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EXPLORING THE MACRO AND MICRO NUTRIENTS STATUS OF SOILS IN DIFFERENT TEHSILS OF FAISALABAD USING CADASTRAL MAP

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ABSTRACT

Background Rapid industrialization and urbanization have severely affected the agriculture of Pakistan, especially in industrial areas. Faisalabad is considered as the hub of agriculture and textile industry in Punjab where mixed cropping system is usually practiced. The intensive cropping has resulted in the depletion of overall soil fertility. The present study was carried out to understand the overall fertility status in terms of macro and micro nutrients along with various factors affecting their availability in soils of district Faisalabad, Punjab, Pakistan.

Methodology The soil samples were collected grid-wise using cadastral map of the study area, and analyzed for the physico-chemical properties including pH, electrical conductivity (EC), organic matter (OM), available phosphorous (P) and potassium (K). Available micronutrients such as iron (Fe), manganese (Mn), zinc (Zn), copper (Cu) and boron (B) were also determined using standard methods.

Results Majority of the soil samples had shown EC less than 4 (98.9%), pH slightly basic (52.5%), low organic matter (53.6%) and satisfactory level of P (58.7%) and K (76.1%). In case of micronutrients, 42.67, 14.49, 93.31. 73.02 and 22.94% soil samples showed deficient level of Zn, Cu, Fe, Mn and B, respectively.

Conclusion The study could provide a guideline to the researchers for recommending adequate and balanced doses of fertilizers to the local farmers of district Faisalabad, Punjab, Pakistan. Furthermore, these findings also suggested that the application of chemical fertilizers is essential to get better growth and yield of crops on sustained basis.

INTRODUCTION

Soil fertility and productivity is greatly dependent on the availability of macro and micro nutrients in the soil. Artificial fertilization is necessary to maintain the adequate level of soil fertility for the better crop yield and productivity. In Pakistan, mostly fertilizers are applied in an imbalanced way that results in decreased crop yield and reduces the fertilizer use efficiency as well. Faisalabad district lies between latitude and longitude 31.3235° N, 73.1822° E, respectively featuring a semi–arid climate (BWh) in Köppen-Geiger classification with very hot and humid summers and dry cool winters. The average maximum and minimum temperatures in the month of June are 40.5°C and 26.9°C, respectively. The soils of Faisalabad district have been formed as a result of weathering of alluvial sediments that have deposited mainly by Chenab River in southern part of the district. These soils are comprised of silt, clay and sand in varying proportions that are accumulated by braided tributaries of Indus River system resulting into silt loams or very fine sandy loam having a weak subsoil structure with common kankers within the depth of five feet (Kamal et al. 2015).

Like other parts of Pakistan, soils of this district have also been exhausted due to continuous cropping along with poor management practices. In addition, to salinity, improper use of chemical fertilizers is a major contributing factor for low crop productivity in

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Pakistan (Khan 1998; Muneeb et al. 2016). Generally, the soils in Pakistan are low in organic matter, nitrogen (N) and available P (Azam 1998). It has been reported that about 81% soils are deficient both in organic matter and P (Pervaiz et al. 2002). Green manuring maintains and improves soil structure by the addition of organic matter and minimizing the N, P and K losses in all types of soils (Gill et al. 1998).

Availability of both macro and micro nutrients to crop plants is a key factor for better crop production. For this, chemical fertilizers have proven to play a pivotal role in improving the overall crop production. However, the fertility status of soil varies with nature of cropping system, management practices and soil type (Hussain et al. 2011). Therefore, assay of fertility status is essential for balanced fertilization to ensure better return from different crops to boost up the economic conditions of the farmers (Haq et al. 2001; Kamal et al. 2015).

Among different techniques used for the determination of soil fertility status, soil tests provide the most reliable and accurate evidences for nutrient status and phytoavailability (Khattak and Hussain 2007). In addition, soil testing is rapid, economical and quick method for evaluation of soil fertility, and afterward proper fertilizer recommendations to farmers (Zaka et al. 2004). Therefore, this study was designed to assess the overall nutrient status of soil in different tehsils of Faisalabad district, and provide a base line to the researchers and farmers for site–specific crop nutrition management.

