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A Study on the Utility of the Different Methods of Assessing Gypsum Requirement for Reclaiming Alkali Soils of the Madras State *

by

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Reclamation of saline and alkali lands has of late assumed greater importance as considerable emphasis has come to be laid on augmenting food production by all possible means. In the Madras State, tangible work has been carried out on the reclamation of saline and alkali lands and the studies point to the necessity of applying gypsum and green manure or F.Y.M. to the alkali lands for reclaiming them at different dosages depending upon the soil type. No attempt has been made in the Madras State so far for accurately predicting the quantity of gypsum required for reclaiming a particular alkali soil; eventhough methods evolved by Schoonover (1952), Puri (1963) and Shawarbi and Abdel-Bar (1954) are in vogue for arriving at the gypsum requirement for reclaiming alkali soils. However uniform results are not obtained with these three methods, and hence their suitability or otherwise for different types of soil is to be assessed before advocating any one of the above three methods. In this paper, the utility of the above three methods for assessing the gypsum required for economically reclaiming the alkali soils of the Madras State is evaluated.

Review of Literature: Richards (1954) considered the presence of abnormally high exchangeable sodium percentage as the chief chemical characteristic of alkali soils. Velayutham *et al* (1967) in their studies on the characteristics and reclamation of a typical alkali soil of Samayanallur farm, Madurai observed that there was a close positive correlation between exchangeable sodium percentage and pH of an alkali soil. A similar observation was also made by Agarwal and Yadav (1956) in respect of the saline and alkali soils of the Indian Gangetic alluvium in Uttar Pradesh. Chawla and Kanwar (1965) tried the methods evolved by Schoonover (1952), Puri (1963) and Shawarbi (1954) for arriving at the gypsum requiremet for reclaiming the alkali soils in the Punjab State. They found that the gypsum requirements arrived at by employing the above three methods were found to be too high and they suggested that 30% of the gypsum calculated as per Schoonover's (1952) method would be an economical dose.

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Material and Methods: Thirty-two surface (0-6″) soil samples were collected from the alkali lands of South Arcot and Coimbatore districts. These samples represented Alluvial and Black soil types of the Madras State. The soil samples were analysed for initial pH, pH after washing with 40% alcohol, Electrical conductivity, exchangeable sodium percentage, available nitrogen and mechanical composition as per standard methods, besides estimating the gypsum requirements in them by Schoonover (1952) F.R.S. (1963) and Shawarbi (1954) methods.

The salient features of the above three methods of estimating gypsum requirement are as follows :

(a) In the Schoonover's method the alkali soil is extracted with saturated solution of calcium sulphate for finding out the amount of calcium adsorbed by the alkali soil. From this, the gypsum requirement is calculated using the following equation. $344 \text{ N} \times \text{T.V} =$ Gypsum requirement in tons / acre (6″ soil) where N is the normality of the versanate solution used.

(b) In the F.R.S. method the alkali soil is leached with normal ammonium carbonate solution. The soil extract is dried, ignited and dissolved in water and the extract is titrated with acid. The gypsum requirement is calculated using the following equation. 1 m.e. exch. Na per 100 gm soil = 1.7 tons gypsum per acre foot.

(c) In the Shawarbi's method the pH of the alkali soil is first detemined and then it is brought down to pH 8 stage by stage by adding N/50 sulphuric acid at the rate of 2 ml for every addition. From the totol volume of sulphuric acid consumed, gypsum requirement is calculated as given below. 1 ml of N/50 H_2SO_4 acid = 1 ton of gypsum/acre (8″ soil)

Results and Discussion: The analysis of the soil samples for available nitrogen and mechanical composition indicated that the soils taken up for the study were of low fertility and their texture ranged from sandy to clay. The pH values of these above soil samples ranged from 7.1 to 9.9. All these samples after leaching with 40% alcohol had higher pH values ranging from 7.3 to 10.5 which indicated that soils were saline alkali. Their electrical conductivity ranged from 0.3 to 4.7. The gypsum requirements recommended by Schoonover, Shawarbi and F. R. S. methods were respectively for 6″, 8″ and 12″ of soils. Hence necessary correction factor was applied for standardising the recommendation for 6″ depth of soil. It is seen from the table I that Schoonover's method gave higher values for the gypsum requirements of the soils which was followed by F.R.S. and Shawarbi's methods.

