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ANALYSIS OF HEAVY METAL LEAD (Pb) IN SOIL SAMPLES COLLECTED FROM AGRICULTURAL FIELDS NEAR INDUSTRIAL AREAS AND THE EFFECT OF LEAD ON SEED GERMINATION PERCENTAGE OF PIGEONPEA (*Cajanus cajan* (L.) Millspaugh) AND MAIZE (*Zea mays* L.).

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ABSTRACT

Soil testing is an acceptably, accurate and rapid soil chemical analysis for assessing heavy metal Lead (Pb) in industrial effluents. The industrial effluents has received wide spread attention. The heavy metal contamination leads to a serious threat to agricultural fields, products and living organisms. Among heavy metals, lead is an element that is easily accumulated in soil and sediments. The level of lead found in plants is often correlated with the level present in the environment. In view of this, the amount of heavy metal lead (Pb) was detected in the soil samples, collected from the agricultural fields near industrial areas. The study also throws light on the effects of lead toxicity on seed germination percentage (%) of Pigeonpea (*cajanus cajan* (L.) millspaugh), a C_3 plant) and Maize (*zea mays* L.) a C_4 plant) in the selected agricultural fields in paravada mandalam, venellapalem village near industrial areas. The analysis of heavy metal lead (Pb) in the soil samples were determined by using **ASTM E1613-12** (Standard test method for determination of lead by inductively coupled plasma atomic emission spectrometry) method. The mean values of heavy metal lead (Pb) and seed germination percentage of Pigeonpea and Maize in both control and contaminated areas.

KEYWORDS: Heavy metal Lead (Pb), Soil samples, Pigeonpea, Maize, Seed germination percentage, Industrial areas, Agricultural fields.

1. INTRODUCTION

Soil contamination by heavy metals is a major ecological concern due to its widespread release from agriculture, human activities and industry (Valko et al., 2005). With the industrial development, the production and emission of heavy metals have increased. The nature of heavy metals to bioaccumulate causes toxicity in biological systems such as humans, animals, microorganisms and plants. Accumulation of heavy metals can reduce soil quality, crop yield and the quality of agricultural products. Thus, it gives negative impacts to the health of human, animals and the ecosystem (Nagajyoti et al., 2010). Lead (Pb), unlike some other heavy metals, is not essential for higher plants and other organisms. At higher concentrations, Pb is highly toxic to man, animals and plants, which is why it is considered a dangerous pollutant. Pb pollution sources are mainly from industry and its products, which use Pb in production technology. Major lead content in the soil comes from weathering of geological rock formations, lead mine's discharge, automobile exhausts, industrial applications, smelting operations, fertilizer impurities, use of lead arsenate in metal plating and finishing operations, tetra- methyl lead applications as anti knocking agent in petrol (Sharma and Dubey, 2005) and plants obtain lead from such agencies (Kabir et al., 2009). Increase in lead concentration in cultivated soils is detected in close proximity to industrial sites. This heavy metal enters the food chain mainly through plants, which is why it is very important to understand its accumulation and distribution in plants and its effect on physiological and biochemical processes in plants (Kabata-Pendias and Pendias, 2000).

Pigeonpea - C_3 plant [*Cajanus cajan (L.)* Millspaugh] is an important pulse crop in India. It is also known as red gram and it is a protein rich staple food. It contains about proteins, fat, minerals and vitamins, which is almost three times that of cereals. Maize - C_4 plant (*zea mays* L.) is the third most important food crop after rice and wheat in India. It is a domesticated plant and has many beneficial uses for human and animal. Maize is used as human food, poultry feed, animal feed, industrial products and beverages.

Therefore, keeping in view of all these deleterious aspects of Pb toxicity, the present study was conducted to determine the concentration of lead (Pb) in the soil and examine the effect of lead (Pb) on seed germination of (7-day) Pigeonpea and Maize in the selected fields.

