https://doi.org/10.29321/MAJ.10.A03673

Nutrient Status and Cation Exchange Capacity of High Level Nilgiri Soils*

by

P. K. MAHALINGAM[1] and D. J. DURAIRAJ

Introduction: Generally laterite soils are very poor in available nutrients and low in cation exchange capacity. In another paper the physical and chemical properties of the Nilgiri soils have been discussed in detail and the soils classified and assigned their proper place among established soil groups. In this paper features regarding the cation exchange capacity and plant nutrient content of the soils of Nilgiris are discussed and an attempt was made to classify them based upon elevation and certain salient features of the soils to bring out clearly the differences in their agronomic use and capability.

Materials and Methods: Thirty eight surface (0–9") soil samples were collected from regions with varying rainfall (50"–90") and altitude (1500' to 8000') in Nilgiri district (Fig. I). The samples were analysed for nitrogen, total and available phosphoric acid, available potash, organic carbon, cation exchange capacity and exchangeable cation employing standard methods of analysis. The data were examined statistically for correlation.

Results and Discussion: Data for nutrient element content, cation exchange capacity and exchangeable cations are presented in Table 1. Total phosphoric acid was generally high for all the samples and ranged from 0·10 to 0·41 per cent. Available phosphoric acid and potash were generally low and varied from trace to 0·02 per cent and 0·031 to 0·072 per cent respectively. The nitrogen content was high and varied from 0·03 to 0·41 per cent. There was a significant correlation ($r = 0{\cdot}655$) between elevation and nitrogen (*Vide* Table 2).

Organic carbon was high and ranged between 0·24 and 4·00 per cent. A significant positive relationship was obtained between elevation and organic carbon ($r = 0{\cdot}548$) (Fig. II). The carbon/nitrogen ratio varied widely from as low as 4·0 to as high as 25·0. There was a general trend for this ratio to increase with increasing rainfall and elevation.

---

* Part of the dissertation of first author submitted for the award of M. Sc. (Ag.) in Soil Science by Madras University.

[1] Assistant Lecturer in Chemistry, Agricultural College, Coimbatore.

[2] Professor of Soil Science, Agricultural College and Research Institute, Coimbatore - 3.

Received on 31—1—1968.

FIG. I.

MAP OF NILGIRIS — LOCATION OF SAMPLE PITS.

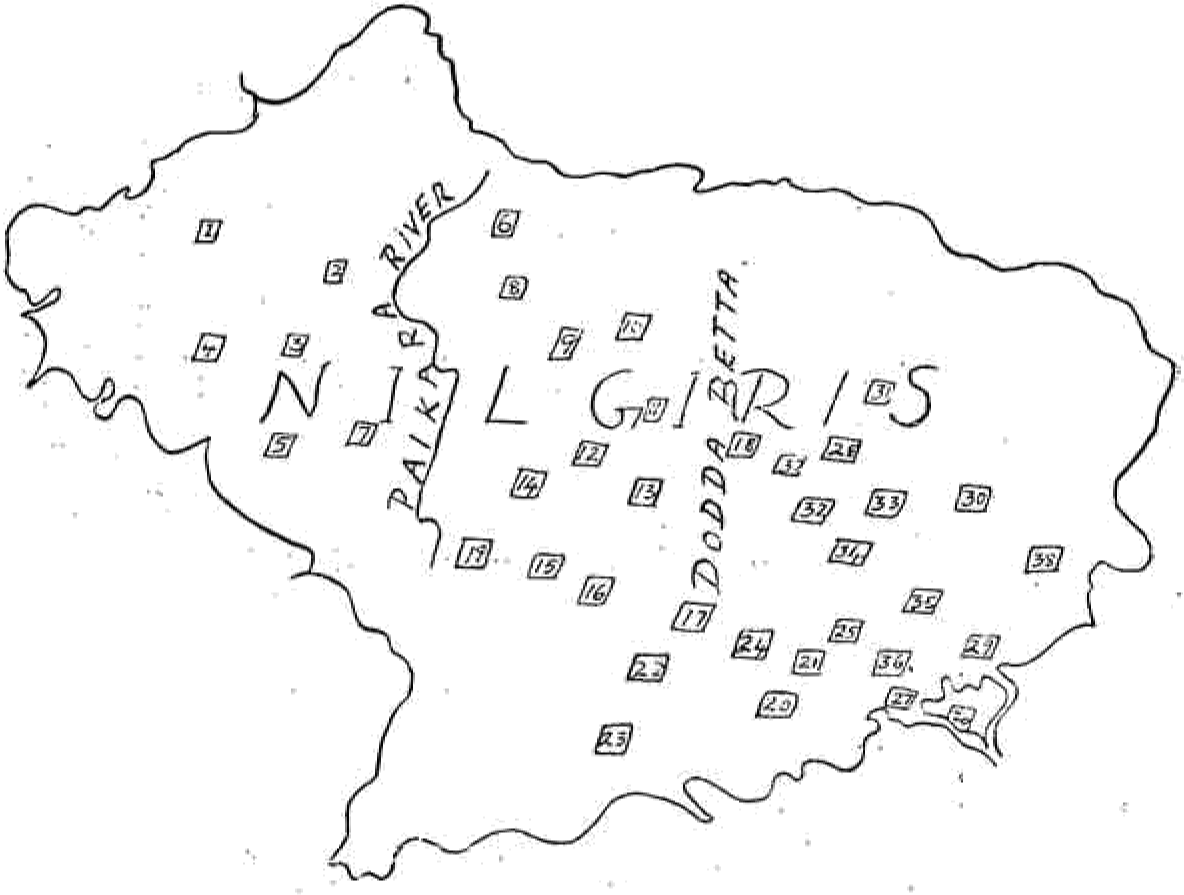
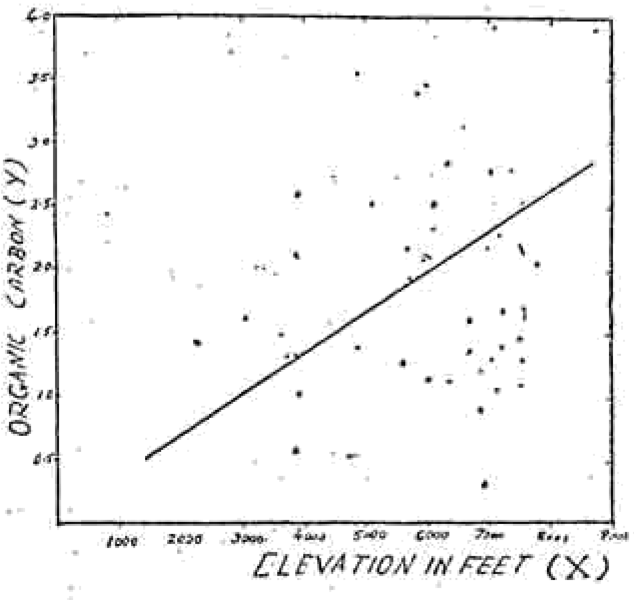


