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Nutrient Index Approach - A Key Assessment of Soil Fertility Status of Chintamani Campus, UAS, Bangalore

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Abstract

The present study was undertaken to assess the fertility status of soil under various cropping sequences followed in different blocks of College of Sericulture, Chintamani Campus, UAS-B. Three wings of Chintamani campus, namely College, ARS and ICAR-KVK falling under four blocks were selected. The soil samples were taken from 0-15 cm depth with the help of an auger after the harvesting of the *kharif* crops during 2020-21, using the GPS locations. Seventy-nine soil samples were taken in different blocks of the campus. Soil pH, electrical conductivity, organic carbon, available major, secondary and micronutrient content of soil were measured. Data were analyzed with descriptive statistics and Parker's nutrient index was used to compare the fertility level. The result revels that soils are acidic in nature; organic carbon content was low to medium while available nitrogen was medium, available phosphorous low and available potassium high. Exchangeable calcium and magnesium were high and available sulphur was low to medium. DTPA extractable zinc, iron and boron contents were deficient and sufficient ranges in the samples, copper and manganese content were sufficient in all the samples.

Keywords: Nutrient index, Soil fertility status, GPS locations

Soil fertility is the intrinsic capability of soil to deliver crop needed nutrients at the right time and the right amount of plant nutrients and requires excellent management. One of every such approach is through assessment of soil fertility (Turamyenyirijiuru *et al.,* 2019) and it is far too complex for only peasant farmers to address considering the range of factors involved. Assisting farmers with proper nutrient management measures to fight soil fertility issues will enhance crop yields in the long run (Evert-Jan and Aniek, 2014).

The evaluation of soil fertility includes the measurement of available plant nutrients and estimation of the capacity of soil to maintain a continuous supply of plant nutrients for a crop. The availability of nutrients depends on various factors such as types of soils, nature of irrigation facilities, pH and organic matter content. Soil test-based nutrient management has emerged as a key issue in efforts to increase agricultural productivity and production, because optimal nutrient use, based on soil analysis, can improve crop productivity and minimise wastage of these nutrients, minimising environmental impact and leading to bias through optimal production. Primary, secondary and micronutrient deficiencies have been identified in intensively cultivated areas.

Soil test data usually are summarized for a respective block and district and on an all India level. Such soil fertility summaries are useful to administrators and planners in deciding the kind and amount of fertilizer most suitable in each area or district and determining the policy of fertilizer, distribution and consumption in different region. The data also are of use to fertilizer association, fertilizer industries and extension workers in promoting their respective programme and to research workers, particularly from the point of view of changes in fertility levels, conditioned by different fertilizer use or by different soil and crop management practices.

Increased crop production in the soil is dependent on soil fertility. It entails not only the provision of nutrients but also their effective control. The nutrient-supplying capacity of a soil is determined by its fertility condition. Organic matter is one of the most important ingredients in soil; a significant amount of organic matter in the soil greatly increases soil fertility. Organic matter decay releases nitrogen, phosphate and mineral nutrients in a form that plants may use. The availability of N, P, K, secondary and micronutrients promotes seed germination, which leads to improved growth and root development. Agriculture alters the chemical, physical, and biological aspects of the soil. Therefore, if the fertility status of soil is investigated, the information will guarantee appropriate fertilizer recommendations and uses. Hence, the objective of this study is to evaluate the fertility status of the College of Sericulture campus, Chintamani.

Material and Methods

Description of Study Area: The study was carried out in 3 wings of the campus namely college, ARS and ICAR-KVK falling under four blocks namely block 1, 2, 3 and 4. College of Sericulture, Chintamani is geographically located in Eastern Dry Zone (Zone -5) of Karnataka and lies between 13.40º N 78.06º E at an altitude of 865 m above the sea level and it receives a rainfall of 400 to 650 mm annually.

