Effects of soil lead (Sb) concentration on some qualitative and quantitative characteristics of *lycopersicum esculentum*

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**Abstract**

Nowadays heavy metal contamination of soils became a big problem with accumulate in plants and affects animals and humans health. This study investigated the effects of soil lead concentration on the quantitative and qualitative characteristics in greenhouse planted tomato. Experiment was carried out based on completely randomized block design (CRBD) with three repetitions and four different levels of lead (control, 250, 500 and 1000 mg in kg of soil). Results showed that different lead concentrations had significant effect on chlorophyll b, carotenoid, bush height and the number of bush branches, number of leaf, stems diagonal and root lead concentration, chlorophyll a, and lead concentration in shoot. Maximum and minimum content of chlorophyll a and b were 6.64 and 3.34 mg.g⁻¹ leave fresh weight respectively. The highest and lowest brush height was observed in control and 1000 mg.kg⁻¹ treatments of lead.

**Keywords:** lead, growth indexes, tomato, chlorophyll.

**Introduction**

Tomato (*lycopersicum esculentum*) is one the most important fruit vegetable needed for humankind healthy in food regime which is affected by heavy metals specially in polluted regions of the world (FAO, 2012). Heavy metals in many polluted cities' agricultural soils are increasing because, different kinds of industrial waste and sludge entrance. Lead pollution is one of the main dangers of bioenvironmental in polluted areas. Its concentration on crustal is on average 15 mg.kg⁻¹ (Kabata-Pendias, 2001). However, environmental pollution due heavy metals because of coil burn and other fossil fuels, derivation activities and metallurgical, transportation and road traffic increase and the use of organic and inorganic dung has increased (Jakson and Watson 1977; Levin et al 1989). The negative effect of lead is mostly because of its little movement power in environment and its high sediment (Garbiso and Alkorta 2001). The effects of lead toxicity in plants usually appear in higher concentration of 30 mg.kg⁻¹ of leaf and at last cause chlorophyll synthesis and growth decrease. Most studies showed that the concentration of some ions (As, Cd, Pb) reaches even 1000 more than natural quantity (Kabata-Pendias, 2001). Such conditions cause plant veneration, growth decrease, product amount decrease (Hutzinger 1980a) and becoming yellow of young leaves, decrease in absorb of some necessary elements like iron cause decrease in photosynthesis amount (Prasad and Stralzka 1999) and cell inner activities (Larbi et al 2003) . Even sometimes lead in fruits and seeds in grains and beans are reported (Shaffer 2001). Researchers indicated that plants show different responses to this pollution, as some sensitive and some other tolerate and absorb much amount of heavy metals like lead. Although, it may not be obvious toxic effects on the plants, but that endangers human or animal health that feed of these plants (Oliver and Naidu 2003). In this research we investigated the effects of soil lead concentration on some qualitative and quantitative characteristics on *lycopersicum esculentum* in Super Urbana cultivar.

**Materials and methods**

Surface soils (0-20 cm) from farm of Shaded University, College of Agriculture, collected and then transferred to the laboratory and air dried-slammed, and then were passed through a 2 mm harp. To determine the physical and chemical characteristics such as soil structure, hydrometer method (Duponsnois et al 2006), pH in saturation...
extract, electrical conductivity with conductivity meter (Rhoades 1996), organic percent as Walkly-Black (Nelson and Sommers 1982), and chlorophyll and corticoid measurement as Arnon method (Arnon 1967) and also some growth indexes were measured. In greenhouse experiment, four treatment of lead from lead nitrate source; Pb(NO$_3$)$_2$ contained lead (pbo, pb250, pb500 and pb1000 mg) treatments mg.kg$^{-1}$ as considered salts dissolved in distilled water, evenly and layered to soil surface that had been put from 4 mm harp was sprayed to get even and monotonous mixture and in each stage, the soil of each pot was mixed and made even separately and evenly. After applying heavy metals treatment in pot (soil net weight in each pot was 3500 g) and making its moisture to arrive FC quantity to get heavy metals balance with pots' soil were kept in incubation for one month. Plant needed food elements on the base of soil test results was added to pots before planting to provide ideal conditions for plant growth and suitable biomass production.

Tomato seed of Super Urbana cultivar was prepared from Karaj seed and plant Research Corporation. Similar Seeds were separated and put for 5 minutes in bleach of 2.5 percent. Then, they were washed by sterile distilled water for 6 to 7 times and to becoming sprout were arranged with distance on clean filter paper and were being put in incubator (in 20 degree of slysyvs). Then, disinfected seeds and sprout were transferred from Petri Dishes to pots and four seeds were planted in each pot that in 4-leaf stage. In each pot, two seedlings were kept. Pots irrigation during growth period was provided with distilled water as weight method 70 to 80 percent of crop capacity. After 120 day of vegetative period and in early vegetative period, the plants were cut of crown place and after noting wet weight they were put in Aven in 70 degree slysyvs for 48 hours and their dry weight were noted. Then, samples were used by mill with steel blade of mill and to measure lead from digestion by dry burn method. After preparing plant extract, lead concentration was measured with the use of atomic absorb set. Experiment was carried out in randomized complete blocks design with three repetitions and data were analyzed by SPSS software however, comparison of means was carried out with Multiple Duncans Range test.

