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RESPONSE OF RUBBER SEEDLINGS IN THE NURSERY TO APPLICATION OF ZINC

Mercykutty Joseph, B. Sudhakumari, K.I. Punnoose and M. Karthikakuttyamma
Rubber Research Institute of India, Kottayam-686009, Kerala, India

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Experiments were conducted to study the response of rubber seedlings in the nursery to application of zinc through two sources *viz.*, zinc sulphate or zinc oxide. Both the sources significantly improved the availability of zinc in the soil and enhanced the growth of seedlings. Application of 5 kg Zn per ha to zinc deficient soils through either of the sources was effective in improving the growth of rubber plants in the seedling nursery.

Key words: *Hevea brasiliensis*, Micronutrients, Seedling nursery, Zinc.

INTRODUCTION

The red ferruginous soils in which rubber is cultivated in south western India are highly weathered acid soils. In general, the availability of micronutrients *viz.*, iron (Fe), manganese (Mn), zinc (Zn) and copper (Cu) are reported to be high in acid soils. However, depending on the nature of the parent material, there can be deficiency of these nutrients. The total Zn status of the soils will be low in places where the parent material is granite, gneiss or basalt which may result in mild Zn deficiency even though the deficiency symptoms are not expressed. Katyal and Sharma (1991) reported that highly weathered coarse textured laterite and red soils are poor in total Zn. Joseph *et al.* (1995) assessed the DTPA extractable Fe, Mn, Zn and Cu status in the rubber growing soils in the traditional rubber growing belt of India and found that the Zn status ranged from traces to high. A study on the micronutrient status of 9682 surface soil samples covering the entire rubber growing areas of Kerala and Tamil Nadu showed that 41.0 per cent of the survey area was deficient in Zn (NBSS and LUP, 1999).

Widespread deficiency of micronutrients has not been reported from rubber plantations in India or other major rubber growing countries so far. However, occasionally, deficiency of Zn is observed in seedlings and young rubber. There are reports from other crops showing 50 per cent reduction in crop growth due to Zn deficiency without any visual symptoms (Gupta, 1995). Zinc is a cofactor for several enzyme systems that regulate various metabolic activities in plants. It is also a vital element for the oxidation process in plant cells which helps in the transformation of carbohydrates and regulation of sugars in plants (Marshner, 1997). Zn deficiency retards photosynthesis and nitrogen metabolism (Mengel and Kirkby, 1987; Marshner, 1997). The effect of micronutrient application on the growth and yield of

Correspondence: Mercykutty Joseph. (Email: mercyjoseph@rubberboard.org.in)

rubber has not been studied in detail due to the rare expression of deficiency symptoms in the field. In an earlier study (Potty *et al.*, 1976), no response to micro nutrient application was noticed for the growth of rubber seedlings in the nursery. This was probably due to the application of large quantities of organic matter every year to nursery soils which might have increased the availability of micronutrients in the soil. Recently, due to the non-availability of farmyard manure and mulch material, addition of organic matter to the nursery soils has come down. Moreover, seedlings are being raised continuously every year in the same nursery bed and the use of large quantities of inorganic fertilizers increases the chances for micronutrient deficiency. This experiment was taken up to study the effect of Zn application on its availability in soil and on growth of seedlings in rubber nursery.

