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Bioaccumulation of Heavy Metals in Soybean (Glycine max (L) Merr)

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ABSTRACT

Bioaccumulation of Heavy Metals like mercury, cadmium lead, by soybean was investigated. The experiments were performed to evaluate the extend of an accumulation of these metals in the aerial part of the plant. The plants were treated with different concentrations in the form of their nitrates. The treatments were given through soil on alternate days till harvesting. The samples were collected every week till the end. The accumulations of these metals were analised by Atomic Absorption Spectrophotometer.

Key word: Bioaccumulation, Mercury, Cadmium, Lead, Soybean.

Heavy Metal pollution considered to be the most dangerous hazardous effecting both developing and developing countries. Increasing global environmental deterioration is bringing much more attention by heavy metals. Metals having density greater than 5m/cc are referred to as heavy metals. Some of these like copper and Iron are essential trace elements found in plants and animal bodies whereas some others are non-essential and extremely toxic like Lead, cadmium and Mercury. The noxious influence of heavy metals on plants is a well known fact and has been described by many authors. These metals are being released into the environment due to industrial, agriculture and mining activities and also from exhaust gases of automobiles. The presence of these heavy metals in organisms can cause many diseases even if present in very low concentration[26]. Studies with macrophytes have been conducted with a veriety of metals such as Pb,Cd,Hg,Cr,Cu and several macrophyte species such as *Hydrilla verticillata*, *Potomogeton pectinatus* and *Vallisnaria*, *spiralis*[11], *Salvinia modesta*, *Azolla pinnata* and *Marsilea trinuata*[9], *Eloedea nuttallia* and *Lemna* spp[20]. There are some variations in terms of metal tolerance and ability to accumulate heavy metals among these macrophytes. Mercury is considered as a non-essential toxic element for living organism. Even at low concentrations mercury and its compounds produce potential hazards due to enrichment in the food chain. On the basis of mean concentration of mercury in cereals, vegetables, pulses, milk and fish. Most plants behave as excluders for Hg, storing the metal mainly in the root[23], acting as a barrier to avoid that heavy metals reach the aerial part of the plant[24]. It is an environmental pollutant which is mainly supplied via anthropogenic sources to the soil and is harmful because of its toxicity, mobility, bioaccumulation, methylation process and transport in the atmosphere[27]. Most of the stored Hg in root is bound to cell wall (80%) in plants[34]. According to Bontidean *et al*.[5], low Hg concentration found in leaves due to reduced translocation, limit the use of several plant species as bio monitors, because they are able to uptake and translocate Hg under field conditions. Hg compounds are highly toxic to plants and concentration in plant tissue increase with age[7]. Soil Hg availability for plants is usually low, because it is absorbed in the soil or precipitated in the solution then it reaches the shoots by translocation or foliar absorption[16]. Mercury concentration was higher in roots than the shots[21].

Cadmium occurs as a major environmental contaminant. In agricultural soil it is mainly derived from fertilizer, fungicides and added to soil through the application of some phosphatic fertilizers as well as deposition from the atmosphere[2]. Cadmium has been reported to been reported to be phototoxic[22] and when take up by animals and human being causes toxicity[8]. Cadmium has also been known to inhibit nitrogen metabolism in higher plants[6]. Williums and David[35] studied accumulation of Cd residues from phosphatic fertilizers and their effects on Cd content in plants. They report that cadmium can enter the agriculture food chain through uptake by plants naturally present in the soil o from anthropogenic inputs via the atmosphere, disposal of sludge on agriculture land or from the application of phosphate fertilizer. Cd is phototoxic in nature and not only inhibits the growth parameters of plants but also causes death of plant[33].

Ham and Dowdy[10] studied growth and composition of Soybean as influenced by soil amendments by sewage sludge applications. Roberts and Johnson[26] reported that the potential harm posed by the uptake of heavy metals such as Cd and Pb by plants depend on their abundance, mobility and Bioaccumulation. The effect of phototoxic elements like Zn,Cd,Cu elements are widely spread and can reach high level in the soil. They are readily accumulation by plant roots[15].

Bell *et al*.[4], reported that the intensive use of phosphatic fertilizers combined with soil properties which generally enhance phytoavailability of cadmium thereby affecting the quality of seeds of Soybean and ground nut and these accumulation Cd at levels greater than that the permitted concentrations. Rayment[25] in his studies on sources of cadmium in agricultural products reported high cadmium concentration due to the inadvertent addition of high ates of Cd an impurities in phosphatic fertilizer, resulting in availability of Cd fo increased uptake by plants[17]. The heavy metal accumulation was highest for Cd followed by Pb on spinach seedlings Khan *et al.*,[14]. Lead is also found in soil vegetation, animals food, water and air in the vicinity of highways although its level decreases exponentially with the distance from the road[29]. Lead levels in sewage sludge may vary between 2.000-8.000 ppm and its use as a fertilizer may give rise to subsequent contamination of agriculture soil. The accumulation of Cd and Pb when the exposer time and concentration increased Thripathi and Panday[32]. Accumulation of Pb and Cd would be accumulation in all plant organs in the order of leaves stem and roots[13].

The present study was carried out on Soybean (Glycine *max* (L.)) for one crop. Three concentrations i.e 0.01m, 0.001m, 0.0001m and three metal nitrates $Hg(NO_3)_2$, $Cd(NO_3)_2$, $Pb(NO_3)_2$ were taken. The application of test solution was started after first week taken for chemical treatment. Plants were transferred to shade and 50ml of test solution was given to each bag on alternate days.

