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# Comparative assessment of different heavy metals in urban soil and vegetables irrigated with sewage/industrial waste water

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**Abstract**. This study was conducted to investigate heavy metals content of sewage water and its impact on soil and their uptake by vegetables irrigated by the sewage/industrial effluent. Twenty five samples each of water, soil, and vegetable leaves and edible vegetable portions were collected from different sites, in Lahore city of Pakistan. Parameters like pH, and electrical conductivity (EC) were also determined The results indicated that soil irrigated by sewage water having tolerable DTPA-extractable metals contents, The concentration of heavy metals in upper layer of soil (0 -15 cm) is higher than the lower layer (15-30 cm). The reason behind is that the upper layer was receiving sewage water permanently while the penetration of sewage water below 15 cm was less. The heavy metal content was above the toxicity level in leafy vegetables grown in the area of Lahore. This study showed that among the different tested plant species, the amount of heavy metals was higher in leaves than fruits. Plants whose fruits grow below the soil showed higher concentration of heavy metals while other showed less concentration whose edible portion was above the ground level. While leafy vegetables (Spinach, Cabbage, Coriander etc) showed higher concentration in leaves than in fruits, indicating that these vegetables should be consumed carefully if produced using the polluted water.
**Key Words**: conductivity, heavy metal, penetration, toxicity.

**Introduction**. Application of industrial or municipal waste water for irrigation purposes has increased over the past years, because of its easy accessibility, discarding troubles and shortage of fresh water. Area irrigated with waste water worldwide is about 20 million hectares and it contributes 40% food production (WHO 1997).In Pakistan, area using the waste water for irrigation is 32,500 hectares (Saleem 2005). Utilize waste water add considerably amount of heavy metal in soil.

Metals are essential for life in low concentrations but in excessive amount they can be harmful. Sewage waste water contains temperature, pH, hardness, alkalinity, chemical oxygen demand, total soluble salts in high values (Ghafoor et al 1995). It also contains the metals which are toxic in nature like cadmium, copper, lead, nickel, iron and zinc (Ali et al 1996; Ali et al 2011). Iron and nickel are essential in low absorption but they show poisonous outcome on high concentration in body (Asaolu 1995).

Metals are very destructive as of their persistent characteristics and their prospective to pile up in diverse body portions (Farid et al 2013). Heavy metals are enormously lethal because they are soluble in water. Even lower quantity of metals has harmful effects on human and animals because here is no fine method introduced for removal from the body. The excessive uses of metals in industries make them abundant in present days. Industrial effluent comprises considerable quantities of toxic metals, which generate drastic complications (Singh et al 2004). Large amount of heavy metals in soil from waste water not only contaminate the soil but also food superiority (Muchuweti et al 2006).

The key sources for the vital metals are the food and water, also from these sources we can come in contact to toxic metals. Heavy metals accumulate in edibles parts of plants in leafy vegetables as compare to the fruits (Ali et al 2011; Mapanda et al

2005). Uptakes of heavy metals by vegetables accumulated in edibles parts of plants are rich in metal content and on their consumption they cause clinical problems both human and animals (Alam et al 2003).

Heavy metals have the capability to accrue in human and animals and at eminent levels they can be noxious. It has been stated that continues intake of insecure absorptions of heavy metals through crops may lead to prolonged amassing of the metals in the kidney and liver of humans affecting distraction of several biological procedures, causing cardiovascular diseases, nervous, kidney failure and bone infections (Jarup 2003; Shakoor et al 2013).

Vegetables and crops having higher heavy metal content as compare to those vegetables that's grown in sterilized soil (Sharma et al 2006, 2007; Marshall et al 2007). Excessive uptake of metals can result into number of severe health hazards. Utilization of metal contaminated food diminish some fundamental nutrients in body initiating reduction in immunological resistances, intrauterine progression delay, impairing mental and neurological function, reduced psycho-social behavior, disabilities related with starvation and extraordinary dominance of higher gastrointestinal cancer.

Irrigation of crops with industrial effluent is a very common rehearsal in subcontinent. The current study was directed with a purpose to evaluate the heavy metals (copper, nickel, zinc, lead, iron, manganese and cadmium) accumulation potential of some frequently grown mature vegetables in Lahore, Pakistan. The consequences of irrigation with sewage sludge or wastewater is also considered in these crops to detect the absorption and uptake of accumulated metals to which human beings are exposed.

## Material and Method

***Study area and sampling site***. A huge amount of effluents water channels scattering around the Lahore city. Frequently these channels are covered but at certain locations they are uncovered. To estimate the metal contamination in the effluent irrigated vegetables and soils, twenty five farmers' fields were selected.

Nominated fields were positioned next to to Taj Company drain, Band road drain, Bakar Mandi drain, Ravi Sewage water areas were (1) Shadra River Area, (2) Ravi River Area, (3) Chota Sandha Kalan, (4) Akram Park, (5) Darogha Wala, (6) Ghosia Colony and (7) Faryad Colony near T-5 Ravi River, Bombay Jhogian Wala Ganda Nala, Babu Sabu Area, Thokar Niaz Baig Area. Samples of sewage water, soil and plants (leaves and fruits) were together from these locations.

***Sewage water analysis***. The sewage water samples were collected arbitrarily from the selected sites. Twenty five (25) samples were taken and go for pH and EC of these samples which was examined by pH and EC meter. Then samples were filtered with Whatman 42 filter paper and stored in storage flasks. Concentration of metals has been evaluated by the Atomic Absorption spectrophotometer (AAS) (Vanselow & Liebig 1948). Standards were prepared with distilled water as matrix for every metal.

***Soil sampling and analysis***. Once considering regular field assortment i.e. extreme higher and lower value, for instance; angle of slop, crop morphology and a grid line was established at specific intervals (15-30 m) and each intersection 1 m diameter area was sampled by taking 8-10 courses. According to the land condition and its use, the depth of the sample was selected. For shallow rooted crops (0-6 cm) and for long rooted crops (6-12 cm) was suitable. At all stages when samples were taken purity of sample was first priority and prevented from contamination. Crushing of soil sample was easier at right moisture level. Then soil was passed over 2-3 mm strainer and air dried. The soil samples were preserved and used in soil analysis according to requirements.

***DTPA preparation***. Take 1.1g of anhydrous $CaCl_2$, 14.92 g of TEA and 1.97 g of DTPA were liquefied in approximately 800 ml of di-ionized water. On hot plate with magnetic stirrer DTPA requires sufficient time to dissolve and then volume was prepared. With the help of 1:1 HCl or 1:1 $NH_4OH$ the pH was maintained at 7.3 (Lindsay & Norvell 1978). Twenty five (25) g of soil was taken and added 50 ml of DTPA solution into soil samples and constantly shaked for 2 hours on plane shaker and after 2 hours of shaking the mixture was filtered. A sample having all substances excluding soil was run with samples as blank. Read every metal concentration by Atomic Absorption Spectrophotometer.

***Plant sampling and analysis***. Sampling was conceded from vegetable farms situated alongside drain wherever vegetables were grownup by contaminated sewage water. For sampling of plants, edible portions (leaves and fruits) were collected arbitrarily from diverse vegetable crops. No new and ancient leaves were taken for further analysis. Leaves of adequate mass, size and age were taken. Similar scheme was applicable for eatable part of vegetables sampling. Plant samples were washed thoroughly and cut into small portions and the 80°C for 4 hours air dried in Fluidized Bed Dryer. The dry sample was then crushed in a hammer mill. Before air-drying the samples material were homogenized and stored in uncontaminated sterilized bottles which were used for further analysis according to requirement.