MATERIALS AND METHODS

The experiment was conducted at the Central Nursery of the Rubber Board of India at Karikattoor, Kottayam District, Kerala on two sets of plants during 1999-2000 and 2000-2001 respectively. Soil of the experimental site belonged to the great group Haplohumults. Before initiating the study, soil samples were collected from the field and were tested for available Zn status by DTPA extraction (Lindsay and Norvell,1978). Deficiency of Zn in the soil was ascertained as per the All India Standard (Katyal, 1985). The seeds were germinated in beds during September to establish the nursery. Seeds were sprouted within six to seven days and were transplanted to nursery beds in four rows with a spacing of 30 x 30 cm in individual plots of size 4.5x1.5m. The gross number of plants per plot was 60 and net plants from which observations were recorded was 26. The experiment was laid out in factorial RBD with two sources and four levels of Zn. The sources of Zn were zinc sulphate (21% Zn) and zinc oxide (60% Zn). The levels of Zn applied were 2.5, 5.0, 7.5 and 10 kg Zn per ha. A foliar spray treatment using 0.5 per cent zinc sulphate four times at biweekly intervals and a control were also included. Weeding, mulching and irrigation were carried out as per the standard schedule. Fertilizer (10:10:4:1.5 NPKMg mixture) was applied at the rate of 25kg per 100 m^2, six weeks after transplanting the sprouted seeds. Two weeks after the fertilizer application, Zn was applied as per the treatment schedule to individual plots. Six weeks after the application of NPKMg mixture, urea at the rate of 5.5 kg per 100 m^2 was applied. Cultural operations and agromanagement practices were followed as per the standard nursery practices. The experiment was repeated in a separate field in the same nursery the next year. The diameter of the seedlings were measured at periodic intervals. Soil samples collected from individual plots after the completion of the experiment in each year were analyzed for the available Zn status as mentioned above and quantified using an Atomic Absorption Spectrophotometer. Total nutrient concentration in the leaves was estimated through standard procedures (Piper, 1966).

RESULTS AND DISCUSSION

Effect of Zn application on the growth of seedlings in the experiment in the first year is presented in Table 1. Significant differences in growth enhancement between

Table 1. **Effect of Zn on the growth of seedlings (2000)**

Treatment	Diameter (cm)			
	April	May	June	July
$ZnSO_4$ 2.5kg/ha	0.908	0.910	1.180	1.593
$ZnSO_4$ 5.0kg/ha	0.900	0.918	1.219	1.690
$ZnSO_4$ 7.5kg/ha	0.876	0.930	1.183	1.670
$ZnSO_4$ 10.0kg/ha	0.951	0.960	1.226	1.687
ZnO 2.5kg/ha	0.859	0.907	1.195	1.550
ZnO 5.0kg/ha	0.917	0.930	1.244	1.673
ZnO 7.5kg/ha	0.859	0.871	1.161	1.583
ZnO 10.0 kg/ha	0.837	0.840	1.116	1.543
$ZnSO_4$ 0.5% Spray	0.860	0.870	1.120	1.590
Control	0.829	0.867	1.111	1.503
SE	0.033	0.028	0.029	0.039
CD ($P \leq 0.05$)	NS	NS	0.087	0.097

NS-Not significant

Table 2. **Effect of Zn application on the availability of Zn in the soil**

Treatment	Soil Zn (ppm)	
	1999-2000	2000-2001
$ZnSO_4$ 2.5 kg/ha	0.381	0.474
$ZnSO_4$ 5.0 kg/ha	0.558	0.685
$ZnSO_4$ 7.5 kg/ha	1.482	0.924
$ZnSO_4$ 10.0 kg/ha	1.868	1.923
ZnO 2.5 kg/ha	0.435	0.382
ZnO 5.0 kg/ha	0.760	0.595
ZnO 7.5 kg/ha	2.477	1.133
ZnO 10.0 kg/ha	2.347	1.573
$ZnSO_4$ 0.5% Spray	0.283	0.417
Control	0.285	0.339
SE	0.056	0.049
CD ($P \leq 0.05$)	0.167	0.147

NS-Not significant

treatments were observed by next year. Zinc applied as zinc sulphate at the rate of 5.0 and 10.0 kg and zinc oxide at the rate of 5.0 kg per ha significantly improved the growth of the plants by June. Foliar spray was not effective. During July, the zinc sulphate treatments at the rates of 5.0, 7.5 and 10.0 and zinc oxide treatments at 5.0 kg Zn per ha significantly improved the growth of the plants.

The initial Zn status of the soil was highly deficient (0.26 ppm). With increased rate of Zn application, its availability in soil also increased (Table 2). Among the two Zn sources, zinc oxide application resulted in higher availability of Zn in the soil. The soil was highly acidic with a pH 4.4. Zinc from zinc oxide is solubilised and made available slowly in acidic environment. The available Zn status of the soil in the second year is shown in Table 2. Zinc application at the rates of 5.0, 7.5 and 10.0 kg Zn per ha irrespective of the sources of supply, significantly increased its availability. The highest Zn availability in the soil was recorded in the plots which received zinc sulphate at 10.0 kg Zn per ha followed by plots with zinc oxide at 10.0 kg per ha.

