Journal of Scientific Research and Development 2 (5): 122-124, 2015
Available online at www.jsrad.org
ISSN 1115-7569

Accumulation ratio of cu from sewage sludge by aquatic plants

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Abstract: Some aquatic plants can remove nutrients and heavy metals from media such as sewage sludge or contaminated sediments. The objective of this research was to investigate the ability of selected aquatic plants such as Typha latifolia ،Phragmites australis to decontaminate the urban sewage sludge from selected heavy metals in dry and hot region of south of Iran. The use of sewage sludge has always been considered by researchers and experts in agriculture and environmental section as a providing source of cheap nutrients in farmlands. Each of the two plant species was cultured in systems; also some systems, without planet, were considered as a control, and it was conducted in a completely randomized design and the Cu uptake of plant species in these treatments has been studied. in plots (6m*0.5m*0.8m) isolated with impermeable plastic sheets containing 200 Kg of dried urban sludge diluted 4 times with tap water. The results showed that Cu accumulation in aerial ground organs of both plant species was higher than roots. Cu accumulation in the tissues of plant species of Phragmites australis was more than that in the tissues of other species. At the end, Kinetics equations of absorption were extracted by Curve expert, 2007. The general form of absorption equations was fitted to exponential equation, these absorption equations are: y = aeb/t and y = (1-e-bt). In these equations, Y is the rate of heavy metal accumulation, it is time, a and b coefficients are regression coefficients. The results represent the superiority of Phragmites australis over the other plant species under study.

Key words: *Typha latifolia*; *Phragmites australis*; Sewage sludge

1. Introduction

However, due to the high concentration of heavy metals in the sewage sludge combination, its direct consumption will cause some problems. Accumulation of heavy metals such as nickel, cadmium, lead and other toxic substances in the soil by using sewage sludge will cause their entrance into the food chain through the plant uptake and make toxicity. Artificial canebrake systems are those that have been used in many parts of the world with low cost and simple technology to refine different types of sewage. In these systems, the heavy metals existing in the sewage are removed by absorbing through aquatic plants, chemical combination, ion exchange, adsorption by soil, and other inorganic materials (Obarska et al., 1999). The results of a survey conducted by Vymazal (2009) in Czech Republic, to determine the removal efficiency of heavy metals from an industrial sewage with artificial horizontal pond systems showed that this system could refine a lot of heavy metals such as Cu and Cr. some aquatic plants were plants examined in this study. The sampling shows that the most decrease in Cu and Cr concentration has been respectively in plants' roots, rhizomes, stems and leaves. (Manios et al., 2003) studied the effect of input concentration of heavy metals existing in sewage sludge on the uptake of these metals through aerial and underground organs of aquatic plant species, *T.* latifolia. Metals investigated in this study were Cd, Cu, Zn, Ni and Pb; the culture mediums were irrigated with water contaminated with above mentioned metals once every two weeks, and after 10 weeks sampling of plants' organs was done. The result showed that this plant species has a high ability in absorbing metal; and the accumulation of these metals in aerial organs was higher than the underground organs. Therefore, the study of effective and environmental friendly methods for heavy metal removal from sediments and sludge is very important in order to minimize prospective health risk during application. Some aquatic plants can remove nutrients and heavy metals from media such as sediments that many studies are focused on accumulation of heavy metal by aquatic plants (Kumar et al., 2008; Ladislas et al., 2012). Selected plants have been successful in absorbing heavy metals such as lead, cadmium, chromium, arsenic, and nickel from soils. Some metals such as Cd, with unknown biological function can also be accumulated. From the aquatic plants, *T.* latifolia and P. australis are common wetland plant that grow widely in tropic and warm regions (Ye et al., 1997). Phytoremediation of Cd and Pb by T.latifolia exposed to single and mixed metal solutions were studied.results confirmed the internalization of Cd and Pb in T. latifolia through scanning electron microscopy (Alonso-Castro et al., 2009). Cu, Zn, Pb, Cr, Cd, Fe, and Ni have been estimated in soils and

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mesophytic and aquatic plants grown in and around an industrial area of Bangladesh (Ahmad and Goni, 2010).

