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A physio-chemical soil study of greater and lesser Cholistan desert of southern Punjab Pakistan

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Abstract:

The present study conducted on the Cholistan desert that was carried out on two distinct regions on the basis of physio –chemical properties of soil, the northern Lesser Cholistan and southern Greater Cholistan. The study area comprises of Drawar Fort, Deen Garh (Greater Cholistan having 6 elevations) Kudwala and Sahiwala (Lesser Cholistan having 6 elevations).Soil samples from 10cm depth

were collected during an expedition of February and March 2014.This study revealed the following information; maximum pH as 8.0±0.17 and Cl^- as 77.83±5.50 in greater cholistan. While maximum EC as 13.87±0.15,HCO_3^{-2} as 74.80±2.55, K^+ as 24.30±3.20,Na^+ as 106.80±5.57, P as 3.90±0.00 in lesser cholistan. Whereas Carbonates are absent in both the greater and lesser cholistan. These lower levels of essential minerals and metals indicate their lower demands by the desert vegetation.

Key words: Soil, Cholistan, desert, vegetation, elevations.

Introduction

The cholistan is a piece of the seventh world's greatest desert, this great desert stretch over the southern part of the province Punjab Pakistan. (Rao *et al*., 1989).The section of this desolate contains approximately 26,000 km^2 it is situated allying the 27º 42' and 29º 45' North and 69º 52' and 75º 24' East (Fig. 1; Arshad *et al*., 2007) at an elevation of about112 m overhead the sea surface (Ali *et al*., 2009).Topography, soil category, texture and flora of the area comprises two marked parts, the northern part (Lesser Cholistan) enfold the 7,770 km^2 while the southern part (Greater Cholistan) encircling 18,130 km2.

One of the significant geological characteristic of the desert is the historic Hakra water course which shriveled about 600 years ago. The Hakra channel forms the clear boundary joining; the two distinct regions of the desolate. The northern portion of the desolate includes north of the Hakra river with the boundary of the Sutluj River, whereas the Greater desert found to the south of the river. The Greater part widen from the new channel of the gone Hakra River to the periphery with India (Akhter & Arshad, 2006).

A consistent, change in weather caused a switch in monsoon winds elsewhere from the area, resulting in a decrease

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in rain fall, and eventually changing the area into a desolate (Leopold, 1963). Soil of the desolate rated as poor, due to its small amount of organic matter. The northern part is consist of large saline areas with colluviums clay in between low sandy groves and mounds which are usually fixed to unfixed, or less frequently moving dunes (Arshad *et al*., 2007).Soil of inter zonal planes differ in character, form, and the extent of salinity and sodicity with pH ranging from 8.2 to 9.6 (Arshad *et al*., 2008). Sand elevations are much lower (less than 100 meters) than those present in the southern part. The Greater desolate consist of large wind-moving sandy elevations and ridges, with lower interdunal flats (Arshad *et al*., 2003).

The climate of the desert is sub-tropical, severe, hot, dried, and dominated by usual monsoons. One of the most significant features of the desert is the occurrence of desiccated years continuously for 4-6 years Annual and even daily temperature changes greatly (Arshad *et al*., 2007). Annual Precipitation is low and unpredictable, ranging from 100-250 mm annually, during July to September during monsoons and January to March during winters (Arshad *et al*., 2006).

Materials and Method

Sampling

Four sites (Drawar fort, Deen Garh. Sahiwala, Kudwala) of Cholistan desert were studied to collect the data. From each site, a soil sample of about half Kg from 10cm depth was taken. The samples were stored in polythene bags, labeled and brought to the lab. Fresh weight of the soil samples were measured by using weight machine. The samples were air dried and crushed gently.

Soil chemical analysis:

Chemical analysis were made to determine various parameters (variables) by applying the standard methods, that include the

determination of soil pH, electrical conductivity, amount of CO_3^{-2}, Cl^-, HCO_3^{-2} Na^+, K^+ and ,Phosphorus. Soil saturation paste was prepared in distilled water Volume up to 50ml and extract was obtained by the help of suction pump. The filtrate material was filtered with Whatman # 1 filter paper.

