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Research Article

IMPACT OF SOIL AMELIORATION RECOMMENDATIONS ON BIVOLTINE SERICULTURE DEVELOPMENT DURING CLUSTER PROMOTION PROGRAMME IN ANDHRA PRADESH

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ABSTRACT

A total of 1472 composite soil samples were collected from the Bivoltine sericulture farmers under Cluster Promotion Programme (CPP) to assess the prevailing nutrient status spread over in 8 Districts of Andhra Pradesh. The soils were subjected for the chemical analysis for soil pH, EC, OC, available macro (N, P & K) and micro (S) nutrients, respectively. The results indicate that mean values of the soil pH was ranged from 6.55 to 7.75 among the soils of the state. Desired level of soil pH (6.5-75) was recorded among 56% soils followed by 32% with high pH (>7.5) and 12% with low level of pH (<6.5). Electrical conductivity (EC) was ranged from 0.06 to 0.33 dS/m registering with 99% soils were ideal with soluble salts (<1.0 dS/m) for mulberry cultivation among all the soils of the state. Organic carbon (OC) was recorded in the range of 0.35 to 0.61% among the soils of various districts. OC distribution was noticed that 74% soils with low level of OC (<0.65%), 22% in medium (0.65-1.0%) where as only 4% soils recorded with higher OC content (>1.0%). In case of essential macronutrients, available Nitrogen (N) was recorded in the range of 208.4 to 388.1kg/ha. In Nitrogen distribution 49% soils with low level N (<250kg/ha), 39% with ideal (250-500kg/ha) and only 12% soils resulted with higher level of N (>500kg/ha) among the districts. Available Phosphorous (P) was recorded between 15.07 to 82.33kg/ha contributing to 47% soils with rich in P (>25kg/ha), 31% with low level of P (<10kg) whereas 22% soils in desired level of P (10-25kg/ha). Potassium (K) content was ranged in 210.1 to 437.9kg/ha. The same was distributed high (>224kg/ha) in 58% soils, desired level (110-224kg/ha) in 35% soils, however only 8% soils were recorded with low level of K (<110kg/ha). In case of micronutrient, Sulphur (S) recorded in 7.66 to 32.8 ppm/ha exhibiting 63% soils with higher S (>15ppm/ha) content followed by 25% soils with desired level of S (10-15ppm/ha) whereas 12% soils only registered with low levels of S (<10ppm/ha) indicating that most of the cluster soils are rich in sulphur.

Keywords: Mulberry, Leaf production, Soil analysis, Soil fertility, Organic carbon.

INTRODUCTION

Mulberry (*Morus alba* L.) being perennial in nature cultivated as seasonal crop for its foliage to feed silkworms (*Bombyx mori* L). As it is cultivated for its foliage demands hefty quantities of organic manures and inorganic fertilizers for its sustainable and nutritious quality leaf. Mulberry cultivation cherish in the 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/ha) in the soils. Therefore, for its prolific growth and quality foliage, it has been prescribed NPK @ 350:140:140kg supplementing with 25MT FYM per/ha/yr, respectively for irrigated mulberry gardens of tropical soils of South India (Dandin *et al*., 2003). Even though use of prescribed doses of manures and fertilizers plays a pivotal role in qualitative and quantity of mulberry leaf, but adoption of the same is not found to the satisfactory level at the farmer's level resulting inferior soil fertility causing reduced levels of mulberry yield (Sarkar, 2000). Further, intensive crop schedules and recurrent harvesting of leaf: shoot biomass (@ 80-100mt/ha/yr with 5crops/annum) it is imperative that depletion of soil fertility status of mulberry gardens is a regular phenomenon. It is also reported that blanket recommendation of fertilisers leading to over or under use of fertilisers leading ultimately to deterioration of soil health (Anonymous, 2011).

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Repeated cultural operations, inorganic fertilizer applications, imparting of disease and pest control measures and industrial effluents are not only altering and depletion of the soil nutrient status but also polluting ground water resources. Therefore, frequent supplementation of essential macro & micro nutrients through inorganic form with sufficient organic manuring for conditioning and balancing the mulberry garden soil nutrient status for enhanced quality leaf production is indispensable. Several researchers emphasized on the need of balanced fertilization and their impact on quality mulberry and cocoon production (Fang Chen *et al,* 2009). Though for several decades the mulberry soils of Andhra Pradesh are utilized for the production of leaf, but efforts to detect the soil fertility status as and when required and recommending of soil amelioration prescriptions for enhanced quality mulberry leaf and cocoon production was not occur (Kar *et al.,* 2008; Subbaswamy *et al*., 2001). In the mean time Cluster Promotion Programme (CPP) was implemented under XI & XII five year plans during 2012-2019 in India for boosting the bivoltine sericulture with a target of >5000 MT/yr raw silk production. Nevertheless after imparting all the modalities (Sudhakar *et al.,* 2018) under CPP successfully we could achieve the targeted bivoltine raw silk production, but still lagging behind in succeeding generation of 3A & above graded silk production and not fetching anticipated market rates by the farming community. The reasons are many, but low level adoption of technical knowhow and lacking judicious use of recommended package of practices in mulberry cultivation. Though the farming community has been extended suitable package of practices for production of quality mulberry leaf, but due to continuous and long term harvesting of mulberry crops (ranging from 10-15 years) and failing either supplementing partial or inadequate supplementation of recommended doses of manures and fertilisers causing depletion of soil nutrient status. In addition to draining of soil nutrient status due to heavy & untimely rains followed by prolonged drought spell limiting the availability of nutrients and uptake. Further, lacking suitable technical knowhow of adoption of soil testing processes and imparting soil analysis based fitting amelioration strategies are the main reasons. Therefore, it is necessary to assess the soil nutrient status of Bivoltine sericulture areas and extending soil amelioration recommendation to the farming community through **'Soil Health Cards'** for enhanced quality mulberry leaf and enhanced gradable Bivoltine cocoon production.

