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DIGITAL EXPRESSION OF SOIL FERTILITY—A NEW APPROACH TO THE INTERPRETATION OF SOIL TEST DATA AND FORMULATION OF FERTILISER RECOMMENDATION

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The soil test values are interpreted and fertiliser recommendations made by different procedures. The most common and widely adopted method is to increase or decrease the approved general recommendation for a particular crop by 25 to 50 per cent when the soils are rated 'low' and 'high' for a particular nutrient and as a result, one and the same recommendation is made for a wide range of soil test values.

Therefore it is felt necessary to evolve a method or procedure which will give due recognition to the actual soil test values for a realistic and rational fertiliser recommendation. Such an approach should also facilitate a coded or digital expression of fertility of soils tested in the laboratories for easy and convenient indexing of the same which will be of much help in the preparation of soil test summaries, nutrient indices and fertility map. Present studies were carried out with these objectives.

Materials and Methods

The soil test data available in the soil testing laboratories amounting to over 1.5 lakh of soil samples representing the major cultivated areas of the State were made use of in the present study.

The available soil test data were sorted into the three textural classes namely sandy, loamy and clayey and observed the frequency distribution of soil test values grouped under the obove three textural classes, studied the major spread of soil test values for N, P and K rated as low, medium and high in fertility in respect of each of the three nutrients to fix the more appropriate limit of soil test values for delineating the soils into the three fertility groups in relation to soil texture.

Field studies were also conducted to test the validity and usefulness of the new suggested approach in the matter of interpretation of soil test values and formulation of fertiliser recommendations. A series of demonstration plots in an area of 1200 sq. metres divided into three sub plots of 400sq. meters were laid out on rice in the cultivators fields with the following treatments (T_1) control-manured as per farmers practice (T_2) manured as per approved fertiliser recommendation for the variety used and (T_3) manured based on soil test data as per the suggested system.

Composite soil samples were drawn from the main plots, analysed for the various fertility factors to determine the fertility classes and fertiliser recommendation evolved as per the new approach for adoption under treatment No.3

Results and Discussion

Classification of soils into different fertility classes

The soil test data are normally grouped into three fertility classes viz. low, medium and high in relation to the probability of profitable response to fertilisation.

Available nitrogen: There is no standardised procedure for assessing the available nitrogen in the soil. The two recognised methods in use are (1) estimation of available nitrogen by alkaline permanganate method and (2) the rapid colorimetric estimation of organic carbon content in the soil. The second one is preferred because of its simplicity, ease and repidity of estimation and also because of the significant correlation reported between the available nitrogen content in the soil and the percentage organic carbon it contains (Thomas, 1962, Premnathan, 1964). According to Muhr *et al* (1961) a soil is rated low, medium and high in nitrogen status when the percentage organic carbon content is less than 0.5%, 0.5 to 0.75% and more than 0.75% respectively.

The above limits followed in the soil testing laboratories for the interpretation of the data for assessing the fertility rating in respect of the 'N' status of soils do not give due recognition to the soil types or the textural variations. Zacharia and Subrahmony (1961) attempted to rectify the above defects and suggested the critical limits for percentage organic carbon for the differnt soil types met within Kerala. The present study has shown that in the case of sandy soils rated as medium in 'N' status the major spread of the organic carbon values recorded is always between 0.3 and 0.9% while in the case of loamy and clayey soils it is between 0.5 and 1.5% and hence the three levels (Table 1) can be fixed as a more reliable limits for grouping the soils into the three fertility classes for available nitrogen in relation to percentage of organic carbon.