Potassium and Sodium ion

Potassium and sodium was determined by flame photometer (Jenway PFP7). K**+** ions were determined by the methods described by (Yoshida *et al.,*1976).

Phosphorus

Phosphorus was determined after Olsen & Sommers (1982), noted with Spectrophotometer (BMS; UV-1900).

pH

Soil pH was measured in 1:5 soil water suspensions with a pH meter (Jackson, 1962). pH of aliquot was determined with JENWAY3505 digital pH meter.

Electrical conductivity

Electrical conductivity was determined by using Jenway 4510 digital conductivity meter.

Carbonates CO_3^{-2}(By titration method)

It was determined by titration method (Jackson, 1962) and calculated as follows.

$$\text{Conc. of } CO_3^{-2}(\text{MEq/L}) = \frac{\text{Vol. of } H_2SO_4 \text{ used} \times \text{Normality of } H_2SO_4 \times 1000}{\text{Volume of Aliquot}}$$

Bicarbonates HCO_3^- (By titration method)

It was determined by titration method (Jackson, 1962), and calculated as follows.

$$\text{Conc. of } HCO_3^- \text{ in MEq/L.} = \frac{\text{vol. of } H_2SO_4 \text{ used} \times \text{N of } H_2SO_4 * 1000}{\text{Volume of aliquot used}}$$

Chloride Cl^-:(By titration method)

Chloride contents was determined by the Richard (1954) and calculated as follows

$$\text{Conc.of chloride (MEq/L).} = \frac{\text{ml. of 0.05N } AgNO_3 \times \text{Normality of } AgNO_3 \times 1000}{\text{Volume of Aliquot}}$$

Statistical analysis

Differences in the soil parameters were estimated by using the 'analysis of variance' (ANOVA) following Steel *et al*., (1997) for the calculation of LSD, Duncan's Multiple , standard errors of the means and means plotted graphically.

Results

Physio-chemical analysis of desert soil: Table 1(b) indicates that Na^+, K^+ P and Cl^- level varying from the 12 soil samples of greater and lesser cholistan. Na^+ concentration ranged from 13.33 mg/g to 106.80 mg/g and Kudwala (Elevation 11) of lesser cholistan have the maximum sodium concentration. While K^+ has same profile as its value ranged from the 11.31mg/g to 24.30mg/g, with the highest concentration in kudwala (Elevation: 10). P has ranges between -0.00 g/ml to 3.90 g/ml at the same location of the lesser cholistan but at different elevations. Cl^- has ranges between 11.27MEq/L to 77.87MEq/L, maximum content was observed in Drawar Fort (Elevation 1) in greater cholistan.

Table 2(b) indicates that pH values of the soil samples ranged from 7 to 8 that is the mean value. Deen Garh (Elevation: 6) has the maximum pH 8. However when the electrical conductance was measured than it ranged from 5.53µS/cm to 13.87µS/cm. Kudwala (Elevation: 10) has the maximum electrical conductance. When the carbonates and

bicarbonates content were measured with titration method than it revealed that carbonates were absent in soil of greater and lesser cholistan whereas bicarbonates ranged from 9MEq/L to 74.80MEq/L, Kudwala (Elevation: 11) had the maximum bicarbonate contents.

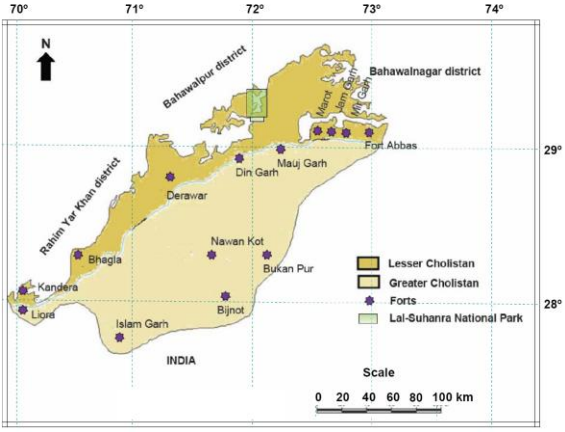

Fig. 1; Arshad *et al.*, 2007

Table: 1 (b) Physio-chemical analysis of Sodium, Potassium, Phosphorus and Chloride in greater and lesser Cholistan.

