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LEAD INDUCED STIMULATION IN THE ACTIVITIES OF PEROXIDASE AND IAA OXIDASE AND THEIR INFLUENCE ON THE GROWTH IN MUNGBEAN

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Foliar application of lead applied in four different concentrations (1, 4, 7 and 10 mM) and the control (0) at five growth stages (28, 35, 42, 49 and 56 DAS) of mungbean resulted in increased activities of both peroxidase and IAA oxidase. Highest stimulation in peroxidase activity was recorded at 56 days after sowing (DAS) by 10 mM dose while IAA oxidase showed maximum activity at 35 DAS under same dose. Lead also caused growth inhibition of plants by decreasing plant height, dry weight of leaf, stem and five entire plants. The effect was pronounced towards higher concentrations of lead.

Key words: Peroxidase, IAA oxidase, Lead nitrate, Mungbean.

Introduction

Metals can impact soil and biota by deposition from polluted air and mineral dissolution. Many studies have been conducted of stack emissions of zinc, cadmium, copper, lead, nickel etc. [1-4]. Plants can become heavily contaminated by surface particulates. Generally most metals are deposited within a few kilometers of the stack, however, significant depositions have been found as far away as 100 km. Automobile lead emissions are generally restricted to 30 meters, but some automotive lead is deposited beyond the Arctic circle [5]. Metal smelters, foundries, steel mills, coal-fired power plants and incinerators are potential air emission sources for cadmium, lead, zinc and copper. Mine spoil and transported ores can become fugitive dusts and move short distances through the air [2].

In plants, inhibition of growth is a general manifestation after the addition of heavy metals [6]. As growth is closely related with active metabolism, any compound which interferes with normal metabolism is likely to inhibit growth. Thus one approach of elucidating the mechanism of growth inhibition action may be to search for the enzyme which are influenced by the extraneous chemicals when applied to plants.

Peroxidase and IAA oxidase play significant role in growth processes of the plant and their activities have been found to vary in plants treated with growth retarding chemicals [7]. Therefore, the level of the activities of the enzymes, which are likely to undergo changes with treatments with a heavy metal like lead, are worth probing. The present investigation has been undertaken to measure the activities of peroxidase and IAA oxidase and also their influence on the growth parameters in mungbean sprayed with lead nitrate solution.

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Materials and Methods

Lead was applied in the form of lead nitrate solution and the treatments comprised 1, 4, 7, 10 mM and the control (0). Mungbean (*Vigna radiata* L. Wilczek) were raised in earthenware pots arranged in a randomized complete block design with four replications. There were ten pots in each treatment/replication. Tween-20 at a concentration of 0.05% was added to the spraying solution as wetting agent and about 100 ml solution was sprayed to the foliar parts of the plants by means of a hand sprayer. First spraying was done at 21 days after sowing (DAS) followed by five more sprays at weekly intervals. Leaf samples were collected at 28, 35, 42, 49 and 56 DAS for the assay of peroxidase as given by Chance and Maehly [8] and IAA oxidase by the method of Hillman and Galston [9]. Data on plant height, dry weight of leaf, stem and five entire plants were recorded during entire duration of the crop at respective growth stages of the plants. Data were analysed statistically and mean values of different treatments were adjudged by the least significant difference (LSD) values.

Results and Discussion

Peroxidase activity showed an increasing trend with increasing lead doses at all five growth stages of plants under study (Fig. 1a). Marked stimulation in peroxidase activity was recorded under the highest dose at 56 DAS. Increase of IAA oxidase activity was also evident by increasing concentration of lead (Fig. 1b). Maximum increment of IAA oxidase activity was found at 35 DAS when more

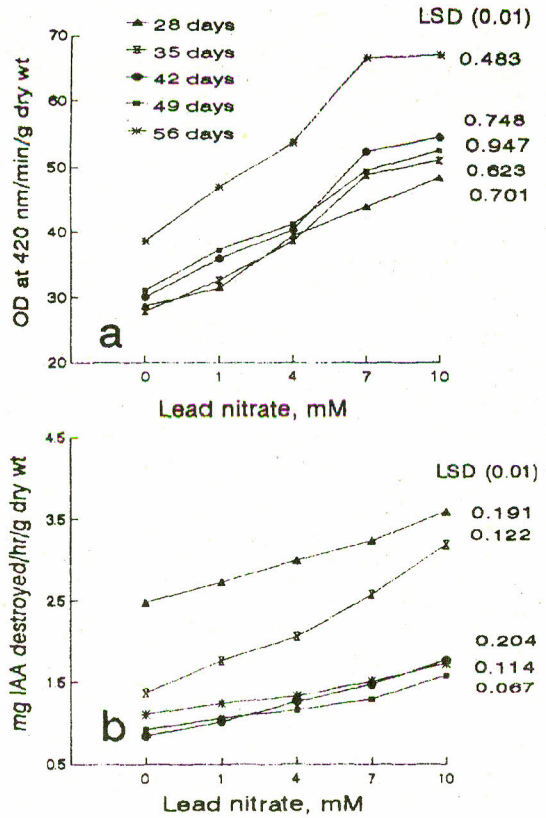

Fig. 1. Effects of different concentrations of lead nitrate on the activities of peroxidase (a) and IAA oxidase (b) in mungbean.

than 2-fold the control activity was observed at the highest dose.

