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Response to zinc on growth and incidence of powdery mildew disease in RRIM 600 clone of *Hevea* in nursery

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Powdery mildew disease of rubber trees (*Hevea brasiliensis* Muell. Arg.), caused by *Oidium heveae* Steinm., is known to be very severe at the time of refoliation after wintering in north east Region and northern part of West Bengal (Mondal *et al.*, 1994; 1998). Repeated defoliation followed by die-back of the branch tips occurs throughout February to May in this region, resulting in a poor canopy for the remainder of the season (Mondal *et al.*, 1998). Moreover, this disease was found to cause a crop loss of 13.5 to 28.5% in Kanyakumari district of Tamil Nadu (Jacob *et al.*, 1992) and northern part of Wet Bengal (Mondal and Jacob, 2002). The control of powdery mildew disease by dusting of agricultural grade sulphur powder is the standard practice adopted in mature rubber plantation. There are some reports which indicate a striking relationship between susceptibility to severe attack by *O. heveae* and zinc status of the plant (Bolle-Jones and Hilton, 1956; Bolle-Jones, 1957; Rubber Research Institute of Malaya, 1956). Therefore, the present investigation was undertaken to evaluate the effect of zinc on the growth and incidence of powdery mildew disease of RRIM 600 clone of *Hevea* in nursery.

The experiment was conducted in nursery at Regional Experiment Station (RES), Nagrakata under the agro-climatic conditions of northern part of West Bengal for two consecutive years, 1999-2001. Nine months old poly bag plants of RRIM 600 clone of *Hevea* of uniform growth were planted at a spacing of 1 m x 1m in nursery during July, 1999 with a gross 25 plants and net 9 plants per plot. In this field trial altogether ten treatments including untreated control were imposed in a factorial randomised block design with three replications per treatment. Two formulations of Zinc (Chelated zinc in the product of Chelazin liquid and Zinc Sulphate) was applied as foliar spray and also in soil near root base for three rounds during October to December and agricultural grade sulphate powder (85%) was dusted during January to March at monthly interval in different experimental plots. The details of treatment are : T1S1 (Untreated control : without zinc and sulphur), T1S2 (Dusted with sulphur only), T2S1 (Chelated zinc: 12% Zn-EDTA: 5 ml/litre of water as foliar application and no dusting of sulphur), T2S2 (Chelated zinc: 5 ml/litre of water as foliar spray and dusting of sulphur), T3S1 (Chelated zinc: 7.5 ml/litre of water in soil application near root base and no dusting of sulphur), T3S2 (Chelated zinc: 7.5 ml/litre of water in soil near root base and dusting of sulphur), T4S1 (Zinc sulphate: Trasco Zinc Active 21%: 2 g/litre of water as foliar application and no dusting of sulphur), T4S2 (Zinc sulphate: 2 g/litre of water as foliar spray and dusting of sulphur), T5S1 (Zinc sulphate : 3 g/litre of water in soil application near root base and no dusting of sulphur) and T5S2 (Zinc sulphate: 3 g/litre of water in soil application near root base and dusting of sulphur). Spraying of zinc on leaf surface was carried out using a hand compression sprayer and screens were used to prevent drift. Before imposing treatments and during July every year, the height (cm) and the diameter (cm) of the experimental plants at the collar region were recorded from 9 sample plants from the inner rows of each plot as per Potty *et al.* (1976). The pre- and post-treatment soil samples were collected from each of the experimental plots and analyzed for available N, P and K following the standard analytical procedure outlined by Karthikakuttyamma (1989). The pre- and post-treatment leaf samples were also collected from each of the experimental plots and analyzed for Zn, N, P and K. Nitrogen content was determined by the micro Kjeldahl method; P and K contents following the method as described by Jackson (1973) and available zinc in soil and zinc content in leaf was determined by DTPA extraction method of Lindsy and Norvell (1978).

The incidence of powdery mildew disease was assessed in nine plants from the inner rows of each plot during April after the final round of all treatments.