2. Materials and methods

Cultivation experiments in artificial canebrake systems were done in the summer of 2012 for 90 days in June, July and August. To conduct the second part of the experiments, six ponds with 5.0 m width, 6 m length and 8.0 m depth were established in a farmland of Islamic Azad University of Dezful. The bottom and the body of the ponds were insulated by three thick plastic layers. As previously mentioned, the young samples of plant species under study were moved to the laboratory immediately after collecting from the fringe of the marshy areas, and after light washing were cultivated in the system. Each of the two plant species was cultivated three times in systems; some systems without plant were considered as a control group and were conducted in a completely randomized design. Within each pond, there was 200 kg dried sewage sludge provided from the filtration plant of Ahvaz and its lead concentration was 320 mg / kg of sludge. Two intended plant species were cultivated with a density of 50 plants per square meter. Given that during the pot experiment, two plant species of T. latifolia and P. australis had good absorption ability, they were used in the second part of the experiment. Then by considering the previous calculation of the ratio of dried sludge to water (ratio: 1:4) in respect of plants' tolerance to the sludge concentration and its salinity, 800 liters of water were added to each pond. Water height in the ponds was measured by an index after reaching to the volume to compensate the lost water, in the case of daily evaporation. Due to the hot weather, especially in July and temperature of 53 ° C on some days in Khuzestan, plants' need for the water was very high and to keep the wetland conditions, heavy irrigation was done every 2 days.

The total retention time for the plants in the ponds was considered 90 days and every 15 days, one complete plant was selected randomly, exited from the pond very carefully by shovel without causing any damage, and moved to the laboratory. After rinsing in the laboratory, the plants' samples were separated into the above ground organs (stem and leaves) and the below ground organs (roots and rhizomes); then weighed and dried at a temperature of 65 ° C for 48 h; the dried plants' samples were weighted and after grinding, they were passed from a 75.0 mm sieve. On the last day of the experiment, the number of plants of each system in one square meter was counted, and according to the average weight of the harvested plant's organ the experiment of the weight of plant biomass was conducted on the 90^{th} day to calculate the percentage of the heavy metal removal per square meter of a system.

3. Results

The concentration rate in tissues of aerial and underground organs of plant species of Phragmites australis was higher than other species. Cu concentration of aerial ground organs in the two plant species was higher than other their under organs. The high concentration in aerial organs indicates Cu transfer from below ground organs to above ground organs. According to the slope of the curves, the fastest absorption rate in plant's organs has been in the middle decades of growing period (IV & V). The highest concentration in the above ground organs of Phragmites australis has been 1122.9 mg /m2; and 855.5 mg /m2 in above ground organs (Fig. 1 and 2) Various species of cultivated aquatic plants in the artificial canebrake system have the ability to absorb existing nutrients in urban, industrial and agricultural sewage. Since the form of absorption curves of various pollutants of different aquatic plant species is usually exponential, the Curve expert software was used in this study. And after entering data about time (from the beginning of the cultivation to the end of the understudy period in terms of day) and data about lead absorption rate in below ground and above ground organs of each plant species in the software, the exponential regression curves for each plant were drawn. The general form of these equations is:

$$y = a(1 - e^{-bt}) \quad (1)$$

$$y = ae^{(b/t)} \quad (2)$$

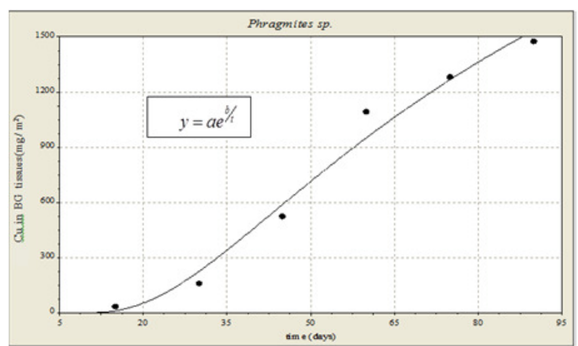

Fig. 1: Cu accumulation in below ground tissues of Phragmites australis

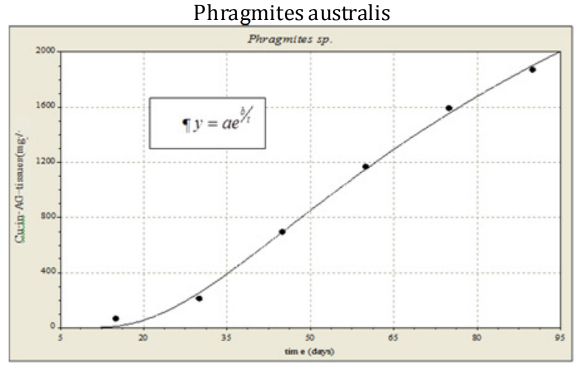

Fig. 2: Cu accumulation in above ground tissues of Phragmites australis

In these equations, t is the time in terms of day, and y represents the heavy metals' absorption rate in the plant's tissues. The coefficients of a and b are regression constant coefficient which are different for different plant species and organs. These coefficients have been calculated for each of the above models. These equations, indeed, are models which can contribute to predict the metal accumulation and aquatic plants' refinement capability in the same geographic conditions.

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