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Soil examination and Measurement of Tehsil Takht-e-Nasrati, Pakistan

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Abstract

A study was conducted to assess the physical and chemical condition of soil in Tehsil Takht-e-Nasrati, District Karak, Pakistan. The result shows that the high extent of sand 72 %, clay 52 % and silt 33 % was found high in southern area of Bogara Shahidan Banda and Jarassi respectively. The sandy clay loamy soil was found in phase 1 and 2 where phases 3 and 4 were composed of sandy clay soil. Communally the area was found sandy clay soil. The low (23.63 g. Kg^{-1}) and high quantity (28 g. Kg^{-1}) of soil organic matter was there in phase 4 and 3 respectively. Lime content value was high 248 g.Kg^{-1} in Siraj Khel while low value 58 g. Kg^{-1} in Chokara. The lowest value of electrical conductivity 0.14 dS m^{-1} was found in site Jahangeri Banda and high value 0.34 dS m^{-1} in Warana. The result shows that the high PH 8.13 was also found in the WM and low pH (6.06) in Jarassi. The amount of Phosphorus 3.86 mg. Kg-1 and Potassium 147.76 mg. Kg^{-1} was high rate in Ambiri Kala and Siraj Khel while it's low 3.13 mg. Kg^{-1} in SJ and 98.89 mg. Kg^{-1} in Zarki Nasrati respectively. It is necessary for the people of the area to analyze the soil for their use in each year and seasons as the soil of area changes by wind and water erosion. The area is semi arid so during rainy season the chemical component of the area may be change due the dissolving of chemical material in universal solvent and the activity of microbial community structure.

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Introduction

The soil is a compound structure consisting of different raw material, gases, organic and inorganic molecules in different structure with different properties and characteristics. Water is present in the pore of soil particles which dissolve the organic and inorganic molecules for use of plants. Soil present key role in environmental, economic and community functions as a basic natural origin. It is nonrenewable in human time scales. High quality soils not only help establish natural ecosystems and enhance air and water quality but also produce better food and fiber. (Griffiths *et al.,* 2010). It is reported that the main factors influencing soil fertility at field scale are differences in fertilization, cropping system and farming practices (Liu *et al.,* 2010). Informative spatial changeability of soil fertility and its influencing factors are important to improve sustainable land use strategies (Qi *et al.,* 2009). Quality of soil fertility is influenced by both land use and soil management practices and varies spatially from field to larger region scale (Sun *et al.,* 2003). Soil quality has been defined as the capability of the soil to function within ecosystem and land use boundaries to, maintain biological productivity, environmental quality and promote plant, animal and human health (Doran *et al.,* 1996). Important indicators of soil quality are nutrient balances and soil fertility changes (Jansen et al., 1995). Maximum plant growth requires the natural capacity of a soil to provide plant nutrients in sufficient amount, forms, and in suitable proportions is soil fertility (Von Uexkuell, 1988). Some studies were also taken concerning soil quality at regional scale in world through Fida *et al.,* (2011), Jin *et al.,* (2011), Darilek *et al.,* (2009), Wang *et al.,* (2009), Zhang *et al.,* (2007), Liu *et al.,* (2006), Amare *et al.,* (2005) and Samaké *et al.,* (2005).

Material and methods

Research area

The Tehsil Takht-e- Nasrati is situated at 32.47° to 33.28° North and 70.30 ° to 71.30° East. The research area is bounded by Tehsil Karak on the North East, District Mianwali on the East, District Lakki Marwat on the South West and Tribal area Adjoining District Bannu on the West (Fig. 1). The total area of Tehsil is about 613.66 Sq. kilometer. Majority of the area consist of ragged dry hills and rough fields areas i.e. 323.97 Sq. kilometers and agriculture land is about 289.7 Sq. kilometer. The major income source of the people is agriculture which is rain depended. The area is situated at 340 m above the sea level. The major problem of the area is shortage of drinking water because the rainfall is scanty in the area. In the year 2010, 62.5 mm. y^{-1} of rainfall recorded. The area is very hot in summer and very cold in winter. June and July are the hottest months, whereas December and January are the coldest months. In the year 2010 the mean maximum temperature was 39.5 C°, in the month of the May, where as the mean minimum temperature was as low as 4 C°, in the month of January. The wind speed was different in different years. In the year 2009 the wind speed was high 6 Km per hour (h) in the month of July whereas in the month of April, 2010 it was high i.e. 7.2 Km. h^{-1}. (Table. 1).

