Original Research Article

Assessment ofnutrient status in the cassava growing tracts of Southern Laterites(Agro-Ecological Unit 8), Kerala, India

Abstract

As part of the study, a survey was conducted to identify the soil fertility constraints of cassava growing tracts of AEU 8, Thiruvananthapuram, which is one of the major cassava growing regions of the State of Kerala in peninsular India. The method of sampling of the survey was random sampling wherein a random sample of size one was taken from each of the 50 ha cassava areas. Panchayat-wise soil samples were collected (77 samples) by geo-referenced soil sampling method from major cassava growing areas of the unit. The samples are analyzed for the soil fertility parameters following standard analytical procedures.Results indicated that the soil was verystrongly acidic to strongly acidic, with normal electrical conductivity, medium organic carbon, medium nitrogen and potassium, high phosphorus, sufficient calcium, sulphur, zinc and copper, deficient magnesium and boron.

Keywords: Agro-ecologicalunit 8, Cassava, Soil sampling and Available nutrients

Introduction

An agro-ecological unit (AEU) is characterized by distinct ecological responses to the macro-environmental elements reflected in the vegetation, soils, and agricultural land use. The State of Kerala in the Indian subcontinent has been divided into 23 distinct AEU's (KSPB, 2013). The AEU 8 (Southern Laterites) extends to the southwestern part of Thiruvananthapuram district in Kerala, covering Thiruvananthapuram city and Nemom, Athiyannoor, Parassala, Perumkadavila and Vellanadu blocks comprising 24 panchayats and one municipality covering a geographicalarea of 387.27 square kilometers.The climate is moist, sub-humid tropical monsoon type. Soils are deep, red, and stronglyacidicand loam. Land use is dominantly coconut plantations and narrow valleys are cultivated with rice, vegetables, tapioca and banana.

Cassava (*Manihot esculenta* Crantz) is one of the world's most important staple food crops.The crop holds a predominant position in the cropping systems of Southern Kerala and occupies an area of 3690 ha in AEU 8 (GOK, 2019).In the present scenario, rice cultivation in the lowlands is being replaced by short-duration cassava varieties, and increasing cassava production for food diversification would help achieve the population's food security.

Among the short-duration varieties of cassava, VellayaniHraswa is the most popular variety in Southern Kerala.The nutrient management of VellayaniHraswa is, at present, based on the blanket recommendation for types with different durations and growth habits. However, balanced fertilizer application is possible by assessingcrop nutrient demand and innate soil fertility status. Hence, the development of scientific nutrient management practices will help the farmers of AEU 8 to use the nutrients judiciously and to achieve better productivity.

Materials and methods

Soil sample collection and analysis

The method of sampling followed in the survey was random sampling wherein a sample of size one was taken randomly from each of 50 ha cassava areas. Panchayat-wise (23 panchayat) soil samples were collected by geo-referenced soil sampling method from major cassava growing areas of the unit.

For soil sample collection, each field was divided into uniform areas and each area was sampled separately. After removing the stubbles and litter, a 'V' shaped cut was made to a depth of 15 cm by using spade.Samples collected from the uniform areas were mixed together to get a composite sample and after the quartering process, 500 g of soil sample was obtained. A total of 77 geo-referenced composite soil samples were drawn at random and the collected soil samples were dried in shade and were analyzed for the soil fertility parameters such as soil reaction, soluble salts, organic carbon, available nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, boron, copper and zinc following standard analytical procedures (Table 1).

Result and discussion

Soil Fertility Status of AEU 8

The soil test data such aspH, EC, organic carbon and available N, P, K, Ca, Mg, S, Fe, Mn, Cu and Zn covering the agro ecological unit 8 was processed and interpreted to arrive at the overall soil fertility status of AEU 8.Distribution of point data over fertility classes of soil reaction, organic carbon and nutrients in cassava growing tracts of AEU 8 were tabulated and given in Table2.

Soil reaction

Out of 77 soil samples, 25 samples are very strongly acidic (32.47 percent) and 23 samples are strongly acidic (29. 87 percent) with value ranging from 4.78to 7.20with a mean value of 5.55 ± 0.65. According to Nair *et al*. (2019) low content of basic cations and high Al saturation of exchange complex which are responsible for acidity are primarily due to lack of liming.Another reason for the increased acidity is the high rainfall prevalent in the area. The area receives an average annual rainfall of 1884 mm (KSPB, 2013). The problem of soil acidity in the tract was found to have aggravatedby the unscientific use of acid producing fertilizers, lack of lime application etc. as identified in the survey.

Electrical conductivity

Out of 77 soil samples 76 samples are normal (98.70per cent) with value ranging from 0.042 to 2.60 dS m^{-1} with a mean value of 0.16± 0.28 dS m^{-1}. Electrical conductivity (EC) is a measure of the soluble salts and is a measure of the cations and anions present in a soil which in turn is a measure of the salinity of the soil.

