EFFECT OF NITROGEN, PHOSPHORUS AND POTASSIUM FERTILIZING ON ZINC AND LEAD CONCENTRATION IN PLANTS, *HELIANTHUS ANNUS, ZEA MYAS* AND *LEPIDIUM SATIVUM* +

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Abstract:

Three plants species *Helianthus annus, Zea myas* and *Lepidium sativum* were used to study the effect of N, P and K fertilizers on zinc and lead concentration. Plants biomass and plants height and concenration of zinc and lead were determined for the three plants in response to Zn and Pb application. The results showed that the plants height was not negatively affected by the zinc and lead application as compared to the controls, and the increasing in plants' height in presence of P is very clear. The growth of plants which is expressed as biomass dry weight was not found to be influenced by Zn and Pb application. Biomass yields in plants with the presence of P showed that the results were higher than other plants. The results of zinc and lead concentration showed that the K was the most effective fertilizer for enhancing Zn and Pb concentration by the three plants. In general, the presence of K enhanced Pb concentration in *L. sativum* very clearly and the presence of K was increased Zn concentration in *Z. myas*. On the other hand, P and N fertilizers were not influenced in a clear way on the plants concentration of Pb and Zn. Also the results showed that the *L. sativum* (Brassicaceae) was the most promising for phytoremediation of contaminated sites with Pb in the presence of K.

تاثير التسميد النتروجيني والفوسفاتي و البوتاسي في تركيز الزنك و الرصاص من التربة المزروعة بالذرة و زهرة الشمس والرشاد

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المستخلص :

ثلاثة انواع من النباتات (الرشاد والذرة وعباد الشمس) استخدمت لدراسة تاثير التسميد بالنتروجين و الفسفور والبوتاسيوم في تركيز الزنك والرصاص في الكتلة الحية وطول النبات. واستجابتها لوجود الزنك والرصاص وتحت المعاملة بالنتروجين والفسفور والبوتاسيوم فيها .

اظهرت النتائج بان ارتفاع النباتات لم يتاثر سلبيا بوجود العناصر الثقيلة مقارنة مع السيطرة وكان هنالك زيادة واضحة في ارتفاع النباتات بوجود الفسفور. نمو النبات مقاسا بالكتلة الحية الجافة ايضا وجد انه لا يتاثر بوجود الرصاص والزنك، وان انتاج النباتات من الكتلة الحية بوجود الفسفور اظهر زيادة واضحة.

+ Received on 1/4/2014 , Accepted on 19/8/2015 .

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اما بالنسبة لتركيز الزنك والرصاص فقد اظهرت النتائج بان البوتاسيوم كان المعالج الاكثر تاثيرا في زيادة تركيز النباتات للمعادن الثقيلة للنباتات الثلاثة. وبصورة عامة فان وجود سماد البوتاسيوم يحفز امتصاص الرصاص في نبات الرشاد بشكل واضح ووجود البوتاسيوم زاد من تركيز الزنك في نبات الذرة بشكل واضح. ومن جهة اخرى فان التسميد بالفسفور والنتروجين لم يؤثر في تركيز الزنك والرصاص. وكذلك اظهرت النتائج بان الرشاد هو من النباتات الذي يمكن استخدامة في تنظيف التربة من المعادن الثقيلة بوجود البوتاسيوم.

Introduction:

Pollution of the soil by toxic metals has accelerated since the beginning of the industrial revolution. The use of heavy metals in many industrial applications has led to their wide distribution in wastewaters, sediments and soil. They are serious pollutants due to their toxicity, persistence and bioaccumulation problems [1]. High concentrations of heavy metals in the environment can pose concerns for human health due to their persistence and cytotoxicity and genotoxicity effects [2]. Toxic heavy metals entering the ecosystem may lead to geo-accumulation, bio-accumulation and bio-magnifications. Heavy metals get into plants via adsorption which refers to binding of materials onto the surface or absorption which implies penetration of metals into the inner matrix. Both mechanisms can also occur [3].

Phytoremediation is a site remediation strategy, which employs plants to remove non-volatile and immisible soil contents. This sustainable and inexpensive process is emerging as a viable alternative to traditional contaminated land remediation methods [4].

