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FERTILITY STATUS OF VEGETABLE GROWING AREAS OF PESHAWER, PAKISTAN

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Abstract

The study was conducted to classify soil of vegetable growing areas of Peshawar with respect to low, medium and high soil fertility status for better management of the whole area. A total of 36 soil samples were collected from different sites surrounding Peshawar city at 0-30 and 30-60 cm depths. Soil samples were analyzed for soil chemical properties and soil fertility status. The data of chemical properties of soil showed that soil pH in both the depths was alkaline in nature and non saline. Organic matter was found deficient and medium in 27 and 55% samples in surface soil while it was deficient and medium in 44 and 55% samples in subsurface soil. Total nitrogen was found deficient and medium in 27 and 61% samples in surface soil while it was found deficient and medium in 44 and 55 % samples in sub surface soil. Ammonium Bicarbonate Di-ethylene Triamine Penta Acetic Acid extractable phosphorus was found deficient and medium in 27 and 11% samples in surface soil while it was found deficient and medium in 33 and 22% samples in sub surface soil. AB-DTPA extractable potassium was found medium and adequate in 44 and 55% samples in surface soil while it was found medium and adequate in 66 and 33% samples in sub surface soil .AB-DTPA extractable copper and manganese were found adequate in all the samples. AB-DTPA extractable iron was found medium and adequate in 11 and 88% samples in surface and sub surface soil. AB-DTPA extractable zinc was found deficient, medium and adequate in 33, 11 and 55% samples in surface soil while it was found deficient, medium and adequate in 44, 16 and 38% samples in sub surface soil. Hence it is recommended that areas which are deficient in P, Zn, and Fe should be fertilized with variable rate of respective fertilizers.

Introduction

Soil fertility and nutrient management influence vegetable productivity and hence, food security and livelihoods. Soils are inherently variable due to differences in soil forming factors operating and interacting over large distances and are modified by other processes which operate more locally or more frequently. The soils of Peshawar valley are slightly to strongly calcareous with neutral to strongly alkaline reaction having pH from 7.2 to 9.1 (Anon., 1973) and produce different types of crops and vegetables. Furthermore, appearance of nutrients deficiencies indicated the prevalence of nutritional disorders of micronutrients (Zn, Cu, Fe, Mn and B) in NWFP (Rehman & Haq, 2006, Khattak & Hussain, 2007) which is due to low organic matter content, calcareous nature of the soil and high pH (Zekri & Obreza, 2003). Rashid & Bhatti (2005) developed maps of macro and micronutrients of Peshawar district which also showed areas with deficiencies of macro and micronutrients. Similarly, Wasiullah & Bhatti (2006) also reported widespread deficiencies of N, P, Zn, Cu and B in Bannu & Kohat districts of NWFP. Due to increased population, poor management practices and inadequate use of fertilizers, the production is not of satisfactory level which is probably reducing due to usage of agricultural land to non agricultural land. One of possible way to increase the production is to assess macro and micro nutrient contents of soil so that fertilizer recommendations can be made on the basis of soil fertility status for profitable vegetable production. For most of the vegetables slightly acidic soil is desirable. Iron deficiency is common in leached tropical soils, particularly calcareous soils derived from limestone. The incorporation of plant materials or residues especially legume plant materials which often have high nitrogen content than non legumes to the soil increases both total nitrogen content and N mineralization potential. (Black, 1968). All plants require major and micro nutrients to be freely available in soil and ready to be absorbed by them. The nitrogen plays an important role in carbohydrate utilization. Phosphorous in energy transformation and potassium in enzymes activation, osmotic regulation and protein synthesis (Samuel *et al.*, 1985).Fe plays role in photosynthesis, Nitrogen fixation and valence charges. Zn is involved in synthesis of auxin and sexual fertilization, Cu in oxidation, photosynthesis, possibly involved in symbiotic N_2 fixation and valence charges and Mn in photo production of oxygen in chloroplasts and indirectly in NO_3 (Kabata Pendias & Pendia, 1985, Katyal & Randhawa, 1983; Shkolnik, 1984). Vegetables and fruits contain non nutritive plant chemicals that have protective or disease preventive properties known as phytochemicals. Some of well known phytochemicals are lycopene in tomatoes, isoflavones in soy and flavanoids in fruits. Phytochemicals are capable of promoting the function of the immune system, can act directly against bacteria and viruses, reduce inflammation and be associated with the treatment and/or prevention of cancer, carcinogen-induced tumors, cardiovascular disease and other malady affecting the health or well being of an individual. (DAS, 2008). Vegetables contain a variety of pigments. Tomato is rich in lycopene. Carrot and sweet potato are rich source of carotene and red cultivars of carrot contain anthocyanin pigment. The red colour of garden beet is due to betacyanin. It also contains yellow pigments betaxanthin (Singh *et al.*, 2008). Farooq *et al.*, (2008) reported that the leaves of spinach cabbage, cauliflower, radish and coriander contained higher concentrations of Cu (0.923mg kg^{-1}), Cd (0.073 mg kg^{-1}), Cr (0.546 mg kg^{-1}), Zn (1.893 mg kg^{-1}) and Pb (2.652 mg kg^{-1}) as compared to other parts of each vegetable. In Pakistan more than 36 varieties of vegetable are grown on large scale comprising a dynamic segment of Pakistan agriculture. The area and production of vegetables in Pakistan during 2007-2008 was 253800 ha and 3136800 tonnes and in Khyber Pakhtoon Khawa it was 39900 ha and 410400 tonnes. (Anon., 2007-2008). Keeping the above all points in view, this study was designed to assess the fertility status of soil with the objectives, to find the current macro and micro nutrient status of vegetable growing areas of Peshawar and to classify the areas into low, medium and high fertility status for the better nutrient management.

