January 2008 *Volume 3 Issue 1*

Trade Science Inc.

Environmental Science

An Indian Journal

Current Research Paper

ESAIJ, 3(1), 2008 [45-48]

Coefficient of correlation for soil physico-chemical parameters

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Received: 27th November, 2007 ; Accepted: 2nd December, 2007

ABSTRACT

Soil samples from twenty agricultural fields of Bantwal taluk of Southwestern Karnataka, India, were subjected to analysis of physico-chemical parameters like, soil texture, pH, electrical conductivity, organic matter content, total nitrogen, P, K, Na, Ca, S, trace elements like Fe, Mn, Zn, Cu, Mg, and B. Simple correlation or Karl Pearson's coefficient of correlation was established between the parameters and in this paper the results are discussed with respect to the statistical significance of the correlations observed.

KEYWORDS

Bantwal;
Karl Pearson's coefficient of Correlation;
Physico-chemical;
Soil quality.

INTRODUCTION

Agriculture productivity of an area depends on the quantity and quality of the soil and availability of water. Qualitative studies of these two physical factors reveal many interesting information. This helps in determining the type of crops and variety of species to be grown in an area and whether any alternatives can be suggested for the study area. The correlation between different parameters can suggest how the presence or absence of a physico-chemical parameter is affected with respect to the others. Earlier literature data suggests that the correlation between parameters is varied in different regions. However, for the study area no such reports are available. Hence this study was undertaken to verify if such correlations exist between soil physico-chemical parameters of the agricultural soils of Bantwal taluk situated in the Southwestern region of Karnataka state.

MATERIALS AND METHODS

Study area

Bantwal taluk lies between the coast and the Western Ghats. The taluk covers an area of about 733 km^2, confined between 74^0 54' 30" to 75^0 13' 18" E longitude and 12^0 39' 42" and 13^0 1' 0" N latitude forming part of Survey of India toposheet numbers: 48 P/1, P/2, 48 L/2 and 48 O/4. The population of the taluk, as per the 2001 census is 3,06,734 with male population of 1,51,394 and female population of 1,55,340 (sex

ratio is 1000:1026), which is spread over 80 villages. Two types of soils are noticed in the taluk: slightly yellow loamy type in the valley regions and brown laterite soils in rest of the taluk under investigation. Agriculture is still the main occupation of the rural areas of the taluk. Rice is the main food crop of the area whereas areca nut and coconut are grown as plantation crops.

Sampling

The soil samples were collected from a depth of 30 cm from agricultural lands of selected villages from Bantwal taluk during the month of April, using cone and quarter method. The samples were dried under shade and packed for further processing. The soil samples were subjected to various analyses like soil texture, pH, electrical conductivity(EC), cation exchange capacity (CEC) organic matter content (OM), total nitrogen(N), phosphorus(P), sodium(Na), calcium(Ca), sulphur(S), trace elements like iron(Fe), manganese(Mn), zinc(Zn), copper(Cu), magnesium(Mg), and boron(B)(TABLE 1).

TABLE 1: List of physico-chemical parameters analyzed

Sl. no.	Analysis	Method, instrument used and reference
1.	pH	pH meter (soil: water)[1] Digisun electronics systems- 2001, India.
2.	Electrical conductivity	Conductivity meter (soil: water)[1] Systronics conductivity meter- 304, India
3.	CEC (Cation exchange capacity)	Sodium saturation method[2] Jenway PFP 7 flame photometer, India
4.	Per cent organic matter	Walkley-Black's wet oxidation method[1]
5.	Total nitrogen	By calculation
6.	Available phosphorous	Olsen's method[4] Systronics spectrophotometer-104, India
7.	Available potassium	Flame photometer (ammonium acetate as extractant)[4] Elico flame photometer- CL-220, India
8.	DTPA extractable Iron	Atomic absorption spectrophotometer(AAS) [3] GBC 932AA, Australia.
9.	DTPA extractable Mn	AAS[3] GBC 932AA, Australia.
10.	DTPA extractable Zn	AAS[3] GBC 932AA, Australia.
11.	DTPA extractable Cu	AAS[3] GBC 932AA, Australia.
12.	Calcium	AAS[3] GBC 932AA, Australia.
13.	Magnesium	AAS[3] GBC 932AA, Australia.
14.	Sodium	Flame Photometer[4] Jenway PFP 7 flame photometer, India
15.	Available sulphur	Turbidimetric method ($CaCl_2$ as extractant)[4] Jenway 6300 spectrophotometer, India
16.	Available boron	Azomethine-H colorimetric method[4] Jenway 6300 spectrophotometer, India