Many studies suggest making different amendment to promote growth and heavy metal uptake of plants. There is a study showed the plants grown in soil fertilized with NPK showed higher concentrations of heavy metals compared to the control [5].

There is a few studies about the effect of N, P and K fertilizers on heavy metals concentration by plants so the present study is to evaluate the suitability of three types of plants the *Helianthus annus, Zea myas* and *Lepidium sativum* as phytoremediation technique and study the effect of N, P and K fertilizers in the presence of zinc and lead on plants height, plants biomass and heavy metal concentration of zinc and lead from the soil.

Materials and methods :

Three plants *Helianthus annus* (species belonging to the Asteraceae family), *Zea myas* (species belonging to the Poaceae family) and *Lepidium sativum* (species belonging to the Brassicaceae family) were used to study the effect of nitrogen, phosphorus and potassium fertilizers on lead and zinc concentration. Specifically, this study investigated the role of various amendments on the plants height, plants biomass and uptake of zinc and lead from the soil.

Stainless steel sieve with a diameter 4 mm were used for the sieving of the soil sample. The seeds of plants were germinated in the soil in pots contain 1 kg of soil and were left to grow for two weeks in the soil without heavy metals added. The Fourteen days old seedlings were transferred into the soil in pots which was treated with $ZnSO_4 . 7H_2O$ at rate of 250mg\kg soil or $Pb(CH_3COO)_2$ at rate of 210mg\kg soil.

Nitrogen was added as urea (46% N) at rate of 250 mg\Kg soil, Phosphate was added as ammonium phosphate at rate of 500mg\Kg soil, while potassium was added a rae of 500mg\Kg as potassium chloride. Plants were irrigated every 2–3 days, with 200 ml of tap water; Care was taken to avoid drainage of solution during the treatment by giving water slightly less than field capacity.

At the end of 45 days experimental period, the shoots of plants were harvested and the roots were carefully taken out of the soil, washed with distilled water in order to remove any dust deposits and surface soil. At the end of the experimental period; plants height, biomass and Zn and Pb content in the plants tissues were determined.

For biomass estimation, the shoots and the roots were separated and oven-dried at 65◦C till a constant weight was obtained. Oven-dried plant parts were weighted separately [6].

For determination of Zn and Pb concentration, the roots tissue was not included in the analysis. (200 mg) of plant materials (aboveground parts) were digested with 3 ml of concentrated nitric acid and 2 ml of hydrogen peroxide at 95°C for 90 min until the evolution of nitrous oxide gas stopped and the digest became clear. The digest was diluted with distilled water to 10 mL and filtered through filter paper [7]. Total concentration of Zn and Pb was determined by atomic absorbtion spectrophotometer (NOVAA 300) Analytik jena germany [8].

Results and Discussion:

To evaluate three plants species for their suitability for using in the phytoremediation of a contaminated site, several features were studied. Plants biomass and plants height and uptake of zinc and lead were determined for *H. annus, Z. myas* and *L. sativum* in response to Zn and Pb stress and the fertilizing with N, P and K fertilizers.

Figure (1) and (2) showed the effect of Zn and Pb on the shoots height at different rates of N, P and K fertilization. Plants height was not negatively affected by the zinc and lead added as compared to the control treatment, while increasing in the shoots height was clear in the presence of the P.

The effects of fertilizers on the roots and the shoots dry mass yields after 45 days in the presence of Zn are showed in figures (3) and (4) respectively.

The growth of plants which was expressed as biomass dry weight was not found to be influenced by Zn and Pb application. Biomass yields in studies plants with application of P fertilizer are showed higher biomass than other plants.

Figures (5) and (6) showed the effects of fertilizers on the roots and the shoots dry mass yields after 45 days in the presence of Pb. Biomass yields in the plants with the presence of P fertilizer showed higher biomass than other plants.