Materials and Methods

A total of 36 soil samples were collected from 18 different sites surrounding Peshawar city, at 0-30 and 30-60 cm depth (Table 1), and were dried, ground, sieved and stored. These samples were analyzed for soil properties i.e., pH, E.C (Richards, 1954), and O.M (Nelson & Sommers, 1982). Fertility status of soil was determined by analyzing total Nitrogen (Bremner, 1996), AB-DTPA extract-able P, K, Cu, Fe, Zn and Mn (Soltanpour, 1985). The data were subjected to simple arithmetic means, standard deviation and coefficient of variation for comparisons.

Results and Discussion

The data regarding the chemical properties, major nutrients and micronutrients, of soil is presented in Tables 1-3.

Table 1. Chemical properties (pH, E.C and O.M) of surface and sub-surface soil.

S. No.	Name of area	Depth (cm)	pH	EC (dSm^{-1})	O.M. (%)
1.	Nahaqi	0-30	8.17	0.15	0.51 L
		30-60	8.12	0.12	0.21 L
2.	Daudzai	0-30	8.52	0.33	1.00 M
		30-60	8.21	0.23	0.47 L
3.	Shinwar Town	0-30	7.87	0.20	1.45 M
		30-60	7.98	0.17	1.62 M
4.	Mohammadzai	0-30	7.67	0.41	1.66 M
		30-60	7.97	0.23	1.06 M
5.	Jaba	0-30	8.06	0.20	2.17 H
		30-60	8.09	0.20	1.69 M
6.	Jalabela	0-30	8.34	0.40	0.75 L
		30-60	8.35	0.45	0.31 L
7.	PakhaGulam	0-30	7.94	0.13	0.79 L
		30-60	7.94	0.11	0.79 L
8.	LandiArgajoon	0-30	7.75	0.39	1.41 M
		30-60	7.77	0.35	1.13 M
9.	ImranAbad	0-30	7.97	0.22	1.75 M
		30-60	8.01	0.38	1.65 M
10.	Mamakhail	0-30	8.04	0.14	1.11 M
		30-60	8.09	0.11	0.20 L
11.	Wakelkala	0-30	7.50	0.19	0.98 L
		30-60	7.79	0.15	0.44 L
12.	Zandai	0-30	7.63	0.36	1.12 M
		30-60	7.73	0.17	1.39 M
13.	ZandiCamp	0-30	7.85	0.16	0.71 L
		30-60	7.68	0.17	1.55 M
14.	GanayBaba	0-30	7.77	0.21	1.72 M
		30-60	7.86	0.20	1.35 M
15.	UrmerBala	0-30	7.76	0.56	2.13 H
		30-60	7.94	0.17	0.87 L
16.	GulAbad	0-30	8.06	0.14	1.42 M
		30-60	8.24	0.12	0.99 L
17.	LandiArbab	0-30	8.14	0.16	1.66 M
		30-60	8..12	0.15	1.45 M
18.	Manacro	0-30	8.00	0.20	2.01 H
		30-60	8.01	0.15	1.82 M
	Min	0-30	7.50	0.13	0.51
		30-60	7.68	0.11	0.200
	Max	0-30	8.52	0.56	2.17