Major Cropping Systems in the Campus

Major crops grown in block 1 includes, agro forestry with teak, red sandal, Semaruba, cattle shed and fodder museum, jamun, mulberry garden V1 and S36 varieties. In block 2. Finger millet or pigeon pea seed production plot, crop production unit, mango orchard, coconut plantation, mixed plantations like coconut + guava, coconut + guava + sapota, cashew and tamarind plantation. While block 3 consist of major crops like simarouba, cashew, seed production plot, multi location trail plots, treated sewage water experimental plots, mango scion bank of badami and rathnagiri, Scion bank of cashew and mango orchard. Block 4 with mixed fruit orchard, tamarind, mango and jack + nursery.

Sample Preparation and Laboratory Procedures: The soil samples were air dried at room temperature, processed and sieved with a 2 mm mesh, properly

Table 1

Soil rating chart and their nutrients indices

Soil Properties	Range		
	Low	Medium	High
Soil pH	< 6.5 (acidic)	6.5-7.5 (Neutral)	>7.5 (Saline / alkaline)
Organic carbon (%)	< 0.5	0.5-0.75	> 0.75
Available N (kg/ha)	< 280	280-560	> 560
Available P_2O_5 (kg/ha)	< 22.9	22.9-56.0	> 56.0
Available N (kg/ha)	< 141	141 -336	> 336
Exch. Ca (cmol (p+) kg^{-1})	<1.5	1.5 - 3	>3
Exch. Mg (cmol (p+) kg^{-1})	<1	1 - 2	>2
Available S (mg/kg)	<10	10 - 20	>20
Micronutrient critical limits			
Zinc (mg/kg)	0.6	Copper (mg/kg)	0.2
Iron (mg/kg)	2.5	Manganese (mg/kg)	2.0
Boron (mg/kg)	0.5		

Table 2

Nutrient index and rating

Nutrient index	Range	Remarks
A	< 1.67	Low
B	1.67 – 2.33	Medium
C	> 2.33	High

Source: Parker *et al.,* (1951)

TABLE 3

pH. EC, OC, Primary and secondary nutrient status of Chintamani campus

Blocks	Percentage of sample falling with range			Range	Mean ± SD	CV (%)
	Low	Medium	High			
Soil pH	(< 6.5)	(6.5-7.5)	(>7.5)			
Block 1	62	38	0.00	5.00 - 7.35	6.21 ± 0.73	11.74
Block 2	93	7	0	3.50 - 6.60	5.69 ± 0.75	13.20
Block 3	96	4	0	3.50 - 6.50	5.32 ± 0.78	14.59
Block 4	100	0	0	5.40 - 5.50	5.45 ± 0.07	1.30
Electrical conductivity (dSm^{-1})	< 1.0	1.0 - 2.0	> 2.0			
Block 1	100	0	0	0.02 - 0.30	0.22 ± 0.07	32.98
Block 2	100	0	0	0.02 - 0.30	0.20 ± 0.07	35.02
Block 3	100	0	0	0.07 - 0.89	0.21 ± 0.17	82.66
Block 4	100	0	0	0.15 - 0.19	0.17 ± 0.03	16.64
Organic carbon (%)	<0.50	0.5-0.75	>0.75			
Block 1	48	42	10	0.28 - 1.00	0.55 ± 0.17	30.54
Block 2	76	17	7	0.03 - 0.90	0.34 ± 0.25	73.72
Block 3	50	32	18	0.09 - 1.15	0.51 ± 0.28	54.51
Block 4	100	0	0	0.10 - 0.44	0.27 ± 0.24	89.04
Available Nitrogen (kg/ha)	<280	280-560	>560			
Block 1	0	100	0	319.8 - 489.7	403 ± 44.86	11.11
Block 2	3	97	0	228.9 - 514.3	383 ± 66.55	17.37
Block 3	0	75	25	385.7 - 711.9	495 ± 98.50	19.87
Block 4	0	100	0	337.9 - 470.9	404 ± 93.69	23.18
Available P_2O_5 *(kg/ha)*	<22.9	22.9-56	>56			
Block 1	97	3	0	2.74 - 26.03	9.38 ± 5.28	56.35
Block 2	97	3	0	2.30 - 28.56	10.39 ± 7.29	70.17
Block 3	100	0	0	2.19 - 14.83	6.18 ± 3.28	53.04
Block 4	100	0	0	6.92 - 10.54	8.73 ± 2.56	29.32
Available K_2O *(kg/ha)*	<144	144-336	>336			
Block 1	0	17	83	251.3 - 1100	641 ± 235.2	39.46
Block 2	100	0	0	70.96 - 222.0	120 ± 45.34	37.53
Block 3	32	18	50	60.4 - 795.0	364 ± 205.7	56.50
Block 4	50	0	50	93.8 - 319.4	253 ± 226.3	89.14
Exch. Calcium ($cmol (p+) kg^{-1}$)	<1.5	1.5 - 3	>3			
Block 1	0	21	79	2.10 - 12.12	4.46 ± 2.38	53.45
Block 2	0	14	86	2.25 - 11.72	4.74 ± 2.14	45.14
Block 3	4	36	60	1.40 - 7.40	4.13 ± 1.81	43.87
Block 4	0	0	100	10.17 - 14.38	12.54 ± 2.60	20.75
Exch. Magnesium ($cmol (p+) kg^{-1}$)	<1	1 - 2	>2			
Block 1	0	3	97	1.42 - 12.93	5.23 ± 2.86	54.70
Block 2	0	17	83	1.05 - 9.65	4.57 ± 2.82	61.57

