ISSN: 0974-4908
http:/rels.seplko.co.in

Res. Environ. Life Sci.
1(1) 25-28 (2008)
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Growth and biochemical responses of nickel toxicity on leguminous crop (*Lens esculantum)* grown in alluvial soil

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Abstract: Plants of lentil (*Lens esculentum*) were grown in alluvial soil (loamy sand texture), irrigated with graded Ni levels. The effect of low (0.01ppm) and high Ni levels (0.5, 5 and 50 ppm) observed on growth and biochemical responses (chlorophyll, protein, catalase and amylase). Low Ni supply level (0.01) increased growth, chlorophyll, protein contents and stimulated the activity of enzymes (catalase and amylase) over control. While, at higher Ni concentrations, all the biochemical activities were suppressed in lentil plants. Protein content in lentil increased with increase in concentration of Ni. Ni at 50 ppm level, supplied for 20 days, significantly reduced dry matter yield by 25%, total chlorophyll content by 23%, catalase by 33.2% and amylase activity by 91% over control. Therefore, low Ni level stimulated growth and metabolic activities, but toxic at it's higher concentrations.

Key words: Growth, Biochemical activities, Toxicity, Nickel

Introduction

The great problem today is related to the elevated level of heavy metals, particularly Ni in agricultural fields. The accumulation of Ni in most of agriculture fields are mainly due to sewage sludge application and use of industrially polluted river water (Srivastava, 1995; Agarwal *et al*., 2000; Indira and Sivaji, 2006), which are often high in Ni (Juste and Mench, 1992; Pandey, 2006). Most of our agricultural fields are alluvial in nature, and represent a sink for Ni accumulation, when continuously irrigated with industrially polluted river waters contain high Ni content (Kaushik *et al*., 2001; Pandey and Srivastva, 2002). Ni is a component of enzyme urease (Dixon *et al*., 1975), considered as essential nutrient element in plants (Eskew *et al*., 1983; Gerendas *et al*., 1999). However, at high concentrations Ni have toxicity effects on growth (Mishra and Kar, 1974; Gerendas *et al*., 1999) and induces metabolic disorders in plants (Baccouch *et al*., 1998; Gopal *et al*., 2002; Rahman *et al*., 2005). Lentil (*Lens esculentum*) is one of the oldest leguminous crop, widly cultivated in temperate and subtropical climates. About 30% production of lentil comes from India of total world's production. They can be grown on a wide range of soils from sandy loam to black cotton soils as rabi crop.

The physico-chemical behaviour of the soil effects uptake of the Ni. It's concentrations also, related to the beneficial/toxic effects in the plants. Therefore, the present study was aimed to find out the effects of graded Ni levels on lentil (*Lens esculentum*) grown in uncontaminated, Gomti-upland alluvial soil of Lucknow.

Materials and Methods

The composite surface sample (0-20 cm) collected (Piper, 1966) from the Gomti-upland, Badshah bagh area in Lucknow. It was insured that soil had not received any fertilizers or contaminants. The soils were air dried, sieved and analyzed for their physico-chemical properties. The above collected composite arid-alluvial soil (Texture Loam-sandy, pH- 6.5, O.M- 0.21%, $CaCo_3$ -0.45% and E.C -2.6 m mhos/cm) sample was analyzed for DTPA extractable metals (Zn- 0.26, Cu- 0.72, Fe -2.48 and Ni -0.007 ppm) by the methods of Lindsay and Norvell (1978). A basal application of NPK (60:30:30 ppm) fertilizers in the forms of urea, P_2O_5 as KH_2PO_4 and K_2O as KCl and KH_2PO_4 respectively was made in soil. Ten kg of soil was filled in polythene tub (20 cm diameter 6 cm depth). Each treatment of Ni supply (0, 0.01, 0.5, 5 and 50 ppm as $NiSO_4$) was made in triplicate. Ten seeds of *Lens esculentum* (lentil) were grown up to 50 days and irrigated only with distilled water. After that, graded level of nickel supply started (Three times in week). The growth of plants (shoot length, visible symptoms) observed regularly. The plants were harvested for dry matter yield and analysis of some biochemical parameters by using the methods- chlorophyll 'a' and 'b' (Lichtenthaler and Wellburn, 1983), protein (Lowry *et al*., 1951), catalase (Euller and Josephson, 1959) and amylase (Katsuni and Fekuhara, 1969). Data presented in the table and figures are the mean ± SE values of three replicates and statistically tested using students't' test of significance.

Results and Discussion

Treatment of *Lens esculantum* (lentil) with graded concentration of Ni, resulted reduction in growth and dry matter yield at excess Ni levels, while, stimulated at low Ni (0.01ppm). The reduction in biomass, attributed from Ni- induced alterations of metabolic processes (Tripathi *et al*., 1981) and decrease in water content (Hsiaq, 1973). Plants grown at excess Ni level (0.5, 5 and 50 ppm) developed toxicity symptoms, such as chlorosis of younger leaves and necrosis followed by yellowing in older leaves. These symptoms resembled as reported by Agarwala *et al*. (1977) and