		30-60	8.35	0.45	1.82
	Mean	0-30	7.94	0.25	1.32
		30-60	7.99	0.20	1.05
	S.D	0-30	0.25	0.12	0.56
		30-60	0.18	0.09	0.54
	C.V (%)	0-30	3.20	49.01	42.56
		30-60	2.28	48.36	51.97

L, M, and H stand for low, medium and high respectively.
The soil pH and EC were determined in 1:5 soil water suspension

Table 2. Total nitrogen and AB-DTPA extractable P and K in surface (0-30 cm) and subsurface (30-60 cm) soil.

S. No.	Name of area	Depth (cm)	Total N (%)	Phosphorus (mgkg^{-1})	Potassium (mgkg^{-1})
1.	Nahaqi	0-30	0.09 L	1.58 L	78.9 M
		30-60	0.09 L	0.97 L	66.8 M
2.	Daudzai	0-30	0.31 H	20.8 H	827.4 H
		30-60	0.10 L	7.59 H	84.3 M
3.	ShinwarTown	0-30	0.10M	11.5 H	105.0 M
		30-60	0.11 M	8.71 H	100.0 M
4.	Muhammadzai	0-30	0.16 M	24.9 H	80.4 M
		30-60	0.12 M	7.18 H	82.7 M
5.	Jaba	0-30	0.17 M	10.9 H	629.0 H
		30-60	0.16 M	4.40 M	437.9 H
6.	Jalabela	0-30	0.07 L	1.79 L	95.5 M
		30-60	0.09 L	2.77 L	74.2 M
7.	PakhaGulam	0-30	0.07 L	2.17 L	135.9 H
		30-60	0.10 L	2.76 L	123.3 H
8.	LandiArgajoon	0-30	0.17 M	15.4 H	166.5 H
		30-60	0.17 M	15.11 H	166.9 H
9.	ImranAbad	0-30	0.19 M	14.9 H	169 H
		30-60	0.17 M	28.4 H	158.8 H
10.	Mamakhail	0-30	0.12 M	3.97 L	96.6 M
		30-60	0.14 M	1.21 L	74.9 M
11.	Wakelkala	0-30	0.13 M	6.49 M	112.0 M
		30-60	0.10 M	1.94 L	93.5 M
12.	Zandai	0-30	0.13 M	13.2 H	141.0 H
		30-60	0.06 L	7.36 H	118.6 M
13.	ZandiCamp	0-30	0.07 L	2.14 L	84.0 M
		30-60	0.09 L	5.37 M	105.0 M
14.	GanayBaba	0-30	0.18 M	17.55 H	369.0 H
		30-60	0.13 M	9.45 H	306.0 H
15.	UrmerBala	0-30	0.21 H	34.2 H	470.0 H
		30-60	0.07 L	4.70 M	115.0 M
16.	GulAbad	0-30	0.14 M	12.5 H	106.0 M
		30-60	0.09 L	4.94 M	75.5 M
17.	LandiArbab	0-30	0.07 L	6.82 M	164.0 H
		30-60	0.10 M	2.79 L	143.3 H
18.	Manacro	0-30	0.12 M	11.7 H	111.0 M
		30-60	0.14 M	7.63 H	105.4 M
	Min	0-30	0.07	1.58	78.95
		30-60	0.06	0.97	66.8
	Max	0-30	0.31	34.26	827.4
		30-60	0.17	28.46	437.9
	Mean	0-30	0.18	11.82	219.2
		30-60	0.11	6.85	135.2
	S.D	0-30	0.14	0.81	214.3
		30-60	0.03	6.43	93.6
	C.V (%)	0-30	79.00	74.5	97.7
		30-60	28.7	93.8	69.2

