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Correlation of Soil Tests for Nitrogen with Response to Added Nitrogen in Madras Soils

by

P. KRISHNAMURTHY[1], S. VENKATACHALAM[2] and K. KHALEEL AHMED[3]

Introduction: Detailed correlation studies are in progress in our State to improve, if possible, the soil test recommendations adopted at present in our State. With phosphorus as the nutrient, Venkatachalam, Subramaniam and Kamalam (1963) had indicated the need to study the soils of Madras State grouped according to probable clay mineral type in order to get reliable correlations. This paper deals with correlation with reference to nitrogen in the soils of Madras State.

[1] and [3] Assistants in Chemistry, Agricultural College and Research Institute, Coimbatore - 3.

[2] Soil Chemist (Radio Isotopes), Agricultural College and Research Institute, Coimbatore - 3.

Received on 24—6—1966.

Review of Literature: According to Black (1957) three types of measurements are used to improve on the nitrogen availability estimates in soils. They are (i) measurement of the content of total nitrogen or organic matter; (ii) measurement of the quantity of nitrogen changed to the mineral form as a result of some chemical treatment, and (iii) measurement of the quantity of nitrogen mineralised in a fixed length of time during incubation under uniform conditions in the laboratory. In all these types of measurements, the figures obtained are assumed to be proportional to the nitrogen availability. Among them the first two lend themselves to adoption for rapid soil test.

Muson and Stanford (1955) investigated the comparative value of these three different types of measurements by correlation of nitrogen with nitrogen uptake and found that total nitrogen value gave lower correlation values than the other two types of measurements which were almost on a par. Andhari Stanford and Schaller (1955) found that the correlation co-efficient was significant between corn yields and total nitrogen while that due to organic matter was not. Peterson, Attoe and Ogden (1960) found that total nitrogen uptake in second crop was significantly correlated with total N, soil organic matter, NH_3 extracted by alkaline $KMnO_4$, while in the first crop the N uptake was correlated with initial soil nitrate. Grumes, Haise, Turner and Allessi (1963) found that growth response to applied nitrogen was correlated with nitrates in soil before as well as after incubation. Subbiah and Asija (1956) found good correlation for available nitrogen as determined by alkaline permanganate method for paddy and wheat.

Materials and Methods: 1. *Soils:* (a) Eight soils consisting of two alluvial soils of pH 6·7 and 7·8, cation exchange capacity 25 and 28 m. e. per 100 gm. clay, texture sandy loam and clay and total nitrogen content 0·05 and 0·06; red soil of pH 6·5 and 7·1, cation exchange capacity 26 to 28 m. e. per 100 gm. clay, texture sandy loam and total nitrogen content 0·051 to 0·057, lateritic soils of pH 4·2 and 4·3, cation exchange capacity 36 to 50 m. e. per 100 gm. clay, texture sandy loam to clay loam, and total nitrogen content 0·156 to 0·420 and black and brown soils pH 7·5 to 7·9, cation exchange capacity 72 to 96 m. e. per 100 gm. clay, texture clay and total nitrogen content 0·05 and 0·07 were used.

(b) SOILS USED FOR PADDY CROP: Ten soils representing alluvial soils of Thanjavur Old Delta of pH ranging from 6·2 to 7·5, cation exchange capacity 50 to 70 m. e. per 100 gm. clay, texture sandy loam to clay loam and total nitrogen status from 0.05 to 0.11 were used.

2. *Crops :* The response to added nitrogen was determined by pot culture experiments using paddy or *ragi* as test crop.

TREATMENTS : The treatments were N_0PK and NPK for *ragi* crop (Variety K2) where nitrogen was applied at 0 and 45 lb. levels per acre, phosphorus and potash basally at 40 lb. each per acre as super and potassium sulphate, respectively. For paddy crop (Variety TKM 6) the treatments were N_0PK, N_1PK, N_2PK, N_3PK and N_4PK where nitrogen was applied at five levels *viz.*, 0, 30, 60, 90 and 120 lb. of nitrogen per acre. Phosphorus and potash were applied basally at 60 lb. per acre each in the form of super and potassium sulphate respectively.

3. *Soil tests for nitrogen :* The available nitrogen on these soils were estimated by (1) Alkaline permanganate method of Subbiah and Asija (1956) and (2) Recent method of Truog (1951). In addition, the total nitrogen was determined by Kjeldal's method in *ragi* soils, organic carbon by the method of Walkely and Black for paddy soils.

4. *Collection and interpretation of data :* Data on yield of grain and straw were recorded. As an index of response, the percentage yield values for grain were calculated as suggested by Bray (1948) in the formula

$$\text{Percentage yield} = \frac{\text{Yield without added nitrogen}}{\text{Maximum yield}} \times 100$$

where yield without added nitrogen is the yield at 0 lb. N level and maximum yield is highest yield obtained in the experiment whether at 0 lb. level or N applied levels.

Results and Discussion : The correlation co-efficients ('r' values) between the soil test values of different methods and percentage yield of *ragi* are given in Table 3. It is seen that for the eight soils taken up for the study, the 'r' value were positive but not significant. However, when two black soils of high cation exchange capacity are omitted the "r" value has increased and has become significant at 5 per cent level for the alkaline permanganate method of Subbiah and Asija (1956) as well as for Truog's method. Further improvement in 'r' value to one per cent level was obtained when log soil test values are correlated with percentage yield. This indicates that the relationship of per cent yield value with soil test values is not linear for these soils but logarithmic and follows the law of sub-proportional increases that can be fitted in hyperbolic equation. Although these soils fall under different classes, *viz.,* red, alluvial and lateritic, all of them have medium cation exchange capacity when calculated on clay basis and can be classed as probably predominently illitic and for this group of soils the alkaline permanganate method of Subbiah and Asija and Truog's method seem to be the best methods suited.

