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Physiochemical Characteristics of Some Important Soil Series of Dargai Khyber Pakhtunkhwa Pakistan

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Abstract

From assessing the fertility status of soil, 20 soil samples were collected from different location of district Dargai area and analyzed in the laboratory of Soil and Environmental Sciences Department, the University of Agriculture-Peshawar. The soil samples were found medium in texture. Almost all soils have alkaline PH, and from moderately to strongly calcareous. The organic matter content was in the range of marginal and deficient. AB-DTPA extractable P was deficient in 11 soil samples, while adequate in 3 soil samples and marginal in 4 soil samples. The K content is deficient in 13 soil samples while 7 soil samples were marginal.

The data collected from physical and chemical analysis of soil samples were statistically analyzed by using standard statistical procedure as described by Steel and Terrie [1].

The result obtained showed that there were significant differences among the physico-chemical properties of soil of Dargai. Dargai soils are non-saline in all soil depth and alkaline pH. So the soils of Dargai have texture varied from sandy loam to silt loam. Permanent crop cover must be maintained to reduce this adverse effect. Generally good soil cover is recommended and to amend soil physico-chemical properties micronutrients of soils and selection of proper cropping system is needed for conservation oriented farming. As soil are deficient, particularly in organic matter and phosphorus and micronutrients, therefore FYM and proper fertilizer management is needed to correct nutrients deficiencies [2].

Opinion

It is a well-known recognized fact that nation's economic and social will being is completely dependent upon its natural resources and if a nation is to continue as a prosperous and powerful unit, it must have a complete and an accurate inventory of all his major resources [3]. Amongst all the natural resources, the real wealth and the greatest heritage of a nation is its soil. For maximum production and good quality, it is necessary to supply nutrients in a balance amount, because inadequate supply of nutrient causes serious disorder in vegetables, fruits and cereals. These nutrients may be classified in to macro and micro nutrients. Macro nutrient include N, P and K requires in larger amount, while micro nutrients include Fe, Cu, Zn and Mn requires in small amount [4]. Macro nutrients along with micro nutrients are needed for various physiological functions of vegetables, fruits and cereals. Nitrogen increase growth and development of living tissue of plants. Phosphorous is necessary for cell division, stimulate roots development, seed and fruit development. Potassium increase size of grains or seeds and improve the quality of fruits. In addition, it is also involved in activation of about 60 enzymes [1].

Recently attention has been focused on the role of these micro nutrients and their availability to plant. The vital impact of these elements on the growth of plants cannot be ignored, since they perform important function in plants. Trace elements are involved in the activation of several enzymes, responsible for various physiological functions occurring in plants like chlorophyll and protein synthesis, formation of growth hormones, respiration, oxidation and reduction reaction, carbohydrates breakdown, cell development and protein synthesis [5]. Micro nutrients have not been applied regularly to soil conjunction with common fertilizers which causes in balance between these nutrients as well as individuals elements. If any of the nutrients is not available to plant in proper amount during its life period, they develop deficiency symptoms, like internal bark, misshaped leaves, leaf chlorosis, bright yellow color of leaves and stunted growth [2].

Keeping in view the nutritional importance of these nutrients for fruits, vegetables and cereals, it was through worth to review the general fertility status of soil. Soil is basic natural resources essential for crop production. Through understanding of soil is therefore vital to optimum sustainable crop yield, which is a prerequisite for perpetuation of human communities in ever changing world [6]. Agriculturally, soils are the media supporting plant life and from which plant obtained their mechanical support and the required essential nutrients. Each soil has its own set of physical and chemical properties. The agricultural productivity to a great extent depends on the type of soil and its physical and chemical properties. To bring about useful changes in soil management, a thorough knowledge of these properties of the soil is imperative [7].

