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ELECTRICAL CONDUCTIVITY AND pH AS SOIL QUALITY INDICATOR OF AGRICULTURAL LAND OF MUNDRA TALUK IN KUTCH DISTRICT

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ABSTRACT

450 surface soil samples (0-20cm) representing fifteen villages of Mundra taluk of Kutch district in Gujarat state were investigated. All samples were collected from Government of Gujarat under soil health card programme. Soil samples were collected by locally trained farmers and brought for analysis to Soil Test Laboratory of Bhuj. Standard Methods were applied for the soil analysis. Soil parameters, namely pH, EC, C, P, K, Fe, Cu, Zn, Mn, Ca, Mg, S were considered for study and analysis. The aim of this paper is to evaluate agricultural soil quality based on electrical conductivity, pH, OC, P and K through reaction index, salt index and nutrient index. Discriminate and Correlation analysis is used for statistical data treatment. This study shows that the electrical conductivity of all samples (100%) is in salt free (0-2) range with good salt index and it shows that the study area fairly good for agriculture. This paper concludes that the application of statistical analysis can provide a scientific stand for agricultural soil fertility management.

KEYWORDS: Electrical Conductivity, Kutch, Mundra, Micronutrients, Soil Parameter

INTRODUCTION

Soil is normally viewed simply as a medium for growing plants. Soil is a basic component of tillage system so that it is necessary to obtain the basic needs of soil. Agriculture soil quality is that the ability of a soil to perform the functions necessary for its intended use. Soil health depends on the combined effects of three major interacting components. These are the chemical, physical and biological characteristics of the soil. The quality of soil are evaluated using soil properties. Soil properties include physical and chemical properties as well as macro- micro nutrients. Soil is natural resource that provides essential nutrients to crope growth, need proper care, conservation and management in order to maintain a high degree of soil fertility system. One of the ways to assess the soil fertility status is to get soil sample tested for different soil nutrients. Statistical analysis, as a powerful tools, can provide such information and assist the interpretation of soil tested data [1-2].

The objectives of this work are

- An application of selected Descriptive statistical tools to study and analysis of soil parameters.

- Soil quality analysis through different indices of electrical Conductivity, pH, OC, P, and K.

- To determine the correlation among soil parameters.

Pearson's correlation was applied to 450 soil samples from different 15 village's agricultural area (30 samples from each village) of Mundra taluk of Kutch district [3-10].

MATERIALS AND METHODS

The Study Area

The present study was conducted in Mundra taluk of Kutch district. Mundra taluk is one among 10 taluks of Kutch district. Study location covers agricultural soil of 15 villages of Mundra taluk of Kutch district. Kutch is a district of Gujarat state in Western India, covering an area of 45,652 km². [11] Present study area covers 888.1 km². Kutch district lies in the extreme west of India between 22^0 44' to 24^0 41 North latitude 68^0 7' to 71^0 46 East Longitude [12]. The temperature range is 45ºC (max.) and 4ºC (min.). Average rainfall is 587 mm. Mundra region was struck by major earthquake on 21 July 1956 as well on 26 January 2001, which caused a great deal of damage and loss of life and property. Major soils are medium black, sandy and hydromorphic type [13]. Major field crops are groundnut, bajra, castor, green gram, wheat, cotton, moth bean and major horticultural crops [14] are mango, papaya, cucurbits, sapota, banana.
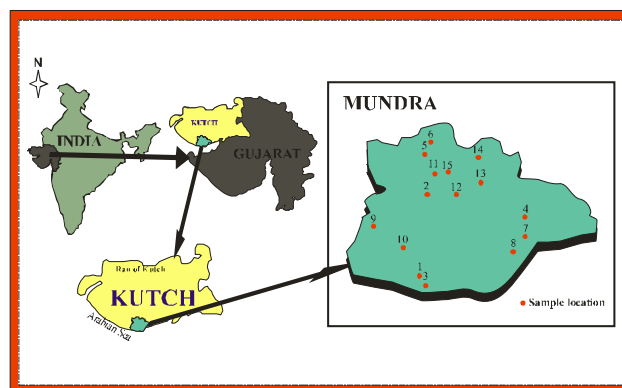
Figure 1: Location Map, Mundra Taluk in Kutch District

From the collected data at different science colleges and STL under the soil health card program by the government of Gujarat, India, we have selected 450 soil samples from different regions of Mundra taluk of Kutch district (Gujarat–India) for this study. All selected samples represent 15 villages (30 samples from each) of Mundra. (Table 2) Numbers of soils samples, names of villages and village code shown in table 2. Location of study area and village code of 450 samples is shown in location map figure 1.

