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Soil nutrient status of mulberry gardens in varied clusters of Andhra Pradesh

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Abstract

Intensive cropping systems have led to an increase in the demand of the crucial nutrients in the soil. Thus, addition of essential inorganic and inorganic nutrients to attain the coveted soil status is necessary for the sustainable leaf production in mulberry. This study was conducted on a total of 1472 soil samples from conventional sericultural regions present in 8 districts of Andhra Pradesh, India. The soils were subjected to the chemical analysis to determine their soil reaction, salinity, and nutrient status including pH, EC, OC, available macro (N, P and K) and micro (S) nutrients. The perusal of the results indicated that out of the received soils, soil pH was recorded at desired levels (6.5-75) in 58% soils, low (<6.5) in 8% soils and high (>7.5) in 33% soils. Most of the cluster soils (99%) showed an ideal range of soluble salts (<1.0 dS/m). Organic carbon (OC) was low in 74% soils (<0.65%), medium (0.65-1.0%) in 21% and high (>1.0%) in only 5% soils. In case of essential macronutrients, available Nitrogen (N) recorded low in 50% soils (<250kg/ha), desired level in 37% (250-500kg/ha) and registered high (>500kg/ha) in only 13% soils. Phosphorous (P) and Potassium (K) were recorded high, >25kg/ha and >224kg/ha in 52% and 54% soils, medium level, 10-25kg/ha and 110-224kg/ha in 21 and 37%; whereas low, <10kg and <110kg/ha in 26% and 9% soils, respectively. In case of micronutrient sulphur (S), 61% of the cluster soils were registered rich in sulphur (>15ppm/ha), 25% showed the admissible range (10-15ppm/ha) whereas only 14% soils were recorded with low levels of S (<10ppm/ha) indicating that most of the cluster soils are rich in sulphur.

Keywords leaf production, mulberry, organic carbon, soil analysis, soil fertility

Introduction

Mulberry (*Morus alba* L.) a perennial plant cultivated as a seasonal crop for its foliage to feed silkworms (*Bombyx mori* L) demands high doses of organic manures and inorganic fertilizers. As it is grown for its foliage, it cherishes under desirable levels of pH (6.5-7.5), Electrical Conductivity (EC-<1.00dS/m), Organic Carbon (OC: 0.65-1.0%), Available Nitrogen (N: 250-500kg/ha), Phosphorous (P: 15-25kg/ha), Potassium (K: 120-240kg/ha) and Sulphur (S: 10-15ppm) in the soils. Therefore, for its sustainable growth and leaf production, it has been prescribed to maintain desirable levels of soil fertility by supplying NPK @