Soil physical properties influence germination and emergence of young seedling, root penetration and growth besides effecting movements and of retention water, air, and nutrients [8]. Important management decisions such as type and time of tillage operations and appropriate crop adoption, fertilize application requires knowledge of soil properties. The distribution of soil properties that influence aggregate stability in the landscape can vary as a function of slope position, slope class, and slope aspects. Khan et al. [3] measured a significant difference among the physiochemical properties of top, mid and bottom slope soil. Bulk density of the top slope (1.51 g cm^{-3}) was the highest followed by mid (1.39 g cm-3) and bottom slope (1.32 g cm^{-3}). Conversely, electrical conductivity EC-2.47 ds m-1), phosphorus (3.40 mg kg^{-1}), potassium (118.8 mg kg^{-1}), organic matter content (1.52 %), clay content (20.39 %) and silt content (49.17%) were the highest at bottom slope followed by mid and top slopes, respectively. Soil A, B and C horizon were also significantly ($P < 0.05$) different in their physio-chemical properties. They also measured the horizon Ap had the highest bulk density (1.43 g cm^{-3}) and lower electrical conductivity (1.74 dS m^{-1}), phosphorus (2.29 mg kg-1), potassium(84.86 mg kg^{-1}), organic matter (1.08%), clay (12.83%) and silt content (40.49%) than both the B and C horizons. The deterioration in physio-chemical properties of top slope as compared to mid and bottom slope and that of Ap horizon as compared to B and C horizons were presumed to be due to past soil erosion effect that removed the finer soil particles including soil organic matter and other plant nutrients [9].

Pakistan is an agricultural which consist of 86.90 million ha of land, out of which 20.43 million has are cultivated and 59.48 million has are uncultivated. Furthermore 25% of the cultivated area is rainfall. In dargai generally the soil is fertile. Area of dargai soil is slope and the soil is nonsaline. The research work aim to study the fertility and physico-chemical properties and micronutrients status of the soils of dargai and the purpose is to provide basic information about the soil of dargai area. Moreover basic information will become available to assess the nutrients status of these soils and recommend fertilizer doses. The study will also help to provide suggestion for the restoration of crop productivity of the studied areas. Since no research work is done in past in this area. To determine the effect of slope position on physico-chemical properties and micronutrients status of soils. The collections of actual data for the relationships among physico-chemical properties, micronutrients status and to restore crop productivity of these soils [10].

Objectives

The objective of the present research work is to characterize and evaluate the fertility status of soil.

a) To determine the fertility status of agriculturally important soils of Dargai.

b) To determine the physiochemical properties of Dargai soil.

c) To collect background information of the study area.

Material and Methods

The proposed study was conducted to assess the physiochemical characteristics of some important soil series of Dargai.

Soil Sampling: Twenty representative soil samples were collected from two depth (0-15 and 15-30 cm) from some important soil series from different locations of Dargai i-e (Heroshah, Utmankhel Cham, Muslim Abad, Habib Gul Banda, Saleem Abad, Zarief Shah Baba, Dawa Khan Banda, Sharief Banda, Afzal Bagh, and Palonow) The recorded data were analyzed for chemical and physical characteristics [11].

Soil Analysis: Soils samples thus collected were ground, sieved and prepared for analysis, than these samples were analyzed for various soil properties and extractable micronutrients (Zn ,Cu Fe , Mn) and other properties are Soil pH, EC, Lime content, Organic matter. AB-DTPA extract of soil for phosphorus and AB-DTPA extract of soil for potassium.

Analytical Procedures

Soil pH: Soil pH was determined in 1:5 soil water suspension follow 15 minutes stirring and read on pH meter (glass and calomel electrodes).

Electrical conductivity: Total soluble salt were determined by measuring soil EC. Soil water suspension 1:5 was used to determine the EC of soil using the electrical conductivity meter.

Lime content: 5 gram of soil was treated with 50ml of 0.5N HCL and back treated, in titrated with 0.025N NaOH, using phenolphthalein as indicator by acid- neutralization method.

Organic matter: One gram of soil was treated with 10mL

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of 1N K Cr_2O_7 rand added 20ml of concentrated H_2 SO_4. After cooling, first added 200ml of distilled water then filtrate in 500ml flask. Then add 2-3 drops of Orhophenolphthalei and titrate against 5 N Ferrous sulphate and note the reading each sample respectively. A blank titration was also run along with samples.

Soil texture: Soil texture was determined by the bouyoucos method 1962. In brief 50 g air-dry soil was dispersed with 5ml 10% sodium hexametaphosphate solution in a mechanical dispersion machine for 5 min. After quantitative transfer of the suspension to a 1 litter bouyoucos cylinder. Filling the cylinder with distilled water to 1 litter mark. After through mixing carefully inserted a hydrometer in the suspension and took the hydrometer reading after 40 sec for silt +clay and after 2 hrs. For clay. Also note temperature of the suspension with each hydrometer reading and necessary corrections in hydrometer readings. Percent silt and clay were calculated from hydrometer readings while % sand was calculated by difference, percent sand, silt and clay were used to determine soil textural class on the USDA soil textural Triangle [12].

