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Short Communication

Characterization of Mercury Toxicity in Rice (*Oryza sativa* L.) Seedlings

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Key Term Index environment pollutant, mercury phytotoxicity, metabolism, enzyme activities, *Oryza sativa*

Summary

The effects of toxic concentrations of mercuric chloride ($HgCl_2$) on the activity of several enzymes in germinating rice (*Oryza sativa* L.) are reported. The activity of catalase, peroxidase, IAA oxidase, IAA synthase and ascorbic acid oxidase increased in response to mercury addition. This behaviour of stimulated enzyme activity synchronized with the similar increase in soluble protein formation.

Mercury acts as an environment pollutant and contaminates soils and plants when it is emitted as waste product from chemical industries. Mercury in toxic concentrations has been reported to interfere with growth and cause marked inhibition of α-amylase and ribonuclease in germinating rice seeds (Mukherji and Ganguly 1974). In this paper, some further questions pertaining to the characterization of Hg toxicity in germinating rice have been approached. Catalase activity measures the metabolic status of a tissue and growth inhibition may be due to an alteration of the auxin level caused by an interplay of peroxidase and IAA oxidase. Together with IAA oxidase, the enzymes for the biosynthesis of IAA assume the possible regulatory function of the level of IAA during the development of different plant organs (Schneider and Wightman 1974). The role of ascorbic acid oxidase as a plant growth regulator and of the interaction of this compound with IAA and gibberellin has been suggested (Chinoy et al. 1957, Edgar 1970). It seems worthwhile to assay these enzymes in treated seedlings.

Rice (*Oryza sativa* L. cv. Rupsail) were spread in batches over filter papers in Petri plates containing different concentrations of $HgCl_2$. They were germinated in dark at a constant temperature of 30 °C for the stipulated period prior to enzyme analysis, the methods of which have been described before (Mukherji and Das Gupta 1972, Mukherji and Maitra 1977). Water controls were maintained for each experiment.

Table 1 records the changes observed in the enzyme activities of rice seedlings following mercury treatment. It is quite clear that all the enzymes studied here demonstrate a stimulated activity under conditions of mercury toxicity. As compared to control, there was an approximately 28% increment in catalase activity at $6 \cdot 10^{-4}$ M $HgCl_2$ and a small further increase was noticed at the highest dosage. Of all the enzymes tested, the maximum stimulation was noticed in case of IAA oxidase, which showed a more than 3-fold increase at $6 \cdot 10^{-4}$ M. The IAA oxidase activity declined somewhat

Table 1 *Effect of various concentrations of mercuric chloride on the activities of catalase, peroxidase, IAA oxidase, IAA synthase, ascorbic acid oxidase and soluble protein content in rice seedlings*
Catalase μmol H_2O_2 destroyed per 15 min and 100 mg fresh wt Peroxidase increase in O D at 420 nm per min and g fresh wt IAA oxidase μg IAA destroyed per h and 100 mg fresh wt IAA synthase: μg IAA synthesized per h and 100 mg fresh wt Ascorbic acid oxidase mg ascorbic acid destroyed per 30 min and g fresh wt. Soluble protein mg protein per g fresh wt Seeds initially germinated in water for 2 days, then transferred to test solutions and kept for another 3 days Total germination time 5 days

Treatment	Catalase	Peroxidase	IAA Oxidase	IAA Synthase	Ascorbic acid oxidase	Soluble protein
Water control	28 8	2 3	13 4	23 0	7 60	5 02
Mercuric chloride						
4 10^{-4} M	30 8	3 3	24 5	26 5	8 65	5 22
6 10^{-4} M	36 8	3 6	40 9	28 8	11 40	6 24
8 10^{-4} M	38 8	4 4	33 8	34 0	14 88	5 76

at the highest applied Hg concentration, but even then an activity of more than double that of the control value was recorded

Peroxidase activity was the highest at 8 10^{-4} M $HgCl_2$ which was about double that of the control value In this respect, however, the relative influence of mercury on peroxidase was weaker than on IAA oxidase at all the concentrations tested This may be due to the fact that plant tissues contain several peroxidases differing in their capacities for participation in the IAA oxidase system (MCCUNE 1961) Thus the existence of a different response to mercury is to be expected

IAA synthesizing capacity was also stimulated considerably in treated seedlings Thus it is seen that mercury toxicity in germinating rice is characterized by simultaneous stimulation of both IAA oxidase and IAA synthase activities It can be suggested that a high IAA oxidase activity may result in the release of IAA synthesizing enzymes from feedback control, thereby raising IAA concentration to a supraoptimal level not conducive to growth

Ascorbic acid oxidase activity increased steadily and was doubled at the maximum $HgCl_2$ concentration These results are consistent with the existence of a mercury-induced growth inhibition (MUKHERJI and GANGULY 1974) The abundance and reactivity of this enzyme indicate that there is rapid conversion of ascorbic acid to its oxidized form dehydroascorbic acid, the latter probably being less important in plant metabolism

In the treatment sets, there was an increase in the level of soluble protein, amounting to about 24% increase at 6 10^{-4} M $HgCl_2$ which coincided with similar increases in enzyme activity From the present study, it is pertinent to suggest that growth inhibition by mercury results from reduction in the auxin level owing to enhanced auxin destruction Similar effects due to the action of copper were reported previously from this laboratory with lettuce seedlings which show increased activities of catalase per-

oxidase and IAA oxidase in response to toxic concentrations of copper (MUKHERJI and DAS GUPTA 1972)

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