***Dry ashing for plant analysis***. Firstly take 1 g of dried and choped plant sample of (leaves and fruit) was weighed in crucibles and then these were sited in oven for 2-3 hours at 550$^o$C. After heating they were taken-out from the oven and put the crucibles in normal atmospheric temperature to cool down. Then in each crucible 5 ml of 2 MHCl was added to liquefy the ash. The crucibles were positioned on hot plate at lower temperature to dissolve ash thoroughly. If material persist un-dissolve increased acid level in crucibles by adding more HCl and heat on hot plate till completely dissolved. Then samples were diluted with distilled water up to 50 ml. Samples were filtered using filter paper (Watman-42) after dilution and stored in sampling bottles (Vanselow & Liebig 1948). A blank solution (comprising all elements excluding plant material) was also digested with samples as blank. Samples run on Atomic Absorption spectrophotometer to detect the metal concentration in fruits and leaves. Following calculations were made for measuring heavy metal content: heavy metal (ppm) = AAS reading x dilution factor.

***Statistical analysis***. All values showed in this paper are mean of three replicates. Analysis of variance (ANOVA) was carried by using a statistical package, SPSS version 16.0 (SPSS, Chicago, IL) followed by Tukey test between the means of treatments to determine the significant difference.

## Results

***pH and EC of sewage water***. Figure 1 shows the pH of industrial waste water used to irrigate the selected sites with different plant species gown there. The maximum pH was measured in Taj Company Drain, Akram Park (Turnip) and Thokar Niaz Baig (Cauliflower) while the minimum was measured in Darogha Wala Lahore (Tomato), Sandha Kalan Nijat Pura, Lahore (Turnip) and Babu Sabu, Lahore (Tomato).

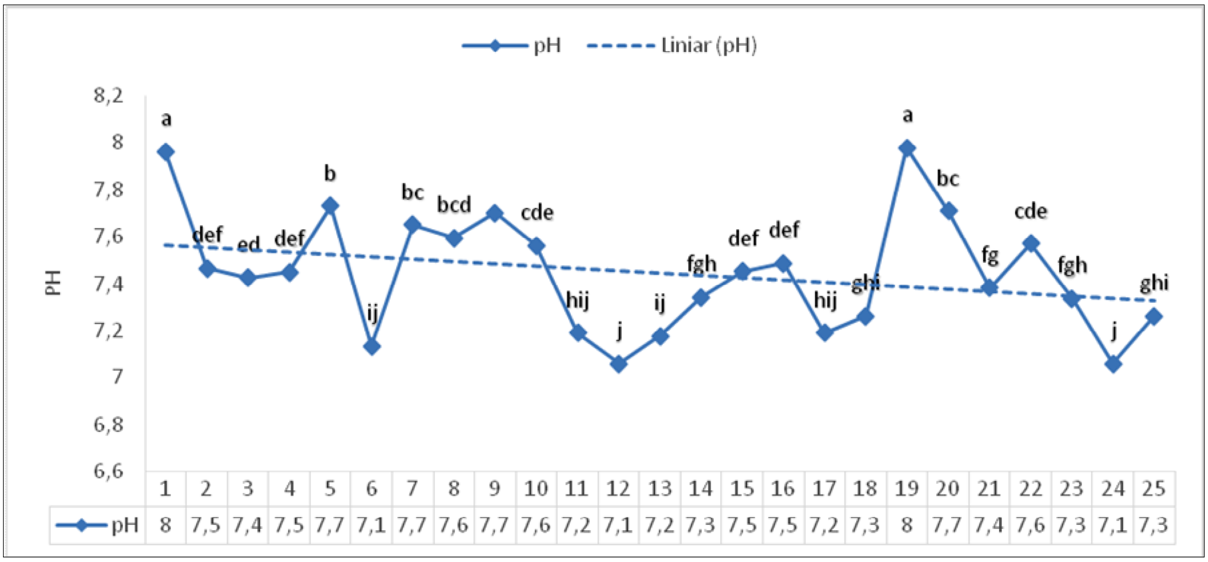


Figure 1. The level of pH in sewage water.

Figure 2 describes the EC of industrial waste water used to irrigate the selected sites with different plant species gown there. The maximum EC was recorded in Thokar Niaz Baig Lahore (Cauliflower) followed by Ghosia Colony T5, Ravi River Lahore (Turnip) while minimum EC was recorded in Bakar Mandi, Lahore (Potato).

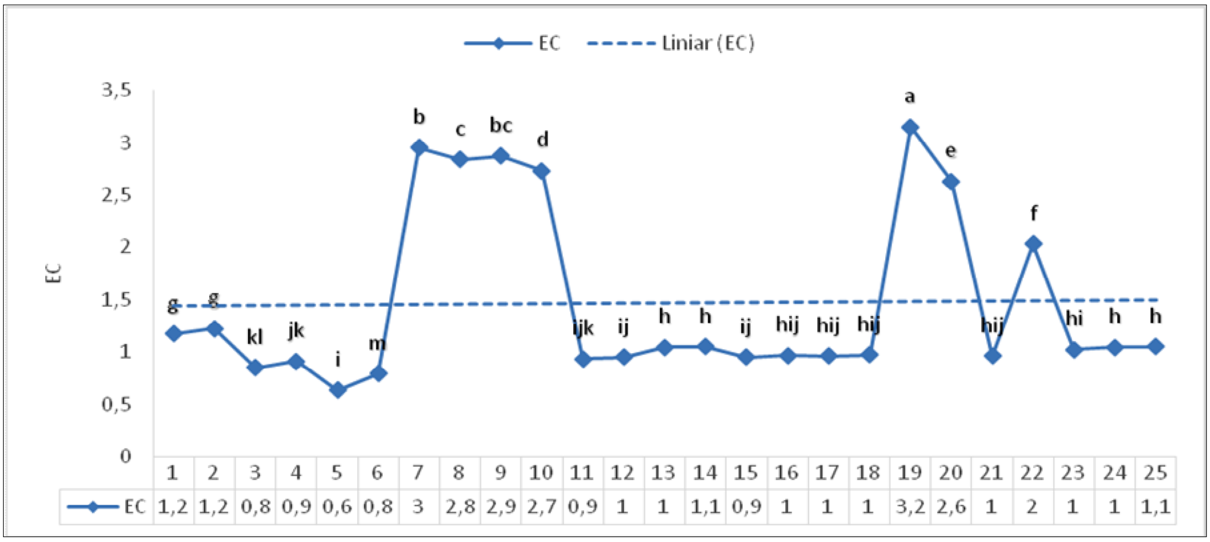


Figure 2. The EC of sewage water.

***Cd content present in soil and in leaves and fruits of plants***. Table 1 describes Cd presence in wastewater used to irrigate selected sites and its accumulation and bioavailability in soil at different depths for plants uptake through their roots in leaves and fruits. The higher Cd was recorded in wastewater which used to irrigate Babu Sabu, Lahore having grown Turnip. The maximum Cd was accumulated in Ghosia Colony T5, Ravi River Lahore (Turnip) at 0-15 cm and 15-30 cm of soil depth. The maximum uptake of Cd and its translocation in leaves was observed in cauliflower grown at Ghosia Colony T5, Ravi River Lahore while for fruits it was observed in Tomato grown at Thokar Niaz Baig, Lahore.