The exchangeable sodium percentage of the soil samples studied ranged from 12.4 to 77.1. Of the soil samples studied only two registered low exchangeable sodium percentage values while others registered more than 15 which is generally considered as the dividing line between alkali and non-alkali soils. The soil samples having low pH and exchangeable sodium values incidentally served as standard for comparing their gypsum requirements with those of alkali soils.

The fact that the exchangeable sodium percentage of an alkali soil mainly determines the gypsum requirement for reclaiming it is given in the following equation of Eriksson (1952).

$$\frac{\text{Na adsorbed (Ca) X}}{\text{(Na) 2 Ca adsorbed (2 Ca+Na) adsorbed.}} = K\ (1)$$

$$\text{where } X = \frac{\text{(Na+2 Ca) adsorbed}}{V} \times \frac{r \times s}{v}$$

(r = surface density of charge, s = specific surface of the clay, v = volume of the exchange phase $s \times \delta$).

Though the above equation holds good under ideal conditions, for routine advisory purposes, it can be modified as follows, as much of variation is not to creep in due to factors like r, s and v.

$$\frac{\left(Na^{+}_{\text{adsorbed}}\right)}{\left(Na^{+}_{\text{in solution}}\right)} \times \frac{\left(Ca^{++}_{\text{in solution}}\right)}{\left(Ca^{++}_{\text{absorbed}}\right)} = K\ (2)$$

where constant K becomes a function of adsorbed Na^{+}, released Na^{+}, Ca^{++} in solution and Ca^{++}adsorbed. Because a saturated solution of $CaSO_4$ is used, the (Ca^{++} in solution) is constant and (Ca^{++}adsorbed) will be directly proportional to (Na^{++}adsorbed). In other words, exchangeable sodium percentage will determine the amount of gypsum required by soils.

Based on the above theoretical assumption, correlations were worked out on one hand between gypsum requirements calculated by Schoonover, F. R. S. and Shawarbi methods and exchangeable sodium percentage values and with the pH values (Col. 4 of Table 1) of the soil samples and also between exchangeable sodium percentage and pH values of the samples. In addition, correlations were worked out between exchangeable sodium percentage values and gypsum requirement, between pH and gypsum requirement under modified Schoonover's method. The correlation co-efficients thus obtained are presented in Table 2 (Figure 1 to 4.). It will be seen from the data that there was not only significant positive correlation between exchangeable sodium percentage and pH but between the gypsum requirements