2. MATERIAL AND METHODS

Study area

- The selected fields in paravada mandalam, venellapalem village, near industrial area are considered as contaminated field area-I of about 5 Kilometer (Km) and contaminated field area-II of about 1 Km. The site is located approximately (Latitude: 17^0 30' 33" to 17^0 31' 48" North and Longitude: 82^0 57' 48" to 82^0 59' 35" East).

- The area, which is away from industrial area, is the Botanical Research farm, Andhra University is located in Hanumanthawakka junction near kailasagiri hill station and it is considered as Control field area. The site is located approximately (Latitude: $17^0$42" North and Longitude: $83^0$17" East).

Collection of a representative soil sample

One of the most important steps in soil testing is collecting the sample. Take soil from a selected field in the zigzag manner minimum of 10 random locations (x) in the sampled area. By using a spade, shovel, khurpi or augers the following technique should be adopted.

Method: Make a V-shaped cut 15-20 cm deep and take a 1 cm slice from the smooth side. Trim sides with a sharp blade or a pen knife leaving a 2 cm strip. Collect the soil sample in a bag and mix together in a clean bucket. Take number of such samples to make a composite sample. Pour the soil into a clean news paper and separate the impurities from the soil samples. Divide the whole soil into quadrant. Soil samples should be air-dried or taken to a test laboratory as soon as possible. To dry a soil sample, spread the soil out in a clean, warm, dry area and let it dry for two to three days. It is best not to heat or dry soil samples in an oven because soil chemical properties may be altered. Bag the soil samples and send it to a laboratory for analysis by using (ASTM E1613-12) method.

Seed germination experiment

The seeds of Pigeonpea [*Cajanus cajan* (L.) Millspaugh] and Maize (*Zea mays* L.) were obtained from International Crops Research Institute for the Semi–Arid Tropics, Hyderabad. Seeds of Pigeonpea and Maize were washed thoroughly under running tap water and finally with distilled water before sowing. The seeds of the two crops were sown 4 cm (Centimeters) deep in the plots of 10 X 10 m (Meters) with a spacing of 75 cm between the rows and 50 cm between the plants within the rows respectively. For recording the data of seed germination percentage of two crops were recorded of 7-day crop plants in both control and contaminated areas of area-I and area-II respectively. Finally, the mean values of seed germination percentage of two crops were given.

3. RESULTS AND DISCUSSION

The present study is confined to determine the amount of lead in soil in the selected agricultural fields near industrial area and the effect of Lead on seed germination of Pigeonpea and Maize crop plants. **(**Adeleken and Abegunde, 2011) reviewed that heavy metals naturally occur in all ecosystems, however, anthropogenic activities can result in higher concentrations of metal productions hence contribute to the pollution.

Table-1. Physio-chemical characteristics of the soils of both control and contaminated areas of area-I and area-II.

S.NO.	DESCRIPTION	UNIT	TEST METHOD	CONTROL AREA	CONTAMINATED AREA-I	CONTAMINATED AREA-II
1.	pH	--	IS 2720 P-33	7.05	7.49	7.84
2.	Lead as Pb	mg/kg	ASTM E1613-12	NOT DETECTABLE	12.360	17.133
3.	**Texture**	--	IS 2720 P-4			
a.	Sand	%		72.36	72.06	69.52
b.	Silt	%		1.5	1.0	1.28
c.	Clay	%		27.0	26.94	29.2
4.	Bulk Density	g/cm^3	IS 2720 P-28	1.3927	1.3919	1.2770
5.	Moisture	%	IS 2720 P-2	1.427	0.301	0.582
6.	Nitrogen as N	%	IS 5194	0.046	0.038	0.042
7.	Phosphorous as P_2O_5	mg/kg	IS 6361	95	88	80
8.	Potassium as K_2O	mg/kg	IS 9497	55	35	35

The experimental soils collected from the crop fields near industrial areas had their physical and chemical characteristics similar to those reported by several authors (Etheringtom, 1976) and (Farooq et al., 1999). In (Table-1) The metal content data determined by (ASTM E1613-12) method. The results showed that mean accumulation of heavy metals in soil analyses was comparatively highest at contaminated area-II, followed by samples from control area and contaminated area-I. The most probable cause of high heavy metal content in

contaminated area-II is the proximity to the industrial areas. The level of contamination of the study areas varied with concentrations from 12.360 mg/kg in contaminated area-I to 17.133 mg/kg in contaminated area-II.

