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Lead content in seeds of Groundnut (*Arachis hypogea L.* Var TMV - 2) grown at different soil lead amendments

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Abstract:- The present paper deals with lead (Pb) accumulation in seeds of groundnut crop (Arachis hypogea L.var TMV-2) grown in lead spiked soil. Pot experimental studies were conducted to study the Lead up take and accumulation in test crop (Arachis hypogea L. Var TMV - 2). The test species was grown in lead spiked soils in test concentrations of 10.2.µg/g, 102 µg/g and 1020 µg/g, besides an unspiked control which is at low available back ground concentration of 1.02µg/g. Lead content in range of 0-36.0 µg/g was found in seeds of test crop(Arachis hypogea L.) grown in soils amended with lead nitrate in various concentrations in range of 0-1020 µg/g lead. These seed lead content were far beyond the permissible limits of lead in vegetables by WHO/FAO.

Keywords:- Lead uptake and accumulation in plants, Heavy metal pollution in soils, lead levels in soil and plants.

I. INTRODUCTION

Environmental quality and food production are of major concern to a country like India where agriculture is the backbone of economy and provide livelihood to the majority. Trace elements released from various anthropogenic activities have entered agricultural systems at alarming levels causing a serious risk to the quality of produce and quality of life. Of these heavy metal contamination of soil has become a major problem in numerous areas of the world (Rooney et al., 1999)

Lead (Pb) is a toxic heavy metal contaminating soil including agricultural soils through various sources and by different means. Mining and smelting wastes; fly ash and sludge amendments; fertilizers and pesticidal applications; vehicular emissions are some of the well known sources of Pb contamination. Pb levels in agricultural soils have ranged from 2-300 µg/g (Bowen, 1979 and Webber et al., 1984). Urban areas where Pb contribution from transport sectors is high, contain high levels of Pb in soils.

Certain trace elements are essential in plant nutrition (micro nutrients), but plants grown in a polluted environments can accumulate trace elements at high concentration, causing a serious risk to human health when plant-based food stuff are consumed (Voutsa et al., 1996). Being at the bottom of the food chain metal accumulating plants directly or indirectly are responsible for a large proportion of dietary uptake of toxic heavy metals by humans and other animals (Kabata – Pendias and Pendias; 1992).

Lead is a toxic contaminant even in very low concentration. According to United States Environmental Protection Agency (USEPA) the maximum permissible limits in waste water and potable water are 0.1 mg/L and 0.015 mg/L for lead (Pb^{+2}). (Park et.al 2005). Severe lead poisoning can cause encephalopathy, with permanent damage while moderate lead poisoning results in neurobehavioral and intelligent deficit (Chen et.al 2007). The presence of lead in drinking water even in low concentrations may cause anemia, hepatitis, and nephritic syndrome (Zulkali etal. 2006). Lead poisoning in human causes severe damage to kidney, nervous system, reproductive system, liver and brain (Ozer, 2007).

Groundnut is widely grown edible oil seed crop in India, a leading country in oil seed map of the world both in acreage and production. This crop forms the second largest agricultural commodity after the cereals. Apart from oil extraction the seeds of these crops are taken as food; oil cake and vegetative parts of the plants are used as fodder for the cattle.

II. MATERIALS AND METHODS

Pot experimental studies were carried out on groundnut (Arachis hypogea L var TMV-2) using sandy loam soils of back ground lead contents 1.02µg/g. Lead nitrate of analytical grade was used to prepare soil amends in test concentrations of 10.2, 102.0, 1020µg/g of lead. Besides the test concentrations, a control is also maintained with unspiked soil.

Pot experiments were conducted by taking 6kg of soil in each pot of 1ft x 1ft dimensions. Appropriate quantity of lead nitrate is added in solution to the soil in pots, and homogenized. Seeds of the selected crop varieties were sown in pots at distances specified in Hand book of Agriculture 1997 by Indian council of Agricultural research.

Soil: A red sandy loam soil is collected from agricultural field around vizag for pot experimental studies on groundnut. Soil is dried for 72 hours powdered to pass through 2 mm sieve and subjected to physico chemical analysis and characterization.

Seeds: Seeds of groundnut crop are collected from Agricultural Research Station of Andhra Pradesh located at Anakapalle, A.P.

Lead Nitrate: Soils were spiked with lead nitrate of Analytical grade (Qualigens) with mol.wt 331.21.

Pot Experimentation: Detailed investigations were carried out on groundnut species (Arachis hypogeal L. var TMV-2) in the experimental farm of Andhra University. Soil was spiked with Lead nitrate to different test concentrations 10.2 µg/g, 102µg/g , 1020µg/g in addition to control which is not spiked. 6 kg of soil was used in each pot having dimension 1ft X 1ft X 1ft. The soil in each pot is homogenized with lead nitrate solution and left for 2 days for stabilization.

Seeds of test species were sown in the pots at the distances and depth as described by ICAR [15]. 3 seedlings were maintained in each pot after 2 weeks of sowing. Experimental potted plants were grown under net house covered with transparent polythene sheet to protect them from rain water leaching, but kept open to air and ambient temperatures.

Estimation of Available Lead in soil: From the air dried, sieved soil, 5g samples were weighed and transferred in to 150ml polythene container followed by addition of 50 ml Ammonium acetate to each container. Samples were gently agitated (75 rpm) for 24 hrs, filtered through Whatman No 41 paper and stored in polythene bottles. Ammonium Acetate was chosen for the experiment because of its well proven use as a measure of plant available fraction of soil [17].