MATERIALS AND METHODS

Faisalabad district was divided into five zones and named on tehsil names i.e. Faisalabad, Jaranwala, Jhumra, Samundri and Tandlianwala (Figure 1). A total of 8343 soil samples were collected from different sampling zones through grid sampling method (on the basis of farmers selected (Table 1) following the cadastral map of study area during year 2017–18. Soil analysis was carried out in the Soil and Water Testing Laboratory, Ayub Agriculture Research Institute (AARI), Faisalabad, Pakistan. For the sample preparation, soil was air dried, ground and analyzed for various physico–chemical properties of soil after passing through 2 mm sieve (Zaka et al. 2004). Soil texture was determined using method described by Bouyoucos (1962).

Soil reaction (pH) and EC were measured on a 1:10 soil–water suspension using a calibrated pH and EC meter, respectively (Malik et al. 1984). Organic matter content were determined using the procedure described by Nelson and Sommers (1982). Extractable K extracted in ammonium acetate (1M, pH 7.0) and determined by Flamephotometer (Perkin Elmer Model No. 2380). Available P extracted with 0.5M NaHCO3 (pH 8.5) followed by colorimetric method as described by Watanabe and Olson (1965). P and B were determined by Spectrophotometer [Spectronic Lmbda (λ) 35]. To compute the total salt index, the EC 1:10 was converted to ECe by multiplying with the factor of saturation percentage as described by US Salinity Lab. Staff (1954). For micro nutrients determination, ammonium bicarbonate diethylene triamine penta acetic acid was used to take the soil extracts (Soltanpour 1985) and used to determine Cu, Fe, Mn and Zn by Atomic Absorption Spectrophotometer (Perkin Elmer Model No. 2380). The soil test values were interpreted using the soil evaluation indices proposed by Malik et al. (1984) and Abrol et al. (1988).

Table 1 Total number of soil sample analyzed from different tehsils of Faisalabad

Sr. #	Depth (cm)	Sampling zone	Total soil samples
1	0–15	Faisalabad	3085
2	0–15	Jaranwala	1654
3	0–15	Jhumra	991
4	0–15	Samundari	1366
5	0–15	Tandlianwala	1247
Grand total			8343

RESULTS

From the five tehsils of district Faisalabad, 8343 soil samples (Faisalabad 3085, Jaranwala 1654, Jhumra 991, Samundari 1366 and Tandlianwal 1247 samples) were collected and analysed (Table 1). Overall, the data regarding different soil parameters including physico-chemical characteristics such as soil texture, EC, pH, organic matter, P, K, and micro nutrients (Zn, Cu, Fe, Mn and B) is presented in Table 2. It was found that 86.97% soil samples have loamy, 10.79% clay loam and 2.24% sandy loam texture. More than 98% soil samples were non-saline, 0.96% moderately saline, 0.04% highly saline and 0.02% very highly saline. For pH, 14.81% samples were neutral, 52.51% slightly basic, 23.82% highly basic and 8.61% sodic. Khattak et al. (2007) reported that salinity/sodicity might be due to the use of brackish water for irrigation purposes. In case of organic matter, 53.66% soil samples showed poor organic matter content, 44.43% satisfactory and 1.91% adequate. Rehman et al. (1995) had reported similar results for analysis of soil, where they found that 84% of soil samples were deficient in organic matter and P, whereas less than 12% samples were with adequate level of P. Likewise,

Figure 1 An over view of map of district Faisalabad

36.81% showed poor P, 58.70% satisfactory and 4.59% adequate P. Possible factors behind the low P concentration might be the low organic matter contents, high soil pH, soil texture and calcareousness nature of soil (Rashid et al. 2008). In case of K, 18.19% soil samples showed poor K, 76.14% satisfactory and 5.67% adequate K. In case of micro nutrients, Zn was deficient in 42.67% samples, satisfactory 47.90% and adequate 9.40%, Cu 14.49% deficient, 49.98% satisfactory and 35.53% adequate, Fe 93.31% deficient, 6.36% satisfactory and 0.32% adequate, Mn 73.02% deficient, 23.86% satisfactory and 3.12% adequate, and B 22.94% deficient, 54.11% satisfactory and 22.95% adequate.