MATERIALS AND METHODS

Keepings the above aspects in mind a research programme was initiated entitled *"Soil health cards for sericulture farmers in Southern States"* at Central Sericultural Research & Training Institute (CSRTI) Mysore. As a part of the programme the Regional Sericultural Research Stations (RSRS) of Anantapuramu (Andhra Pradesh) was assigned to collect as many soil samples of sericulture farmers mulberry gardens and assess for their soil reaction, salinity and major and micronutrients of mulberry soils and issue analysis based amelioration recommendations in the form of 'Soil Health Cards' for sustainable leaf and cocoon production. Under the programme the station has collected/received 1472 soil samples during 2016-17 (at 0-30cm depth) from 13 cluster areas of CPP scattered under 8 districts *viz.* Kurnool, Anantapuramu, Chittoor, Kadapa signifying Rayalaseema whereas East Godawari, West Godavari, Prakasham, and Vizianagaram districts representing the Coastal region of Andhra Pradesh (A.P.). Heterogeneous soil samples received from the said districts during 2016-17 were subjected for chemical assay for their soil reaction (pH), Electrical Conductivity (EC), Organic Carbon (OC) and other macro and micronutrients status (available N, P, K & S) at this station as well as CSRTI, Mysore following the standard procedures (Sudhakar *et al*., 2018). Based on the soil analysis results, analysis based suitable amelioration recommendations were prepared in the form of "Soil Health Cards" and served to the sericulturists for enhanced quality mulberry leaf and development of gradable bivoltine cocoon production.

RESULTS AND DISCUSSION

Out of the 1472 soil samples received from various districts of Andhra Pradesh state during 2016-17 sorted out and noticed that maximum number of soils were exhibiting red loamy (>70%) in nature, moderate number in red lateritic (>20%) and very few were in black cotton and clay loamy soil type (around 10%). On the whole majority of the soils were noticed congenial for mulberry cultivation supporting sericulture very much in the state. The chemical analysis results of the sericulture farmer garden soils among the clusters of various districts and their nutritional status are as narrated below.

Soil Reaction (pH): The minimum and maximum values of soil pH of the sericulture farmer gardens varied in a different way. The minimum values of soil pH of the soils under the districts ranged from 6.11 to 7.32 and maximum were in the range of 7.04 to 8.67. The mean values of soil pH of all the clusters were recorded in the desired level (6.55 to 7.75). All the districts garden soils were recorded with desired ranges of soil pH except in case of Prakasham (7.67) and Kurnool were showing slightly alkaline in nature (7.75). The distribution of soil pH among the districts varied differently. Mean values of all the district soils recorded in the range of 6.5-7.5 indicating that the soils were disseminated with desired soil pH. However, Kurnool (91%), Prakasham (63%) Kadapa (47%) and Ananthapuramu (43%) districts showed soils of alkaline in nature while East Godawari (56%) and West Godawari (34%) districts recorded acidic soils in nature. Therefore, for these undesired type of soils (low & high pH), instead of imparting chemical method of correction (adding Lime/Gypsum) for bringing them to desired level advised organic farming. They were advised to impart eco-friendly farming by imparting enhanced doses of farmyard manure (FYM) followed by adopting organic farming methods such as green manuring and adopting trenching & mulching during monsoon for not only improving the soil health but also contributing in bringing the soil reaction to desired level thereby improving the nutrient availability for the mulberry for abundant growth. (Table 1,2).

Total soluble salts (EC): The minimal level of total soluble salt content (EC) of the various district soils ranged from 0.02 to 0.10 dS/m and maximal level of EC was ranged from 0.32 to 1.26 dS/m. The average values of EC among the districts ranged from 0.06 to 0.31 dS/m. However, EC of all the districts soils recorded in the desired level (<1.00 dS/m) for the mulberry growth except in Kurnool (1.26 dS/m) district where the same was recorded slightly higher side but not in harming level to mulberry cultivation. The distribution of soluble salts (EC) was recorded in the range of 97-100% with desired level of EC (<1.00 dS/m) among all the districts of Andhra Pradesh indicating amiable for mulberry cultivation. The results indicated that mulberry growing soils of all the districts of Rayalaseema and Coastal region of Andhra Pradesh bivoltine sericulture areas were normal with respect to soil salinity indicating friendly for mulberry growth.

