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Evaluation of Soil Nutrient Status of Regional Research Station Farm, Paiyur, Krishnagiri District, Tamil Nadu, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Soil fertility evaluation of Regional Research Station farm, Paiyur, Krishnagiri district, Tamil Nadu, India was done for efficient land use planning and crop production. Soil testing provides information on soil available nutrient status and serves as basis for making fertilizer prescription to crops. Soil samples were collected at 0-15 cm depth from each and every field of Regional Research Station farm, Paiyur and analysed for their nutrient status. The results revealed that the farm soils were

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slightly alkaline (pH 7.69) in reaction, non saline (0.06 dSm^{-1}), low in organic carbon (0.41 per cent) and available nitrogen (238 kg ha^{-1}), high in available phosphorus (24.8 kg ha^{-1}) and medium in potassium (177 kg ha^{-1}) status. The nutrient index value of organic carbon and available nitrogen were <1.66 and categorized under low fertility status. The nutrient index value for available phosphorus >2.33 and categorized under high and available potassium was 1.66-2.33 and grouped under medium category.

Keywords: Soil fertility; soil testing; fertilizer prescription; available nutrients; nutrient index.

1. INTRODUCTION

Soil and water are the basic resources that are essential for the sustainable agriculture development and human life. Soil is fundamental for production of food, fodder, fibre and for the maintenance of environmental quality. Soil fertility is the inherent capacity of soil to sustain crop growth by supplying essential plant nutrients and providing favourable physical, chemical and biological characteristics as a habitat for plant growth. Soil fertility status indicates the plant growth in relation to available nutrient status of soil.

Soil fertility evaluation is the most basic decision making tool for efficient planning of land use system for a particular area [1]. There are various diagnostic techniques available for soil fertility evaluation. Soil testing is one of the best tools for assessing the fertility status of soil. Soil testing provides the details about soil properties and available nutrient status of soil which form the basis for fertilizer application to crops. Soil test based fertilizer application is an effective nutrient management approach through which sustainable soil health and crop production can be achieved. In this context, present study was undertaken to assess the nutrient status of Regional Research Station farm soil for further land use planning and crop production.

2. MATERIALS AND METHODS

The study was carried out in Regional Research Station farm, Paiyur, Krishnagiri district, Tamil Nadu, India. The research farm is located in the latitude 12º 21` N and longitude 78º 18` E and at an altitude 490m above mean sea level. The farm comprises of eight blocks and 106 fields. Surface (0-15 cm) soil samples were collected from each and every field of Regional Research Station farm. Collected soil samples were air dried, powdered with wooden mallet and sieved through 2 mm sieve, labelled and stored in cloth bags for analysis. The processed soil samples were analyzed for available nutrient status by following standard procedure. Organic carbon content by wet chromic acid digestion [2] (Walkley and Black, 1934), Available nitrogen by Alkaline permanganate [3] (Subbiah and Asija, 1956), Available phosphorus by 0.5 M Sodium bicarbonate [4] (Olsen et al. 1954) and Available potassium by Neutral normal ammonium acetate [5] (Stanford and English, 1949) method were followed.

2.1 Categorization of Soil Samples Based on Critical Limits

Based on the critical level of individual nutrient, the samples analyzed were categorized into low, medium and high. The per cent sample at each category was assessed for each element at block level.

Nutrient	Low	Medium	High
Organic Carbon (%)	<0.5	0.5 - 0.75	>0.75
Available N (kg ha^{-1})	<280	280 - 450	>450
Available P (kg ha^{-1})	<11	11 - 22	>22
Available K (kg ha^{-1})	<118	118 - 280	>280

2.2 Nutrient Indexing System

Nutrient indexing system was developed by Parker et al. [6] and this concept is very useful in formulating area wise fertilizer recommendations and in comparing fertility status of different areas. Nutrient index calculated by giving weightage to number of soil samples falling in low, medium and high soil fertility classes. In this concept, weightage 1 is given for the samples with low fertility class, 2 for medium fertility class and 3 for high fertility class.

