

The Uptake of Heavy Metals in Plants

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Abstract: Absorption of these elements is often taken place through the root and transmitted to pneumatic organs. The action depends on different factors such as: (1) Total amount of these elements in soil; (2) Proportion of all the elements which have a form absorbable in a plant; (3) Plant ability for carrying metals along root-plant system. In 1980, United Nations Organization declared its anxiety in relation to war effects on the environment and paid great attention to environmental effects of nuclear war. In 1995, in Persian Gulf War and Kosovo war also, tests have been indications of great destructions in relation to the environment. It is a long time that war and its due environmental damages have attracted a lot of attentions. Soil pollution also is one of the most important war environmental effects. Cultivation of crops in a land intensely polluted chemically and the use of waters contaminated with lethal compounds in agricultural farms will cause irrecoverable effects. In most cases, war bombardment and various bullets used during wars contaminate soils in terms of heavy metals. The study done by environmental Organization, Forest Organization and Switzerland National Development Plan (SAEFA) show that the contacts of bombs and bullets widely pollute heavy metals. Lead and copper are the main polluting metals. Due to the movement of most aquatic species and the close relationship between contaminated sediments and waters on the other hand and the lack of distinction between these two, investigation of the effects of trace elements in aquatic ecosystems is very hard. Soil erosion also is the most important process that pollutes aquatic ecosystem by heavy metals. The issue of plants intoxication by trace elements also is emphasized for two reasons. Firstly, in case of outbreak of intoxication in agricultural plants, their function is significantly reduced per surface unit. Secondly, the onset of intoxication in plants of an area and loss of vegetation causes sharp increase in water and wind erosion in those areas.

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1. Introduction

In 1980, United Nations Organization declared its anxiety in relation to war effects on the environment and paid great attention to environmental effects of nuclear war. In 1995, in Persian Gulf War and Kosovo war also, tests have been indications of great destructions in relation to the environment.

It is a long time that war and its due environmental damages have attracted a lot of attentions. Soil pollution also is one of the most important war environmental effects. Cultivation of crops in a land intensely polluted chemically and the use of waters contaminated with lethal compounds in agricultural farms will cause irrecoverable effects. In most cases, war bombardment and various bullets used during wars contaminate soils in terms of heavy metals. The study done by environmental Organization, Forest Organization and Switzerland National Development Plan (SAEFA) show that the contacts of bombs and bullets widely pollute heavy metals. Lead and copper are the main polluting metals.

Due to the movement of most aquatic species and the close relationship between contaminated sediments and waters on the other hand and the lack of distinction between these two, investigation of the effects of trace elements in aquatic ecosystems is very hard. Soil erosion also is the most important process that pollutes aquatic ecosystem by heavy metals.

The issue of plants intoxication by trace elements also is emphasized for two reasons. Firstly, in case of outbreak of intoxication in agricultural plants, their function is significantly reduced per surface unit. Secondly, the onset of intoxication in plants of an area and loss of vegetation causes sharp increase in water and wind erosion in those areas.

But one of the most important aspects of the issue is penetration of these metals into plants and subsequently the animals feeding on them.

The onset of gastrointestinal complications and numerous cancers in relation to these metals are attributed to foodstuffs. For example, in the case of lead, it is more emphasized on its toxicity effect in men, animals, aquatic organisms and birds; however,

this metal rarely causes intoxication in plants. Therefore, it can penetrate into a plant with high concentration without having any dangers to it; but after entering other creatures' bodies, it can be dangerous. Of course currently, there are lots of blind spots in relation to man's knowledge about war. Discontinuation of studying systems, lack of registered information and the existing problems related to sampling have limited studying in this field.

Bombardments, destruction of houses and cities and villages and homelessness of many individuals, have constantly placed people under pressure; but the discomforts and diseases after the war should not be disregarded. Iran and Iraq war is not an exception and has caused a lot of damages to the environment. Unfortunately, after the war and clearing the occupied territories, the lands are used for agriculture, aquaculture and other cases without investigation in terms of soil and water pollution state and the products enter the market and this can result in serious problems.