Results of different growth parameters are graphically depicted in Fig. 2. Gradual decrease in plant height was the result of increasing concentration of lead (Fig. 2a) and the maximum inhibitory effect was noted at 56 DAS whereby the height of the shortest plant measured about 37% less than the control value under 10 mM dose. The trend of decrease with dry weight of leaf, stem and five entire plants was more or less similar (Figs. 2b, 2c and 2d) where highest magnitude of reduction of 31, 24 and 75% was recorded under highest dose at 42, 56 and 56 DAS respectively.

Peroxidase plays significant role in growth and development processes of plants through participation in a pathway of reactions controlling cell wall rigidification [10,11]. Peroxidases maintain the regulation of auxin level through auxin catabolism [12]. There is no information regarding the effect of lead on IAA oxidase activity in leaves; there is, however, evidence relating to the effect of other heavy metals. Activities of catalase, peroxidase and IAA oxidase were shown to be enhanced by heavy metals like copper and mercury [13,14]. Morgan *et al.* [15] observed an increase of IAA oxidase activity at the toxic level of manganese. It has been reported that tissues of cotton plant, when exposed to toxic levels of manganese, show higher activities of catalase and peroxidase [16]. The general pattern of changes in IAA oxi-

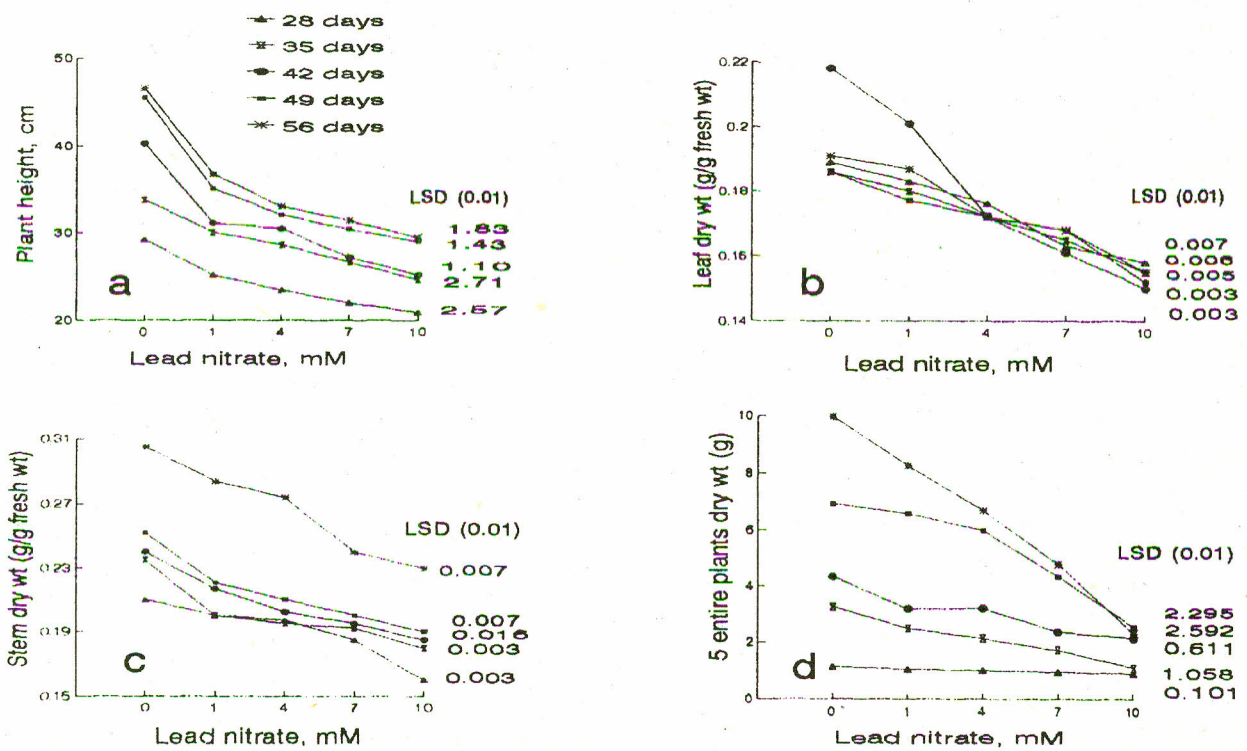

Fig. 2. Effects of different concentrations of lead nitrate on plant heigh (a), leaf dry wt (b), stem dry wt (b), stem dry wt (c) and 5 entire plants dry wt (d) in mungbean.

dase is similar to that of peroxidase in response to lead treatment. This similarity is expected since peroxidase enzyme is generally thought to be a part of the enzyme complex responsible for auxin destruction *in vivo* [17]. This stimulation in peroxidase and IAA oxidase activity can be correlated with the observed growth inhibition [18]. Since an increased peroxidase activity is associated here with increased IAA oxidase activity, it is pertinent to suggest that growth inhibition by this metal results from the reduction in the auxin level owing to enhanced auxin destruction [11]. The observed enhancement in the activities of these two enzymes seems to correspond with a few published reports dealing with the possible relationship between growth inhibition and peroxidase activity. It has been demonstrated that plants possessing a dwarf habit of growth usually have a higher peroxidase activities than their normal counterparts [19]. Infection of plant tissues with viruses, bacteria or fungi results in an increase of their peroxidase activity, with a lag phase which ranges from some minutes to several hours [20,21]. Gasper *et al.* [11] reported that growth and development reactions, in response to external signals, involved a rapid activation of peroxidases.

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