Pakistan
Journal of Biological Sciences

Physico-chemical Characteristics of Soils of Pothwar and Determination of Organic Matter

[1]Samina Fateh, [1]Muhammad Arshad, [2]Muhammad Azhar Naeem and [2]Muhammad Imran Latif
[1]Department of Botany, University of Arid Agriculture, Rawalpindi, Pakistan
[2]Department of Soil Science, University of Arid Agriculture, Rawalpindi, Pakistan

Abstract: The present study was conducted to assess the physico-chemical characteristics of selected areas and to compare the different methods of organic matter determination. Soil samples were collected from different areas of Rawalpindi and Fateh Jang for the estimation of soil texture, soil pH, electrical conductivity, saturation percentage and available sodium and potassium contents and for the comparison of routine method of organic matter determination with the active organic matter determination method. A total of 24 composite soil samples were collected from six locations, Fateh Jang, Adiayla, Taxila, Swan, Kahuta and Gujar Khan. These soil samples were analyzed. All the samples were loam in texture. Soil pH values of all less than 8.0 and electrical conductivity of all soil samples was normal except Taxila which showed very high salt deposition. Available sodium was satisfactory while in available potassium, 42% samples were satisfactory and 58% were adequate. Comparison of both methods of organic matter estimation is not a true presentation of organic matter contents of soil.

Key words: Soils, fertility status, pothwar, organic matter

INTRODUCTION

Total area of Pakistan is 79.61 m ha, out of which 20.61 m ha are cultivated, 3.16 m ha are under forests and 11.10 m ha are not available for cultivation (GOP, 1993). About 5.13 m ha in Pakistan are salt effected soils, of which 80% salt effected soils are in Punjab. Soils of Pakistan are mostly saline sodic and constitute 56% of salt effected area.

Soil and water as the basic natural resources are essential for crop production and soil is a non-renewable source upon which the mankind depends for his survival. Historically the rise of great civilization has been inexorably linked to quality of soil and the availability of water (Lone, 1995.). Equally, the demise of such civilization is attributed to mismanagement of soil and in its broadest sense. Crop productivity and soil fertility were thus synonyms. In today's overcrowded world, the challenge to feed and cloth the burgering population of developing countries is a chanting task. Yields have to be increased from existing land areas, adding fertility to the soils to satisfy the demands of higher yielding crops is essential. Soils vary greatly in their capacity to grow crops without fertilizers, even the richest soils experience declining yields without man's intervention. In essence, soil is not always a perfect medium for growing plants (Brady and Weil, 1996).

In most of soils in Pakistan have been exhausted due to continuous crop production and less replenishment, particularly in rainfed areas. Balanced use of fertilizers is a basic need for boosting crop production. The soils of Pakistan are characteristically low in organic matter <1%

(Hassan, 1975; Tahir, 1980; Azam, 1988). Out of 6000 samples analyzed for organic matter, 61.8% sites were deficient in Punjab (Malik *et al.*, 1984). Studies on different crops had shown large increase in yields in soils deficient in organic matterunder increasing level of N and P (Khan *et al.*, 1987) and green manuring (Akram *et al.*, 1982). Farm Yard Manure (FYM) is very useful to improve the physical condition of soils and offset nutritional problems of the plants (Ghafoor *et al.*, 1990) and if it is used continuously, it helps in lowering soil pH, increase in organic matter, Cation Exchange Capacity (CEC) and exchangeable cations (Lohia *et al.*, 1980). Bhariguvanshi (1988) observed that long term application of FYM and fertilizers resulted in improving Water Holding Capacity (WHC) by 25% in sandy loam and 35% in clay loam soils and not effecting soil pH while use of fertilizers alone increased salt content (conductivity) of soils.

