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Physico-Chemical Properties and Fertility Status of District Rahim Yar Khan, Pakistan

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Abstract
Physico-chemical properties of soils in Rahim Yar Khan district of Punjab Province, Pakistan, were determined for better management. A total of 3198 soil samples collected from all tehsils of Rahim Yar Khan district (662 samples from Khan Pur, 800 samples from Liaquat Pur, 866 samples from Rahim Yar Khan and 870 soil samples from Sadiq Abad) were tested in Soil and Water Testing Laboratory, Bahawalpur, Pakistan during 2011-2013. Soil characteristics of Rahim Yar Khan district were evaluated through physical and chemical analyses. Representative soil samples received/collected from farmers fields were analyzed for texture, electrical conductivity (EC), pH, organic matter (OM), available phosphorus (P) and potassium (K) contents. Texture of the soils varied from sandy loam to loam. About 53% soils had EC values within the normal range (< 4 dS m^{-1}). The pH values of 92% soils ranged from 7.5 to 8.5 with an average of 8.06 and 7% soils had pH > 8.5. About 93% soils were poor (< 0.86%) in organic matter and only 7% soil samples had satisfactory level of organic matter (0.86-1.29%). About 47% soils were poor(< 7 ppm) in available phosphorus,33 % samples had satisfactory level of available phosphorus (7-14 ppm) and only 20 % samples had adequate level of available phosphorus (>14 ppm) contents. The K status of most of soils was in satisfactory (50%) and adequate range (43%). The objective of present study is to assess the soil fertility and salinity status of Rahim Yar Khan district for formulation of optimum fertilizer recommendations for different crops grown in the area.
Keywords: Soil Analysis, EC, pH, SOM, P, K, Rahim Yar Khan

Introduction
Rahim Yar Khan District is a district in the Punjab province of Pakistan, the city of Rahim Yar Khan is the capital. The district lies between 27.40' - 29.16' north latitudes and 60.45' - 70.01' east longitudes. The Indus flows on the northern outskirts of the districts of Dera Ghazi Khan and Muzaffargarh. There is no other river, Nallah or lake in this district. Rahim Yar Khan is bounded on the north by Muzaffargarh District, on the east by Bahawalpur District, on the south by Jaisalmer (India) and Ghotki District of Sindh province and on the west by Rajanpur District.This district is divided into three main physical features i.e. (a) Riverside area. (b) Canal irrigated area and (c) Desert area which is called Cholistan. The surface of the desert consists of a succession of sand dunes rising at places to a height of 150 meters and covered with the vegetation peculiar to sandy tracts.The district has an area of 11,880 square kilometres and comprises four Tehsils(Khanpur,Liaqatpur, Rahimyarkhan and Sadiqabad).

The climate of the district is hot and dry in the summer and cold and dry in the winter. The summer season is comparatively longer. Dust storms are frequent during the summer season. The average rain fall is about 100 millimetres. The main crops of the district are cotton, sugarcane, and wheat; most of the orchards are of mangoes and citrus. The main industries of the district are textile, cotton ginning and pressing, sugar, cottonseed oil, edible oil, soap, beverage making, agricultural implement manufacturing, and fertilizer manufacturing. The human interference in the form of irrigation network has greatly damaged the natural environment. Increases in cultivation, waterlogged areas, and salinity have badly hurt plant life. Because of the increase of salinity at the surface, only salt resistant plants can survive in most of the area. The southern half of the district, characterized by sand dunes, is mostly barren.

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. 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).

Keeping the above all points in view, this study was designed to assess the fertility status of soil with the objectives, to classify the areas into low, satisfactory and high fertility status for the better nutrient management. Soil Physical properties influence the germination and emergence of young seedlings, root penetration and growth into soil, besides affecting the movement of water within the soil. The composition of soil air and the availability of the plant nutrients influence plant growth, having comprehensive information of these characteristics at hand; influences about the probable performance of a soil for different uses can be made with considerable confidence. Important management decisions and the judgment about practically valued concerns are based on the knowledge of soil physical properties .Similarly, the chemical properties of soil control the solubility and bioavailability of essential plant nutrients and thus establish a strong relationship between soil constituents and plant productivity. Therefore understanding the physical and chemical properties of soil as they effect agricultural productivity is extreme important.