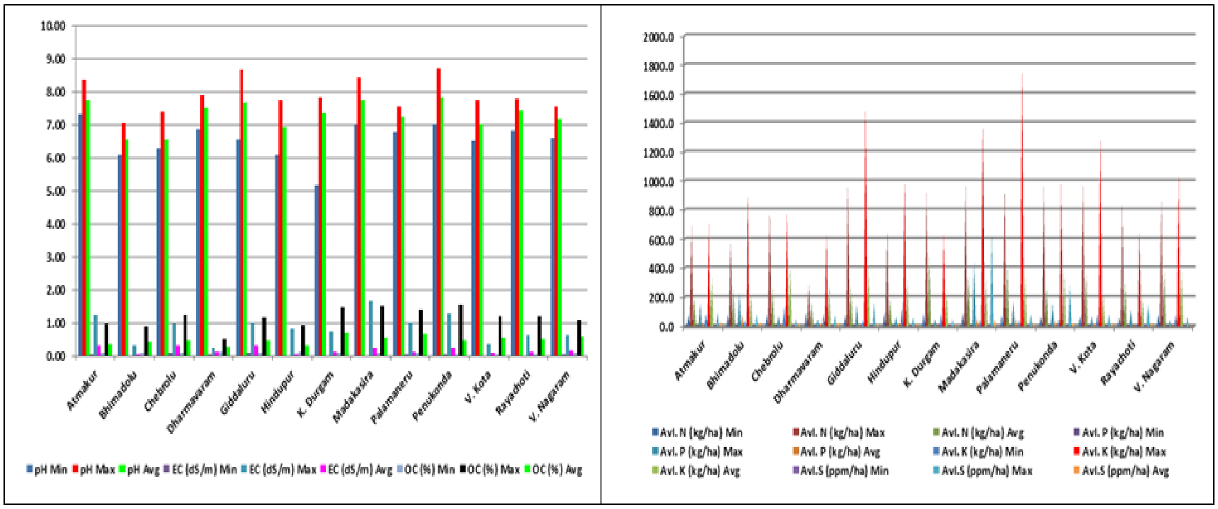

Figure 1. Minimum, maximum and mean values of soil reaction and nutrient status of mulberry garden Soils of cluster farmers

350:140:140kg/ha/yr and 20MT FYM/ha/yr for irrigated mulberry cultivated in the tropical areas of South India [1]. Even though the use of recommended doses of manures and fertilizers plays a pivotal role in mulberry leaf yield and quality, the adoption of the same is not found up to the satisfaction level at the farmers level resulting in low mulberry yield and soil fertility [2]. Further, due to hectic crop schedules and frequent harvesting of leaf shoot biomass @ 80-100mt/ha/yr (@ 5crops/yr) depletion of soil fertility status of mulberry gardens has become a regular phenomenon. It is also reported that blanket recommendation of fertilizers leads to over or underuse of fertilizers leading to ultimate deterioration of soil health [3]. Frequent cultural operations, inorganic fertilizer applications, imparting of diseases and pest control measures and industrial emissions and effluents are not only altering and depleting the soil nutrient status, but also polluting the groundwater resources. Therefore, frequent supplementation of essential macro and micronutrients along with the sufficient manuring for conditioning the soils and balancing the soil nutrient status for enhanced quality mulberry leaf production is essential. Earlier workers emphasized the need for the balanced fertilization and their impact on the quality mulberry and cocoon production [4].

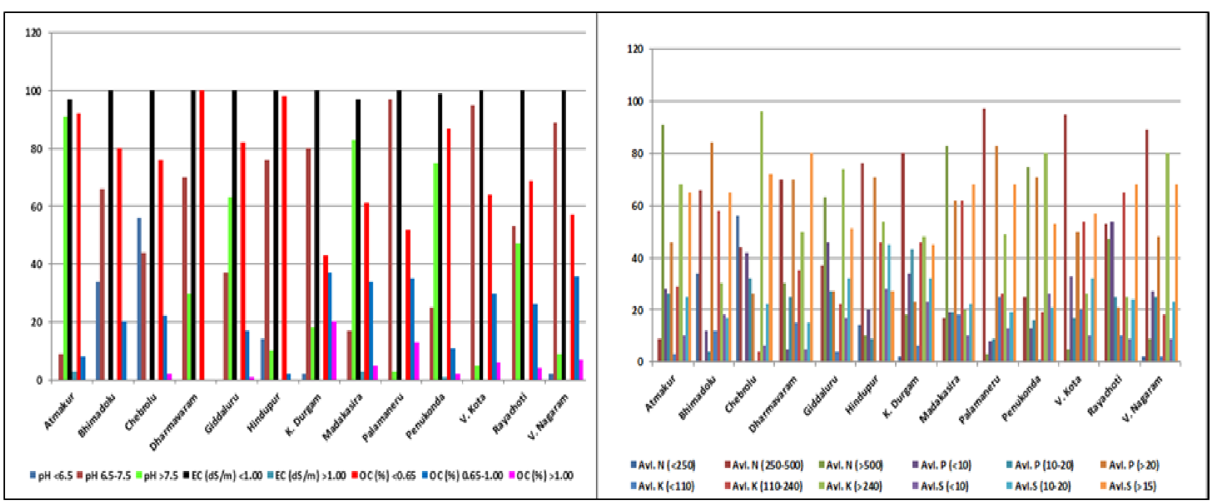

Figure 2. Distribution of soil reaction and nutrient status of cluster farmers of mulberry garden soils

Table 1. Clusters wise trends of soil reaction, organic carbon and other available micro and macro nutrients status of sericulturists