Lead is estimated in the solution after pre concentration technique of APDC & MIBK extraction and Atomic Absorption Spectrophotometer (Perkin Elmer 3110)

Estimation of Total Lead in Soil: Soil samples were dried at 50 ^{o}C and sieved to 2 mm size and 0.2 g accurately weighed sample is then transferred in to boiling tubes. 10 ml Conc HNO3 is added, boiled to 3 ml and further 10 ml Conc HCl was added and then boiled to 3 ml. The solution was then diluted to 100 ml with DDW, and Lead is estimated by Atomic Absorption Spectrophotometer.

Estimation of Lead in Seed: The test crop plants from the experiment pots wereharvestedonday90,taken to laboratory, washed with deionised double distilled water (DDW).These plants were separated in to parts of root, shoot, leaf and pods and were dried in oven at 65 ^{o}C for 72 hours. From the dried pods, seeds were removed, ground and kept in desiccator. This ground seed material was used for estimation of lead as per methods prescribed by Robinson[16] et al 1998.

From the seed material 0.2g was accurately weighed and transferred in to a set of boiling tubes.10 ml of concentrated $HNO_3$was added to each tube and mixture was heated on heating block until a final volume of 3ml was reached. Then 10 ml of conc. HCl was added to this and boiled to 3 ml. The samples were then diluted to 50 ml using DDW, and stored in plastic containers. Lead in sample solution was quantified using Atomic Absorption Spectrophotometer (Perkin Elmer 3110).

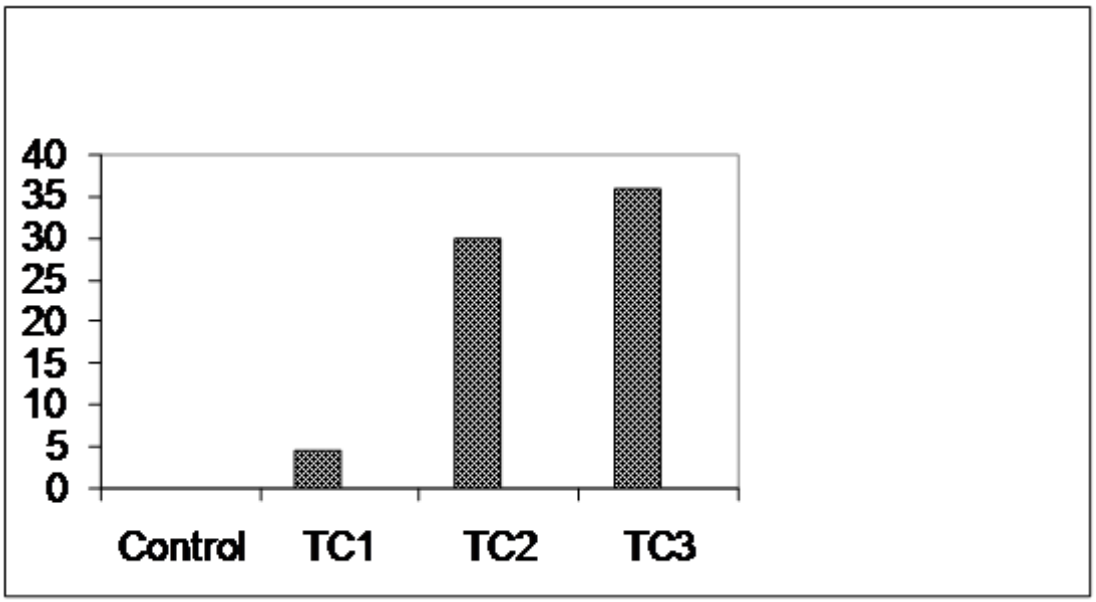
III. RESULTS AND DISCUSSION

Lead content in seed of Groundnut crop grown at different soil lead amendments was given in table; and shown in figure. It was found that the seed in control soil grown plant in test crop showed no lead content. With increasing soil lead, the seed lead content also increased in test crop species.

Table: Lead content (µg/g) in seeds of groundnut grown in amended soils were obtained as follows:

Test concentration of soil lead	Lead content in seed of groundnut (µg/g)
Control	**0.0**
TC_1 (10.2µg/g)	**4.7**
TC_2 (102µg/g)	**30.0**
TC_3 (1020µg/g)	**36.0**

Figure: Lead content in seed (µg/g) in different test concentrations



Results of the present study reveal that the lead (Pb) concentration in seed of groundnut grown in amended soils were well above the maximum permissible limit prescribed for the food stuffs WHO/FAO prescribed the maximum permissible limit for lead in food stuffs as 0.3mg/kg, (Oyedele et al., 1995). The Kernel (seed) of groundnut is most widely was food stuff for various preparations and also raw food; in addition to oil extraction. Pb content in seed is 4.7 µg/g even at 10.2 ppm (TC1) soil concentration while at 102.0 µg/g (TC2) and at 1020 µg/g (TC3) it was 30.3 µg/g and 36.0 µg/g respectively. Oil cakes obtained after oil extraction from seeds in groundnut are used as feed for cattle, poultry, and is also used as food by some people.

Such elevated concentrations in some cases exceeding the maximum permissible levels for human consumption were observed for lead in trace element content of vegetables grown in greater industrial area of Thessaloniki (Panayiotopoulos etal., 1976). Vousta etal., 1996 reported Pb levels of 0.49 – 15.5 µg/g, 0.05 – 0.1µg/g, 0.31 – 16.5µg/g, 0.17 – 15.3µg/g, 1.42 – 24.2µg/g in cabbage, carrot, leek, lettuce and endive respectively in industrial area soil's of Thessolonki, N.Greece.

III. CONCLUSION

The present study clearly indicate that soil Pb concentration can cause increased Pb uptake by plants and such increased uptake by food crops may pose serious problems of bio magnification in human and animals. Thus groundnut cultivated in lead contaminated soils can pose serious threats to human health and thus should be regarded as not suitable for food consumption.

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