The nutrient index was arrived by using the following formula

$$\text{Nutrient Index} = [(N_L*1) + (N_M*2) + (N_H*3)] / N_T$$

Where,

N_L = Number of samples falling under low category of nutrient status.
N_M = Number of samples falling under medium category of nutrient status
N_H = Number of samples falling under high category of nutrient h status
N_T = Total number of samples analysed for a nutrient in the given area

Separate indices are calculated for different nutrients like nitrogen, phosphorus and potassium. The soils were rated as per the nutrient index values as low (less than 1.66), medium (1.66-2.33) and high (more than 2.33) fertility class.

2.3 Statistical Analysis

The database on analysis of soil available nutrient content was developed by using Microsoft Excel page. Descriptive statistical parameters *viz*., mean, range, standard deviation and coefficient of variation of various soil parameters were computed.

3. RESULTS AND DISCUSSION

Results on the physic-chemical properties soils of different blocks of RRS Farm, Paiyur are presented in Table 1.

3.1 pH

It is one of the important soil properties that have direct effect on the nutrient availability and plant growth. The pH of the soil samples ranged from 7.39 to 7.99, 7.28 to 7.81, 7.79 to 7.83, 7.47 to 7.81, 7.63 to 8.15, 7.47 to 7.84, 7.40 to 7.84 and 7.59 to 7.84 with mean values of 7.72, 7.55, 7.81, 7.67, 7.80, 7.72, 7.64 and 7.76, respectively in A, B, C, D, E, F, G and H blocks. It indicated that, soil categorised under slightly alkaline in soil reaction.

3.2 Electrical Conductivity

The electrical conductivity of the soil ranged from 0.03 to 0.08, 0.03 to 0.15, 0.05 to 0.07, 0.02 to 0.07, 0.03 to 0.07, 0.03 to 0.10, 0.02 to 0.17 and 0.03 to 0.08 dSm^{-1} with mean values of 0.05, 0.09, 0.06, 0.04, 0.04, 0.05, 0.07 and 0.06 dSm^{-1}, respectively in A, B, C, D, E, F, G and H blocks. The mean electrical conductivity of surface soil ranged from 0.04 to 0.09 dSm^{-1} and it indicated that the soils were classified under non saline category.

3.3 Organic Carbon

The range values recorded for organic carbon content in soils of different blocks were 0.19 to 0.52 per cent in A, 0.38 to 0.53 per cent in B, 0.24 to 0.29 per cent in C, 0.41 to 0.58 per cent in D, 0.43 to 0.56 per cent in E, 0.22 to 0.35 per cent in F, 0.21 to 0.47 per cent in G, 0.32 to 0.53 per cent in H block, respectively.The mean organic carbon content of soil ranged from 0.26 to 0.51 per cent and it indicated that the soils were classified under low to medium category.

3.4 Available Nitrogen

The mean value of soil available nitrogen content in surface soil was 220, 258, 197, 203, 290, 242, 209 and 250 kg ha^{-1} with the range values from 183 to 301, 186 to 312, 183 to 212, 143 to 312, 278 to 301, 194 to 287, 147 to 296 and 198 to 291 kg ha^{-1} in A, B, C, D, E, F, G and H blocks, respectively. The highest mean available nitrogen content was recorded in E block (290 kg ha^{-1}) and least in C block (197 kg ha^{-1}) in surface soil. Soils of E block were medium and all the other blocks were low in available nitrogen status.