Data presented in Table 3 indicated soil characteristics in different tehsils of Faisalabad district. It was found that 97.99, 0.19 and 1.82% samples in Faisalabad tehsil, 64.81, 34.10 and 1.09% in Jaranwala. 95.76. 0.10 and 4.10% in Jhumra, 95.24, 0.00 and 4.76% in Samundari and 73.06, 26.38 and 0.56% in Tandlianwala had loamy, clay loam and sandy loam texture, respectively. Likewise, 98.57, 1.39, 0.03 and 0.00% in Faisalabad tehsil, 98.49, 1.27, 0.12 and 0.12% in Jaranwala. 99.90, 0.10, 0.00 and 0.00% in Jhumra, 100, 0.00, 0.00 and 0.00% in Samundari and 98.8, 1.20, 0.00 and 0.00% in Tandlianwala were non-saline, moderately saline, highly saline and very highly saline, respectively. In case of pH 0.13, 5.90, 88.62, 5.32 and 0.03% in Faisalabad tehsil, 0.18, 0.06, 6.47, 57.50 and 35.85% in Jaranwala. 0.40, 0.10, 8.68, 78.20 and 12.61% in Jhumra, 0.07, 5.12, 87.70, 7.10 and **0.00%** in Samundari, and 0.72, 78.75, 20.53, 0.00 and 0.00% in Tandlianwala were acidic, neutral, slightly basic, highly basic and sodic, respectively. With respect to

Table 2 Overall average physico–chemical properties and nutrient status of soils in Faisalabad district

Soil properties	**Remarks**	**Reference value**	**Number of soil samples** (n= 8343)	**Percentage**
EC (dS m^{-1})	N	<4	8258	98.98
	MS	4–8	80	0.96
	HS	8–12	3	0.04
	VHS	>12	2	0.02
Soil pH	A	<7.0	21	0.25
	NT	7.0–7.5	1236	14.81
	SB	7.5–8.0	4381	52.51
	HB	8.0–8.5	1987	23.82
	S	>8.5	718	8.61
Soil organic matter (%)	P	<0.86	4477	53.66
	SF	0.86–1.29	3707	44.43
	AQ	>1.29	159	1.91
Soil P (mg kg^{-1} soil)	P	0–8	3071	36.81
	SF	8.0–15.0	4897	58.70
	AQ	>15	375	4.49
Soil K (mg kg^{-1} soil)	D	<80	1518	18.19
	SF	81–180	6352	76.14
	AQ	>180	473	5.67
Soil texture	L		7256	86.97
	CL		900	10.79
	SL		187	2.24
Soil Zn (mg kg^{-1} soil)	D	<0.5	3560	42.67
	SF	0.5–1.0	3996	47.90
	AQ	>1	784	9.40
Soil Cu (mg kg^{-1} soil)	P	<0.1	1209	14.49
	SF	0.1–0.2	4170	49.98
	AQ	>0.2	2964	35.53
Soil Fe (mg kg^{-1} soil)	D	<2	7785	93.31
	SF	2.0–4	531	6.36
	AQ	>4	27	0.32
Soil Mn (mg kg^{-1} soil)	D	<0.5	6092	73.02
	SF	0.5–1.0	1991	23.86
	AQ	>1.0	260	3.12
Soil B (mg kg^{-1} soil)	D	<0.2	1914	22.94
	SF	0.2–0.5	4514	54.11
	AQ	>0.5	1915	22.95

