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A study on the relationship between Nitrogen and Organic matter in Urban and Rural Composts *

by

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Synopsis: The relationships between total nitrogen and organic carbon between total nitrogen and organic matter, between organic carbon and organic matter in the compost samples collected from municipalities, from panchayats and panchayat unions have been studied by working out their correlation coefficients and regression equations. The findings of the study are discussed in this paper.

Introduction: In tropical and subtropical countries where the humus content of soils is poor due to to the high temperature and low moisture conditions, the problem of constantly replenishing the organic matter content to maintain the normal fertility of soil assumes greater importance. Besides improving the general tilth and moisture holding capacity of the soil, organic matter supplies nitrogen in a form which is not easily lost by rain, but at the same time becomes gradually available by a process of nitrification. Black and Goring (1953) have reported that the carbon, nitrogen and phosphorus contents of organic materials are positively correlated. Ghosh (1959) has reported on the existence of a positive correlation between the organic matter and nitrogen contents in the compost produced by Municipalities of the Bihar State, from town-refuse and night-soil. He has also laid down that the calculated values of organic matter, obtained by multiplying the nitrogen values of compost samples by 17·7 were very proximate to those found experimentally. The present study was undertaken with a view to finding out whether any such correlation exists between organic matter and total nitrogen contents, on the one hand, between total nitrogen and organic carbon, and between organic matter and organic carbon in compost produced by Municipalities, Town Panchayats and panchyat unions of the Madras State, on the other. The results of the findings are reported below.

Review of Literature: Acharya *et al.* (1946) showed that there is greater availability of "available nitrogen" in compost having a C/N ratio less than 12 : 1. Shrikhande (1946) reported that the conservation of all nitrogen in night-soil is possible only when there is enough carbonaceous material for composting. Lyon and Buckman (1952) laid down that since a more or less definite ratio is known to exist between the organic nitrogen and the organic matter in a soil, the amount of organic matter that can be maintained in any soil is contingent upon the amount of Nitrogen present, and as such the percentage of nitrogen present may serve to indicate the organic matter level

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of soil. Krishnamurthy and Samboornaraman (1964) in their studies on the quality of composts produced by the local bodies of the Madras State during the years 1956—'60, observed that taking the nitrogen and phosphoric acid contents of compost, Tirunelveli compost was consistently good followed by North Arcot. Jeyasingh Bennet *et al* (1964) have reported a close correlation between the nitrogen and phosphoric acid contents in urban composts of Madras State and suggested the phosphating of compost for increasing its nitrogen content. Ramanathan *et al* (1964) in their study on the composting of Sea weeds showed that the composting of Sea weeds washed in fresh water under pit system produced compost richer in nitrogen and phosphoric acid contents.

Materials and Methods: For the present study, out of the compost samples collected from Municipalities, Town Panchayats and Panchayat unions during the period from January 1963 to September 1963, fifty compost samples were selected at random, each for Municipalities, panchayats and panchayat unions. In the case of Municipalities and panchayats, the composting was carried out in piles. Rectangular piles measuring $40' \times 11'$ at the base were built up to a height $3\frac{1}{2}'$ with alternate layers of rubbish and night-soil, in beds of 9" and 3" respectively. The piles were provided with adequate moisture. The rubbish were allowed to decompose for a period of six months, after which the compost was removed for field application. On an average, about 20 tons of compost was obtained from each compost heap. Compost samples drawn from several points in a heap were mixed and a composite sample representative of 3 or 4 heaps was prepared. In the case of panchayat unions, composting was done strictly according to the Bangalore method in pits of $15' \times 8' \times 3'$ from farm wastes, using cow dung emulsion as the starter. In the case of panchayat unions, each compost sample was representative of four tons of compost and which was obtained after decomposition for a period of six months. In the laboratory, the compost samples were treated with dilute acetic acid to prevent further decomposition, air-dried, powdered and passed through one millimeter mesh sieve before taking them up for chemical analysis. The total nitrogen content of the compost samples was determined by the Kjeldahl method. The organic matter content of the compost samples was determined by igniting them till a constant weight was obtained, and there by calculating the loss on ignition on oven dry basis. The analysis for the organic carbon content of compost samples was carried out by Walkley and Black's method (1934).