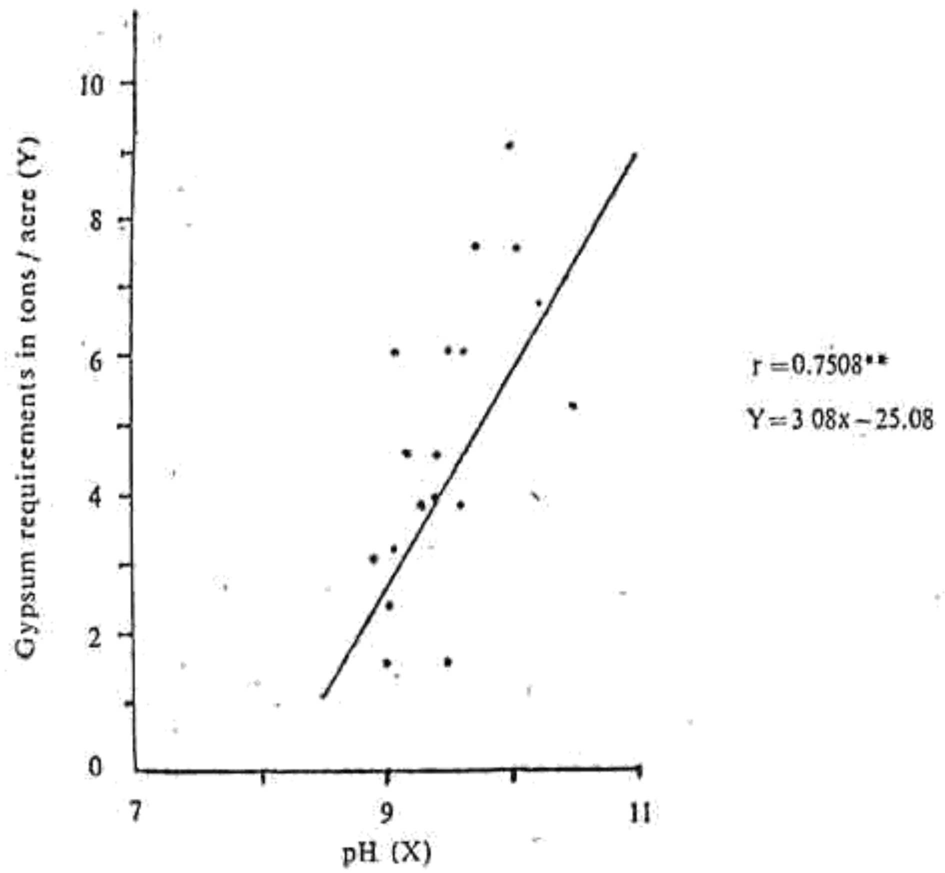

FIGURE 1. pH vs Gypsum requirement (Shawarbi Method)

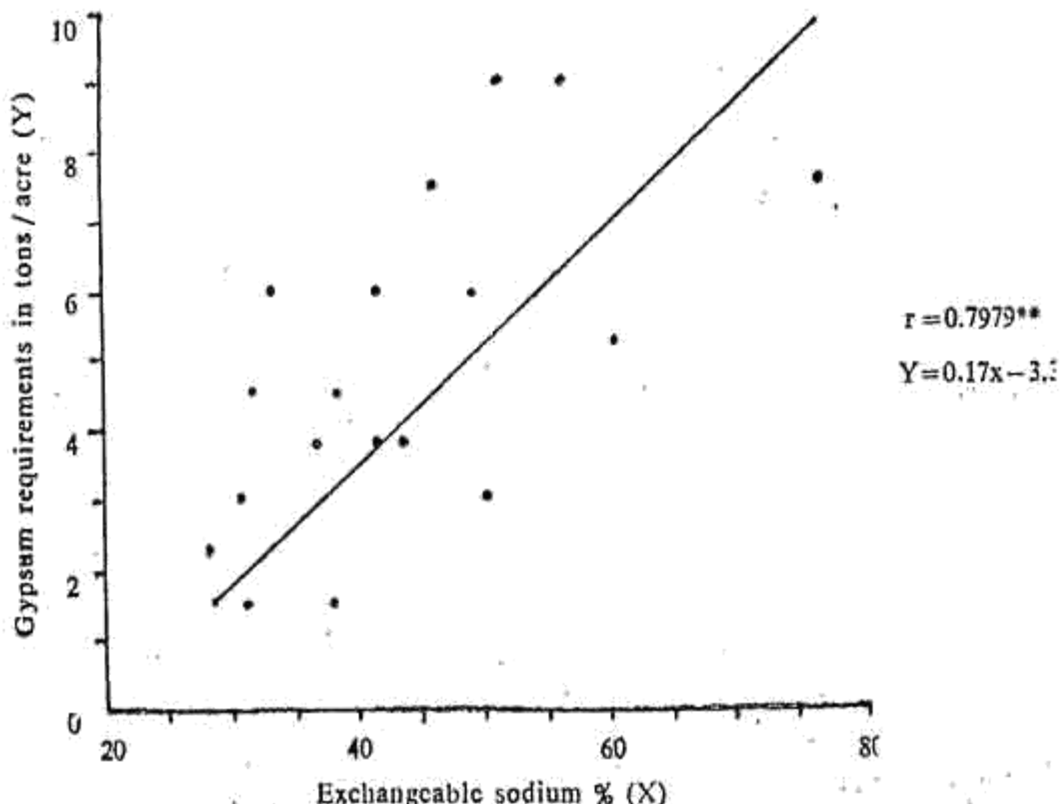

FIGURE 2. Exchangeable sodium % vs Gypsum requirement (Shawarbi Method)