Tiessen *et al.* (1994) reported that many tropical soils are poor in inorganic nutrients and rely on the recycling of the nutrients from soil organic to maintain fertility. In undisturbed rainforests such nutrients are recycled through the litter. The role of humus quality and its environmental functions has been discovered only during the last 30 years, whereas the role of organic matter in soil fertility has been well known for hundred of years (Hargitai, 1993). Syres and Springett, 1984 reported that earthworms play an important role to redistribute organic materials within the soil, increase the soil penetrability and under certain conditions, influence ion transport in soils. The

---

Corresponding Author: Muhammad Arshad, Department of Botany, University of Arid Agriculture, Rawalpindi, Pakistan

availability of N, P, K and organic contents of the soil at 0 to 15, 15 to 30 and 30 to 45 cm depths were estimated in a long term field experiment testing Farm Yard Manure (FYM) and fertilizer N doses in a pearlmillet wheat cropping sequence. Application of (FYM) increased available P, K and organic C content of soil at all depths and doses of fertilizer N (Gupta *et al.*, 1992).

Organic matter is the most widely acknowledged core indicator of soil quality, temporal changes in soil active organic matter may provide an early indication of soils capability to perform under different management practices. Active organic matter determination is a highly simplified method in which neutral dilute solution of Potassium permanganate and other chemicals react with most of Active Organic Matter, changing the deep purple colour of solution to light pink colour or colourless. The lighter the colour or colourless of $KMnO_4$ solution after reacting the soil, the greater the active organic matter content and better will be the soil quality. Compared to total soil organic matter, the active organic matter measured by this method is closely related to crop yield and soil quality parameters.

As the essential elements substitute for one another, so it is critically important to identify where and when these deficiencies occur. That's why the role of soil and plant analysis comes in. Techniques have been developed to evaluate soil fertility constraints, based on soil chemical extraction and analysis of plants on such soils. Both are complementary and when calibrated with field crop response to fertilizer, provide a rational basis to identify that what type of element is missing and how much fertilizer to apply. Therefore soil and plant analysis laboratories have a vital role in agricultural development.

Therefore, the present study was planned to assess the present fertility status of Rawalpindi and Fateh Jang area and to compare two different methods of organic matter determination.

MATERIALS AND METHODS

The present study was conducted in the areas of Rawalpindi and Fateh Jang during 2003. Twenty four composite soil samples from six areas, Fateh Jang, Adiayla, Taxila, Swan, Kahuta and Gujar khan were collected from 0-30, 30-60, 60-90 and 90-120 cm depths. The samples were analyzed for physico-chemical characteristics such as soil texture (Ryan and Marter, 1992), soil pH, Electrical Conductivity (EC), saturation percentage (U.S. Salinity Lab. Staff, 1954), sodium, potassium (Richards, 1954) organic matter (Moodie *et al.*, 1959). And also methods of active organic matter determination was compared with the routine organic matter determination method.

RESULTS AND DISCUSSION

Soil analysis of Fateh Jang: Textural analysis of Fateh Jang area was sandy loam and pH of this area varied from 7.63 to 7.98 at different depths. Electrical conductivity of soil ranged from 0.388 to 0.708 dS m^{-1}, which increased up to 90 cm from top and at the depth below 90 cm, it decreased. As the total soluble salts increased with the depth, so Na and K contents also increased with depth. The salts in soil of this area are of Na and K. Saturation percentage was 35%. Values of Potassium contents for soil depths were 80, 120, 460 and 600 meq L^{-1}, respectively. So potassium increased with the depth significantly (Table 1). Qureshi *et al.* (2001) and Muhammad (1978) reported similar results. Similarly Sodium contents also increased with the depth and its values for soil depths were 115, 124, 161 and 218 meq L^{-1}, respectively. Organic matter varied from 0.655 to 0.932%. Active organic matter was excellent i.e., within 0.75-1.00% in all depths. So both the methods of organic matter estimation agreed within this area.