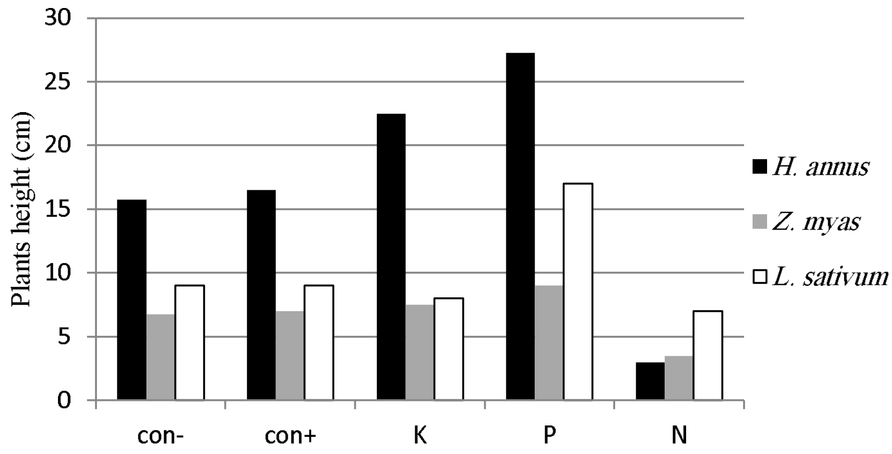

Figure (1) Effect of Zn on the plants height at different levels of N, P and K fertilizers
con- : control negative; con+: control positive; K: plant in the presence of K; P: plant in the presence of P; N: plant in the presence of N

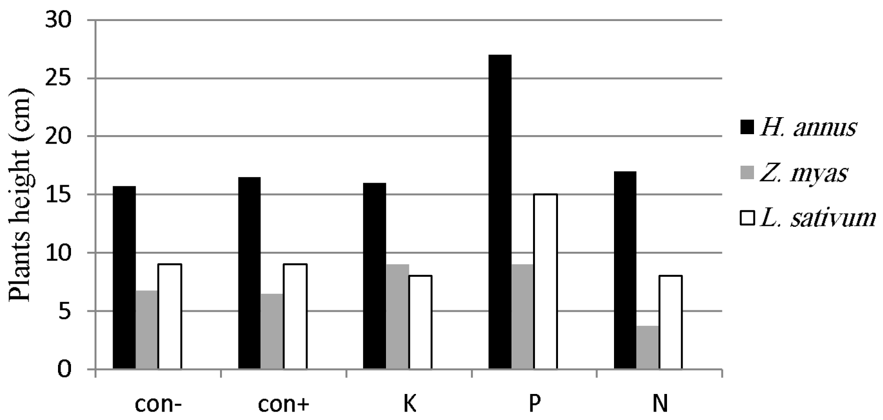

Figure (2) Effect of Pb on the plants height at different levels of N, P and K

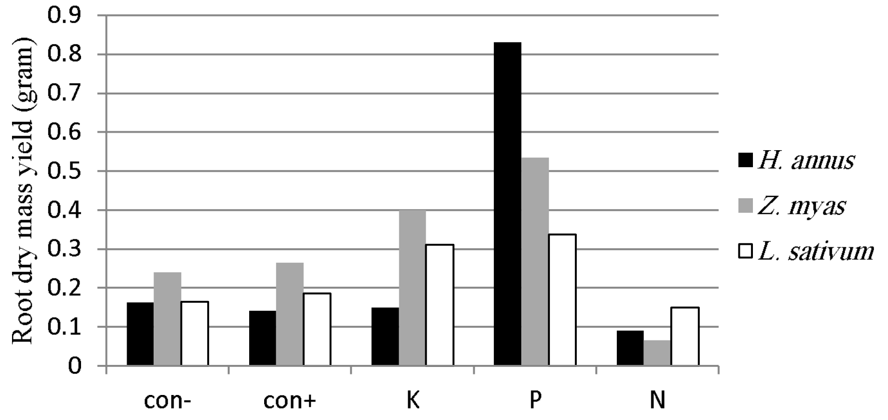

Figure (3) Effect of Zn on root dry mass yields at different levels of N, P and K fertilizers