Soil Sampling and Analysis: Soil samples were managed by a systematic sampling strategy at 0 to 20 cm depth below the surface. Before testing all the samples were dried and passed through a 2 mm sieve to prepare them for laboratory analysis. All the samples were tested using standard method by following the "Methods Manual-Soil Testing in India"[15]. All the samples were tested and analyzed for soil properties like organic carbon (OC), phosphorus (P), potassium (K), electrical conductivity (EC), pH. Fe (Iron), Cu (Copper), Zn (Zinc), Mn (Manganese), Ca (Calcium), Mg (Magnesium), and S (Sulfar). Same study was reported for other location by M. Kumar [16] and Wajahat Nazif [17]

Tools and Techniques: Statistical analysis namely mminimum, maximum, mean, standard deviation (SD) and variance are calculated for measured soil properties. Descriptive statistical analysis and Pearson's correlation analysis are used to analyze soil samples data. Variables used for analysis in this study include organic carbon (OC), phosphorus (P), potassium (K), electrical conductivity (EC), pH. Fe (Iron), Cu (Copper), Zn (Zinc), Mn (Manganese), Ca (Calcium), Mg (Magnesium), and S (Sulfar)[18]. MATLAB and EXCEL are used for all statistical analysis.

RESULTS AND DISCUSSIONS

Soil properties (pH, EC, C, P, K, Fe, Cu, Mn, Zn Ca, Mg, and S) and descriptive statistics of soil analysis is shown in table 1.

Table 1: Discriptive Statistics of the Distribution of Soil Parameters of Mundra Taluk

Sr. No	Soil Parameters	N	Minimum	Maximum	Mean	Std. Deviation	Variance
1	pH	450	7.10	7.90	7.57	.23	.05
2	EC	450	.10	.96	.47	.19	.04
3	OC	450	.19	69.00	.85	3.22	10.39
4	P	450	13.00	387.00	33.76	18.33	335.92
5	K	450	141.00	532.00	277.05	55.36	3064.70
6	Fe	450	1.00	5.20	2.79	1.10	1.21
7	Cu	450	.20	.80	.42	.15	.02
8	Mn	450	2.00	8.00	4.65	1.43	2.05
9	Zn	450	.25	25.00	4.65	2.37	5.61
10	Ca	450	7.00	15.40	11.46	2.65	7.02
11	Mg	450	2.00	8.00	5.11	1.51	2.28
12	S	450	22.32	49.60	35.85	6.59	43.45

