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# Assessment and rating of available nutrient status of rice soil in the southern laterites (AEU 8) of Kerala

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**Abstract**

The present investigation was carried out the wetlands of selected farmer's field in Chenkal panchayat of Parassala block, Thiruvananthapuram, Kerala, to assess the available nutrient status of rice soil in Southern laterites (AEU 8). The overall fertility status of this region indicated that the soil was strongly acidic, high in organic carbon, available nitrogen and phosphorus and medium in potassium. Excess levels of phosphorus and wide spread of deficiencies of calcium, magnesium, sulphur, zinc and boron are the major limitations to crop production in this region. Liming of acid soils in accordance with soil test results is highly essential. Amelioration of soil acidity and external inputs of secondary and micronutrients along with the major nutrients are essential for enhancing crop productivity in the Southern Laterites (AEU 8). Use of phosphatic fertilizers should be restricted to be tune of 25-30 per cent of POP recommendation. Thus a balanced fertilization along with appropriate micronutrient mixtures will help to enhance the productivity of rice and improve the nutrient use efficiency.

**Keywords:** Rice, available nutrients, southern laterites (AEU 8)

## Introduction

Rice is a predominant crop in the lowlands of the Southern laterites (AEU 8). Rice is "life" for more than sixty per cent of the world's population and plays a major role in the economic and social stability of the world (Chauhan *et al.*, 2014) [2]. In India, rice is grown in an area of 43.95 M ha annually with a production of 106.54 million tonnes, and an average productivity of 2424 kg $ha^{-1}$ during 2013-2014 (GOI, 2014) [6]. The productivity of rice has to be increased to 4 t $ha^{-1}$ if the production target of 12 t from 3 lakh hectares to be achieved (Leenakumari, 2013) [10]. However paddy accounted only for 7.6 per cent of the total cropped area with a productivity of 2.83 t $ha^{-1}$ in 2013-'14 (GOK, 2015) [7]. The prime cause for the low productivity in rice is the inadequate and imbalanced supply of fertilizers with special reference to location/ region specific recommendations which take into account the soil fertility status, climate and cropping pattern (Dwivedi and Meshram, 2014) [4]. Productivity enhancement of rice requires the identification of region-specific production constraints and formulation of separate package for increasing productivity. Supplementing micronutrients to responsive crops and soils with low status resulted in balanced nutrition, correction of hidden hunger, better utilization of the major nutrients and in enhanced growth and yield (Mathew, 2007) [11]. Application of Zinc and boron in conjunction with NPK was observed to increase the test weight, yield and protein content of rice (Abbas *et al.*, 2013) [1]. Balanced fertilization along with appropriate micronutrient mixture will help to enhance the productivity of rice and improve the nutrient use efficiency.

Kerala has been delineated into 23 agro-ecological units (Nair *et al.*, 2012) [12]. An agro-ecological unit (AEU) is a homogenous geographical area which has the production environment in terms of agro-climate, resource endowment and socio-economic conditions is homogenous, and majority of the farmers have similar production constrains and research needs (KSPB,2013). Since the agro-ecological unit (AEU) wise studies show distinct intra unit variation with respect to crop yield, specific packages mitigating the yield barriers need to be developed to address the yield gap and to enhance the productivity of AEU. The southern Laterites (AEU 8) is spread over 24 panchayaths (5 blocks) in south-western part of Thiruvananthapuram district of Kerala state in India, which covers an area of 38727 ha. The region lies between 8° 21' 30.6" N latitude and 77° 05' 04" E longitude at an altitude of 28 m above the mean sea level. Soils of AEU 8 showed significant levels of Zn deficiency and widespread deficiency of B (KSPB, 2013).The yield variation analysis conducted for rice in AEU 8 revealed that a higher N/K ratio of 1: 1.3 resulted in higher yields (Sheela *et al.*, 2014) [14]. Productivity enhancement of rice requires the identification of region- specific constraints and formulation of separate packages for increasing productivity.