3.5 Available Phosphorus

The soil available phosphorus content ranged from 11.6 to 45.1, 19.4 to 51.6, 10.6 to 14.3, 10.4 to 21.3, 14.3 to 24.7, 11.6 to 21.0, 10.4 to 21.7 and 22.6 to 42.3 kg ha^{-1} with the mean values of 28.5, 30.8, 12.4, 16.4, 20.1, 16.0, 15.2 and 31.4 kg ha^{-1} in A, B, C, D, E, F, G and H blocks, respectively. The highest mean available phosphorus content was recorded in H block (31.4 kg ha^{-1}) and least in C (12.4 kg ha^{-1}) block in surface soil. Available phosphorus content was high in A, B and H blocks and medium in other five blocks.

3.6 Available Potassium

The mean soil available potassium content was 172, 145, 130, 223, 225, 177, 154 and 185 kg ha^{-1} with range values from 121 to 234, 110 to 210, 123 to 137, 142 to 286, 184 to 301, 108 to 256,

126 to 193 and 128 to 243 kg ha^{-1} in A, B, C, D, E, F, G and H blocks, respectively. The highest mean available potassium content was observed in E block (225 kg ha^{-1}) and lowest in C block (130 kg ha^{-1}). In general, all the blocks were medium in available potassium status.

Soil fertility status of RRS farm soil is presented in Table 2. Soil reaction ie., pH of samples ranged from 7.28 to 8.15 with mean value of 7.69 and categorized under slightly alkaline class. The pH showed less variation among the blocks. Similar study on variation in soil pH was reported by Khadka et al. 2019 [7]. Electrical conductivity of soil samples ranged from 0.02 to 0.17 dSm^{-1} and categorized under non-saline class. The soil samples were found suitable for growing crops. This might be attributed to the coarse texture condition of soil. Similar results were reported by Singh et al. 2016 [8].

Organic carbon content of soil samples ranged from 0.19 to 0.58 per cent. Available nitrogen, phosphorus and potassium content of soil samples ranged from 143 to 312, 10.4 to 51.6 and 108 to 301 kg ha^{-1}, respectively. The soil samples were low in organic carbon (0.41%) and nitrogen (238 kg ha^{-1}), high in phosphorus (24.8 kg ha^{-1}) and medium in potassium (177 kg ha^{-1}) status. The soil samples showed variation in organic carbon, available nitrogen, phosphorus and potassium content. It was mainly due to adoption of various crop management practices, crop rotation, fertilizer application methods in crop production. Low organic carbon and available nitrogen content might be due to less use of organic manures and due to coarse texture soil. Similar results were reported by Sahu et al. [9] and Sathish et al. [10].

3.7 Nutrient Index Values and Fertility Rating of Farm Soil

Nutrient index values and fertility rating in soils of RRS Farm, Paiyur was calculated and presented in Table 3.

Table 1. Range and mean values of soil properties of different blocks of RRS Farm

Block	Particulars	pH	EC (dSm^{-1})	Organic Carbon (%)	Available nutrients (kg ha^{-1})		
					N	P	K
A	Range	7.39- 7.99	0.03- 0.08	0.19- 0.52	183- 301	11.6- 45.1	121- 234
	Mean	7.72	0.05	0.35	220	28.5	172
B	Range	7.28- 7.81	0.03- 0.15	0.38- 0.53	186- 312	19.4- 51.6	110- 210
	Mean	7.55	0.09	0.45	258	30.8	145
C	Range	7.79- 7.83	0.05- 0.07	0.24 - 0.29	183- 212	10.6- 14.3	123- 137
	Mean	7.81	0.06	0.26	197	12.4	130
D	Range	7.47- 7.81	0.02 - 0.07	0.41- 0.58	143- 312	10.4- 21.3	142- 286
	Mean	7.67	0.04	0.49	203	16.4	223
E	Range	7.63 - 8.15	0.03 - 0.07	0.43- 0.56	278 - 301	14.3- 24.7	184- 301
	Mean	7.80	0.04	0.51	290	20.1	225
F	Range	7.47- 7.84	0.03- 0.10	0.22- 0.35	194- 287	11.6- 21	108- 256
	Mean	7.72	0.05	0.29	242	16.0	177
G	Range	7.40- 7.84	0.02- 0.17	0.21- 0.47	147- 296	10.4- 21.7	126- 193
	Average	7.64	0.07	0.33	209	15.2	154
H	Range	7.59- 7.84	0.03- 0.08	0.32- 0.53	198- 291	22.6- 42.3	128- 243
	Mean	7.76	0.06	0.45	250	31.4	185