The results of correlation co-efficients of soil tests and percent yield of paddy are given in Table 3. The soils used are all alluvial with clays of medium cation exchange capacity. The 'r' values show that considering all the ten soils taken for the study the correlation co-efficient were positive but not significant. However, when one of the soils with a very low pH was omitted, the correlation co-efficient for alkaline permanganate method and Truog's method were significant at 5 per cent level. Even though the Truog's 'r' value is higher than alkaline permanganate method, the differences between the two methods were not statistically significant.

Unlike the experiment conducted with *ragi* as test crop, use of log soil test values has not improved the 'r' value significantly although there was slight increase for alkaline permanganate method while there was decrease in 'r' value for Truog's method. This might be due to the fact that the relation of soil test values with crop response was different for paddy or to the narrow range of available nitrogen status (154 to 196 lb. per acre) in various soils on which the experiment was conducted.

TABLE 1. *Soil particulars of nitrogen status and per cent yield values of soils used for ragi crop—Variety K2—1962-'63*

Sl. No.	Soil Particulars	Cation exchange capacity m. e. / 100 gm. clay	Total nitrogen per cent	Alkaline KMnO₄ method lb./acre	Truog's method lb./acre	Per cent yield of grain
1.	Gobi I	27·9	0·057	154	32·5	39·22
2.	Gobi II	26·3	0 051	210	49·3	35·81
3.	Chinthalakarai	72·7	0·050	112	41·4	73·05
4.	Thittankulam	96·1	0·070	140	82·9	98·63
5.	Ithalar	49·9	0·156	623	397·6	86·04
6.	Numadala	36·8	0·420	1008	845·6	90·12
7.	Palur I	25·5	0·050	399	100·8	85·74
8.	Palur II	28·2	0 060	252	72·8	59·05

TABLE 2. *Soil particulars, nitrogen status and per cent yied values of soils used for paddy crop—Variety TKM 6—1963-'64*

Sl. No.	Soil Particulars	Cation exchange capacity m. e. / 100 gm. clay	Total nitrogen per cent	Organic carbon per cent	Alkaline KMnO₄ method lb./acre	Truog's method lb./acre	Per cent yield of grain
1.	Rajapalayam	56·9	0·051	0·71	182	75·6	71·76
2.	Mayavaram	63·1	0 078	0·44	183	26·6	56·96
3.	Maharayapuram	52 5	0·113	0·75	182	67·2	59·98
4.	Kilasooriyamalai	62·8	0·052	0·69	182	67·2	67·59
5.	Ombalpadi	68·3	0 039	0·34	168	26·6	17·20
6.	Kabisthalam	—	0·088	0·97	196	95·2	52·53
7.	Sooramangalam	—	0·079	0·55	154	39·2	16·07
8.	Pangal	59·9	0 086	0·66	196	68·6	52·76
9.	Mukunthanur I	70·0	0 071	0·69	154	58·8	51·78
10.	Mukunthanur II	66 6	0 068	0·59	196	65·8	74·92

TABLE 3 *Correlation co-efficients between soil test values and per cent yield*

S. No.	Soil Test		Crop: *Ragi* (1962—'63) 'r' value			Crop: Paddy (1962—'63) 'r' value		
			All soils	Six soils of medium CEC	Log soil test	All soils	Nine soils	Log soil test
1.	Alkaline permanganate method	...	+0·451	+0·810*	+0·951**	+0 57	+0·68*	+0 70*
2.	Truog's method	...	+0·462	+0·814*	+0·863*	+0·40	+0·78*	+0·75*
3.	Total nitrogen	...	+0·252	+0·603	+0 646	—	—	—
4.	Organic carbon	...	—	—	—	+0·35	+0·51	+0·63

** Significant at 1 per cent level

* Significant at 5 per cent level

These findings are in general agreement with those of Subbiah and Asija (1956) who obtained significant correlation for paddy and wheat using 0.32 per cent $KMnO_4$ + 2.5 per cent NaOH adopted on this work. These authors have recommended the method for Indian soils, in general. In this study, significant correlation has been obtained for soils of medium cation exchange capacity (on clay basis), and for soils of high cation exchange capacity such as black soils no correlation has been worked out due to lack of sufficient data. That such soils have to be classified separately for correlation studies has been indicated. For a given soil test value the black soil has given a much higher per cent yield value as compared to the soils of medium cation exchange capacity indicating that soil test values for sufficiency level may be different for the different soil groups. Further work is necessary to throw more light on this aspect.

Summary and Conclusions: Correlation studies were conducted to select a soil test method for nitrogen best suited for soils of Madras State with *ragi* and paddy as test crops.

Three soil test methods were tried, *viz.*, total nitrogen, available nitrogen by alk. $KMnO_4$ method and Truog's method on four different soil types with *ragi* as test crop. It was found that alkaline permanganate methode gave the highest positive correlation of 0.95 significant at one per cent level followed by Truog's method (r = 0·84 significant at 5 per cent level) for eight soils of medium cation exchange capacity (clay basis) for *ragi*.

In the case of paddy, the experiment was conducted with ten alluvial soils and it was found that alkaline permanganate method of Subbiah and Asija (1956) and Truog's method gave positive correlation

(r = 0·78 and 0·68 respectively - both significant at 5 per cent level). It was concluded that for soils of medium cation exchange capacity (clay basis) alkaline permanganate method of Subbiah and Asija or of Troug is the best for predicting response to applied nitrogen.

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