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Distribution of Soil nutrients and fertilizer recommendation for paddy at NICRA village in Thiruvarur district of Tamil Nadu

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Abstract
Knowledge of soil fertility is important for site specific nutrient management. Continuous cropping with high yielding crops, unbalanced fertilization without soil testing may be the reason behind deterioration of soil fertility. To sustain the soil fertility as well as to improve the rice yield under "National Innovations in Climate Resilient Agriculture (NICRA)" project, 50 soil samples were collected at Keezhapattu village, Needamangakam block, Thiruvarur district & analyzed for various soil parameters namely, soil pH, EC, Organic carbon, available nitrogen, available phosphorus and available potassium and fertilizer recommendation for rice was calculated. Soils were neutral to alkaline in reaction with normal Electrical Conductivity (EC). Soil organic carbon content was low to medium, available nitrogen in soil was low, available phosphorus was low to high, available potassium was low to high. The observed spatial variability in various soil properties that influence soil fertility was used for deciding nutrient application to rice. Thus providing balanced nutrients to rice based on analysis of fertility of each parcel of land, which has resulted in enhanced rice productivity and net returns. The nutrient status in farmer's field was low in available nitrogen, high in available phosphorus and medium in available potassium. The recommendation as per farmers practice for rice crop was 161:58:75 kg NPK per ha, but, recommendation of fertilizer based on soil test was 188:50:50. With this, there is reduction in cost of cultivation up to Rs 785 ha^{-1}, also maintained the balanced nutrition and increased the productivity of rice with additional returns of 1107 kg ha^{-1}.

Keywords: Rice, fertilizer recommendations, NICRA, Additional returns

Introduction
The ability of soil to support crop growth for optimum crop yield is one of the most important components of soil fertility that determine the productivity of agricultural systems. Many of the processes that influence the soil fertility and productivity are controlled by different characteristics of soil. A proper understanding of the physical, chemical and biochemical properties of soil will throw greater insight into the dynamics of these soils. By characterization of these soils one can clearly understand the inherent capacity of soil for crop production as well as problems that arise in successful management of such soils for achieving higher production.

Soil fertility is one of the important factors controlling yield of the crops. Soil characterization in relation to evaluation of fertility status of the soil of an area or region is an important aspect in the context of sustainable agricultural production because of imbalanced and inadequate fertilizer use coupled with low efficiency of other inputs. The response (production) efficiency of chemical fertilizer nutrients has declined tremendously under intensive agriculture in recent years (Yadav and Meena, 2009).

Knowledge of soil fertility is important for site specific nutrient management. Continuous cropping with high yielding crops, unbalanced fertilization without soil testing may be the reason behind deterioration of soil fertility. To sustain the soil fertility as well as to improve the rice yield under "National Innovations in Climate Resilient Agriculture (NICRA)" project, 50 soil samples were collected at Keezhapattu village, Needamangakam block, Thiruvarur district & analyzed for various soil parameters namely, soil pH, EC, Organic carbon, available nitrogen, available phosphorus and available potassium and fertilizer recommendation for rice was calculated.

Materials and Methods

Study area

The Keezhapattu village is under the revenue administration of Rayapuram panchayat in Needamangalam block of Thiruvarur district, Tamil Nadu situated in Cauvery Delta Zone of Tamil Nadu, located at 10^0 73' N Latitude, 79^0 42' E Longitude. The soils are clay loamy in texture.

Collection of soil samples and analysis

Soil samples (0–30 cm) were collected at one sample for 5–6 ha covering cultivated area of the village during 2018. The co-ordinates were recorded using GPS for all the soil samples collected in the study area. The soil samples were air dried and processed for analysis.

Processed soil samples were analysed for nutrient availability by following standard analytical techniques. The pH and electrical conductivity of soil samples were determined in 1:2.5, soil: water suspension (Jackson 1973) [2]. Soil was finely grounded and passed through 0.2 mm sieve and organic carbon was determined by Walkely and Black (1934) [9] wet-oxidation method as described by Jackson (1973) [2] and expressed in percentage. Available nitrogen was analyzed by potassium permanganate method of Subbiah and Asija (1956) [7]. Available phosphorus and available potassium were determined as per the standard procedures (Jackson, 1973) [2] (Table 1).