Soil analysis of Rawalpindi (Adiayla): Textural analysis of Adiayla area was sandy loam and pH of this area varied from 7.88 to 7.91 at different depths. Electrical conductivity of soil ranged from 0.397 to 0.219 dS m^{-1}. The maximum value i.e., 0.39 dS m^{-1} was found in 0-30 cm depth which might be due to salt deposition while the minimum value i.e., 0.219 dS m^{-1} was found in 90-120 cm depth which might be due to low pH and exchangeable cautions. Shakirullah *et al.* (1996) reported similar results. Saturation percentage was 36%. Values of Potassium contents for soil depths from top to bottom were 440, 680, 60 and 60 meq L^{-1}, respectively. Maximum value i.e., 680 meq L^{-1} was found in 60-90 cm depth and 90-120 cm depth of soil. These values of Potassium correspond to the values of electrical conductivity. Values of sodium contents for soil depths from top to bottom were 89, 121, 154 and 115 meq L^{-1}, respectively. Maximum value i.e., 154 meq L^{-1} was found in 60-90 cm depth of soil. While minimum value i.e., 89 meq L^{-1} was found in 0-30 cm depth of soil. Values of organic matter for soil depth from top to bottom were 0.518, 0.69, 0.725 and 0.863%, respectively. Active organic matter was excellent i.e., 0.50-0.75% in lower three depths of soil. Here both methods of organic matter estimation did not agree within this area.

Soil analysis of Kahuta: Textural analysis of kahuta area was sandy clay loam in 0-30 cm depth and sandy loam in lower three depths and pH of this area varied from 7.76 to 7.97 at different depths. Electrical conductivity of soil ranged from 0.424 to 0.190 dS m^{-1}, which was found in 90-120 cm and 30-60 cm depth series of soil, respectively.

Table 1: Physico-chemical characteristics of soil collected from different areas

Sampling area	Sampling depth (cm)	AOM	T	EC (dS m^{-1})	pH	OM	S (%)	K (meq L^{-1})	Na (meq L^{-1})
Fateh Jang	0-30	E	Sandy loam	0.388	7.63	0.655	35	80	115.0
	30-60	E	=	0.525	7.98	0.932	34	120	124.2
	60-90	E	=	0.708	7.85	0.897	35	460	161.0
	90-120	E	=	0.654	7.77	0.794	35	600	218.5
Rawalpindi (Adiayla)	0-30	E	Sandy loam	0.397	7.88	0.518	36	440	89.7
	30-60	G	=	0.267	7.88	0.69	36	680	121.9
	60-90	G	=	0.284	7.91	0.725	36	60	154.1
	90-120	G	=	0.219	7.90	0.863	36	60	115.0
Kahuta	0-30	E	Sandy clay loam	0.246	7.86	0.69	35	660	197.8
	30-60	E	Sandy loam	0.190	7.94	0.72	35	100	121.9
	60-90	G	=	0.196	7.97	0.517	36	80	131.9
	90-120	G	=	0.424	7.76	0.621	35	160	69.0
Rawalpindi (Swan)	0-30	E	Sandy loam	0.360	7.93	0.587	38	210	71.3
	30-60	E	Sandy clay loam	0.516	7.79	0.449	38	190	165.6
	60-90	E	=	0.450	7.94	0.69	38	130	85.1
	90-120	E	=	0.351	7.95	0.759	38	100	98.9
Taxila	0-30	E	Loam	5.39	7.40	0.759	39	120	57.5
	30-60	G	=	4.77	7.46	0.172	39	140	690.0
	60-90	G	=	5.84	7.48	0.69	40	180	225.4
	90-120	G	Clay Loam	5.76	7.48	0.828	39	600	506.0
Gujar Khan	0-30	E	Clay Loam	0.778	7.54	0.518	40	600	506.0
	30-60	E	Sandy Clay Loam	0.650	7.82	0.966	40	580	25.3
	60-90	E	=	0.722	7.73	0.897	41	540	27.6
	90-120	E	=	0.512	7.84	0.863	41	660	101.2

AOM = Active Organic Matter, OM = Organic Matter, T = Texture, S% = Saturation Percentage

Saturation percentage was 35%. Potassium contents of soil ranged from 660 to 80 meq L^{-1}, which decreased up to 90 cm from top and at depth below 90 cm, it increased. Value of Sodium contents for soil depths top to bottom were 197.8, 121.9, 131.9 and 69 meq L^{-1}, respectively (Table 1). Organic matter varied from 0.172 to 0.69%. Active organic matter was excellent i.e., within 0.75-1.00% in upper two depths and good i.e., within 0.5-0.7% in lower two depths of soil. So both the methods of organic matter estimation agreed except 0-30 cm depth of soil.

