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NUTRITIONAL STATUS OF DIFFERENT ORCHARDS IRRIGATED WITH WASTEWATER IN DISTRICT PESHAWAR

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ABSTRACT

The major micronutrients and heavy metals accumulation in soil and leaves irrigated with wastewater in Loquat, Peach, Apricot, Plum and pear orchards at Pandu (in district Peshawar) were studied during 2004. The soil samples were collected from two depths 0-30cm and 30-60cm. A total of 10 composite soil samples (mixing of 10-15 sampling) each for both depths from each orchard, along with 5 composite plant leaves and water samples were collected. All the samples were analyzed for macronutrients (N, P, and K) and micronutrients (Cu, Zn, and Mn) and heavy metals (Ni, Cd, and Pb). The average values of N, P, K, Cu, Zn, Mn, Ni, Cd, and Pb were found to be 0.04%, 1.04, 49.25, 2.50, 0.27, 2.09, 0.47, 0.32 and 1.09 mg kg^{-1} , respectively in 0-30cm soil depth where as 0.03%, 0.66, 78.01, 3.55, 0.35, 2.27, 0.47, 6.26 and 1.52 mg kg^{-1} , respectively were found in 30-60cm soil depth. The differences in nutrients accumulation were non- significant (using t-test at $P\leq 0.05$) between these two soil depths for all micronutrients except P. The macronutrients (N, P and K) in soil, and only N in leaves were deficient; where as P and K accumulation in leaves were adequate. Micro nutrients accumulations in leaves of various orchards were adequate in comparison to P(0.13-0.35), K(2.5-3.0), N(2.0-2.5), Zn(2-150), Cu(5-20), Mn(20-50), Ni(6-10), Cd(0.02), and Pb(2.0) mg kg^{-1} critical values in plants leaves , while Ni and Cd were high. Cu, Zn, and Mn concentration in wastewater were adequate where as Ni, Cd, and Pb was higher than the standard. Additional N application along with micronutrients and wastewater application may be better to use for improving nutritional status of the study area.

Keywords: Wastewater, Heavy metals, Toxic elements, nutritional status, Orchards.

INTRODUCTION

Soil fertility is an important factor, which determines the growth of a plant. Soil fertility is determined by the presence or absence of plant nutrient i.e. macro and micronutrients. These nutrients are inorganic raw material required in minute quantities for plant growth and development. For high yield and quality nitrogen, phosphorous and potash are supplied through commercial fertilizers. N plays an important role in carbohydrates utilization. P in energy transformation and K in enzymes activation, Osmotic regulation and protein synthesis (Samuel, 1985). Nutrients taken up by plants are used for their growth and development, and the concentration at root surface plays a key role in meeting these requirements (Wild and Jones, 1988). Imbalance use of NPK fertilizers can also have soil degradation and poor yield perspectives. Being essential nutrient excessive P concentration can promote the growth of biota and may cause problem of biological oxygen demand (BOD) for aquatic life (Varshney, 1983). In previous studies high P concentration was reported by Barber (1992). The ideal ratio of NPK is 2: 1:0.5 while according to National Fertilizer Corporation (NFC) repot 43% farmers are using less N, 74% use less P, and 99% use no k which is a clear indication of reduction of soil fertility due to imbalance use of these major nutrients (Hussain and Higa, 2001).

Although micronutrients are required in minute quantities but have the same agronomic importance as macronutrients have, and play a vital role in the growth

of plants such as increase plant productivity, (Bansal, 1992). The main sources of these micronutrients are parent material, sewage sludge, town refuse and farmyard manure and are present in small amount ranging from few mg kg-1 to several thousand mg kg-1 in soil (Awad and Romheld1993;). Researchers have reported positive and significant correlation among the micronutrients content and soil physio-chemical properties (Singh and Mongina 1993; Goswamii and Darmaker, 2002).

Majority of our farmers are poor and cannot afford the cost of commercial fertilizers. To curtail the cost of commercial fertilizer, some of the nutrient deficiency is recovered by irrigation via industrial/domestic wastewater. The ignorance of our farmer from the quality of water, soil and plant cause lower farm produce. The domestic wastewater for irrigation is widely practice in urban agriculture of Pakistan. In that context this study of wastewater used for irrigation in Pandu village of district Peshawar was carried out to evaluate the fertility status of the target area.

MATERIALS AND METHODS

Fertility status of different orchards (plum, pear, apricot and loquat) of village Pandu district Peshawar, and a single peach orchard of agricultural research farm, NWFP Agricultural University, Peshawar irrigated with Warsak canal were evaluated by measuring nutrients like nitrogen, phosphorous, potash, micronutrients (cu, zn, and mn) and heavy metals (ni, cd, and pb) during summer 2004.