Materials and Methods

This study was conducted in Soil and Water Testing Laboratory, Bahawalpur, Pakistan during 2011-13. Composite soil samples from all tehsils of district Rahim Yar Khan (662 samples from Khan Pur, 800 samples from Liaquat Pur, 866 samples from Rahim Yar Khan and 870 soil samples from Sadiq Abad) were collected from 0-15 cm depths for crops and vegetables. Samples were air dried, passed through 2 mm sieve and analyzed for soil texture, by measuring saturation percentage of soils (Malik *et al.*, 1984), electrical conductivity (EC) by preparing 1:10 soil and water suspension (Soil Salinity Lab. Staff, 1954), pH (Schofield and Taylor, 1955), organic matter (Nelson and Sommers, 1982), available P (Olsen and Sommers, 1982) and K (Helmke and Sparks, 1996). The data were subjected to statistical analysis using MS Excel 2007 package.

The criteria used to categorize the soil samples for various classes of texture, salinity/ sodicity and nutrients are given in table 1, 2 and 3 (Malik *et al.,* 1984).

Table 1: The criteria used to categorize the soil samples for various classes of texture

Saturation % age	**Textural Class**
0-20 %	Sand
21-30 %	Sandy Loam
31-45 %	Loam
46-65 %	Clay Loam
66-100 %	Clay

(Malik *et al*, 1984)

Table 2: The criteria used to categorize the soil samples for various classes of salinity/sodicity

Status	**E.C (dSm^{-1})**	**Soil pH**
Normal	< 4.0	<8.5
Saline	$\geq$ 4.0	<8.5
Saline Sodic	$\geq$ 4.0	>8.5
Sodic	< 4.0	>8.5

(Malik *et al*, 1984)

Table 3: The criteria used to categorize the soil samples for various classes of essential soil nutrients

Status	**Organic Matter**	**Available phosphorus**	**Available Potassium**	**Nutrient Index Value**
	%	**mg kg^{-1}**	**mg kg^{-1}**	
Poor	< 0.86	< 7	< 90	< 1.5
Satisfactory	0.86-1.29	7-14	90-180	1.5-2.5
Adequate	> 1.29	> 14	> 180	> 2.5

(Malik *et al*, 1984; Motsara, 2002)

Table 4: Minimum, maximum and mean values of different soil parameters of Rahim Yar Khan District

Estimation	**Range**	**Mean**	**Standard Deviation**
Saturation % age	26-50	36.55	4.27
Soil pH	4.4-88.4	8.06	1.47
EC	0.4-112.5	6.94	9.70
Organic Matter	0-1.03	0.57	0.21
Avail. Phosphorus	0.4-75	9.41	7.88
Exchangeable Potassium	28-670	201.14	119.43

Table 5: Categorization of soil samples into different classes based on criteria described in Table-1, 2 &3.

Particular		No.of Samples	Percentage (%)
Soil Texture			
1.	Light	298	9
2.	Medium	2881	90
3.	Heavy	19	1
Salinity/Sodicity			
1.	Normal (EC< 4.0)	1708	53
2.	Saline (EC ≥4.0)	1490	47
Soil pH			
1.	>7.5	30	1
2.	7.5-8.5	2936	92
3.	>8.5	232	7
Soil Organic Matter			
1.	Poor (< 0.86 %)	2967	93
2.	Satisfactory (0.86-1.29 %)	231	7
3.	Adequate (>1.29 %)	0	0
Available Phosphorus			
1.	Poor (<7.0 mg kg^{-1})	1499	47
2.	Satisfactory(7-14 mg kg^{-1})	1040	33
3	Adequate (> 14 mg kg^{-1})	659	20
Available Potassium			
1.	Poor (< 80 mg kg^{-1})	208	7
2.	Satisfactory(80-180 mg kg^{-1})	1614	50
3	Adequate (> 180 mg kg^{-1})	1376	43

Results and Discussion

Soil Texture

Soil texture is basic to many other soil properties and serves as an indicator of water holding capacity, cation exchange capacity, aeration and organic matter content. Soil texture also controls the retention and losses of nutrients in soil-plant environment.