Disease severity was scored from five plants having immature top whorl of leaves, selected at random from each plot. For a visual scoring and classification of severity, a scale of 1-5 was used where 1 = 0% (no infection), 2 = 1 - 15%, 3 = 16 - 30%, 4 = 31 - 50% and 5 = > 51 % leaf area infected. For estimation of severity (S), the sum of infection grades of each sample was divided by the total number observed, which included both infected and non-infected leaves (Samaradeewa *et al.*, 1985). Disease incidence (I) was calculated by dividing the number of diseased plants (irrespective of grade of disease) by the total number of plants observed and expressed as percentage. The data were subjected to analysis of variance (ANOVA) and the treatment means were compared LSD (P = 0.05).

The maximum growth of RRIM 600 in terms of height (154.2 cm) and diameter (0.91 cm) was noticed in T2S2 (Table 1) followed by T2S1 (139.9 cm and 0.89 cm), T3S2 (135.9 cm and 0.81 cm) with the minimum in T5S1 (84.7 cm and 0.49 cm). The growth of RRIM 600 in untreated control plot (T1S1) was adversely affected (73.4 cm and 0.47 cm) due to the high incidence and severity of powdery mildew disease. The percent growth increase in terms of height and diameter over control (Table 2) was the highest in T2S2 (110.2 and 116.2) followed by T2S1 (90.8 and 112.3), T3S2 (85.2 and 90.8), T3S1 (62.9 and 98.5) with the minimum in T5S1 (20.0 and 17.5). It is evident from the data presented in Table 2 that the application of chelated zinc in both ways significantly improved the growth of RRIM 600 clone of *Hevea* over control. Ohki (1976) reported that the reduction in growth is the overall effect of deficiency of available zinc and this may be related to the major effect of zinc deficiency on inhibition of chlorophyll synthesis. The beneficial effect of added zinc chelate on the growth of *Hevea* seedlings in nursery was also reported by Mondal *et al.* (2002). The positive effect of zinc on growth of plants may be due to the facts that zinc favours the enzyme carbonic anhydrase activity, auxin and protein synthesis directly or indirectly (Dell and Wilson, 1985; Sharangi *et al.*, 2002; Sharma *et al.*, 1999).

The incidence and severity of powdery mildew disease assessed in different experimental plots are presented in Table 1. The results revelaed that the experimental plots with treatment T2S2 was the most effective in reducing the disease incidence from 100.0 (T1S1) to 7.5% and the disease severity from 3.9 (T1S1) to 0.7 followed by T2S1 (22.3% and 0.9), T3S2 (26% and 0.9) with the minimum in T5S1 (90.8% and 2.8). The data on the percent disease reduction over control with respect to the incidence and severity of powdery mildew disease in different experimental plots are shown in Table 2. The percent disease reduction over untreated control (T1S1) was the highest in T2S2 (92.6) followed by T2S1 (77.7), T3S2 (74.0) with the minimum in T5S1 (9.2). Though the incidence and severity of powdery mildew disease was reduced significantly in T2S1 and T4S2, neither was effective as treatment T2S2, T2S1 and T3S2 (Table 1). Application of chelated zinc during October to December at doses 5 and 7.5 ml/l water reduced the incidence of powdery mildew disease significantly in the subsequent seasons. Similar results were also reported by Mondal *et al.* (2002) under the agroclimatic conditions of Assam. Thus it appears that zinc deficiency predisposes the plants to infection by *O. heveae.* Welch *et al.* (1982) reported that zinc deficient plants lost the membrane integrity, which stimulates the leakage of soluble organic substrates into the environment, which may attract the inoculum of *O. heveae* and also aid in the invasion process on immature leaves. According to Bolle-Jones and Hilton (1956) without a sufficiency of zinc, the rubber plant is unable to produce enough of a certain metabolite which offers some degree of resistance to *Oidium.* Prasad (1979) reported that zinc conferred a form of tolerance to disease rather than resistance. Beneficial effects of added zinc

Table 1. Influence of zinc on grwoth, Incidnece and severity of powdery mildew disease in RRIM 600 clone of *Hevea* in nursery (Mean of 2 years)