Soil sampling:

Soil samplings were done by digging four to five pits at the crossing point of four trees at a depth of 0-30cm and 30-60cm. About one kg of the composite sample was taken through mixing of 10-15 sub samples. The samples were air dried in the laboratory ground with wooden mortar and passed through 2mm nylon sieve, finally packed in the polythene bags and labeled for conducting analysis.

Soil extraction:

20ml of AB-DTPA extracting solution was added to 10 grams of air-dried and sieved soil put in a conical flask, were shaken for 15 minutes, and then the soil suspensions were filtered through Whatman No. 42. (Havlin and Soltanpour, 1981). A blank extraction was also taken. Extractions were stored in bottles for further observations.

Plant sampling:

The 18-20 mid shoot leaves were taken randomly from each orchard at both sites, washed with distilled water, initially air dried and then dried in the oven at 72ºC for 48 hours, the dried samples were ground sieved through 2mm mesh and stored in bottles. To record the nutrients, 0.5mg of plant samples were taken in 100ml flask, 10ml concentrated HNO_3 was added and kept over night and then 4ml of concentrated HCl was added. These samples were digested using a hot plate, the samples were filtered in 100ml volumetric flask and the volume was made up to the mark with distilled water. (Black, 1965).

Water sampling:

Water samples were taken at random from irrigating water used for orchards irrigation during summer at each irrigation time. A total of 2-3 samples were mixed, and stored in laboratory for various observations.

The soil, plant and wastewater extraction/samples were analyzed for Total nitrogen in soil and plants by kjeldahl method (Bremner and Mulvaney, 1982), in wastewater (Tandon 1993), ABDTPA extractable P and K by extraction method, using Spectronic 601 and Flame photometer, respectively (Halvin and Sultanpourm 1981). The significance results were tested by t-test ($P<0.05$) and correlation were worked out through SPSS. The ABDTPA extractable Cu, Zn, Mn, Ni, Cd and Pb were determined by atomic absorption spectra photometer.

RESULTS AND DICUSSION

Nitrogen in soil, plant and water

Total N content in the soil sample under orchards ranged from 0.02 to 0.07 % with a mean value of (0.04%) recoded in 0-30cm depth as compared to (0.03%) for 30-60cm depth Table-1. These differences were however non-significant using t-test (Table-4), the change in organic matter, pH, soil texture, drainage condition, volatilization, and leaching may be responsible for low N concentration in surface soil (Midrar-ul-Haq et al., 2003). The various orchards have different concentrations of nitrogen. The data in Table-2 showed that N content in the plant under orchards ranged from 0.71 to 1.25 %. Minimum Nitrogen concentration was recorded in the loquat orchard and the greater in the plum orchard. All the orchards were deficient in nitrogen content as reported by Tandon (1993). The different nitrogen concentration might be due to various nitrogen metabolism and plant uptake. Similarly the data in Table-3 showed that N content in the water irrigation ranged from 0.03 – 0.07 mg kg^{-1}. The minimum nitrogen (0.03 mg kg^{-1}) was recorded in the plum orchard while the maximum nitrogen concentration was recorded in the pear orchard (0.07 mg kg^{-1}). Positive correlation was recorded both for N content (%) in soil and plant (Figure-1) as well as between wastewater and plant (Figure-2).

Phosphorous in soil, plant and water

The concentration of phosphorous [P] in both soil depth showed that [P] in the soil under orchards ranged from 0.14 to 1.70 mg kg^{-1} with a mean value of (1.04) recoded in 0-30cm depth as compared to (0.66) for 30-60cm depth (Table-1). These differences were significant at ($P<0.05$). These differences might be ascribed to mineralization of organic matter in the soil, as top soil contains more microbes than beneath the top one (Scott and Batten, 2003). This mineralization along with wastewater application may build up [P] levels to considerable concentration with time. Anwer and Sattar (1975) reported the average value of 6.85 mg kg^{-1} for available P in Tharparker district (Sindh), while Puno (1991) reported AB-DTPA extractable soil P (1.8 mg kg^{-1}) at Latif Exp. Farm, S.A.U. Tandojam, Sindh. These differences might be due to low loss of phosphorus as compared to nitrogen. Similarly [P] in the plant leaves ranged from 0.10 to 0.17 mg kg^{-1} with a mean value of (0.14 mg kg^{-1}), minimum phosphorous concentration (0.10 mg kg^{-1}) was recorded in plum orchards and maximum (1.0 mg kg^{-1}) in apricot orchard (Table-2). All the orchards were adequate for [P] as reported by Tandon, 1993. The data in Table-3 showed that [P] content in the water irrigating the orchards ranged from 4.49 to 5.29 mg kg^{-1} with a mean value of 5.4 mg kg^{-1}.

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(Figure-1) showed correlation studies between plant in soil P content and plant in wastewater (Figure-2) were positive.