Bioaccumulations of the heavy metals were estimated by the method given by Mithis and Cumming[19] and APHA[3]. The samples were collected in conical flask and were acidified with concentrated HNO3 on the spot to bring the pH of the samples were determined by Atomic Absorption Spectrophotometer Model 2380 (Perkin Elmer, USA) using flame atomization and HGA400 graphite furnace. The pretreatment procedure specified by APHA[3]. To 5gm of plant sample 25ml of acid solution (four volumes of concentrated Nitric acid and 1 volume of concentrated Percloric acid made from Analar grade acids) was added. The solution was evaporated until the volume was diluted to 50ml with distilled deionized water and metal content was determined by using Atomic Absorption Spectrophotometer at 283nm(Pb), 229nm(Cd), 254nm(Hg) wavelengths.

The accumulation of the three heavy metal *i.e.* Hg, Cd, Pb was estimated in the aerial part of control and all the treated plants at weekly intervals till77 days. Results are presented in figure 1 it is indicated that the accumulation of Hg did not increase much till 42 days. After which there was an abrupt increase in the accumulation of this metal in plants treated with higher concentrations. After that it was increased till 63 days after which there was a sudden increase in the accumulation which continued till the end. However, the accumulation in the plants treated with lower concentration was much lower than the medium concentration.

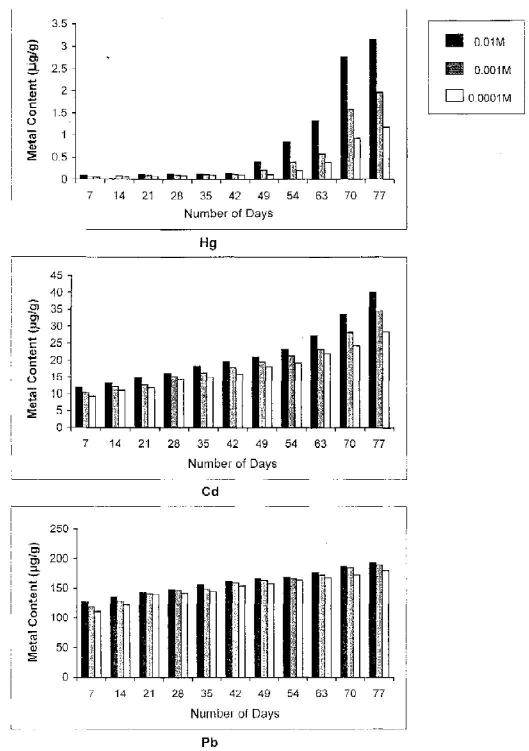

Fig. 1. Bioaccumulation of heavy metals in Soyabean [Glycine max (L.)]

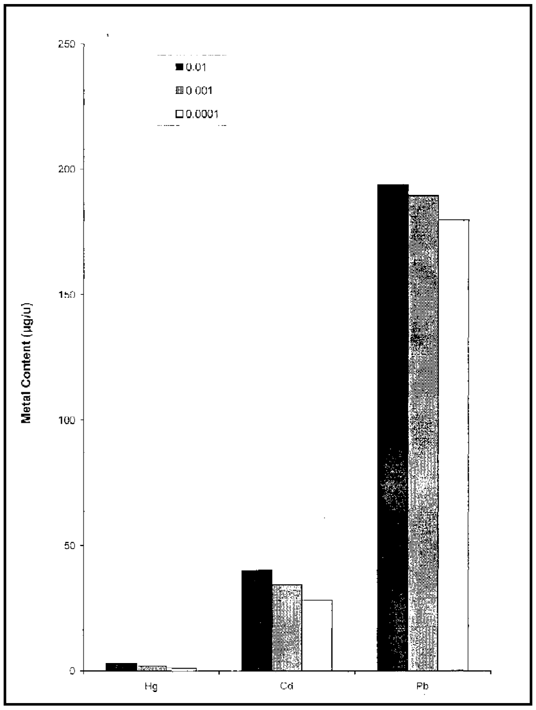

Fig. 2. Bioaccumulation of heavy metals in Soyabean [Glycine max (L.)] after 77 days

Figure 1 indicates that the accumulation of Cd in all the $Cd(NO_3)_2$ treated plants increased gradually with time till end those plants treated with higher concentration. But those plants treated with lower concentration were not so abrupt.

Figure 1 also indicates the accumulation of Pb in the plants treated with three concentrations. It is clear from the figure that the accumulation of Lead was quit high even in the initial stages which increased substantially during two to three weeks. After which the increase was gradual till the end. It may be mentioned here that the accumulation of the three metals was not observed in water treated plants at any stage. Figure 2 represents a comparison of the amount of three metals accumulated in the plants treated with the respective metal nitrates after 77 days of the start of experiment. The figure shows that the accumulation of Hg was considerably lesser than Cd and Pb.

The bioaccumulation of Pb is ten times more than that of Hg, twenty times more than that of Cd and three hundred times more than that of Hg. This results were supported the work of Johnson and Proctor[12]. According to these workers Pb is strongly absorbed by soils from insoluble crystalline compounds in soil and hence seldom reaches high levels in leaves or stem. In these soils which have adequate amount of phosphorous the plants do not accumulate Pb Miller *et al.*,[18]. It has also been reported earlier that freshly added Pb salts are more readily available to plants.

In the present investigation $Pb(NO_3)_2$, treatments was given on every alternate days and such a frequent addition might have increased the bioaccumulation of Pb accumulation in Soybean. The bioaccumulation of Hg is much lesser than that of the other two metals this was more toxic even at low concentration.

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