The saturation percentage ranged from 26-50 with a mean value of 36.55 (Table 4). The 9 % soil samples were light and 90% were satisfactory textured (Table 5) whereas, the proportion of heavy soil was only 1%. These satisfactory textured (loam) soils are suitable for cultivation of all common crops while the light soils has less water holding capacity which needs to be enhanced through addition of farm yard manure to improve physical condition of these soils.

Dissolved Salts (Electrical Conductivity)

Dissolved salts in soils create hindrance in normal nutrient uptake process by imbalance of ions, antagonistic and osmotic effects. Normally for research purpose, electrical conductivity of soil extract (ECe) is used for total dissolved salts but for assessing soil salinity and sodicity for advisory purpose, a soil-water suspension of EC1:10 is normally used as described in the manual of Malik et al.,1984. The data (Table 5) showed that 53 percent of soil samples analyzed in district Rahim Yar Khan were free from salinity/sodicity and approximately same (47percent) soils were saline/sodic. Regarding ranges of EC (Table 4), minimum value was 0.4 dS/m while maximum value 112.5 dS/m was noticed in district Rahim Yar Khan, with an average value of 6.49 dS/m during the year 2011-13.

Soil Reaction (pH)

The pH has significant influence on solubility and bioavailability of nutrients. NO_3 and NH_4 -N are available in a relatively wider range of pH (6.0-8.5). In calcareous soils with high pH the availability of P to plants is decreased. The solubility of P is optimum over a narrow pH range (6.5-7.5). The micronutrients, Fe, Cu, Zn and Mn are more soluble in the pH range 5.0 to 6.0, and their availability in soils varies considerably with the seasonal changes in temperature, moisture and microbial activity (Hodgson, 1963).

The results (Table 5) further revealed that 1 percent soils at district level had pH < 7.5, which are considered as the best for agricultural use especially for growing high value crops, fruits and vegetables. Similarly 92 percent soils had pH 7.5-8.5. The soil pH values ranged from 4.4 to 88.4 with an average value of 8.06. The data (Table 5) indicated that 7% samples were either saline or saline sodic. These soils are also good for agriculture but pH towards higher side (i.e. > 8.5) has some limitations for high value crops. Soils having pH > 8.5 need special attention and some suitable amendment (acid or gypsum) is to be applied for their reclamation according to the soil gypsum requirement. When the average values are taken in to consideration, the area looks free from salinity/ sodicity menace. As the pH of soils is alkaline due to the indigenous parent material, calcareousness and low organic matter, this situation is similar in almost all soils. These results are supported by the findings of earlier workers.

Soil Organic Matter (SOM)

Nitrogen requirements are usually recommended by the Soil Testing Laboratories, based on the estimation of nitrogen released by the SOM contents (Cooke, 1982).

Higher organic matter reflects the higher crops yield. The data (Table 5) showed that 93 percent soils in Rahim Yar Khan district were poor and only 7 percent were satisfactory with respect to organic matter. The reason for low organic matter is that the temperature in summer exceeds 45 °C due to which its decomposition rate is increased. Also farmers generally do not use farm yard manure and remove crops totally (grain plus straw) from soils leaving it fallow. The trend of green manuring is also not observed. These results are in line with those of earlier scientists who found that soils in these areas are deficient in organic matter.

Plant available Phosphorus

The data (Table 5) showed that 47 percent soils in Rahim Yar Khan district were poor, 33 percent satisfactory and only 20 percent were adequate with respect to phosphorus availability to plants. The reasons for poor plant available phosphorus is that the farmers do not apply phosphatic fertilizers to crops according to recommendations and only nitrogenous fertilizers are applied due to price hike of phosphatic fertilizers. These results coincide with the findings of previous scientists according to which soils in this tract are poor in available phosphorus.