L, M, and H stand for low, medium and high respectively.

Table 3. AB-DTPA extractable Cu, Fe, Zn and Mn in surface (0-30 cm) and subsurface soils (30-60 cm).

S. No.	Name of area	Depth (cm)	Cu	Fe	Zn	Mn
			mg kg^{-1}			
1.	Nahaqi	0-30	3.43 H	12.98 H	0.37 L	15.54 H
		30-60	2.40 H	11.59 H	0.22 L	9.67 H
2.	Daudzai	0-30	4.20 H	8.21 H	0.64 L	9.92 H
		30-60	1.56 H	6.13 H	0.10 L	4.94 H
3.	ShinwarTown	0-30	9.82 H	10.02 H	2.35 H	20.35 H
		30-60	10.81 H	10.58 H	1.94 H	26.65 H
4.	Muhammadzai	0-30	12.66 H	11.28 H	1.60 H	24.45 H
		30-60	13.03 H	10.91 H	1.76 H	16.33 H
5.	Jaba	0-30	7.88 H	5.89 H	1.84 H	20.34 H
		30-60	6.66 H	5.64 H	0.61 L	22.00 H
6.	Jalabela	0-30	4.46 H	8.86 H	0.91 L	19.78 H
		30-60	3.13 H	10.03 H	0.29 L	20.06 H
7.	PakhaGulam	0-30	6.67 H	8.42 H	0.06 L	9.82 H
		30-60	4.85 H	6.91 H	0.35 L	20.60 H
8.	LandiArgajoon	0-30	8.94 H	8.9 H	1.93 H	16.13 H
		30-60	8.71 H	9.39 H	1.61 H	22.72 H
9.	ImranAbad	0-30	18.1 H	7.92 H	3.93 H	9.95 H
		30-60	18.06 H	9.67 H	4.15 H	21.80 H
10.	Mamakhail	0-30	2.95 H	2.34 M	1.02 M	20.94 H
		30-60	2.87 H	2.82 M	0.47 L	22.71 H
11.	Wakelkala	0-30	2.46 H	3.29 M	0.49 L	16.23 H
		30-60	1.31 H	2.85 M	0.12 L	9.49 H
12.	Zandai	0-30	5.36 H	9.88 H	3.52 H	22.56 H
		30-60	5.06 H	8.19 H	3.38 H	22.20 H
13.	ZandiCamp	0-30	3.33 H	5.08 H	2.82 H	22.95 H
		30-60	5.34 H	10.04 H	3.87 H	21.70 H
14.	GanayBaba	0-30	4.00 H	6.81 H	0.25 L	20.36 H
		30-60	3.03 H	4.52 H	1.05M	18.50 H
15.	UrmerBala	0-30	6.99 H	9.76 H	2.87 H	20.00 H
		30-60	5.19 H	7.46 H	1.14 M	23.3 H
16.	GulAbad	0-30	3.69 H	5.8 H	1.06 M	17.95 H
		30-60	4.42 H	7.73 H	0.54 L	15.49 H
17.	LandiArbab	0-30	19.2 H	8.38 H	4.06H	20.34 H
		30-60	8.24 H	9.02 H	1.45 M	22.08 H
18.	Manacro	0-30	8.02 H	12.91 H	1.71H	21.51 H
		30-60	9.00 H	12.71 H	1.89 H	22.89 H
	Min	0-30	2.46	2.34	0.06	9.82
		30-60	1.31	2.82	0.10	4.94
	Max	0-30	19.25	12.98	4.05	24.40
		30-60	18.06	12.71	4.15	26.65
	Mean	0-30	7.34	8.15	1.74	18.27
		30-60	6.31	8.12	1.38	19.07
	S.D	0-30	4.96	2.92	1.27	4.51
		30-60	4.37	2.87	1.27	5.75
	C.V (%)	0-30	67.50	35.8	72.8	24.60
		30-60	69.20	35.3	92.2	30.10

