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Research Article

Toxic effect of lead nitrate [Pb(NO_3)$_2$] on the black gram seedlings (*Vigna mungo* (L.) Hepper)

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Abstract

Heavy metals are integral components of ecosystem. The distinctiveness characteristic of heavy metal is poisoning and resulting in the inactivation of enzyme systems. All heavy metals are potentially toxic at elevated concentrations. In the present investigation, effect of Lead nitrate [Pb (NO_3)$_2$], on the morphological parameters of black gram seedlings (*Vigna mungo* (L.) Hepper), the germination percentage and morphological parameters such as, root length, shoot length, number of leaf, total leaf area, root nodules, fresh and dry biomass were analyzed on the 15th days of seedlings. Among the all parameters were reduced in increasing the Pb(NO_3)$_2$ concentration when compared to control plants.

Keywords: Lead Nitrate [Pb (NO_3)$_2$], *Vigna mungo* (L.) Hepper, Morphological parameters.

Introduction

Heavy metal toxicity is one of the foremost current environmental health evils, and potentially dangerous due to bioaccumulation through the food chain and in plant products for human utilization. Therefore, heavy metal contaminations of soils and plants have become a greater than ever problem. The heavy metals Lead nitrate Pb(NO_3)$_2$, is caused increasing International concern due to its toxicity is commonly considered to be much higher than those of other heavy metals and it is eagerly taken up by plants.

Heavy metals refers to metals and metalloids having densities larger than 5 g cm^{-3} and is regularly linked with pollution and toxicity even though, some of these elements (essential metals) are necessary by organisms at low concentrations (Adriano, 2001). The most common heavy metal contaminants are Lead (Pb), cadmium (Cd), chromium (Cr), copper (Cu), mercury (Hg), nickel (Ni) and zinc (Zn). Due to the awareness of the pessimistic effects of ecological pollution, everyone is appropriate aware about result innovative methods for preventing pollution of the environment including soil (Lasat, 2002).

Among the heavy metals Pb(NO_3)$_2$ is a very toxic metal in all ecosystems the sources of Pb(NO_3)$_2$ is natural weathering processes the main sources of Pb(NO_3)$_2$ pollution are exhaust fumes of automobiles, chimneys of factories using Pb effluent from storage battery industry mining and smelting of Pb ores metal plating and finishing operation fertilizers pesticides and additives in pigments and gasoline (Eick *et al.*, 1998). The Pb occurs in soils in the form of insoluble and soluble salts (Singh *et al.*, 1997). It strongly binds to organic soil particles (Kumar *et al.*, 1995), which may decrease the mobility of lead in most soils and may reduce uptake by plants (Salim *et al.*, 1993; Kumar *et al.*, 1995; Cooper *et al.*, 1999).

Lead is one of the most comprehensively dispersed heavy metals and is incredibly toxic to in all ecosystems (Kosobrukhov *et al*., 2004). In complete plant, Pb can affect photosynthesis at the stomata level, mesophyll cells, pigment content and light and dark reactions. It interferes with nutritional elements of seedlings and plants, consequently causing deficiencies or horrible ion release within the plant (Trivedi and Erdei, 1992) as well as growth humiliation (Malkowski *et al*., 2002). And sometimes disables the creation of quality food products and animal feeds (Kabata Pendias, 2001). Moreover this $Pb(NO_3)_2$ was showed to be able to alleviate Pb toxicity in crop plants. Thus the aim of the present investigation was lead nitrate $Pb(NO_3)_2$ action on plant growth characteristics of black gram *Vigna mungo* (L.) Hepper.

Materials and Methods

Experimental Design and Details

Cultivar	: Blackgram (*Vigna mungo* (L.) Hepper
Variety	: ADT-3
Experimental design	: pot culture experiment
No. of treatments	: 5 Treatments
Replicates	: Five
Sampling days	: 15 DAS.