Available Potassium (K)

The available K varies with the soil texture depending upon the parent material and its degree of weathering. Generally, clayey soils have more available K than loamy and sandy soils (Saleem and Bertilsson, 1978).

The K contents ranged from 28-670 with a mean value of 201.14 mg kg^{-1}. The classification (Table 5) showed that 7% soil samples were poor, 50% samples contained satisfactory while 43% had adequate K contents. The K content had invariably been reported as adequate in Punjab soils except eroded or light textured soils (Bajwa, 1990).

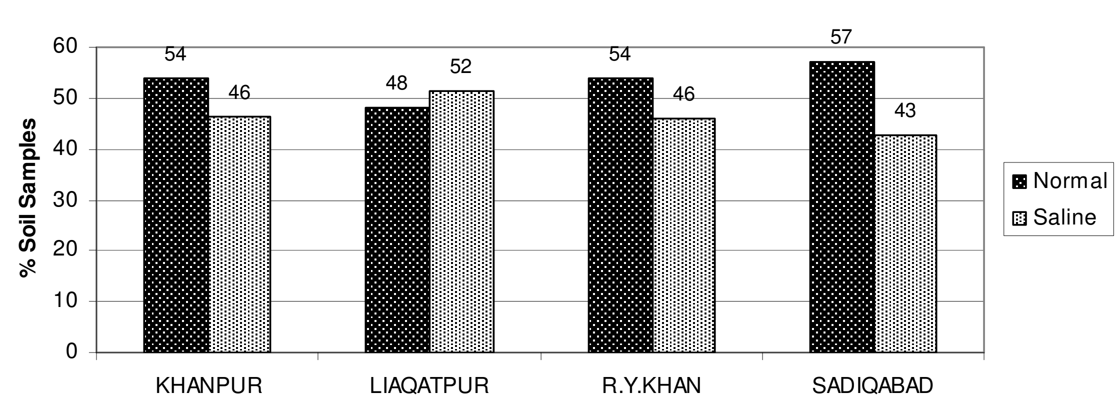
Recommendations

These soils are also good for agriculture but pH towards higher side (i.e. > 8.5) has some limitations for high value crops. Soils having pH > 8.5 need special attention and some suitable amendment (acid or gypsum) is to be applied for their reclamation according to the soil gypsum requirement.

Inorganic fertilizers (NPK) should be applied in balanced form according to soil test value and their use efficiency can be increased by band placement for row-sown crops. Soil organic matter level and soil fertility status may be increased by green manuring (sesbania, guar, etc.) once in three years. With this practice, the sufficient moisture can be preserved for rabi crops (wheat, canola, etc).

RANGES OF DIFFERENT SOIL PARAMETERS(TEHSIL-WISE)