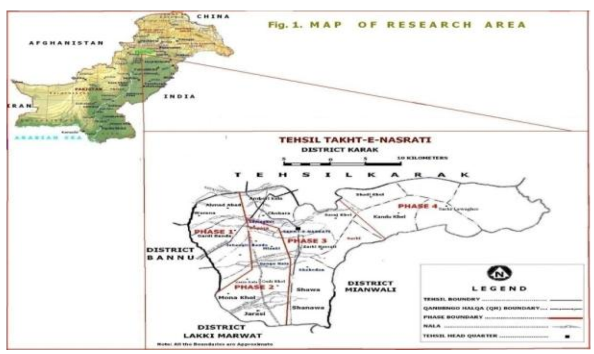

Fig. 1. Map of Tehsil Takht-e- Nasrati, District Karak.

Soil collection

Two kg soil samples were collected from 4 phases of Tehsil Takht-e-Nasrati further divided into 22 sites up to depth of 15 - 45 cm depending upon the area situation using the outer periphery of plants canopy or at the centre of plants with the help of soil auger and mixed to make a composite sample in 2009 -2010. After air drying and passed through 2 mm sieve it was stored in a polythene bag and labeled. Five replicates were taken from each site. These were analyzed for different chemical and physical parameters i.e. soil texture, organic matter (OM), lime contents, pH, electrical conductivity (EC), Phosphorus (P) and Potassium (K) as follows:

Examination of soil texture

Bouyoucos hydrometer method (Bouyoucos, 1962) was used for determining soil texture.

Soil pH and electrical conductivity (EC)

To 5g air-dried soil sample, 25 ml water was added the suspension made was shaken briskly for 5 min then placed for 2h. The pH and EC of each suspension was determined with pH meter and EC meter (DDC-308A), respectively, using standard methods. (Hussain, 1989; Jackson, 1962).

Measurement of organic matter and lime content

Litter was separated from each sample and expressed in percentage. OM and lime content was determined by Walkley & Black's titration method (Hussain, 1989; Jackson, 1962) through following formula:

$$Organic\ Matter\ \% = (S - T) / S \times 6.7$$

$$Where\ S = Blank\ reading$$

$$T = Volume\ used\ of\ FeSo4$$

Measurement of Phosphorus (P) and Potassium (K)

The P and K in soil were measured in the Ammonium bi-carbonate diethylene triamine penta-acetec acid (AB-DTPA) extract (Soltanpour, 1985). This extracting reagent was prepared by adding 1M of NH_4HCO_3 with 0.005M DTPA. Potassium was read on flame photometer (Model PFP-7 Jenway, U.K) and P on spectrophotometer (Lambda-35) at 880 nm.

Statistical Analysis

The data collected for various parameters were analyzed statistically by analysis of variance technique.

Results and discussion

The soil is a compound structure, consisting of different raw material, gases, organic and inorganic molecules in different structure with different properties and characteristics. Water is present in the pore of soil particles which dissolve the organic and inorganic molecules for use of land plants. The quantity of these molecules affects the structural and physical condition of the soil. These molecules play a key role in stopping waste elements in a definite soil due to the presences of highly reactive charged particles and the positively charged surfaces serve as anion exchange media for negatively charged constituents. Soil is the upper surface of the earth which is produced from the parent material through environmental factors and chemical reaction of different molecules consequently provide the natural medium for the plant growth and differs from parent material in physical, morphological, chemical and biological properties and characteristics.