Potassium in soil, plant and water

The potassium concentration [K], varied between 36.47 to 83.80 mg kg^{-1} in both soil depth with a mean value of (49.25 mg kg^{-1}) recoded in 0-30cm depth as compared to (78.01 mg kg^{-1}) for 30-60cm depth (Table-1). These differences were non-significant at ($P<0.05$) using t-test (Table-4). These differences might be ascribed to irrigation water, which mainly contained the effluents from house hold of the discharge. Similarly potassium concentration ranged from 1.37 mg kg^{-1} recorded in plum to (4.19 mg kg^{-1}) recorded in apricot orchard with a mean value of 2.63 mg kg^{-1} (Table-2). Loquat, peach and plums orchards were deficient in potassium, while peach had adequate and apricot orchard had high potassium concentration (Tandon, 1993). The data in Table-3 showed that [K] in the water irrigating various orchards ranged from 5.64 to 28.22 mg kg^{-1} with a mean value of 16.05 mg kg^{-1}. Correlation studies presented in Figures-1 and 2 revealed that positive correlation between plant and soil as well as between plant and wastewater for K concentration.

Micronutrients status in the soil

The micronutrient concentration in soil play an important role in making available other micro and macro nutrients e.g. Zn uptake by rice affected by Zn (Chaudey and Wallace, 1970). Similarly Fe and Mn interaction was studied by Pathak et al. (1979). Various micronutrient studied in the present study were Cu, Zn, Mn, and heavy metals Ni, Cd and Pb. Almost all the micronutrients were deficient in both soil depths i.e. 0-30cm and 30-60cm in all orchards except Cu in both soil depths (Perveen et al., 1993), Mn at 0-30cm soil depth in loquat and plum orchard and at 30-60cm soil depth in apricot, plum and pear orchards (Table-1). The criteria used for categorization of elements were based on Havlin and Soltanpur, (1981). These results are in line with Munawar (1990), who reported Zn, Fe, Mn, B deficiency in soil sample colleted from different areas of NWFP. Statistical analysis revealed that all micronutrients were non significantly affected using t-test (Table-4). Mean value of Cu (2.50 and 3.55), Zn (0.27 and 0.35), Mn (2.09 and 2.27), Ni (0.47 and 0.47), Cd (0.32 and 0.26) and Pb (1.09 and 1.52 mg kg^{-1}) were recorded in soil depth of 0-30cm and 30-60cm, respectively. Positive correlation was recorded for micro nutrients and heavy metals in plant with micro and heavy nutrients in soil as well as in water.

Micronutrients status in Plant leaves

Micronutrients concentration in plant leaves is one of the important constituent. They play an important role in different metabolic processes, antagonistic relationship with each other and other macronutrients. (Pathak et al., 1979). Mean values of Cu, Zn, and Mn in different orchards were found to be 87.86, 17.00 and 32.80 mg kg^{-1}, respectively (Table-2). These were adequate in almost all orchards except Zn concentration in plum and Pear orchards which were deficient. Similarly Ni, Cd, and Pb concentration of 33.54, 1.94 and 39.52, respectively were high in all orchards except Pb concentration which was below permissible limit in pear orchards (Table-2). These classifications were based on Wild and Jones, 1972. These micronutrients in plant leaves may cause antagonistic or synergetic effect of trace elements with one another. . Correlation studies presented in Figures-1 and 2 showed positive correlation between micro and heavy nutrients in plant with micro and heavy nutrients in soil and wastewater.

Micronutrients status in wastewater

Quality of water used for irrigation play an important role in productivity of orchards and crop yield. Micronutrients accumulation in wastewater, Cu (0.99 mg kg^{-1}) Zn (0.06), Mn(0.32), Ni (0.11), Cd (0.26) and Pb (0.75) were adequate in all water samples used in orchards except Ni accumulation in wastewater used for Apricot, Plum and Pear, which were high according to USEPA standard for irrigation water (1999).

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Table-1. Nutrients accumulation (mg kg^{-1}) in soil of different orchards irrigated with wastewater.

Parameter	Depth (cm)	Loquat	Peach	Apricot	Plum	Pear	Mean
N (%)	0-30	0.05¶	0.04¶	0.02¶	0.04¶	0.07¶	**0.04**
	30-60	0.06¶	0.02¶	0.04¶	0.04¶	0.02¶	**0.03**
P	0-30	1.70¶	0.14¶	1.04¶	1.48¶	0.86¶	**1.04**
	30-60	0.96¶	0.29¶	0.37¶	1.33¶	0.37¶	**0.66**
K	0-30	39.70¶	36.47¶	83.80†	43.40¶	42.90¶	**49.25**
	30-60	48.67¶	42.10¶	69.00†	42.10¶	188.20‡	**78.01**
Cu	0-30	5.10†	0.85†	1.40†	0.95†	4.22†	**2.50**
	30-60	4.18†	1.28†	6.51†	3.06†	2.73†	**3.55**
Zn	0-30	0.34¶	0.22¶	0.26¶	0.21¶	0.32¶	**0.27**
	30-60	0.48¶	0.17¶	0.66¶	0.23¶	0.21¶	**0.35**
Mn	0-30	1.78†	0.49¶	0.09¶	6.80†	1.33¶	**2.09**
	30-60	1.68¶	1.54¶	4.05†	1.89†	2.17†	**2.27**
Ni	0-30	1.28¶	0.34¶	0.15¶	0.26¶	0.31¶	**0.47**
	30-60	0.64¶	0.22¶	0.81¶	0.27¶	0.39¶	**0.47**
Cd	0-30	0.02¶	0.90¶	0.30¶	0.20¶	0.20¶	**0.32**
	30-60	0.08¶	0.20¶	0.30¶	0.40¶	0.30¶	**0.26**
Pb	0-30	2.00¶	0.96¶	0.12¶	0.86¶	1.50¶	**1.09**
	30-60	2.30¶	0.84¶	1.64¶	2.32¶	0.48¶	**1.52**

