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PHYTOACCUMULATION OF NICKEL AND CADMIUM IN MUNGBEAN GROWN UNDER SPIKED AND SEWAGE WATER COMBINED WITH PHOSPHATIC FERTILIZER

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Abstract: To investigate the effect of phosphate fertilizer on growth and yield of mung bean under the sewage water and applied concentration of Cadmium and Nickel an experiment was carried out at Department of Soil and Environmental Sciences, Gomal University, Dera Ismail Khan. Cadmium and Nickel concentration was applied at 12 and 20 mg kg^{-1} and sewage water was applied as source of irrigation in the respective pots. While phosphatic fertilizer was applied at the rate of 0, 30, 60 and 90 kg P ha^{-1} as Single super phosphate. The experiment was designed as complete randomized, each treatment was replicated three times. Concentration of Cd and Ni was measured in sewage water before the experiment, after harvesting Cd and Ni concentration was analyzed in shoot, root and soil. Cadmium accumulation in root and retention in soil was highest in T_4 (90 kg P ha^{-1}), similarly Ni accumulation in shoot was highest in T_4 (90 kg P ha^{-1}). Concentration of sewage water, Cd and Ni have showed significant ($P<0.05$) effect on plant height (cm) and root length (cm). Treatments of phosphate fertilizer has exhibited statistically significant effect on plant height (cm), pod length (cm), number of seeds pod^{-1} and seed yield of plant. The interaction between metal × Phosphatic fertilizer was significantly recorded for root length, number of seeds pod^{-1}, pod length and 10 seed weight. It may be concluded from the study that application of phosphate level showed significant increase in the Cd in plant root and soil. While for Ni it was found non – significant. The increase in the seed yield by the application of phosphatic fertilizers has revealed that the metal stresses have been combated by the use of fertilizer.

Keywords: Phosphatic fertilizers, Cadmium, Nickel, Contamination, Mung bean, Sewage water

1. INTRODUCTION

Soil contamination by heavy metal toxicity pose a great threat to agriculture particularly in the peri-urban areas of the world. The situation is worst in the developing countries (Hussain et al., 2010; Wahid et al., 2009; Sabir et al., 2011). The hazards caused by heavy metals include the decrease in soil fertility; reduce crop yield and decrease microbial activity (Yang et al., 2005). The deposition of sewage sludge, sewage water irrigation, utilization of metals containing farm manures, fertilizers and industrial wastes are responsible for danger effect of heavy metals in plants and animals. Their presence in food stuff has hazardous effects on the life of human being and also effect on plants and aquatic life (Chitmanat & Traichaiyaporn, 2010; Abdollahi et al., 2011). The plant growth and the yield are reduced to extent if the concentration of heavy metals increases above certain levels (Jalloh et al., 2009; Khan et al., 2007).

In order to achieve maximum crop yields, organic or inorganic fertilizer are needed by soil having deficient plant nutrients. Phosphorus (P) is the second macro-nutrient required by the plant for optimum growth and yield. A significant role has been played by phosphorus in decreasing the uptake of several heavy metals (Cu, 2015).

Mung bean (*Vigna radiate L.*) belonging to family Fabaceae, is an important legume crop grown in Pakistan. Amongst the pulses crops in Pakistan, mung bean ranks third. As far as its dietary or nutritional value is concerned, mung bean is an old and well-known crop among Asian countries (Shanmugasundaram, 2004). Mung bean crop produced specific bacteria to create and establish a symbiotic relationship (Kaisher et al., 2010), biological N-fixation in root nodules was setting up (Mahmood & Athar, 2008), N-fixation covers the plants need for nitrogen (Mandal et al., 2009).

Mung bean quickly responds to phosphate fertilizer. Phosphorus is an important nutrient for the legumes crops, in order to fix nitrogen in soil. A decrease in the mung bean yield and quantity of crop is reported due to lack of phosphorus. In order to obtain maximum yield potential of different crop, phosphate fertilizer is very essential. The aim of this study is to investigate linkage between phosphate fertilizer and the two metals cadmium and nickel on the growth and yield of Mung bean.

2. MATERIALS AND METHOD

A pot experiment to analyse the effect of Sewage Water, spike dosage of Cd and Ni and phosphatic fertilizers on accumulation of metals, growth, yield and nodule formation of mungbean was conducted in lath house of Department of Soil Science, Gomal Uiniversity, Dera Ismail Khan (Pakistan) during year 2019. The experiment was laid out in Randomized Complete Design with two factors i.e. Cd, Ni and Sewage Water and level of phosphatic fertilizer. Earthen pots (34 cm in height and 29 cm in diameter were used in the experiment. Cd and Ni obtained from Cadmium acetate and Nickel sulphate 6-hydrate respectively and were applied at 12 and 20 mg kg^{-1} to respective pots. Also, the Sewage Water was applied as source of irrigation to the respective pots during the course of experiment. Phosphatic fertilizer was the second factor, which was applied at 30, 60 and 90 kg ha^{-1}, and a control without P was also included. The source of phosphatic fertilizer used was Single Super Phosphate. Each treatment was replicated three times. Improved mungbean variety Inqilab was sown. A starter dose of nitrogen at the rate of 20 (kg ha^{-1}) was applied to each pot.