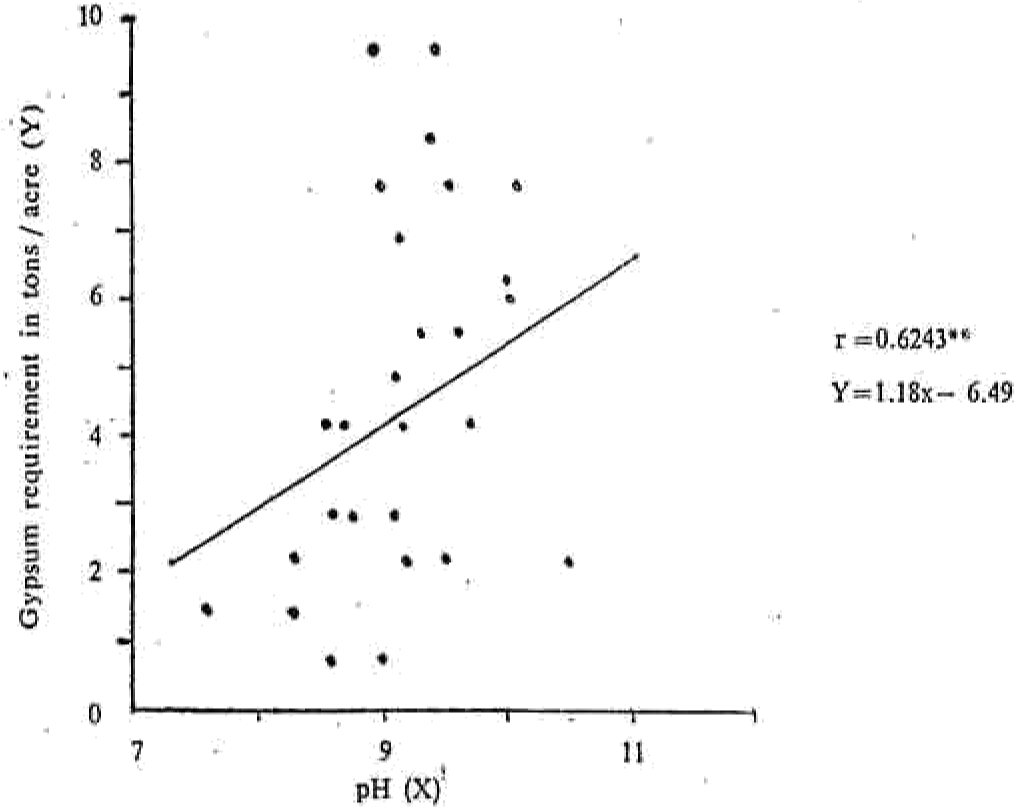

FIGURE 3. pH vs Gypsum requirement (Schoonover - modified)