Soil nutrients	Status	Cluster wise soil samples received under various clusters												
		Atma-kur	**Bhima-dolu**	**Che-brolu**	**Dharma-varama**	**Gidda-luru**	**Hinu-pur**	**Kalyan-durg**	**Madaka-sira**	**Palama-neru**	**Penu-konda**	**V. Kota**	**Raya-choti**	**Vijayana-garam**
Soils (no)	**1472**	**65**	**89**	**50**	**20**	**200**	**94**	**82**	**395**	**77**	**171**	**117**	**68**	**44**
pH	Min	7.32	6.11	6.30	6.88	6.56	6.10	5.17	7.01	6.78	7.01	6.52	6.81	6.61
	Max	8.38	7.04	7.39	7.91	8.67	7.76	7.84	8.46	7.56	8.71	7.76	7.80	7.57
	Avg	**7.75**	**6.55**	**6.56**	**7.51**	**7.67**	**6.96**	**7.36**	**7.74**	**7.24**	**7.82**	**7.02**	**7.45**	**7.19**
EC (dS/m)	Min	0.07	0.018	0.085	0.06	0.10	0.02	0.029	0.02	0.04	0.04	0.02	0.02	0.04
	Max	1.26	0.320	0.974	0.24	1.00	0.82	0.725	1.68	1.00	1.29	0.35	0.62	0.62
	Avg	**0.31**	**0.064**	**0.304**	**0.11**	**0.33**	**0.06**	**0.114**	**0.251**	**0.14**	**0.26**	**0.08**	**0.11**	**0.18**
OC (%)	Min	0.10	0.100	0.100	0.12	0.08	0.11	0.100	0.100	0.09	0.06	0.05	0.05	0.10
	Max	0.96	0.88	1.230	0.51	1.18	0.95	1.490	1.500	1.38	1.54	1.19	1.21	1.10
	Avg	**0.35**	**0.45**	**0.479**	**0.30**	**0.48**	**0.32**	**0.722**	**0.566**	**0.65**	**0.48**	**0.57**	**0.51**	**0.60**
Avl. N (Kg/ha)	Min	86.0	86.0	86.0	94.0	78.0	89.0	86.0	86.0	82.0	71.0	67.0	67.0	86.0
	Max	696.0	590.0	820.0	283.0	988.0	682.0	934.0	993.0	988.0	990.0	988.0	895.0	882.0
	Avg	**208.4**	**259.7**	**278.7**	**168.6**	**279.8**	**181.6**	**472.3**	**354.7**	**413.8**	**278.6**	**362.3**	**311.9**	**378.1**
Avl. P (kg/ha)	Min	2.0	3.00	2.0	9.00	1.00	0.96	2.0	0.24	6.00	3.48	3.00	0.50	2.50
	Max	156.0	235.0	77.0	45.0	146.0	70.07	52.0	456.0	175.0	159.0	72.0	114.0	44.0
	Avg	**26.52**	**82.33**	**17.01**	**23.60**	**20.97**	**25.18**	**16.4**	**49.30**	**52.58**	**33.64**	**22.39**	**11.97**	**15.07**
Avl. K (kg/ha)	Min	89.6	44.8	134.0	89.60	44.0	134.4	89.6	44.80	44.8	44.0	89.0	17.0	89.0
	Max	716.8	940.8	806.0	627.2	1568.0	1030.4	627.2	1433.6	1836.8	985.0	1344.0	672.0	1030.0
	Avg	**338.4**	**231.0**	**437.6**	**293.4**	**437.9**	**323.1**	**252.4**	**329.2**	**356.7**	**382.9**	**222.1**	**210.1**	**375.5**
Avl. S (ppm)	Min	7.64	6.05	8.04	9.63	6.05	6.45	6.85	6.85	8.00	6.45	8.04	8.04	8.44
	Max	98.01	84.47	50.24	75.32	169.3	62.98	45.06	656.1	86.9	281.5	88.06	151.4	68.15
	Avg	**32.8**	**28.0**	**27.75**	**31.39**	**30.85**	**14.13**	**18.10**	**46.46**	**25.46**	**28.40**	**25.14**	**28.87**	**7.66**