Before sowing of mung bean physico chemical properties of soil samples were analyzed (Table 1), moreover Sewage Water sample was also analyzed before the experiment and is presented in table 2.

Cadmium and Nickel analysis of Soil and plants were carried out by using the procedure given by Soltanpour, (1985) and Allen et al., (1986) respectively. Agronomic parameters including Plant height (cm), Root length (cm), Number of seeds pod^{-1}, Pod length (cm), 10-seeds weight (g), Seed yield $plant^{-1}$. Also, Fresh weight of plant, Dry weight of plant and Number of root nodules $plant^{-1}$ were calculated during the study. Statistical analysis determined by the procedure given by Steel et al., 1997. Statistics 8. package was used for analysis.

3. RESULTS AND DISCUSSION

3.1. Cd concentration

3.1.1. Shoot

Cadmium accumulation in shoots of mung bean showed non-significant effect of applied concentrations (Cd 12 mg kg^{-1} and Sewage Water) and phosphate fertilizer (Fig. 1). However, the highest value 0.30 (mg kg^{-1}) was recorded in Cd (12 mg kg^{-1}) and phosphatic fertilizer applied at 90 kg P ha^{-1}, while lowest concentration 0.11 (mg kg^{-1}) was found in T_2 (30 kg P ha^{-1}) of sewage water pot. Panwar et al., (1999) reported that Cd concentration in the tissues of Cowpea and Mung bean decreased due to application Phosphatic fertilizer at increasing rate. They consider the decreased in Cd by plant may be attributed to the growth response of plant to phosphatic fertilizer. It has been reported by Damian et al., (2018) that plant species are not the factor responsible for transfer of metals, it is concentration of Cd present in soil.

Table 1. Physico – chemical characteristics of soil before sowing

Physical Properties of soil						
Particulars	Texture	Clay%	Silt%	Sand%	Bulk Density (gcm^{-3})	% Porosity
Values	Loamy sand	7.8	18	74.2	1.39	51.12

Chemical properties of soil						
Particulars	Organic matter (%)	Extractable P (mg kg^{-1})	ECe (µS cm^{-1})	Lime (%)	pH	SAR
Values	0.60	6.00	601	20	8.00	8.9

Table-2 Chemical properties of Sewage Water

Particulars	Organic Matter (g kg^{-1})	Extractable P (mg kg^{-1})	ECe (µS cm^{-1})	pH	Cadmium (mg kg^{-1})	Nickel (mg kg^{-1})
Values	7.00	20.00	611	7.59	0.22	0.16

In contrary to our finding Stigliani (1995) revealed that phosphate fertilizer applied at 5 - 70 kg P ha^{-1} may enhance the plant Cd concentration 0.04 to 0.12 mg kg^{-1}.

3.1.2. Root

Cadmium concentration in the pots receiving Sewage Water and Cd 12 mg kg^{-1} along with the phosphatic fertilizer enhanced the Cd accumulation in root (Fig. 1). The highest detention of (0.31 mg kg^{-1}) was recorded in pots receiving Cd (12 mg kg^{-1}) along with phosphatic fertilizer at 90 kg P ha^{-1}, while lowest value of 0.06 mg kg^{-1} was found where Cd 12 mg kg^{-1} was applied without any P fertilizer. Thomas et al., (2012) found that phosphatic fertilizers applied at 80 and 100 kg ha^{-1} have the higher concentration of Cd in the plant roots. Cadmium retention was mainly found in the roots, some of the workers have stated that the concentration of metals in excess is usually stored in the roots of plant (Rivelli et al., 2014; Damian et al., 2019). Also, De Maria et al., (2013) recorded that Sunflower grown in Cd contaminated soil showed its higher accumulation in roots of plants and older mature leaves, they also reported that due to this phenomenon the plant does not exhibit any detrimental effect on the growth of plant.

3.1.3. Soil

The results regarding the metals concentrations of Cd in soil was found significantly different amongst the treatments of Sewage Water, spiked Cd (12 mg kg^{-1}) and phosphatic fertilizer levels (Fig. 1). The greater value 0.31 mg kg^{-1} was recorded in Cd (12 mg kg^{-1}) and 90 kg P ha^{-1}, while lowest retention of 0.04 mg kg^{-1} was Sewage water and 60 kg P ha^{-1}. Fergusson (1990) reported that phosphatic fertilizer are the direct source of Cd and phosphatic contains 300 mg Cd kg^{-1}. Phosphatic rocks contains several metals in high concentration but the concentration of Cd is the highest. Another scientist Sheppard et al., (2009) also concluded that not only the phosphatic fertilizers but also the organic inputs i.e. manures and municipal solid waste are responsible for Cd enrichment of soil.

