Effect of Different Levels of Phosphorus Fertilizer on Heavy Metals Concentration in Corn (Zea mays) Cultivated in Oil Polluted Soil

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A B S T R A C T:
A pot experiment was conducted at the experimental farm of the Agriculture College, Salahaddin University of Erbil, at Grdarasha field in silty clay loam (south of Erbil city) (36° 07' N, 44° 00' E), 411m above the sea level, during summer growing season of year 2016, to study the effect of five levels of phosphorus fertilizer (0, 20, 40, 60 and 80 kg ha⁻¹) on heavy metals concentration in corn plants growing in polluted and non polluted. The results revealed that the oil contaminated soil affects the growth performance of corn as percent germination. As well as showed that spent oil in soil has highly significant (p ≤ 0.05) effects on some soil physico-chemical properties including pH, EC, Ca, Carbon and heavy metals concentrations. The spent oil also significantly reduced (p ≤ 0.05) the germination percentage; the seeds observed in the control pots had normal growth, whereas in the polluted soils with oil the seeds had no germination, the plants had stunted growth. Therefore contamination of agriculture soils with oil should be avoided and public awareness should be created on the detrimental effects of oil pollution in our terrestrial ecosystem.

KEY WORDS: Soil pollution, Corn; Heavy metals, Phosphorus.
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1. INTRODUCTION:

Currently, about 80% of lands are contaminated by products of petroleum origin (hydrocarbons, solvents etc.) used as energy source in the oil industry, as well as chemicals. There is a variety of pollutants affecting soil and sub soil, such as fuel and oil products, hydrocarbon residues, crude oil (Gudin, 1987).

The environmental problems with heavy metals are that they as elements are un destroyable and the most of them have poisonous effect with high concentration.

Furthermore, some heavy metals are being subjected to bio accumulation and may pose a risk to human health when transferred to the food chain, whether in urban or agricultural areas represent a major sink for metals released in to the environment from a wide variety of anthropogenic source (Adriano, 2001). Oil pollution in whatever form is toxic to plant and soil micro-organism (Adenipekun and Kassim, 2006) and (Adenipekun et al., 2009). The studies by (Cook and Westlake, 1974) had described that oil spills kill agricultural plant or inhibit the growth performance of the entire vegetation cover.

Plants have been described as the first victims of oil spill on land ecosystem (Odejimi and Oghalu, 2006) and (De Jong, 1980) reported that
oil in soil creates unsatisfactory conditions for plant growth probably due to insufficient aeration of the soil. Oil readily penetrates the pore space of terrestrial vegetation following any spill (Bossert and Bartha 1984) with heavier friction which may block the pores and this subsequently impedes photosynthesis and other physiological processes in plant (Odu, 1981). Oil contamination can affect soil physical and chemical properties. Oil usually causes anaerobic environment in soil by smothering soil particles and blocking air diffusion in the soil pores and affects soil microbial communities. Heavy crude oil pollution can cause complete damage of marsh vegetation (Ying et al., 2013).

The main objectives of this study are to estimate the effect of phosphorus fertilizer on heavy metals concentration in corn plants growing in polluted and non polluted soils.

2. MATERIALS AND METHODS

A pot experiment was carried out in summer season of 2016 at the Grdarasha field of Agriculture College to study the effect the effect of phosphorus fertilizers using (Triple Super Phosphate % 46 P₂O₅) in different levels on heavy metals concentration in soils and corn plants growing in polluted and un polluted soil were collected from Latifawa oil selling station (36˚ 12´ N, 43˚ 96´E) at the road of Erbil- Makhmur. The soil samples were taken from the land surface (0-30) cm depth. The 6kg of polluted and unpolluted soil packed to a pot with the dimensions 22cm diameter and 22 cm high, then three seeds of corns planted in each pot, all pot treated by different levels of phosphorus fertilizer (0, 20, 40, 60 and 80 kg ha⁻¹) and the pots irrigated by weighing method whenever needed. On 1/7/2016 three seeds of test crop used Corn (Zea mays) directly planted in each pot of the contaminated and non contaminated soils, using five levels of phosphorus (0.0, 20, 40, 60 and 80 kg P₂O₅ ha⁻¹ soil) which equivalent to (0.0, 43.47, 86.95, 130.43 and 173.91 mg TSP kg⁻¹ soil) using factorial CRD with three replicates ,and a fixed amount of nitrogen (22.5 mg N kg⁻¹ soils) which equivalent to (90 kg N/ha⁻¹) was added to all pots. After the seeds were planted and pots watered to field capacity immediately after that the subsequently irrigation depending on weighing method whenever needed. The particle size distribution was determined by hydrometer method as described by Tel and Hargaty (1991). Soil pH measured in soil extraction(1:5) using HANNA pH meter, model pH211 microprocessor pH meter (Jackson, 1958). Total nitrogen was determined by the kjeldahl method as described in Rowell (1996). Available phosphorus was determined by using Olsen method (Allen et al., 1974). The parameters measured such as heavy metals (Cadmium, Iron and Nickel) concentration in the soil by using Atomic Absorption Spectrophotometer (Alpha- 4) (AAS) according to (Allen et al., 1974). Parameters measured such as percentage of germination and the influence of heavy metals on soil physico-chemical properties .The concentration of heavy metals was also determined, and the analysis was carried out at the soil and water department laboratories, in Agriculture College, at Salahaddin University.