Table-2. Nutrients accumulation (mg kg^{-1}) in Plant leaves of different orchards irrigated with wastewater.

Parameter	Loquat	Peach	Apricot	Plum	Pear	Mean
N	0.71¶	1.40¶	1.42¶	1.48¶	1.25¶	**1.25**
P	0.14†	0.16†	0.17†	0.10†	0.13†	**0.14**
K	3.08¶	2.50†	4.19‡	1.37¶	2.01¶	**2.63**
Cu	91.00†	90.50†	47.60†	111.00†	99.20†	**87.86**
Zn	20.80†	22.70†	30.40†	17.00¶	10.10¶	**17.00**
Mn	48.20†	40.50†	30.40†	1.20†	43.70†	**32.80**
Ni	38.90‡	22.20‡	51.70‡	10.10‡	44.80‡	**33.54**
Cd	0.60‡	1.10‡	1.70‡	5.30‡	1.00‡	**1.94**
Pb	92.00‡	10.00‡	30.00‡	63.00‡	2.60¶	**39.52**

Table-3. Nutrients accumulation (mg kg^{-1}) in wastewater used for irrigation of different orchards.

Parameter	Loquat	Peach	Apricot	Plum	Pear	Mean
N	0.04	0.07	0.05	0.03	0.07	**0.05**
P	5.23	5.04	5.29	4.49	5.17	**5.04**
K	16.93	5.64	11.48	18.00	28.22	**16.05**
Cu	1.14†	1.84†	1.13†	0.54†	0.30†	**0.99**
Zn	0.07†	0.05†	0.04†	0.04†	0.10†	**0.06**
Mn	0.08†	0.16†	0.88†	0.05†	0.43†	**0.32**
Ni	0.01†	0.04†	0.23‡	0.21‡	0.04‡	**0.11**
Cd	0.07†	0.31†	0.24†	0.56†	0.13†	**0.26**
Pb	0.51†	0.95†	0.02†	0.05†	2.22†	**0.75**