N: Normal, MS: Medium saline, HS: Highly saline, VHS: Very highly saline, A: Acidic, NT: Neutral, SB: Slightly basic, HB: Highly basic, S: Sodic, D: Deficient, SF: Satisfactory, AQ: Adequate, L: Loam, CL: Clay Loam, SL: Sandy Loam

organic matter, 54.20, 43.60 and 2.20% in Faisalabad tehsil, 60.34, 37.67 and 2.00% in Jaranwala. 27.25, 71.04 and 1.72% in Jhumra, 28.26. 68.81 and 2.93% in Samundari, and 92.30, 7.62 and 0.08% in Tandlianwala had poor, satisfactory and adequate level, respectively. Low organic matter contents might be attributed to high summer temperature and low rainfall in this region (Zaka et al. 2004). High temperature resulted in the degradation/break down of the organic matter. This problem was further aggravated by imbalanced use of fertilizer and extensive cropping (Nazif et al. 2006).

In case of available P, 30.11. 68.85 and 1.04% in Faisalabad tehsil, 67.05, 32.83 and 0.12% in Jaranwala. 32.49, 67.41 and 0.10% in Jhumra, 32.81, 67.57 and 0.22% in Samundari, and 21.73, 51.24, and 27.02% in Tandlianwala were deficient, satisfactory and adequate, respectively. These results are in line with the findings of Zaka et al. (2004) who reported that about 65% soil samples collected from semi-arid area of Sargodha district were deficient in P. In case of K, 19.32, 77.67 and 3.01% in Faisalabad tehsil, 21.24, 65.76 and 13.0% in Jaranwala. 17.86, 80.02 and 2.12% in Jhumra, 23.28, 72.91 and 3.81% in Samundari, and 6.34, 86.29 and Jaranwala 17.86, 80.02 and 2.12% in Jhumra, 23.28,

Table 3 Physico-chemical properties and macro nutrient status of soil collected from different tehsils of Faisalabad district

Soil properties		Reference Value	Tehsils of Faisalabad									
			Faisalabad (n = 3085)		Jaranwala (n=1654)		Jhumra (n=991)		Samundri (n=1366)		Tandlianwala (n=1247)	
			TS	Percent	TS	Percent	TS	Percent	TS	Percent	TS	Percent
EC (dS m^{-1})	N	<4	3041	98.57	1629	98.49	990	99.90	1366	100	1232	98.8
	MS	4–8	43	1.39	21	1.27	1	0.10	0	0	15	1.2
	HS	8–12	1	0.03	2	0.12	0	0	0	0	0	0
	VHS	>12	0	0	2	0.12	0	0	0	0	0	0
Soil pH	A	<7.0	4	0.13	2	0.18	5	0.40	1	0.07	9	0.72
	NT	7.0–7.5	182	5.90	1	0.06	1	0.10	70	5.12	982	78.75
	SB	7.5–8.0	2734	88.62	107	6.47	86	8.68	1198	87.70	256	20.53
	HB	8.0–8.5	164	5.32	951	57.50	775	78.20	97	7.10	0	0
	S	>8.5	1	0.03	593	35.85	124	12.61	0	0.00	0	0
Organic matter (%)	P	<0.86	1672	54.20	998	60.34	270	27.25	386	28.26	1151	92.30
	SF	0.86–1.29	1345	43.60	623	37.67	704	71.04	940	68.81	95	7.62
	AQ	>1.29	68	2.20	33	2.00	17	1.72	40	2.93	1	0.08
Soil P (mg kg^{-1} soil)	D	0–8	929	30.11	1109	67.05	322	32.49	440	32.21	271	21.73
	SF	8.0–15.0	2124	68.85	543	32.83	668	67.41	923	67.57	639	51.24
	AQ	>15	32	1.04	2	0.12	1	0.10	3	0.22	337	27.02
Soil K (mg kg^{-1} soil)	D	<80	596	19.32	348	21.04	177	17.86	318	23.28	79	6.34
	SF	81–180	2396	77.67	1091	65.96	793	80.02	996	72.91	1076	86.29
	AQ	>180	93	3.01	215	13.00	21	2.12	52	3.81	92	7.38
Soil texture	L		3023	97.99	1072	64.81	949	95.76	1301	95.24	911	73.06
	CL		6	0.19	564	34.10	1	0.10	0	0.00	329	26.38
	SL		56	1.82	18	1.09	41	4.14	65	4.76	7	0.56