3. RESULTS AND DISCUSSION

The soil physico-chemical properties as affected by the presence of oil are presented in Table 1 and Figure 1. However, visual observation showed that plots that received spent oil treatment decreased water infiltration and percolation in the soil. Air- drying of the impacted soils took relatively longer time. On drying, the soil gave a cemented waxy appearance which more or less repelled or resisted water rewetting. This result indicated that spent oil in soil has a significant effect on soil properties such as nitrogen content, pH, carbon and presence of trace heavy metals. Metals present included iron, zinc, copper, lead, cadmium, manganese,
Table (1) Physico-chemical properties of soil before experimentation and after oil affecting.

| Parameters                       | Physico-chemical properties of soils (before experimentation) | Physico-chemical properties of soils affected by spent oil in soils |
|----------------------------------|---------------------------------------------------------------|--------------------------------------------------------------------|
| Sand (%)                         | 19.80                                                        | 18.00                                                              |
| Silt (%)                         | 50.90                                                        | 52.40                                                              |
| Clay (%)                         | 29.30                                                        | 29.60                                                              |
| Textural class                   |                                                              |                                                                    |
| Soil pH                          | 7.30                                                         | 6.40                                                               |
| Electrical Conductivity (mSm⁻¹) | 0.44                                                         | 543                                                                |
| Organic carbon (%)               | 0.89                                                         | 1.20                                                               |
| Water Content (%)                | 12.25                                                        | 25.98                                                              |
| Organic matter (g kg⁻¹)          | 2.60                                                         | 2.86                                                               |
| Total N (%)                      | 0.03                                                         | 0.01                                                               |
| Available P (%)                  | 16.00                                                        | 19.00                                                              |
| Pb²⁺ (mg kg⁻¹)                   | 0.00                                                         | 0.00                                                               |
| Ca²⁺ (cmol kg⁻¹)                 | 9.82                                                         | 11.04                                                              |
| Mg²⁺ (cmol kg⁻¹)                 | 1.38                                                         | 2.67                                                               |
| K⁺ (cmol kg⁻¹)                   | 1.70                                                         | 2.68                                                               |
| H⁺ (cmol kg⁻¹)                   | 0.45                                                         | 0.89                                                               |
| E.CEC (cmol c kg⁻¹)              | 24.96                                                        | 31.30                                                              |
| Cd (mg kg⁻¹)                     | 1.97                                                         | 1.98                                                               |
| Fe (mg kg⁻¹)                     | 1520                                                         | 2340                                                               |
| Ni (mg kg⁻¹)                     | 9.50                                                         | 11.7                                                              |

nickel and chromium. This observation is in harmony with earlier reports of Atuanya (1987) and Agbogidi and Egbuchua (2010) they noted that oil in soil has deleterious effects on the biological, chemical and physical properties of the soil depending on the type of the oil and other factors.

All seeds of the corn sown in the uncontaminated soils germinated on the 4th day after sowing, however the corn seed not germinated when sown in contaminated soils with the spent oil or the oil in soil prevent the seedling emergence of seeds sown in soils contaminated with oil. This finding supports the reports of Anoliefo and Vwioko (2001) on Chromolaena odorata, Sharifi et al. (2007) on six plant species and Agbogidi (2009) on cowpea. The performance of the corn sown in the contaminated soils also had shown a significant reduction when compared to seedlings as grown in the control plots. Reduced plant heights, canopy spread and total dry matter of plants exposed to oil treatments have also be reported by Anoliefo and Vwioko (2001), Agbogidi and Nweke (2005), and Tigere et al. (2006).
The reduction could be due to one or a combination of the following factors: unfavorable soil conditions mainly due to insufficient aeration following a decrease in the air filled pore space (Atuanya, 1987), effect on soil microbes (Benka-Coker and Ekundayo, 1995), presence of toxic oil components / herbicidal properties of the oil (Siddiqui and Adams, 2002), reduced biochemical activities and metabolic activities as well presence of heavy metals (Agbogidi and Egbuchua, 2010) and a disruption in the soil water-plant interrelationship (Agbogidi, 2011).
4. CONCLUSIONS

This study assessed the effects of spent oil on soil physiochemical properties and growth of corn in Latifawa station of oil at the road of Erbil – Makhmor. The study showed that spent oil in soil affected on soil physicochemical properties, reduced percentage germination and delayed germination as well as the growth indices of corn. The effects were happened with oil dependent.

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