The concentration of Zn in the leaves was influenced by the application of Zn (Table 3). The values ranged from 30.0 to 38.8 ppm. The highest value of 38.8 ppm Zn in leaves was noticed for zinc oxide application at 5.0 kg per ha. Concentrations of N, P, K, Ca and Mg in the leaves were not influenced significantly by the application of Zn although N, P and Ca were found to be low when compared to control. Application of Zn might have enhanced the metabolism in the plant and improved the translocation of metabolites within the plant resulting in better utilization of nutrients in the Zn treated plants (Mengel and Kirkby, 1987 and Marshner, 1997).

In the second year also, the influence of application of Zn on the growth of seedlings became significant by July (Table 4). Irrespective of the sources of Zn supply and levels of application, all the treatments including the foliar spray showed significant

Table 3: **Effect of Zn application on the concentration of nutrients in the leaves (1999-2000)**

Treatment	Leaf nutrient concentration					
	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Zn (ppm)
$ZnSO_4$ 2.5 kg/ha	2.96	0.223	0.473	0.526	0.265	30.20
$ZnSO_4$ 5.0 kg/ha	3.17	0.237	0.460	0.594	0.285	35.47
$ZnSO_4$ 7.5 kg/ha	3.02	0.237	0.427	0.688	0.279	37.00
$ZnSO_4$ 10.0 kg/ha	3.20	0.207	0.433	0.581	0.287	38.07
ZnO 2.5 kg/ha	3.18	0.223	0.420	0.611	0.285	30.10
ZnO 5.0 kg/ha	3.24	0.220	0.500	0.616	0.271	38.80
ZnO 7.5 kg/ha	3.08	0.217	0.447	0.506	0.239	36.67
ZnO 10.0 kg/ha	3.18	0.217	0.433	0.571	0.264	38.27
$ZnSO_4$ 0.5% Spray	3.14	0.213	0.513	0.620	0.282	30.50
Control	3.44	0.237	0.473	0.682	0.277	30.00
SE	0.131	0.011	0.028	0.070	0.015	3.076
CD ($P \leq 0.05$)	NS	NS	NS	NS	NS	NS

NS-Not significant

Table 4: **Effect of Zn application on the growth of seedlings (2001)**

Treatment	Diameter (cm)					
	February	March	April	May	June	July
$ZnSO_4$ 2.5 kg/ha	0.933	1.065	1.267	1.410	1.666	1.86
$ZnSO_4$ 5.0 kg/ha	0.904	1.046	1.266	1.427	1.569	1.78
$ZnSO_4$ 7.5 kg/ha	0.938	1.041	1.274	1.417	1.624	1.84
$ZnSO_4$ 10.0 kg/ha	0.982	1.040	1.195	1.413	1.530	1.74
ZnO 2.5 kg/ha	0.895	1.051	1.222	1.393	1.607	1.82
ZnO 5.0 kg/ha	0.918	1.004	1.229	1.440	1.609	1.82
ZnO 7.5 kg/ha	0.953	1.051	1.311	1.410	1.700	1.93
ZnO 10.0 kg/ha	0.930	1.030	1.299	1.427	1.650	1.87
$ZnSO_4$ 0.5% Spray	0.876	0.995	1.161	1.383	1.667	1.86
Control	0.846	0.998	1.081	1.270	1.296	1.44
SE	0.030	0.035	0.045	0.050	0.054	0.069
CD($P \leq 0.05$)	NS	NS	NS	NS	NS	0.206

NS Not significant

growth enhancement compared to control plants indicating a positive response to Zn application in the nursery on the growth of seedlings.

Application of Zn thus increased its availability in the soil and improved the growth of rubber seedlings in the nursery. Both the sources of Zn *viz.*, zinc sulphate and zinc oxide were effective in improving the available Zn when applied at least at 5.0 kg Zn per ha.

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