	Elevations	K^+(mg/g) $LSD_{.05}$=3.83	% increase over highest value	Na^+ (mg/g) $LSD_{.05}$=9.55	% increase over highest value	P (g/ml) $LSD_{.05}$=0.065	% increase over highest value	Cl^- (MEq/l) $LSD_{.05}$=6.57	% increase over highest value
Greater Cholistan	Elevation:1*	13.1±0.85 bc	45.84	13.33±6.67 a	_	0.01±0.00 f	99.97	77.83±5.50 a	_
	Elevation:2*	12.37±1.11 c	49.09	34.47±1.40 de	72.92	0.20±0.00 c	95.46	27.33±4.85 c	64.88
	Elevation:3*	13.07±0.72 bc	43.62	32.67±9.50 de	74.34	-0.02±0.00 f	98.71	20.00±3.00 d	74.30
	Elevation:4 **	14.60±1.41 bc	39.91	25.17±4.95 de	80.23	0.11±0.00 d	97.60	41.87±2.93 b	46.20
	Elevation:5 **	12.87±3.36 c	49.09	25.5±2.12 de	79.97	0.73±0.00 de	83.45	24.00±4.97 cd	69.16
	Elevation:6 **	12.97±3.45 c	87.35	85.57±5.41 c	48.80	4.44±0.00 a	_	35.50±3.67 b	54.64
Lesser Cholistan	Elevation:7	12.80±0.61 c	47.32	28.20±8.85 de	77.85	0.10±0.13 de	97.61	73.33±3.71 a	5.78
	Elevation:8	11.31±1.05 c	54.19	35.20±3.80 d	72.35	-0.01±0.00 f	99.9	20.23±1.96 d	74.00
	Elevation:9	13.50±2.40 bc	44.44	26.37±2.96 de	79.29	0.74±0.00 de	98.28	40.47±4.32 b	48.00
	Elevation:10***	24.30±3.20 a	_	91.60±3.33 c	28.06	-0.00±3.4 f	100	21.73±3.02 cd	72.08
	Elevation:11***	17.24±4.05 b	29.05	106.80±5.57 b	16.12	3.90±0.00 b	12.08	36.27±3.71 b	53.39
	Elevation:12***	11.77±0.55 c	51.56	23.13±6.50 e	81.83	0.03±0.00 ef	99.2	11.27±3.67 e	85.51

Means with the same letters in each column did not differ significantly at 5% level. Table 4.2.1(b) * shows site 1(Drawar fort), ** shows site2 (Deen Garh fort), site 3(Sahiwala) with no star.site4 (Kudwala) with *** values are means±SD; n=3

Fig.1(b):Total concentration of sodium, potassium, phosphorus and chloride ions of soil at different sites of Cholistan Desert