Table 1

The level of Cd in sewage water, at different depths of soil and in leaves and fruits of different plant

| Sr # | Site name | Plant type | Cd in sewage | Cd in soil 0-15 cm | Cd in soil 16-30 cm | Cd in leaves of plants | Cd in fruits of plants |
|---|---|---|---|---|---|---|---|
| 1 | Taj Company Drain. Akram Park | Turnip | 0.0200f | 1.9167 mn | 0.0733 bcdef | 10.167 ij | 5.3667 efgh |
| 2 | ChotaSandha, Akram Park | Sugar beet | 0.0200f | 1.5600 no | 0.0633 cdefg | 6.1667 defgh | 5.7667 cdef |
| 3 | Baka rMandi, Lahore | Carrot | 0.0500 ef | 2.0300 m | 0.0800 abcde | 6.1000 defgh | 6.4000 c |
| 4 | Bakar Mandi, Lahore | Radish | 0.7667 a | 5.1600 cd | 0.0667bcdefg | 4.7000 j | 6.2333 cd |
| 5 | Bakar Mandi, Lahore | Potato | 0.1100 def | 5.2367 c | 0.1063 a | 5.3667 ghi | 4.6667 ghij |
| 6 | Darogha Wala, Lahore | Tomato | 0.4000 bcd | 2.8433 ij | 0.0820 abcd | 5.6000 efghi | 5.1333 fghi |
| 7 | Darogha Wala, Lahore | Green beans | 0.3267cdef | 3.2667 hi | 0.0847 abc | 7.7000 bc | 4.2667 j |
| 8 | Darogha Wala, Lahore | Green sticks | 0.2467 def | 5.8000 b | 0.0813 abcd | 5.1000 hij | 8.8000 b |
| 9 | Ghosia Colony T5, Ravi River Lahore | Turnip | 0.3333cdef | 7.3433 a | 0.1070 a | 5.0000 hij | 5.4000 efg |
| 10 | Ghosia Colony T5, Ravi River Lahore | Cauliflower | 0.3267cdef | 4.6333 e | 0.0847 abc | 6.2333 defgh | 5.1000 fghi |
| 11 | Chota Sandha, Akram Park | Brinjal | 0.4333abcd | 4.6333 e | 0.0937 ab | 6.8667 bcde | 5.4333 defg |
| 12 | Sandha Kalan, Nijat Pura, Lahore | Turnip | 0.2300 def | 2.5767 jkl | 0.0817 abcd | 6.7000 bcdef | 5.5667 def |
| 13 | Ghosia Colony T5, Ravi River Lahore | Carrot | 0.026 7f | 3.4367 gh | 0.1050 a | 8.0000 b | 1.4667 k |
| 14 | Sandha Kalan, Nijat Pura, Lahore | Radish | 0.4000bcd | 2.0467 m | 0.0820 abcd | 5.1333 hij | 1.2333 k |
| 15 | Sandha Kalan, 32 Chowk, Band k sath Droghawala | Chillies | 0.1900 def | 1.1467 o | 0.0823 abcd | 4.7000 ij | 1.2333 k |
| 16 | Ghosia Colony T5, Ravi River Lahore | Pumpmkin | 0.0200 f | 2.3367 klm | 0.0577 cdefg | 5.2000 ghij | 6.0000 cde |
| 17 | Ghosia Colony T5, Ravi River Lahore | Brinjal | 0.6000abc | 4.0467 f | 0.0810 abcd | 5.2000 ghij | 4.5667 hij |
| 18 | SandhaKalan, 32 Chowk, Band k sath Droghawala | Sugar beet | 0.0300 f | 2.7000 jk | 0.0500 fgh | 4.7000 ij | 4.5333 ij |
| 19 | Thokar Niaz Baig, lahore | Cauliflower | 0.2267 def | 4.5400 e | 0.0567 defg | 7.0000 bcd | 5.7000 cdef |
| 20 | Babu Sabu, Lahore | Chillies | 0.3667bcde | 3.9100 f | 0.0430 ghi | 6.4667 cdefg | 6.1000 cde |
| 21 | Babu Sabu, Lahore | Turnip | 0.0200 f | 4.7500 de | 0.0230 hi | 5.4000 fghi | 5.1667 fghi |
| 22 | Thokar Niaz Baig, Lahore | Tomato | 0.3033cdef | 5.2367 c | 0.0533 efg | 10.167 a | 9.8600 a |
| 23 | Thokar Niaz Baig, Lahore | Potato | 0.1467 def | 2.1233 lm | 0.0433 ghi | 5.2333 ghij | 5.1333 fghi |
| 24 | Babu Sabu, Lahore | Tomato | 0.2300 def | 4.5333 e | 0.0223 i | 5.6000 efghi | 5.3333 efghi |
| 25 | Thokar Niaz Baig, Lahore | Turnip | 0.7000 ab | 3.7233 fg | 0.0170 i | 4.7000 k | 0.0800 l |

***Cu content***. Table 2 shows the presence of Cu in wastewater used to irrigate selected sites and its accumulation and bioavailability in soil at different depths for plants uptake through their roots in leaves and fruits. The higher Cu was recorded in wastewater which used to irrigate Babu Sabu, Lahore having grown Turnip. The maximum Cu was accumulated in Ghosia Colony T5, Ravi River Lahore (Turnip) at 0-15 cm and at 15-30 cm of soil depth it was noted in Babu Sabu, Lahore (Potato). The maximum uptake of Cd and its translocation in leaves and fruits was observed in Turnip grown at Babu Sabu, Lahore.

Table 2

The level of Cu in sewage water, at different depths of soil and in leaves and fruits of different plant