Physical properties

Soil texture: Soil texture presents to the significant summation of sand, silt and clay. Sand particles are large and coarse, clay elements are very fine and smooth, and silt particle intermediate. The result shows that the high extent of sand 72% was found in SB and low extent 42% was found in JA. In clay the extent was high 52% in SD and low 24 % in SB. In site JA, high extent of silt 33% was found while in site SJ (2%) the quantity was low. Sand, clay and silt was high in Phase 1 (64.75 %), 3 (43.57%) and 2 (11.71 %) respectively. The soil texture in phase 1 and 2 was sandy clay loamy whereas in phase 3 and 4 the sandy clay was found. Collectively the area was found sandy clay. The amount of sand and clay decreases with the increase of altitude while the silt amount was different at different altitude (Table 2). The results of particle soil analysis of the area showed that the soils generally contained large proportion of sand followed by clay and very small proportion of silt. Such type of study was carried out by Gee & Bauder (1986). Majority of area soils were Sandy Clay Loam 10 sites, 8 sites were sandy clay, 2 sites of clay soil while in one site loamy and clay loamy was present. This result shows that most of the areas consist of sand. The soil microbial community structure may be changed with the change of soil texture in different areas. Similar study was also carried out by Bach et al., (2010). The area is more suitable for the legume plant due to the presence of high content of sand particles. The texture of the Phase 1, 2 and 3 are also depending on the soil erosion due to the presence of hilly area of Phase 4 through winds and rain water. The mountains range present in the east of the research area consist of hills made up of sand, therefore it is called SHINGHAR (In local language Pashto; Shin: sand, Ghar: Hill) (Fig. 2). Plant life growth somewhat indirectly manipulated through soil structure. It also effects the seedling growth which is very sensitive to physical condition of soil texture. The rigid compacted layer slows down the growth of the seedling for root that cannot penetrate easily in such soil.

Table . 1. Climatic data of Tehsil Takht-e-Nasrati, District Karak for the year 2010.

Months	Temperature (C^o)		Humidity (%)		Rainfall (mm)	Soil Temperature (C^o) Average	Wind speed (Km h^{-1})
	Max	Min	Max	Min			
January	20	4	-	-	19.0	2.1	2.1
February	21	7	-	-	19.2	3.5	3.3
March	30	15	82	39	11.5	5.9	2.5
April	35	20	68	32	20.2	10.4	7.2
May	38	23	62	26	1.8	10.6	5.7
June	34	27	64	40	80.5	13.4	5.1
July	34	24	86	44	345.2	88	5.2
August	33.7	25.6	84.7	52.6	167	86	3.4
September	34	20	73	36	82.8	83	1.95
October	32	19	85	48	-	77	2.23
November	26	10	77	36	-	69	2.32
December	21	4	84	38	2.8	57.82	2.61

Table. 2. Particle size of soil in Tehsil Takht-e-Nasrati, district Karak, Pakistan.

		Sand				**Clay**					**Silt**					**Textural Class**
Ph	St	Min (%)	St	Max (%)	Mean (%)	St	Min (%)	St	Max (%)	Mean (%)	St	Min (%)	St	Max (%)	Mean (%)	
1	WN	61	AA	70	64.75	AA	26	WN	33	30.5	GB	3	WN	6	4.75	Sandy Clay Loam
2	JA	42	SB	72	57.43	SB	24	NB	43	30.86	GK	3	JA	33	11.71	Sandy Clay Loam
3	SD	43	SH	63	52.14	SH	32	SD	52	43.57	SJ	2	TN	6	4.29	Sandy Clay
4	KK	39	SL	59	52.75	SL	33	KK	41	37.25	SK	5	KK	20	10	Sandy Clay
Mean		46.25		66	56.76		28.75		42.25	35.55		3.25		16.25	7.69	Sandy Clay