Though for several decades the mulberry soils of Andhra Pradesh are utilized for the production of leaves, but the timely efforts to detect the soil fertility status and recommending the analysis based suitable soil amelioration prescriptions for enhanced mulberry leaf and cocoon production are limited [5-6]. Cluster Promotion Programme (CPP) was implemented under the 12th five-year plan during 2012-2019 in India for boosting the bivoltine sericulture with a target of >5000 MT/yr raw silk production. Under this program, the state and Central Government jointly organized 178 clusters all over India out of which 14 clusters were implemented in Andhra Pradesh. Though we could successfully achieve the targeted bivoltine raw silk production with all the above mentioned efforts, we are still lagging behind in succeeding the 3A & above grade silk production and not gaining the anticipated market rates from the sericultural farming community. The reasons are many, but low-level adoption of technical knowhow and lacking the judicious imparting of the recommended package of practices in mulberry cultivation has a crucial role. Though the farming community has been extended the suitable package of practices for the production of the quality mulberry leaf, soil nutrient status depleted due to the continuous and long term harvesting of the mulberry crops (ranging from 10-15 years) and supplementing with the insufficient doses of manures and fertilizers. Further, draining of soil nutrients occurs due to heavy and untimely rains and drought spell situations limiting the nutrients uptake and availability. However, lacking the technical knowhow of the adoption of soil testing and imparting analysis based amelioration of garden soils are the main reasons of soil nutrients depletion. Therefore, it is necessary to assess the current soil nutrient status of prominent bivoltine sericultural areas of Andhra Pradesh and to extend the soil analysis based amelioration recommendation in the form of '**Soil Health Cards**' for improving their mulberry soils and to enhance their quality mulberry and cocoon production.

Methodology

Keepings the above thrust areas of research in mind a research program entitled "**Soil health cards for sericulture farmers in Southern States**" was initiated at Central Sericultural Research & Training Institute (CSRTI) Mysore. Under the program, the Institute as well as the Regional Sericultural Research Stations (RSRS) of Ananthapur (Andhra Pradesh), Bangalore (Karnataka) and Salem (Tamil Nadu) were assigned to collect the soils of sericultural areas and assess their reaction, salinity and major and micronutrients contents.

Table 2. Distribution of soil pH, EC, OC, macro and micro nutrients status of sericulture farmers Mulberry gardens under various clusters

Nutrients	Ranges	% off soil nutrient distribution among the mulberry garden soils of cluster farmers.												
		Atma -kur	Bhima -dolu	Che -brolu	Dharma -varama	Gidda -luru	Hindu -pur	Kalyan -durg	Madaka -sira	Palama -neru	Penu -konda	V. Kota	Raya -choti	Vijayana -garam
No. of soils	1472	65	89	50	20	200	94	82	395	77	171	117	68	44
pH	<6.5	0	34	56	0	0	14	2	0	0	0	0	0	2
	6.5-7.5	9	66	44	70	37	76	80	17	97	25	95	53	89
	>7.5	91	0	0	30	63	10	18	83	3	75	5	47	9
EC (dS/m)	<1.00	97	100	100	100	100	100	100	97	100	99	100	100	100
	>1.00	3	0	0	0	0	0	0	3	0	1	0	0	0
OC (%)	<0.65	92	80	76	100	82	98	43	61	52	87	64	69	57
	0.65-1.00	8	20	22	0	17	2	37	34	35	11	30	26	36
	>1.00	0	0	2	0	1	0	20	5	13	2	6	4	7
Avl. N (Kg/ha)	<250	75	46	52	80	46	81	27	37	30	54	39	46	36
	250-500	20	53	46	20	44	18	57	24	45	39	37	43	32
	>500	5	1	2	0	10	1	16	39	25	7	24	12	32
Avl. P (kg/ha)	<10	28	12	42	5	46	20	34	19	8	13	33	54	27
	10-20	26	4	32	25	27	9	43	19	9	16	17	25	25
	>20	46	84	26	70	27	71	23	62	83	71	50	21	48
Avl. K (kg/ha)	<110	3	12	0	15	4	0	6	18	25	1	20	10	2
	110-240	29	58	4	35	22	46	46	62	26	19	54	65	18
	>240	68	30	96	50	74	54	48	20	49	80	26	25	80
Avl. S (ppm)	<10	10	18	6	5	17	28	23	10	13	26	10	9	9
	10-15	25	17	22	15	32	45	32	22	19	21	32	24	23
	>15	65	65	72	80	51	27	45	68	68	53	57	68	68