N: Normal, MS: Medium saline, HS: Highly saline, VHS: Very highly saline, A: Acidic, NT: Neutral, SB: Slightly basic, HB: Highly basic, S: Sodic, P: Poor, SF: Satisfactory, AQ: Adequate, L: Loam, CL: Clay Loam, SL: Sandy Loam, TS: Total samples

Table 4 Micronutrients status of soil samples collected from different tehsils of Faisalabad district

Micronutrient		**Reference Value**	**Tehsils of Faisalabad**									
			Faisalabad (n=3085)		**Jaranwala (n=1654)**		**Jhumra (n=991)**		**Samundri (n=1366)**		**Tandlianwala (n=1247)**	
			TS	**Percent**	**TS**	**Percent**	**TS**	**Percent**	**TS**	**Percent**	**TS**	**Percent**
Soil Zn (mg kg^{-1} soil)	D	<0.5	1691	54.81	672	40.63	616	62.16	341	24.96	240	19.25
	SF	0.5–1.0	1200	38.90	711	42.99	275	27.75	922	67.50	888	71.21
	F	>1	194	6.29	271	16.38	100	10.09	100	7.32	119	9.54
Soil Cu (mg kg^{-1} soil)	D	<0.1	731	23.70	141	8.52	52	5.25	182	13.32	103	8.26
	SF	0.1–0.2	1326	42.98	793	47.94	617	62.26	778	56.95	656	52.61
	F	>0.2	1028	33.32	720	43.53	322	32.49	406	29.72	488	39.13
Soil Fe (mg kg^{-1} soil)	D	<2	2816	91.28	1627	98.37	886	89.40	1267	92.75	1189	95.35
	SF	2.0–4	268	8.69	27	1.63	79	7.97	99	7.25	58	4.65
	F	>4	1	0.03	0	0.00	26	2.62	0	0.00	0	0.00
Soil Mn (mg kg^{-1} soil)	D	<0.5	2441	79.12	1224	74	768	77.50	879	64.35	780	62.55
	SF	0.5–1.0	585	18.96	384	23	206	20.79	423	30.97	393	31.52
	F	>1.0	59	1.91	46	3	17	1.72	64	4.69	74	5.93
Soil B (mg kg^{-1} soil)	D	<0.2	1044	33.84	247	15	278	28.05	40	2.93	305	24.46
	SF	0.2–0.5	1440	46.68	734	44	447	45.11	1029	75.33	864	69.29
	F	>0.5	601	19.48	673	41	266	26.84	297	21.74	78	6.26

D: Deficient, SF: Satisfactory, AQ: Adequate, TS: Total samples

72.91 and 3.81% in Samundari, and 6.34, 86.29 and 7.37% in Tandlianwala were deficient, satisfactory and adequate, respectively. Reasons behind sufficient K might be the use of canal and tube well irrigation water containing 5-6 ppm and 3-4 ppm K, respectively (Arif et al. 2006).

Table 4 indicated the tehsil wise status of micro nutrients status in Faisalabad district. For Zn, 54.81, 38.90 and 6.29% in Faisalabad tehsil, 40.63, 42.99 and 16.38% in Jaranwala. 62.16, 27.75 and 10.09% in Jhumra, 24.96, 67.50 and 7.32% in Samundari, and 19.25, 71.21 and 9.54% in Tandlianwala were deficient, satisfactory and adequate, respectively. For Cu, 23.70, 42.98 and 33.32% in Faisalabad tehsil, 8.52, 47.94 and 43.53% in Jaranwala. 5.25, 62.26 and 32.49% in Jhumra, 13.32, 56.95 and 29.72% in Samundari, and 8.26, 52.61 and 39.13% in Tandlianwala were deficient, satisfactory and adequate, respectively. For Fe, 91.28, 8.69 and 0.03% in Faisalabad tehsil, 98.37, 1.63 and 0.00% in Jaranwala. 89.40, 7.97 and 2.62% in Jhumra, 92.75, 7.25 and 0.00% in Samundari, and 95.35, 4.65 and 0.00% in Tandlianwala were deficient, satisfactory and adequate, respectively.