Results and Discussions

Analysis of chemical and physical used soil characters and greenhouse planting soil were presented in table.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Caco$_3$</th>
<th>OC</th>
<th>SP</th>
<th>EC (dSm$^{-1}$)</th>
<th>pH</th>
<th>Silt%</th>
<th>% clay</th>
</tr>
</thead>
<tbody>
<tr>
<td>quantity</td>
<td>11.25</td>
<td>0.54</td>
<td>24.05</td>
<td>2.45</td>
<td>8.5</td>
<td>39</td>
<td>35</td>
</tr>
</tbody>
</table>

Analyses of variance showed significant differences in studied characters of tomato in lead different treatments (Table 2). Results showed that between different lead concentrations, there was significant difference in chlorophyll b, carotenoid, bush height and the number of bush branches, the number of leaf, stems diagonal and lead concentration in root in $p$$\leq$0.01, and also, in chlorophyll a, lead concentration in shoot in $p$$\leq$0.05. Maximum and minimum of chlorophyll a and b were 6.64 and 3.34 mg.kg$^{-1}$ in control and 1000 mg.kg$^{-1}$ treatment respectively.

Furthermore, results showed that increasing lead amount in soil caused decrease of carotenoid amount, bush height, branch number, leaf number and stem diagonal (Table 3). Studies showed that with the increase of lead concentration, the amount of lead concentration in shoot and root were increased (Table 3). However, results showed that veneration with lead first caused root growth stop that it is because of lead much aggregation in root and its toxicity. Similar results have been observed in the other plants (Yell Yang et al 2000). According to Foy (1978) the most part of absorbed lead sediment in the partition of root cells cause some crack in partition which prevents root linear growth (Yell Yang et al 2000). Using study on wheat Marry (1976) reported that heavy metals become viscosity and decrease stretch ability of cell partition root and cause decrease in root linear growth. Root wet and dry weight also decreases because of toxicity with lead and growth stopping. The effect of root biomass decrease and its growth because of toxicity with lead also has been reported in other plants (Georgiva and Tasev 1997, Marry et al 1986b).

In this research results showed that the maximum concentration of lead was in the roots and shoots in of 1000 mg.Kg$^{-1}$, 235.65 and 12.24 mg.Kg$^{-1}$ dry matter, respectively. The same results have been reported by other researchers, (Kovalevskiy 1979, Marry et al 1986b).
Table 2. Analysis of variance in tomato characters in different lead concentrations

<table>
<thead>
<tr>
<th>Change sources</th>
<th>Pb concentration in root mg.kg⁻¹</th>
<th>Pb concentrations in shoot mg.Kg⁻¹</th>
<th>Stem diagonal cm</th>
<th>Leaf number</th>
<th>Branch number</th>
<th>Bush height cm</th>
<th>carotenoid mg.kg⁻¹</th>
<th>Chlorophyll b mg.kg⁻¹</th>
<th>Chlorophyll a mg.kg⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pb₀</td>
<td>5.46 ± 0</td>
<td>55.0 ± 0</td>
<td>52.0 ± 0</td>
<td>90.85 ± 0</td>
<td>33.0 ± 0</td>
<td>50.63 ± 0</td>
<td>62.0 ± 0</td>
<td>34.3 ± 0</td>
<td>64.8 ± 0</td>
</tr>
<tr>
<td>Pb₅₀₀</td>
<td>32.04 ± 2</td>
<td>32.0 ± 4</td>
<td>51.0 ± 0</td>
<td>66.56 ± 0</td>
<td>33.0 ± 0</td>
<td>10.49 ± 0</td>
<td>47.0 ± 128</td>
<td>42.0 ± 2</td>
<td>44.0 ± 4</td>
</tr>
<tr>
<td>Pb₁₀₀₀</td>
<td>41.1 ± 116</td>
<td>45.0 ± 7</td>
<td>47.0 ± 0</td>
<td>33.82 ± 0</td>
<td>66.7 ± 0</td>
<td>5.49 ± 0</td>
<td>22.1 ± 116</td>
<td>30.1 ± 0</td>
<td>95.0 ± 1</td>
</tr>
<tr>
<td>Pb₂₀₀₀</td>
<td>61.2 ± 235</td>
<td>24.0 ± 12</td>
<td>41.0 ± 0</td>
<td>66.87 ± 0</td>
<td>33.8 ± 0</td>
<td>26.47 ± 0</td>
<td>71.8 ± 1</td>
<td>76.0 ± 0</td>
<td>04.1 ± 0</td>
</tr>
</tbody>
</table>

Similar letter shows not significant difference in each column.

Conclusion

We concluded that lead concentration increase in the soil, has negative effect on all vegetative growth traits such as chlorophyll, carotenoids, plant height, number of branches per plant, number of leaves, leaf and stem diameter and also grain, lead concentration in roots and shoots, but the aerial part was higher affected in compared with roots. However, the roots of plants grown in polluted sites are not recommended to be used.

References


Oliver D, R Naidu, 2003. Uptake of copper (Cu), lead (Pb), cadmium (Cd) arsenic (As) and Dichlorodiphenyltrichloroethane (DDT) by vegetables Grown in urban environments. Environmental protection and Heritage Council. 151 -161.