Pot culture experiments

Blackgram (*Vigna mungo* (L.) Hepper plants were grown in pots in untreated soil (control) and in soil to which Lead nitrate [Pb $(NO_3)_2$] had been applied (Control, 25, 50, 75, 100 and 150 mg kg^{-1} soil). The inner surfaces of pots were lined with a polythene sheet. Each pot contained 3 kg of air dried soil. The [Pb $(NO_3)_2$] was applied to the surface soil and thoroughly mixed with the soil. Ten seeds were sown in each pot. All pots were watered to field capacity daily. Each treatment including the control was replicated five times.

Cultivation details

Soil

Seedlings were grown in pot containing garden soil, red soil, and sand in the ratio of 1: 2: 1

Irrigation schedule

Uniform irrigation was given for a three times per a week. Five plant samples were randomly collected at (15 DAS) and they were used for observations of morphological parameters like root length, shoot length, root nodules, number of leaves, total leaf area, fresh weight and dry weight of the plants.

Shoot length and root length

Five plants were randomly selected for recording the root length and shoot length of black gram seedlings. They were measured by using centimetre scale.

Total leaf area (Kalra and Dhiman, 1977)

Five plant samples were collected at 15^{th} days, and the length and breadth of the leaf samples were measured and recorded. The total leaf area was calculated by using the Kemp's constant.

Total leaf area = $L \times B \times K$

Where, L - length, B - breadth and K - Kemp's constant (for dicot - 0.66).

Root nodules

Five plants from each pot with intact roots were removed with the help of digging fork. The root nodules were carefully separated from the soil by gently pinching and washing the soil. The following characters were recorded.

Fresh weight and dry weight

Five plant samples were randomly selected at 15 DAS. They were separated into root and shoot. Their fresh weight was taken by using an electrical single pan balance. The fresh plant materials were kept in a hot air oven at 80°C for 24hr and then their dry weight were also determined.

Results and Discussion

A fast growing industrialization and its use in agriculture had [Pb $(NO_3)_2$] to regional and global reorganization of metals with resulting ecological pollution. The role of environmental pollution to produce various types of deleterious effects an assortment of living system has been well established.

Heavy metals are the most dangerous pollutants as they are non-degradable and get accumulated and become toxic to all ecosystems.

Lead is common heavy metal and can be found in batteries, ceramics, chemicals and fertilizers. It is also used in a number of products including gasoline, hair dyes, leaded glass, newsprint, paints, pesticides, pottery and rubber toys. Inhibition to germination and retardation of plant growth has been reported due to lead toxicity (Jaffer *et al.*, 1999).

Pb $(NO_3)_2$ is known to induce a broad range of toxic effects to living organism, including those that are morphological, physiological, and biochemical in origin. This metal impairs plant growth, root elongation, seed germination, seedling development, transpiration, chlorophyll production, lamellar organization in the chloroplast, and cell division (Sharma and Dubey 2005; Krzeslowska *et al.*, 2009; Gupta *et al.*, 2009, Maestri *et al.*, 2010).

The minimum percentage of germination (20) at 150 mg kg^{-1} of Pb $(NO_3)_2$ and maximum (96) was observed at control plants (Table.1). The decrease in seed germination percentage of black gram can be attributed to the accelerated breakdown of stored food material in seed by the application of heavy metal. (Kalimuthu and Siva, 1990) found reduction in seed germination in black gram treated with different concentration of lead acetate and mercuric chloride. Excessive amounts of toxic elements usually caused reduction in plant growth.