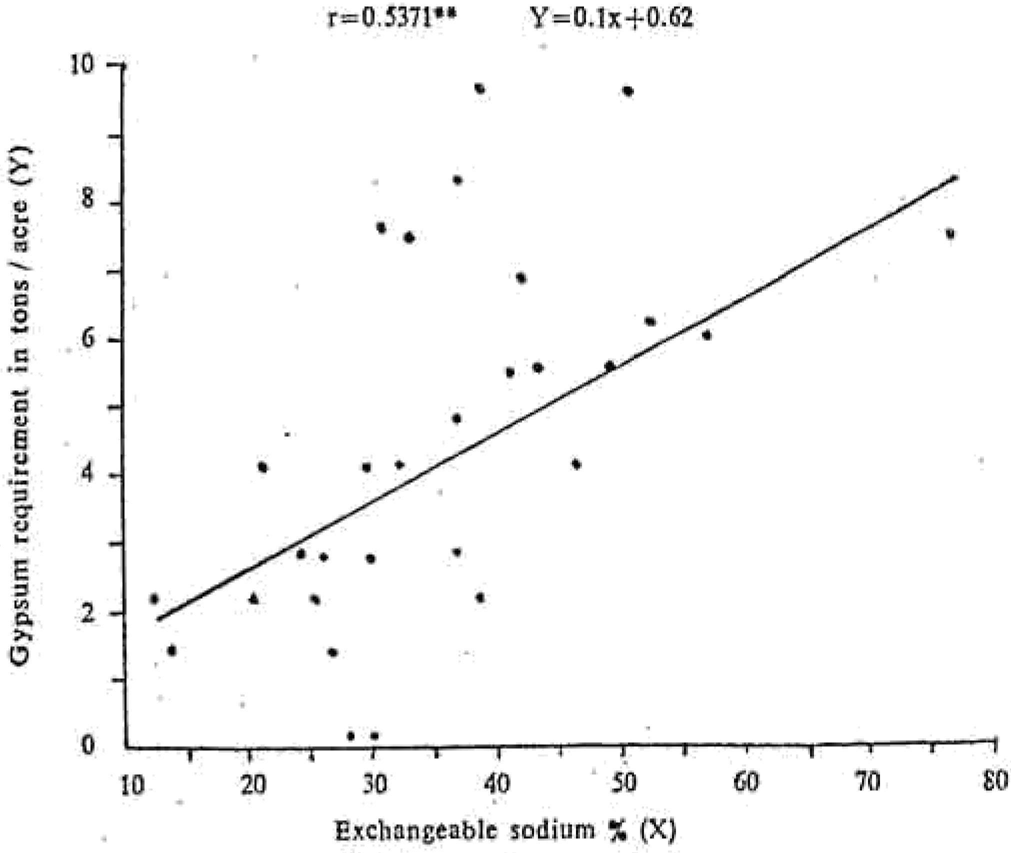

FIGURE 4. Exchangeable sodium % vs Gypsum requirement (Schoonover - modified)

