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STUDY OF SOIL CLAYS FROM DIFFERENT SOURCES OF ALLUVIAL PARENT MATERIALS UNDER VARYING RAINFALL CONDITIONS

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In the course of soil surveys in some alluvial soil regions of India several profiles were studied for classifying and mapping of soils. In order to understand the soil developmenta nd soil genesis, typical soils were selected and analysed. In the present paper are reported data from the soils collected from Satna (Madhya Pradesh) Sumerpur and Suratgarh (Rajasthan) Nawanshahr(Punjab) Delhi and Rann of Kutch (Gujarat). The soils are of known history and are derived from different sources but are existing under present-day rainfall and other environmental conditions. An analysis of the clays and sands for their chemical, physico-chemical and mineralogical composition revealed that, in general, parent material has influenced the clay minerals. Further the clays contain considerable amounts of magnesium and potassium. Thus it is evident that the reserves of soil potassium being high, the soils mostly need nitrogen and phosphorus for raising the fertility level.

INTRODUCTION

In the course of soil surveys in alluvial soil regions of west and northwestern India several profiles were studied for classifying and mapping of soils. Further typical soils were analysed, in order to understand the development and soil genesis. The profiles are chosen of known history of the sediments which are existing under present-day climatic conditions.

Profiles collected are from Nawanshahr in Punjab, Delhi, Suratgarh and Sumerpur in Rajasthan, Satna in Madhya Pradesh and three profiles from Rann of Kutch. The chemical and mineralogical properties of soil clays are discussed in the present study.

METHODS

Cation exchange capacity of the soils and their clay fractions was determined by Schollenberger's method (1930). Exchangeable potassium was determined by flame photometer. The soils—their clay fractions were fused with sodium carbonate and iron, aluminium, magnesium and potassium were determined in the fusion extract by standard method (Piper 1950). The fine sand fractions of the soils were further separated into heavy and light fractions using bromoform (sp. gr. 2.85). The mineralogical make up of the heavy fraction was arrived at by using petrological microscope.

RESULTS AND DISCUSSION

The details of parent material, climate and rainfall of the soil profile area are given in Table I. The rainfall characteristics of the profile regions show three distinct

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TABLE I

Brief description of the profiles selected

Location and parent material	Climate	Annual average rainfall (cm)
Suratgarh		
Deep alluvium	Arid	25
Sumerpur		
Deep alluvium—Aravalli granites	Arid	40
Nawanshahr		
Deep alluvium	Semi arid	70
Satna		
Deep alluvium (Limestone)	Sub humid	112
Delhi		
Deep alluvium Aeolian-Quartzites	Semi arid	66
Rann of Kutch		
Deep (Inundated by sea—Basalts and gneisses)	Arid	38

features. Nawanshahr and Kutch fall in the region of winter disturbances, Suratgarh and Sumerpur are outside the monsoon influence, while Delhi and Satna are in the region influenced by monsoon. The places are also characterized by low rainfall and high evaporation. Due to this, the biological effects within the soil mass will be confined to top few cm and leaching action is also not prominent. Thus all pedological action and profile development are suppressed.

The alluvial sediments at Nawanshahr and Delhi are derived from Himalayan regions and date back to a long time.

The profile at Sumerpur is alluvial and not much sorted. The alluvium of Rann of Kutch is still under marine influence and gradully emerging out of the sea bed. Thus the time factor is varying in respect of the soils reported here.

The data on the chemical analysis of the clay fractions are given in Table II. Cation exchange capacity of these soils is low (10–30 meq/100 g). Cation exchange capacity values of the clay fractions vary between 30 to 50 meq/100 g indicating dominance of micaceous minerals, with good amounts of smectite, except that of Satna, with C.E.C. value of 70–80 meq/100 g, which indicates dominance of smectite in their clay fraction. High values of K_2O (ranging from 2.5 to 8.7 per cent) with good amount of MgO and the molar SiO_2/Al_2O_3 and SiO_2/R_2O_3 ratios confirm the mineralogy.

