https://doi.org/10.29321/MAJ.10.A03719

The Characteristics and Reclamation of a typical Alkal Soil of Samayanallur Farm, Madurai *

by

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Introduction: Halomorphic or salted soils are often characterised by high concentration of salts. They develop under imperfect drainage conditions in arid and semi-arid regions. The chemical characteristics and the intensity of alkalinity met with in the soils of T. V. S. Farm, Samayanallur, were studied in detail and suitable recommendations made. The suitability or otherwise of the well waters of the farm was also pointed out from the detailed analysis of water samples.

Review of Literature: Gedroiz (1924) showed that the permeability of soil was greatly reduced by replacing the naturally occurring exchangeable bases chiefly Ca^{++} with Na^{+}. He gave the name 'solonetz' for such alkali soils. De'Sigmond (1932) pointed out five stages in the evolution and development of alkali soils, namely, salinization, alkalinization, desalinization, degradation and regradation. Kelley (1951) observed that it is inconsistent and arbitrary to restrict the term, alkali, to those soils which contain abnormal proportions of exchangeable sodium. According to him a saline soil is as much as and even more than an alkali soil after the salts have been leached out. Richards (1954) considered the presence of abnormally high exchangeable sodium percentage as the chief chemical characteristic of alkali soils.

Materials and Methods: Soil and water samples were collected from the farm belonging to T. V. S. and Sons Limited, situated about ten miles from Madurai in Paravai village. The total area of the farm is about 32 acres and 20 cents divided into two blocks on either side of the main road, named as northern and southern blocks. Surface soil samples and profile samples were collected and analysed for texture, lime content, total C. E. C., exchangeable Na percentage, pH, EC, gypsum requirement and available N, P and K.

Results: The depth of the farm soil varied from 6" to 38". In the northern block, in the profile examined, the top soil was sandy upto six inches, with a hard clay pan of five inches thickness underneath and below this, weathered parent material was found, with kankar interspersed.

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* Received on 15—9—1965.

Forty-six soil samples were analysed for pH and E. C. The pH ranged from 8·1 to 9·1 for southern block and 8·4 to 9·5 for the northern block. The E. C. values were within the "harmless" limits indicating the low total salt content. The analytical data for the chemical analysis of the composite surface soil samples of northern and southern blocks and the profile samples of northern block are presented in Table No. 1. The texture of the surface soil in the northern block varied from sand to sandy clay loam while in the case of southern block it was sandy loam. Mechanical analysis showed an increase in clay content down the profile in the northern block. The soils in both blocks were calcareous in nature, the lime content in the northern block being 1·33 per cent while half of this amount was present in the southern block.

The pH of the surface samples was above 8·9 and the value increased for the sub-soil samples in the profile. The E. C. figures conformed to the "harmless" limit excepting for the samples below 20 inches depth which contained critical amounts of salts. The Ex. Na percentage was above 35 with the maximum value of 56·4 for the surface samples. This figure also increased for the sub-soil samples in the northern block. This was due to the increased clay content of the sub-soil samples compared to the surface soil. These figures clearly showed the typical non-saline alkali nature of the farm soils, wherein the pH was above 8·9 the Ex. Na percentage above 36 and the E. C. less than 4 millimhos per cm. In this regard, the northern block was worse than the southern block.

Discussion: The clay complex of the soil contained Ex. Na in greater proportions making the clay into a Na-clay which imparted bad physical conditions to the soil. Under such conditions of high Ex. Na, and low electrolyte content, the clay colloid would have hydrolysed, dispersed and deflocculated rendering the soil structure water-unstable. The clay particles, therefore, tended to permeate down the profile forming an incipient and impermeable clay pan resulting in reduced rate of water infiltration, permeability, poor drainage and aeration.

Though there was six inches of water stagnation in the field, when water was externally drained and sub-soil cut for opening out a drain, there was no moisture present at lower depth. This clearly indicated the reduced permeability due to the dispersed soda clay acting as an impervious layer. The soil was therefore, very plastic and stickly when wet, forming hard compact clods when dry.

In between the two blocks and just by the side of the main road there is a big tank. It is probable that the possible rise of the ground water tabe following the periodic stagnation of water in the tank with the onset

TABLE I

Analytical data of the soil samples from T. V. S. Farm, Samayanallur

S. No.	Particulars	Coarse sand per cent	Fine sand per cent	Silt per cent	Clay per cent	Texture	Lime content per cent	Total CEC meq/100 gm soil	Ex. Na meq/100 gm clay	Total CEC meq/100 gm clay	Ex. Na meq/100 gm clay	Ex. Na per cent	Available lb./acre N	P	K	pH	Ec m. mhos —1 cm
1.	No. 1 N. plot	52·8	22·2	4·4	20·3	Sandy clay loam	1·33	8·8	3·2	43·4	15·8	36·4	112 VL	6·4 L	300 L	9·0 ALK	0·3 HS
2.	No. 2 N. plot	54·0	22·4	4·2	15·5	Sandy loam	1·33	12·3	7·0	79·4	45·2	56·4	126 VL	6·4 L	365 M	9·4 ALK	0·6 HS
3.	Southern Block West	61·7	15·2	2·6	19·3	Sandy loam	0·69	12·0	4·4	62·2	22·8	36 3	168 VL	29·2 VH	140 M	9·0 ALK	0·25 HS
4.	Southern Block Eastern plot	62·3	14·1	5·0	18·7	Sandy loam	0·59	12·8	4·5	68·5	24·6	35·7	182 L	56·0 VH	500 M	8·9 ALK	0·3 HS
5.	Profile N plot sample 0—3″	61·7	20·1	2·4	14·4	Sand	0·80	12·6	7·0	87·5	48·0	55·3	112 VL	3·8 L	320 M	9·4 ALK	0·6 HS
6.	3″—20″	50·1	16·1	3·2	24·4	Sandy clay loam	1·49	12·0	8·0	66·6	32 8	62·3	42 VL	10·0 L	400 M	10·2 ALK	0·9 HS
7.	20″—32″	48·6	19·0	4·3	25·9	Sandy clay loam	2·48	13·5	9·4	52·1	36·3	69·4	14 VL	19·2 M	390 M	10·2 ALK	1·5 CR
8.	32″—38″	60·2	14·7	1·0	23·4	Sandy clay loam	3·56	11·3	8·0	48·3	34·2	71·2	14 VL	15·2 M	380 M	10·1 ALK	1·2 CR

