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Variations in heavy metals concentration in soil, sewage water and three different growth stages of *Brassica campestris* (L.) irrigated with sewage water of sargodha

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Abstract: The present study was carried out in order to compare the heavy metal concentrations in soil, sewage water and three different growth stages of *Brassica campestris* (L.) irrigated with sewage water of Sargodha city. Field surveys were carried out. Three experimental sites were selected in Sargodha area during this survey. Water, soil and vegetable samples were collected from these sites. The collected samples were analyzed for Copper (Cu^{+2}) Chromium (Cr^{+2}), Lead (Pb^{+2}), Cadmium (Cd^{+2}), Nickel (Ni^{+2}), Zinc (Zn^{+2}), Cobalt (Co^{+2}), Arsenic (As^{+2}), Manganese (Mn^{+2}), Iron (Fe^{+2}), Magnesium (Mg^{+2}) and Molybdenum(Mo). The surveyed data showed significant variations in heavy metals concentrations of different water, soil and vegetable samples at different growth stages.

Keywords: Heavy metal, Sewage water, *Br*assica *campestris* (L.).

Introduction

Due to increasing anthropogenic activities, the heavy metal pollution of water, soil and atmosphere has increased. Heavy metals may enter the food chain as a result of their uptake by edible plants. So, the determination of heavy metals in environmental samples is very important (Alirzaveya *et al*., 2006). Vegetables growing on heavy metal contaminated soils can accumulate very high concentrations of trace elements and cause serious health risk to consumers (Long *et al*., 2003).

Accumulation of heavy metals in crops grown in metal-polluted soil may easily cause damaging effects to human health through food chain (Fu *et al*., 2008). Pakistan is facing chronic shortage of water due to which untreated wastewater is being commonly used for agriculture, which is responsible for a variety of environmental health problems in the country (Khan *et al*., 2001).As there is shortage of water, so farmers are forced to use water polluted with urban waste directly to irrigate their crops. Greater amounts of wastewater are being generated and used to grow a variety of crops in many developing countries of the world.Vegetables accumulate heavy metals in their edible and non edible parts. Although some of the heavy metals such as Zn, Mn, Ni and Cu act as micro-nutrients at lower concentrations but they become toxic at higher concentrations. Health risks due to heavy metal contamination of soil and vegetables have been widely reported (Satarug *et al*., 2000).Those crops and vegetables which are grown in soils contaminated with heavy metals have greater accumulation of heavy metals than those grown in uncontaminated soil (Marshall *et al*., 2007). Present research work was therefore carried out in order to compare the heavy metal concentrations in soil, sewage water and three different growth stages of *Brassica campestris* (L.) irrigated with sewage water of Sargodha city.

Materials and Methods

Collection of samples: The samples of *Brassica campestris* (L.) were randomly collected from the fields irrigated with sewage water of Sargodha city at seedling, vegetative and maturity stages. Leafy vegetables were preferred for sampling because previous researches indicate that they accumulate heavy metals at a greater capacity than other vegetables.

Study area: Three sites were selected to study the sewage water effects on vegetables (i.) Silanwali road, (ii.) Chak 85 and (iii.) Faisalabad road The collected vegetable samples were washed with distilled water to remove dust particles. The samples were then cut to separate the roots/ stems and leaves. Fresh weight of samples

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was taken using Electric balance. Leaves of vegetables were air-dried and then placed in an oven at 100 °C and then dry weights were taken in grams. Dried samples of leaves of vegetables were ground into a fine powder and stored, until used for acid digestion.

Preparation of samples / Wet digestion: Samples (0.2g) of leaves of each vegetable were weighed on electric balance and treated with 10 ml of concentrated HNO_3. A sample was prepared applying 10 ml of HNO_3 into empty digestion flask. The flasks were kept for a night at room temperature. After that the samples were digested against 2ml H_2O_2 on Hot plate. H_2O_2 was further added to the sample (2ml of each was added occasionally) and digestion continued until a colorless solution was obtained.

After cooling, the solution was filtered with Whatman No. 42 filter paper and it was then transferred quantitatively to a 50 ml volumetric flask by adding distilled water up to 50ml volume. Soil digestion was also carried out in the same way as above. Water was filtered and then subjected to analysis.

Preparation of standards and analysis of samples: Working standard solutions of Lead (Pb), Copper (Cu), Chromium (Cr), Zinc (Zn), Cadmium (Cd), Iron(Fe), Arsenic (As), Cobalt (Co), Aluminum (Al), Mercury (Hg),Manganese (Mn), Nickel (Ni), Magnesium (Mg) and Molybdenum (Mo) were prepared from the stock standard solutions containing 1000 ppm of element and measurement of elements were analyzed using atomic absorption spectrophotometer.

Statistical analysis: Three samples of leaves of each vegetable were analyzed individually. Data were reported as significant and non significant. One way SPSS analysis of variance (ANOVA) was used to determine significant difference between groups.