Treatments	Disease severity						Height (cm)			Diameter (cm)		
	Level of sulphur		Mean of zinc	Level of sulphur		Mean of zinc	Level of sulphur		Mean of zinc	Level of sulphur		Mean of zinc
	S1	S2		S1	S2		S1	S2		S1	S2	
T1	100.0	42.6	71.3	3.9	1.3	2.6	73.4	89.9	80.0	0.47	0.55	0.5
T2 (5ml/lit. water)	22.3	7.5	14.9	0.9	0.7	0.8	139.9	154.2	145.0	0.89	0.91	0.9
T3 (7.5 ml/lit. water)	44.5	26.0	35.2	1.4	0.9	1.2	119.7	135.9	127.8	0.83	0.81	0.8
T4 (2g/lit.water)	77.8	33.4	55.6	2.2	1.0	1.5	100.3	96.7	98.5	0.48	0.66	0.5
T5 (3g/lit. water)	90.8	37.0	63.9	2.8	1.5	2.1	84.7	94.8	87.8	0.49	0.53	0.5
Mean of sulphur	67.0	29.3		2.2	1.0		102.9	112.7		0.6	0.7	
	Zn	S	ZnxS	Zn	S	ZnxS	Zn	S	ZnxS	Zn	S	ZnxS
CD (P=0.05)	15.4	9.74	21.78	0.37	0.23	0.52	14.27	9.03	NS	0.07	0.04	NS

Table 2. Effect of zinc on the percent growth increase and reduction of powdery mildew disease in RRIM 600 clone of *Hevea* in nursery over control

Treatments	Disease severity						Height (cm)			Diameter (cm)		
	Level of sulphur		Mean of zinc	Level of sulphur		Mean of zinc	Level of sulphur		Mean of zinc	Level of sulphur		Mean of zinc
	S1	S2		S1	S2		S1	S2		S1	S2	
T1	0.0	53.8	26.9	0.0	66.3	33.1	0.0	22.6	11.3	0.0	30.8	15.4
T2 (5ml/lit. water)	77.7	92.6	85.2	76.0	82.6	79.3	90.8	110.2	100.5	112.3	116.2	114.3
T3 (7.5 ml/lit. water)	55.5	74.0	64.8	63.8	75.2	69.5	62.9	85.2	74.0	98.5	90.8	94.7
T4 (2g/lit.water)	22.2	66.6	44.4	44.0	72.5	58.2	36.9	31.7	34.3	18.3	57.2	37.8
T5 (3g/lit. water)	9.2	62.9	36.0	26.3	62.0	44.1	20.0	28.7	24.4	17.5	25.5	21.5
Mean of sulphur	32.9	70.0		42.0	71.7		42.1	55.7		49.3	64.1	
	Zn	S	ZnxS	Zn	S	ZnxS	Zn	S	ZnxS	Zn	S	ZnxS
CD (P=0.05)	15.78	9.98	22.32	9.52	6.02	13.46	19.31	12.21	NS	17.68	11.19	NS

in increasing host resistance against mildew and leaf spot diseases in other crops have also been reported (Graham, 1983; Mehrotra and Claudius, 1973; Reis *et al.*, 1982; Singh and Aggarwal, 1979). As indicated by Skoog (1940) the favorable effect of zinc on disease control may be attributed to the direct influence of zinc on the quantity of auxin produced.

The data on available zinc (ppm) of pre- and post-treatment soil samples are analyzed. The available zinc in post-treatment soil was found to be present in the range of 0.42 (T2S1) to 3.14 (T3S2) while the pre-treatment soil showed 1.23 ppm. This result clearly indicates that the available zinc present in pre- and post- treatment soil are of medium range. Immature leaf samples of all ten treatments showed comparatively higher zinc content in the range of 47.2 to 66.4 ppm than mature one (30.2 to 61.5 ppm). The nutrient content of N, P and K in pre- and post-treatment leaf samples were in the grade of 4.74, 0.69 and 2.5% respectively. The total nitrogen content (%) in post-treatment immature leaf samples were observed in the range of 2.82 (T5S2) to 3.94 (T3S1), phosphate (%) was in the range of 0.4 (T2S1) to 0.52 (T2S1) and the potassium (%) was in the range of 1.55 (T1S1) to 1.82 (T3S1).

From the results of the present experiment, it may be concluded that the foliar application of chelated zinc (5 ml/litre water) has been found to be very effective and superior to zinc sulphate for increasing growth of RRIM 600 clone of *Hevea* and also for control of powdery mildew disease. Therefore, the foliar application of chelated zinc appears to be a viable alternative approach to dusting of agricultural grade sulphur powder for the management of powdery mildew disease and consequent healthy growth of rubber plants.

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