2. Review of previous studies

As pollution caused by war is of great importance in today's world, lots of studies have been done in this relation.

During Iran and Iraq war, surface soil compaction caused flooding in farmlands and left great effects. On the other hand, change and conversion of the flow of rivers, cutting off irrigation waters, saturation and becoming a salt marsh have been reported as lands turned into wetlands at the time of destruction of irrigation channels.

Karun River in Khuzestan province is one of the most important regions in terms of economic activities. Due to war, it was contaminated severely. Drowned ships and carcasses of the aircraft which are still seen along Arvand River threaten fishing industry and ecology of the region.

In Persian Gulf War also, 6-8 million barrels of crude oil were spilled in the sea. This oil was created due to sinking of oil tankers or bombardment of oil platforms. Smoke arising from burning of wells also has had great impacts.

Because of burning of these platforms, 40000 tons of sulfur dioxide, 3000 tons of hydrogen sulfide and 500000 tons of carbon monoxide in addition to 50000 tons of Greazy Soot particles were released. From its effects, it can be referred to black rainfall in Himalayas which is 2700 kilometers away, or acid rain in China and also reduction of temperature in Kuwait.

Based on the studies done by Zare-Maivan (1998), lots of people informed about the change of quality of drinking water and also irrigation water in Iran.

In an experiment done in Khuzestan, the lead levels of acid rain fallen in Dezful and Ahvaz were respectively reported 0/24ppm and 0/33ppm in comparison with 0/11ppm and 0/18ppm in Bandar Abbas and Shiraz. The amounts of chlorides, sulfides, iron, sodium and nitrate also have been very high and this issue can affect all aspects of human lives. For example, drinking, irrigation and underground waters are contaminated and it is very dangerous.

Over the studies done by Sedigh et al., regional dispersion of thousands of tons of heavy metals, caused by Persian Gulf War in Iran, has been reported.

The underground water discharged from Zagros is one of the most important drinking and irrigation water supply resources. High levels of acidity and contaminated sediments, which are considered as dangers for people in this area, have been reported in this mountain (including SO_4^{-2} and other contaminants).

Main polluting materials such as NO_x and SO_4^{-2} , smoke particles, organic materials and carbon resulting from burning of wells can be stopped by Zagros Mountain due to the height, but through washing by precipitation enter catchment and groundwater and finally can threaten underground and surface waters.

Throughout World War II also, contamination of the Pacific Ocean has been reported. Burning vessels and explosion of submarines all have helped the pollution of this area. A lot of islands local and migrant birds were annihilated in those areas. Their nests were burnt and their eggs were destroyed and there was extinction danger of many species. Many hunting animals (ferals) also were lost in the islands of this ocean.

In 1995, Al-Ajami reported that during Persian Gulf War, due to destruction and loss of protecting layers of soil, bulk motion of coastal sand in Kuwait was accelerated after the attack of Iraq. It was followed by blocking of irrigation canals, roads and products and fields entries, especially covering of %20 of farm lands.

Mine application, digging tunnels, fogging caused by oil, oil spilling, formation of oil lakes and movement of military vehicles all affect flora and fauna.

During the studies done by Zaman and Al-Sadir Avi, the critical effects of war on plant community in Kuwait became quite clear. A very high level of heavy metals was measured in vegetation. The existence of oil lakes severely threatened animals and birds. In discharging only one oil lake, lots of dead birds, which were trapped in this area, were found.

According to the studies done by Omar Aldosari on deserts in Kuwait, it became clear that these areas are the shelter of more than 374 plant species which made them appropriate places for bird and animal life. These places attract thousands of migratory birds. In these areas, there are more than 300 different bird species, %61 percent of which is native. Extensive movement of vehicles, digging tunnels and channels, explosions and other military activities have greatly damaged this community.

Due to precipitation of oil particles and aerosols on perennial plants, these plants include a high level of heavy metals. The plants should be prevented from grazing domestic and wild animals because they can intensely poison them.

