Conclusion: The low yield of milk is positively correlated with the lactation days. Milk production could be increased substantially only if animals with long lactation periods are bred in future. Closely associated with this problem is the price of the animal. Generally, lactation period is a breed character and animals with long lactation periods appear to be in great demand and command a premium in the market. With production of a large number of livestock with long lactation periods price will not be a deterrent in keeping animals of good quality. It appears that there is considerable scope to reorganise the resources of fodder and concentrates that are being used as inputs. There is need to rationalise feeding methods so that they are realistic from the production point of view.

Acknowledgement: The authors are grateful to Dr. M. Ramachandran, Associate Professor of Agricultural Economics for rendering guidannce in preparing the article.

REFERENCE

Heady, Earlo 1952 *Economics of Agricultural Production and Resource Use.* New York, Printice Hall in Co. pp. 850.

---

https://doi.org/10.29321/MAJ.10.A03731

Chemical Composition of the Clay Fraction of Some Alkali and Adjoining Soils of Uttar Pradesh

by

BHARAT SINGH[1]

Introduction: Clay colloids are the most important fraction responsible for the base exchange phenomenon in soils. Donahue (1958) considers the cation exchange capacity to be the single index of fertility. Therefore, the more clayey the soil, the more is its cation exchange capacity and hence the chances of its being fertile are greater. Hocking (1948) reported that clay minerals present even in the coarser fractions of the soil also contribute to the cation exchange phenomenon. The individual contents of silica, alumina, iron oxide, potash and magnesia in the clay are indicative of the dominant clay minerals (Grim 1953). The ratio between silica, alumina and iron oxide has widely been used in assessing the nature of clay minerals and process of soil formation. In the present investigation, the clay samples fractionated from alkali and adjoining soil profile samples have been analysed for their chemical composition with a view to studying the depthwise distribution of clay minerals content in the profiles.

---

[1] College of Agriculture, Banaras Hindu University, Varanasi, U. P.

Received on 27—8—1966.

Material and Methods : Samples from three alkali profiles as well as from their adjoning cultivated fields were collected from districts of Uttar Pradesh, *viz.*, Ballia, Jaunpur and Varanasi. Genetically, all the soils are gangetic alluvium affected by salinity and alkalinity. All the soil samples were found to be on the alkaline side with pH ranging from 7·2 to 9·4. Fractionation of clay involved the washing of the soil samples for carbonates, sulphates *etc.* as described in International pipette method and dispersion by dilute caustic soda solution. The clay suspensions were siphoned off and evaporated on water bath for drying. They were finely powdered and sieved through 1 mm (100 mesh) sieve. Cation exchange capacities of the clay samples were determined by leaching with N-ammonium acetate and estimating adsorbed ammonia by Markhan distillation method.

Preliminary steps in the analysis of clay involved sodium carbonate fusion, double evaporation of the hydrochloric acid extract of the fuse and dehydration. Silica was determined by ignition and purification by hydrofluoric acid. Other constituents (R_2O_3, Fe_2O_3, K_2O, MgO and CaO) were determined in aliquots of HCl-extract of the clay fuse. Sesqui oxides were determined gravimetrically but iron alone was determined colorimetrically by orthophenanthroline method as described by Jackson 1958 and calculated as Fe_2O_3. Alumina was obtained by difference. Potash was determined by cobaltinitrite method; calcium oxide volumetrically by oxalate method and magnesia gravimetrically by phosphate method.

Results and Discussion : Analytical data regarding chemical composition of the clay samples are given in Table 1. Texture, pH and $CaCO_3$ content of the corresponding soils were presented in an earlier paper (Singh & Singh 1966).