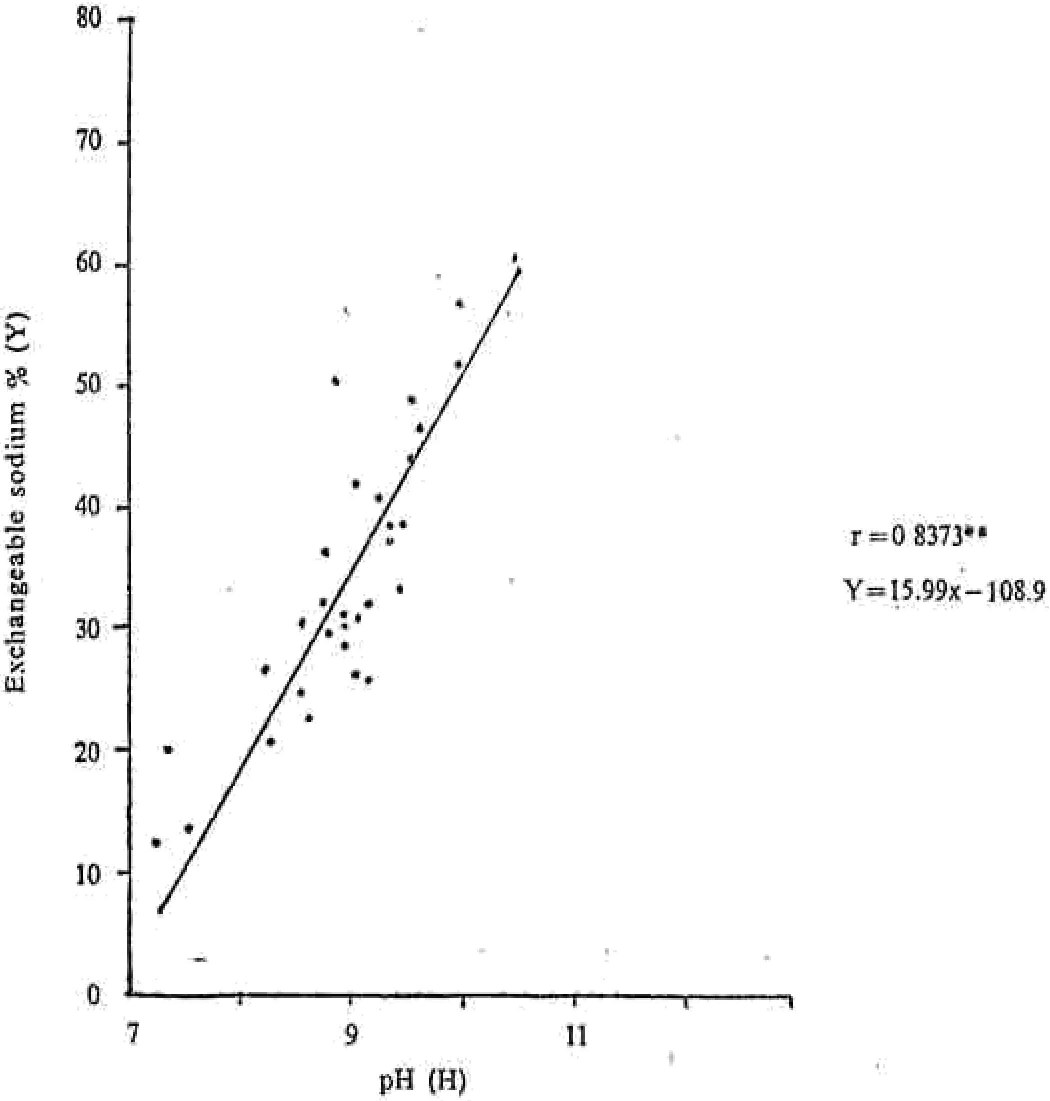

FIGURE 5. pH vs Exchangeable sodium %

for all the four methods studied and the exchangeable sodium percentage on one hand and pH values of the soil samples on the other. However, in respect of the latter relationship very close correlations significant at 1% level were obtained for Shawarbi's method. This was followed by modified method of Schoonover, Schoonover and F.R.S. methods. The above close correlations obtained for Shawarbi's method did reflect on the dosage of gypsum required as seen from the data presented in table 1. For Shawarbi's method the gypsum required for reclaiming an alkali soil having an exchangeable sodium percentage of 35 on an average worked out to 2.74 tons/acre which was indeed an economical dose when compared to those obtained for modified Schoonover, Schoonover and F.R.S. methods. The method of Schoonover, modified as outlined earlier, was found to rank next to Shawarbi's method in respect of the economical dose of gypsum. The unique applicability of Shawarbi's method was further revealed from the fact that Puri and Schoonover methods came in for gypsum requirements even for normal soils.

TABLE 1. *Results of soil analysis and gypsum requirement*

Soil classification	pH	pH after washing with alcohol 40%	E. C. m. mhos /cm.	Exchangeable sodium %	Gypsum requirement in tons per acre (6" depth soil)			
					Schoonover method	Schoonover modified	F. R. S. method	Shawarbi's method
Sandy loam	8.6	9.1	0.55	42.0	11.4	6 9	4 0	6.0
Sandy	8.6	9.1	0 60	30.7	2.2	4.8	2.0	3 0
Clay	8 4	8.9	0 60	50 5	11.7	9.6	6 0	3.0
Loamy sand	9.0	9.7	1 50	46.4	7.7	4.1	4 8	7.5
Sandy clay loam	8 8	9.4	1.00	38.6	12.8	9.6	13.8	4.5
Sandy	8.9	9.5	0 50	38.4	6.6	2.1	4.0	1.5
Sandy loam	9.1	10.0	2 60	52.1	13.5	6.2	13 0	9 0
Sandy clay loam	9.1	10.0	3 00	57.1	16.1	6.0	13 1	9.0
Sandy loam	8.3	9 0	2.60	31.1	11.4	7.6	11.4	1 5
Sandy loam	8.2	8.8	0.50	30.2	8.4	2.8	4.5	—
Clay loam	7.5	7.6	0.40	13.7	4.4	1.4	2.7	—
Sandy clay loam	7.3	7.3	0 35	12 4	4.0	2.1	3 6	—
Sandy loam	9 1	9.6	1.20	49.0	5.3	5.5	4.6	6.0
Clay	8.9	9.6	0 70	43.7	4.9	5.5	3.5	3.8
Sandy loam	8.7	9 2	4.70	31.8	2.3	4.1	2.6	4 5
Sandy clay loam	8.9	9.5	1.20	33.4	8.3	7.6	5.5	6 0
Sandy loam	9.7	10.1	3.40	77.1	8.7	7.6	5.8	7.5
Clay	8 6	9.4	0 95	37.1	7.6	8.3	7.7	3.8
Clay	7.7	8.3	1.80	20.6	2.3	2 1	6.3	—
Sandy loam	8.2	9.0	1.10	28.6	0.8	0.7	2.8	2.3
Clay	7.6	8 3	0.45	26.5	1.5	1.4	4.1	—
Clay	7.8	8.6	0.45	24.6	1.9	2.8	4.5	—
Clay	7.9	8.7	0.30	22.2	0.3	4 1	3.4	—
Clay	8.0	9.1	0.70	26.3	0.3	2.8	3.4	—
Sandy loam	8.0	9.2	0 40	25.4	0.3	2.1	1 0	—
Sandy clay loam	8.0	9 0	0.35	30.8	1.5	0.7	2.2	—
Silty clay loam	8.3	9.3	2.10	41.3	2.3	5.5	2.2	3.8
Sandy	9 9	10.5	3.90	60.5	2.3	2 1	3.5	5 2
Loamy sand	7.1	7.4	0.30	20,0	—	—	1.0	—
Sandy loam	8 0	8.8	1.00	36.8	0.3	2.8	1.2	—
Clay loam	8.0	8 6	0.70	30.4	3 0	0 7	4.0	—
Sandy loam	8 2	8 8	0.70	29.5	2.7	4.1	4.8	—
				Total	166.8	133 7	157.0	87.9
				Average	5.21	4.18	4.9	2.74