Blocks	Percentage of sample falling with range			Range	Mean ± SD	CV (%)
	Low	Medium	High			
Block 3	0	39	61	0.35 - 5.88	4.60 ± 1.89	54.44
Block 4	0	100	0	1.10 - 1.18	1.49 ± 0.54	36.66
Available Sulphur (mg/kg)	<10	10 - 20	>20			
Block 1	10	41	49	7.62 - 32.84	18.86 ± 5.78	30.67
Block 2	83	17	0	0.39 - 10.84	5.53 ± 3.01	54.44
Block 3	36	7	57	0.39 - 59.62	25.49 ± 2.36	88.62
Block 4	50	0	50	5.56 - 22.27	22.27 ± 5.56	84.91

labeled and packaged for laboratory analysis using standard procedures at Soil Health Clinic, College of Sericulture, Chintamani. Soil pH, EC, organic carbon, available major, secondary and micronutrients were measured. Soil pH and electrical conductivity was measured in 1:2.5 soil water ratio according to Rhoades and Oster (1986). Per cent organic carbon was determined by the method given by Walkley-Black (Walkley and Black, 1934), available nitrogen (kg/ha) was by Kjeldhal Digestion method (Subbaiah and Asija, 1956). Available phosphorus (kg/ha) was extracted with Bray-1 and further reading was done using colormetrically. Available potassium (kg/ha) was determined by flame photometer, Exchangeable Ca and Mg (cmol (p^{+}) kg^{-1}) were extracted with 1N ammonium acetate (Jackson, 1973). Available sulphur (mg/kg) was by Turbidimetry, Bradsley and Lancester (1965). The micronutrients (Zn, Cu, Fe and Mn mg/kg) were measured with Atomic Absorption Spectrophotometer according to Lindsay and Norvell (1978) while Colorimetry using Azomethane-H was used for measuring hot water extractable boron mg/kg (Page *et al.,* 1982).

Data Analysis

Data were subjected to descriptive statistics such as mean, standard deviation and coefficient of variation.

Determination of Nutrient Availability Index

Nutrient availability index was calculated based on fertility rating chart in Table 1 and nutrient index introduced by Parker *et al*. (1951) and modified by Kumar *et al*. (2013) was used to compare soil fertility level in the College of Sericulture, Chintamani.