| *Sr #* | *Site name* | *Plant type* | *Cu in sewage* | *Cu in soil 0-15 cm* | *Cu in soil 16-30 cm* | *Cu in leaves of plants* | *Cu in fruits of plants* |
|---|---|---|---|---|---|---|---|
| 1 | Taj Company Drain. Akram Park | Turnip | 0.5367 lmn | 1.9167 k | 1.0600 k | 12.767 kl | 17.400 f |
| 2 | ChotaSandha, Akram Park | Sugar beet | 0.4367 no | 1.5567 l | 0.5533 l | 31.233 h | 3.2000 p |
| 3 | Baka rMandi, Lahore | Carrot | 0.6467 jkl | 2.0167 k | 1.2333 jk | 14.300 kl | 23.400 e |
| 4 | Bakar Mandi, Lahore | Radish | 0.7700 ghi | 5.1200 c | 2.3233 cd | 167.47 d | 6.4667 jkl |
| 5 | Bakar Mandi, Lahore | Potato | 0.7700 ghi | 5.2400 c | 1.9133 efg | 23.233 i | 15.533 gh |
| 6 | Darogha Wala, Lahore | Tomato | 0.8133 fgh | 2.8467 h | 2.5533 c | 167.47 c | 32.467 c |
| 7 | Darogha Wala, Lahore | Green beans | 0.8800 efg | 3.3667 g | 1.4600 hij | 14.167 kl | 7.6667 j |
| 8 | Darogha Wala, Lahore | Green sticks | 1.1667 d | 5.8667 b | 3.3367 b | 12.100 klm | 5.5000 lmn |
| 9 | Ghosia Colony T5, Ravi River Lahore | Turnip | 0.9767 e | 7.3433 a | 3.5200 b | 5.1667 o | 3.4333 op |
| 10 | Ghosia Colony T5, Ravi River Lahore | Cauliflower | 1.3133 c | 4.7667 d | 2.3100 cd | 45.767 e | 25.400 d |
| 11 | Chota Sandha, Akram Park | Brinjal | 0.3600 o | 4.5000 e | 1.4167 hijk | 199.20 b | 4.6333 mno |
| 12 | Sandha Kalan, Nijat Pura, Lahore | Turnip | 0.4600 p | 2.5733 i | 1.1667 jk | 36.700 g | 6.0000 klm |
| 13 | Ghosia Colony T5, Ravi River Lahore | Carrot | 0.2267mno | 3.4367 g | 1.3767 ijk | 9.4000 mn | 4.4333 nop |
| 14 | Sandha Kalan, Nijat Pura, Lahore | Radish | 0.5133 mn | 2.0500 k | 1.0600 k | 12.200 klm | 24.500 de |
| 15 | Sandha Kalan, 32 Chowk, Band k sath Droghawala | Chillies | 0.5700 klm | 1.1700 m | 1.1233 jk | 17.600 j | 24.500 de |
| 16 | Ghosia Colony T5, Ravi River Lahore | Pumpmkin | 0.6567 jk | 2.3433 ij | 2.3000 cde | 37.300 g | 16.000 fg |
| 17 | Ghosia Colony T5, Ravi River Lahore | Brinjal | 0.6600 ijk | 4.0433 f | 1.7333 ghi | 17.400 j | 15.600 gh |
| 18 | SandhaKalan, 32 Chowk, Band k sath Droghawala | Sugar beet | 1.4267 b | 3.0667 h | 1.4600 hij | 15.000 jk | 14.400 h |
| 19 | Thokar Niaz Baig, lahore | Cauliflower | 1.2367 cd | 4.5467 de | 1.7767 fgh | 14.000 kl | 16.600 fg |
| 20 | Babu Sabu, Lahore | Chillies | 0.8900 ef | 3.9100 f | 2.4500 cd | 11.333 lm | 9.3667 i |
| 21 | Babu Sabu, Lahore | Turnip | 1.6533 a | 4.7300 de | 1.3667 ijk | 202.33 a | 179.70 a |
| 22 | Thokar Niaz Baig, Lahore | Tomato | 0.4467 no | 5.2900 c | 2.1467 def | 41.333 f | 35.567 b |
| 23 | Thokar Niaz Baig, Lahore | Potato | 1.5567 a | 2.1267 jk | 1.2167 jk | 7.6333 no | 6.9800 jk |
| 24 | Babu Sabu, Lahore | Tomato | 0.7533 hij | 2.9000 h | 4.2200 a | 5.5333 o | 5.3667 lmn |
| 25 | Thokar Niaz Baig, Lahore | Turnip | 0.9333 e | 1.9100 k | 2.1600 def | 11.333 lm | 9.7000 i |

***Fe content.*** Table 3 illustrates the occurrence of Fe in wastewater used to irrigate selected sites and its accumulation and bioavailability in soil at different depths for plants uptake through their roots in leaves and fruits. The higher Fe was noted in wastewater which used to irrigate Thokar Niaz Baig, Lahore having grown Potato. The maximum Fe was accumulated in Thokar Niaz Baig, Lahore (Potato) at 0-15 cm and at 15-30 cm of soil depth it was observed in Ghosia Colony T5, Ravi River Lahore (Pumpmkin). The maximum uptake of Fe and its translocation in leaves was observed in Cauliflower grown at Thokar Niaz Baig, Lahore while in fruits it was observed in Turnip grown at Sandha Kalan, Nijat Pura, Lahore.

Table 3

The level of Fe in sewage water, at different depths of soil and in leaves and fruits of different plant

| *Sr #* | *Site name* | *Plant type* | *Fe in sewage* | *Fe in soil 0-15 cm* | *Fe in soil 16-30 cm* | *Fe in leaves of plants* | *Fe in fruits of plants* |
|---|---|---|---|---|---|---|---|
| 1 | Taj Company Drain. Akram Park | Turnip | 0.3333 jkl | 16.723 o | 2.3767 m | 103.00 l | 295.47 k |
| 2 | ChotaSandha, Akram Park | Sugar beet | 0.2467 l | 18.717 m | 2.4767 lm | 35.300 t | 212.60 p |
| 3 | Baka rMandi, Lahore | Carrot | 0.4267fghijk | 16.437 o | 3.6600 hi | 152.70 h | 342.80 g |
| 4 | Bakar Mandi, Lahore | Radish | 0.5667cdefgh | 40.333 d | 4.3733 g | 61.800 n | 373.47 e |
| 5 | Bakar Mandi, Lahore | Potato | 0.6500 cd | 45.233 c | 4.3767 g | 102.00 m | 224.23 o |
| 6 | Darogha Wala, Lahore | Tomato | 0.5800 cdefg | 34.030 i | 0.5233 n | 103.10 l | 371.00 f |
| 7 | Darogha Wala, Lahore | Green beans | 0.6133 cde | 37.540 f | 2.7667 jkl | 52.300 q | 453.13 c |
| 8 | Darogha Wala, Lahore | Green sticks | 0.7233 bc | 45.523 c | 6.1200 d | 134.53 j | 227.30 n |
| 9 | Ghosia Colony T5, Ravi River Lahore | Turnip | 0.7267 bc | 35.990 g | 5.6333 e | 105.37 k | 62.567 s |
| 10 | Ghosia Colony T5, Ravi River Lahore | Cauliflower | 0.8467ab | 45.920 b | 3.9600 h | 44.633 r | 420.63 d |
| 11 | Chota Sandha, Akram Park | Brinjal | 0.4133 ghijkl | 30.277 k | 3.7500 hi | 145.10 i | 319.90 h |
| 12 | Sandha Kalan, Nijat Pura, Lahore | Turnip | 0.4600 efghij | 18.247 n | 3.5500 i | 52.133 q | 586.13 a |
| 13 | Ghosia Colony T5, Ravi River Lahore | Carrot | 0.5133defghi | 38.500 e | 2.8833 jk | 42.600 s | 583.20 b |
| 14 | Sandha Kalan, Nijat Pura, Lahore | Radish | 0.4167 ghijk | 13.990 p | 3.0667 j | 255.57 b | 303.00 i |
| 15 | Sandha Kalan, 32 Chowk, Band k sath Droghawala | Chillies | 0.3467 ijkl | 5.0667 t | 2.4267 lm | 183.10 f | 297.70 j |
| 16 | Ghosia Colony T5, Ravi River Lahore | Pumpmkin | 0.4267 fghijk | 12.043 q | 8.4700 a | 59.600 o | 62.900 s |
| 17 | Ghosia Colony T5, Ravi River Lahore | Brinjal | 0.4000 hijkl | 40.353 d | 5.3767 e | 187.67 e | 228.10 n |
| 18 | SandhaKalan, 32 Chowk, Band k sath Droghawala | Sugar beet | 0.2800 kl | 31.467 j | 4.3700 g | 193.57 d | 235.30 m |
| 19 | Thokar Niaz Baig, lahore | Cauliflower | 0.3500 ijkl | 24.620 l | 4.9900 f | 287.50 a | 304.67 i |
| 20 | Babu Sabu, Lahore | Chillies | 0.3133 jkl | 33.967 i | 2.7600 jkl | 144.80 i | 160.43 r |
| 21 | Babu Sabu, Lahore | Turnip | 0.9133a | 35.747 g | 5.3467 e | 254.43 c | 288.77 l |
| 22 | Thokar Niaz Baig, Lahore | Tomato | 0.3867 ijkl | 35.420 h | 4.7500 f | 59.600 o | 62.867 s |
| 23 | Thokar Niaz Baig, Lahore | Potato | 0.9533a | 46.233 a | 2.6400 klm | 156.30 g | 164.40 q |
| 24 | Babu Sabu, Lahore | Tomato | 0.6000 cde | 6.7267 s | 7.4100 b | 59.733 o | 61.100 s |
| 25 | Thokar Niaz Baig, Lahore | Turnip | 0.5867 cdef | 10.323 r | 6.8900 c | 58.267 p | 62.000 s |

***Mn content***. Table 4 demonstrates the Mn occurrence in wastewater used to irrigate selected sites and its accumulation and bioavailability in soil at different depths for plants uptake through their roots in leaves and fruits. The higher Mn was recorded in wastewater used to irrigate Thokar Niaz Baig, Lahore having grown Potato. The maximum Mn was accumulated in Ghosia Colony T5, Ravi River Lahore (Pumpmkin) at 0-15 cm and at 15-30 cm of soil depth it was observed in Bakar Mandi, Lahore (Potato). The maximum uptake of Mn and its translocation in leaves and fruits was observed in Cauliflower grown at Thokar Niaz Baig, Lahore.