Table 2: Rating of Soil Propertis of Mundra Taluk

V.ID	Village Name	T.S.	Rating	pH	EC	OC	P	K	R.I.	S.I.	N.I. OC	N.I. P	N.I. K
1	Navinal	30	L	0	30	2	15	0	2.00	1.00	2.23	1.50	2.30
			M	30	0	19	15	21					
			H	0	0	9	0	9					
2	Gelda	30	L	0	30	3	9	0	2.00	1.00	1.97	1.70	2.43
			M	30	0	25	21	17					
			H	0	0	2	0	13					
3	Borana	30	L	0	30	3	11	0	2.00	1.00	2.10	1.63	2.60
			M	30	0	21	19	12					
			H	0	0	6	0	18					
4	Chhasara	30	L	0	30	13	12	0	2.00	1.00	1.60	1.60	2.40
			M	30	0	16	18	18					
			H	0	0	1	0	12					
5	Tappar	30	L	0	30	0	8	0	2.00	1.00	2.53	1.73	2.70
			M	30	0	14	22	9					
			H	0	0	16	0	21					
6	Kanajara	30	L	0	30	1	10	0	2.00	1.00	2.47	1.67	2.33
			M	30	0	14	20	20					
			H	0	0	15	0	10					
7	Vadala	30	L	0	30	10	11	0	2.00	1.00	1.50	1.63	2.60
			M	30	0	16	19	12					
			H	0	0	1	0	18					
8	Luni	30	L	0	30	1	11	0	2.00	1.00	2.50	1.63	2.80
			M	30	0	13	19	6					
			H	0	0	16	0	24					
9	Khakharmoti	30	L	0	30	3	6	0	2.00	1.00	2.37	1.80	2.27
			M	30	0	13	24	22					
			H	0	0	14	0	8					
10	Shiracha	30	L	0	30	1	10	0	2.00	1.00	2.60	1.67	2.63
			M	30	0	10	20	11					
			H	0	0	19	0	19					
11	vanki	30	L	0	30	1	9	0	2.00	1.00	2.47	1.70	2.60
			M	30	0	14	21	12					

No	Name	T.S.							R.I.	S.I.	N.I. (OC)	N.I. (P)	N.I. (K)
			H	0	0	15	0	18					
12	Patri	30	L	0	30	3	10	0	2.00	1.00	1.97	1.67	2.43
			M	30	0	25	20	17					
			H	0	0	2	0	13					
13	Bagada	30	L	0	30	9	9	0	2.00	1.00	2.07	1.63	2.40
			M	30	0	10	20	18					
			H	0	0	11	0	12					
14	vaghura	30	L	0	30	2	6	0	2.00	1.00	2.50	1.80	2.47
			M	30	0	11	24	16					
			H	0	0	17	0	14					
15	Lakhapar	30	L	0	30	1	9	0	2.00	1.00	2.50	1.70	2.53
			M	30	0	13	21	14					
			H	0	0	16	0	16					
L=Low, M=Medium, H=High, R.I.= Reaction Index, S.I = Salt Index, N.I.= Nutrient Index, T.S.= Toatal Samples													

Electrical Conductivity, pH and OC of Soil Samples

Statistical data analysis of collected soil samples shows pH range maximum (7.9) and Minimum (7.1). Soils are neutral in reaction, pH varied from 7.1 to 7.9 with the mean value of 7.57. Electrical conductivity (EC) is varied from 0.1 to 0.96 dSm^{-1} with a mean value of 0.47 dSm^{-1}. All samples (100%) are salt free i.e. values are between 0 - 2 (ref: table 3 and 1).

Organic carbon (OC) of the soil is varied from 0.19 – 69.00 % with a mean value of 0.85 %.

Available Macronutrients in Soil Samples

Phosphorus content of studied samples is minimum 13 kg/ha and maximum 387 kg/ha with mean value 33.76kg/ha. With the consideration of critical limit (table 3) the available Phosphorus of almost samples was found to be normal. Potassium (K) range 141-532 kg/ha with mean 277.05 kg/ha shows high value in study area. Sulfur content range 22.32 – 49.60 ppm with mean 35.85 ppm. All the samples contain high value of Sulfur. All the samples were containing adequate amount of Calcium (Ca) (Minimum 7 and maximum 8 meq/100gm) and also Magnesium (Mg) (22.32 -49.60 meq/100gm).

Available Micronutrients in Soil Samples

The available Micronutrients Iron (Fe) contents of the soils are minimum 1.0 ppm and maximum 5.2 ppm with mean value 2.79ppm. As per critical limit ref. table 3, the soils of the study area appeared to be low amount in available Fe. The available (Cu) content of the soils is minimum 0.20ppm and maximum 0.80ppm with mean 0.42ppm. According to Critical limit all samples are quite sufficient in available Cu. The available Zinc (Zn) varied from 0.25 ppm to 25 ppm. Looking to mean value 4.65, it shows that most of the soils contain high amount of available Zn. The available Mn(Manganese) content of soils is minimum 2.0 ppm and maximum 8.0 ppm with mean 4.65 ppm. Considering the critical limit suggested by MMSOIL [15], the soils of study area appears to sufficient in Mn.