L, M and H stand for low, medium and high respectively.

Soil chemical properties

Soil pH, EC and organic matter: Soil pH ranged from a minimum of 7.50 at Wakel Kala to a maximum of 8.52 at Daud zai, with a mean value of 7.94 in surface soil while it ranged from a minimum of 7.68 at Zandi Camp to the maximum of 8.35 at Jalabela, with a mean value of 7.99 in sub surface soil (Table 1) . These results showed that pH of the study area were alkaline in nature. Variation in pH was relatively greater in surface soil than sub-surface soil .Similar results were obtained by Rashid *et al*., (2008). The soil of Peshawar valley are slightly to strongly calcareous with neutral to strongly alkaline reaction, having pH from 7.2 to 9.1 (Anon., 1973).

Electrical conductivity ranged from a minimum of 0.13 dSm^{-1} at Pakha Gulam to a maximum of 0.56 dSm^{-1} at Urmer Bala in surface soil while it ranged from 0.11 dSm^{-1} at Pakha Gulam to a maximum of 0.45 dSm^{-1} at Jalabela in sub surface soil (Table 1). The mean value was 0.25 dSm^{-1} in surface soil while it was 0.20 dSm^{-1} in sub surface. Standard deviation was greater in surface soil than sub surface soil. These results were similar to that of Qureshi *et al*., (2007) who reported that these soils have low content of soluble salts and there is no danger of salinity. Hernandez *et al*., (1993) reported that the drainage water is characterized by its alkalinity, which allows a reduction in the solubility of heavy metals. The co-efficient of variation was a little bit greater in surface soil than sub-soil.

Organic matter ranged from 0.51% at Nahaqi to 2.17% at Jaba in surface soil while it ranged from a minimum of 0.20% at Mama Khail to a maximum of 1.82% at Manacro in sub surface.Organic matter was high at Jaba,Urmer Bala and Manacro in surface soil, while the rest of the samples ranged from low to medium, being medium in 55 % samples in both the depths as shown in Table 1.The results were similar to that of Bhatti *et al*., (1998). Co-efficient of variation was higher in sub surface than surface. These variations in the organic matter content might be due to the addition of different quantities of domestic sewage, industrial waste and storm water at different sites. Low organic matter might be due to restricted application of FYM and the warmer climate of the area. The fact that largest source of organic matter is crop residue but un-fortunately in Pakistan and many other developing countries, negligible amount of crop residue is left in field after crop harvest especially of wheat and rice. The crop residue is either used to feed animals, to make paper or use as a fuel (Kauser, 1996). In developed countries, crop residues are disposed off by burning in the fields to facilitate straw disposal, seed bed preparation and weed control (Biederbeck *et al*., 1980).