Table 4

The level of Mn in sewage water, at different depths of soil and in leaves and fruits of different plant

| *Sr #* | *Site name* | *Plant type* | *Mn in sewage* | *Mn in soil 0-15 cm* | *Mn in soil 16-30 cm* | *Mn in leaves of plants* | *Mn in fruits of plants* |
|---|---|---|---|---|---|---|---|
| 1 | Taj Company Drain. Akram Park | Turnip | 0.9900 d | 36.327 h | 6.8200 i | 63.100 o | 36.333 p |
| 2 | ChotaSandha, Akram Park | Sugar beet | 1.1233 c | 36.267 h | 6.6667 i | 26.900 t | 54.333 j |
| 3 | Baka rMandi, Lahore | Carrot | 0.9700 d | 36.873 g | 5.7900 k | 80.100 h | 50.133 k |
| 4 | Bakar Mandi, Lahore | Radish | 0.8600 e | 38.840 bcd | 9.3500 b | 112.10 b | 42.167 m |
| 5 | Bakar Mandi, Lahore | Potato | 0.5200 jk | 39.240 a | 10.557 a | 59.300 q | 38.700 o |
| 6 | Darogha Wala, Lahore | Tomato | 0.4133 mn | 37.300 f | 7.9700 de | 60.133 p | 38.500 o |
| 7 | Darogha Wala, Lahore | Green beans | 0.3867 mno | 39.023 abc | 4.6200 lm | 66.333 l | 39.500 no |
| 8 | Darogha Wala, Lahore | Green sticks | 0.4900 kl | 38.627 d | 5.9833 k | 65.233 m | 66.100 f |
| 9 | Ghosia Colony T5, Ravi River Lahore | Turnip | 0.5767 j | 39.050 ab | 4.7000 l | 69.100 k | 47.200 l |
| 10 | Ghosia Colony T5, Ravi River Lahore | Cauliflower | 0.6667 hi | 14.863 i | 8.0500 d | 75.200 j | 48.600 l |
| 11 | Chota Sandha, Akram Park | Brinjal | 0.4300 lm | 39.027 abc | 7.6767 fg | 90.333 d | 40.500 n |
| 12 | Sandha Kalan, Nijat Pura, Lahore | Turnip | 0.3533 nop | 38.747 bcd | 5.7633 k | 89.167 e | 38.500 o |
| 13 | Ghosia Colony T5, Ravi River Lahore | Carrot | 0.4167 mn | 10.723 k | 9.0233 c | 86.700 g | 76.100 d |
| 14 | Sandha Kalan, Nijat Pura, Lahore | Radish | 0.2900 p | 9.6533 l | 3.3733 o | 87.767 f | 47.300 l |
| 15 | Sandha Kalan, 32 Chowk, Band k sath Droghawala | Chillies | 0.2133 q | 37.540 ef | 4.0767 n | 74.533 j | 30.700 q |
| 16 | Ghosia Colony T5, Ravi River Lahore | Pumpmkin | 0.1833 q | 39.347 a | 7.5300 gh | 47.500 r | 43.500 m |
| 17 | Ghosia Colony T5, Ravi River Lahore | Brinjal | 0.3233 op | 39.343 a | 9.3100 b | 59.600 pq | 56.800 i |
| 18 | SandhaKalan, 32 Chowk, Band k sath Droghawala | Sugar beet | 0.4833 kl | 39.300 a | 7.7933 ef | 64.100 n | 58.500 h |
| 19 | Thokar Niaz Baig, lahore | Cauliflower | 0.3367 op | 38.747 bcd | 9.3633 b | 151.60 a | 125.63 a |
| 20 | Babu Sabu, Lahore | Chillies | 0.6567 i | 38.643 cd | 7.4767 gh | 78.100 i | 73.600 e |
| 21 | Babu Sabu, Lahore | Turnip | 1.4033 b | 38.977abcd | 6.3467 j | 86.300 g | 78.800 c |
| 22 | Thokar Niaz Baig, Lahore | Tomato | 0.7800 fg | 37.910 e | 9.3467 b | 63.100 o | 81.400 b |
| 23 | Thokar Niaz Baig, Lahore | Potato | 1.6533 a | 10.937 k | 7.3400 h | 26.900 t | 63.000 g |
| 24 | Babu Sabu, Lahore | Tomato | 0.7300 gh | 9.8100 l | 4.4667 m | 80.100 h | 59.800 h |
| 25 | Thokar Niaz Baig, Lahore | Turnip | 0.8000 ef | 11.840 j | 3.4700 o | 112.10 b | 34.887 p |

***Ni content***. Table 5 illustrates the occurrence of Ni in wastewater used to irrigate selected sites and its accumulation and bioavailability in soil at different depths for plants uptake through their roots in leaves and fruits. The maximum Ni was observed in wastewater which used to irrigate Babu Sabu, Lahore having grown Chillies. The maximum Ni at 0-15 cm was accumulated in Thokar Niaz Baig, Lahore (Tomato) while at 15-30 cm of soil depth it was observed in Ghosia Colony T5, Ravi River Lahore (Pumpmkin). The maximum uptake of Ni and its translocation in leaves was observed in Turnip grown at Thokar Niaz Baig, Lahore while in fruits it was observed in Carrot grown at Bakar Mandi, Lahore.

Table 5

The level of Ni in sewage water, at different depths of soil and in leaves and fruits of different plant