Nutrient index = {(1X A) + (2 X B) + (3 X C)} / NS

Where,

A = Number of samples in low category.

B = Number of samples in medium category.

C = Number of samples in high category.

NS = Total number of samples.

Soil pH, organic carbon, available major, secondary and micronutrient were used to calculate nutrient index values based on specific rating chart on Table 2.

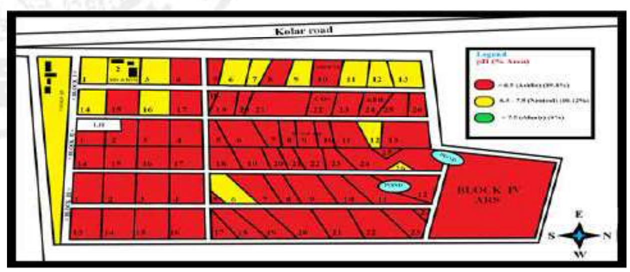

Fig. 1 ; pH, status of the Chintamani campus

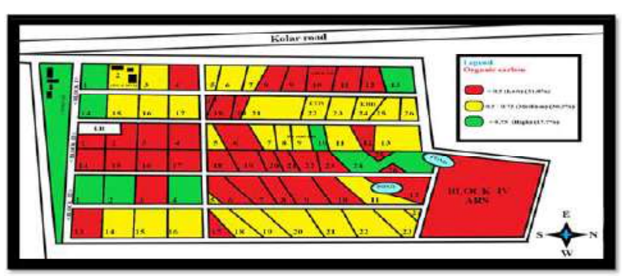

Fig. 2 : Organic carbon status of the Chintamani campus

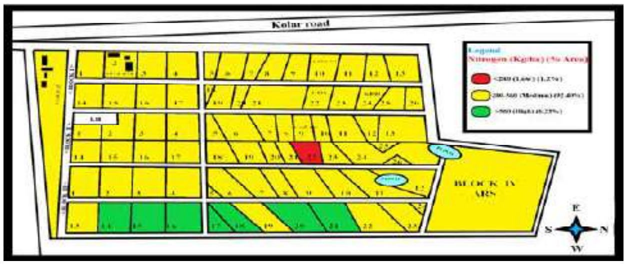

Fig. 3 : Available nitrogen status of the Chintamani campus

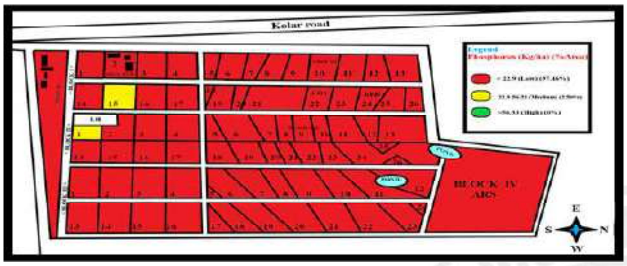

Fig. 4 ; Available phosphorus status of the Chintamani campus

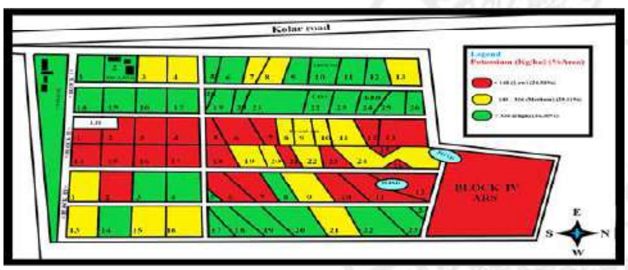

Fig. 5 : Available potassium status of the Chintamani campus

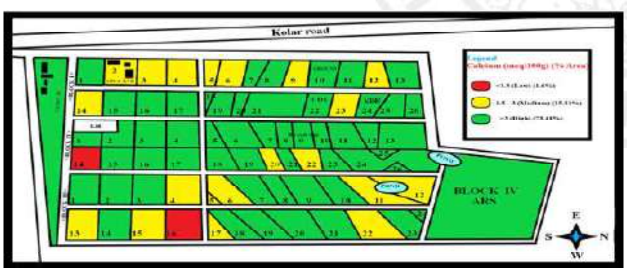

Fig. 6 : Exchangeable calcium status of the Chintamani campus

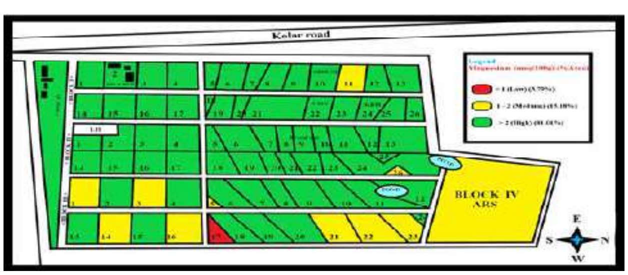

Fig. 7 : Exchangeable magnesium status of the Chintamani campus

