pot^{-1}) compared to Vertisol. However, the highest DMP was observed when 5.0 mg Zn kg^{-1} was applied to rice crop grown in Entisol (13.46, 45.87 and 103.95 g pot^{-1}) at tillering stage, panicle initiation and harvest stages respectively. The photosynthetic activities following increased LAI influenced dry matter production. In the present study, addition of 5.0 mg Zn kg^{-1} recorded maximum LAI at both the stages. This was confirmed by significant positive correlation between LAI and DMP (r=0.89**). Higher DMP could also be due to increase in CGR, RGR and NAR. Miah *et al*. (1996) reported higher values of CGR increases DMP. Increase in DMP due to zinc was reported by earlier workers (Malik *et al*., 2011).

Grain and straw yield

Perusal of the data in Table 3 indicated significant influence of graded dose of zinc, soils and their interaction on grain and straw yield over control. The mean grain yield ranged from 18.70 (control) to 37.53 g pot^{-1} and straw yield increased from 26.68 g pot^{-1} (control) to 48.64 g pot^{-1} upto 5.0 mg Zn kg^{-1} and then decreased at 7.5 mg Zn kg^{-1}. The per cent increase in grain yield ranged from 66.7 to 100.7 due to different Zn levels over control. Similarly, the per cent increase in straw yield ranged from 56.9 to 82.3 due to different Zn levels over control. The grain yield response was 12.47, 18.83, 18.15 g pot^{-1} due to $Zn_{2.5}$, $Zn_{5.0}$ and $Zn_{7.5}$ over control (no zinc) respectively. The grain and straw yield was statistically comparable at $Zn_{5.0}$ and $Zn_{7.5}$ respectively. Increase in grain and yield due to zinc was the logical result due to increase in yield components. In the present study, number of panicles m^{-2}, number of grains panicle^{-1}, panicle length and 1000 grain weight increased with Zn levels and highest value was obtained with 5 mg Zn kg^{-1}. The above argument was ably supported by linear relationship between grain yield with number of panicles m^{-2}($Y = 3628 – 0.703x + 0.010x^2, x^2, R^2 = 99^{**}$), number of grains panicle^{-1} ($Y = 4688- 83.49 x – 9.322 x^2$, $R^2=99^{**}$), panicle length ($Y = -353.6 + 393.6x – 4.473 X^2, R^2= 0.99^{**}$) which showed that 99 per cent variation in grain yield are brought out by different yield attributes. Rahman *et al*. (2011) reported increase in grain yield due to improvement in yield components. Higher straw yield due to Zn fertilization was reported earlier by Jain and Dahama (2007). This was confirmed by significant and positive correlation between straw yield with DTPA-Zn (r=0.961**, r=0.901**, r=0.931**) and Zn uptake (r=0.981**, r=0.965**, r=0.987**) at tillering and panicle initiation stages respectively.

CONCLUSION

The present study find out growth characters and highest grain and straw yield noticed with 5.0 mg Zn kg^{-1} in Vertisol and Entisol respectively. However the efficiency of rice was higher in Entisol than Vertisol.

Table 1. Effect of zinc application on plant height (cm) at different stages of rice crop

Zn levels (mg kg^{-1})	Tillering stage		Mean	Panicle initiation stage		Mean	Harvest stage		Mean
	S_1	S_2		S_1	S_2		S_1	S_2	
0	46.2	51.0	48.6	71.8	75.3	73.6	86.3	90.6	88.5
2.5	50.3	58.4	54.4	77.9	81.4	79.7	92.5	96.1	94.3
5.0	56.7	62.5	59.6	84.3	89.5	86.9	98.9	102.6	100.7
7.5	55.5	61.0	58.2	83.2	88.0	85.6	97.1	101.0	99.0
Mean	52.2	58.2		79.3	83.5		93.7	97.5	
	Zn	S	Zn x S	Zn	S	Zn x S	Zn	S	Zn x S
SEd	1.37	1.43	1.50	1.91	2.00	2.11	2.23	2.38	2.43
CD (p=0.05)	2.86	2.98	3.10	3.98	4.18	4.40	4.63	4.96	5.03

Table 2. Effect of zinc application on dry matter production (g pot^{-1}) at different stages of rice crop

Zn levels (mg kg^{-1})	Tillering stage		Mean	Panicle initiation stage		Mean	Harvest stage		Mean
	S_1	S_2		S_1	S_2		S_1	S_2	
0	11.59	12.54	12.06	20.44	28.37	24.53	33.03	59.46	46.24
2.5	12.28	13.23	12.75	30.00	38.72	34.36	57.35	91.02	74.18
5.0	12.51	13.46	12.98	36.00	45.87	40.93	70.51	103.95	87.23
7.5	12.45	13.17	12.92	34.36	45.35	39.85	70.20	103.79	86.99
Mean	12.20	13.15		30.64	40.42		57.77	89.55	
	Zn	S	Zn x S	Zn	S	Zn x S	Zn	S	Zn x S
SEd	0.08	0.19	0.30	0.25	0.29	0.58	0.76	0.53	1.07
CD (p=0.05)	0.18	0.41	0.63	0.53	0.60	1.21	1.58	1.12	2.24

Table 3. Effect of zinc application on grain and straw yield (g pot^{-1})

Zn levels (mg kg^{-1})	Grain yield		Mean	Straw yield		Mean
	S_1	S_2		S_1	S_2	
0	13.68	23.73	18.70	18.48	34.89	26.68
2.5	25.68	36.66	31.17	30.67	53.06	41.86
5.0	32.04	43.02	37.53	37.45	59.84	48.64
7.5	31.36	42.34	36.85	37.03	59.42	48.22
Mean	25.69	36.43		30.90	51.80	
	Zn	S	Zn x S	Zn	S	Zn x S
SEd	0.36	0.26	0.52	0.44	0.31	0.63
CD (p=0.05)	0.76	0.54	1.08	0.93	0.66	1.32

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