¶= low, †= Adequate, ‡= High

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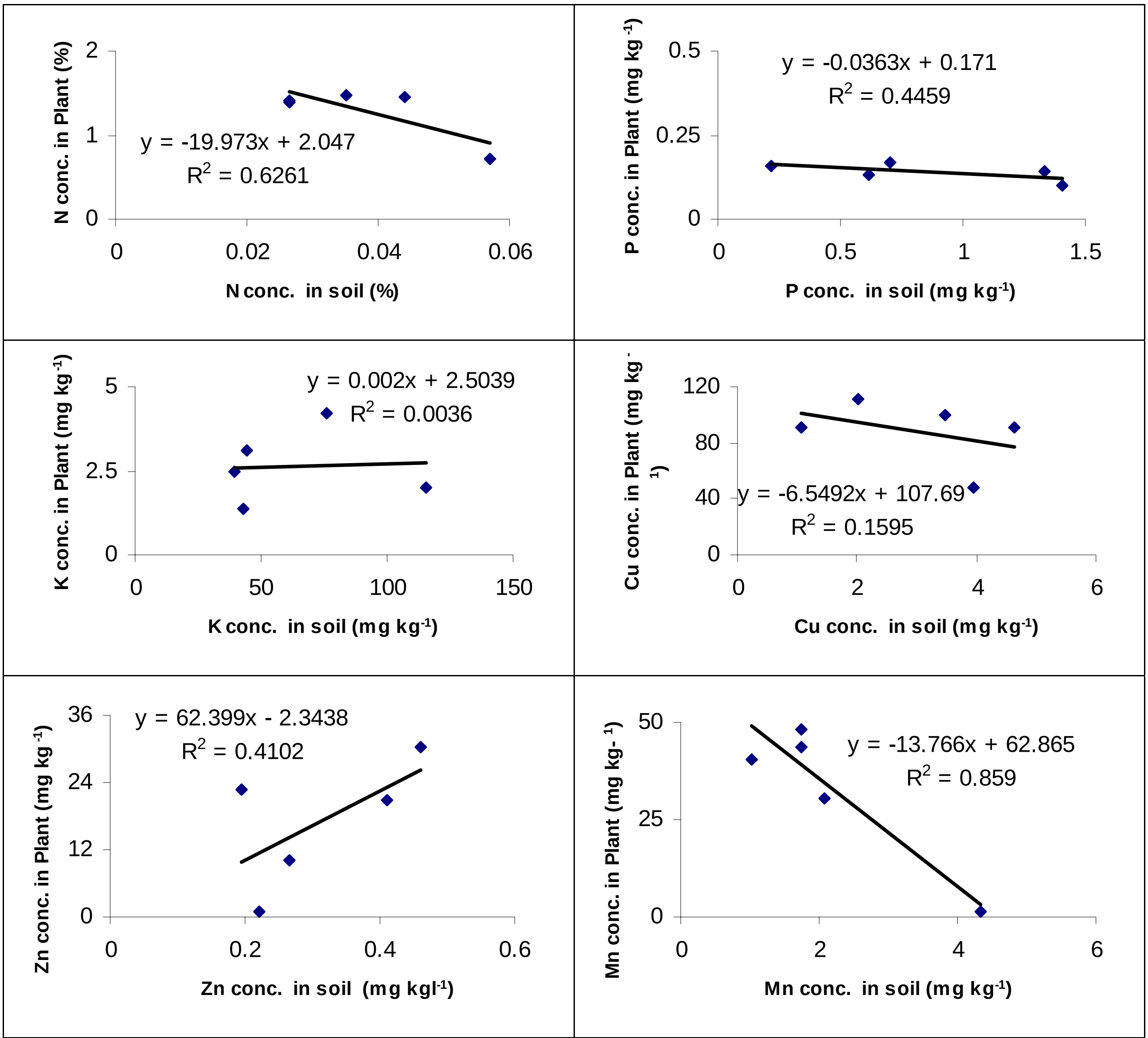
Table-4. Comparison of Nutrients accumulation in 0-30cm and 30-60cm soil depth Using t-test.

Parameter	Nutrients concentration (mg kg^{-1})		t-statistic	P-value
	0-30 cm soil depth	30-60cm soil depth		
N	0.04	0.03	0.724	0.509
P	1.04	0.66	2.272	0.046
K	49.25	78.01	-0.978	0.384
Cu	2.50	3.55	-0.758	0.491
Zn	0.27	0.35	-0.887	0.425
Mn	2.10	2.27	-0.103	0.923
Ni	0.47	0.47	0.010	0.993
Cd	0.32	0.26	0.422	0.695

Figure-1. Correlation between various nutrients in plant and soil.