## Methodology

To characterize the fertility status of soil, composite surface soil samples were collected from farmers' fields spread all over the Southern laterites (AEU 8). Rice cultivation is in vogue in 3 blocks, covering 11 panchayaths, in AEU 8. They are Nemom (Balaramapuram, Kalliyoor, Pallichal, Malayinkeezhu), Parasala (Chenkal, Parasala, Karode), Perumkadavila (Aryancode, Kollayil, Kunnethukal, Perumkadavila). Total of 150 georeferenced soil samples were drawn at random depending on the extent of paddy area in the respective panchayats and analysed for 13 soil fertility parameters: soil reaction, soluble salts, oxidisable organic carbon and available phosphorus, potassium, calcium, magnesium, sulphur, iron, manganese, copper, zinc and boron following standard analytical procedures (Jackson, 1973). The data generated were used for assessing soil fertility status and preparing plant nutrient management plan for the region based on the existing package of practice recommendations (KAU, 2011)

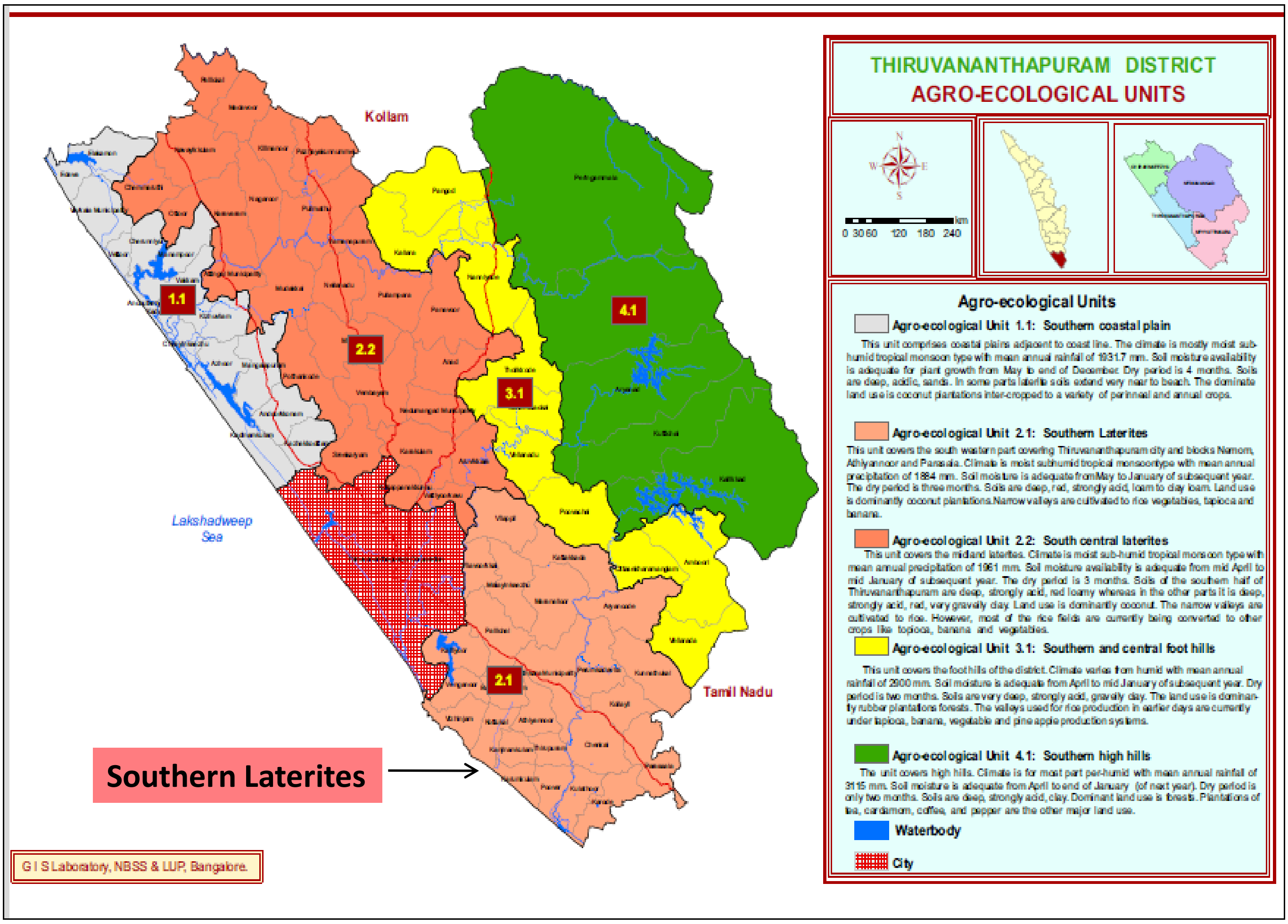


**Fig 1:** Agroecological units in Thiruvananthapuram district

## Results and Discussion

The content of soluble salts in the soil was normal for rice and no deficiency of micronutrients iron and manganese was recorded in any of the analyzed samles. Based on the soil test values for oxidisable organic C, available, P,K, Ca, Mg, S, Fe, Cu, Mn, Zn and B the soil samples were classified into three categories *viz*., low, medium and high as per the ratings suggested by Dev (1997) [3]. Range and mean value of various soil test parameters in the region is given in Table 1.

## Soil reaction

The pH of the soils ranged from extremely acid (<4.5) to neutral to slighyly alkaline (<6.5) with mean value of 5.50. However the major share of the soil comes under strongly acid (5.1-5.5) followed by moderately acidic (5.6-6.0). (Fig. 2.). About 97.77 per cent of soils are acidic in reaction and 75.7 per cent strongly to extremel acidic. The problem of acidity has aggravated to extreme levels in soils due to heavy inputs of acid producing fertilizers, without regular application of lime to neutralize the acidity generated. Application of lime based on soil test has to be followed. Liming is essential for favorable soil reaction and to ensure availability of essential nutrients.