AB-DTPA Extractable Phosphorous: AB-DTPA extractable phosphorous concentration in soil samples will be determined by extracting it in soil solution as described by Sultan-pour 1985. In this method, 10g of soil was shaken in 20 ml of AB-DTPA solution for 15 minutes in open conical flask. Suspension will be then filtered through Wattman 42 filter paper. Then 2mL of filtrate will be added in 25 ml volumetric flask. Then 3ml of distilled water will be added. After it 5 ml of ascorbic acid mixed indicator will be added and volume will be adjusted up to 25 ml by adding distilled water. These 25 ml bolumetric flask will be placed in dark in dark for development of blue color for 15 minutes. Absorption curve will be developed on spectrophotometer for 0, 2, 4, 6, 8 and 10ug P ml-1 standards which will be then used for calculation of AB-DTPA extractable P in samples [13].

Table 1: Critical values of macronutrient concentration in soil (AB-DTPA extractable N. P and Source: Bhatti (1997) and Sultanpour (1985).

Property	Unit	Low	Medium	High
PAB-DTPA Extractable	mg kg^{-1}	< 4	4-7	>7
KAB-DTPA Extractable	mg kg^{-1}	< 60	60-120	>120

AB-DTPA Extractable potassium: AB-DTPA extractable K was extracted in solution by AB-DTPA is reported by Sultan pour 1985, and was determined by flame photometer. Jenway PF7 as reported by Knudsen et al. 1982 Standard solution (Table 1).

Extractable micronutrients in soil: The concentration of extractable micronutrients (Zn, Cu, Fe, and Mn) in soil was determined by the AB-DTPA extraction procedure. In this method 10g soil sample was shaken with 20 ml AB-DTPA extract in an open Erlenmeyer flask for 15 min. After filtration the extract was read for Zn, Cu, Fe and Mn on an Atomic Absorption Spectrophotometer (Perkin Elmer Analyst-200 USA) (Table 2).

Table 2: Critical values of micronutrient concentration in soil (ug.g^{-1} soil) in AB-DTPA extract (Cu, Fe, Zn, Mn). Sultanpour (1985) and Johnson and Fixen (1990).

Micronutrient	Low	Marginal	Adequate
Zn	< 0.9	0.9-1.5	> 1.5
Cu	< 0.2	0.2-0.5	>0.5
Fe	< 3,0	3.0-5.0	>5.0
Mn	< 0.5	0.5-1.0	>1.0

Results and Discussion

Table 3: Textural classes of the soil samples.

S. No.	Farmer Name	Location	Depth (cm)	%Sand	%Silt	%Clay	Textural Class
1	Abdur Raziq	Hero shah	0-15	43	3.8	53.2	Sandy loam
			15-30	41	3.8	55.2	Sandy loam
2	Raza khan	Utman khel cham	0-15	52	2.8	55.2	Silt loam
			15-30	78	2.8	19.2	Silt loam
3	Ali Muhammad	Muslim Abad	0-15	64	3.8	32.2	Silt loam
			15-30	54	2.8	43.2	Silt loam
4	Hazrat Said	Habibgul Banda	0-15	67	2.8	30.2	Silt loam
			15-30	74	2.8	23.2	Silt loam
5	Safdar Ali	Saleem Abad	0-15	49	3.8	47.2	Sandy loam
			15-30	45	3.8	51.2	Sandy loam
6	Rahmat Zeb	Zarief shah baba	0-15	62	4.8	33.2	Silt loam
			15-30	66	4.8	29.2	Silt loam
7	Faraz	Dawa khan Banda	0-15	38	12.8	49.2	Sandy loam
			15-30	38	4.8	57.2	Sandy loam

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8	Naeem	Sharief Banda	0-15	77.2	3.8	18	Silt loam
			15-30	83	3.8	13.2	Silt loam
9	Sardar	Afzal Bagh	0-15	64	3.8	32.2	Silt loam
			15-30	67	3.8	29.2	Silt loam
10	Naimat shah	Palonow	0-15	62	4.8	35.2	Silt loam
			15-30	66	4.8	29.2	Silt loam

Soil Texture: Soil texture refers to the size of the individual soil particles. Soil particles have different size, depending on the kind of parent rocks and degree of weathering. The particle size diameter ranges are categorized as sand (0.05-2.0 mm), silt (0.002-0.05mm), and clay (<0.002 mm). On the basis of the proportions of these fractions, the soils are divided into twelve textural classes. Results (Table 3) show that seven samples were silt loam and three samples were sandy loam [14].