3.2 Ni concentration

3.2.1 Shoot

Nickel accumulation by shoot under sewage water, applied concentrations of Ni (20 mg kg^{-1}) and phosphatic fertilizer showed non-significant effect on the Ni concentration of plant (Fig. 2). However, highest interaction was recorded 3.31 (mg kg^{-1}) in sewage water pots with 90 kg P ha^{-1}, while lowest assembling was 1.85 (mg kg^{-1}) in Ni (20 mg kg^{-1}) without phosphatic fertilizer. It has been reported that the uptake of metal depends on the plant species, concentration and form of metals, soil pH and organic matter content (Yanai et

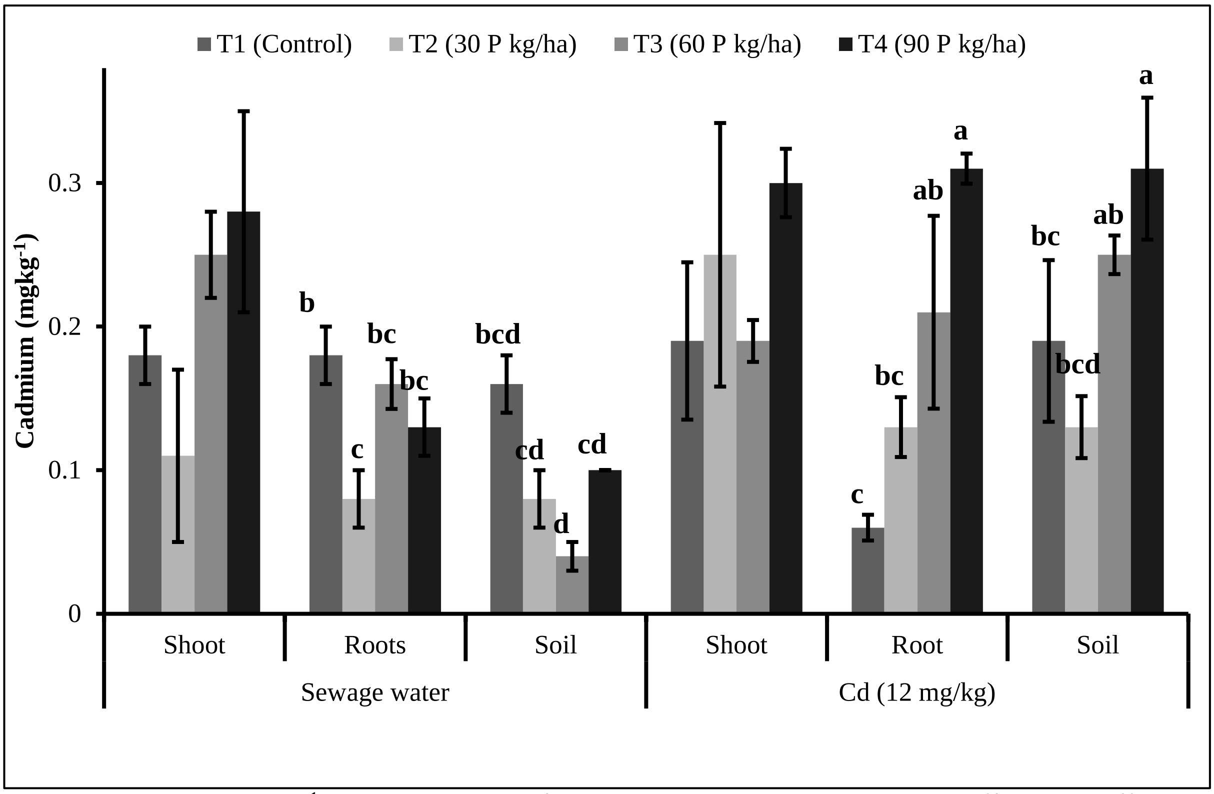


Figure 1. Cd uptake (mg kg^{-1}) by shoot and root of Mung bean and Cd retention in soil as affected by different levels of phosphate fertilizer, Cd and sewage water application

al., 2006; Chen et al., 2009). Also the Ca+ reduces the uptake of Ni (Amari et al., 2017), as soil in the current experiment has Lime content greater hence it may have reduced the Ni uptake by shoot.

3.2.2. Root

Nickel retention in root under sewage water, applied concentration of Ni (20 mg kg^{-1}) and phosphate fertilizer showed non-significant effect. Highest value 2.57mg kg^{-1} recorded in Ni (20 mg kg^{-1}) without P fertilizer. While, lowest Ni of 1.29 mg kg^{-1} was found in sewage water and control P pots. It has been reported that some of the plant growth promoting bacteria (PGPB) decrease the Ni uptake by the plants, due to production of certain siderphores and enzymes which produce ethylene to protect the Ni uptake by roots (Burd et al. 1998). Other scientist have correlated phyto-availability of Ni to organic matter content, soil pH and oxides of iron and manganese (Massoura et al., 2006; Rooney et al., 2007).