Fig.1 Categorization of District Rahim Yar Khan Soils with regard to EC



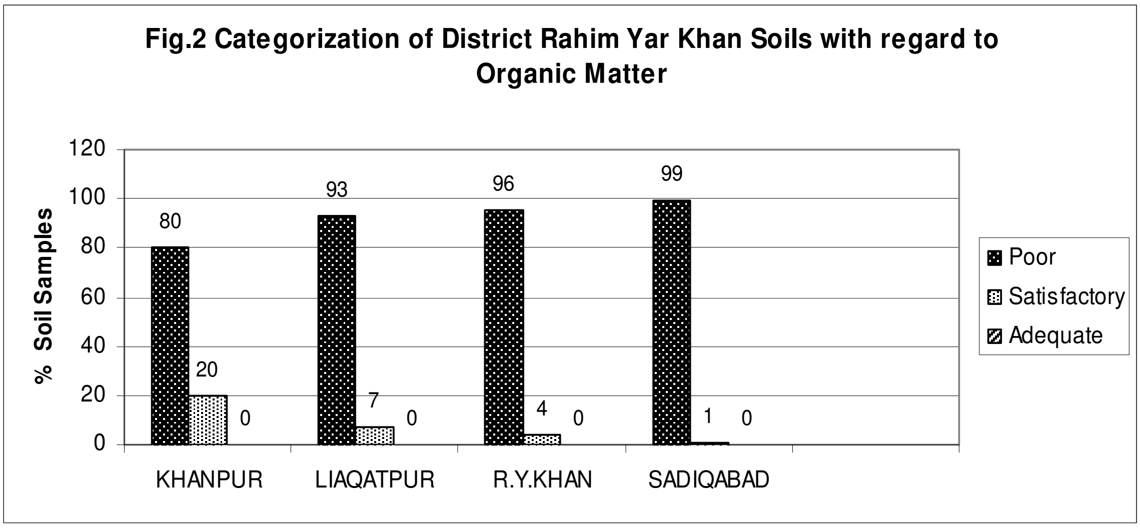


Fig.2 Categorization of District Rahim Yar Khan Soils with regard to Organic Matter
% Soil Samples
120
100
80
60
40
20
0
80
20
0
93
7
0
96
4
0
99
1
0
KHANPUR
LIAQATPUR
R.Y.KHAN
SADIQABAD
Poor
Satisfactory
Adequate

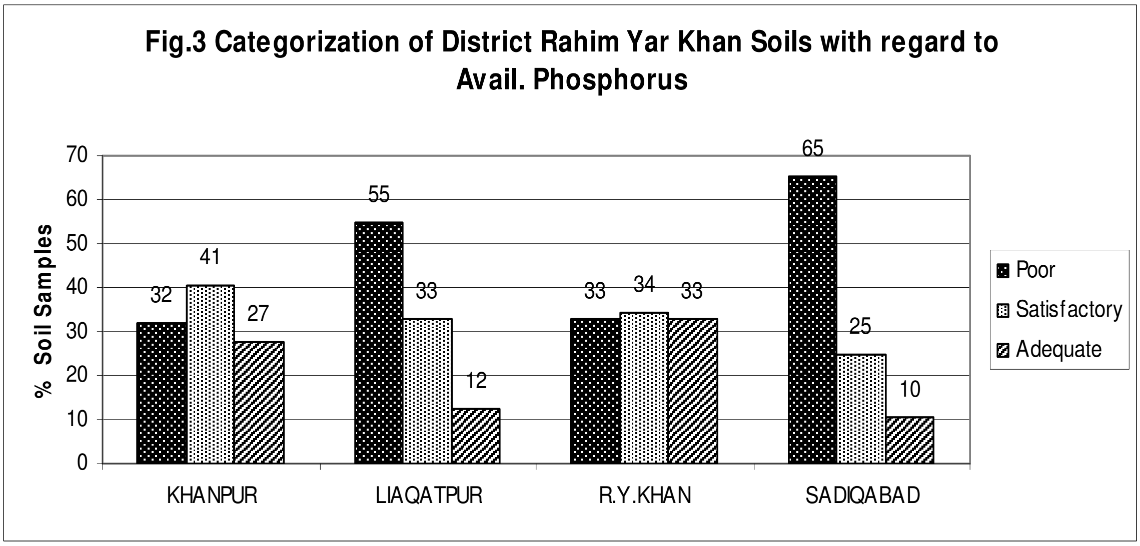


Fig.3 Categorization of District Rahim Yar Khan Soils with regard to Avail. Phosphorus
% Soil Samples
70
60
50
40
30
20
10
0
32
41
27
55
33
12
33
34
33
65
25
10
KHANPUR
LIAQATPUR
R.Y.KHAN
SADIQABAD
Poor
Satisfactory
Adequate