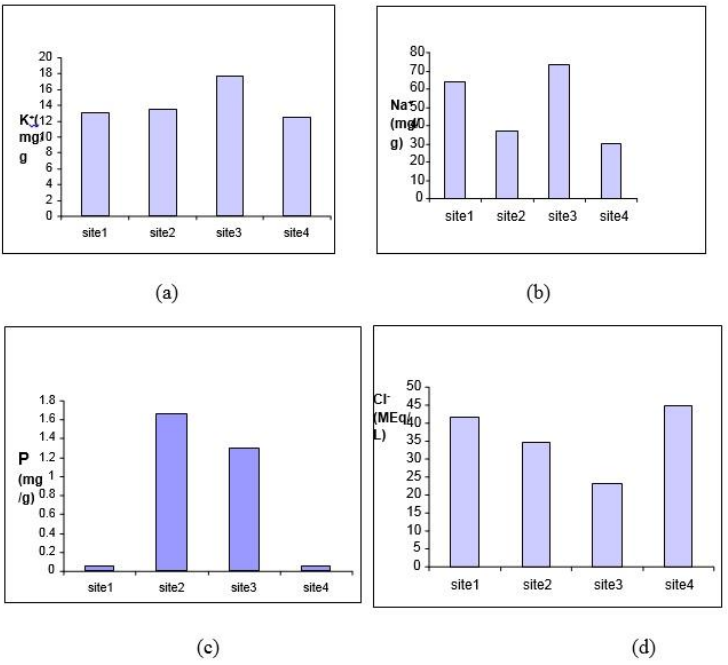

Fig. 1(b): sodium, potassium phosphorus and chloride in soil, (a) potassium, (b) sodium, (c) phosphorus, (d)chloride; site1 &2 greater cholistan , site3 &4 lesser cholistan, Site1:Drawar Fort, Site2: Deen Garh, Site 3:Sahiwala, Site 4:Kudwala

Table:1 (a) Analysis of variance (ANOVA) of Sodium, Potassium, Phosphorus and Chloride in soil of greater and lesser Cholistan

		MS			
Sources	df	K^+	Na^+	P	Cl^-
Soil	11	34.45***	4316.60***	7.75***	1291.93***
Error	24	5.15	32.11	0.00	15.19
Total	35				

*** Highly significant at 0.05 level.

Table: 2(a) Analysis of variance (ANOVA) of EC, pH and $HCO3^{-2}$ in soil of greater and lesser Cholistan

Source		MS		
	Df	EC	pH	HCO_3^{-2}
Soil	11	20.97***	0.21**	808.66***
Error	24	0.10	0.049	10.59
Total	35			

, * Highly significant at 0.05.

Table 2(b) Electrical Conductivity, pH and Bicarbonate in soil of greater and lesser Cholistan.

	Elevations	EC (µS/cm) $LSD_{.05}$=0.54	%increase over highest value	pH $LSD_{.05}$=0.37	% increase over highest value	HCO_3^{-2} (MEq/L) $LSD_{.05}$=5.48	%increase over highest value
Greater Cholistan	Elevation:1*	7.47±0.31 f	41.14	7.00±0.10 d	12.5	21.67±4.16 cd	59.47
	Elevation:2*	9.37±0.15 d	32.44	7.37±0.15 bcd	7.87	15.00±3.00 e	71.94
	Elevation:3*	6.50±0.36 g	53.13	7.47±0.25 bc	6.62	20.00±4.00 cde	62.59
	Elevation:4**	7.60±0.20 f	45.29	7.57±0.35 bc	7.87	48.90±1.34 ab	8.54
	Elevation:5**	5.53±0.38 h	60.12	7.30±0.10 cd	8.75	15.37±1.19 e	70.69
	Elevation:6**	11.37±0.45 c	18.02	8.00±0.17 a	_	53.47±3.60 a	_
Lesser Cholistan	Elevation:7	6.40±0.35 g	53.85	7.23±0.15 cd	4.62	24.33±4.04 c	54.49
	Elevation:8	12.37±0.40 b	0.11	7.33±0.25 cd	5.87	45.33±5.69 b	15.22
	Elevation:9	8.57±0.30 e	38.21	7.47±0.30 bc	6.62	9.00±1.00 f	83.16
	Elevation:10***	13.87±0.15 a	_	7.17±o.25 cd	10.37	46.80±2.88 b	12.47
	Elevation:11***	6.37±0.25 g	45.92	7.43±0.25 bc	7.12	74.80±2.55 ab	10.60
	Elevation:12***	7.64±0.38 f	44.91	7.77±0.15 ab	2.87	18.00±2.00 de	66.33

Means with the same letters in each column did not differ significantly at 5% level., Values are means, n=3. * shows site 1(Drawar fort), ** shows site2 (Deen Garh fort), site 3(Sahiwala) with no star.site4(Kudwala) with ***.