3.2.3. Soil

The results pertaining to Ni retention in soil was significantly influenced by the interaction

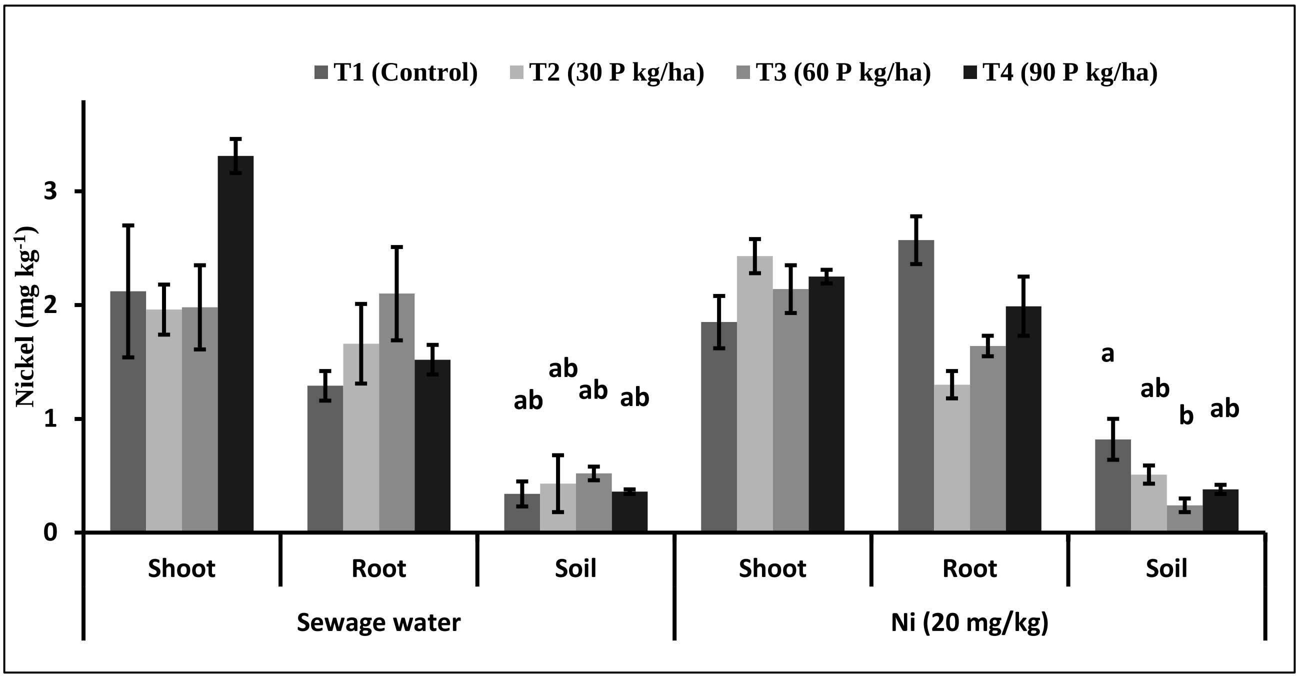


Figure 2. Ni uptake (mg kg^{-1}) by shoot and root of Mung bean and Ni retention in soil as affected by different levels of phosphate fertilizer, Ni and sewage water application