Abbreviations: VL = Very low; L = Low; M = Medium; MH = Moderately high; H = High; VH = Very high; HS = Harmless; CR = Critical; INJ = Injurious; ALK = Alkaline.

of rains would have contributed to the deposition of salts in the soil mass and the development of such a condition over prolonged period of time. The insufficient rainfall of the tract incapable of leaching down completely the salts and the prevalence of the intense summer would have aggravated the situation resulting in the observed condition of the soil.

It is recognised that a value of Ex. Na percentage of 15 is the dividing line between non-alkali and alkali soils. This limit is arbitrary and tentative and cannot be taken to represent a classifying value for different soil types. The critical value of Ex-Na percentage as a boundary limit should be correlated with the adverse crop failure under conditions of values exceeding this limit. Even under conditions of Ex. Na percentage above 36, it was observed that the growth of the crops like paddy, daincha, guinea grass, and vegetables like bhendi, tomato and brinjal was satisfactory though not excellent. The fact that the crops were at least able to establish to a satisfactory level under such conditions lends support for a justifiable change of the 15 per cent Ex. Na as the boundry value and critical limit. What value of Ex. Na percentage will be the critical limit to distinguish non-alkali and alkali soils of the different types of soils for crop growth is to be elucidated yet for each type of soil of this State.

McGeorge and Breazeale (1951) observed that Ex. Na and gypsum requirement, both expressed in meq/100 gram of soil, were closely related to each other. For soil samples having Ex. Na contents ranging from 0·1 to 12 meq/100 gram, they expressed the relation between the two variables by the equation.

$$\text{Ex. Na meq/100 gram} = 0{\cdot}96 + 0{\cdot}99 \times (\text{gypsum requirement meq/100 gram}).$$

In the present study also it was observed that there was a strong positive relationship between these two variables. The correlation coefficient obtained, $r = +0{\cdot}836$ was significant at 0·1 per cent level. The following regression equation can be used for prediction purposes.

$$\text{Gypsum requirement meq/100 gram} = 2{\cdot}71\,x + 10{\cdot}12.$$

The estimation of Ex. Na content of alkali soils is both tedious and time consuming. Therefore, any other easily determinable chemical property which is by itself a good diagnostic index for such alkali soils, and which is also at the same time closely related to E. S. P. can be taken as a reliable, rapid, diagnostic index for characterising typical alkali soils. With the data on hand, the presence of a strong positive correlation between E. S. P. and pH significant at 0·1 per cent level was observed. The correlation coefficient value obtained was r = + 0·94. The 88 per cent coefficient of determination arrived at justifies the use of pH in predicting E. S. P. of alkali soils. The following regression equation applies for prediction.

$$Y = 24{\cdot}82 \times - 183{\cdot}37.$$

Agarwal and Yadev (1954) and Govinda Iyer *et al.* (1963) observed a similar relationship for the saline and alkaline soils of Indian gangetic alluvium and for the alkali soils of Amaravathy ayacut area, respectively.

Reclamation: The average gypsum requirement as found by the Schoonover's (1952) method worked out to 9·7 tons per acre of furrow slice for northern block and 7·8 tons per acre for southern block. For practical application such high doses are not necessary. Kanwar (1962) reported that from 30 to 50 per cent of the calculated gypsum requirement would be optimum for practical application. Hence it is recommended that gypsum may be applied at the rate of five tons per acre for northern block and at four tons per acre for southern block. After application of gypsum, water from well No. 1 and 2 may be used for flooding and leaching. The salts present in the water will tend to prevent dispersion of clay and contribute to the percolation of water and leaching of amendments to subsoil. Dilution will increase soluble Na^+ and decrease Ex. Na in the soil. The effect of gypsum in replacing the Ex. Na from the clay complex will be hastened in these soils due to their calcareous nature.

Summary: The degree of alkalinity of the T. V. S. Farm soils was assessed against the chemical background of the soils. The typical alkali nature of these soils was revealed by the high pH and exchangeable sodium values. High correlation existed between the exchangeable sodium and gypsum requirement of the soil on the one hand and between E. S. P. and pH on the other. The study suggested pH value as a reliable and rapid diagnostic index of typical alkali soils.

Acknowledgment: The help rendered by the members of the Soil Testing Laboratory, Kovilpatti and Coimbatore is gratefully acknowledged.

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