Results and Discussion: The data obtained for total nitrogen, organic matter and organic carbon contents were first plotted on a graph sheet for finding out the trend in the relationships between total nitrogen and organic matter contents, between total nitrogen and organic carbon contents, and between organic carbon and organic matter contents of the compost samples. Even though the individual data obtained for the total nitrogen, organic matter and organic carbon contents of the compost samples were utilised for studying the relationship between total nitrogen and organic matter on the one hand, between total nitrogen and organic carbon, and between organic carbon and organic matter on

the other, only their average values obtained under each district for Municipalities and Panchayats separately are presented in Tables I and II, in order to present a precise picture for the total nitrogen, organic matter and organic carbon contents of the compost samples that were studied. In the case of panchayat unions, the average values presented in Table III are in respect of each panchayat union. The degree of relationship between total nitrogen and organic matter, between total nitrogen and organic carbon and between organic carbon and organic matter was found out by working out their correlation coefficients. The correlation coefficients, thus obtained along with their regression coefficients and regression equations, are presented in Table IV. The figures (i), (ii) and (iii) for Municipalities, Panchayats and Panchayat Unions, respectively, contain the regression lines for the above mentioned relationships and they are found to have a linear trend.

TABLES I & II

Data for Total Nitrogen, Organic Matter and Organic Carbon (District-wise expressed as percentage on Ovendry basis)

S. No.	Name of District	Nitrogen	Loss on ignition	Organic carbon
		Municipalities		
I				
1.	Coimbatore	... 1·7	21·5	10·0
2.	Madurai	... 1·0	13·1	7·2
3.	Tirunelveli	... 1·5	24·3	12·2
4.	Tanjore	... 1·2	18·4	8·4
5.	Trichy	... 0·9	16·7	7·9
6.	North Arcot	... 1·1	17·4	9·5
7.	South Arcot	... 0·8	9·1	8·0
8.	Chingleput	... 0·5	9·5	3·5
9.	Ramnad	... 0·9	14·7	5·6
10.	Salem	... 0·4	12·5	3·8
11.	Kanyakumari	... 1·1	15·8	7·2
12.	Nilgiris	... 1·0	31·5	13·5
II		*Panchayats*		
1.	Coimbatore	... 0·9	13·3	6·4
2.	Madurai	... 0·8	15·9	6·8
3.	Tirunelveli	... 1·0	17·5	5·7
4.	Tanjore	... 0·9	20·2	7·5
5.	Trichy	... 1·2	18·2	7·4
6.	Salem	... 0·9	18 0	6·6
7.	North Arcot	... 1·2	22·0	12·2
8.	South Arcot	... 0·8	22·6	6·7
9.	Chingleput	... 1·2	17·4	7·5
10.	Ramnad	... 0·3	5·1	0·1

TABLE III

Data for Total Nitrogen, Organic Matter and Organic Carbon for Panchayat Unions Block wise expressed as percentage on ovendry basis

S. No.	Name of Block	Nitrogen	Loss on ignition	Organic matter
1.	Turaiyur ...	0·6	15·9	5·9
2.	Gudalur ...	1·1	29·4	11·4
3.	Gangavalli ...	0·9	26·1	12·2
4.	Sankari ...	0·8	17·1	8·4
5.	Koilpatty ...	1·0	23·1	10·9
6.	Melur ...	0·8	14·3	7·0
7.	Melpuram ...	1·1	22·6	12·3
8.	Koradachery ...	0·7	13·3	7·0
9.	Usilampatti ...	0·7	13·3	5·7
10.	Madurantagam ...	1·0	24·9	11·2
11.	Kuringipadi ...	0·5	13·2	5·5
12.	Kabilamalai ...	0·3	8·8	1·7
13.	Vembakkam ...	1·4	33·3	15·3

TABLE IV

Statistical Data for the Relationship between Total Nitrogen and Organic Carbon, between Total Nitrogen and Organic Matter and between the Organic Carbon and Organic Matter of Composts produced by Municipalities, Panchayats and Panchayat Unions

S. No.	Particulars	Correlation Coefficient	Regression Coefficient	Regression Equation
I.	*Municipalities:*			
	(i) Nitrogen against organic carbon ...	0·709***	5·086	y=5·086x+2·858
	(ii) Nitrogen against organic matter ...	0·696***	10·03	y=6·439+10·037x
	(iii) Organic carbon against organic matter ...	0·737***	1·38	y=1·3765x+5·5698
II.	*Panchayats:*			
	(i) Nitrogen against organic carbon ...	0·746***	7·61	y=7·6115x−0·2459
	(ii) Nitrogen against organic matter ...	0·840***	15·57	y=15·5686x+2·8451
	(iii) Organic carbon against organic matter ...	0·740***	1·23	y=1·2313x+7·6907