FIG. II

Regression of Organic Carbon on Elevation



r = 0·548

N = 38

y = 0·00033 × — 0 01

As the soils are of lateritic type, the cation exchange capacity of the soils analysed were understandably very low and ranged from 5·1 m. e. to

TABLE 1

Sample No.	Locality		Rainfall in inches	Elevation in feet	Nitrogen	Organic carbon	Carbon / Nitrogen ratio	Cation Exchange capacity	Exchangeable		
									Calcium	Magnesium	Potassium
(1)	(2)		(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1.	Tharapalli	...	90	3600	0·10	1·20	12·0	7·2	5·2	1·0	0·7
2.	Salisbury	...	90	3500	0·11	1·20	11·8	8·0	3·7	3·1	1·3
3.	Gudalur	...	90	3500	0·03	0·48	16·0	7·4	2·9	1·0	1·3
4.	Ovally Road	...	90	3600	0·23	2·58	11·2	14·8	10·1	3·6	1·1
5.	Marappalam	...	90	3400	0·15	1·44	10·3	10·1	1·6	1·0	0·7
6.	Sigur Bridge	...	90	3500	0·10	1·02	10·2	14·0	11·1	2·3	0·6
7.	Theppakadu	...	90	3500	0·11	2·10	19·0	18·8	14·7	3·6	0·5
8.	Sholur	...	60	7200	0·15	4·00	25·0	7·9	3·1	1·6	2·1
9.	Melur	...	60	7000	0·10	0·84	8·4	8·8	2·3	2·8	1·6
10.	Kavaratty	...	60	6800	0·08	0·66	8·2	10·1	1·9	1·7	2·9
11.	Dhavani	...	60	6800	0·23	0·24	4·0	5·3	1·4	1·1	2·8
12.	Mullkikorai	...	60	7300	0·15	2·28	15·2	8·0	1·4	2·7	3·5
13.	Ootacamund	...	55	7200	0·23	2·36	12·0	10·5	2·5	2·1	4·3
14.	Emerald Camp	...	60	6900	0·16	1·14	7·1	15·0	5·8	3·0	4·1
15.	Nanjanad	...	60	7100	0·19	2·22	11·7	13·7	4·7	2·7	6·1
16.	Pudubatty	...	60	7200	0·11	1·26	11·5	5·1	1·1	0·4	1·0
17.	Kotty Valley	...	55	6000	0·18	2·46	13·1	8·2	2·2	1·5	1·0
18.	Doddabetta peak	...	60	8600	0·41	3·90	9·5	9·6	2·4	2·8	3·6

TABLE 1. (Contd.)