Under the program, 1472 soil samples received during 2016-17 (0-30cm depth) from 13 CPP areas such as Atmakuru (Kurnool district), Bhimadole (West Godavari), Chebrolu (East Godavari), Giddalur (Prakasham), Dharmavaram, Hindupur, Kalyanadurgam, Madakasira, Penukonda (Ananthapur), Palamaneru and V. Kota (Chittoor), Rayachoti (Kadapa) and Vijayanagaram under Vijayanagaram District spread over in under Andhra Pradesh (A.P.) were analyzed for their nutrient status and the results are presented in Table 1, 2, 3 and Figure 1, 2. A total of 1467 soil samples with varied heterogeneity were also analyzed for their soil reaction (pH), Electrical Conductivity (EC), Organic Carbon (OC) and other macro and micronutrients status such as available N, P, K and S in the Soil Testing Laboratories of RSRS, CSB, Ananthapur and CSRTI, Mysore. Based on the soil analysis results, analysis based suitable soil amelioration recommendations were prepared in the form of "**Soil Health Cards**" and served to the sericulturists for the enhanced quality mulberry leaf and bivoltine cocoon production. Though all the clusters are falling in the same tropical geo-climatic zones, they have typically varied soil characters and textures. Soils received from the cluster areas included loamy, red, lateritic and black soils with varied soil reactions (pH), salinity (EC) and nutrient parameters. Soil samples received from the sericulture farmers at 0-30cm depths were air-dried in shade, then powdered and passed through a 10µ mesh sieve and were stored in fresh polythene covers with proper labeling following the standard procedures [1]. Soil characters like pH, EC, organic carbon (OC %), available nitrogen (N/ha), phosphorous (P/ha), potassium (K/ha) and sulphur (S-ppm) were determined by using the standard methods [7-8].

Results and Discussion

Out of the soils (1472) received during the period (2016-17), most of the soils were red loamy (>70%), a moderate were red lateritic (>20%) and very few were black cotton and clay loamy soils (around 10%). Almost all the soils were congenial for sericulture and it may be the reason sericulture has become a predominant farming and flourishing cultivation in almost all the clusters demarcated in the Districts of A.P. The nutritional status of the soils of the clusters are as narrated below.

Soil Reaction (pH)

The minimum and maximum values of the soil pH of the sericultural farmers varied differently. The minimum value of soil pH of the clusters ranged from 5.17 to 7.32; and the maximum was ranging from 7.04 to 8.71. The mean values of pH of all the clusters were recorded at the desired level i.e. 6.50 to 7.50. The distribution of soil pH among the clusters varied differently. Except in case of Bhimadolu (34%), Chebrolu (56%) and Hindupur (14%) where cluster soils recorded lower pH (<6.5); most of the clusters of the soils recorded in the desired levels of pH (between 6.5 to 7.5). Higher pH of the cluster soils was recorded in Atmakur (91%), followed by Madakasira (83%), Penukonda (75%), Giddaluru (63%) and Rayachoti (47%). Therefore, the farmers were advised to utilize eco-friendly inputs such as enhanced manure (FYM), adopting eco-friendly farming with green manuring crops followed by trenching and mulching during monsoon not only to improve the soil health but also to bring the soil reaction to a desired range, thereby improving the nutrient availability of these soils (Table 1, 2, 3 and Figure 1, 2).