The mineralogical analysis of the heavy fraction of fine sands of the soils is presented in Table III. The light fractions of these sands are all dominant in quartz and felspars, As seen from Table III, except in Sumerpur, Delhi and Lakhpat-Piprala, the resistant mineral zircon is in traces and the mica minerals are predominant. High amounts of hornblende and chlorite are characteristics

TABLE II

Analysis of clay fractions

Profile	Depth (cm)	C.E.C. of soils	C.E.C. of clays (meq/100 g)	MgO (%)	K_2O (%)	Molar ratios $\frac{SiO_2}{Al_2O_3}$	Molar ratios $\frac{SiO_2}{R_2O_3}$
Suratgarh	0–38	16	46	1.3	5.5	3.59	2.58
	38–145	10	40	0.9	5.3	3.35	2.58
	145–182	6	43	0.9	5.1	3.25	2.42
Sumerpur	0– 15	10	54	0.5	4.4	3.87	2.88
	15– 95	12	64	1.2	4.5	3.79	2.94
Nawanshahr I	0– 23	14	39	1.2	5.2	3.32	2.42
	23–140	17	45	0.5	4.6	3.36	2.53
Nawanshahr II	0– 38	15	41	0.6	5.5	3.43	2.58
	38–102	19	45	0.7	5.0	3.64	2.63
	102–198	14	45	0.8	5.1	3.72	2.64
Satna	0– 12	31	81	0.6	4.0	3.60	2.88
	12– 90	29	68	0.5	3.8	3.96	2.88
Delhi	0– 60	17	46	2.6	3.4	3.14	2.40
	60–125	14	45	2.5	2.4	3.35	2.43
Lakhpat-Piprala	0– 30	22	34	3.5	8.7	6.10	3.50
	30– 90	27	30	3.6	6.2	5.35	2.81
Nanda	0– 15	25	35	3.8	4.5	7.55	3.50
	15–100	27	32	4.6	4.3	5.82	3.25
	100–225	23	29	2.6	6.4	4.61	3.06
Gonthana	0– 28	28	34	3.6	8.0	7.16	3.86
	28–142	24	31	4.2	8.5	4.91	3.60

of the soils of Delhi, Sumerpur and Rann of Kutch. In general, the mineralogical composition of the sand fractions gives confirmatory evidence for chemical composition of the soils.

Soils of Rann of Kutch are a group by themselves with high molar SiO_2/Al_2O_3 and SiO_2/R_2O_3 ratios and high percentage of magnesium and potassium, which suggests dominance of both micaceous and smectite minerals but the C.E.C. values are 30–35 meq/100g only. The general conditions prevailing in the Rann of Kutch area are such that the normal processes of soil formation are influenced by temporary waterlogging, high salt content and high water-table. The profiles thus show the intrazonal characters of saline and alkali soils. Automorphous and hydromorphous conditions prevail in the area. During the receding of inundating (sea) waters, the dilute soil solution gets concentrated with respect to salts of magnesium and calcium. The exchange reactions between the clays and the very nearly saturated

TABLE III

Mineralogical analysis of fine sands—heavy fraction

Profile	Depth (cm)	Iron oxides & Iron ores	Horn-blende	Chlo-rite	Mica		Garnet	Zircon	Epidote
					Mus-covite	Biotite			
Suratgarh	0– 38	7	T	–	68	20	2	T	
	38–145	8	–	–	64	24	1	–	–
Sumerpur	0– 15	9	45	26	3	6	8	3	
	15– 95	10	38	29	2	6	10	2	–
Nawanshahr I	0–23	13	1	4	48	27	4	T	–
	23–140	52	2	4	23	17	2	T	–
Nawanshahr II	0– 38	17	2	3	49	26	2	1	–
	38–102	20	2	2	46	29	T	T	–
Satna	0– 12	20	–	1	51	26	T	–	–
	12– 90	70	–	1	18	10	T	–	–
Delhi	0– 60	21	27	10	10	8	4	8	–
Lakhpat-Piprala	0– 30	65	15	–	5		2	4	4
	30– 90	37	25	–	10		4	4	21
Nanda	0– 15	75	11	T	T		7	5	2
	15–100	30	30	15	10		2	T	15
	100–225	58	30	2	T		2	T	10
Gonthana	0– 28	15	30	30			2	T	25
	28–142	18	30	25			1	T	25

T=Traces

mixture of salt solutions are of complex nature and may be responsible for transformation of smectite type mineral as suggested by Giescking (1951).

Laboratory studies on leaching of these soils indicated that with continuous leaching Na is the first to leach out with K and Mg following later. This indicates that potassium is not held firmly in the mineral lattice and becomes available by irrigation. Further the cation exchange capacity increases to about 50 meq/100 g with the leaching.

The results reported confirm that the soils are young and dominant in micaceous minerals. Thus the dominance of micaceous minerals may in general be taken as a measure of the availability of K and limits all fertiliser application to N and P alone. A study of the mineralogy of these soils (on profile basis), nutrient levels and chemical data will help in better management of the alluvial soils.

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