TABLE 1

Mineral constituents of the clay samples of alkali and adjoining soil profiles

Depth (cm)	Loss on ignition per cent	Silica per cent	Sesqui-oxides per cent	Al_2O_3 per cent	Fe_2O_3 per cent	K_2O per cent	MgO per cent	CaO per cent	Cation exch. cap per cent mo
				1. Abhanpur (Ballia)—Alkali soil					
0—4	15·2	34·2	24·5	16·3	8·2	1·4	1·0	0·9	108
5—25	16·2	33·7	25·4	17·0	8·4	1·7	1·2	0·8	106
25—51	11·6	31·3	20·6	10·8	9·6	8·4	0·8	1·0	88
51—89	13·4	40·8	35·5	25·7	9·8	1·4	0·6	1·2	104
89—127	12·7	38·5	35·3	25·5	9·8	1·3	13·9	1·1	76
127—165	12·5	43·3	32·6	24·0	9·6	1·3	2·5	2·1	108
155—188	12·1	40·5	32·5	23·7	8·8	1·4	2·7	2·3	104

TABLE I (*Contd.*)

Depth (cm)	Loss on ignition per cent	Silica per cent	Sesqui-oxides per cent	Al_2O_3 per cent	Fe_2O_3 per cent	K_2O per cent	Mgo per cent	CaO per cent	Cation exch. cap per cent me
				2. Abhanpur (Ballia)—Adjoining soil					
0—20	12·3	44·4	34·0	24·2	9·7	1·4	1·3	1·8	112
20—51	12·3	38·3	30·6	21·6	8·9	1·6	2·4	4·5	138
51—81	12·6	37·1	28·9	21·2	7·7	1·6	2·8	5·6	128
81—122	18·0	32·2	34·8	27·0	7·8	1·3	0·9	4·8	150
122—165	16·3	36·6	28·3	20·1	8·2	1·3	4·6	5·6	132
165—183	18·6	35·9	25·0	16·8	8·3	1·2	4·1	6·1	128
				3. Lagdharpur (Jaunpur)—Alkali soil					
0—5	14·0	41·2	33·2	23·3	9·9	1·5	1·0	1·8	101
5—20	17·0	40·4	32·7	22·6	10·1	1·8	2·0	1·7	106
20—51	11·4	40·4	29·6	19·8	9·8	1·7	2·7	0·8	124
51—81	14·8	38·8	31·3	21·4	9·9	1·5	2·5	3·1	108
81—112	13·8	41·1	34·4	24·4	10·0	1·3	2·6	2·4	305
112—157	13·5	47·1	32·0	22·5	9·5	1·3	2·1	0·9	112
				4. Lagdharpur (Jaunpur)—Adjoining soil					
0—15	17·7	39·7	34·0	22·0	8·9	1·9	1·9	1·8	102
15—48	13·1	44·5	32·8	27·5	9·2	1·8	0·4	2·0	92
48—89	8·9	40·4	33·6	24·15	9·1	1·1	0·4	3·0	112
89—132	13·4	36·2	31·2	22·0	9·1	1·4	3·3	3·7	116
132—165	14·0	39·9	30·7	22·0	8·8	1·4	2·5	3·1	108
				5. Korajpur (Varanasi)—Alkali soil					
0—5	14·2	38·3	34·7	24·9	9·8	1·4	0·5	0·9	96
5—30	11·8	44·4	36·1	96·5	9·7	1·6	0·7	1·1	104
30—61	11·6	45·4	34·5	24·9	9·6	1·5	2·7	1·1	68
61—91	11·8	45·4	33·5	23·9	9·7	1·5	2·6	1·1	62
91—127	11·2	46·1	34·8	24·2	10·5	1·5	2·4	1·2	56
127—168	11·7	42·5	35·4	26·6	10·8	1·4	0·2	1·3	54
168—191	12·0	47·8	37·4	28·8	8·6	1·5	0·3	1·4	88
				6. Karajpur (Varanasi)—Adjoining soil					
0—25	13·2	36·2	35·5	26·3	9·2	1·9	1·8	1·3	84
25—61	13·4	41·8	36·3	26·8	9·5	1·9	0·6	1·5	60
61—90	13·3	40·2	35·3	26·7	8·7	1·9	0·5	1·4	68
91—122	13·5	43·2	35·3	26·5	8·7	1·8	1·6	1·3	58
222—152	13·4	43·4	38·6	28·2	10·4	1·8	0·5	0·9	74
152—178	13·1	39·7	35·0	26·9	8·1	1·7	0·6	0·9	70