| *Sr #* | *Site name* | *Plant type* | *Ni in sewage* | *Ni in soil 0-15 cm* | *Ni in soil 16-30 cm* | *Ni in leaves of plants* | *Ni in fruits of plants* |
|---|---|---|---|---|---|---|---|
| 1 | Taj Company Drain. Akram Park | Turnip | 0.0300 cd | 0.4500 ijk | 0.2267 cde | 27.500 a | 22.200 e |
| 2 | ChotaSandha, Akram Park | Sugar beet | 0.0300 cd | 0.3233 kl | 0.1667 de | 30.167 a | 25.400 d |
| 3 | Baka rMandi, Lahore | Carrot | 0.0400 cd | 0.5200 ijk | 0.1100 e | 33.567 a | 35.700 a |
| 4 | Bakar Mandi, Lahore | Radish | 0.0200 d | 1.3600 cde | 0.2433 cde | 30.500 a | 29.200 c |
| 5 | Bakar Mandi, Lahore | Potato | 0.0300 cd | 1.6100 bc | 0.2633 cde | 28.500 a | 20.433 g |
| 6 | Darogha Wala, Lahore | Tomato | 0.0367 cd | 1.2400 ef | 0.2567 cde | 27.333 a | 17.200 h |
| 7 | Darogha Wala, Lahore | Green beans | 0.0633 cd | 1.5100bcde | 0.2100 cde | 26.600 a | 13.300 kl |
| 8 | Darogha Wala, Lahore | Green sticks | 0.0533 cd | 0.1100 l | 0.2767 cde | 29.333 a | 28.600 c |
| 9 | Ghosia Colony T5, Ravi River Lahore | Turnip | 0.0433 cd | 0.8667 gh | 0.1800 de | 33.400 a | 12.733 lm |
| 10 | Ghosia Colony T5, Ravi River Lahore | Cauliflower | 0.1100 bcd | 0.9667 fg | 0.3100 cd | 34.533 a | 21.300 f |
| 11 | Chota Sandha, Akram Park | Brinjal | 0.0233 d | 0.6700 hij | 0.2667 cde | 32.600 a | 17.300 h |
| 12 | Sandha Kalan, Nijat Pura, Lahore | Turnip | 0.0400 cd | 1.4000bcde | 0.1433 de | 29.200 a | 14.300 j |
| 13 | Ghosia Colony T5, Ravi River Lahore | Carrot | 0.0200 d | 1.4700bcde | 0.1433 de | 35.400 a | 9.4333 o |
| 14 | Sandha Kalan, Nijat Pura, Lahore | Radish | 0.0567 cd | 0.9167 gh | 0.1533 de | 16.100 a | 9.6000 o |
| 15 | Sandha Kalan, 32 Chowk, Band k sath Droghawala | Chillies | 0.0767 cd | 0.5533 ijk | 0.1633 de | 13.500 a | 12.000 mn |
| 16 | Ghosia Colony T5, Ravi River Lahore | Pumpmkin | 0.0500 cd | 0.7200 ghij | 0.6333 a | 14.100 a | 13.567 jk |
| 17 | Ghosia Colony T5, Ravi River Lahore | Brinjal | 0.0200 d | 1.3000 de | 0.3567 bc | 10.500 a | 9.6000 o |
| 18 | SandhaKalan, 32 Chowk, Band k sath Droghawala | Sugar beet | 0.0600 cd | 1.4667bcde | 0.2600 cde | 18.300 a | 15.700 i |
| 19 | Thokar Niaz Baig, lahore | Cauliflower | 0.0700 cd | 1.4400bcde | 0.2633 cde | 14.633 a | 13.733 jk |
| 20 | Babu Sabu, Lahore | Chillies | 0.3333 a | 1.6733 b | 0.2567 cde | 18.600 a | 17.767 h |
| 21 | Babu Sabu, Lahore | Turnip | 0.2367 abc | 1.5433bcd | 0.3500 bc | 12.133 a | 11.600 n |
| 22 | Thokar Niaz Baig, Lahore | Tomato | 0.1867 abcd | 2.3667 a | 0.2567 cde | 35.200 a | 34.367 b |
| 23 | Thokar Niaz Baig, Lahore | Potato | 0.1467 abcd | 1.2233 ef | 0.2100 cde | 16.300 a | 15.800 i |
| 24 | Babu Sabu, Lahore | Tomato | 0.3000 ab | 0.4333 jk | 0.1433 de | 18.200 a | 17.633 h |
| 25 | Thokar Niaz Baig, Lahore | Turnip | 0.1900 abcd | 0.7367 ghi | 0.5133 ab | 347.80 a | 9.8700 o |

***Pb content***. Table 6 describes the occurrence of Pb in wastewater used to irrigate selected sites and its accumulation and bioavailability in soil at different depths for plants uptake through their roots in leaves and fruits. The maximum Pb was recorded in wastewater used to irrigate Ghosia Colony T5, Ravi River Lahore having grown Cauliflower. The higher Pb at 0-15 cm was accumulated in Bakar Mandi, Lahore (Carrot) while at 15-30 cm of soil depth it was observed in Thokar Niaz Baig, Lahore (Potato). The maximum uptake of Pb and its translocation in leaves and fruits was noted in Tomato grown at Thokar Niaz Baig, Lahore.

Table 6

The level of Pb in sewage water, at different depths of soil and in leaves and fruits of different plant

| *Sr #* | *Site name* | *Plant type* | *Pb in sewage* | *Pb in soil 0-15 cm* | *Pb in soil 16-30 cm* | *Pb in leaves of plants* | *Pb in fruits of plants* |
|---|---|---|---|---|---|---|---|
| 1 | Taj Company Drain. Akram Park | Turnip | 0.0267 m | 15.077 e | 0.9567 c | 71.100 e | 66.400 c |
| 2 | ChotaSandha, Akram Park | Sugar beet | 0.0400 lm | 17.333 c | 1.5800 b | 74.200 d | 57.700 f |
| 3 | Baka rMandi, Lahore | Carrot | 0.0600 klm | 45.500 a | 0.4200 ij | 67.700 f | 59.333 e |
| 4 | Bakar Mandi, Lahore | Radish | 0.3000 efghi | 11.760 g | 0.5100 hij | 61.333 h | 60.733 d |
| 5 | Bakar Mandi, Lahore | Potato | 0.1600 ijklm | 13.400 f | 0.7533 defg | 75.300 c | 28.700 p |
| 6 | Darogha Wala, Lahore | Tomato | 0.2000 ghijk | 15.990 d | 0.7567 def | 71.400 e | 34.600 n |
| 7 | Darogha Wala, Lahore | Green beans | 0.2467 fghij | 5.8367 k | 0.7400 efg | 78.300 b | 41.000 i |
| 8 | Darogha Wala, Lahore | Green sticks | 0.2600 fghi | 16.333 d | 0.7667 def | 59.367 i | 71.633 b |
| 9 | Ghosia Colony T5, Ravi River Lahore | Turnip | 0.3200 defgh | 6.7667 j | 0.5133 hij | 55.500 k | 41.433 i |
| 10 | Ghosia Colony T5, Ravi River Lahore | Cauliflower | 0.3500 cdef | 39.533 b | 0.5667 ghi | 53.667 l | 36.667 l |
| 11 | Chota Sandha, Akram Park | Brinjal | 0.4300 bcde | 15.837 d | 0.7633 def | 57.800 j | 43.400 h |
| 12 | Sandha Kalan, Nijat Pura, Lahore | Turnip | 0.4700 bc | 12.410 g | 0.5667 ghi | 58.733 i | 38.267 k |
| 13 | Ghosia Colony T5, Ravi River Lahore | Carrot | 0.1067 jklm | 7.9200 i | 0.3900 ij | 65.467 g | 25.367 r |
| 14 | Sandha Kalan, Nijat Pura, Lahore | Radish | 0.1800 hijkl | 14.840 e | 0.3667 j | 40.100 p | 20.133 s |
| 15 | Sandha Kalan, 32 Chowk, Band k sath Droghawala | Chillies | 0.2400 fghij | 4.6300 l | 0.7700 cdef | 39.300 qr | 18.667 t |
| 16 | Ghosia Colony T5, Ravi River Lahore | Pumpmkin | 0.3333 cdefg | 2.4433 no | 0.4200 ij | 30.700 t | 26.800 q |
| 17 | Ghosia Colony T5, Ravi River Lahore | Brinjal | 0.4600 bcd | 3.7800 m | 0.6167 fgh | 36.133 s | 33.400 o |
| 18 | SandhaKalan, 32 Chowk, Band k sath Droghawala | Sugar beet | 0.5300 ab | 3.7200 m | 0.6567 efgh | 38.700 r | 33.233 o |
| 19 | Thokar Niaz Baig, lahore | Cauliflower | 0.5533 ab | 5.6200 k | 0.8200 cde | 39.300 qr | 35.630 m |
| 20 | Babu Sabu, Lahore | Chillies | 0.6200 a | 2.7200 n | 0.7633 def | 45.800 n | 43.767 h |
| 21 | Babu Sabu, Lahore | Turnip | 0.3367 cdefg | 11.000 h | 0.5400 hij | 39.800 pq | 35.300 mn |
| 22 | Thokar Niaz Baig, Lahore | Tomato | 0.2600 fghi | 2.7233 n | 0.5000 hij | 97.167 a | 84.467 a |
| 23 | Thokar Niaz Baig, Lahore | Potato | 0.6367 a | 1.9533 o | 2.2000 a | 42.000 o | 39.667 j |
| 24 | Babu Sabu, Lahore | Tomato | 0.5567 ab | 2.2567 no | 0.9300 cd | 52.800 m | 49.500 g |
| 25 | Thokar Niaz Baig, Lahore | Turnip | 0.5167 ab | 2.7567 n | 0.7600 def | 36.020 s | 33.233 o |