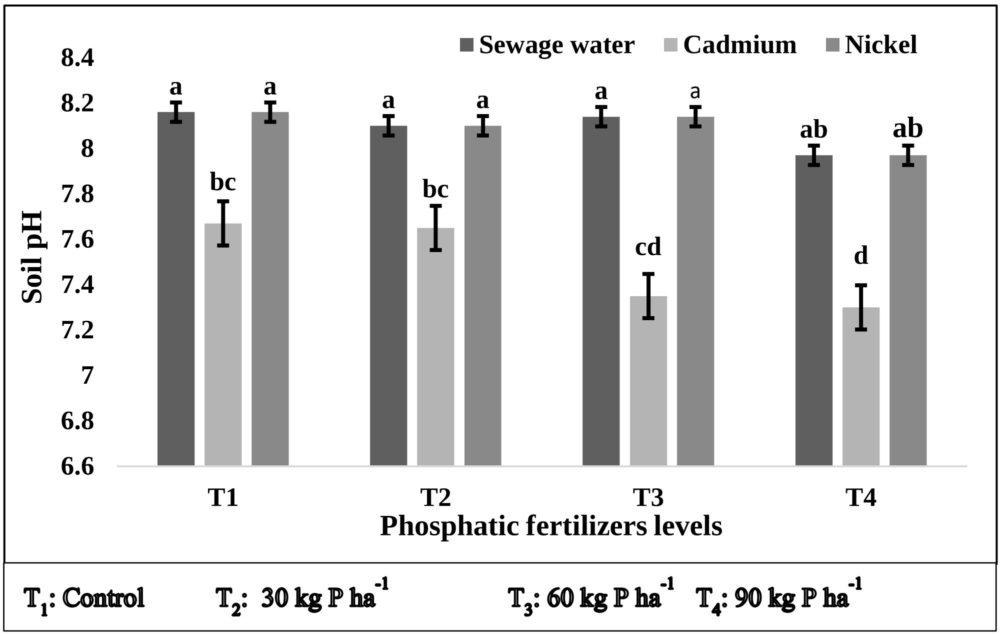


Figure 3. Soil pH as affected by Cd, Ni, Sewage water and phosphatic fertilizer

between the applied metals (sewage water and Ni concentration) and phosphatic fertilizer. The highest detainment was recorded 0.82 mg kg^{-1} in Ni spiked pots without the use phosphatic fertilizer, while lowest value was revealed 0.18 mg kg^{-1} in Ni spiked with 60 kg P ha^{-1} (Fig. 2). The soil Ni retention as compare to high Cd was higher and the mobility of Ni was lower. It is due to fact that Ni is adsorbed on the clay particles, organic matter and oxides of manganese and Iron (McLean & Bledsoe, 1992). They further concluded that the mobility of metals in soil to plants is in sequence Cd > Zn > Cu = Ni.

3.4. Soil pH

Soil pH is an important soil chemical parameter, which influence the availability of ions in soil and plants. In the current study soil pH was significantly influenced by the application of sewage water, heavy metal concentration in-combination with phosphatic fertilizers (Fig. 3). The pH was found significantly higher in the pots receiving Sewage water and Ni along with application of phosphatic fertilizer. But the pH declined in the pots where Cd was applied, and the increasing rate of phosphatic fertilizer further lowered the soil pH.

Batool et al., 2015 reported that phosphate fertilizers significantly decrease the pH of the soil. Effect of Ni applied at 60 and 240 mg kg^{-1} did not significantly influence the soil pH (Nkrumah et al. 2019). Also, non – significant influence of waste water usage with different quality parameters and depth on soil have been reported by (Nazário et al., 2019).

3.5. Dynamics of Cd and Ni affected by Soil pH

As the geochemistry of most of the heavy metals is considered to be controlled by soil pH. In the current study the concentration of Cd and Ni with increasing pH has been depicted through a graphical representation. It is clearly evident that both the metal behave differently with increasing soil pH. In case of

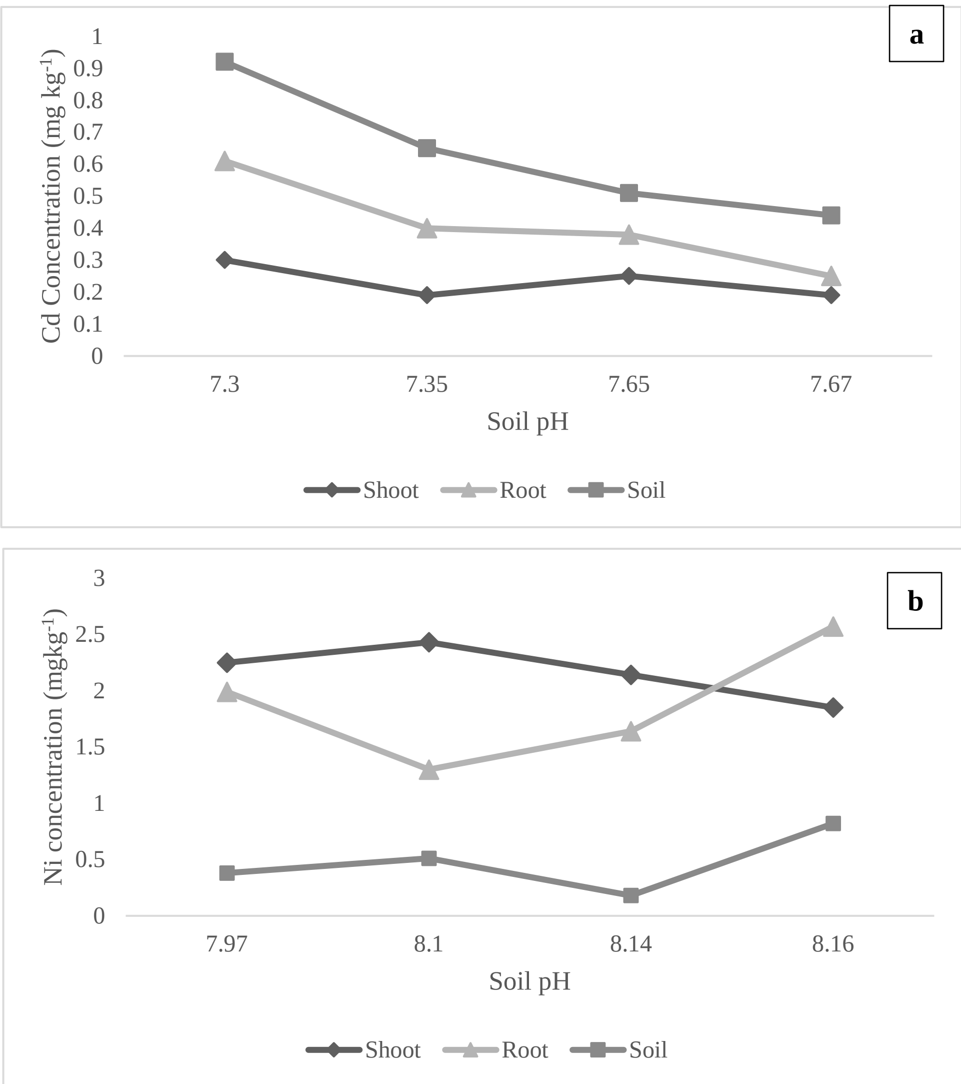


Figure 4. Cadmium (a), Nickel (b) concentration in Shoot, Root and Soil affected by soil pH