It will be seen that the silica and alumina contents of the clay are generally found to increase in the deeper horizons of alkali soil profiles. On the other hand, in adjoining soil profiles, they either decrease down the profile or show no definite trend of distribution. The depletion of silica and alumina from the complex in alkali soil profiles is seen to be more pronounced than in adjoining soil profiles. It may be due to the solubility of silicon and aluminium in more alkaline medium of alkali soils. Also, due to dispersion of clays by sodium in alkali soils, there can be mechanical illuviation if the dispersion is slight. Agarwal and Mukerji (1946) have noted similar disruption of silica and alumina from the complex subject to amount of weathering under the climatic conditions.

The iron oxide content, however, exhibits a more or less stability in all the individual alkali and adjoining soil profiles showing no signs of disruption of Fe_2O_3 from the complex in the profiles. Potash shows a similar trend of distribution indicating a close similarity in its values. It shows that weathering has been able to help the disintegration of potash.

In general, magnesia is found to be considerably higher in the deeper horizons of both alkali and adjoining soil profiles of Ballia and Jaunpur. This may be due to movement of magnesia to the lower horizons on account of their open texture. In alkali and adjoining soil profiles of Varanasi, the magnesia is very roughly distributed throughout the profile with large fluctuations at alternate depths. It seems that percolation and depletion of magnesia of the complex is not indicated in these profiles.

Calcium oxide content is found to increase in lower layers of all the alkali and adjoining soil profiles. The content is higher in the horizons where a large accumulation of calcium carbonate is found in the soil showing a good positive relationship between the calcium oxide contents of the clay and its corresponding soil.

Per cent loss on ignition of clay shows nearly similar values varying in a short range in all alkali and adjoining soil profiles except in profile 4. This is probably due to similar composition of clay samples of all the soil profiles.

In general, cation exchange capacities of the clay samples under the present investigation are found to be fairly higher than those reported by Agarwal and Mukerji (1946) for Bundelkhand soil clays and Kanwar (1961) for Punjab soil clays, High base exchange capacity of the clays are in accordance with the views of Kanwar (1961) that the clay minerals in alkali soils are of expanding lattice type. According to Donahue (1958) higher cation exchange capacities of soil clays of the soil profiles of Ballia and Jaunpur than those of the soil profiles of Varanasi reveal a better fertility status of the soils of Ballia and Jaunpur.

Ranges of the derived data for clay samples are given in Table 2. Holmes *et al* (1938) reported that SiO_2/R_2O_3 ratio in well drained soils is as low as 1·2, while drained soils have nearly double the value. The data for

SiO_2/R_2O_3 ratio, in the present investigation, indicate a poor drainage in the soils. The alkali and adjoining soils of Jaunpur with normal drainage. A wider range of SiO_2/R_2O_3 ratios in the profiles show that the development stage of the soil is in between ferralitic and highly siliceous soils. Karim and Khan (1956) have reported similar observation in East Pakistan soils. Silica and sesqui oxides contents gave positive correlations (Table 3) for all the soil profiles (significant only in profile 1 and 6). Silica and alumina contents also gave positive correlation (Table 3) in all the soil profiles except in profile 2 where a negative correlation was found (significant in profile 1). A wider range (2·6 to 5·0 and 2·0 to 3·6) of SiO_2/Al_2O_3 ratio in profile 1 and 2 respectively shows preferential movement of Al_2O_3 or SiO_2 with respect to each other.