Results and Discussion

The survey data showed variation in heavy metals concentrations of different water sources. All the sewage water samples by which vegetables were irrigated showed the safe limits of heavy metals accumulation. The field experimental data showed that due to sewage water application, Zinc (Zn) content was much higher in leaves of *Brassica campestris* (L.). Cadmium accumulation in the vegetables irrigated with sewage water was also much higher. Like all the heavy metals, Nickel also showed the similar trend for its accumulation in the vegetables. In water there was higher concentration of heavy metals as compared to vegetables but lower than that of soil samples.

Rests of the elements are not toxic to human unless they are present in high concentrations. The present study provides baseline data on trace metal concentrations of Lead (Pb), Copper (Cu), Chromium (Cr), Zinc (Zn), Cadmium (Cd), Iron(Fe), Arsenic (As), Cobalt (Co), Aluminum (Al), Mercury (Hg),Manganese (Mn), Nickel (Ni), Magnesium (Mg), and Molybdenum (Mo) in *Brassica campestris* (L.).

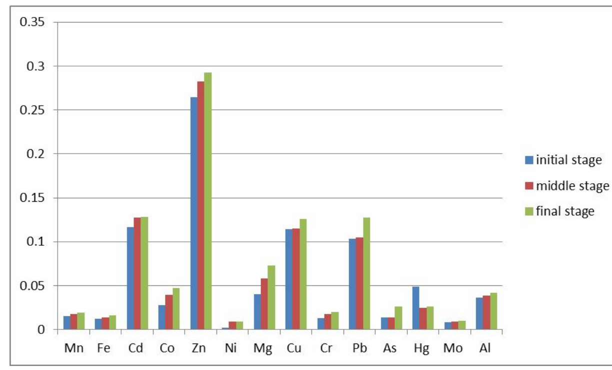

Figure 1.1: Concentration of heavy metals in Soil at 3 Growth Stages of *Brassica campestris* (L.) (mg kg^{-1})

Mn Concentration was maximum at final stage and minimum concentration was examined at initial stage with much lower concentration differences. Fe concentration in *soil* was higher in final stage but nearly equal at middle and initial stage. Cd concentration *in soil* was maximum at final stage but minimum at initial stage. Co concentration *in soil* was maximum at final stage and minimum at initial stage. Zn concentration *in soil* was in order as final>middle>initial. Ni concentration *in Soil* was minimum at initial stage but almost equal at middle and final stages. Mg concentration *in Soil* was in order as final >middle>initial. Cu concentration *in soil* was maximum at final stage but nearly equal at initial and middle stage. Cr concentration *in Soil* was maximum at final stage, minimum at initial stage and intermediate at middle stage. Pb concentration *in Soil* was in order as final >middle>initial. As concentration *in soil* was maximum at final stage but almost same at middle and initial stages. Hg concentration *in Soil* was maximum at initial stage but minimum at middle stag. Mo concentration *in Soil* was minimum at initial stage but almost equal at middle and final stages. Al Concentration was maximum at final stage and minimum concentration was examined at initial stage.

Micronutrients accumulation was mostly high at maturity stage. Similar types of results regarding micronutrients accumulation in different vegetables were reported by Komai and Yamamoto (1992), Adheniya (1996), Farid (2003), Khan (2001).

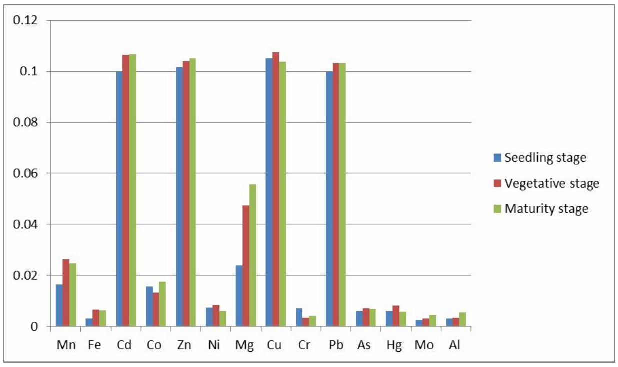

Figure 1.2 Concentration of heavy metals in Leaves at 3 Growth Stages of *Brassica campestris* (L.) (mg kg^{-1})