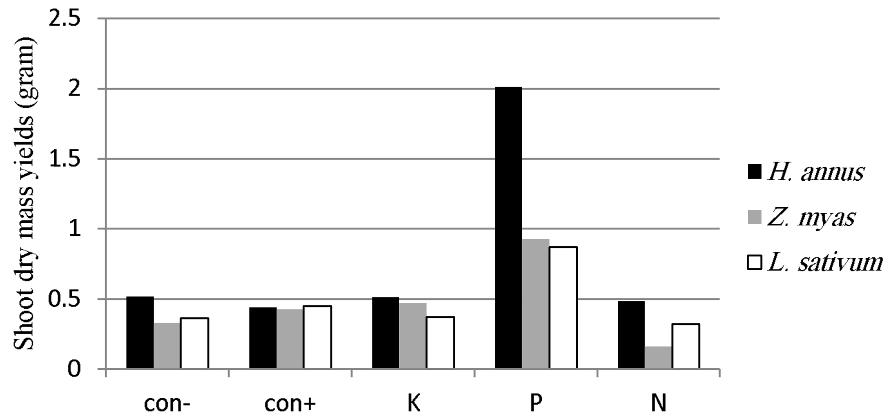

Figure (4) Effect of Zn on shoot dry mass yields at different levels of N, P and K fertilizers

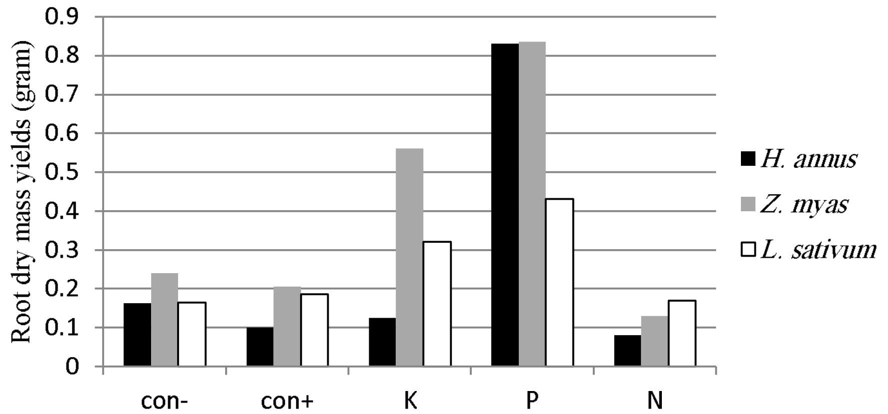

Figure (5) Effect of Pb on root dry mass yields at different levels of N, P and K fertilizers

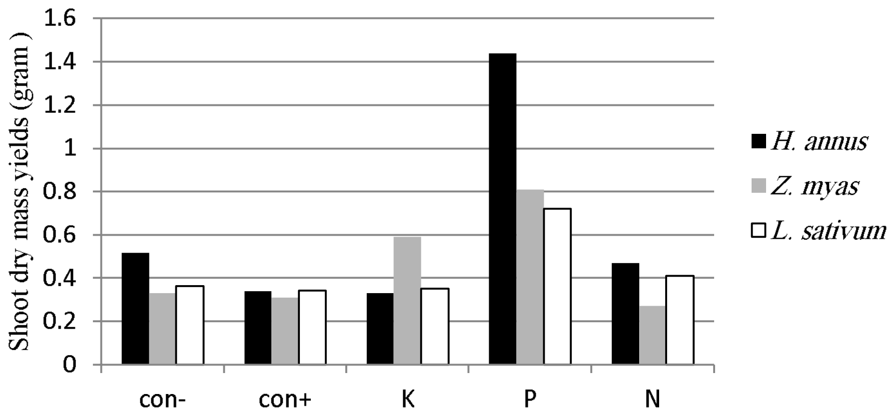

Figure (6) Effect of Pb on shoot dry mass yields at different levels of N, P and K fertilizers

Effects of fertilizers (N, P and K) on the plants concentration of Zn and Pb are showed in figures (7) and (8) respectively. The results showed that K was the most effective fertilizer for enhancing Zn and Pb concentration by the three plants. In general, the presence of the K enhanced Pb uptake in *L. sativum* very clearly and the presence of the K increased Zn uptake in *Z. myas*. The tendency of plant species to accumulate one metal but not another is supported by previous research into this field [4]. On the other hand, the presence of the P and N was not influenced in a clear way on the plants uptake of Pb and Zn.