TABLE 2

Range of the derived data for clay samples

Profile No.	Locality	Nature of soil profile	SiO_2/R_2O_3 range	SiO_2/Al_2O_3 range	SiO_2/Fe_2O_3 range
1.	Abhanpur (Ballia)	Alkali	2·4—3·3	2·6—5·0	8·7—13·4
2.	,,	Adjoining	3·0—3·1	2·0—3·6	11·0—12·8
3.	Lagdharpur (Jaunpur)	Alkali	2·6—3·3	2·2—3·6	10·7—13·2
4.	,,	Adjoining	2·5—3·0	2·8—3·1	10·6—12·8
5.	Korajpur (Varanasi)	Alkali	2·4—3·0	2·6—3·2	10·4—14·8
6.	,,	Adjoining	2·2—2·7	2·4—2·8	10·5—13·2

* Ratios are expressed as molecular ratios

TABLE 3

Correlation coefficients between the factors, silica, sesquioxides, alumina and iron oxide of clay samples

Factors correlated	Correlation coefficient					
	Alkali soil profiles			Adjoining soil profiles		
	Profile 1 (Ballia)	Profile 3 (Jaunpur)	Profile 5 (Varanasi)	Profile 2 (Ballia)	Profile 4 (Jaunpur)	Profile 6 (Varanasi)
SiO_2 & R_2O_3	+ 0·86 †	+ 0·09	+ 0·11	+ 0·18	+ 0·53	+ 0·90 †
SiO_2 & Al_2O_3	+ 0·91 *	+ 0·59	— 0·26	+ 0·02	+ 0·85	+ 0·59
SiO_2 & Fe_2O_3	+ 0·07	— 0·88 †	— 0·39	+ 0·88	+ 0·31	+ 0·35

† Significant at 1 per cent level.

* Significant at 5 per cent level.

The SiO_2/Fe_2O_3 ratio seems to range narrowly in all the profiles except in profile 1 (8·7 to 13·4) in which a wide range in the ratio is seen. This shows no distinct preferential movement of Fe_2O_3 or SiO_2 with respect to each other in all the soil profiles except in profile 1 (Alkali profile of Ballia). SiO_2 and Fe_2O_3 contents gave positive correlation in all the profiles (Table 3) except in profile 3 and 5 in which a negative correlation is found (significant only in profile 2 and 3).

Summary: Clay fractionated from three alkali and corresponding adjoining soil profile samples of Uttar Pradesh were subjected to chemical analysis.

It was observed that the values of loss on ignition, SiO_2, R_2O_3, Fe_2O_3 and K_2O show a close similarity in the alkali and their respective adjoining soil profiles separately, but the values of CaO is considerably higher in adjoining soil profile of Ballia while those of MgO show a rough distribution. The cation capacities of the clays of soil profiles of Ballia and Jaunpur are considerably higher than those of Varanasi. This is indicative of the fact that the soils of Ballia and Jaunpur have better fertility status than those of Varanasi.

Acknowledgement: Acknowledgement is made to the Ministry of Scientific Research and Cultural Affairs, Government of India for the award of a research scholarship to the author during the investigation period.

REFERENCES

Agarwal, R. R. and P. Mukerji 1946 *Indian J. agric Sci.*, **16** : 483.

Donahue, R. L. 1958 *An Introduction to Soils & Plant Growth.* Prentice-Hall. Inc., New York.

Grim, R. E. 1953 *Clay Minerology.* Mc. Graw Hill Book Co., N. Y.

Holmes, R. S., W. E. Hearn and H. G. Byers 1938 *U. S. Dept. Agr., Technical Bull.*, **554** : 33.

Hosking, J. S. 1948 *Council Sci. Ind. Res. Aust.*, **21** : 38.

Jackson. M. L. 1958 *Soil Chemical Analysis* Prentic-Hall. Inc. England.

Kanwar, J. S. 1961 *J. Ind. Soc. Soil Sci.*, **9** : 36.

Karim. A. and Khan, D. H. 1965 *Soil Sci.*, **81** : 389.

Singh, S. and B. Singh 1966 *J. Ind. Soc. Soil Sci.* (*In press*).