Organic carbon

The available organic carbon status of the cassava growing tract of AEU 8 showed that 52 soil samples (67.53 per cent) tested medium range organic carbon with a mean content of (1.45± 0.46)% and a range of 0.51to 3.18 % .Most soils of AEU 8 being the laterite type low activity clay soils, it is essential to maintain high organic matter content in the soil.Cassava is a heavy feeder and requires nutrients in abundant quantity. In spite of the higher requirement of nutrients, the cassava growing tracts of AEU 8 had a medium level of soil organic carbon content in general. The crop cassava is characterized by leaf abscission leading to leaf fall and fallen leaves add a moderate quantity of dry matter to the soil along with major and minor nutrients.

Lack of application of sufficient quantity of organic manures and non-adoption of management practices to protect the soil organic carbon could have seriously affected the organic carbon status of soil. Decline in the organic carbon status of cassava cultivated soils under continuous cultivation was previously reported by Francis *et al*. (2013).

Primary nutrients

The available nitrogen status of the AEU 8 showed that 42 soil samples (54.55 per cent) tested had medium range nitrogen with value ranging from 125.44 to 489.22 kg $ha^{-1}$with a mean value of 289.81±69.19 kg ha^{-1}. Most of the farmers in AEU 8 use poultry manure as organic source in the cassava field and is usually applied in several split doses upto two months before the harvest. Poultry manure hashigher nitrogen content (1.12-1.28 per cent) as reported by Limisha (2022). However the late split application of this manure would be resulted in the release of N to the soil after the crop duration which would have reflected on the available N status of the soil.

In general, most of the study area could be rated as high in available phosphorus, ranging from 1.12 to 897.90 kg $ha^{-1}$with a mean value of (232.81±212.58) kg ha^{-1}. Of the total, 63 soil samples (81.82 per cent) tested high phosphorus content. The High P levels in these soils are usually due to over-fertilizing through high analysis complex or straight fertilizers having P. The major portion of Kerala soils has high P availability due to excess use of phosphatic fertilizers through factomphos which is manufactured in the State itself (Rajasekharan*et al*.,2014).As explained by Ahmed *et al*. (2021), when exogenous P content is lower, there are abundant adsorption sites on soil colloids and there is a higher chemical adsorption binding capacity for soil P, and lower desorption capacity.

The available potassium status of the AEU 8 showed that 41 soil samples (53.25per cent) tested had medium range of potassium with values ranging from 79.20 to 986.73 kg $ha^{-1}$with a mean value of (265.90±200.55) kg ha^{-1}.The cation exchange capacity of the low activity clay minerals in the soils does not permit significant amounts of potassium retention in exchangeable form. The lateritic nature of the soil and prevailing humid climate necessitates regular application of potassium fertilizers to the crop plants.Cassava takes up a substantial quantity of potassium from the soil and the harvested roots in particular contain large amounts of K - the NPK ratio in the roots being 5:1:10 in comparison to the typical ratio of 7:1:7 as in other crops

(Vanlauwe *et al.*, 2008). Uptake of K^+ is a driving process for accessing both the exchangeable pool and even a significant part of the nonexchangeable pool in the soil (White *et al*., 2013).

Secondary nutrients

In the case of available calcium status, 50 samples (64.94 per cent) had sufficient Ca content, which could be due to the practice of liming by most cassava cultivators.The range of calcium was found to vary from 70 to 610.00 mg kg^{-1} with an average of (330.38±133.72) mg kg^{-1}.Another possible reason for higher Cacontent in soil could be the antagonistic effect of higher soil P content on Ca through competition in the absorption of these nutrients for the same transporters such as non-specific carrier proteins (Reitra*et al.*, 2017). This antagonistic influence could have affected the crop uptake of Ca, leaving unutilized amount of this nutrient in the soil.

Magnesium was deficientin 52 samples (67.53 per cent) with a mean content of (114.44 ± 66.90) mg kg^{-1} and a range of 18 to 396.00 mg kg^{-1}.Magnesium is less strongly bound to soil colloids due to its higher hydrated ionic radii and hence easily leached off. The predominance of coarse textured soils, well drained condition and intense leaching losses, and less addition of inputs supplyingmagnesium to soil (Bhindhu and Sureshkumar, 2021) could be the reasons for prevalence of magnesium deficiency in the tract.

Analysis of the sulphurstatus of the soils indicted that 47 soil samples (61.04 per cent) had sufficientsulphur content with a mean value of (15.17±20.98) mg kg^{-1} and a range of 0.5to 90.00 mg kg^{-1}. This is in conformation with the general status of sulphur in Kerala soils.Use of the complex fertilizer factomphos (N:P:K:S @ 20:20:0:13) which is manufactured in Kerala and widely available throughout the State would have resulted in sufficient S status in Kerala soils as reported by Rajasekharan*et al*. (2014).

