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Study of Applicability of a Modified Durairaj Method of Rapid Mechanical Analysis for Evaluating Soil Texture

by

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Introduction: Several methods have been developed in the past to estimate the mechanical components of soil and each one has its own merits and demerits. Among them, International Pipette Method is considered to be accurate and is widely used. The Bouyoucos (1927) Hydrometer method, though not involving gravimetric estimations, takes considerable time and requires specialised apparatus. When a large number of soils have to be examined in a short time as in Soil Testing Laboratories or in Soil Survey Work, "Feel Method" is employed which depends upon the skill and vast experience of the individual and differs to a great extent between different evaluations. Durairaj (1961) while studying the mechanical components of South Indian soils brought out clearly that the proportions of clay, and fine and coarse sand in soils are highly correlated among themselves. He showed that the correlation was dependent upon soil type, so that for a given soil type and a given value of one of the mechanical components, only one pattern of the values of the rest was possible. He also devised an apparatus for the rapid method of mechanical analysis for the purpose of field workers. Based on his study, his rapid method of mechanical analysis was modified to suit laboratory conditions. This method involves the estimation of course and fine sand fractions, the other fractions being calculated using the multiple regression equations derived for each soil type. Details regarding a comparative study between the values by modified Durairaj method and by International Pipette Method are reported in this paper.

Materials and Methods: Thirty soil samples of alluvial type from Thanjavur district and thirty-two red soils from Dharmapuri and Coimbatore districts were considered for the study. The soils are surface ones as well as those from profile pits.

International Pipette Method: Clay, silt, coarse sand and fine sand fractions were estimated by Robinson Pipette method and the results were expressed on moisture free basis. The samples were pre-treated with N/5 HCl to remove carbonates and hydrogen peroxide in cases where organic matter contents were high.

Modified Durairaj Method: About 50 gm of soil samples (weighed up to two decimals) were taken in a 250 cc tall form beaker and 20 ml of

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1N.NaOH solution were added. Sufficient quantity of rain water was added and stirred well using a glass rod for 15 minutes. Stirring with mechanical stirrer for 10 minutes was found to be more effective for dispersing the clay. The sand particles were allowed to settle for 5 minutes and the supernatant clay supension was decanted. The residue in the beaker was washed thoroughly with rain water to remove clay and silt by decantation process taking care to avoid the pouring off the sand particles. After tho complete removal of clay and silt, the residue was evoporated on a water bath to remove moisture and then dried in an air oven at 105°C for 15 minutes. The residue was transferred to a 100 mesh sieve to separate coarse and fine sand fractions. The two fractions were weighed separately and the percentage was worked out.

To avoid weighing, volumetric estimation of these fractions may be followed. The materials were transferred to a stoppered measuring cylinder (or a burettee with a cork stopper at the top) containing known volume of water. Increase in volume was noted, taking care to avoid the adherence of air particles along the solid portions. The volume increase was multiplied by the densities of coarse sand (2.62) and fine sand (2.85) to obtain the weight. The comparative values of coarse sand and fine sand and fine sand by gravimetric and volumetric estimations is given in Table 1. The densities of sand fractions may vary in the case of laterite soils due to accumulation of ferrigunous gravel and may be experimentally found out.

TABLE 1. *Comparison of gravimetric and volumetric method*

Sample No.	Coarse sand		Fine sand	
	Gravimetric method	Volumetric method	Gravimetric method	Volumetric method
1	17.4	17.2	36.2	36.0
2	20.0	20.4	34.1	34.6
3	13.0	13.0	26.5	26.6
4	11.3	11.4	30.2	30.2
5	13.8	13.6	26.0	26.0
6	52.5	52.6	20.0	20.4
7	53.9	54.0	18.0	18.2
8	55.6	55.6	26.4	26.2
9	59 3	60.0	18.9	18.4
10	57.9	57.2	22 6	22.4

The percentage of clay was calculated by using the values of coarse and fine sand in the following multiple regression equations, for each soil type. The silt fraction was estimated by difference. To avoid calculation using the equation each time, a three-dimensional table can be conveniently prepared for each soil type, to find out the values of clay from the values of sand fractions.