**Table 1:** Range and mean of soil fertility parameters

| Sl. No | Parameter | Content | Rating | Method used |
|---|---|---|---|---|
| 1 | Available N (kg $ha^{-1}$) | 292.15 | high | Alkaline permanganate method (Subbiah and Asija, 1956) |
| 2 | Available $P_2O_5$ (kg $ha^{-1}$) | 103.04 | high | Bray colorimetric method (Jackson, 1973) |
| 3 | Available $K_2O$ (kg $ha^{-1}$) | 178.31 | medium | Ammonium acetate method (Jackson, 1973) |
| 4 | Available Ca (mg $kg^{-1}$) | 22.56 | very low | Ammonium acetate method (Jackson,1973) |
| 5 | Available Mg (mg $kg^{-1}$) | 6.58 | very low | Ammonium acetate method (Jackson, 1973) |

| | | | | |
|---|---|---|---|---|
| 6 | Available S (mg $kg^{-1}$) | 2.03 | very low | Turbidimetric method (Chesnin and Yien, 1950) |
| 7 | Organic carbon (%) | 0.68 | high | Walkley and Black rapid titration method (Jackson, 1973) |
| 8 | Soil reaction (pH) | 5.50 | acidic | 1:2.5 soil solution ratio using pH meter with glass electrode (Jackson, 1973) |
| 9 | Available Fe (mg $kg^{-1}$) | 12.93 | very high | Extraction using 0.1M HCl and estimation using Atomic Absorption Spectrophotometer (Sims and Johnson, 1991) |
| 10 | Available Cu(mg $kg^{-1}$) | 0.97 | Slightly low | Extraction using 0.1M HCl and estimation using Atomic Absorption Spectrophotometer (Sims and Johnson, 1991) |
| 11 | Available Mn(mg $kg^{-1}$) | 4.13 | Sufficient | Extraction using 0.1M HCl and estimation using Atomic Absorption Spectrophotometer (Sims and Johnson, 1991) |
| 12 | Available Zn(mg $kg^{-1}$) | 0.60 | low | Extraction using 0.1M HCl and estimation using Atomic Absorption Spectrophotometer (Sims and Johnson, 1991) |
| 13 | Available B (mg $kg^{-1}$) | 0.12 | very low | Extraction with hot water and estimated colorimetrically by Azomethine-H using spectrophotometer (Gupta,1967) |