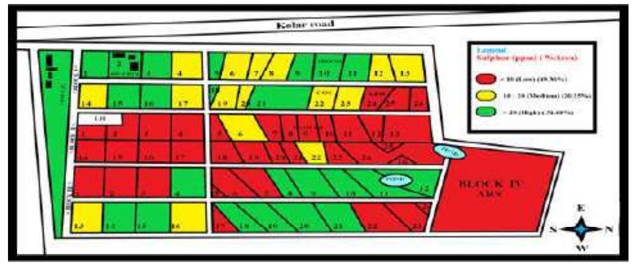

Fig. : 8 : Available sulphur status of the Chintamani campus

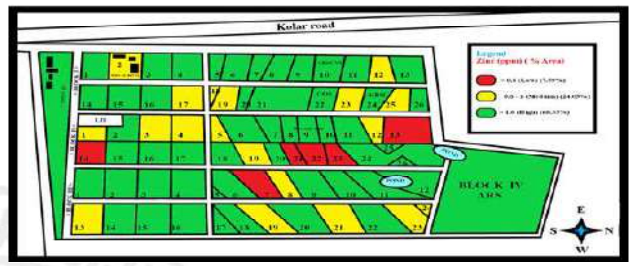

Fig. 9 : DTPA extractable zinc status of the Chintamani

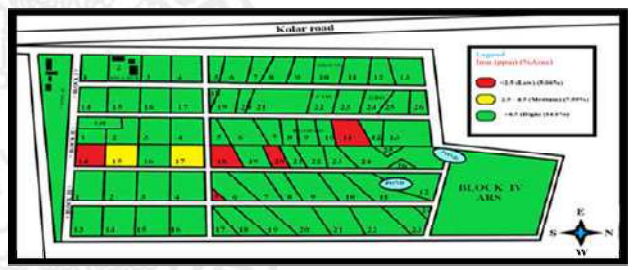

Fig. 10 : DTPA extractable iron status of the Chintamani

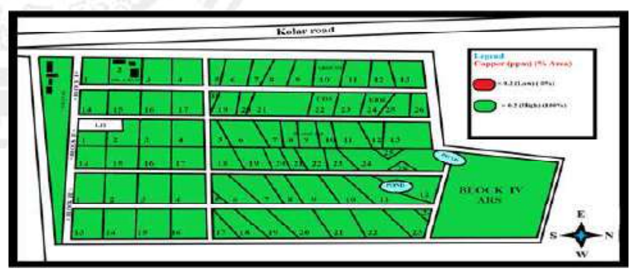

Fig.11 : DTPA extractable copper status of the Chintamani campus

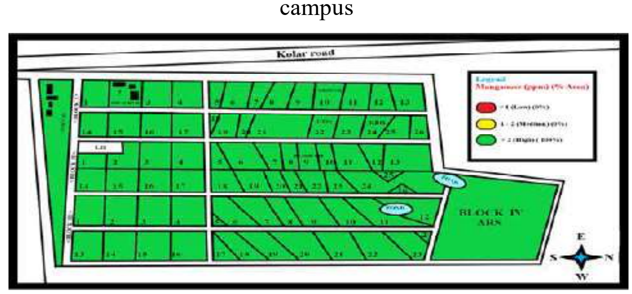

Fig.12 : DTPA extractable manganese status of the Chintamani campus

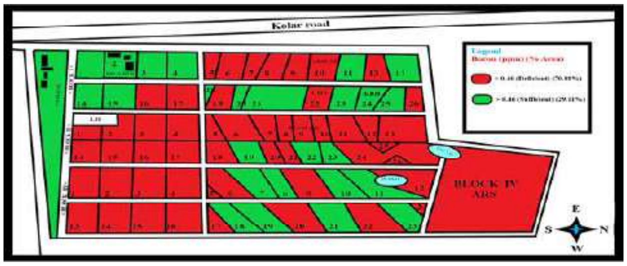

Fig. 13 : Hot water extractable boron status of the Chintamani

RESULTS AND DISCUSSION

pH, EC, OC, Primary and Secondary Nutrient Status of the Chintamani Campus

Soil pH values ranged from 5.00-7.5 (block 1), 3.5-6.60 (block 2), 3.50-6.50 (block 3) and 5.40-5.50 (block 4) (Table 3 and Fig 1-8). Organic carbon content of soils of block 1 ranged from 0.28-1.00 per cent and

TABLE 4

Micronutrients status of Chintamani campus

Soil pH	Percentage of sample falling with range		Range	Mean ± SD	CV (%)
	Deficiency	Sufficiency			