Karl Pearson's coefficient of correlation

Simple correlation or Karl Pearson's coefficient of correlation is widely employed to measure the degree of relationship between two variables. The value of 'r' lies between ±1. Positive values of r means positive correlation between the two variables i.e., if one parameter increases there is an increase in the other parameter. Negative values of *r* means that there is a negative correlation, i.e., if one parameter increases the other decreases or vice-versa. A zero value of *r* indicates that there is no association between the two variables. When r=(+)1, it indicates perfect positive correlation and when it is (-)1, it indicates perfect negative correlation. If *r* is very near to +1 or –1 it means that a high degree of correlation exists between the two variables[5].

RESULTS AND DISCUSSION

The results of the statistical analysis, namely, correlation between chemical and physical parameters are presented in TABLES 2 and 3.

In the soil samples of Bantwal taluk, pH is highly positively correlated with sand and negatively correlated with silt. Electrical conductivity (EC) is positively correlated with clay; and negatively correlated with sand. This fact is very well known in soil science and clay mineralogy. The clay is a good ionic exchange and it reduces the grain boundary effects and results in higher EC, whereas sand in contrary induces grain boundary effect and obviously the EC decreases. The cationic exchange capacity (CEC) is positively correlated with Fe, Mn, Mg and B. There is a non- significant negative correlation of CEC with sand and non-significant positive correlation of CEC with silt and clay particles of the soil. This fact further supports the results of electrical conductivity. The clay and silt contains higher concentration of ferromagnesium minerals compared to the

TABLE 2: Pearson's co-efficient of correlation for soil parameters of Bantwal taluk (pH, EC, CEC, OM, Total N, P and K)

	pH	EC	CEC	OM	TOTAL N	P	K
SAND	0.739*	-0.761*	-0.475	-0.290	-0.321	-0.372	-0.279
SILT	-0.703*	0.518	0.430	0.472	0.485	0.142	0.214
CLAY	-0.553	0.859**	0.387	-0.058	-0.012	0.577	0.282
pH	1	-0.551	-0.159	-0.127	-0.160	-0.024	-0.164
EC	-0.551	1	0.024	-0.238	-0.213	0.583	0.531
CEC	-0.159	0.024	1	0.475	0.498	0.313	-0.250
OM	-0.127	-0.238	0.475	1	0.998**	-0.532	-0.070
TOTAL N	-0.160	-0.213	0.498	0.998**	1	-0.523	-0.080
P	-0.024	0.583	0.313	-0.532	-0.523	1	0.078
K	-0.164	0.531	-0.250	-0.070	-0.080	0.078	1
Fe	-0.142	0.063	0.884**	0.311	0.353	0.337	-0.493
Mn	0.274	-0.224	0.670*	0.306	0.305	0.123	-0.134
Zn	-0.086	0.406	0.305	-0.008	0.038	0.386	-0.350
Cu	-0.094	-0.064	0.333	0.068	0.116	-0.013	-0.179
Na	-0.557	0.390	-0.106	0.118	0.095	0.035	0.601
Ca	0.401	-0.180	0.373	0.282	0.301	0.024	-0.137
Mg	-0.209	0.350	0.687*	0.214	0.230	0.413	-0.058
S	-0.011	0.232	-0.036	-0.523	-0.489	0.340	0.268
B	0.107	-0.167	0.679*	0.385	0.372	0.159	-0.269

Note: xyz*: Correlation is significant at the 0.05 level (2-tailed); xyz: Correlation is significant at the 0.01 level (2-tailed).**

TABLE 3 : Pearson's correlation coefficient for soil parameters of Bantwal taluk (Fe, Mn, Zn, Cu, Na, Ca, Mg, S and B)