cadmium the increasing pH showed a declining trend root and soil, while in shoot Cd concentration rebound with increase in soil pH (Fig. 4a). Nickel behave differently for both root and shoot. Both root and shoot have opposite trends, as the concentration of Ni in shoot increases it declines in the root (Fig. 4b). While in soil it gave a rebound trend, with slight increase with soil pH. Cui et al., (2016) reported that available, leachable and bioavailable Cd concentration decrease with the increase in soil pH, after applying with lime and apatite. They consider it due to adsorption of metal at alkaline pH and also precipitation with phosphate, carbonates, hydroxide, chlorides etc.

Siebielec & Chaney, (2006) varied that pH effect the movement of nickel in soil. Nickel concentration has been reported to increase in plants with increasing pH despite of the fact that the available Ni concentration in the soil decreased (Kukier et al., 2004).

3.6. Growth Parameters

3.6.1. Plant height (cm)

The results regarding plant height of mung bean showed significant effect of applied metals stress and sewage water, with tallest plants of 55.67cm recorded in sewage water pots, while the applied concentration of Cd (12 mg kg^{-1}) and Ni (20 mg kg^{-1}) were 31.0 and 33.3cm respectively (Table 3). The treatments of phosphatic fertilizer also showed significant effect on the plant stature, with the maximum plant height of 43 cm in T_3 (60 kg P ha^{-1}) which was at par with the rest of the treatments except the control. The interaction between metals (sewage water + Cd + Ni) and phosphorus levels was showed non-significant influence on the plant height. Ishtiaq & Mahmood (2011) showed similar result for mung bean grown under different Ni concentrations (50, 100, 150 mg kg^{-1}), they recorded the plant height 77, 66 and 53 cm respectively. Murtaza et al., (2014) examined the effect of phosphorus on plant height of mash bean and found significant increase by the application of 90 and 120 (kg P ha^{-1}).

3.6.2. Root length (cm)

Root length under applied metals concentration and sewage water significant changed (P>0.05). Maximum root length of (18.67cm) was found in sewage water, while the root length decreased to 15 and 17.50cm in the applied concentration of Cd and Ni respectively (Table 3). Treatments of phosphate fertilizer showed non-significant effect on root length of mung bean. Interaction between (sewage water + Cd + Ni) and treatments of phosphate fertilizer exhibited significant influence on the root length. The

Table-3 Effect of sewage water, Cd and Ni (mg kg^{-1}) along with different levels of Phosphorus on growth and yield parameters of Mung bean.

	Plant Height (cm)	Root length (cm)	Number of seeds pod^{-1}	Pod length (cm)	10-seeds weight (gm)	Seed yield plant^{-1}
Metals						
Cadmium (Cd)	55.67 a	18.67 a	5.75^{NS}	7.92 ^{NS}	0.59 ^{NS}	2.57 ^{NS}
Nickel (Ni)	31.00 b	15.00 b	6.25	7.33	0.58	2.55
Sewage Water (SW)	33.33 b	17.50 ab	6.5	7.33	0.55	2.72
Phosphatic levels						
T_1 (Control)	37.11 b	16.44 ^{NS}	5.56 b	7.11 b	0.53 ^{NS}	1.88 b
T_2 (30 kg P ha^{-1})	41.56 ab	17.11	6.33 ab	7.56 ab	0.57	2.88 ab
T_3 (60 kg P ha^{-1})	43.00 a	16.56	6.22 ab	7.78 a	0.60	2.52 ab
T_4 (90 kg P ha^{-1})	38.33 ab	18.11	6.56 a	7.67 ab	0.59	3.16 a
Metal × Phosphatic levels						
Cd × T_1	56.67 ^{NS}	18.33 ab	5.33 b	7.33 ab	0.57 ab	2.52 ^{NS}
Cd × T_2	58.00	19.00 ab	6.00 ab	8.00 ab	0.57 ab	2.00
Cd × T_3	55.33	17.67 ab	5.67 ab	8.33 a	0.63 a	2.00
Cd × T_4	52.67	19.67 a	6.00 ab	8.00 ab	0.58 ab	2.77
Ni × T_1	27.33	13.33 b	5.67 ab	7.00 b	0.56 ab	1.45
Ni × T_2	33.00	15.33 ab	6.00 ab	7.33 ab	0.56 ab	2.93
Ni × T_3	32.00	15.00 ab	7.00 ab	7.67 ab	0.58 ab	2.59
Ni × T_4	31.67	16.33 ab	6.33 ab	7.33 ab	0.67 a	3.22
SW × T_1	27.33	17.67 ab	5.67 b	7.00 b	0.46 b	1.67
SW × T_2	33.67	17.00 ab	7.00 ab	7.33 ab	0.57 ab	2.72
SW × T_3	41.67	17.00 ab	6.00 ab	7.33 ab	0.58 ab	2.99
SW × T_4	30.67	18.33 ab	7.33 a	7.67 ab	0.58 ab	3.50