Soil fertility status

Total nitrogen, AB-DTPA extractible P, K: Total nitrogen ranged from 0.07% at Zandi Camp to 0.31% at Daud Zai in surface soil while it ranged from a minimum value of 0.06% at Zandai and maximum value of 0.17% at Landi Argajoon in sub surface soil. Total nitrogen was adequate at Daud Zai and Urmer Bala in surface soil, while the rest ranged from low to medium, being medium in 61 % samples in surface soil and 55% samples in subsurface soil as shown in Table 2 when values were compared with Sillanpaa (1982). Standard deviation was 0.14 in surface soil and 0.03 in subsoil. Coefficient of variation was much higher in surface soil than sub-surface soil samples. The results were similar to that of Jung *et al*., (2005). Mitra & Gupta (1999) reported that enrichment with organic matter, nitrogen and phosphorous was comparatively higher in sewage irrigated soil as compared to the tube well irrigated soil.

AB-DTPA extractable phosphorous ranged from 1.58 mg/kg at Nahaqi to 34.26 mg/kg at Urmar Bala in surface soil while the soil at Nahaqi showed a minimum value of 0.97 mg/kg and soil at Imran Abad showed a maximum value of 28.46 mg/kg in sub-surface soil. AB-DTPA extractable P was found deficient, medium and adequate in 27, 11 and 61% samples respectively in surface soil while it was found deficient, medium and adequate in 33, 22 and 44% samples respectively in subsurface soil when compared with the values reported by Soltanpour (1985) as shown in Table 2. Standard deviation was 8.81 in surface soil and it was 6.43 in sub surface, showing a wide range of variations in samples in both the surfaces. Coefficient of variation was 74.5% in surface soil and it was 93.8% in sub surface (Table 2). The results were similar to that of Rehman *et al*., (1993) and Rashid & Bhatti (2005).

AB-DTPA extractable potassium ranged from 78.95 mg kg^{-1} at Nahaqi to 827.4 mg kg^{-1} at Daud Zai in the surface soil while it ranged from a minimum of 66.8 mg kg^{-1} at Nahaqi to a maximum of 437.9 mg kg^{-1} at Jaba in sub surface. Standard deviation value was 214.3 in surface soil and 93.6 in sub surface soil. This showed great variation in values of samples. Coefficient of variance was higher in surface soil than sub surface soil. Data showed that there was no deficiency of potassium in surface as well as in sub surface soil, being adequate in 55% samples in surface soil and 33% samples in subsurface soil (Table 2). These results were similar to the report of Ahmad *et al*., (2008) according to which the two primary soil minerals, the micas and feldspars (orthoclase) form bulk of soil K reserves (Al-Rawi & Al-Mohammidi, 1979). The sand fraction of the alluvial soils of Pakistan are mainly composed of quartz; feldspars and biotite mica. The granite and granodiorite derived soils have lesser mica and greater Ca-feldspar and chlorite in sand. The silt fractions are mainly composed of quartz, mica and chlorite. The moderately weathered silt has lower biotite than muscovite The less weathered alluvial soils contain the highest K both in sand and silt. The soils derived from shale, sandstone and limestone have the lowest extractable K. The granite and granodiorite derived soils contain an intermediate amount of extractable K (Awan *et al*., 1998).

Soil AB-DTPA extractable Cu, Fe, Zn, Mn: AB-DTPA extractable Cu ranged from 2.46mg kg^{-1} at Wakelkala to 19.25mg kg^{-1} at Landi Arbab in the surface soil while it ranged from 1.312mg kg^{-1} at Wakelkala to 18.06 mg kg^{-1} at Imran Abad in the sub surface soils. Cu was found adequate in all the samples as compared with the values of Soltanpour (1985). Co-efficient of variation in both surfaces were not much more different from each other, as mentioned in Table 3. The results were similar to that of Rashid *et al*., (2008). Ahumada *et al*., (1999) stated that untreated waste water application increased Cu concentration in the soils.