	Fe	Mn	Zn	Cu	Na	Ca	Mg	S	B
SAND	-0.408	0.114	-0.443	-0.206	-0.503	-0.086	-0.401	-0.006	-0.070
SILT	0.249	-0.186	0.210	0.095	0.675*	0.079	0.239	-0.290	0.159
CLAY	0.501	0.024	0.628	0.296	0.100	0.068	0.501	0.421	-0.079
pH	-0.142	0.274	-0.086	-0.094	-0.557	0.401	-0.209	-0.011	0.107
EC	0.063	-0.224	0.406	-0.064	0.390	-0.180	0.350	0.232	-0.167
CEC	0.884**	0.670*	0.305	0.333	-0.106	0.373	0.687*	-0.036	0.679*
OM	0.311	0.306	-0.008	0.068	0.118	0.282	0.214	-0.523	0.385
TOTAL N	0.353	0.305	0.038	0.116	0.095	0.301	0.230	-0.489	0.372
P	0.337	0.123	0.386	-0.013	0.035	0.024	0.413	0.340	0.159
K	-0.493	-0.134	-0.350	-0.179	0.601	-0.137	-0.058	0.268	-0.269
Fe	1	0.549	0.635	0.483	-0.436	0.411	0.646	0.103	0.486
Mn	0.549	1	-0.098	-0.146	-0.378	0.029	0.769*	-0.116	0.816**
Zn	0.635	-0.098	1	0.505	-0.457	0.510	0.231	0.198	-0.098
Cu	0.483	-0.146	0.505	1	-0.296	0.729*	-0.237	0.612	-0.360
Na	-0.436	-0.378	-0.457	-0.296	1	-0.351	-0.140	-0.193	-0.101
Ca	0.411	0.029	0.510	0.729*	-0.351	1	-0.179	0.229	-0.064
Mg	0.646	0.769*	0.231	-0.237	-0.140	-0.179	1	-0.194	0.778*
S	0.103	-0.116	-0198	0.612	-0.193	0.229	-0.194	1	-0.561
B	0.486	0.816**	-0.098	-0.360	-0.101	-0.064	0.778*	-0.561	1

Note: xyz*: Correlation is significant at the 0.05 level (2-tailed); xyz: Correlation is significant at the 0.01 level (2-tailed).**

impurities or traces of these elements in sand particles. Obviously the cation exchange capacity reduces in sand particles containing soil, and hence the fertility of the agricultural soil automatically decreases in sand rich soil. The organic matter(OM) is positively correlated with total N (TABLE 2). In the case of micronutrients in the soil samples of the taluk, Fe is positively correlated with CEC, Mn is positively correlated with CEC, Mg, and B, Cu is positively correlated with Ca. Mg is positively correlated with CEC; Mn; and B; B is positively correlated with CEC, Mn and Mg(TABLE 3). In the present study, except for a positive correlation of pH with sand, and negative correlation between pH, silt and clay in Bantwal taluk, there is no significant relation with any soil chemical parameter. A positive but non-significant correlation is seen in the taluk between copper and pH in contrast to the study reports from other regions[6]. The influence of soil parameters on the DTPA extract-

able micronutrients in texturally different soils of arid lands appeared variable[7]. In the present study Mn was highly positively correlated with boron, then with CEC and Mg in the soil samples of the taluk. Exchangeable Mg was positively correlated with CEC and boron; whereas no significant relation could be established between Mg and other soil parameters. In the present study no significant correlation could be established between available sulphur and any other physico-chemical parameters of the soil samples. In another study, available boron was positively correlated with electrical conductivity, organic carbon, and available potash contents of the soil[8]. But in the present study, boron was positively correlated with only CEC, Mn and Mg.

CONCLUSION

It can be concluded from the present study that as the clay content of the soil increases, the electrical conductivity of the soil also increases and as the sand content increases it decreases. But the pH of the soil increases with an increase in the sand content and decreases with the increase in the silt content. Cation exchange capacity of the soil is influenced by the presence of micronutrients like Fe, Mn, Mg and B.

In the present study, soil physico-chemical parameters show varying correlations as reported by the earlier workers from various region of the country[6-8]. Such statistical studies could be used to predict the changes in the soil physico-chemical parameters with the application of external agents like chemical fertilizers and/ organic manures. These early detections could also be gainfully employed by the user agencies that plan to suggest alternatives to the local farmers to get better production from their agricultural lands.

ACKNOWLEDGMENTS

The first author acknowledges Dr. S.N. Ramaswamy, Professor Emeritus, Department of Studies in Botany, University of Mysore, Mysore for his suggestions and the University Grants Commission of India for the financial help provided to carry out the research work.

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