Means within a column followed b different letter are significantly different at 5% level of significance longest roots of 19.67cm was observed in T_4 (90 kg P ha^{-1}) of sewage water pot, while the shortest root length of 13.33cm was recorded in T_1 (control) along with applied concentration Cd. Arzoo et al., (2014) found that Ni affect the length of root, the root length was significantly reduced when Ni at 100 mg kg^{-1} was applied. Madhvi et al., (2014) reported that the root length enhanced by the application of industrial waste water as compared with the groundwater, the increment of root was due presence of nutrient in the industrial waste water. Badar et al., (2015) revealed that root length of plant increased by phosphate fertilizer.

3.6.3. Number of seeds pod^{-1}

Number of seeds per pod of mung bean showed non-significant influence under sewage water and applied concentration of Cd and Ni. While the phosphatic fertilizer applied at increasing rate had significant effects on number of seed pod^{-1}, highest number of seeds pod^{-1} were found 6.56 in T_4 (90 kg P ha^{-1}) which was at par with T_3 (60 kg P ha^{-1}) and T_2 (30 kg P ha^{-1}), while lowest number of seeds pod^{-1} 5.56 were recorded in control without phosphatic fertilizer (Table 3). Interaction between (sewage water + Cd + Ni) and phosphorus levels was found significant ($p<0.05$), maximum number of seeds pod^{-1} (7.33) was observed in T_4 (90 kg P ha^{-1}) of Ni (20 mg kg^{-1}) pot. Ghani, (2010) concluded that seed pod^{-1} was decreased as concentration of cadmium increased as compared to the control with Cd. According to Murtaza et al., (2014) phosphatic fertilizer have significant effect on the number of seed pod^{-1}, highest number of seed pod^{-1} were found at 90 (kg P ha^{-1}) when compared with 0 (kg P ha^{-1}).

3.6.4. Pod length (cm)

Pod length of mung bean was non-significantly changed by sewage water and applied metals stress, while showed significant greater pod length by the increasing level of phosphatic fertilizer (Table 3). The highest pod length of 7.78cm was recorded in T_3 (60 kg P ha^{-1}) which was at par with 7.67cm in T_4 (90 kg P ha^{-1}), while lowest pod length of 7.11cm was found in T_1 (0 kg P ha^{-1}). Interaction between (sewage water + Cd + Ni) and phosphorus levels has showed significant influence on Pod length (cm), highest pod length of (8.33cm) was recorded in T_3 (60 kg P ha^{-1}) of sewage water pot, while lowest pod length of 7cm was found in T_1 (0 kg P ha^{-1}) of both Cd and Ni pots. Ghani, (2010) reported that by increasing concentration of cadmium showed decease in length of pod. Also, Addo et al., (2013) found that Ni increase has resulted in decreased pod length. Parvez et al., (2013) examined the effect of phosphate fertilizer on pod length of mung bean plant, pod length was increased due to phosphate fertilizer.

3.6.5. 10-seeds weight (gm)

The result pertaining 10-seeds weight was found non-significant ($P<0.05$) by applied metals concentrations and sewage water (Table 3). Also, the phosphate level showed non-significant effect on the 10-seeds weight. However, the interaction between Sewage water + Cd + Ni and levels of phosphatic fertilizer was showed significant effect on 10-seeds weight, with 0.67g the highest found in Cd along with phosphatic fertilizer applied at 90 kg P ha^{-1} (T_4), the least 10-seeds weight of 0.46g was found in Ni applied at 20 mg kg^{-1} along with phosphatic level control. Our current result of 10-seeds weight was comparable with Hayat et al., (2013) indicated that increase in concentration of cadmium reduce the weight of 10-seeds. Parvez et al., (2013) found that rate of phosphate fertilizer enhanced the weight of seed over control.