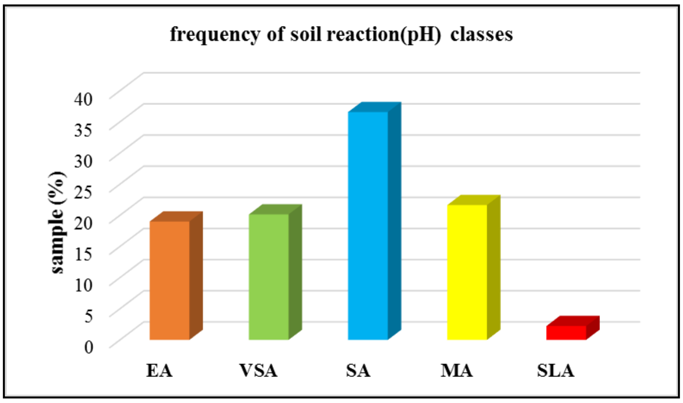


**Fig 2:** Frequency of soil reaction classes: EA- Extremely acid (pH<4.5), VSA-Very strongly acid (pH 4.5- 5.0), SA- Strongly acid (pH 5.1- 5.5), MA- Moderately acid (pH 5.6- 6.0), SLA-Slightly acid (pH 6.1- 6.5)

### Primary nutrients

The available nitrogen status of the soils of this region reveals that 85.32per cent of samples have indicated medium to high levels of available nitrogen (Fig. 3). Correction of soil acidity can lead to better microbial activity and consequently to better utilization of applied nitrogen fertilizer and possibly reduction in their use.

Plant available phosphorus is high in 97 per cent of the soil samples tested (Fig. 3.).

Heavy inputs of phosphatic fertilizers lead to build up of very high levels of the nutrient in soils. High levels of available phosphorus can have negative influence of uptake of other nutrients especially zinc and boron. Soil tested regularly and applies fertilizers accordingly. Use of phosphatic fertilizers should be restricted to be tune of 25-30 per cent of POP recommendation.

In general, the potassium status of Kerala soils is found to be low can be attributed to the tropical climate of our state. The available potassium status of the region varied from medium to high. Major part (97.74 %) of the soils of Southern Laterites belonged to the medium potassium content. Balanced N and K nutrition helped in improving utilization of nitrogen. Inadequate application of K along with excess application of N was observed to be a serious problem in modern intensive crop production systems (El-Hadi *et al.*, 2013) [5]. The present recommendation dose of N and K as per POP of Kerala Agricultural University is 90:45 (2:1 ratio). It is observed that there is higher uptake of N and K at rates exceeding the recommendation amounts. If this trend continues, the soil will be gradually depleted of its native N and K. Therefore maintenance of proper NK ratio in the soil is important to realize higher yields. The yield variation analysis conducted for rice in AEU 8 revealed that a higher N/K ratio of 1:1.3 resulted in higher yields (Sheela *et al.*, 2014) [14].