Table 3. Cluster wise soil nutrient status and performance of DFLs brushing, yield, market rate and raw silk production

Cluster details	Soil nutrient status of cluster soils								Silkworm rearing performance			
	No of soils	pH	EC (dS/m)	OC (%)	Avl. N (kg/ha)	Avl. P (kg/ ha)	Avl. K (kg/ ha)	Avl. S (ppm/ha)	DFLs brushd (Lakh)	Yield/ 100dfs (kg)	Rate/ (Rs/kg)	Est. raw silk (MT)
Atmakur	65	7.75	0.31	0.35	208.4	26.52	338.4	32.8	1.80	70.80	416.0	17.81
Bhimadole	89	6.55	0.06	0.45	259.7	82.33	231.0	28.0	2.16	67.26	327.0	20.73
Chebrolu	50	6.56	0.30	0.48	278.7	17.01	437.6	27.75	3.63	76.11	362.0	37.16
Dharmavaram	20	7.51	0.11	0.30	168.6	23.60	293.4	31.39	2.65	69.07	326.0	26.15
Giddalur	200	7.67	0.33	0.48	279.8	20.97	437.9	30.85	3.43	68.39	420.0	33.51
Hindupur	94	6.96	0.06	0.32	181.6	25.18	323.1	14.13	6.88	67.90	405.0	60.90
Kalyandurgam	82	7.36	0.11	0.72	472.3	16.40	252.4	18.10	5.41	70.60	423.0	54.53
Madakasira	395	7.74	0.25	0.57	354.7	49.30	329.2	46.46	10.06	72.54	419.0	104.3
Palamaner	77	7.24	0.14	0.65	413.8	52.58	356.7	25.46	13.57	68.58	420.0	132.9
Penukonda	171	7.82	0.26	0.48	278.6	33.64	382.9	28.40	3.62	79.64	405.0	36.50
V. Kota	117	7.02	0.08	0.57	362.3	22.39	222.1	25.14	15.10	72.93	413.0	156.9
Rayachoti	68	7.45	0.11	0.51	311.9	11.97	210.1	28.87	0.90	68.05	350.0	8.75
Vizianagaram	44	7.19	0.18	0.60	378.1	15.07	375.5	7.66	0.65	65.75	315.0	6.11

DFLs = Disease-free laying

Total soluble salts (EC)

The minimal level of total soluble salt content (EC) of the cluster soils ranged from 0.02 to 0.10 dS/m; and maximal level of EC was ranged from 0.32 to 1.68 dS/m. The average values of EC of the clusters ranged from 0.06 to 0.33 dS/m. However, EC of all the cluster soils recorded in the desired level (<1.00 dS/m) for the mulberry growth, except the clusters like Atmakur (1.26 dS/m), Penukonda (1.29 dS/m) and Madakasira (1.68 dS/m) where it was more than 1.0 indicating harmful to mulberry cultivation. The distribution of soluble salts (EC) was recorded 97-100% with the desired level of EC (<1.00 dS/m) in all the clusters indicating congenial for mulberry cultivation. The results indicated that mulberry growing soils of all the clusters of the A.P. bivoltine sericulture area were normal with respect to the soil salinity indicating amiable for mulberry growth.

Organic Carbon (OC %)

The minimal values of OC content among the 14 clusters was recorded as 0.05 to 0.11%, whereas the maximum was ranged from 0.88 to 1.54%. The mean value of the soil organic carbon was ranging from 0.32 to 0.72%. The distribution of the soil organic matter among the 43% to 100% of the recorded soils have the lower content of organic carbon (<0.65%), whereas 0 to 35% of the cluster soils recorded desired levels of organic carbon (0.65 to 1.00%). However, very few number of soils of the cluster farmers recorded more than the desired ranges (>1.00%) of organic carbon ranging from 0 to 20%. Soil OC is considered as the fertility indicator of any farming soils. Therefore, it is an important parameter that controls sustainability of crop production through the conditioning of soil physical properties and acts as a reservoir of the essential nutrients and promotes the maximum utilization of the inorganic fertilizers. Therefore, the A.P. soils of bivoltine area are advised to enhance organic inputs (manures) applications followed by the regular imparting of green manuring and trenching and mulching during monsoon as a mandatory of serifarming.