Sample No.	Locality	Rainfall in inches	Elevation in feet	Nitrogen	Organic corbon	Carbon / Nitrogen ratio	Cation Exchange capacity	Exchangeable Calcium	Exchangeable Magnesium	Exchangeable Potassium
19.	Uppor Bhavani ...	60	7900	0·17	2·10	12·3	16·9	2·9	2·1	1·5
20.	Katary ...	55	5900	0·07	0·90	13·0	8·3	3·9	1·3	3·1
21.	Karumpalam ...	55	5500	0·11	1·14	10·3	12·3	5·5	2·9	3·3
22.	Adikaratti ...	60	7300	0·16	1·68	10·5	14·0	0·9	0·3	0·7
23.	Manjoor ...	55	6800	0·11	1·08	9·8	7·5	3·9	1·0	0·6
24.	Aruvankadu ...	55	6500	0·14	1·56	11·1	7·7	0·9	1·4	1·3
25.	Coonoor ...	60	6000	0·13	2·28	13·0	11·1	4 6	3 3	2·1
26.	Kallar ...	60	1500	0·14	1·38	9·8	12·7	7·7	3·0	2·1
27.	Burliar ...	60	3000	0·13	1·68	13·0	13·6	10·1	2·2	2·1
28.	Naragiri ...	50	5500	0·14	1·36	11·8	9·4	5·1	1·5	1·5
29.	Konavakorai ...	50	5000	0·17	2·46	14·5	10·6	5·7	2·3	2·2
30.	Benthatty ...	50	6000	0·20	3·54	17·7	13·1	4·4	0·7	2·4
31.	Kookal valley ...	50	4500	0·15	1·26	8·4	9 9	2·9	2·7	3·1
32.	Farm Tea Estates ...	50	5900	0·32	3·46	10·8	12·6	5 6	2·9	2·8
33.	Kotagiri ...	50	6200	0·09	0·90	10·0	7·6	1·5	2·9	3·1
34.	Ghoro Houso ...	50	5800	0·29	2 04	7·0	8·9	5·5	1·1	2·0
35.	Jackanarai ...	50	6300	0·20	2·82	14·1	14·5	10 7	1·8	2·5
36.	Hadathorai Estates ...	50	5500	0·13	2·16	16·6	8·2	3·2	2·1	2·6
37.	Gundada ...	50	6500	0 14	1·20	8·6	8·0	1·3	1·1	2·1
38.	Kongarai ...	50	5000	0·21	3·66	17·4	7·4	2·4	3·0	2·0

TABLE 2. *Results of Statistical Analysis for Correlation*

S. No.	Relationship between X	Y	Correlation coefficient (r)	Regression equation
1.	Elevation	organic carbon	+ 0·548***	Y = 0 00033X — 0·01
2.	Elevation	Nitrogen	+ 0·655***	Y = 0·00027X — 1·37
3.	Elevation	Cation Exchange capacity	— 0·319*	Y = 03·62 + 0·00055X
4.	Elevation	Carbon/Nitrogen Ratio	+ 0·495*	Y = 7·39 + 0·0014 X
5.	Rainfall	Nitrogen	+ 0·298	X = ...
6.	Rainfall	Organic carbon	— 0·422*	...
7.	Organic carbon	Nitrogen	+ 0·849***	Y = 0·03 + 0·0662 X
8.	Cation Exchange Capacity	Exchangeble calcium	+ 0·746***	Y = 0·731X — 2·93

NOTE: *** Significant at 0·1 per cent level
* Significant at 500 per cent level.

18·8 m. e. per 100 gm. of soil. There was a significant negative correlation (r = 0·319) between elevation and cation exchange capacity. Exchangeable calcium, magnesium and potassium were very low in all the samples. There was no significant relationship between mean annual rainfall or elevation and the individual cations.

There was a significant correlation (r = 0·348) between elevation and organic carbon. This may be due to the low temperature and high rainfall of high elevations. The high rainfall is conducive to profuse growth of vegetation leading to production of high amounts of organic matter, the decomposition of which is retarded by the prevailing low temperature. Similar results were obtained by Costin *et al.*, (1952), Jenny and Raychaudhuri (1958) and Unnikrishnan (1961).

In high rainfall areas, due to luxuriant vegetative growth and consequent addition of organic matter to soil there is the possibility of high nitrogen content in the soil. There was a general trend of relationship between rainfall and nitrogen. This was similar to that obtained by Dean (1937) and Jenny and Raychaudhuri (1958). A significant positive correlation (r = 0·655) was obtained between elevation and nitrogen. The observations indicated a general trend for the carbon/nitrogen ratio to increase with increasing rainfall. There was a significant positive correlation (r = 0·495) between elevation and carbon/nitrogen ratio. The soils studied were high in total phosphorus but the available phosphorus and potash were very low. This may be due to the fixation of phosphorus by iron and alumina, which have been established in the previous paper, to be very high in these soils. This is supported by the work of Martin and Doyne (1927), Mariakulandai and Venkatachalam (1955) and Brito Muthunavagam (1957).