DTPA Ext. Zinc (mg/kg)	<0.6	>0.6			
Block 1	0	100	0.60 - 6.85	1.73 ± 1.25	72.51
Block 2	14	86	0.35 - 4.01	1.43 ± 0.97	67.92
Block 3	11	89	0.49 - 3.07	1.25 ± 0.61	48.81
Block 4	0	100	1.58 - 2.70	2.14 ± 0.79	37.01
DTPA Ext. Copper (mg/kg)	<0.2	>0.2			
Block 1	0	100	0.48 - 5.48	1.38 ± 1.00	72.81
Block 2	0	100	0.28 - 3.20	1.15 ± 0.78	68.27
Block 3	0	100	0.39 - 2.45	1.00 ± 0.48	48.34
Block 4	0	100	1.26 - 2.16	1.71 ± 0.64	37.22
DTPA Ext. Iron (mg/kg)	<2.5	>2.5			
Block 1	0	100	4.52 - 20.80	9.89 ± 3.48	35.16
Block 2	3	97	1.48 - 32.36	13.24 ± 9.62	72.63
Block 3	3	97	2.20 - 18.46	10.01 ± 4.51	45.11
Block 4	0	100	9.48 - 11.65	10.57 ± 1.53	14.52
DTPA Ext. Manganese (mg/kg)	<2.0	>2.0			
Block 1	0	100	10.16 - 27.96	20.38 ± 5.54	27.16
Block 2	0	100	19.20 - 44.63	30.81 ± 6.36	20.66
Block 3	0	100	7.12 - 53.55	27.74 ± 0.70	38.57
Block 4	0	100	24.00 - 32.80	28.40 ± 6.22	21.91
Hot water ext. Boron (mg/kg)	<0.5	>0.5			
Block 1	48	52	0.09 - 4.84	0.94 ± 1.06	89.02
Block 2	79	21	0.01 - 0.75	0.17 ± 0.20	88.56
Block 3	57	43	0.03 - 9.24	0.78 ± 0.79	75.25
Block 4	50	50	0.33 - 1.04	0.69 ± 0.50	73.29