Soil type	Multiple regression equation	Derived by
Alluvial soil	$Y=76.6-0\ 866X_1-0\ 704X_2$	Durairaj (1961)
Red soil	$Y=76\ 2-0.88\ X_1-0.92\ X_2$	Authors
Black soil	$Y=77.6-1.21\ X_1-0.369X_2$	Durairaj (1961)
Laterite soil	$Y=63.2-0\ 862X_1-0.481X_2$	Durairaj (1961)

Y = Clay ; X_1 = Fine sand ; X_2 = Coarse sand.

The values obtained by the above two methods are tabulated in a comparative way in Tables 3 and 4.

Results and Discussion : The regression equations derived by Durairaj (1961) were utilised for alluvial soils and for red soils ; the multiple regression equation was derived by the authors from the analyses of 20 red soils.

The values obtained for each fraction by the two methods agree quite closely in the case of alluvial soils, with a maximum deviation of ± 9.0. In the case of red soils the frequency of deviation was higher. The frequency of deviation from pipettee method is given in Table 2. The mean deviations for each fractions are given at the ends of Tables 3 and 4. The acid solubles and organic matter contents may separately be estimated for the soils rich in these contents and corrections could be made for arriving at more accurate values.

TABLE 2. *Frequency of deviation from pipette method*

Mechanical fraction	Deviation below $\pm$ 5.0 (absolute values)	Deviation between $\pm$5.0 and $\pm$ 10 0 (absolute values)	Number of samples
Alluvial Soil			
a) Coarse sand	29	1	30
b) Fine sand	29	1	30
c) Clay	23	7	30
d) Silt	30	Nil	30
Red Soil			
a) Coarse sand	23	9	32
b) Fine sand	27	5	32
c) Clay	28	4	32
d) Silt	28	4	32

The textural classification based upon the triangular diagram of U.S.D.A. for the values by the two methods are identical. This proves the validity of the modified rapid method for most of the practical purpose of textural classification especially in Soil Testing Laboratories and in Soil Survey Work.

TABLE 3. *Comparative values of soil separates by the two methods (Alluvial Soil)*

Coarse sand % estimated by		Fine sand % estimated by		Clay % estimated by		Silt % estimated by		Textural classification	
Pipettee method	Modified Durairaj method	Pipette method	Modified Durairaj method	Pipette method	Modified Durairaj method	Pipette method	Modified Durairaj method	Pipette method	Modified Durairaj method
1	2	3	4	5	6	7	8	9	10
Negamangalam									
18.4	17.4	35.1	36.2	33.8	33.0	9.6	13.7	Sandy clay	Sandy clay
20.6	20.0	32.1	34.1	32.1	33.0	10.6	12.9	-do-	-do-
14.1	13.0	27.1	26.5	42.5	44.5	11.5	16.1	Clay	Clay
15.3	11.3	27.5	30.2	39.2	42.5	13.0	16.0	-do-	-do-
15.0	13.8	30.1	26.0	37.7	44.4	14.4	15.9	-do-	-do-
10.2	8.7	23.1	22.0	47.6	51.4	14.9	16.8	-do-	-do-
12.1	12.0	27.5	30.8	47.4	41.5	13.3	15.7	-do-	-do-
9.1	8.4	28.6	29.0	49.2	45.6	13.6	18.1	-do-	-do-
12.6	11.2	29.1	29.0	45.0	43.6	14.2	16.2	-do-	-do-
Sikkil									
4.2	4.8	36.9	38.2	42.2	40.1	17.2	16.8	-do-	-do-
4.5	5.7	38.1	35.4	41.3	41.9	16.4	17.0	-do-	-do-
4.8	6.1	37.9	32.5	40.1	44.1	16.7	16.3	-do-	-do-
5.1	5.2	30.4	30.0	40.2	47.0	17.1	17.9	-do-	-do-
5.4	6.8	30.7	31.0	38.5	45.0	20.3	17.2	-do-	-do-
4.4	4.4	28.0	27.5	41.9	49.7	15.8	18.4	-dc-	-do-
4.4	4.2	22.8	20.6	46.8	55.8	18.3	19.4	-do-	-do-
4.2	4.0	24.3	25.0	47.1	52.2	17.8	18.8	-do-	-do-
9.0	6.7	43.1	47.0	27.2	31.2	11.1	15.1	Sandy clay loam	Sandy clay loom
Kallathottam									
52.9	52.3	19.1	18.9	22.7	23.4	5.0	5.4	-do-	-do-
62.6	58.9	12.7	16.6	22.8	20.8	4.3	3.8	-do-	-do-
49.7	48.7	19.8	20.8	23.9	24.3	6.4	6.2	-do-	-do-