TABLE IV *(Contd.)*

S. No.	Particulars	Correlation Coefficient	Regression Coefficient	Regression Equation
III.	*Panchayat Unions:*			
	(i) Nitrogen against organic carbon ...	0·937***	14·10	y=14·1012x−3·0398
	(ii) Nitrogen against organic matter ...	0·907***	23·06	y=23·063x+0·1158
	(iii) Organic carbon against organic matter ...	0·937***	1·91	y=1·9075x+3 0510

*** Significant at p=0·001

(i) Carbon Nitrogen Ratios of Urban and Rural Composts: Before the relationships between total nitrogen, organic matter and organic carbon contents for Municipalities, panchayats, and panchayat unions are discussed, it is quite essential to touch upon the carbon/ nitrogen ratios of the compost samples under Municipalities, panchayats and panchayat unions, as that alone serves to indicate the degree of decomposition undergone by the materials used for composting (Shrikhande 1945 and 1946). In fact the idea behind composting itself is to obtain "humus" from human and agricultural wastes, with a carbon/nitrogen ratio less than 12:1 (Shrikhande 1946). When the carbon/nitrogen ratio of the final compost is narrower than 12:1 the degree of mineralisation of nitrogen in such composts is greater when applied to soil (Acharya *et al* 1946). In the case of compost samples of Municipalities and panchayats that were studied, the carbon/ nitrogen ratios obtained were respectively 7.4:1 and 7.7:1. Bhaskaran *et al* (1957) showed that carbon/nitrogen ratios of the composts prepared according to the Bangalore method of composting had a carbon/ nitrogen ratio of 6 to 8 and they analysed about 1 per cent nitrogen. Further, they have reported that all the pathogens and helminthicora were completely destroyed in three months time. In the case of panchayat unions, the carbon/nitrogen ratio of the compost samples was 10·4 : 1 which is wider than those of Municipalities and panchayats. This is explainable as due to the low nitrogen factor of farm wastes, and also the use of cow dung emulsion as the starter which is not so rich in nitrogen as night-soil. It will be seen from the carbon/nitrogen ratios obtained for urban and rural composts, that the urban composts have the narrowest C/N ratio, and rural composts having wider C/N ratio. This clearly indicates that urban composts have undergone higher degree of humification than the rural compost (Shrikhande 1947). The higher degree of humification undergone by the compost materials in the case of urban composts is attributable to the night-soil being used as a starter in which the nitrogenous compounds probably lend themselves more readily than the hippuric acid derivatives found in cow-dung, to the catabolic and anabolic changes concerned in the production of organic manure (Fowler 1930)

(ii) Correlation Coefficients: In the present study the regression equations have been worked out in all the three relationships studied for finding out their pattern and extent of variation, instead of employing the algebraic equation, $y = mx$ employed by Ghosh (1959). The correlation coefficients obtained for all the three relationships for Municipalities, panchayats and panchayat unions are statistically significant at a very high level. But in the case of panchayat unions, it will be seen from table IV that the correlation coefficients obtained for all the three relationships, are nearing unity. The close correlation between the total nitrogen and organic matter, between total nitrogen and organic carbon, and between organic carbon and organic matter in the case of compost produced by the panchayat unions is explainable as due to the carrying out of composting by ryots under the direct supervision of departmental personnel, resulting in uniformity of preparation methods and also due to the homogenous nature of materials used in composting. In the case of Municipalities and panchayats, the correlation coefficients obtained for all the three relationships studied, even though they are highly significant, are not nearing unity. As the refuse materials used in composting in the case of Municipalities and panchayats contain brick-bats, stones, glass-pieces and other undecomposable materials like rags, the material becomes heterogenous and this probably accounts for the absence of high correlation in these cases, similar to the ones in the case of panchayat unions.