Fertilizer Recommendation

The fertilizers were recommended based on the soil test results to the selected farmers. After harvest of the crop, yield observation was recorded to study the impact of soil test based fertilizer use in sustaining the yield.

Results and Discussion

Soil Reaction

The soil reaction in surface soils of Keezhapattu village ranged from 6.50 to 8.85 (Table 2). The soil reaction of the surface soil was neutral to alkaline in nature and results also indicated 20.00 per cent area was neutral (pH 6.5–7.5), 80.00 per cent area was alkaline (pH 7.5–8.5).

Electrical conductivity

The electrical conductivity of surface soil samples varied from 0.02 to 0.145 dSm^{-1} in with a mean of 0.47 dSm^{-1} in Keezhapattu village. The electrical conductivity of the surface soil was normal in nature and results also indicated 94.00 per cent area was normal (less than 1 dS m^{-1}), 6.00 per cent area was slightly saline (1.1 -3.0 dS m^{-1})

Organic carbon

The Organic carbon content of the surface soils ranged from 0.04 to 0.49 per cent with mean of 0.33 per cent in Keezhapattu village (Table 2). About 100 per cent area was low, Low organic carbon in the soil was due to low input of FYM and crop residues as well as rapid rate of decomposition due to high temperature.

The monocropping of cereals practiced by many farmers might be one of the reasons for low organic carbon in these areas. These results were in confirmatory with results reported by Waikar *et al.,* (2004) [8].

Table 1: Critical limits for different soil parameters

S. No.	Parameters/Nutrients	Ratings		
1.	pH	< 6.5 (Acidic)	6.5 – 7.5 (Neutral)	> 7.5 (Alkaline)
2.	EC (dS m^{-1})	< 1.0 (Non – Saline)	1.1 -3.0 (Slightly Saline)	> 3.0 (Saline)
		Low	**Medium**	**High**
3.	Organic carbon (%)	< 0.5	0.5-0.75	> 0.75
4.	Available Nitrogen (Kg/ha)	< 280	280-450	> 450
5.	Available Phosphorus (kg/ha) Olsen P	< 11	11-22	>22
6.	Available Potassium (kg/ha)	< 118	118-280	> 280

Table 2: Status of major nutrients in surface soil samples of Keezhapattu village

	pH	EC (dS m^{-1})	OC (%)	Av. N	Av. P_2O_5	Av. K_2O
				kg ha^{-1}		
Range	6.5-8.85	0.02-1.45	0.04-0.49	92-374	10-34	101-572
Mean	7.90	0.47	0.33	183	20	231

Table 3: Comparisons between general recommendation and soil test based fertilizer recommendation

Crop	Farmers practice - recommendation (NPK kg ha^{-1})	Based on soil test (NPK kg ha^{-1})	Yield (kg/ha)	Net returns (Rs.)	BC ratio
Rice	----	188:50:50.	5975	63615	2.83
	161:58:75	----	4868	48285	2.53

Table 4: Comparison between quantity and cost of fertilizer under general recommendation and soil test based fertilizer recommendation

Fertilizers	Rice	
	Farmers practice	Soil test based fertilizer recommendation
Urea (kg)	2100	2555
DAP (kg)	3125	2725
MOP(kg)	2500	1660
Total Cost (Rs)	7725	6940

Note: Urea- Rs 7.00/ kg, DAP- Rs 25 /kg and MOP- Rs 20 /kg

Available nitrogen

The available nitrogen content of surface soil samples in Keezhapattu village varied from 92 to 374 kg ha^{-1} in the study area. About 92 per cent area was low, 8 per cent area was medium. Similar to organic carbon content, available nitrogen was also low in these soils. The variation in N content was related to soil management, application of FYM and fertilizer to previous crop (Ashok Kumar, 2000) [1].