1	2	3	4	5	6	7	8	9	10
Kalluthottam contd.									
58.5	57.0	15.8	17.0	21.5	21.7	4.5	4.3	Sandy clay loam	Sandy clay loam
55.9	55.6	14.9	15.1	25.4	24.4	4.6	4.9	-do-	-do-
59.3	57.0	18.6	20.4	19.5	18.8	4.3	3.8	Sandy loam	Sandy loam
55.0	55.9	18.2	17.9	20.4	21.7	6.8	4.5	Sandy clay loam	Sandy clay loam
53.9	52.5	18.0	20.0	25.4	22.3	3.6	4.2	-do-	-do-
57.2	53.9	15.0	18.0	25.0	23.7	2.9	4.4	-do-	-do-
Pattukkottai									
60.7	55.6	22.7	26.4	15.5	14.6	3.0	3.4	Sandy soil	Sandy soil
58.3	59.3	20.8	18.9	18.7	18.5	2.7	3.4	Sandy loam	Sandy loam
61.5	57.9	19.7	22.6	16.3	16.2	2.3	3.2	Sandy soil	Sandy soil
Mean of deviations from International method									
	1.38		2.17		2.87		1.63		

TABLE 4. *Comparative values of soil separates by the two methods (Red Soil)*

Coarse sand % estimated by		Fine sand % estimated by		Clay % estimated by		Silt % estimated by		Textural classification	
Pipette method	Modified Durairaj method	Pipette method	Modified Durairaj method	Pipette method	Modified Durairaj method	Pipette method	Modified Durairaj method	Pipette method	Modified Durairaj method
1	2	3	4	5	6	7	8	9	10
Thimmapuram									
54.6	48.3	19.5	24.6	10.8	10.1	15.8	17.0	Sandy loam	Sandy loam
40.1	45.8	12.0	8.4	20.4	26.6	16.5	19.2	Sandy clay loam	Sandy clay loam
46.4	48.5	12.4	10.4	20.4	22.4	17.9	18.7	-do-	-do-
56.3	58.4	11.3	10.0	8.5	13.7	16.5	17.9	Sandy loam	Sandy loam
52.4	56.2	12.3	8.6	13.9	16.9	17.8	18.2	-do-	-do-
59.7	64.3	11.9	7.7	6.1	10.3	15.5	17.7	-do-	-do-
62.2	66.9	12.4	7.6	3.1	4.0	12.8	11.5	-do-	-do-
60.1	65.8	14.8	10.0	2.8	6.9	12.4	17.4	-do-	-do-