The characteristics of the soil include pH, texture (sand, slit and clay), bulk density moisture and N, P_2O_5, K_2O respectively. The general ranges reported for these parameters are well comparable with others indicating the soils, used for experiments on groundnut are of uncontaminated by lead (Pb) and ideal for lead amendments.

Table-2. Seed germination percentage of (7-day) Pigeonpea (*cajanus cajan* (L.) millspaugh), a C_3 plant) and Maize (*zea mays* L.) a C_4 plant) in both control and contaminated areas of area-I and area-II.

CROP PLANTS OF C3 AND C4	NO. OF SEEDS	CONTROLLED AREA	CONTAMINATED AREA-I	CONTAMINATED AREA-II
Pigeonpea	100	92.87%	70.89%	52.74%
Maize	100	95.57%	80.45%	63.14%

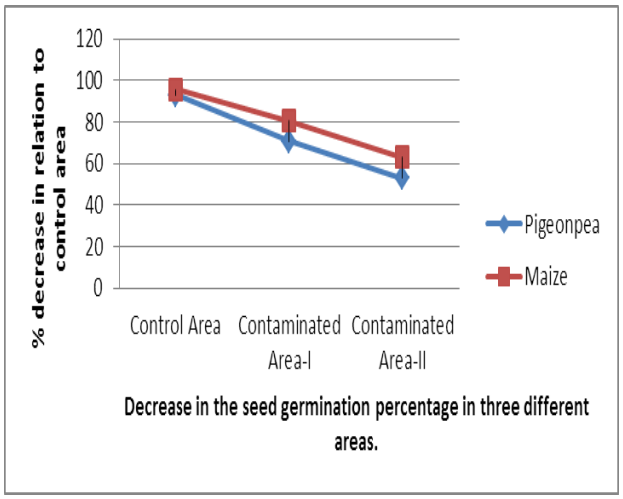

Figure 1. Represents the seed germination percentage of (7-day) Pigeonpea and Maize crop plants grown in both control and contaminated areas.

The decrease in seed germination is attributed by the heavy metal lead in the soil. (Jamal et al., 2006) and (Mahmood et al., 2005). Lead had inhibitory effect on seed germination percentage of (7-day) pigeonpea and Maize. The result showed in (Table-2) and In figure 1. In controlled area, the seed germination percentage of Pigeonpea is 92.87% and 95.57% of Maize is observed. In contaminated area-I, the seed germination percentage of Pigeonpea is 70.89% and 80.45% of Maize is observed. Where as in contaminated area-II, the seed germination percentage of Pigeonpea is 52.74% and 63.14% of Maize is observed. There was a continuous decrease in the seed germination percentage with the increase of Lead concentration in the soil.

CONCLUSION

The aim of the investigation was to determine the amount of lead in the soil samples and the effect seed germination percentage on Pigeonpea [*Cajanus cajan (L.)* Millspaugh] and Maize (*Zea mays* L.) crop plants. Lead is considered as important potent environmental contaminant. Various ecological, environmental and evolutionary processes in the microsphere are disrupted because of lead toxicity to the microbial community. It is concluded that, the inhibitory effect on seed germination with the increase of lead concentrations in the agricultural field areas near industries. So, agricultural soils, on sides of highways and industrial areas should be checked for lead contamination periodically before their use for cultivation.

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