Fig. 2 (b) Electrical Conductivity, pH and Bicarbonates in various sites of Cholistan

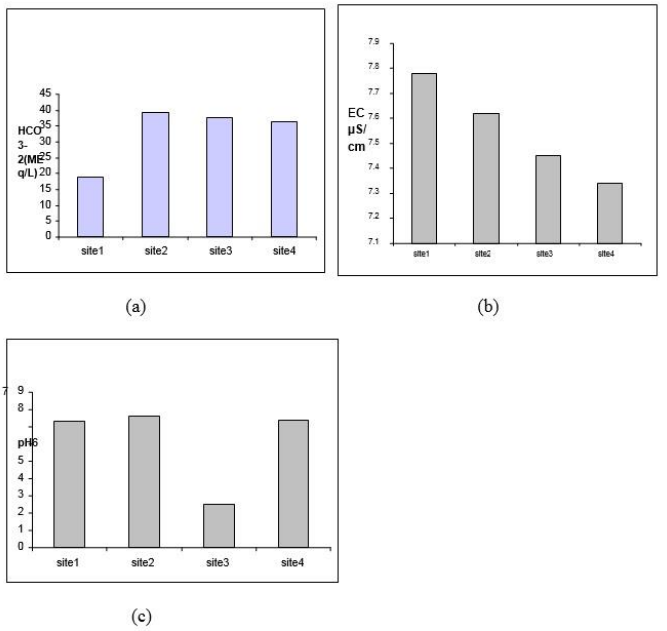

Fig.2 (b) Site1:Drawar Fort, Site2: Deen Garh, Site 3:Sahiwala, Site 4:Kudwala (a) Bicarbonates, (b)Electrical conductivity, (c)pH , site1 &2 greater cholistan , site3 &4 lesser cholistan

Discussion

Bharucha (1960) recorded the pH, total soluble salts, chloride, carbonates and exchangeable cations of soil from a number of plant associations in Western Rajhastan. Soil pH determines acidity and basicity behavior of soils and also responsible for the availability of nutrients to the plants which in turn effect the plant growth (Ashraf *et al* 1999).The present study reports pH range from 7 to 8 refluxing neutral to slightly basic nature of soil of the greater and lesser cholistan. Electrical conductivity measurements of soil are index of soluble salt contents. If the EC value is greater than 15mS/cm than soils

are considered as strongly saline (Cresser *et at* 1993).Results presented in this work shows EC values of 0.0053-0.0139mS/cm refluxing saline nature of soil. Bicarbonates are normal constituent of soil water extract of saline soil. Carbonate and Bicarbonate often present in alkaline soil. When the carbonates are present in soil water extracts than pH of the extract is 8.5 or higher whereas the concentration of bicarbonate never exceeds 10MEq/L in the absence of carbonate (Ashraf *et al* 1999).In our findings as carbonates were absent so pH range from 7 to 8, so these results were in accordance to my findings, but the concentration of bicarbonates is more than 10MEq/L that shows contrary result. Chloride is the principal anion in extracts of saline soil, Chloride is more toxic to plants when present as calcium chloride than sodium chloride (Ashraf *et al* 1999) results shows minimum level of 11.27 MEq/L to maximum level 77.83MEq/L that is the mean value. Sodium concentration is high in the soil types where salinity is high (Arshad *et al*., 2003) in the present case maximum sodium concentration is 106.80 mg/g in lesser cholistan. Potassium is an essential nutrient that activates many enzyme systems. Its deficiency adversely affects the plant growth and metabolism (Rahim *et al*., 2008).In this case maximum potassium concentration is 24.30mg/g in lesser cholistan. Phosphorus is the most important mineral of the soil it is more limiting mineral to productivity of grazing animals throughout the world, because of low availability to plants due to its loss through soil erosion (Vallentine, 1990).

Conclusion

The results of this study clearly demonstrate the existence of the difference in the nutrient level of the lesser cholistan in comparison to the soil of the greater cholistan. Soil of the greater and lesser cholistan is deprived of carbonates where as the soil of the greater cholistan is rich in chloride contents

having maximum pH 8.Whereas the soil of the lesser cholistan have more sodium, potassium, phosphate, Bicarbonates and EC than the greater cholistan. Similar profile is expected for other minerals and metals.

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