The minimum shoot and root length (5.6 and 2.2) at 150 mg kg^{-1} of Pb $(NO_3)_2$ and maximum (24.8 and 10.8) was observed at control plants (Table.1). Pb $(NO_3)_2$ treatment showed greater toxic effects on root growth of blackgram. The reduction in root length in metal (Pb $(NO_3)_2$ treatments could be due to reduced mitotic cells in meristematic zone of root. Lerda (1992) made similar observations in roots of on *Allium cepa*. These findings confirm that metal treatment reduced the frequency of mitotic cell in meristematic zone and are responsible for inhibition in root growth. The explanation of reduced seedling length in metal $Pb(NO_3)_2$ treatments could be the reduction in meristematic cells present in this region and some enzymes contained in the cotyledon and endosperms. Cells become active and begin to digest and store food which is converted into soluble form and transported to the shoot and root tips for enzyme amylase which converts starch into sugar and protease act on protein. So when activities of hydrolytic enzyme are affected, the food does not reach to the root and shoot affecting the seedling length (Kopittke *et al*., 2007**;** Shafiq *et al.*, 2008).

The data recorded on seedling fresh and dry weight revealed that treatment of Pb $(NO_3)_2$ the minimum fresh and dry weights of black gram (2.11 and 0.37) at 150 mg kg^{-1} of Pb $(NO_3)_2$ and maximum (11.3 and 4.53) was observed at control seedlings (Table.1). The metal Pb $(NO_3)_2$ treatments showed more effects on seedling dry weight which is evident from the poor growth of root and aerial parts.

Table 1: Effect of different concentrations of Lead nitrate [Pb $(NO_3)_2$] on growth parameters of Blackgram (*Vigna mungo* (L.) Hepper on 15 days plants.

[Pb $(NO_3)_2$] added in the soil (mg kg^{-1})	**Germination percentage**	**Shoot length (cm/plant)**	**Root length (cm/plant)**	**Fresh weight (Shoot) (mg/g fr. wt.)**	**Dry weight (Shoot) (mg/g dr. wt.)**
Control	96 ± 4.80	24.8 ± 1.24	10.8 ± 1.16	11.3 ± 0.56	4.53 ± 0.22
25	83 ± 4.15	17.4 ± 0.87	8.1 ± 0.40	9.90 ± 0.49	3.80 ± 0.19
50	71 ± 3.55	14.8 ± 0.74	6.3 ± 0.31	7.75 ± 0.38	2.36 ± 0.11
75	60 ± 3.00	11.2 ± 0.56	4.3 ± 0.21	5.43 ± 0.27	1.10 ± 0.05
100	32 ± 1.60	9.0 ± 0.45	2.8 ± 0.14	3.97 ± 0.19	0.75 ± 0.03
150	20 ± 1.00	5.6 ± 0.28	2.2 ± 0.11	2.11 ± 0.10	0.37 ± 0.01

± Standard deviation

A minimum number of leaves, total leaf area, number of root nodules of black gram (2.0, 1.9, and -) at 150 mg kg^{-1} of Pb $(NO_3)_2$ and maximum (12.2, 11.8, and 20.2) was observed at control seedlings (Table.2). Root/shoot and leaf area ratios indicate that increased concentrations of Pb $(NO_3)_2$ are more toxic reduce root and shoot ratio and other all morphological parameters of growth. These findings confirmed that increased concentrations of Pb $(NO_3)_2$ showed higher percentage reductions indicating its toxicity in black gram seedlings.

Table 2: Effect of different concentrations of Lead nitrate [Pb $(NO_3)_2$] on growth parameters of Blackgram (*Vigna mungo* (L.) Hepper on 15 days plants.

[Pb $(NO_3)_2$] added in the soil	**Number of leaves**	**Total leaf area L ò B ò K**	**Number of root nodules (cm)**
Control	12.2 ± 0.61	11.8 ± 0.59	20.2 ± 1.01
25	8.3 ± 0.41	7.3 ± 0.36	15.5 ± 0.77
50	6.0 ± 0.30	4.8 ± 0.24	11.0 ± 0.55
75	4.2 ± 0.21	4.0 ± 0.20	9.2 ± 0.46
100	2.6 ± 0.13	3.2 ± 0.16	4.5 ± 0.22
150	2.0 ± 0.10	1.9 ± 0.09	-

± Standard deviation

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