Table 4: Organic Matter (%) in soil samples.

Depth (cm)	Minimum	Maximum	Mean	S. Deviation
0-15	0.69	1.38	1.009	0.19
15-30	0.62	1.27	0.92	0.23

Organic Matter: Table 4 shows O. M content of soil. In 0-15 cm depth, the O.M ranged from 0.69-1.38 with a mean value of 1.01%, while in 15-30 cm it ranged from 0.62-1.27 % with a mean value of 0.92 %. It shows that O.M on surface soil is greater than subsurface soil; this might be due to more residues on surface soil. The results further suggest that all the samples are marginal to deficient in O.M. (Table 4).

Lime Content: Table 5 shows lime content of soil of surface and subsurface soil. In 0-15cm soil depth lime content ranged from 8.50 to 20 with a mean value of 16.657 % while in 15 to 30 cm soil lime content ranged from 11.75 to 20 % with a mean value of 17.75 %. It was concluded that all the samples were highly calcareous. The lime content increased with increased in soil depth.

Table 5: Lime content (%) in soil samples.

Depth (cm)	Minimum	Maximum	Mean	S. Deviation
0-15	8.05	20	16.65	3.69
15-30	11.75	20	17.17	2.85

Table 6: pH of the soil samples.

Depth (cm)	Minimum	Maximum	Mean	S.Deviation
0-15	7.88	8.14	8.017	0.09
15-30	7.74	8.17	8.027	0.14

Soil pH: The PH value of soil samples collected from different locations 0-15cm and 15-30cm of Dargai valley are given in table 6. The soil sample in 0-15 cm depth ranged from 7.88-8.14 with a mean value of 8.10, while the soil sample collected 15-30cm ranged from 7.74-8.13 with a mean value of 8.02. All soil sample are alkaline in reaction. However, PH is not considered important in categorizing soil as salt affected. Shainberg and Oster reported that PH is not an accepted criterion because it tends to be buffered by soil and most crops can tolerate a wide range of PH. The normal PH range for most crop plants is 6.5 -7.5. University of California committee of consultant, 1994 (Table 6).

Electrical Conductivity (dsm^{-1}): The EC of soil samples from 0-15cm and 15-30cm are shown in table 7. Sample collected from 0-15cm ranged from 0.4-0.45 dSm^{-1} with a mean value of 0.423 dSm^{-1}. While the EC of soil sample 0f 15-30 cm ranged from 0.38-0.47 dSm^{-1} with a mean value of 0.42 ds m^{-1}. The results show that the soils are normal with respect to salinity (Table 7).

Table 7: Electrical Conductivity (dsm^{-1}) of soil samples.

Depth (cm)	Minimum	Maximum	Mean	S.Deviation
0-15	0.39	0.45	0.42	0.01
15-30	0.38	0.47	0.41	0.03

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Table 8: AB-DTPA Extractable Potassium (mg kg-1) content of soil samples.

Depth (cm)	Minimum	Maximum	Mean	S. Deviation
0-15	32.8	93.2	64.96	21.1
15-30	25.4	103.8	51.66	22.7

AB-DTPA Extractable Potassium (mg/kg): Result of k content of soil in surface (0-15 cm depth) and sub–surface (15-30cm) soil is given in table 8. From the table, it can be seen that k content ranged from 32.8 to 93.2 mg kg^{-1} with a mean value of 64.96 mg kg-1 whereas in sub-surface soil (15-30 cm) it ranged from 25.4 to 103.8 mg kg^{-1} with a mean value of 51.74. It can be concluded from these results that there was no constant trend of k content with respect to soil depth that may be due to differences/variation in the present material. The overall result suggests that k content was deficient in all the soils under study and need supplemental k as fertilizer for profitable crop production. Similar results were given by sulthanpour 1985.