Available Phosphrous

The available P_2O_5 ranged from 10 to 34 kg ha^{-1} in Keezhapattu village (Table 2). About 46 per cent area was medium and 42 per cent area was high in available phosphorus content. The commonly used phosphorus fertilizer in the area is DAP. The farmers tend to apply excess of DAP fertilizer without knowing the crop requirement and soil availability. Hence, in most of the areas higher available phosphorus was observed. Also variations in available P content in soils are related with the intensity of soil weathering or soil disturbance, the degree of P- fixation with Fe and Ca and continuous application of mineral P fertilizer sources as indicated by Paulos (1996).

Available potassium

The available potassium content of surface soil samples varied from 101 to 572 K_2O kg ha^{-1} in Keezhapattu village (Table 2). About 14 per cent area was low in available potassium content, 62 per cent area was medium in available potassium content and 24 per cent area was high in available potassium content. As reported by Patiram and Prasad (1991), the high K status in these soils is associated with the presence K rich minerals in soil.

Nutrient management and fertilizer recommendations

Application of fertilizers based on soil test results would help in providing balanced nutrients to crop, reduce excess application, reduces over mining of nutrients from the soil and also reduces the cost of cultivation.

The soil test results were used for management of soil and fertilizer recommendation to various crops. The organic carbon level of the soil in village was low to medium. In order to maintain organic carbon level in soil, application of organic matter is recommended through various sources like FYM, vermicompost, green manuring and incorporation of crop residues into the soil so as to improve soil physical, chemical and biological properties of soils.

The availability nitrogen in the project area soils was low to medium, hence wherever available nitrogen was low, 27 kg ha^{-1} of additional dose of nitrogen fertilizer is recommended along with recommended fertilizer in case of rice (Table 2).

Phosphorus fertilizer (DAP) is very expensive and also nearly 42 % area is high in available P_2O_5 where it was suggested to reduce the dose of P_2O_5 by 8 kg ha^{-1} from recommended fertilizer for rice. The village showed 24 per cent area as high in available potassium content in soil, hence, 25 kg ha^{-1} less potassium (K_2O) was recommended to reduce the luxury consumption.

Soil test based fertilizer recommendation

The fertilizer recommendation was made based on the site specific nutrient status to all the beneficiary farmers of operational research project being operated in this village. With the adoption of this method, only required fertilizers are provided to specific field and crop. In comparison with the fertilizer recommendation made as per crop production guide of Tamil Nadu. The site specific nutrient recommendation provides all the major nutrients based on the availability of these nutrients in soil and crop need. This has ensured providing only required quantity of nutrients, balanced nutrition and in some cases reducing fertilizer cost.

Fertilizer recommendation for Rice

The nutrient status in farmer's field was low in Soil organic carbon and available nitrogen and medium to high in available phosphorus and available potassium. The recommendation of fertilizer based on soil test was for rice crop was 188:50:50 kg NPK per ha, but, recommendation of fertilizer based on farmers practice was 161:58:75. With this, there is reduction in cost of cultivation up to Rs 785 ha^{-1}, also maintained the balanced nutrition and increased the productivity of rice with additional returns of 1107 kg ha^{-1}.

The total quantity of fertilizers in terms of urea, DAP and MOP based on soil test fertilizer recommendation was 7300, 2180 and 1660 kg instead of farmers practice recommendation of 6000, 2500 and 2500 kg for 20 ha comprising of 50 farmers. There was reduction in total cost of fertilizer up to Rs 15,700.

The comparison made with farmers practice and site specific nutrient recommendation clearly showed the advantage of providing balanced nutrition which helped in the availability of nutrients to crop for better growth and yield (Smaling and Braun, 1996) [6].

Conclusion

If the soil test based fertilizer recommendation is adopted in total cultivated area under rice (1,20,000 ha) in Thiruvarur district. Then we can reduce considerable cost on fertilizers and provide balance nutrition to crop. It can be concluded that, the geospatial technologies helps in preparing soil nutrient status maps which facilitates management of nutrients.

In the present study, a soil of Keezhapattu village was low in soil organic carbon content and available nitrogen. Available phosphorus and available potassium were medium to high.

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