Ph: Phases, Ph 1: GB: Gardi banda, TK: Tater khel, AA : Ahmad Abad, WN: Warana

Chemical properties

Soil organic matter and lime content: In soil much terrestrial plant's waste accumulates as dead organic matter. The organic matter of soil was present in high quantity 28 g. Kg^{-1} in phase 3 followed by phase 2, (27.93 g. Kg^{-1}), phase 1, (25.25 g. Kg^{-1}) and less quantity 23.63 g. Kg^{-1} was initiated in Phase 4. The differences of organic matter in different sites are, by reason of the changing of soil, caused by the soil erosion through wind or rainy water (Fig. 3). Comparison in sites the high amount of organic matter 56 g. Kg^{-1} was found in SJ which show that the vegetation was high in these areas but due to the low amount of water these particles could not be used by the plants even as the low amount 5 g. Kg-1 was found in Shnawa (SN). So as to show that the area was highly saturated with vegetation which used the organic maters due to the presence of water or the people use the dead particles for burning purposes (Table. 3). Such type of study was also carried out by Huang *et al.,* (2007) and Hu *et al.,* (2007).

Table. 3. Value of organic matter and lime content in soil of Tehsil Takht-e-Nasrati, Pakista.

		Soil organic matter (mg. Kg^{-1})				Soil lime content (mg. Kg^{-1})				
Ph	St	Min	St	Max	Mean	St	Min	St	Max	Mean
1	TK	8	WN	47	25.25	GB	105	GB	245	175.5
2	GK	7	JA	51	27.93	JA	88	KD	248	172.36
3	SH	6	SJ	56	28	CH	58	SJ	234	148.14
4	SN	5	SK	43	23.63	SN	94	SL	211	153.37
Mean		6.5		49.3	26.202		86.25		234.5	162.342

Phase 2: SB: Southern Bogara, NB: Northern Bogara, GK: Gandiri Khattak, KD: Kiri Dhand, JB: Jahangeri Banda, MK: Mona Khel, JA: Jarassi.

Table. 4. Value of elective conductivity (dS m-1) and pH in soil of Tehsil Takht-e-Nasrati, Pakistan.

		Soil elective conductivity (dS m^{-1})				Soil pH				
Ph	St	Min	St	Max	Mean	St	Min	St	Max	Mean
1	GB	0.16	WN	0.34	0.237	AA	7.13	WN	8.13	7.55
2	JB	0.14	MK	0.21	0.177	JA	6.06	GK	7.15	6.61
3	SH	0.16	AK	0.21	0.194	SB	6.89	SJ	7.93	7.31
4	SL	0.17	SK	0.25	0.207	SL	7.24	SK	7.74	7.56
Mean		0.157		0.252	0.203		6.83		7.737	7.25

Phase 3: CH: Chokara, AK: Ambiri Kala, SH: Shawa, SJ: Siraj khel, SB: Shahidan Banda, ZN: Zarki Nasratti, TN: Takht-e- Nasrati

Table. 5. Value of Phosphorus and Potassium in soil of Tehsil Takht-e-Nasrati, Pakistan.

		P (mg kg^{-1})				K (mg. Kg^{-1})				
Ph	St	Min	St	Max	Mean	St	Min	St	Max	Means
1	WN	3.76	GB	3.79	3.775	AA	114.05	GB	125.6	119.955
2	GK	3.64	JA	3.84	3.728	NB	115.6	JA	135.16	122.69
3	SJ	3.13	AK	3.86	3.677	ZN	98.89	SJ	147.76	125.397
4	SN	3.69	SL	3.79	3.742	SL	122.03	SN	131.42	127.412
Means		3.555		3.815	3.731		112.643		134.985	123.864

Phase 4: SS: Sarki Lawager, KK: Kandu Khel, SK: Shadi Khel, SN: Shnawa

Comparison in phases showed that the highest lime value 175.5 g. Kg^{-1} was found in phase 1 while low value 148.14 g. Kg^{-1} in phase 3. In sites comparison proved that the lowest value 58 g. Kg^{-1} was in CH even as high value 248 g. Kg^{-1} in SJ (Table. 3). The results further demonstrated that lime in Phase 1 soil mean range 175.5 g. Kg^{-1} was high which showed that the soil in Phase 1 were strongly calcareous in nature. High lime content in the study area may be due to the soil parent material usually existing in the arid and semiarid regions. Lime may be used for increasing soil PH in the area because it replaces hydrogen ions and also provides 2 nutrients. Lime constructs phosphorus so as to be added to the soil more available for plant growth. Lime also increases the availability of nitrogen through rushing the decomposition of organic matter. Liming materials leave no objectionable residues in the soil and are relatively cheap and soft to handle. Lime may be used in alkaline soil to loss the PH. It was noticed that the amount of soil organic matter were increased with increase of altitude while the lime content were decreased with increase of altitude.