Soil analysis of Rawalpindi (Swan): Textural analysis of Swan area was sandy loam in 0-30 cm and sandy clay loam in lower three depths of soil and pH varied from 7.79 to 7.95. Tariq *et al.* (1998) reported similar results. Electrical conductivity of soil ranged from 0.516 to 0.351 dS m^{-1}. Maximum value i.e., 0.516 dS m^{-1} was found in 90-120 cm depth of soil. Saturation percentage was 38%. Potassium contents varied from 210 to 100 meq L^{-1}, which increased with depth significantly. Values of Sodium contents for soil depths from top to bottom were 71.3, 165.6, 85.1 and 98.9 meq L^{-1}, respectively. Organic matter showed values for soil depths from top to bottom, were 0.587, 0.499, 0.69 and 0.828%, respectively. Active organic matter was excellent. So, both methods of organic method estimation did not agree within this area.

Soil analysis of Taxila: Textural analysis of Taxila area was loam, which remained up to 90 cm from top and at the depth below 90 cm it was clay loam. pH of this area varied from 7.40 to 7.48, which increased with depths of soil. Electrical conductivity of soil ranged from 4.77 to 5.84 dS m^{-1}, which may be due to the use of drainge water for irrigation. Similar results were reported by Chaudhary *et al.* (2001). Saturation percentage was 39% Potassium contents varied from 120 to 600 meq L^{-1}, which increased with the depths significantly. Values of sodium contents for soil depths from top to bottom were 575, 690, 225.4 and 506 meq L^{-1}, respectively. Organic matter varied from 0.172 to 0.828%. Active organic matter was excellent in 0-30 cm depth and was good up to bottom, so both methods of organic matter did not agree within this area.

Soil analysis of Gujar Khan: Textural analysis of Gujar Khan area was clay loam in 0-30 cm depth and sandy clay loam in lower three depths of soil. pH of soil varied from 7.54 to 7.84. Electrical conductivity of soil depths ranged from 0.512 to 0.778 dS m^{-1}, which was found in 90-120 cm depth and 0-30 cm depth of soil, respectively. It did mean, there was high salt concentration in uppermost depths of soil. Saturation percentage was 40.5%. Potassium contents varied from 540 to 660 meq L^{-1}, which decreased up to 90 cm from top and at the depth below 90 cm, it increased. Khalid *et al.* (2002) reported similar results. The highest K contents may be due to medium to heavey textured soils in this area. Saleem and Bertistisson (1978) reported that soils with high clay content had higher available K. While sandy soils are

deficient in K (Mian and Ashraf, 1980). Sodium contents of soil depths from top to bottom were 506, 25.3, 27.6 and 101.2 meq L^{-1}, respectively. Organic matter of soil depths varies from 0.518 to 0.966%. Active organic matter was excellent. So, both methods of organic matter estimation almost agreed within this area.

REFERENCES

Akram, M., M.A. Rajput, R.S. Iltaf and C.M. Shafi, 1982. Effect of different level of fertilization on the yield of wheat under green manure condition. J. Agric. Res., 20: 84-87.

Azam, F., 1988. Studies on organic matter fractions of some agricultural soils of Pakistan. Sarhad J. Agric. 4: 355-365.

Bhariguvanshi, S.R., 1988. Long term effect of high doses of farm yard manure on soil properties and crop yield. J. Indian Soc. Soil., 36: 784-786.

Brady, N.C. and R.R. Weil, 1996. The Nature and Properties of Soils Prentice Hall Int'l. Inc. London, pp: 740.

Chaudhary, M.R., M. Iqbal and K.M. Subbani, 2001. Management of Breakish water impact on soil and crops. Pak. J. Soil Sci., 20: 33-38.

GOP., 1993. Agricultural statistics of Pakistan. Ministry of Food Agriculture and live stock, Economic Wing, Islamabad, pp: 270.

Gupta, A.P., R.P. Narwal, R.S. Antil and S. Dev, 1992. Sustaining soil fertility with organic carbon, nitrogen, phosphorus and potassium by using farm yard manure and fertilizer-N in or semiarid zone: A long term study. Dept. Soil Sci., India, Arid Soil Res. Rehab., pp: 243-251.

Ghafoor, A., S. Muhammad, N. Ahmed and M.A. Mian, 1990. Making salt effected Soils and water productive. I. Gypsum for the reclamation of sodic and saline sodic soil. Pak. J. Sci., 41-42: 23-27.