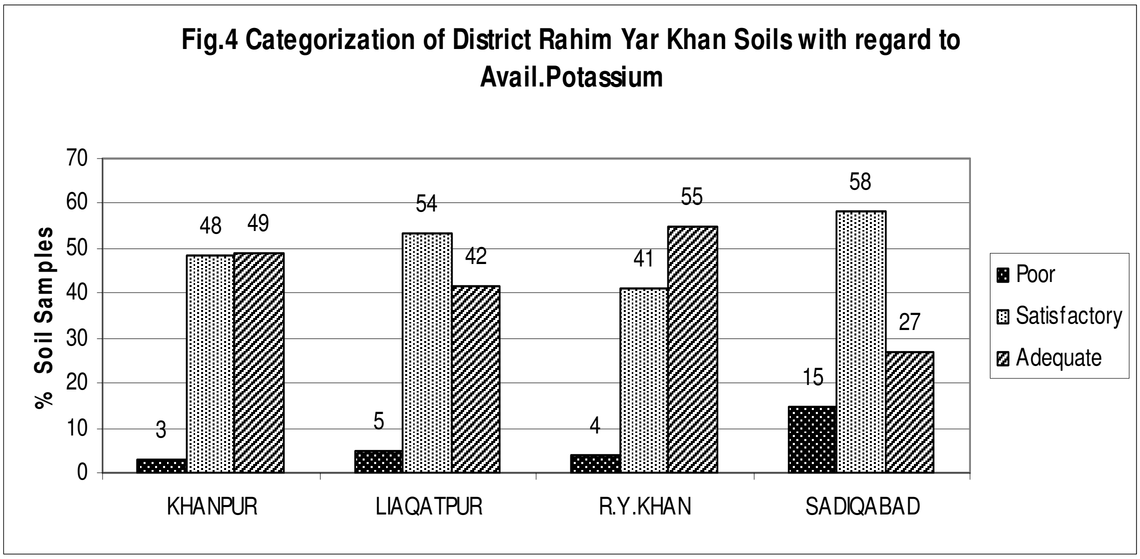
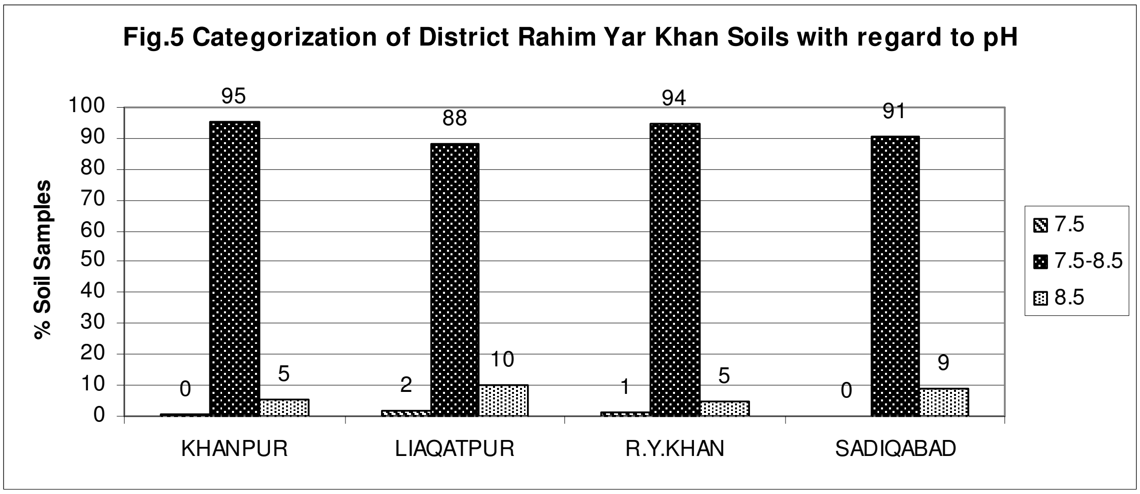


Fig.4 Categorization of District Rahim Yar Khan Soils with regard to Avail.Potassium
% Soil Samples
70
60
50
40
30
20
10
0
3
48
49
5
54
42
4
41
55
15
58
27
KHANPUR
LIAQATPUR
R.Y.KHAN
SADIQABAD
Poor
Satisfactory
Adequate



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