Fig. 2. View of Shingher from plain area.

Soil electrical Conductivity (EC) and pH: Nowadays soil electrical conductivity is one of the simplest, least pricey soil measurements accessible to farmers. The highest mean value 0.237 dS. m^{-1} was found in Phase 1 while low (0.177 dS.m^{-1}) in phase 2. The low value 0.14 dS m^{-1} was found in Jahangeri Banda (JB) and high value 0.34 dS m^{-1} was found in WN. (Table 4). Similar study was also done through Jin *et al.,* (2011). In WN the saline conditions was found due to the saline water comes from the saline area of Karak and therefore most of the plants species have been planted on normal soil devoid of salt injury. Soil EC measurement can give more measurements in a shorter time than usual lattice soil variety.

Fig. 3. Soil erosion by wind in summer.

Fig. 4. Hills made up of sand in research area.

The result shows that the high pH 8.13 was fond in the WN which shows the alkalinity in the area and low pH 6.06 was found in JA. In comparison of the mean value of pH show high amount (7.56) in phase 4 whereas less in Phase 2 (Table 4). Soil pH presents diverse evidences regarding soil resources and is easily determined. The solubility of minerals or nutrients is mostly affected through soil pH. Phosphorus is soluble in the soil with a pH around 6.5. Conifer trees are tolerated and grow well in strong acidic soils. The soil pH controls the activity of beneficial microorganism's community activity like bacteria which effect the plant growth because the decomposition of soil organic matter is delayed in strong acidic soils. This avoids organic matter from dividing, resulting in an accumulation of organic matter and fastens of nutrients to hold in the organic matter. Such type of study was also done by Jin *et al.,* (2011).

Fig. 5. Soil colour of hill in research area.

Fig. 6. People made home in sandy hill.

Soil phosphorus (P) and potassium (K): The amount of P was high rate 3.86 g.Kg^{-1} in Ambiri Kala (AK) while low 3.13 mg. Kg^{-1} in SJ. Comparison in phases the amount of P was in high rate 3.775 mg. Kg^{-1} in phase 1 while low rate 3.677 mg. Kg^{-1} in phase 3. The amount of K is high 147.76 mg. Kg^{-1} in SJ while low 98.89 mg. Kg^{-1} in Zarki Nasrati. In phase 4 the amount is high 127.412 mg. Kg^{-1} while low 119.955 mg. Kg^{-1} in phase 1 (Table 7). Comparison with the critical values of P in soil reported by Soltanpour, (1985), our data showed that extractable soil P was deficient in all soil sample of research area. It was evident that soil at high altitude was more deficient in P than the lower altitude.

Fig. 7. *Capparis spinosa* in sandy hill in research area.

From the result it was noticed that the amount of P was decreased with the increase in altitude except at high altitude while the amount of K increase with the amount of altitude. The reason may be the plant availability in the area, because in the lower altitude the vegetation rate was high as compare to the high altitude. On other side the most rain water comes from the high altitude area to lower area so the soil content change with the coming of new soil through rainy water. In some area the soil is also change with the wind erosion during summer season because at that time the plant are absent in most area. So the soil can easily move from one site to another site.

Conclusion

From the present investigation it was noticed that in research area the soil was not stable especially in phase 1 and 2, thus the soil analysis may be change with the change of season and year to year. So it is necessary for the people of the area to analyze the soil for their use in each year and season. The area is semi arid so during rainy season the chemical component of the area may be change due the dissolving of chemical material in universal solvent and the activity of microbial community structure.

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