Based on the studies done by Savari and Nabavi on Persian Gulf waters during Iran and Iraq war and also Persian Gulf War, the rate of heavy metals such as lead, cadmium, copper, zinc, nickel and cobalt was higher than standards in sediments in this area. During the war with Iraq, the rate of lead in waters of the northern Persian Gulf which were directly attacked was more than the time of Persian Gulf War. The rate of these metals in this area in comparison with oceans water that was studied by Menari Railey and Chaster is much higher and in some cases 1000 times or more.

On the base of these studies, it was specified that the rate of lead, in the sediments of Khuzestan region to Boushehr and the north of Kharg Island, is high. Other metals like copper and zinc show higher amount especially in Kharg and Bushehr regions. For nickel and cobalt also such a trend can be obviously seen especially in sediments of regions such as Bandar Rig and Kharg Island which are located near Norouz wells.

In addition, in a study done on the rate of heavy metals in Shayegan region, intense contamination of sediments and aquaculture in terms of heavy metals was reported. As the power supplies of Shadegan wetland are Jarrahi River, Karun flooding and also winter outbursts of Bahman Shir River through coastal estuaries; therefore, there is the danger of contamination of this wetland which is one of natural environments for lots of plant species and birds.

The studies by Farrokhian and Imandel confirm the existence of a large amount of metals such as lead, cadmium and zinc in the animal bodies and also water and soil environments. One of the reasons can be attributed to the sediments resulting from Bahman Shir River, and also carrying contaminated sediments from Abadan and Khorramshahr.

3. Absorption of heavy metals in plants

Absorption of these elements is often taken place through the root and transmitted to pneumatic

organs. The action depends on different factors such as:

- Total amount of these elements in soil
- Proportion of all the elements which have a form absorbable in a plant
- Plant ability for carrying metals along root-plant system

Due to some surveys, Tiffen (1977) mentioned that plants are pseudo acceptors for trace elements or heavy metals; however, this statement was expressed based on apparent indications.

Absorbency of these elements by plant depends on the chemical form and the position of these elements in soil. That part of metals which have been located in solution phase can more easily be absorbed by root but on the contrary, absorption of the parts which form a bond with solid phase of soil (for example, inside crystal network of initial stone) is hard.

However, another effective factor is the charge of absorbing parts of the surface of minute particles such as clay and organic materials.

The higher the charge is, the more rigidly it is absorbed.

Moreover, acidity, organic material and drain conditions are factors which affect metals chemical form and thus its absorption by plant.

Due to having cationic exchange ability, the root surface can absorb metals.

When heavy metals in soil are more than the standard level, they damage roots or leaves and finally the product; and if used for animal's grazing or man's nourishment, they can be dangerous. For example, the intensity of cadmium and lead may not harm plant but it is very harmful for the feeding man.

However, the damages to microscopic creatures should not be neglected.

Rath et al. (1987) reported that microbes are the first community damaged by the presence of heavy metals. Growth reduction and fixation of nitrogen by cyanobacteria can be seen as the result of adding heavy metals to soils.

In general, through entering the bodies of these microscopic organisms, these elements affect their metabolism; and in many cases, they produce toxic substances which lead to the loss of organisms.

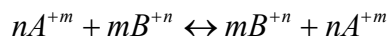
In case of human and other creatures feeding on contaminated materials also, we see creatures' physiological, physical or psychological disruption; because, after entering a body, the materials cause illness. These elements often enter a body through skin, digestive system and inhalation.

4. Absorption of heavy metals in soil

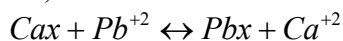
The most important chemical feature of soils is their ability in absorbing and exchanging positively charged ions on colloids surface. Due to the type of

research, heavy metals including zinc, cadmium, lead, chromium, nickel, and also manganese and copper have been studied in terms of quantity and their changes in soil.

There are different attitudes about cations absorption on colloids surface and probably the simplest attitude is the law of mass effect which is discussed under the title of The Law of Mass Action in chemistry. For instance, if we consider one of the elements under study, the following equation can be presented for it:



As we see, the equation consists of 2 components. One component is related to a solution phase and the other is a solid phase. Given that the dominant cation in most Khuzestan soils is calcium, the issue of covalent elements exchange, which is easily justified, is raised:



Below, we examine each heavy metal under study in soil.

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