For Mn, 79.12, 18.96 and 1.92% in Faisalabad tehsil, 74.0, 23.0 and 3.0% in Jaranwala. 77.50, 20.79 and 1.71% in Jhumra, 64.35, 30.97 and 4.68% in Samundari, and 62.55, 31.52 and 5.93% in Tandlianwala were deficient, satisfactory and adequate, respectively. For B, 33.84, 46.68 and 19.48% in Faisalabad tehsil, 15.0, 44.0 and 41.0% in Jaranwala. 28.05, 45.11 and 26.84% in Jhumra, 2.93, 75.33 and 21.74% in Samundari, and 24.46, 69.29 and 6.25% in Tandlianwala were deficient, satisfactory and adequate, respectively. Low availability of micro nutrients in soil might be attributed to nutrient fixation due to calcareous nature of soil, parent material, high soil pH, use of plant stubbles as hay, burning of stubbles, less use of farmyard and green manure by the farmers (Azhar et al. 2007; Khattak and Hussain, 2007; Akram et al. 2014; Dahar et al. 2014; Iqbal et al. 2016; Sarfraz et al. 2016). Muneeb et al. (2017) reported higher nutrient availability in soil at slightly acidic to neutral pH owing to less precipitation/fixation.

CONCLUSION

Soils of Faisalabad district exhibited low organic matter content and normal level of salinity and sodicity. Majority of the soils were deficient in micro and macronutrients. Therefore, organic/inorganic fertilization could be suggested to improve the nutritional status of soil and crop productivity.

REFERENCES

Abrol IP, JSP Yadav, FI Massoud (1988) Salt-affected soils and their management. Food and Agriculture Organization, In: Proc. Second World Congress. International Water Resources Association, New Delhi, India, pp 335–342.

Akram Z, S Hussain, M Mansoor, M Afzal, A Waqar, I Shabbir (2014) Soil fertility and salinity status of Muzaffargarh district, Punjab Pakistan. *Universal Journal of Agricultural Research*, **2:** 242–249.

Arif M, MA Chohan, S Ali, R Gul, S Khan (2006) Response of wheat to foliar application of nutrients. *Journal of Agricultural and Biological Science*, **1:** 30–34.

Azam F (1998) Studies on organic matter fractions of some agricultural soils of Pakistan. *Sarhad Journal of Agriculture*, **4:** 355–365.

Azhar N, MY Ashraf, MU Shirazi, MA Khan, MA Parvez, S Ahmad (2007) Studies on soil and plant micronutrients relationship of mango orchards in Hyderabad district of Pakistan. Proceedings of International Symposium on Prospects of Horticultural Industry in Pakistan, Institute of Horticultural Sciences, University of Agriculture, Faisalabad.

Bouyoucos GJ (1962) Hydrometer method improved for making particle size analysis of soils. *Agronomy Journal*, **54:** 464–465.

Dahar GJ, PA Baloch, BA Abro (2014) Distribution of micronutrients in different soil series around Tando Jam, Sindh, Pakistan. *Science, Technology and Development*, **33:** 7–13.

Gill KH, J Iqbal, SA Sherazi, AA Sheikh (1998) Combined effect of green manuring and NPK application on paddy production. *Pakistan Journal of Soil Science*, **14:** 32–35.

Haq I, H Rahman, BH Niazi, M Salim (2001) Effect of horizontal flushing on the reclamation of sodic soils and yield of fodder crops after gypsum application. *International Journal of Agriculture and Biology*, **3:** 323–325.