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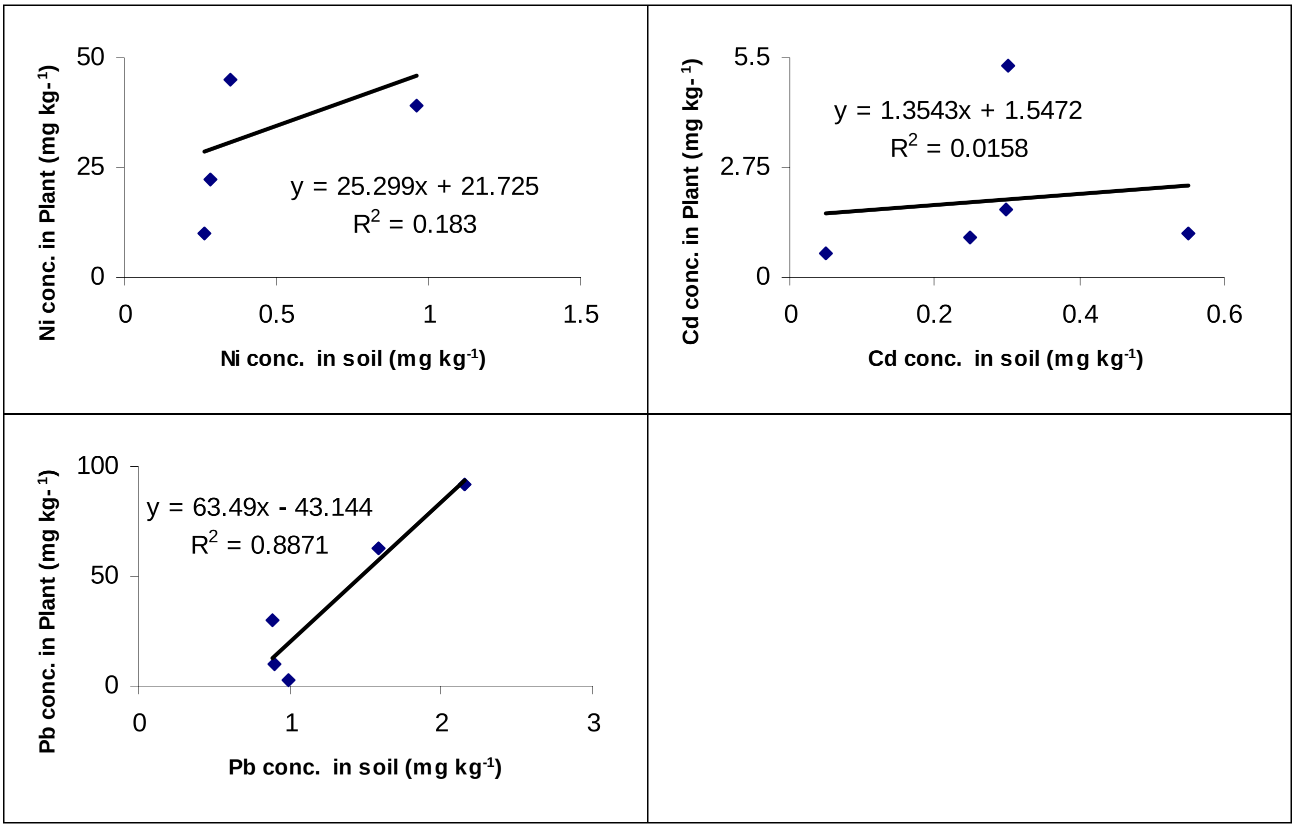
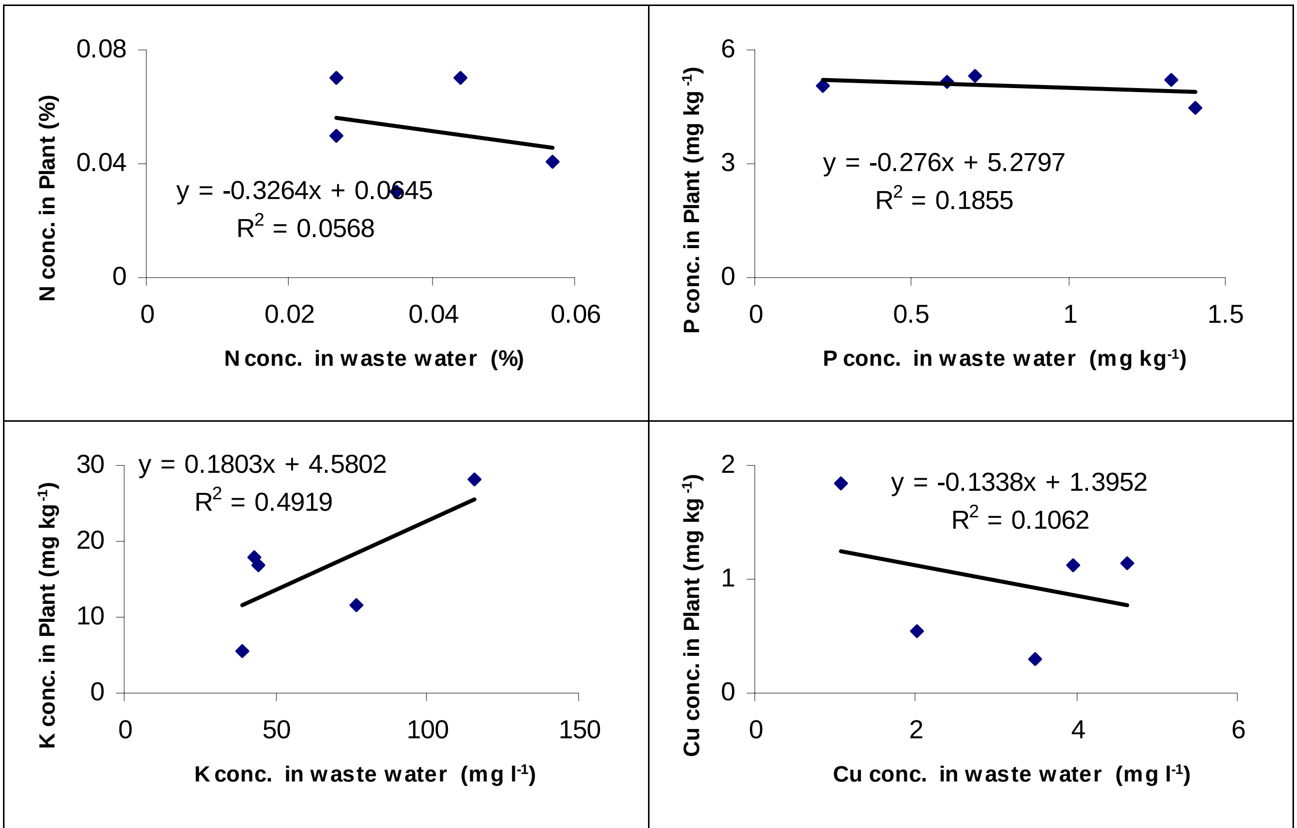


Figure-2. Correlation between various nutrients in plant and wastewater.