The data obtained indicated no relationship between the mean annual rainfall and cation exchange capacity of Nilgiri soils, but there was a significant negative correlation ($r = -0{\cdot}319$) between altitude and cation exchange capacity.

Nilgiri soils could be classified into four broad classes based upon the observed association of texture and nutrient status with elevation. This classification has a bearing on the agronomic use capability of the soils.

Class I: Soils upto an elevation of 3000 feet. Loamy sand with fair amounts of nitrogen and organic matter and low amounts of iron and aluminium oxides.

Class II: 3000 feet to 5000 feet. Sandy loam, with medium amounts of nitrogen, organic carbon, iron and alumina.

Class III: 5000 feet to 7000 feet. Sandy clay-loam, with high amounts of nitrogen and organic matter and fairly large amounts of iron and alumina.

Class IV: 7000 feet and above. Sandy clay-loam, with fair amounts of nitrogen and organic matter, high amounts of iron and alumina and very low amounts of alkali and alkaline earth bases.

Summary and Conclusions: Thirty eight surface soil samples representing different altitude and rainfall in the Nilgiris were analysed for their cation exchange capacity, organic carbon and important plant nutrient elements. The effect of mean annual rainfall and elevation on these constituents was statistically worked out and the following conclusions were arrived at.

A negative correlation between elevation and cation exchange capacity and a positive correlation between cation exchange capacity and exchangeable calcium were noticed. The organic carbon and nitrogen were correlated significantly with elevation. There was a general increase of nitrogen with mean annual rainfall. There was a high positive correlation between organic carbon and nitrogen. The carbon/nitrogen ratio increased significantly with elevation and also showed a definite tendency to widen with increasing rainfall. The total phosphorus was high, but the available phosphorus and potash were very low.

Nilgiri soils could be classified into four classes depending on the texture, nitrogen, organic carbon and sesquioxide content and elevation, this classification being useful in deciding upon the agronomic use of these soils.

Acknowledgement: The authors' thanks are due to the University of Madras for kindly granting permission to publish the above work which formed part of the dissertation by the first author under the guidance of the second author.

REFERENCES

BRITO MUTHUNAYAGAM, A. P. K. 1957. Studies on soil phosphorus I. chemical nature and distribution of phosphorus in soils of Travancore-Cochin. *Bull. Cent. Res. Inst.*, **24**: 63-76.

COSTIN, A. B., E. G. HALLSWORTH and M. WOOF. 1952. Studies in pedogenesis in New South Wales III. Alpine humus soils. *J. Soil. Sci.*, **3**: 190.

DEAN, L. A. 1937. The effect of rainfall on the carbon nitrogen content and carbon/nitrogen ratios of Hawaiian soils. *Soil Sci. Soc. Amer. Proc.*, **2**: 455-60.

JENNY, H. and S. P. RAYCHAUDHURI, 1958. *Effect of climate and elevation on the organic matter reserves of Indian Soils*. I. C. A. R. New Delhi.

MARIAKULANDAI, A. and S. VENKATACHALAM, 1955. Improvement of phosphate availability in laterite soils of Nilgiris by application of silico-phosphates. *J. Indian Soc. Soil Sci.*, **3**: 15-22.

MARTIN, F. J. and H. C. DOYNE, 1927. Laterite and lateritic soils of Sierra Leone. *J. agric. Sci.*, **17**: 530-47.

UNNIKRISHNAN, K. 1961. The effect of rainfall and elevation on the properties of laterite soils. Diss. M. Sc. (Ag.) Univ. of Madras (Unpubl.).

Effect of Increasing Levels of N and P on the Uptake of Nitrogen and Yield of Wheat *

by

R. M. SINGH [1] and B. P. GOVIL [2]

In recent years there has been a tendency to use high levels of fertilizers to secure high yields of crops. Without knowing the actual requirement of a crop in a given area, indescriminate use of fertilizers may result in its waste, loss of yield and reduction in the margin of profit. In heavy soils of Udaipur, nitrogen is a limiting factor. While determining its actual requirement, it was thought necessary to study if application of phosphate has any influence on the nitrogen nutrition and yield of wheat. With this end in view, a field experiment consisting of different levels of N and P was laid out.

---

* Contribution from the Department of Agronomy, University of Udaipur.

[1] Associate Dean and [2] formerly Post Graduate student.

Received on 2—1—1968.