Micronutrients

The range of boron was found to vary from 0.004 to 0.404 mg kg^{-1} with an average of (0.13±0.11) mg kg^{-1}. Available boron was deficient in 100per cent soil samples. Boron is one of the important micronutrient among all essential micronutrients required for proper growth and development of plants. An estimated annual B requirement of 3.9 thousand tonnes by 2025 is an indication of its emergence as a major limiting nutrient to obtain optimum yield of many crops (Murthy, 2006). Major soils of Kerala, derived from acid igneous rocks are, however, deficient in B (SSO, 2007). Moreover, being highly mobile in the soil (Tisdale *et al*., 1985), leaching losses further aggravate B insufficiency in the high rainfall zones of Kerala, frequently leading to development of deficiency symptoms in crop plants.

Available zinc was sufficient in 76 samples (98.70 per cent) with a mean content of (9.75 ± 5.20) mg kg^{-1} and a range of 0.86 to 29.42 mg kg^{-1}. Low Zn status of soil could have been attributed to the antagonistic effect of high P content in soils as reported by Tisdale *et al*. (1985). Available copper was sufficient in 77 samples (100 per cent) with a mean content of (3.49±2.06) mg kg^{-1} and a range of 1.04 to 9.38 mg kg^{-1}. Copper is an important ingredient of common fungicides and element retentionin soil organic matter may explain the adequate level of copper in the soil.

Conclusion

According to the survey, most farmers' management practices for cassava in AEU 8 are poorly related to actual crop requirements and probably lead to significant nutrient losses due to over-application and yield losses due to under-application. The overall fertility status of agro-ecological unit 8(AEU 8) indicated that the soil was very strongly acidic to strongly acidic, normal electrical conductivity, medium organic carbon, medium nitrogen and potassium, high phosphorus, sufficient calcium, sulphur, zinc and copper, deficient magnesium and boron and it was used for developing a scientific nutrient management package which could help the farmers in judicious management of costly chemical fertilizers and to achieve better productivity through increasing the nutrient use efficiencies.

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Table 1. Standard analytical procedures adopted for soil samples in Agro Ecological Unit 8

Sl.no	Parameters	Method used

1	pH	Soil and water suspension of 1:2.5 and read in pH meter (Jackson,1958)
2	Electrical conductivity (dS m^{-1})	Soil and water suspension of 1:2.5 and read in EC meter (Jackson,1958)
3	Organic carbon (%)	Walkley and Black method (Walkley and Black,1934)
4	Available N (kg ha^{-1})	Alkaline permanganate method (Subbiah and Asija,1956)
5	Available P_2O_5 (kg ha^{-1})	Ascorbic acid reduced molybdophosphoric blue colour method (Bray and Kurtz,1945)
6	Available K_2O (kg ha^{-1})	Neutral normal ammonium acetate extract using flame photometer (Jackson,1958)
7	Available Ca (mg kg^{-1})	Neutral normal ammonium acetate extract using Atomic Absorption Spectrophotometer
8	Available Mg (mg kg^{-1})	Neutral normal ammonium acetate extract using Atomic Absorption Spectrophotometer
9	Available S (mg kg^{-1})	$CaCl_2$ extract-turbidimetry method (Chesnin and Yien, 1951)
10	Available B (mg kg^{-1})	Azomethine H method
11	Available Zn (mg kg^{-1})	HCl acid extract method using Atomic Absorption Spectrophotometer (Sims and Johnson, 1991)
12	Available Cu (mg kg^{-1})	HCl acid extract method using Atomic Absorption Spectrophotometer (Sims and Johnson, 1991)

Table 2: Distribution of point data over fertility classes of soil reaction, organic carbon and nutrients in cassava growing tract of AEU

Parameters	Fertility class	Critical range	No of samples	Per cent samples
Soil reaction pH	Extremely acidic	3.5 - 4.4	0	0.00
	Very strongly acidic	4.5 – 5.0	25	32.47
	Strongly acidic	5.1 – 5.5	23	29. 87
	Moderately acidic	5.6 - 6.0	6	7.79
	Slightly acidic	6.1 – 6.5	17	22.08
	Neutral		6	7.79
Electrical conductivity	Normal	< 0.8	76	98.70
	Critical for germination	>0.8	1	1.30
OC	Low	< 0.5	0	0.00
	Medium	0.5 – 1.5	52	67.53
	High	>1.5	25	32.47
N	Low	< 280	35	45.45
	Medium	280 - 560	42	54.55
	High	> 560	0	0.00
P	Low	< 11	9	11.69
	Medium	11 - 24	5	6.49
	High	>24	63	81.82
K	Low	<116	11	14.28
	Medium	116 - 275	41	53.25
	High	> 275	25	32.47
Ca	Deficient	<300	27	35.06
	Sufficient	>300	50	64. 94
Mg	Deficient	<120	52	67.53
	Sufficient	>120	25	32.47
S	Deficient	<5	30	38. 96
	Sufficient	5-10	47	61.04
B	Deficient	<0.5	77	100.00
	Sufficient	>0.5	0	0.00
Zn	Deficient	<1	1	1.30
	Sufficient	>1	76	98.70
Cu	Deficient	<1	0	0.00
	Sufficient	>1	77	100.00