Table 1

Fertility classes of soils based on percentage of organic carbon

Soil type	Low	Medium	High
Sandy	Less than 0.3%	0.3 to 0.9%	More than 0.9%
Loamy	Less than 0.5%	0.5% to 1.5%	More than 1.5%
Clayey	Less than 0.5%	0.5% to 1.5%	More than 1 .5%

Classification of soil test values

Class No.	pH	CLASS VALUES Total soluble salts (E.C. mmhos/cm²)			Av. Nitrogen (% O.C)				Av. Potassium (kg/ha)		Fertility code Number
		S	L	C	S	L		C			
					From	To	From	To	From	To	
1	Less than 4.0	0.1	0.2	0.3	0.00	0.10	0.00	0.10	0.0	3.0	0
	4.1 to 4.5	0.2	0.4	0.6	0.11	0.20	0.17	0.33	3.1	6.5	1
	4.6 to 5.0	0.3	0.6	0.9	0.21	0.30	0.34	0.50	6.6	10.0	2
2	5.1 to 5.5	0.4	0.8	1.2	0.31	0.45	0.51	0.75	10.1	13.5	3
3	5.6 to 6.0	0.5	1.0	1.5	0.45	0.60	0.76	1.00	13.6	17.0	4
4	6.1 to 6.5	0.6	1.2	1.8	0.6	0.75	1.01	1.25	17.1	20.5	5
5	6.6 to 7.0	0.7	1.4	2.1	0.7	0.90	1.26	1.50	20.6	24.0	6
6	7.1 to 7.5	0.8	1.6	2.4	0.9	1.10	1.51	1.83	24.1	27.5	7
7	7.6 to 8.0	0.9	1.8	2.7	1.1	1.30	1.84	2.16	27.6	31.0	8
8	8.1 to 10.0	1.0	2.0	3.0	1.31	1.50	2.17	2.50	31.1	34.5	9
9									35.6	39.5	

S = Sandy soil L = Loamy soil C = Clayey soil

Fertility Rating

1) pH Code Nos. 0, 1, 2, 3, 4 and 5 — Acidic 6 and 7 Normal neutral, 8 and 9 Alkaline.

2) TSS Code Nos. 0, 1 and 2 Normal for all crops, 3, 4, 5 and 6 — Normal for semi tolerant crops, 7, 8 and 9 Normal for tolerant crops

3) N P K code Nos. 0, 1, 2 Low, 3, 4, 5 and 6 — Med , 7, 8 and 9 in High.

Phosphorus and potassium: The levels of P and K content in a soil expressed as Kg/ha for being rated as low, medium and high in fertility as per Mhur ef. *al* (1961) can be followed as such since the present study as explained in the case of nitrogen has not indicated any need for a change in the level suggested for the three fertility classess for P and K. Most of the laboratories are following three class war system for the interpretation of soil test data and formulation of fertiliser recommendation. The apparent defects of this system of interpretation of soil test data, for the formulation of fertiliser recommendations, are there can be only 27 combinations. (2) one and the same recommendation is given just because the value falls within or above the range of the fixed levels of the three fertility classes (3) the actual amounts of available nutrients in the soil as revealed by analysis is not given the due recognition it deserves. In order to overcome the above defects and to make the formulation of fertiliser recommendation ensuring due recognition of the actual amounts of available nutrients in the soil, it is felt that a reasonable number of sub classes under the three main fertility classes, will have to be adopted. Therefore, it is suggested that the soil test values for each of the fertility factorsestimated in the soil testing laboratories be placed under 10 classes as detailed in Table 2.

Formulation of fertiliser recommendation

The approved general fertiliser recommendation to a particular crop is suggested to be given to the critical values corresponding to the upper class value of class 2 ie. 100% of the general recommendation for N is given to the soil test values of 0. 5% organic carbon in a loamy or clayey soil. The maximum increase of general recommendation is suggested as 133% for a soil testing 0% in orgonic carbon and a minimum of 50% N is suggested for the upper class values of class 9. No minimum ceiling is suggested in the case of P and K. With these points thus fixed, a curve is drawn showing the soil test values in the X axis and the percentage on the Y axis and from the curve thus fitted, the percentage of general recommendation to be given for each of the 10 fertility classes is drawn by noting the corresponding percentage for the middle value of each of the fertility classes, and presented as Table 3 and Fig. 1

From the principle thus enunciated and the percentages suggested in Table 3, a chart showing the fertiliser recommendation for N, P and K in relation to the approved general fcr different crops can be easily prepared for each of the 10 suggested fertility classes. Such a chart can be used as a useful guide to formulate site and situation specific fertiliser recommendations to the farmers.