Table 9: AB-DTPA Extractable Phosphorous (mg/kg) content of soil samples.

Depth (cm)	Minimum	Maximum	Mean	S. Deviation
0-15	2.76	9.8	5.93	2.47
15-30	1.5	4.44	3.04	1.02

AB-DTPA Extractable Phosphorus (mg/kg): The result of P content of soil in surface (0-15cm depth) and sub-surface (15-30 cm) soil is given in (Table 9). From the table, it can be seen that p content ranged from 2.76 to 9.8 mg/kg with a mean value of 5.94 mg/kg whereas in sub-surface soil (15-30 cm) it ranged from 1.5 to 4.44 mg/kg with a mean value of 3.04. It can be concluded from these results that there was a constant trend of p content with respect to soil depth. On the surface soil it has greater p content than sub-surface soil, which may be due to immobility of p in soil. The overall result suggests that in some soil sample it was adequate, but in most soil samples were deficient and need supplemental phosphorus as fertilizer for profitable crop production. Similar results were given by soltanpour 1985.

AB-DTPA Extractable Micronutrients (mg/kg): The data obtained on concentration of AB-DTPA extractable micronutrients in Dargai soil are presented in (Table 10). The concentration of micronutrients in soils varied with depth The concentration of zn was generally high in the surface 0-15 cm soil but decrease gradually with increasing soil depth. The concentration of Zn in the 0-15 cm soil depth ranged from 0.35 to 1.98 mg/kg, while 15-30 cm soil it ranged from 0.3 to 1.56 mg/kg with a mean value of 0.88 mg/kg. The concentration of Fe also decreases gradually with increasing soil depth. The concentration of Fe in the 0-15 cm soil ranged from 1.12 to 2.99 mg/kg, while in 15-30 cm soil it ranged from 0.44 to 2.66 mg/kg with a mean value of 1.76 mg/kg, while in 15-30 cm soil it ranged from 0.44 to 2.66 mg/kg with a mean value of 1.29 mg/kg.

The concentration of Cu was gradually decreased with increase soil depth. The concentration of Cu in the 0-15 cm soil ranged from 1.54 to 3.84 mg/kg with a mean value of 2.18 mg/kg while in 15-30 cm soil it ranged from 1.23 to 3.81 mg/kg with a mean value of 1.87 mg/kg. The concentration of Mn in the 0-15 cm soil ranged from 1.48 to 19.76 mg/kg with a mean value of 9.12 mg/kg, while in 15-30 cm soil it ranged from 2.6 to 19.8 mg/kg with mean value of 7.98 mg/kg. The concentration of Mn was not in a constant trend with respect to soil depth that may due to differences/variation in the parent material (Table 10).

Table 10: AB-DTPA Extractable micronutrients (mg kg^{-1}) content of soil samples.

	Zn (mg kg-^{1})		Fe (mg kg^{-1})		Cu (mg kg^{-1})		Mn (mg kg^{-1})	
Depth (cm)	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30
Mini	0.35	0.30	1.06	0.44	1.54	1.23	1.48	2.6
Maxi	1.98	1.56	2.99	2.66	0.84	3.81	19.76	19.8
Mean	1.28	0.87	1.75	1.29	2.18	1.86	9.12	7.98
S.Dev	0.49	0.36	0.62	0.73	0.77	0.62	5.80	5.30

Conclusion

The following conclusions were drawn for the research work conducted.

a) The soil samples collected from area are medium textured.

b) Almost all samples have alkaline PH.

c) Majority of soil samples are strongly calcareous.

d) Soil organic matter contents are marginal or deficient and none was adequate.

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e) AB-DTPA extractable P was deficient in most soil sample, while adequate in few soil samples.

f) In soil, 9 samples were deficient in Zn while, 5 samples were adequate and 6 were low. Fe concentrations were deficient in 15 soil samples, while marginal in 5 soil samples. Mn and Cu concentration of soil samples are adequate.

Recommendation

The following recommendations are formulated based on the findings of the conducted research work. The sites that are classified as marginal in available macro and micronutrients will become low in these essential nutrients in future; therefore these soils should be properly supplied with the deficient nutrient for increased and sustainable crop production.

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