TABLE 5

Soil Fertility index of pH, OC and major nutrient content in Chintamani campus

Blocks	Soil pH		Organic carbon (%)		Available P_2O_5 (kg/ha)		Available K_2O (kg/ha)		Available K_2O (kg/ha)	
	Nutrient index	Rating	Nutrient index	Rating	Nutrient index	Rating	Nutrient index	Rating	Nutrient index	Rating
Block 1	1.38	L	1.62	L	2.00	M	1.03	L	2.83	H
Block 2	1.07	L	1.31	L	1.97	M	1.03	L	1.00	L
Block 3	1.04	L	1.68	M	2.25	M	1.00	L	2.18	M
Block 4	1.00	L	1.00	L	2.00	M	1.00	L	2.00	M

0.03-0.90 per cent in block 2 while it ranged between 0.09-1.15 per cent and 0.10-0.44 per cent in block 4. The available nitrogen was medium in all the blocks. Available phosphorus was low in all the blocks and it ranged from 2.74-26.03 kg/ha (block 1), 2.30-28.56 kg/ha (block 2), 2.19-14.83 kg/ha (block 3) and 6.92-10.54 kg/ha (block 4). Available potassium was highest in block 1 and lowest in block 2. Exchangeable calcium values ranged from 2.10-12.12 (cmol (p^+) kg^{-1}) 2.25-11.72 (cmol (p^+) kg^{-1}), 1.40-7.40 (cmol (p^+) kg^{-1}) and 10.17-14.38 (cmol (p^+) kg^{-1}) in block 1,2,3 and 4, respectively. Exchangeable magnesium was highest in block 1 and 2 and medium in block 3 and 4. Available sulphur found to be low in 1, 2 and 3 blocks and medium to high in block 4 (Fig. 6 - 8).

The soil pH is adequate for crop production according to Onwudike *et al.* (2016). Lower pH values in all the blocks could be as a result of the litter falls that releases organic acids after decomposition which produced H+ and Al+++ ions on soil exchange complex (Ibrahim and Idoga, 2015). About 89.8 per cent of soils are acidic in nature which may be due to the soils of Chintamani campus mainly contains red soil as they are formed by weathering of acid crystalline rocks, due to application of acidic fertilizers (Urea and DAP), the content of essential nutrients like nitrogen, phosphorus, lime is very less in red soils which results in slightly acidic behaviour. About 10.12 per cent of soils are having Neutral pH it may be due to the addition of organic matter and SSP fertilizer. Lower soil organic carbon content in all the blocks could be attributed to the exposure of soil to harsh climatic factors. Musinguzi *et al.* (2016), pointed out that for good fertilizer response, a soil should have 1.9 - 2.2 per cent of soil organic carbon. About 51.8 per cent of soils are having low organic carbon content it may be due to exposure of soils to sunlight the carbon content in the soils are converted to carbon dioxide, less CEC, soils are sandy in nature as they have low carbon holding capacity organic carbon is less in these blocks and 17.7 per cent of soils are having high organic carbon content it may be due to root exposure, organic biomass and leaf litter decomposition from forest areas around leads to increase in organic carbon content of the soil It is possible that the medium available nitrogen and high available potassium in camps are caused by the increased organic material production from root and tree litter. Decomposition of organic materials can produce humus which releases the nitrogen and potassium in the soil (Kavitha and Sujatha, 2015) about 7.59 per cent of soils have high nitrogen content, it may be due to high application of Urea, DAP fertilizers and high C:N ratio present in soil. 1.25 per cent of soils have low in nitrogen content due to volatilization and leaching. While, 44.30 per cent of soils have highest potassium content, due to high percentage of feldspar parent material present in soil and high application of MOP fertilizer. 26.58 per cent of soils have lowest potassium content, due to increase in application of DAP and Urea only. Higher exchangeable bases (Ca and Mg) in all the blocks could be due to the effects of higher organic matter content which improves the base status of the soils (Sharu *et al.,* 2013). Low sulphur