Ramamoorthy and Velayudham (1972) have rightly pointed out that the rate of fertiliser doses to be applied for a particular crop requires greater accuracy in fertiliser adjustments to soil test data in order to make them as economical as possible. According to Ghosh and Hassan (1976) the scientific as well as economic approach would imply the use of plant nutrients according to the actual

Table 3

General recommendation of NPK for different soil fertility classes

Code No.	Fertilizer recommendation percentage of the general recommendation.			Fertility rating
	N	*P*	*K*	
0	128	128	128	
1	117	117	117	Low
2	106	106	106	
3	97	94	94	
4	91	33	83	Medium
5	84	71	71	
6	78	60	60	
7	72	48	48	
8	63	37	37	High
9	54	25	25	

need of the situation which can best be judged through soil tests. Therefore the suggested new approach in the interpretation of soil test data and formulation of fertiliser recommendation will in a large measure help to achieve this desired adjustments to soil test data as well as to evolve an economical fertiliser dossage warranted by actual needs of the situation.

Coding **of soil test values**

The above class war approach to the interpretation of soil test data makes it very convenient and easy to index the soil fertility and facilitates the expression of the same with the help of a few digits. Soil texture is an important factor deserving due recognition in the interpretation of soil test data. Though texture is being assessed by all the laboratories and indicated as sandy, loamy, or clayey it is quite possible to identify different textural classes by the 'feel' method as described by Perur *et al.* (1973). Since the texture is an important soil characteristic to be considered in the interpretation of soil test data, the same also should find a place in the digital expression of soil fertility. The suggested textural name, code number and fee! characteristics are given in Table 4. The codes for the soil texture and other soil test values may be written begining with the code number for texture followed by pH and TSS, Then an oblique line followed by code number for N, P and K as illustrated in Table 5.

Table 4

Textural name and characteristics of soils.

Sl. No.	Textural Name	Code No.	Feel Characteristics: Feel of fingers	Ball formation	Stickiness	Ribbon formation	Main textural group
1	Sand	1	Very gritty	No ball formation	Does not stain fingers	No	
2	Loamy sand		do	Form easily broken ball	Stains slightly	No	Sandy
3	Sandy loam	3	Moderately gritty	Moderately firm ball break easily	Stains fingers	No	
4	Loam	4	Not very gritty nor smooth	Forms firm ball	- do—	No	
5	Slit loam	5	'Buttery' feel	Moderately hard ball when dry	—do—	Slight ribben formation withflaky surface	Loamy
6	Clay loam	6	Slightly gritty	—do—	—do—	Forms ribbon but break easily	
7	Slity clay loam	7	Very smooth	—do—	—do—	Forms ribbon with flaky surface	Clay
8	Clay	8	Forms hard ball when dry	—do—	—do—	Squeezes out into ribbon	

Table 5

Codes of soils based on different soil test data

Example No.	Soil Test Data						Digital Fertility code
	Texture	pH	T. S. S.	Org. C	P	K	
			(Ec-mmhos/cm²)	%	(kg/ha)	(kg/ha)	
1	Clay loam	5.1	0.6	0.42	12.5	340	623/238
2	Sandy loam	6.2	0.2	0.35	18.8	40	353/351

Dosages of fertilisers applied and the yield of rice recorded in the experimental plots