The results showed that *L. sativum* (Brassicaceae) the most promise for phytoremediation of contaminated sites with Pb in the presence of K. The *L. sativum* was seen to accumulate significantly higher Pb concentrations than other plants species under the studied treatment. Members of the Brassicaceae family have attracted much interest in field heavy metal uptake. This family has the largest number of identified heavy metal hyperaccumulators [9].

Arabidopsis arenosa also belongs to this family. This species has often been described as commonly occurring on heavy-metal polluted sites [10].

Thlaspi caerulescens is a natural Zn, Cd and Ni hyperaccumulator species belonging to the Brassicaceae family [11]. In addition to that, *Arabidopsis halleri* is a well known species for its metal tolerance and Zn hyperaccumulation and it is from the same family [12].

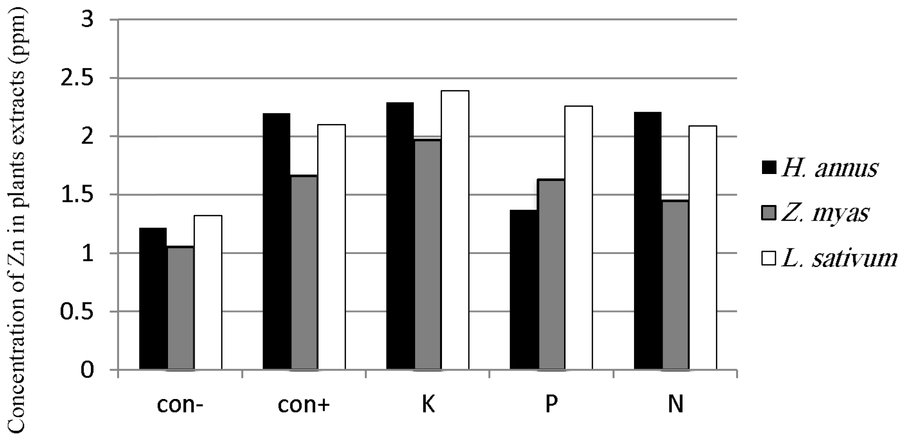

Figure (7) Concentration of Zn in plants extracts at different levels of N, P and K fertilizers

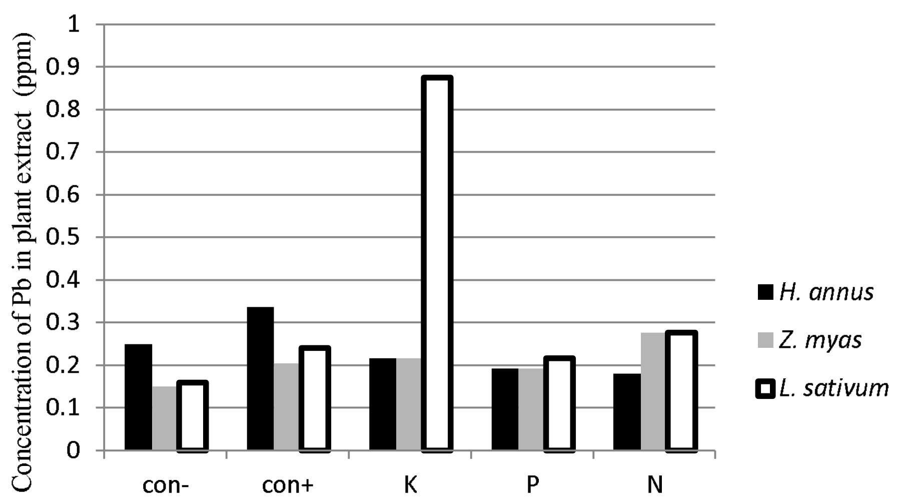

Figure (8) Concentration of Pb in plants extracts at different levels of N, P and K fertilizers

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