Hussain J, Najeeb Ur Rehman, AL Khan, H Hussain, A Al-Harrasi, L Ali, F Sami, ZK Shinwari (2011) Determination of macro and micronutrients and nutritional prospects of six vegetable species of Mardan, Pakistan. *Pakistan Journal of Botany*, **43:** 2829–2833.

Iqbal MM, H Rehman, G Murtaza, T Naz, W Javed, SM Mehdi, S Javed, AA Sheikh (2016) Transformation and adsorption of lead as affected by organic matter and incubation time in different textured salt-affected soils. *Journal of Environment Agriculture*, **1(2):** 140–145.

Kamal MA, MU Arshad, SA Khan, BA Zaidi (2015) Appraisal of geotechnical characteristics of soil for different zones of Faisalabad, Pakistan. *Pakistan Journal of Engineering and Applied Sciences*, **17:** 1–10.

Khan GS (1998) Soil salinity/sodicity status in Pakistan. Soil Survey of Pakistan. P. 59.

Khattak GK, IU Haq, A Malik, MJ Khattak, Naveed-

ullah (2007) Effect of various levels of gypsum application on the reclamation of salt affected soil grown under rice followed by wheat crop. *Sarhad Journal of Agriculture*, **23:** 675–680.

Khattak RA, Z Hussain (2007) Evaluation of soil fertility status and nutrition of orchards. *Soil and Environment*, **26:** 22–32.

Muneeb A, I Ahmad, A Ghani, M Ibrar, MA Sultan, M Iftikhar, R Kausar (2017) Nutrients availability in relation to spatio-temporal variations in soil properties of Vanhar Valley, Punjab, Pakistan. *Journal of Environment Agriculture*, **2(1)**: 166-172.

Malik DM, MA Khan, TA Chaudhry (1984) Analysis manual for soils, plants and waters. Rapid Soil Fertility Survey and Soil Testing Institute, Lahore, Pakistan. pp 56.

Nazif W, S Perveen, I Saleem (2006) Status of micronutrients in soils of district Bhimber (Azad Jammu and Kashmir). *Journal of Agricultural and Biological Science*, **1:** 35–40.

Nelson DW, LE Sommers (1982) Total carbon, nitrogen and organic matter. In: Page AL, Miller RH, Keeney DR (eds.). Methods of soil analysis. Part 2. Chemical and Microbial Properties. ASA and SSSA, Madison Wisconsin, USA, pp 539-579

Pervaiz Z, SSH Kazmi, KH Gill, M Mukhtar (2002) Soil fertility and salinity status of Gujrat district. *Pakistan Journal of Soil Science*, **21:** 11–14.

Rashid M, AU Bhatti, F Khan, Wasiullah (2008) Physico–chemical properties and fertility status of soils of district Peshawar and Charsadda. *Soil and Environment*, **27:** 228–235.

Rehman OU, KH Gill, MR Raja, A Hussain, GM Din (1995) Soil fertility and salinity status of Attock district. *Sarhad Journal of Agriculture*, **11:** 355–362.

Sarfraz M, SM Mehdi, M Ilyas, MA Qureshi, A Naz, M Ehsan, MA Zaka (2016) Response of wheat (Triticum aestivum L.) to NPK nutrition in gypsum amended saline-sodic soil. *Journal of Environment Agriculture*, **1(2)**: 120−127.

Soltanpour PN (1985) Use of AB-DTPA soil test to evaluate elemental variability and toxicity. *Communications in Soil Science and Plant Analysis*, **16:** 323–338.

US Salinity Lab Staff (1954) Diagnosis and improvement of saline and alkali soils. In: USDA Handbook No. 60. US Govt. Printing Office, Washington, DC, USA.

Watanabe FS, SR Olson (1965) Test of an ascorbic acid method for determining phosphorus in water and $NaHCO_3$ extracts from soil. *Soil Science Society of America Proceedings*, **29:** 677–678.

Zaka MA, N Hussain, G Sarwar, MR Malik, KH Gill (2004) Fertility status of Sargodha District soils. *Pakistan Journal of Scientific Research*, **56:** 69–75.