Sl. No.	Location	Variety	General Recommendation (Kg/ha) T_2			Soil test Recommendation (Kg/ha) T_3			Yield of rice in Kg/ha.			% increase of T_3 over T_1	% increase of T_3 over T_2
			N	P	K	N	P	K	T_1	T_2	T_3		
1st Crop season 77/78													
1.	Kanhangad	I. R. 8	90	45	45	82	27	32	4870	4600	5050	3.7	9.8
2.	Cheruthazham	Jyothi	70	35	35	59	28	42	2700	3075	3500	29.6	15.7
3.	[illegible]	Aswathy	90	45	45	87	37	48	4450	4675	4900	10.1	4.8
4.	[illegible] kuthar	Bharathy	90	45	45	105	22	37	2040	2120	2440	19.6	15.1
5.	Ko[illegible]	Sabari	90	45	45	70	32	58	5800	5400	5475	3.3	1.4
6.	Bo[illegible]	Bharathy	80	45	45	64	53	37	4025	4550	4650	15.5	1.6
2nd Crop season							27						-
1	Kanhangad	I. R. 8	80	45	45	95	40	58	3375	3275	3550	5.2	1.4
2	Cheruthaad im	Jaya		,,	,	105	1	53	3406	3025	4075	10.0	.4
3	Pallikkarzha	I. R. 0		,,	,	65	.1	53	4325	4675	4925	13.0	8.3
4	Eramanika uf	I. R. 8		,,	,	57	5	53	2460	2400	2840	15.4	19.3
5	Kodlamouth	Jaya		,,	,	95	-	48	5025	5075	5225	4.0	5. Os
3rd Crop season (Puncha)							48						8
							42						2
1.	Kanhangad	Thriveni 2	70	35	35	54	55	37	4175	4400	4675	12.0	6.3
2.	Pallikkara	Jaya	80	45	45	57	3	32	4625	4875	4925	6 5	1.0
3.	Kelathara	,,		,,		70	2	1	3525	4200	4450	26.2	5.9
4.	Cheruvar r	,,		,,		76	58	58	3380	3380	3560	5.3	5.3

T_1 Control = Manured as per farmers practice T_2 Manured as per approved general recommendation

T_3 Manured based on soil test data as per the suggested system.

The first portion of the code indicates the type and nature of the soil and the second portion, to fertility status of the soil in respect of major nutrients viz. N, P and K. Higher numbers in the last three digits indicate higher fertility levels and less requirements of N, P and K. The summarised soil test information has proved to be quite useful for deliniating areas of deficiency and sufficiency in respect of one or more nutrients.

The suggested coded expression of soil fertility facilitates proper and convenient indexing of soil fertility, easy preparation of soil test summaries and quicker formulation of fertiliser recommendations, besides enabling the preservation of large fund of analytical information in a more concise and convenient manner.

The validity and usefulness of the above suggested approach in the matter of interpretation of soil test data and formulation of fertiliser dosages recommended were verified with the field studies on rice through a series of demonstration plots laid out in the cultivator's fields and the results obtained are presented in Table 6. It may be seen that the fertilisation based on soil test data adopting the suggested class system has recorded increased yield over the fertilisation based on the general recommendation as well as over the farmers practice in all the three seasons, the increase observed being 1.4 to 15.1% and 3.3 to 29.6% during 1st crop season 2.9 to 18.3% and 4 to 19.6% during the 2nd crop season and 1 to 6.3% and 5.3 to 26 2% during the 3rd crop season. The proposed ten class system provides greater accuracy in fertiliser adjustments to soil test data and permits the use of fertilisers to the extent warranted by situation as revealed by soil tests avoiding wastage and ensuring more efficient utilisation of added fertilisers.

Summary

Using the soil test data available in the various soil testing laboratories of Kerala State a new digital expression of soil fertility has been evolved for the formulation of more accurate fertilizer recommendations. This also facilitates easy preparation of soil test summaries and thus enable the preservation of large fund of analytical data, when available, in a concise and convenient manner,

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GUIDE LINES FOR FERTILISER COMPUTATION BASED ON SOIL TEST DATA