Available Nitrogen (N_2O)

Available nitrogen was recorded at minimum level among the 13 cluster sericulture farmer mulberry soils ranging from 67.0 to 94.0 kg/ha whereas the maximum level was 283.0 to 993.0 kg/ha. The average available nitrogen was recorded from 168.6 to 413.8 kg/ha. The lower quantity of available nitrogen (<250kg/ha) was recorded in the range of 27% to 81% soils. Maximum quantity of available nitrogen was recorded in Hindupur (81%) followed by Dharmavaram (80%), Atmakuru (75%), Penukonda (54%) and Chebrolu (52%) soils. However, the rest of the clusters were recorded with the lower quantity of nitrogen (<250kg/ha) in the range of 27% to 46% soils. The desired range of available nitrogen (250-500kg/ha) was obtained in 18% to 57% soils. Very limited number of cluster soils were recorded with higher doses of available nitrogen (>500kg/ha) ranging from 0 to 39% soils (Table 1, 2, 3 and Figure 1, 2).

Available Phosphorous (P_2O_5)

Among the cluster soils minimum level of available phosphorous was recorded from 0.24 to 9.00 kg/ha whereas, maximum level of available phosphorous was recorded in the range of 45.0 to 456.0 kg/ha. The average available phosphorous was recorded in the range of 11.97 to 82.33 kg/ha. Lower quantity of available phosphorous (<10kg/ha) was recorded among the soils in the range of 5% to 54%. Higher number of soils were recorded with lower quantity of available phosphorous in Rayachoti cluster (54%) followed by Giddaluru (46%), Chebrolu (42%), Kalyanadurgam (34%) and V. Kota (33%), however rest of the clusters recorded lower quantity of available phosphorous ranging from 5.0 to 28%. Desired levels of available phosphorous (between 10-20kg/ha) was recorded in the range of 4% to 43% soils. Higher quantity of available phosphorous was recorded among the cluster soils like Kalyanadurgam (43%) followed by Chebrolu (32%), Giddaluru (27%), and Atmakuru (26%). The results indicated that almost all the cluster soils of the Andhra Pradesh has shown higher quantity of available phosphorous indicating that AP soils are rich in available phosphorous.

Available Potassium (K_2O)

Minimum quantities of available potassium was recorded ranging from 17.0 to 134.4 kg/ha, whereas the maximum levels of the same was recorded in the range of 627.2 to 1836.8 kg/ha. The mean value of the available potassium was recorded in the range of 210.1 to 437.9 kg/ha. Lower quantity of available potassium (<110 kg/ha) was recorded among the cluster soils in the range of 0% to 25%. Higher number of soils were recorded with the lower quantity of available potassium in Palamaneru cluster (25%) followed by V. Kota (20%), Madakasira (18%), Dharmavaram (15%), Bhimadolu (12%) and Rayachoti (10%). Desired levels of available potassium (between 110-240 kg/ha) was recorded in 4% to 65% soils. Higher quantity of available potassiumm was recorded among the clusters in the descending order of Rayachoti (65%), Madakasira (62%), Bhimadolu (58%), V. Kota (54%), Hindupure & Kalyanadurgam (46%), Dharmavaram (35%), Palamaneru (26%) and Giddaluru (22%). The results clearly indicated that most of the clusters of Andhra Pradesh has recorded higher quantity of potassium (>240kg/ha) among the sericultural farmers gardens.

Available Sulphur (S)