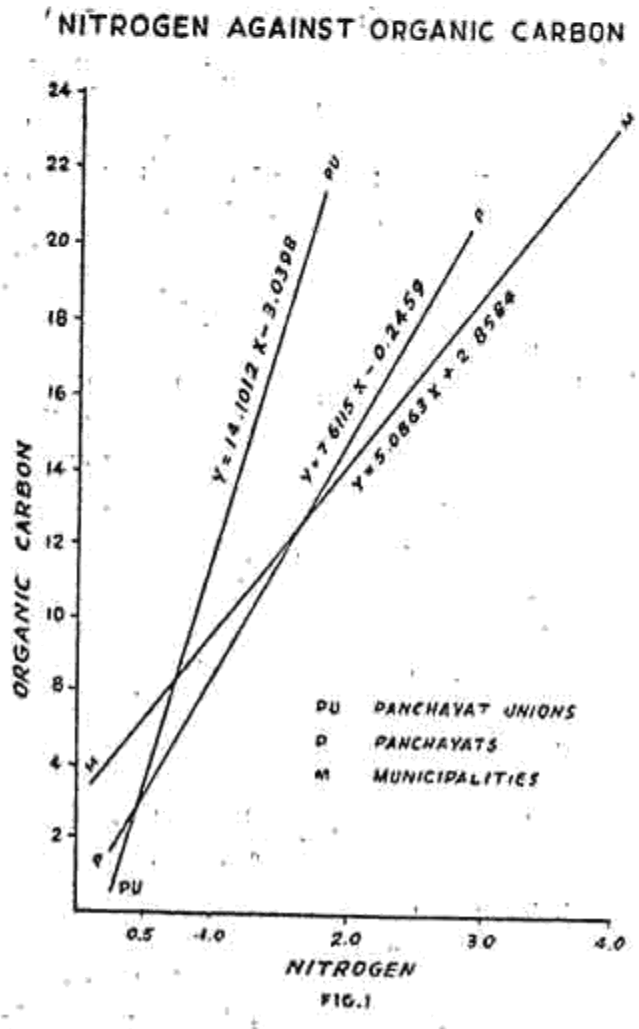

FIG.1

(iii) Relationship between Total Nitrogen and Organic Carbon: From fig (i) it will be seen that the regression line obtained for the relationship between total nitrogen and organic carbon contents of compost of panchayat unions is steeper than those obtained for Municipalities and panchayats. This clearly indicates that the C/N ratio of the compost produced from farm wastes is wider than those of Municipalities and panchayats. It will be seen from the figure that the regression lines for Municipalities and panchayats cut each other and subtend a small angle between themselves. This shows that there is no difference in their pattern of relationships. This observation tallies with the calculated values of C/N ratios for Municipal and panchayat

composts, which are 7.4 : 1 and 7.7 : 1. Looking at fig (i) again, it will be seen that the regression lines obtained for Municipalities and panchayats are closer to the nitrogen axis(x — axis) than it is the case with panchayat unions. This establishes beyond doubt that Municipal and panchayat composts are richer in nitrogen than panchayat union compost. The reason for the high nitrogen content of Municipal and panchayat composts, when compared with that of panchayat union compost, is attributable to the night-soil, which is rich in nitrogen and other plant nutrients, and also to the meat stall and slaughter-house wastes, which find place in the materials used for composting by Municipalities and panchayats.

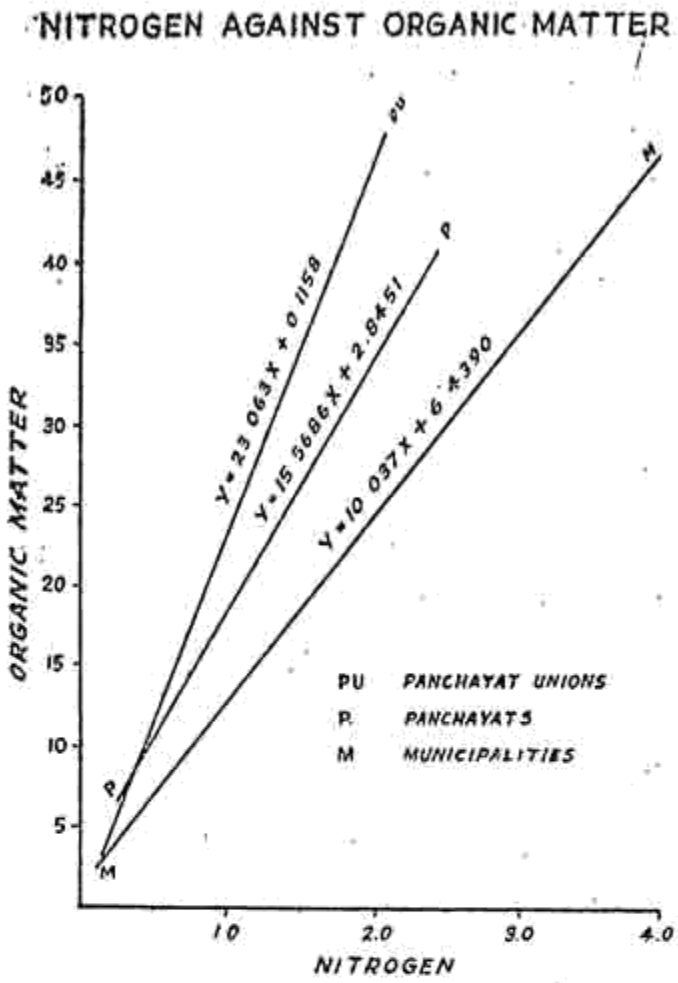

FIG. 2.