Manganese (Mn^{+2}) Concentration was maximum at vegetative stage and minimum concentration was examined at initial stage. Iron (Fe^{+2}) concentration in *Brassica campestris* (L.) was minimum in seedling stage but nearly equal at vegetative and maturity stage. Cadmium (Cd^{+2}) concentration in *Brassica campestris*(L.) was maximum at maturity stage but minimum at seedling stage. (Co^{+2}) concentration in *Brassica campestris*(L.) leaves was maximum at maturity stage and minimum at vegetative stage. Zinc (Zn^{+2}) concentration in *Brassica campestris*(L.) leaves was in order as maturity>vegetative>seedling. Nickel (Ni^{+2}) concentration in *Brassica campestris*(L.) was maximum at vegetative stage but minimum at maturity stage. Magnesium (Mg^{+2}) concentration in *Brassica campestris(L.)* leaves was in order as maturity >vegetative>seedling. Copper (Cu^{+2}) concentration in *Brassica campestris(L.)* was maximum at vegetative stage but minimum at final stage. Chromium (Cr^{+2}) concentration in *Brassica campestris*(L.) leaves was maximum at seedling stage but minimum at vegetative stage. Lead (Pb^{+2}) concentration in *Brassica campestris(L.)* leaves were minimum at seedling stage and almost equal at vegetative and maturity stage. As concentration in *Brassica campestris*(L.) leaves was maximum at vegetative stage and minimum at seedling stage.

Mercury (Hg^{+2}) concentration in *Brassica campestris*(L.) was maximum at vegetative stage but minimum at maturity stage. Molybdenum (Mo^{+2}) concentration in *Brassica campestris*(L.) leaves was in order as maturity>vegetative>seedling. Aluminum (Al^{+2}) concentration was maximum at maturity stage but nearly equal at seedling and vegetative stage.

Mostly higher concentration was examined at maturity stage which may be due to Bioaccumulation or Biomagnifications. These results are in accordance with results of (Qadir *et al.*, 1999) .Some of these metals are even not essential for plant growth and after accumulating in the soil could be transferred to food chain.

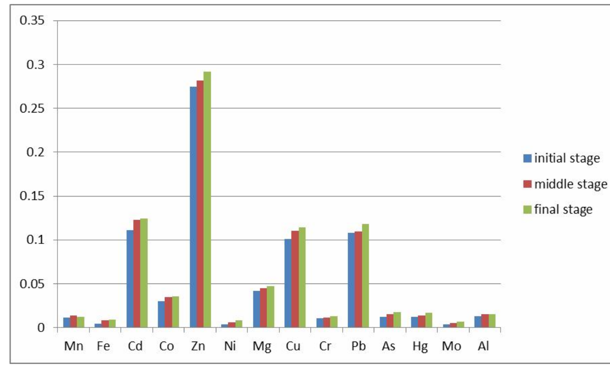

Figure 1.3 Concentration of heavy metals in Sewage water at 3 Growth Stages of *Brassica campestris* (L.) (mg L^{-1})

Manganese (Mn^{+2}) Concentration was maximum at middle stage and minimum concentration was examined at initial stage. Iron (Fe^{+2}) concentration about Brassica campestris(L.) in Sewage water was minimum at initial stage but maximum at final stage. Cadmium (Cd^{+2}) concentration about Brassica campestris(L.) *in* Sewage water was maximum at final stage but minimum at initial stage. Cobalt (Co^{+2}) concentration in Sewage water was maximum at final stage. Minimum concentration was examined at initial stage. Zinc (Zn^{+2}) concentration in Sewage water was in order as final >middle>initial. Nickel (Ni^{+2}) concentration in Sewage water was minimum at initial stage and maximum at final stage. Magnesium (Mg^{+2}) concentration in Sewage water was in order as final >middle>initial. Copper (Cu^{+2}) concentration in Sewage water was maximum at final stage but minimum at initial stage and intermediate at middle stage. Chromium (Cr^{+2}) concentration in Sewage water was nearly equal at all three stages. Lead (Pb^{+2}) concentration in Sewage water was in order as final >middle>initial. Arsenic (As^{+2}) concentration in Sewage water was in order as final >middle>initial. Mercury (Hg^{+2}) concentration in Sewage water was minimum at initial and maximum at final stage. Molybdenum (Mo^{+2}) concentration in Sewage water was in order as final> middle>initial. Aluminum (Al^{+2}) Concentration was maximum at final stage and minimum concentration was examined at initial stage.

All these results seem to fall within the safe limits. Same results were reported by Hussain *et al.* (1995).He studied the concentration of lead, cadmium, and mercury in 134 samples of the imported fruits and vegetables marketed in Kuwait. Results showed that most of the samples did not exceed the maximum permissible concentration of metals in fresh fruits and vegetables. Only few samples of fruits and vegetables contained mercury, cadmium and lead, which exceeded the maximum permissible levels.

From this study it is concluded that all the analyzed samples of sewage water, soil and vegetables showed the safe limits of heavy metals accumulation. The field experimental data showed that due to sewage application, Zinc (Zn^{+2}) content was much higher in leaves of *Brassica campestris* (L.). Cadmium (Cd^{+2}) accumulation in the vegetables irrigated with sewage water was also much higher. Like all the heavy metals, Nickel also showed the similar trend for its accumulation in the vegetables. In water there was higher concentration of heavy metals as compared to vegetables but lower than that of soil samples.

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