TABLE 6

Soil fertility index of secondary and micronutrients content in Chintamani campus

Blocks	Exch. Ca (cmol (p+) kg-1)		Exch. Mg (cmol (p+) kg-1)		Available S (mg/kg)		Zn (mg/kg)		Cu (mg/kg)		Fe (mg/kg)		Mn (mg/kg)		B (mg/kg)	
	Nutrient index	Rating	Nutrient index	Rating	Nutrient index	Rating	Nutrient index	Rating	Nutrient index	Rating	Nutrient index	Rating	Nutrient index	Rating	Nutrient index	Rating
Block 1	2.79	H	2.97	H	2.39	H	3.00	H	3.00	H	3.00	H	3.00	H	2.52	H
Block 2	2.86	H	2.83	H	1.17	L	1.86	M	3.00	H	2.97	H	3.00	H	2.21	M
Block 3	2.56	H	2.61	H	2.21	M	1.89	M	3.00	H	2.97	H	3.00	H	2.43	H
Block 4	3.00	H	2.00	H	2.00	M	3.00	H	3.00	H	3.00	H	3.00	H	2.50	H

content available, due to the cultivated lands of the Chintamani campus received no sources of sulphur in the form of fertilizer, so that sulphur deficiency is observed in these soils. Low available sulphur content because Chintamani campus's farmed area didn't receive sulphur sources in the form of fertilizer, causing a sulphur deficiency to be seen in these soils.

Micronutrient Status of the Chintamani campus

Block 1 and 4 had the sufficient mean zinc and block 2 and 4 had the deficient mean zinc content (Table 4 and Fig 9-13). Copper content ranged from 0.28-5.48 mg/kg, with highest mean in block 4 and lowest in block 3. Iron content was sufficient in block 1 and 4 and blocks 2 and 3 it was deficient. Manganese content was sufficient in all the blocks. Boron content was highest in block 1 and was lowest in block 2, 3 and 4.

DTPA extractable Zn, Fe, Cu and Mn of Chintamani campus were in sufficient range. About 68.35 per cent of soils were high in zinc content, 84.8 per cent of soils are high in Iron content, and copper and manganese are 100 per cent in the soils of College of Sericulture, Chintamani. It may be due to acidic nature of the soils and pH play a important role in availability of micronutrient cations. Sometimes it reaches to toxic level where the soils are highly acidic.About 70.88 per cent soils are deficient in available boron in Chintamani campus due to pH and availability of boron content in soils. As pH increases from acidic to neutral the availability of boron decrease about 29.11 per cent. Soils are sufficient in available boron content in Chintamani campus due to decomposition of crop residues application of FYM may leads to release of available boron to soil.

Soil Fertility Index of pH, OC, Primary and Secondary Nutrient Status of the Chintamani Campus

Soil pH was slightly acidic, organic carbon was low to medium in block 3 and available nitrogen was medium (Table 5 and 6). Available phosphorus was low in the entire campus. Available potassium was low in block 2, medium in block 3 and 4 but high in block 1. Exchangeable calcium and magnesium was high in entire campus but available sulphur was low in block 2, medium in block 3 and 4 and high in block 1. DTPA extractable Zn, was medium in block 2, 3 and high in block 1, 4. Copper, iron and manganese contents were high in campus. Medium nutrient index was recorded with hot water extractable boron in the campus.

The soil fertility status of Chintamani campus was low to high and soil pH was acidic to neutral that is optimum condition for crop cultivation. Organic carbon was medium, available nitrogen was medium and available phosphorus was low. Available potassium was low to high. Exchangeable calcium and magnesium were high while available sulphur was low to high. The level of micronutrients Zn and boron was medium to high and Cu, Mn and Fe were high in campus. Organic carbon demands management practices that will include application of integrated nutrients supplying system and use of soil amendments which will increase the nutrient status of soil.

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