***Zn content***. Table 7 demonstrate the occurrence of Zn in wastewater used to irrigate selected sites and its accumulation and bioavailability in soil at different depths for plants uptake through their roots in leaves and fruits. The highest Zn was observed in wastewater which used to irrigate Thokar Niaz Baig, Lahore grown Potato. The maximum Zn at 0-15 cm was accumulated in Thokar Niaz Baig, Lahore (Tomato) while at 15-30 cm of soil depth it was observed in Ghosia Colony T5, Ravi River Lahore (Cauliflower). The maximum uptake of Pb and its translocation in leaves was observed in Radish grown at Bakar Mandi, Lahore while in fruits it was observed in Radish grown at Sandha Kalan, Nijat Pura, Lahore.

Table 7
The level of Zn in sewage water, at different depths of soil and in leaves and fruits of different plant

| Sr # | Site name | Plant type | Zn in sewage | Zn in soil 0-15 cm | Zn in soil 16-30 cm | Zn in leaves of plants | Zn in fruits of plants |
|---|---|---|---|---|---|---|---|
| 1 | Taj Company Drain. Akram Park | Turnip | 0.2333 jkl | 1.5733 o | 1.2167 n | 68.300 j | 49.367 g |
| 2 | ChotaSandha, Akram Park | Sugar beet | 0.1600 l | 2.2700 m | 1.1800 n | 124.00 c | 38.100 mn |
| 3 | Baka rMandi, Lahore | Carrot | 0.1533 l | 1.5467 o | 1.0467 n | 82.167 f | 57.500 d |
| 4 | Bakar Mandi, Lahore | Radish | 0.2600 ijkl | 5.7000 f | 3.2233 j | 153.10 a | 47.433 h |
| 5 | Bakar Mandi, Lahore | Potato | 0.3233 ijkl | 6.5567 c | 3.2567 j | 70.500 i | 34.667 p |
| 6 | Darogha Wala, Lahore | Tomato | 0.5167 efgh | 3.1167 k | 4.5900 g | 58.500 lm | 56.233 de |
| 7 | Darogha Wala, Lahore | Green beans | 0.3400 ijk | 4.7667 h | 2.0233 k | 131.40 b | 35.100 p |
| 8 | Darogha Wala, Lahore | Green sticks | 0.5567 efg | 8.2100 a | 7.2633 d | 46.100 o | 50.200 g |
| 9 | Ghosia Colony T5, Ravi River Lahore | Turnip | 0.6467 de | 8.2767 a | 7.5667 c | 38.767 r | 40.200 kl |
| 10 | Ghosia Colony T5, Ravi River Lahore | Cauliflower | 0.5333 efgh | 8.3100 a | 4.0467 h | 61.700 k | 37.667 n |
| 11 | Chota Sandha, Akram Park | Brinjal | 0.5200 efgh | 1.5200 o | 2.1300 k | 94.467 e | 55.000 ef |
| 12 | Sandha Kalan, Nijat Pura, Lahore | Turnip | 0.4267 fghi | 2.5167 l | 1.7667 lm | 102.17 d | 42.800 j |
| 13 | Ghosia Colony T5, Ravi River Lahore | Carrot | 0.1867 kl | 4.1100 i | 0.7233 o | 61.300 k | 31.800 q |
| 14 | Sandha Kalan, Nijat Pura, Lahore | Radish | 0.2867 ijkl | 2.0167 n | 1.6600 m | 58.800 l | 95.100 a |
| 15 | Sandha Kalan, 32 Chowk, Band k sath Droghawala | Chillies | 0.2800 ijkl | 1.4900 o | 1.1000 n | 75.900 g | 54.300 f |
| 16 | Ghosia Colony T5, Ravi River Lahore | Pumpmkin | 0.3867 ghij | 6.6100 c | 9.7267 a | 43.100 p | 41.533 jk |
| 17 | Ghosia Colony T5, Ravi River Lahore | Brinjal | 0.3767 hij | 5.9367 e | 5.6000 f | 57.000 m | 56.000 def |
| 18 | SandhaKalan, 32 Chowk, Band k sath Droghawala | Sugar beet | 0.9900 ab | 3.7000 j | 1.9833 kl | 77.300 g | 69.800 c |
| 19 | Thokar Niaz Baig, lahore | Cauliflower | 0.8733 bc | 2.5233 l | 1.9667 kl | 74.167 h | 71.600 b |
| 20 | Babu Sabu, Lahore | Chillies | 0.7900 cd | 4.9833 g | 3.8000 i | 46.800 o | 41.600 jk |
| 21 | Babu Sabu, Lahore | Turnip | 0.9733 ab | 6.0667 e | 3.2100 j | 42.700 pq | 39.567 lm |
| 22 | Thokar Niaz Baig, Lahore | Tomato | 0.5600 ef | 6.2233 d | 4.0667 h | 41.000 q | 37.400 no |
| 23 | Thokar Niaz Baig, Lahore | Potato | 1.0567 a | 7.6800 b | 5.9233 e | 49.200 n | 45.500 i |
| 24 | Babu Sabu, Lahore | Tomato | 0.6633 de | 3.6533 j | 3.7100 i | 42.000 pq | 41.000 kl |
| 25 | Thokar Niaz Baig, Lahore | Turnip | 0.7600 cd | 1.4800 o | 9.1567 b | 38.267 r | 35.633 op |

**Discussion**. Study was carried out to detect Cu, Pb, Cd, Fe, Mn, Zn and Ni concentration in soil and vegetables irrigated with sewage water since last 40 years permanently. Spinach, turnip, brinjal, cabbage, pumpkin, coriander, radish and cauliflower were the main vegetables. In general, the suitability of soils for receiving wastewater without deterioration varies widely, depending on their infiltration capacity, permeability, cation exchange capacities, phosphorus adsorption capacity, texture, structure, and type of clay mineral (Ivan & Earl 1972).

In developing countries, the more attention of public and governmental agencies is towards the contamination of soil by heavy metals (Yanez et al 2002). Mainly, the human contact to soil contamination is through food chain or by accidentally soil ingestion. In this investigation we mainly focused on these two exposer ways. The metal transformation from soil to plant is key component of human contact to heavy metals through food chain (Sharma et al 2007). Present investigation and previous finding (Liu et al 2005; Muchuweti et al 2006; Sharma et al 2007) describes that the plantation grown on those soils which are irrigated from wastewater pose a main human health concern. The different vegetables have different metal content which is mainly influenced by the nature and absorption capacity each plant for different metals which changed due to many factors like, plant type, soil type, composition of soil and other environmental interferences (Zurera et al 1989).

