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Effect of Lead toxicity on Germination and Seedling Growth of Vigna Mungo (L.) Hepper

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ABSTRACT

A study was conducted to determine the effect of different concentrations of lead (10µmol/l, 25µmol/l, 50µmol/l and 75µmol/l) on seed germination and seedling growth of Vigna mungo. Lead treatment at different concentrations show wide range of toxic effects on various growth parameters of Vigna mungo. At lower concentration of lead, there is optimum percentage of germination, root and shoot length. Inhibition in seed germination, root, shoot length and seedling dry weight was found at 75µmol/l. The result of the study suggest that due to better metal tolerance indices there is a possibility for growing Vigna mungo in areas contaminated with lead.

KEYWORDS: Lead, Seed germination, Vigna mungo

Introduction

Heavy metals are defined as metals having density higher than 5 gcm^3 . Of the total 90 naturally occurring elements, 53 are considered as heavy metals and few are biologically important. Among the heavy metals Zn, Ni, Cu,V,Co,W and Cr are non heavy elements at low concentrations whereas As, Hg, Ag, Sb, Cd and Pb have no known function as nutrients and seems to be more or less toxic to plants and microorganisms (Hasan et al., 2009). Heavy metals such as Lead and Cadmium are highly toxic pollutants as they are added in the environment through automobile exhaust (Lagerwerff and Specht, 1970).Tetra ethyl lead, which is an antiknocking additive, is added to gasoline which escapes from auto exhaust and goes into the soil. Other sources may include pesticides and fertilizers (Srinivasan et al., 2008), mining and smelting activities, use of lead containing paints and drainage of untreated municipal sewage (Chaney and Ryan, 1994). Heavy metal contamination affects the biosphere in many places worldwide (Cunningham et al., 1997; Raskin and Ensley, 2000; Meagher, 2000). The sources of heavy metals in plants are their growth media, nutrients, agro inputs and soil. Bioaccumulations of toxic heavy metals by various crop plants have been reported by number of workers and are a matter of serious health hazard (Mishra and Singh, 2000). Excess concentrations of some heavy metals in soil such as Cd (II), Cr (VI), Ni (II) and Zn (II) have caused the disruption of natural, aquatic and terrestrial ecosystem (Gardea-Torresdey et al., 1996; Meagher, 2000).

Among the metals, Lead particularly has become a cosmopolitan environmental pollutant (Sharma and Dubey, 2000). Of the known heavy metals Cd2+, Ni2+, Zn2+, Cu2+ are toxic to plants at elevated levels whereas Pb2+ has been generally observed to cause phytotoxicity (Hasan et al., 2009). It is a non-essential element for plants but it shows high tendency of uptake and accumulation in different plant organs. The aim of present work is to find out the effect of different concentrations of lead on seed germination and plant growth of Vigna mungo.

Materials and Methods

The healthy seeds of Vigna mungo were collected from Tamilnadu Agricultural University, Coimbatore, Tamilnadu. The seeds were air dried and stored at room temperature before treatments with the metal solution. The seeds were immersed in 3% v/v formaldehyde/deionised water for 5 minutes to avoid fungal contamination. The selected seeds were washed with deionised water and placed in petriplates lined with Whatmann No: 42 filter paper. 50 seeds were placed in each petridish for treatment (Hasan et al., 2009). Lead solutions were prepared by using different concentrations of Lead nitrate solution viz., 10µmol/l, 25µmol/l, 50µmol/l, 75µmol/l. Petriplates containing seeds were poured with corresponding metal solution and incubated at room temperature for 7 days. The number of seeds germinated were recorded daily. Seventh day old seedlings were subjected to measure the root and shoot length of seedlings. Seedling dry weight was determined by placing the seedlings in oven at 80°C for 24 hours and the weight was measured using electrical balance. All determinants were carried out in triplicates.

Results and Discussion

The results revealed that lead inhibits seed germination, seedling growth and dry weight of Vigna mungo at higher concentration. The growth parameters were found to decline with the increasing concentration of lead with respect to control. Lead treatment at lower concentration, 10µmol/l produced significant influence on seed germination when compared to control. At higher con-

centrations (25, 50 and 75µmol/l) lead shows adverse effect on seed germination. Reduction in seed germination of Vigna mungo indicates that the element like Cd^{2}+ or Pb^{2}+ present in excess is responsible for producing toxic effects. Similar results were reported by jute varieties (Raskin and Ensley, 2000). They have reported reduction in seed germination, root, shoot and seedling length at different concentrations of lead.

Root length was consistently reduced with increased concentration of Lead. Maximum suppression of root length (3.7cm) was recorded at higher of concentration of Lead (75 µmol/l) as compared to control. Lead treatments at 10 and 25µmol/l shows increase in shoot length by 7.8 and 8.0 cm respectively. However there is a reduction in shoot length with increase in concentration of lead to 50 and 75µmol/l. The reduction in root length reveals that due to accumulation of metals within the root reduces the mitotic rate in the meristamatic zone specially blocking the metaphase in meristamatic cells (Goldbold and Kettner, 1991; Sharifah and Hishashi, 1992).

The data of seedling dry weight revealed that application of lead at 10µmol/l, 25µmol/l, 50µmol/l and 75µmol/l suppressed the dry weight to 36.2, 34.3, 33.4 and 31.2 mg respectively when compared to control (37.5 mg). This was supported by Cho and Wang, 1990, who found that dry biomass of maize plant, was reduced by the addition of heavy metals. It was concluded that inhibitory effects of lead treatments were most severe on germination, root length,shoot length, seedling length and seedling dry weight at higher concentrations of 75µmol/l.

Conclusion

Different concentrations of lead significantly inhibit the growth of Vigna mungo. All the growth parameters were gradually declined with increase in concentration from 10 to 75µmol/l. Seedling length and seedling dry weight shows more sensitivity to lead. Hence, there is an urgent need to implement certain rules that help in the reduction of metal level from a wide range of emission sources such as metal processing industries and power generation plants.

Table 1: Effect of different concentrations of lead on seed germination, root, shoot, Seedling length and dry weight of Vigna mungo

Treatments µmol/l	Seed germination (%)	Root length (cm)	Shoot length (cm)	Seedling length (cm	Dry weight (mg)
Control	94 ± 5.45	5.0 ± 0.07	8.0 ± 0.22	13.0 ± 0.25	37.5 ± 0.30
10	86 ± 5.45	4.8 ± 0.02	7.8 ± 0.06	12.6 ± 0.04	36.2 ± 0.03
25	77 ± 5.45	4.2 ± 0.04	7.5 ± 0.06	11.9±0.15	34.3 ± 0.11
50	69 ± 5.45	3.5 ± 0.12	7.3 ± 0.20	10.8 ± 0.12	33.4 ± 0.07
75	56 ±5.45	3.7 ± 0.12	6.0 ± 0.16	9.7 ± 0.28	31.2 ± 0.07

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