1	2	3	4	5	6	7	8	9	10
Thimmapuram contd.									
42.9	36.1	9.2	14.8	35.0	30.0	12.9	19.1	Sandy clay	Sandy clay
33.8	29.8	17.3	20.8	33.7	30.5	16.2	18.9	-do-	-do-
52.5	56.1	16.4	14.0	15.4	12.3	14.3	17.6	Sandy loam	Sandy loam
64.3	68.9	17.8	13.8	4.3	1.1	12.4	17.2	Sand	Sand
50.7	52.3	25.1	23.4	5.6	7.2	15.5	17.1	Sandy loam	Sandy loam
39.5	39.1	18.0	18.0	21.3	24.4	12.8	18.5	Sandy clay loam	Sandy clay loam
33.0	36.2	17.3	13.0	31.0	31.4	17.6	19.4	Sandy clay	Sandy clay
31.9	34.1	18.8	15.7	30.7	31.1	13.6	19.2	Clay	Clay
26.4	30.0	24.6	20.6	30.8	30.5	19.1	18.9	Sandy clay	Sandy clay
28.4	30.4	23.5	20.5	24.2	29.2	18.1	19.9	Sandy clay loam	Sandy clay loam
43.4	37.3	19.3	25.5	19.7	19.4	17.9	17.9	Sandy loam	Sandy loam
35.3	41.7	35.3	30.4	15.4	11.2	13.7	16.8	-do-	-do-
34.1	35.3	32.7	30.8	15.6	16.7	16.2	17.3	-do-	-do-
26.5	20.0	35.8	35.0	19.6	19.6	16.4	17.4	-do-	-do-
23.4	23.0	44.1	44.0	14.6	16.3	13.2	16.7	-do-	-do-
23.5	30.8	48.2	41.1	8.8	11.4	18.2	16.7	-do-	-do-
25.5	30.7	48.4	42.4	9.7	10.6	18.8	16.4	-do-	-do-
25.9	26.9	41.4	40.7	16.8	15.6	15.1	16.9	-do-	-do-
Coimbatore									
1.1	1.1	1.8	2.0	70.2	73.4	18.5	13.3	Clay	Clay
2.2	5.2	10.4	6.4	63.4	66.8	17.8	21.6	-do-	-do-
1.5	1.6	6.3	6.0	63.1	69.4	23.8	23.0	-do-	-do-
3.2	3.4	14.3	13.8	66.1	71.9	12.1	10.9	-do-	-do-
1.0	1.7	9.3	9.0	66.6	76.7	20.8	22.6	-do-	-do-
1.6	1.6	12.6	12.0	70.5	73.6	14.3	12.8	-do-	-do-
Mean of deviations from International method									
	3.34		2.97		2.99		2.42		

This modified method differs from Durairaj method of rapid mechanical analysis, in using sodium hydroxide for complete dispersion of clay and in the estimation of both the fractions of sand instead of coarse sand alone. The use of the values of boath the fractions in the multiple regression equations give more precise value for clay. This method can be done only in laboratories whereas the device by Durairaj can be used by field workers.

Summary: A modified Durairaj method of rapid mechanical analysis for evaluating the soil separates was adopted, based upon the correlations of proportions of different separates depending upon soil type. The values were compared with International pipette method. The close agreement of the values by the two methods and especially of the textural classification proves the validity of this modified method for adoption in Soil Testing Laboratories and in Soil Survey work.

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REFERENCES

Bouyoucos, G. J. 1927. The Hydrometer as a new method for the mechanical analysis of soils. *Soil Sci.*, **23**: 343.

Durairaj, D. J. 1961. Study of relationship between Mechanical components of South Indian Soils. *J. Indian Soc. Soil Sci.*, **9**: 13-28.

Chemical Transformations in Paddy Soils of Tamil Nadu in Relation to Paddy Growth and Yield

I. Progressive Variations in Chemical Composition of Soils

by

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Introduction: Rice being the staple diet of a large section of the population, a detailed study of the transformation of nitrogen and phosphorus in submerged paddy soils and of factors which might induce the increase of toxic principles to deleterious levels is bound to be of great importance in the economic use of nitrogen and phosphorus fertilisers under varying soil conditions.

Although benefits of green manuring have been observed in paddy soils, no systematic attempt has been made in paddy soils of Tamil Nadu to understand the behaviour of rice plant in relation to its peculiar chemical regime, which is totally different from that of normal upland soils. In the present investigation, it was proposed to investigate this aspect in detail.

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