Reaction, Salt and Nutrient Index Value

Based on concept of Reaction index, Salt index and Nutrient index (Ref. table 2) values, the soils of study location were found in fair and salt free with respect to Electrical conductivity and Neutral in reaction with respect to pH. Study shows considerable nutrient indices for OC (Organic carbon), P (Phosphorus) and K (Potassium).

Table 3: Critical Limit of Soil Properties (Followed by MMSOIL-Gov. of India-2011 and Soil Test laboratories of Gujarat)

Sr.No	Soil Parameters	Unit	Low	Medium	High
1	pH		< 6.5 (Acidic)	6.5 - 8.2(Neutral)	> 8.2 (Alkaline)
2	EC	dS/m	< 1.0	1.0 - 3.0	> 3.0
3	C	%	0.5	0.50 - 0.75	> 0.75
4	P	Kg/ha	< 28	28 - 56	> 56
5	K	Kg/ha	< 140	140 - 280	> 280
6	Fe	ppm	< 5	5--10	> 10
7	Cu	ppm	< 0.2	0.2 - 0.4	> 0.4
8	Mn	ppm	< 5	5--10	> 10
9	Zn	ppm	< 0.5	0.5 - 1.0	> 1.0
10	Ca	Meq/100gm		6.0 - 18	
11	Mg	Meq/100gm		2.0 - 10	
12	S	ppm		8.0 - 10	

Correlation of EC and PH with Soil Parameters

Correlation matrix and coefficient (r) is given in table-4.

Correlation studies of EC with Micronutrient Fe, Cu, and Zn shows Less positive relationship with r value 0.023, 0.050 and 0.054 respectively, where as negative correlation with Mn (r =-0.085), Relationship of EC with available P shows (r=0.032) positive but not significant correlation. Available OC(r=-0.004), K(r=-0.047), Zn(r=-0.023), and S (r=-0.075) shows negative relation with EC. Low degree positive correlation was found between pH and micronutrients Cu(r=0.044), Mn(r=0.003) and Zn(r=0.038), macronutrients P(r=0.009), K(r=0.017), Ca(r=0.003), Mg(r=0.027). There was positive significant correlation with S(r=0.5)

Similar study about relationship among pH, EC and soil parameters were also reported [3-5],[16].

Table 4: Tabular Form of Matrix Correlations among Soil Parameters

Parameters	pH	EC	OC	P	K	Fe	Cu	Mn	Zn	Ca	Mg	S
pH	1											
EC	.012	1										
OC	-.055	-.002	1									
P	.009	.032	.017	1								
K	.017	-.047	.039	-.004	1							
Fe	-.040	.023	-.036	.021	-.013	1						
Cu	.044	.050	-.048	-.062	.059	-.072	1					
Mn	.003	-.085	.012	-.093	-.010	-.020	-.087	1				
Zn	.038	-.023	.000	.047	-.038	-.045	.053	.044	1			
Ca	.003	.044	.018	-.047	.080	.048	.064	-.024	.039	1		
Mg	.027	.055	-.035	.030	.024	.074	.034	.092	.055	.209	1	
S	.051	-.075	-.043	.043	-.031	-.035	.028	-.080	.018	.111	.035	1

CONCLUSIONS

- Based on reaction index and salt index through electrical conductivity and pH, the study area posses fairly good agricultural land.

- Nutrient index with respect of OC, P and K shows sufficient amounts of nutrients in the soil samples.

- Present Study shows that the study area is free from salt.

- High value of Sulfur in soil samples shows excess fertilizer practice.

- In present tillage system the value of EC and pH are fairly good for agriculture practice.

- Present study concludes that statistical methods e.g. correlation analysis can provide a scientific basis for controlling and monitoring agriculture soil fertility management.

- Observation shows low positive correlation of EC with Phosphorus, Iron, Copper, Calcium and Magnesium.

- Sulfur has high degree of positive correlation with pH.

- Electrical conductivity inversely correlates with Organic Carbon, Potassium, Manganese, Zinc and Sulfur.

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