In case of Sulphur, minimum was recorded in the range from 6.05 to 9.63 ppm/ha whereas maximum levels was recorded in the range of 45.06 to 656.1 ppm/ha. Similarly the average values of sulphur determined among the cluster farmers garden soils resulted in 7.66 to 46.46 ppm/ha. Less than the desired quantity of available quantity of Sulphur (<10 ppm/ha) was recorded in the limited number of soils ranging from 5 to 28%. Desired levels of available Sulphur quantity was recorded among the clusters ranging from 15 to 45% soils. However, maximum number of soils of the cluster farmers recorded higher quantity of available Sulphur quantity ranging from 27 to 80%. This indicated that maximum number of cluster farmers mulberry garden soils are rich in sulphur content. Therefore, the cluster soils of the Andhra Pradesh recorded either moderate in the desired level or rich in the available Sulphur content indicating that there is no threat of sulphur deficiency and it is congenial for silkworm rearing (Table 1, 2, 3 and Figure 1, 2). Nitrogen, phosphorous and sulphur are the limiting nutrients, which are commonly applied to mulberry gardens for effective crop production. Optimum quantity of nitrogen from an appropriate source increases the crop yield [9]. Prasad et al., [10] opined that efficiency of nitrogen is affected by the availability of other plant nutrients, and the maximum benefits from N application can only be obtained when adequate supply of other essential plant nutrients assured. Similarly, Bennet [11] gave a detailed account on the sulphur deficiency and its impact on the chlorophyll development thereby affecting the yield, nutrient status on the chlorosis occurrence which further encounters in a number of nutrient disorders. Whereas, phosphorous is a major constituent of important organic compounds, which are, in addition to inorganic phosphorous, involved in energy utilization and storage reactions [12] and ultimately biomass production. Absorption of phosphorous in plants depends on the source of nitrogen [13]. Under P-deficient conditions, even if sufficient nitrogen is applied, argentine is accumulated in plants, which lead to reduced protein synthesis [6]. Kurose [14] opined that silkworms fed on P-deficient mulberry leaves exhibited inhibitory growth. These observations are of special significance since mulberry leaves are the sole food of silk producing caterpillar (*Bombyx mori* L.) and the stability of silkworm crop greatly depends on the quality of mulberry leaves.

Importance of micronutrients on various crop plants and their influence on the crop yield and production was extensively studied by several workers [15-18]. Since several decades efforts have been inserted to modify the soil properties to enhance the crop production [19]. Fageria et al., [15] pronounced that micronutrient deficiencies occurs due to numerous factors such as use of fertilizers with low levels of soil organic matter, increased cultivation in areas with low soil fertility and reduced application of organic residues in cultivated areas. In mulberry, micronutrients deficiency is a regular phenomenon as it is also cultivated for its foliage and its leaves are harvested five times in a year @ 60MT/ha/yr leaf. Dandin et al., [1] has detailed the importance of macro and micronutrient deficiencies in mulberry and their impact on silkworm rearing and quality cocoon production.

Though no correlations were drawn between the soil reaction, salinity and nutrient parameters of the 13 clusters soils of Andhra Pradesh with the performance of silkworm rearing i.e. cocoon yield, silk production and market rate, soil fertility and productivity is directly proportional to the enhanced quality cocoon production [20]. Moreover, irrespective of the soil fertility status of the clusters spread over Coastal and Rayalaseema areas of the Andhra Pradesh enhanced cocoon yield (65.75 to 76.1kg/100dfls) was recorded with an increased market rate (Rs. 315.0 to 423/-per kg) and enhanced raw silk production (6.11 to 132.9MT) when compared among the regions (Fig. Table 1, 2 & Fig. 1, 2). Thus, the compilation of soil test results showed that majority of the mulberry growing bivoltine sericultural areas of 13 clusters under Andhra Pradesh were optimal for mulberry growth. The soils of many clusters showed low organic carbon level (OC), low to medium available nitrogen (N) and phosphorous (P) content, and moderate to high available potassium (K) and sulphur (S) (Table 1,2,3 & Fig. 1,2). Hence, the sericulture farming community of Andhra Pradesh were advocated to enhance the application of >20-25% of the present doses of organic manures viz. FYM, compost, green manuring followed by the imparting of trenching and mulching for the instant enhancing of soil organic carbon (OC) and organic matter (OM) for improving and retaining the soil fertility and heath. Furthermore, bivoltine sericultural farming community of Andhra Pradesh were also advised to carry timely soil chemical analysis of their garden soils at least once in a year or once in two years and impart soil analysis based (Soil Health Cards) soil amelioration recommendations for correcting the soil health and maintaining the desired levels of soil nutrient status for cherishing mulberry with enhanced quality mulberry leaf production thereby resulting in enhanced Bivoltine cocoon production [21].

Conclusion

Soil analysis based fertilizer prescription hinders the overuse or underuse of fertilizers for crop requirement. Therefore, soil analysis based prescriptions are necessary to improve the crop productivity and to increase the nutrient use efficiency. Hence, the sericulture farming community is advised to conduct timely soil chemical analysis of their garden soils at least once in a year or once in two years and impart soil analysis based (Soil Health Cards) soil amelioration recommendations for correcting the soil health and increasing the quality mulberry leaf production.

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