TABLE 2. *Correlation coefficients between gypsum requirement, pH and exchangeable sodium % of various methods (No. of samples = 32)*

S. No	Relationship between x	y	Correlation coefficient r	Regression equation	
a)	*Schoonover method*				
1.	pH and gypsum requirement		+ 0.4244*	Y = 2.65 x	− 18.75
2.	Exch. sodium % and gypsum requirement		+ 0.5360**	Y = 0.176x	− 1.06
b)	*F. R. S. method*				
3.	pH and gypsum requirement		+ 0.3753*	Y = 1.74x	− 10.83
4.	Exch. sodium % and gypsum requirement		+ 0.3712*	Y = 0.09x	+ 1.7
c)	*Shawarbi method*				
5.	pH and gypsum requirement		+ 0.7508**	Y = 3.08x	− 25.08
6.	Exch. sodium % and gypsum requirement		+ 0.7979**	Y = 0.17x	− 3.3
d)	*Schoonover method* (modified)				
7.	pH and gypsum requirement		+ 0.6243**	Y = 1.18x	− 6 49
8.	Exch. Na % and gypsum requirement		+ 0.5371**	Y = 0.1 x	+ 0.62
9.	pH and Exchangeable sodium %		+ 0 8373**	Y = 15.99x	− 108.9

* Significant at 5% level ** Significant at 1% level

The gypsum calculated as per Shawarbi's method was, applied at calculated quantities to alkali soil samples on hand on laboratory scale for finding out whether the gypsum requirements based on the above method, if applied to an alkali soil would be sufficient to reclaim it. For this purpose, the original pH values of the soil samples were compared with those recorded after adding gypsum at calculated quantities. The pH values had been markedly reduced in all the soil samples excepting sample No. 5 and 8.

Summary and Conclusions: The utility of the three methods of assessing gypsum requirements namely Schoonover, F.R.S. and Shawarbi for reclaiming the alkali soils of the Madras State was evaluated in this study. Soil samples collected from the typical alkali areas of South Arcot and Coimbatore districts were analysed for initial pH, pH after washing with alcohol, EC, exchangeable sodium percentage, available N and mechanical composition. The gypsum requirements from the above soil samples were assessed not only according to the above three methods but also according to the modified Schoonover method. Based on the theoretical assumption derived from Briksson's equation correlations were worked out between exchangeable sodium percentage values and gypsum requirements calculated as per the above methods on one hand, and on the other between pH and gypsum requirements as per the above

methods Correlation was also worked out between exchangeable sodium percentage and pH values of the soil samples studied. The evaluation of the above relationships, revealed very close correlation between pH and gypsum requirement and exchangeable sodium % and gypsum requirement for Shawarbi's method and was followed by modified Schoonoer's method.

The recommendation that flowed from the Shawarbi's method for application of gypsum worked out to 2.74 tons/acre on an average for reclaiming an alkali soil having exchangeable sodium percentage of 35, which was lower than those obtained for other methods and which was also an economical dose. The above recommendation was tested on the soil samples on hand on laboratory scale and was found to hold good as revealed by the marked reduction in their pH.

Shawarbi's method was found to be easy for adoption by soil testing laboratories for making recommendations on gypsum requirements as it involves no sophisticated instruments.

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