(iv) Relationship between Total Nitrogen and Organic Matter: From fig (ii) in which the regression lines obtained for the relationship between total nitrogen and organic matter for Municipalities, panchayats, and panchayat unions have been depicted, it will be seen that in the case of Municipalities, the regression line is closer to the x-axis, indicating that the Municipal compost is richer in nitrogen than composts of panchayats and panchayat unions. The regression line for panchayat unions is steeper than that for panchayats, indicating that the nitrogen content of compost of panchayat unions is less than that of panchayat compost. The high nitrogen content of Municipal compost when compared with that of panchayat compost, might be attributable to the better care with which the night soil has been collected without loss of plant nutrients, and also to the larger quantities of slaughter-house and meat-stall wastes, that might have found their way in compost heaps in the case of Municipalities.

(v) Relationship between Organic Carbon and Organic Matter: In fig (iii) are found the regression lines for the relationship between organic carbon and organic matter for municipalities, panchayats and panchayat unions. The position of the two lines which are observed to cut and which subtend only a very small angle between themselves, indicates that the difference between Municipalities and panchayats is not significant in respect of the relationship between organic

carbon and organic matter. This is also the case with these two compost producing agencies in respect of the C/N ratio. In the case of panchayat unions, the regression line is steeper indicating that there is more of organic matter in the compost produced by panchayat unions.

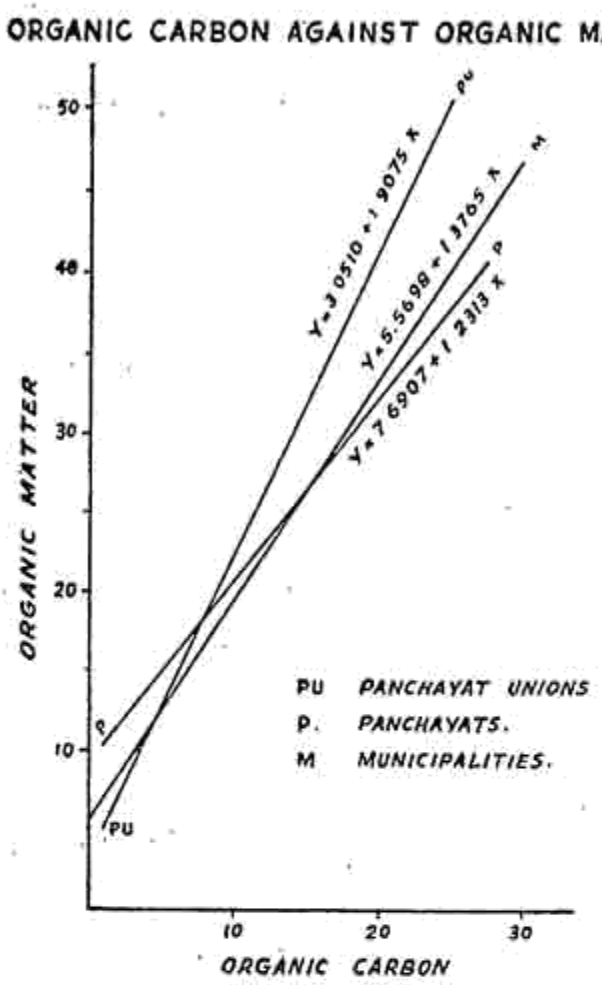

FIG. 3.

From the foregoing discussion, it is patent that the procedure for analysis of compost samples can be simplified by estimating only organic carbon in the compost samples, and from the values of organic carbon, the nitrogen values of compost samples can easily be predicted. It has also to be mentioned here that the organic carbon contents of 30 compost samples can easily be estimated in a day, but for estimating their nitrogen contents by Kjeldahl method it would take a week, provided all facilities for the same are satisfied.

Summary and Conclusions: In the case of panchayat unions, very close correlation has been obtained for all the three relationships studied and this is due to the fact that composting is done under the direct supervision of departmental personnel which results in the uniformity of preparation methods and also due to the homogenous nature of materials used for composting. The close correlations obtained for all the three relationships in the case of rural compost indicate the upper limit for the degree of their relationships and this is to be achieved for urban composts also by removing all undecomposable materials from compost materials before composting. The nitrogen content of urban composts can be further increased by suitably adjusting the proportion between night-soil and town refuse. In the case of rural compost, the nitrogen content can be increased by increasing the quantity of cow-dung emulsion used as starter for composting.

Further the analysis of compost samples can be simplified by estimating only their organic carbon contents, and then predicting the nitrogen values from them.

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