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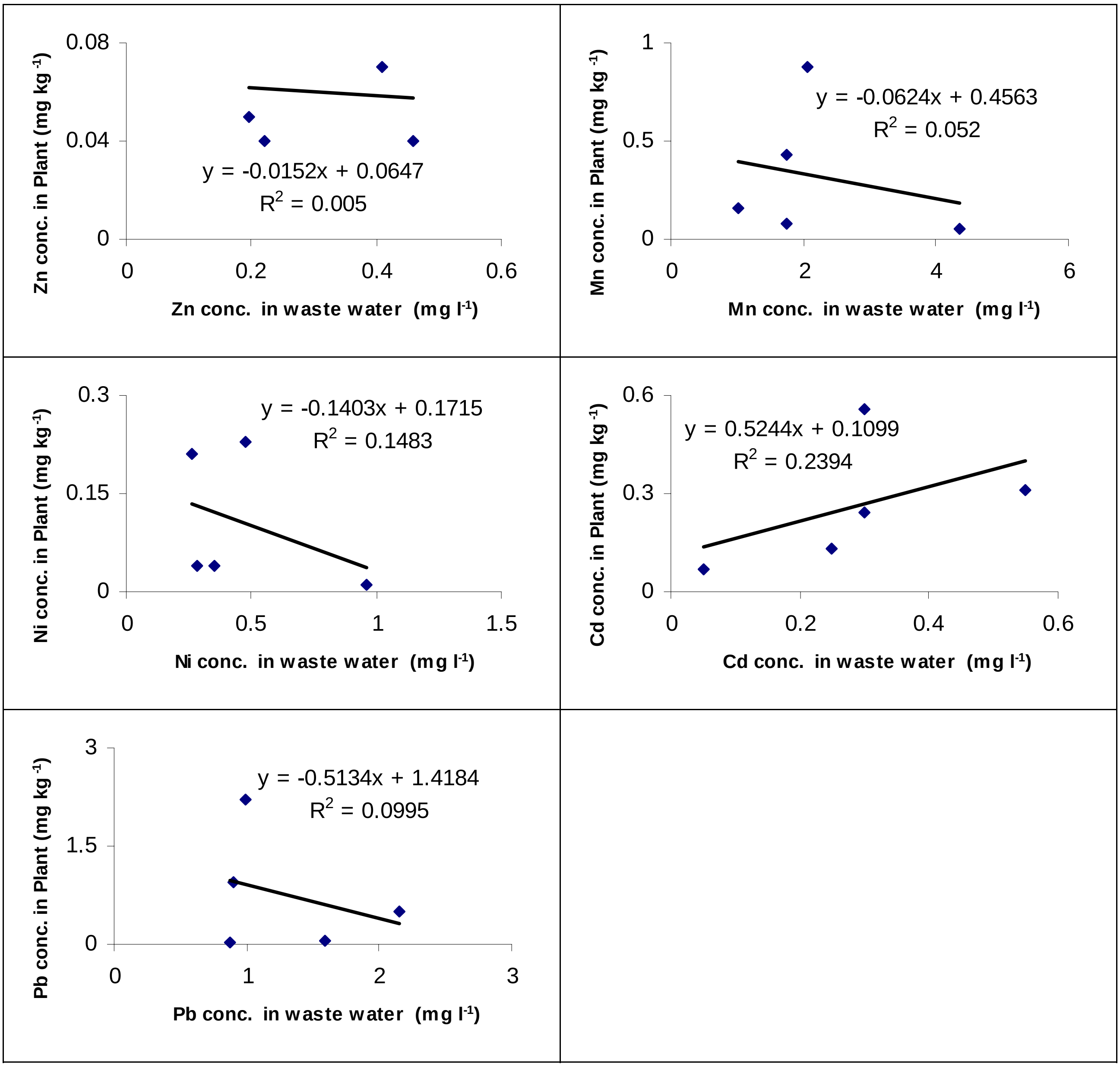

Table-5. Criteria for plant extractable macronutrients (Tandon, 1993), and micro nutrients (Wild and Jones,1972).

Nutrients (mg kg^{-1})	Low	Medium	High
P	0.09-0.12	0.13-0.35	>0.35
K	2.0-2.4	2.5-3.0	>3.0
N	1.8-1.9	2.0-2.5	>2.5
Zn	<20	25-150	>150
Cu	<4	5-20	>20
Mn	<20	20-50	>50
Ni	2-6	6-10	>10
Cd	<0.02	.02	>0.02
Pb	0.01-1	2.0	>2.0

Table-6. AB-DTPA extractable criteria for micronutrients in soil (Halvin and Soltuapur, 1981).