The results of our study showed agreement with earlier studies describing continuous irrigation with wastewater results in elevated levels of heavy metals in edible parts of food crops (Liu et al 2005; Khan et al 2008). Vegetables irrigated with wastewater containing heavy metals did not show any phenotypic abnormalities and no previous findings has been found about these effects (Gupta et al 2010). Plants have different abilities to accumulate metals from soil (Cui et al 2004; Wang et al 2006).

***pH****.* The use of wastewater for irrigation has led to variations in physicochemical characteristics of soil and uptake of heavy metal by food crops, mainly vegetables. Changes in pH of soil are mainly depending on pH of wastewater used for irrigation and pH of soil has excessive influence on bioavailability and mobility of heavy metals. Our results describes that regular application of wastewater for irrigation led to raised heavy metal level in soil and edible parts of crops. Accumulation of heavy metal in vegetables is gaining more attention due to its potential public health concern (Cui et al 2005; Bi et al 2006).

***EC****.* The bioavailability of heavy metals to plant is also affected by the EC. Positive correlation found between the EC values and Zn contents in the selected plants (*Cousinia* sp. and *C. congestum*). Same trend was established among EC values and Fe contents in lower parts (below the surface) of *C. congestum*, *V. speciosum* and any part of *C. juncea*. In the root of *C. juncea* and in any part of *Cousinia* sp. EC had negative effect on Mn uptake. The dissimilarity in number of cases simply involves that, in estimating heavy metal uptake by the plants the isolation is not a dominant factor. In fact, it may be the diversity and interface of every feature, in addition to variety of heavy metals and organic content.

***Cd****.* Cd standard set by WHO in vegetables are 0.1 mg $kg^{-1}$ (WHO 2001). The present study results showed a great difference among all selected vegetables in uptake of different Cd concentration. The results also describe that the leafy vegetables were on high risk in accumulation of Cd as compared to their edibles parts like fruits. Some previous findings showed that aging of Cd in soil decreased bioavailability of Cd reduce the content of Cd in edible parts of plants (Gray et al 1998; Martinez & Motto 2000). Our results are same with previous studies that leafy vegetables have higher concentration of Cd than seeds and fruits (Jinadasa et al 1997; Lund et al 1981). Our findings are comparable with earlier studies that the accumulation amount of Cd is higher in areal parts of plants (Yle 1998). The Cd concentration in soil tends to decline but it is very slow and long term phenomena based on environmental conditions of that site (Oliver 1997) the transferable fraction of Cd from soil to plant is significantly correlated with available Cd ($r$ = 0.735, $p$ = 0.01) (DEFRA 1999).

***Cu****.* High amount of copper in samples of vegetables is the result metallic burden from environmental sources like households and industrial wastewater. Yang et al (2002) and Gupta et al (2010) investigated the reactions of three vegetables to toxicity of Cu and found increasing level of Cu in both shoot and root, but when the concentration of Cu increased then Cu level increased sharply in roots which showed lesser accumulation of Cu in shoots. Xiong & Wang (2005) found that the concentration of Cu in shoots is significantly based on the concentration of Cu in soil and drastically increased as soil concentration of Cu increased.

***Fe***. The major sink reported of iron accumulation is leaves which used to form chlorophyll. When the pH of soil decreased to 5.0 and concentration of Fe increased to 300 mg $kg^{-1}$ triggers Fe toxicity in plants (Li et al 2006). However, previous studies reported the high concentration of Fe in vegetables and its effects on synthesis of chlorophyll in plants relevant to its abundance in earth crust.

***Mn***. The permissible level of Mn is 0.2 mg $kg^{-1}$ (WHO 1995), and the results of our study are higher than of this limit. The elements responsible for high portion of Mn in vegetables were supposed to by the application of fertilizers and agricultural pesticides and of soil type (Sridhara et al 2008).

***Ni***. Ni is a lethal heavy metal. The safe level of Ni set by WHO (1995) is 0.2 mg $kg^{-1}$. The smaller quantity of Ni is found in food stuffs of many plants but its higher amount is found in food stuffs like nuts, seeds and grains (National Food Agency of Denmark 1995). Weigert (1991) investigated that concentration of Ni nearby 68 mg $kg^{-1}$ by fresh weight can be harmless for its consumption. Ni can safely be extracted as organic matter because more than 90% is taken in held in which reduce the risk to Ni exposure. The previous studies of Otitoloju (2003) and Sharma et al (2008) described that the Ni level was higher than of permissible limits described in different literatures.

***Pb***. The maximum level of Pb in edible parts of crops established by WHO (2001) for human health is 0.3 mg $kg^{-1}$. The higher level of Pb in soil and plants parts is attributed to lead acid batteries as waste dumped in streams and rivers which further used to irrigate the crops. The Pb uptake can be increased by increasing organic matter and pH of soil. Lead is a serious body cumulative it enters in body through water and air and cannot be detached from vegetables and fruits by washing (Sharma et al 2007). According to our results the lead showed a little availability and similar results were also reported by Blaylock et al (1997) and Salt & Kramer (2000). Pb is very toxic metal and can damage the plants, although large amount of Pb is usually accumulate without showing visible differences in their yield and appearance. In most of plants the accumulation of Pb can increase several hundred times than permissible limits for human (Wierzbicka 1995). Pb introduction in food chain can affect the human health and the accumulation in vegetables has increasing attention (Coutate 1992).

***Zn***. The maximum limit of Zn level set is 0.2 mg $kg^{-1}$ and maximum permitted level of Zn in vegetables is 100 mg $kg^{-1}$ (WHO 2001). Zn is least toxic among all heavy metals and an essential part of human diet because it is required by the body to maintain the immune system functioning. Higher Zn is least detrimental to human health than its deficiency. The permissible recommended level of Zn for woman is 12 mg $day^{-1}$ and 15 mg $day^{-1}$ for men but its higher concentration may cause renal damage, cramps and vomiting (Alexander et al 2006). Vegetables grown on heavy metal polluted soils can store high content of Zn and cause health risks. The previous studies show that excess Zn triggers toxicity to grown vegetables crops.

**Conclusions**. Apparently for Pb, Cd, Ni and Cu that concentration in both edible and non-edible portion of crops exceeded the standard limits. Most of studies have revealed that mineral grade in the diet, such as Zn, Fe and Cu would affect the latent danger of heavy metals (Reeves & Chaney 2001).

In the present investigation the concentration of heavy metals decreased with soil depth. These results are in agreement with the findings obtained later (Yadav et al 2002). Since the soil surface is richer in heavy metals than the underlying layers, greater accumulation in the topsoil probably is due to soil texture low mobility of heavy metals in soil (Afyoni et al 1998), and surface application of wastewater. In difference with other opinions, as a matter of fact, high concentration of heavy metals in wastewater leads to increase them in soil (Huerta et al 2002; Nan et al 2002; Mapanda et al 2005).

Heavy metal concentrations varied among different vegetables, which may be attributed to differential absorption capacity of tested vegetables for different heavy metals (Zurera et al 1989). All the heavy metal concentrations were several folds higher in the vegetables. Arora et al (2008) have also found higher concentrations of heavy metals in radish, spinach, turnip, brinjal, cauliflower and carrot grown under waste water irrigation as compared to those at clean water irrigated site. The increase in accumulation in different vegetables and their different parts was not constant and is not in directly proportion to the increase in Zn, Cu and Ni concentration in soils. Some vegetables showed a sensitive behavior towards the sewage water. For example, pumpkin did not show its full growth while irrigated with sewage water. As compared to this attitude, some vegetables like spinach, turnip and coriander grow healthily in sewage water.

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