Table 2. Soil fertility status of RRS farm soil

Statistical parameter	pH	EC (dSm^{-1})	Organic Carbon (%)	Available nutrients (kg ha^{-1})		
				N	P	K
Minimum	7.28	0.02	0.19	143	10.4	108
Maximum	8.15	0.17	0.58	312	51.6	301
Mean	7.69	0.06	0.41	238	24.8	177
Standard Deviation	0.16	0.03	0.10	45.3	10.1	45.5
Coefficient of Variation	2.10	48.5	24.5	19.0	40.9	25.6

Table 3. Nutrient index values and fertility rating for available nutrients status in soils of different blocks of RRS Farm

Block	No. of samples	Nutrient index values				Fertility rating			
		Organic carbon	Nitrogen	Phosphorus	Potassium	Organic carbon	Nitrogen	Phosphorus	Potassium
A	27	1.1	1.2	2.6	2.0	L	L	H	M
B	23	1.2	1.4	2.8	1.8	L	L	H	M
C	2	1.0	1.0	1.5	2.0	L	L	L	M
D	12	1.4	1.2	1.9	2.2	M	L	M	M
E	11	1.6	1.9	2.2	2.2	M	M	M	M
F	8	1.0	1.3	2.0	1.9	L	L	M	M
G	9	1.0	1.2	1.7	2.0	L	L	M	M
H	14	1.4	1.1	3.0	2.0	M	L	H	M
Over all	106	1.23	1.31	2.43	1.99	L	L	H	M

3.8 Organic Carbon

The nutrient index value for the organic carbon content of soil was 1.1, 1.2, 1.0, 1.0 and 1.0 in A, B, C, F and G blocks respectively and categorized under low fertility status. D (1.4), E (1.6) and H (1.4) blocks were categorized under medium fertility status.

3.9 Available Nitrogen

The nutrient index value of available nitrogen for soil ranged from 1.0 to 1.9. All the seven blocks *viz*., A, B, C, D, F, G, and H were categorized under low status except E block was categorized under medium status.

3.10 Available Phosphorus

The nutrient index value of available phosphorus for soil ranged from 1.5 to 3.0. The highest nutrient index value for available phosphorus recorded was 3.0, 2.8 and 2.6 in H, B and A blocks respectively and grouped under high fertility status. The lowest nutrient index value for available phosphorus was recorded in C block (1.5) and grouped under low fertility status.

3.11 Available Potassium

Nutrient index value of 1.8-2.2 was observed in all the eight blocks of farm. Nutrient index value of available potassium was higher in D and E (2.2) blocks and categorized under medium fertility status. All the eight blocks were grouped under medium fertility status.

In overall, the nutrient index value of organic carbon and available nitrogen were <1.66 and categorized under low fertility status. The nutrient index value for available phosphorus >2.33 and categorized under high and available potassium was 1.66-2.33 and grouped under medium category.

4. CONCLUSION

Results on the analysis of Regional Research Station farm soil samples indicated that soil were slightly alkaline and non saline. Organic carbon and available nitrogen content were low, available phosphorus and potassium were high and medium status, respectively. Hence, it is necessary to replenish the farm soil fertility with organics, green manures and inorganic source of nutrients for enhancing the nutrient use efficiency, maximizing crop productivity and sustaining the soil fertility. Adoption of STCR-IPNS nutrient management approach will provide balanced nutrition to crops which in turn is helpful in maintaining the soil health and enhancing the yield of crops grown in the farm.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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