Nutrients (mg kg^{-1})	Low	Medium	High
Zn	<0.9	0.9-0.15	>150
Cu	<0.3	0.3-0.5	>0.50
Mn	<0.6	0.6-1.0	>1.0

Table-7. USEPA standard for irrigation water (1999).

Nutrients (mg kg^{-1})	USEPA
Zn	2-5
Cu	0.2
Mn	2.0
Ni	0.02
Cd	5.0
Pb	5.0

CONCLUSION

Based on the above study carried out for various orchards the accumulation of major nutrients (N, P, K) in soil, N only in leaves were deficient where as P and K in leaves were adequate. All micronutrients accumulated were deficient in soil except Cu, which were adequate in leaves; Cu, Zn, and Mn were adequate in leaves, while Ni, Cd, and Pb were high. Wastewater has adequate micronutrients concentration, except Ni, which was high. Additional N supply and wastewater application may be better to use for improving nutritional status of the study area and consequently optimizing better orchards productivity.

REFERENCES

Anwar, M. and S. A. Sattar. 1975. Phorphous and Potasssium status of soil and cotton crops of Tharparker District. The Pak. Cotton. 19 (2): 127-134.

Awad, F. and V. Romheld. 2000. Mobilization of heavy metals from contaminated calcareous soils by plant born, microbial and synthetic chelators and their uptake by wheat plants. Ninth International Symposium on Iron Nutrition and Interactions in Plants, Stuttgart, Germany, 20 25 July, 1997 23(11-12): 1847-1855.

Bansal, O. P. 1992. Changes in micronutrients (Cu, Zn, Mn, Ni and Cd) concentration in soil amended with sludge. Clay Research. 2(1):29-32.

Black, C. A. 1965. Method of Soil Analysis. Par-II. Soc. Agron. Inc. Pub. Madison, Wisconsin. U.S.A.

Bremners, J. M., and C.S. Mulvaney. 1982. Nitrogen total. In A.L. Page., R.H. Miller., and D.R. Keeney. Methods of soil analysis. Part 2(2nd ed) Agronomy, (9): 595-621.

Chaudary, F. M. And A. Wallance. 1976. Zinc uptake by rice as affected by iron and a chaletor of ferrous iron. Plant & soil. 45 (3) 697-700.

Goswami, D. and R. M. Darmakar. 2002. Fertility status of soils of citrus research station. Tinsukia, A. A. U., Assam. Annuals-of- Agri-Bioresearch. (7):139-142.

Halvin, J. L., and P. N. Soltanpour. 1981. Evaluation of the NH4HCO3 E-DTPA Soil test for Fe, Zn, Mn, Cu., Soil Sci. Soc. Amer. J. 45: 70-55.

Hussain, T. and T. Higa. 2001. Beneficial and effective microorganisms for a sustainable agricultural and environment. Nature Farming Res. Center, Univ. of Agric. Faisalabad, Pakistan. pp. 155.

Scott B. and G. Batten. 2003. Crop nutrition. . In Jim P. (ed). Principles of Field Crop Production, 4th Edition. Oxford University Press. Pp. 276.

Midrar-ul- Haq, H. K. Puno, R. A. Khattak and M. S. Saif. 2003. Accumulation of NPK in effluent irrigated soils of the Korangi industrial area Karachi-Sindh. Sarhad J. of Agric. 19(3):375-382.

Munawar, K. 1990. Study of micronutrients status of NWFP soil. M.Sc (Hons) Thesis. NWFP Agric. Univ. Peshawar.

Pathak, A. N., Singh and R.S. Singh. 1979. Effect of Fe and Mn interaction on yield, chemical composition and their uptake in crops. Fertilizer News. 24 (3): 35-40.

Perveen S. M. Tariq Farman ullah, J. K. Khattak and A. Hamid. 1993. Study of micronutrients status of some important sites of N.W.F.P. Sarhad J. of Agric. 9(5):467-473.

Puno, H. K. 1991. Calibration of soil test P with crop response to applied phosphorus. Ph.D. Thesis. Dept. of Soil Sci. Sindh Agric. Univ. Tandojam. Pakistan.

Samuel, L. T., N. L. Wernner and B. D. James. 1985. Soil Fertility and Fertilizers. 4th Edition, Macmillan Publish. Co. Inc. USA. pp. 61-70.

Singh, N. T. and A. D. Mongia. 1993. Distribution of zinc, copper, manganese and iron in soil of Andaman and Nicobar Island. Agrochimica. 37: (1-2) 18-25.

Tendon, H. L. S. 1993. Methods of analysis of soils, plants, waters and fertilizers. Fert. Dev. Consultation org New Delhi: India. pp. 138.

Varshney, C. K. 1983. Water Pollution and Management. Wily Eastern Ltd. New Delhi. pp. 242.

Wild, A. And L. H. P. Jones. 1972. Mineral nutrition of crop plants. In: Russell's soil conditions and plant growth. 11th Ed. Longman Group UK. pp. 69-112.