AB-DTPA extractable Fe ranged from 2.34mg kg^{-1} at Mama Khail to 12.98mg kg^{-1} at Nahaqi in the surface soil while it ranged from 2.82 mg kg^{-1} at Mama Khail to 12.71 mg kg^{-1} at Manacro in sub surface soil. AB-DTPA extractable Fe was found adequate in 88% samples and medium in 11% samples in both the depths when compared with the standard values (Soltanpour, 1985). Coefficient of variation was same in both the surfaces, as shown in Table 3. The result was similar to that of Rizvi *et al*., (1995). According to Al-Ogaily *et al*., (1999) while studying the disposal of sewage waste from the city of Al-Riyadh the pH of the water was alkaline, very hard with high level of total dissolved solids having lower concentration of heavy metal than soil, plants and fish. The amount of heavy metals in the water was lower than the amount in the soil, plants and fish. The maximum concentration of heavy metals was found in the soil. Overall, Fe the highest concentration, followed by Zn, Co, Cu, Cr and Pb, Ag, Cd, and Ni showed the lowest concentrations.

AB-DTPA extractable Zn ranged from 0.058 mg kg^{-1} at Pakha Gulam to 4.05 mg kg^{-1} at Landi Arbab in surface soil while it ranged from 0.098 mg kg^{-1} at Daud Zai to 4.15 mg kg^{-1} at Imran Abad in sub surface soil. AB-DTPA extractable Zn was found deficient, medium and adequate in 33, 11 and 55% samples respectively in surface soil while it was found deficient, medium and adequate in 44, 16 and 38% samples respectively in subsurface soil when compared with the published standard values of Soltanpour (1985) as mentioned in Table 3. Standard deviation was 1.27 in both the depths. Coefficient of variation was greater in sub surface soil than surface soil, as mentioned in Table 2. The result was similar to that of Ayed & Chaudary (1989). According to Jiang *et al*., (2000) who surveyed two adjacent sites of a landfill in one having been irrigated with leachate for two years and the adjacent site having not received leachate, to assess the accumulation of Cu ,Zn. Pd and Cd in soil and plants after landfill leachate irrigation.. The results showed that all heavy metals measured, showed accumulation through out profile at the 0.05 level of significance except Zn. There was evidence of Zn accumulation only in the 0-20 cm upper layer.

AB-DTPA extractable Mn ranged from 9.82 mg kg^{-1} at Pakha Gulam to 24.4 mg kg^{-1} at Muhammad Zai, in surface soil while it ranged from 4.936 mg kg^{-1} at Daud zai to 26.65 mg kg^{-1} at Shinwar Town in sub surface soil. The average value was 18.27 mg/kg in surface soil while it was 19.07 mg kg^{-1} in sub surface soil. Standard deviation was 4.51 in surface soil and 5.75 in subsurface soil, as mentioned in table 3. The results were similar to that of Rizvi *et al*., (1995) who reported that Mn was found adequate in all the samples as compared with the values of Soltanpour (1985) as mentioned in Table 3. Green *et al*., (2003) reported that increases in total electrolyte concentration during reduction indicate that this may be the result of displacement of exchangeable metals by Mn following reductive dissolution of Mn oxides.

Conclusions

The pH of all soil samples in both the depths was alkaline in nature and was non saline while the organic matter was found adequate in 16% samples and total nitrogen was found adequate in 11% samples only in surface soil and the rest of samples were mostly in medium range in both the depths. Thus, it is recommended that farmyard manure green manure and crop residues should be incorporated in soil continuously for a long period of time to overcome deficiency of organic matter in the whole area. Nitrogen fertilizer should be applied in recommended dose and also grow leguminous crop etc., to overcome nitrogen deficiency in the whole area. The data showed that there was a great variation in soil AB-DTPA extractable P and Zn ranging from deficient to adequate in both the depths, being adequate in surface soil as compared to sub surface soil, while there was no deficiency of AB-DTPA extractable K in both the depths. AB-DTPA extractable Fe was found adequate in 88% samples in both the depths. Cu and Mn were adequate in all the samples. Hence it is recommended that areas which are deficient in P, Zn, and Fe should be fertilized with variable rate of respective fertilizers. Periodic soil testing should be adopted to understand the current fertility status of soil and maintain it in future.

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