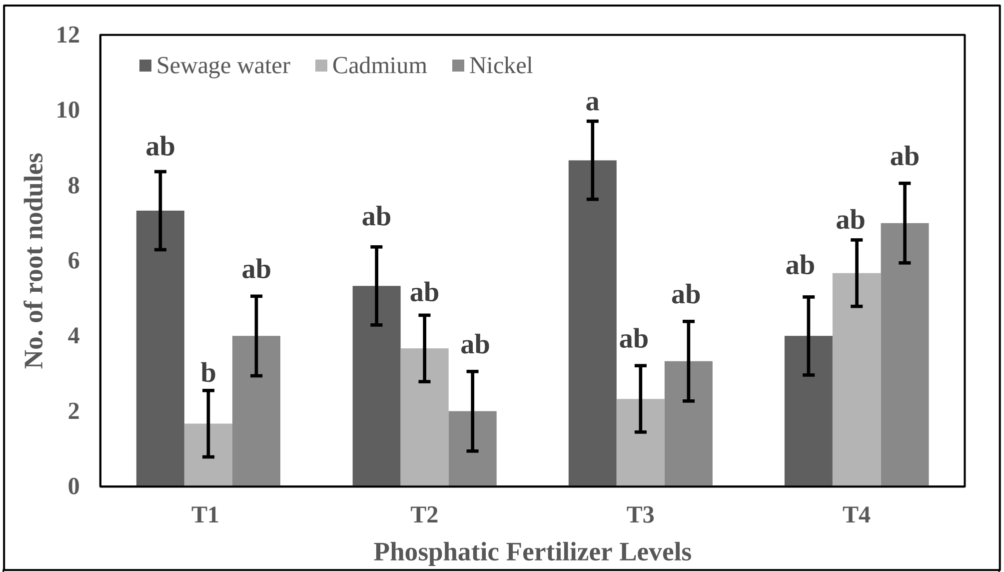
3.6.6. Seed yield plant^{-1}

The seed yield plant^{-1} of mung bean was non – significantly influenced by the application sewage water and concentrations of Cd and Ni. While, the phosphatic fertilizer applied at an increasing rate has showed significant effect on Seed yield plant^{-1}. The highest seed yield plant^{-1} of 3.16gm was recorded in T_4 (90 kg P ha^{-1}) which was at par with T_3 (2.52gm) and T_2 (2.88gm), lowest seed yield plant^{-1} was recorded 1.88gm in control (Table 3). Interaction between (sewage water + Cd + Ni) and phosphorus levels were showed non-significant influence on seed yield plant^{-1}. Hayat et al., (2013) investigated that seed yield plant^{-1} was reduced under cadmium concentration, highest seed yield of 10.94gm plant^{-1} was recorded in control having cadmium concentration were neglected, lowest seed yield of plant^{-1} was found in Cd (100 mg kg^{-1}). Parvez et al. (2013) observed significantly higher seed yield plant^{-1} by applying phosphate fertilizer at increasing rate.

3.6.7. Number of root nodules plant^{-1}

Interaction between (sewage water + Cd + Ni) and phosphorus level showed significant influence on the number of root nodules plant^{-1}. Highest number of root nodules plant^{-1} (8.67) was found in T_3 (60 kg P ha^{-1}) of sewage water pot, lowest number of root nodules plant^{-1} was recorded (1.67) in T_1 (0 kg P ha^{-1}) of Cd (12 mg kg^{-1}).

Our results were similar to study of Yilmaz et al., (2012) who reviewed number of root nodules plant^{-1} under cadmium stress (Fig. 4). They found that number of root nodules plant^{-1} inhibited by cadmium



T_1: Control **T_2: 30 kg P ha^{-1}** **T_3: 60 kg P ha^{-1}** **T_4: 90 kg P ha^{-1}**

Figure 4. Number of root nodules affected by Sewage water, Cadmium and Nickel combined with phosphatic fertilizer. Mean followed by different letters and significantly different at 5% level of significance.

concentration, highest number of root nodules plant^{-1} was found in Cd (0 mg kg^{-1}), root nodules plant^{-1} declined when Cd at 16 mg kg^{-1} was applied. Khan et al., (1996) examined the effect of Nickel chloride on number of root nodules, root nodules was decreased when concentration of $NiCl_2$ increase. According to Saeed et al., (2015) sewage water surges number of root nodules plant^{-1}; maximum root nodules plant^{-1} was found in (1 g L^{-1}) soap solution of sewage water, number of root nodules plant^{-1} was reduced in (0 g L^{-1}).

4. CONCLUSIONS

The metal concentrations i.e. Cd and Ni in the soil, root and shoot of Mung bean crop behave differently. Although the Cd concentration showed great variation with the increasing level of phosphatic fertilizer, but the influence was significant in soil and root samples, but was non – significantly changed in the shoot. In case of Ni the concentration was found higher in the shoot and root samples as compared to the soil. But has shown significant change by increasing phosphatic level in the soil samples taken after the harvest of crop. It has been found that soil pH has played an important role in the regulation of Ni and Cd concentration in soil, root and shoot. The metal concentrations have shown non – significant influence on the agronomic parameters except for plant height and root length. The Phosphatic fertilizers applied at an increasing level has showed significant influence on the agronomic parameters. The interaction between metal concentration and phosphatic fertilizer have shown significant influence all the agronomic parameters except plant height and seed yield. Number of root nodules has showed increase in the sewage water plots with phosphatic fertilizer as compared to the Cd and Ni concentration.

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