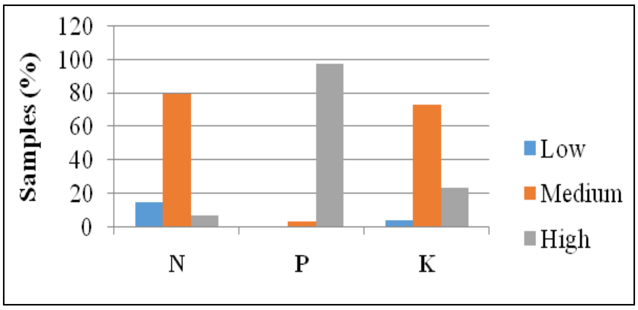


**Fig 3:** Frequencey of available nitrogen, phosphorus and potassium classes

### Secondary nutrients

In the case of available calcium status, only 100 per cent of the samples were deficient. The deficiency is more pronounced in areas with strongly acidic soil reaction. Similar trend was observed for available magnesium. Use of required quantity of lime for regulation of soil reaction can take care of calcium and magnesium nutrition as well. Sulphur deficiency observed in 89 per cent of the soil samples. Most phosphatic fertilizers contain sulphur as an additional constituent and that may be responsible for satisfactory levels in soils. Foliar application could be considered only as a supplement to soil application of calcium and magnesium.

### Micronutrients

There was no deficiency of iron and manganese in any of the samples. Zinc deficiency was recorded in 92 per cent soil samples in the region. Copper deficiency was noticed in 80 per cent of the soil samples in the region (Fig. 4.). Pandey *et al.* (2007) [13] reported good response of rice to NPK and Zn application. Severe Zn deficiency causes loss of grain yield, and rice grain with low zinc content contribute to human nutritional zinc deficiencies (Johnson *et al.*, 2009). Boron is another essential micronutrient required for rice crop. About 96 per cent samples from rice growing area have recorded boron deficiency, which indicates the urgent need for boron fertilization in rice for enhancing productivity of rice. Application of zinc and boron in conjunction with NPK was observed to increase the test weight, yield and protein content of rice (Abbas *et al.*, 2013) [1]. Thus a balanced fertilization along with appropriate micronutrient mixtures will help to enhance the productivity of rice and improve the nutrient use efficiency.

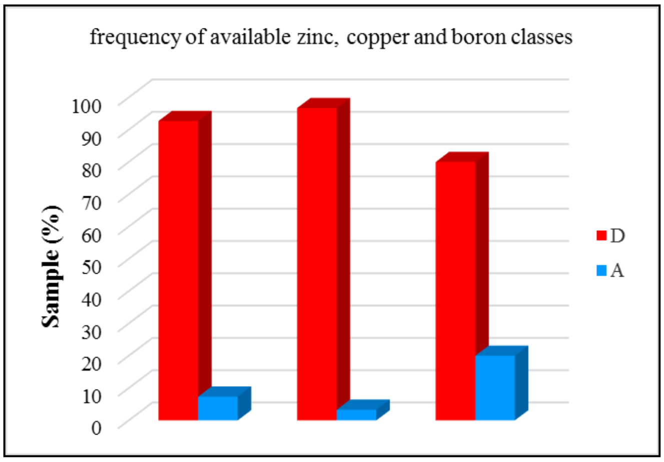


**Fig 4:** Frequency of available Zinc, Copper and Boron availability classes: D-Deficient A-Adequate

## Conclusion

The overall fertility status of this region indicated that the soil was strongly acid with high levelin organic carbon, high in available nitrogen and phosphorus, medium in potassium. Excess levels of phosphorus and wide spread of deficiencies of calcium, magnesium, sulphur, zinc and boron are the major limitations to crop production in this region. Amelioration of soil acidity and external inputs of secondary and micronutrients along with the major nutrients are essential for enhancing crop productivity in the Southern Laterites (AEU 8). Apply zinc as foliar spray (0.2 % solution of zinc sulphate) in zinc deficient areas, apply copper sulphate @1.5 kg per hectare to correct copper deficiency, apply borax @ 10 kg/ha in soil or foliar spray of 0.2 per cent solution of borax. Use of phosphatic fertilizers should be restricted to be tune of 25-30 per cent of POP recommendation. Thus, a balanced fertilization along with appropriate micronutrient mixtures will help to enhance the productivity of rice and improve the nutrient use efficiency.

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