Hassan, S.S., 1975. Country Report Pakistan. In Proceeding of International conference Water logging and salinity 13-17 oct. 1975. Univ. Eng. Tech. Lahore, Pakistan, pp: 102.

Hargitai, L., 1993. The role of organic matter content and humus quality in the maintenance of soil fertility and in environmental protection. Dept. Soil Sci. Agrechem. Univ. Hortic Food Ind., pp: 161-167.

Khan, M.A., D.M. Malik and A. Khan, 1987. Fertility Status of Punjab Soils. Responses of different fertilizer elements on some major crops under varied fertility levels. Pak. J. Soil. Sci., 2: 23-27.

Khalid, R., K. Saif-ur-Rehman, S.Y. Naz, H. Mahmood and R.H. Khan, 2002. Potassium Status of Gujar Khan Tehsil. Pak. J. Soil Sci., 21: 41-44.

Lone, M.I., 1995. Comparison of blended and cyclic use of water for agriculture Final Research Report of Project ENGG.13 (90).UGC. Islamabad, pp: 111.

Lohia, S., S.L. Singh and R.N.S. Verna, 1980. Effect of continuous Application of farm yard manure and chemical fertilizers on some soil properties. J. Indian Soc. Soil Sci., 28: 170-172.

Malik, D.M., M.A. Khan and T.A. Chaudhary, 1984. Analysis manual for soils plants and water. Rapid Soil Fertility Survey and Soil Testing Institute, Lahore, Pakistan.

Mian, M. Alim and M.A. Ashraf, 1980. land resources in the irrigated plain of Pakistan. Soils Bull., pp: 13.

Moodie, C.D., H.W. Smith and R.A. Mcreery, 1959. Laboratory manual for soil fertility. Pullman State College of Washington, Mimeograph, Washington, DC., USA., pp: 31-39.

Muhammad, S., 1978. Salt effected Soils of Pakistan. In: Qureshi *et al*. (Eds.) Proceeding of Workshop, Ist Seminar on Membrane Biophysics and Salt Tolerance in Plants University of Agriculture, Faisalabad, Pakistan.

Qureshi, S.J., S. Bano, M.A. khan, A.G. Awan and M. Arshad, 2001. Soil Fertility Status of University of Arid Agriculture Rawalpindi. Pak. J. Sci., 53: 43-47.

Richards, L.A., 1954. Diagnosis and Improvement of Saline and Alkali Soils. US Government Printing Office, Washington, DC., USA.

Ryan, J. and A. Marter, 1992. Fertilizer use efficiency under Rainfed. Agriculture in west Asia and North Africa. Proceeding of 4th Regional Soil Test Calibration Workshop in West Asia North Africa region, Agarid, Morocco, May 5-10, 1991. ICARDA, Aleppo, Syria.

Saleem, M.T. and G.U.B. Bertilsson, 1978. Current status and research needs concerning the potash requirement of crops in Pakistan. NFDC, Islamabad, Pakistan.

Shakirullah, M., H.R. Salahuddin and F. Ahmed, 1996. Cations exchange capacity and soil properties of Sawabi and Mardan districts. Pak. J. Sci. Res., 48: 46-55.

Syres, J.K. and J.A. Springett, 1984. Earthworms and Soil fertility. Dept Soil. Sci. Massey Univ., Palmerston North, New Zealand, Proc. Conf. Biological Processes and Soil Fertility Tinsley, J., pp: 93-104.

Tahir, M., 1980. Wheat Production Manual. Pakistan Agriclture Research Council, Islamabad, pp: 77-80.

Tariq, M., H. Mahmood, M.R. Raja and K.H. Gill, 1998. Soil fertility Status of Rawalpindi district. Pak. J. Soil Sci., 14: 66-69.

Tiessen, H., E. Cuevas and P. Chacon, 1994. The role of soil organic matter in sustaining soil fertility. Nature, 371: 783-785.

U.S. Salinity Lab. Staff, 1954. Diagnosis and Improvement of Saline and Alkali Soils. US. Dept. Agric. Hand Book 60, Washington DC.