Organic Carbon (OC%): The organic carbon (OC) content of all the districts soils registered heterogeneous in nature. The minimal values of OC content was recorded among the 8 districts as 0.05 to 0.10% where as the maximum OC was ranged from 0.88 to 1.29%. The mean values of the soil organic carbon was ranging from 0.35 to 0.61%. The distribution of the soil organic carbon among the soils showed that maximum number of soils (74%) are deficient in OC content (<0.65), 22% soils showed rich in OC (between 0.65-1.00%) whereas only meager number of soils (4%) exhibited their richness in OC content (>1.00%). Soil OC is considered as the fertility indicator of any farming soil. Soil organic carbon also considered an important parameter to decide the fertility of the soils and control the sustainability of any crop production. Organic carbon acts by not only conditioning of soil physical properties by acting as a reservoir of essential nutrients but also promote maximum utilization of the inorganic fertilizers supplemented converting into available form leading to the enhanced quality crop production. Therefore, the A.P. soils of bivoltine area are advised to enhance organic inputs (manures) application followed by the regular imparting of green manuring and trenching & mulching during monsoon as a mandatory practice for serifarming to maintain desired level of OC for increased yield of mulberry.

Available Nitrogen (N_2O): Minimum ranges of available nitrogen per hectare was recorded among the farmer mulberry garden soils of 8 districts of AP ranging from 67.0 to 86.0 kg/ha where as the maximum quantities was recorded in 590.0 to 993.0 kg/ha range. The average available nitrogen was recorded from 208.4 to 388.1 kg/ha. Lower levels of available nitrogen (<250kg/ha) was recorded in the range of 35% to 75% soils. Maximum number of soils recorded in desired levels of available nitrogen (250-500kg/ha) in the range of 20% to 53%. However neglected number of soils among the districts was registered increased quantity of (>500kg/ha) nitrogen ranging from 1% to 32%. Maximum ratio of soils under Kurnool district (75%) were registered below the desired ranges of available Nitrogen (<250kg/ha) whereas the other districts recorded around 50% in the deficient levels of Nitrogen.

Table 1. District wise soil nutrient status of mulberry gardens of sericulture farmers among various districts of AP

Soil parameters	Nutrient Status	District wise soil samples received under CPP programme							
		Anantapuramu	Chittoor	East Godavari	Kadapa	Kurnool	Prakasham	Vijayanagaram	West Godavari
Soils (no)	1472	762	194	50	68	65	200	44	89
pH	Min	6.43	6.65	6.30	6.81	7.32	6.56	6.61	6.11
	Max	8.14	7.66	7.39	7.80	8.38	8.67	7.57	7.04
	Avg	7.48	7.13	6.56	7.45	7.75	7.67	7.19	6.55
EC (dS/m)	Min	0.03	0.03	0.09	0.02	0.07	0.10	0.04	0.02
	Max	0.95	0.68	0.97	0.62	1.26	1.00	0.62	0.32
	Avg	0.16	0.11	0.30	0.11	0.31	0.33	0.18	0.06
OC (%)	Min	0.10	0.07	0.10	0.05	0.10	0.08	0.10	0.10
	Max	1.20	1.29	1.23	1.21	0.96	1.18	1.10	0.88
	Avg	0.48	0.61	0.48	0.51	0.35	0.48	0.60	0.45
Avl. N (kg/ha)	Min	85.2	74.5	86.0	67.0	86.0	78.0	86.0	86.0
	Max	776.4	988.0	820.0	895.0	696.0	988.0	882.0	590.0
	Avg	291.2	388.1	278.7	311.9	208.4	279.8	378.1	259.7
Avl. P (kg/ha)	Min	3.14	4.50	2.00	0.50	2.0	1.00	2.50	3.00
	Max	156.4	123.5	77.0	114.0	156.0	146.0	44.0	235.0
	Avg	29.62	37.49	17.01	11.97	26.5	20.97	15.07	82.33
Avl. K (kg/ha)	Min	80.48	66.90	134.00	17.00	89.6	44.00	89.00	44.80
	Max	940.7	1590.4	806.0	672.0	716.8	1568.0	1030.0	940.8
	Avg	316.2	289.4	437.6	210.1	338.4	437.9	375.5	231.0
Avl. S (ppm/ha)	Min	7.25	8.02	8.04	8.04	7.6	6.05	8.44	6.05
	Max	224.19	87.48	50.24	151.40	98.0	169.30	68.15	84.47
	Avg	27.70	25.30	27.75	28.87	32.8	30.85	7.66	28.00

Table 2. Distribution of soil nutrients among the mulberry farming gardens of sericulturists under various districts of AP

Nutrients	Ranges	% of soil nutrient distribution among the mulberry garden soils of cluster farmers.								
		Ananta-puramu	Chi-toor	East Godawari	Kada-pa	Kur-nool	Praka-sham	Vizia-nagaram	West Godawari	Total/ Avg.
Soils	1472	762	194	50	68	65	200	44	89	1472
pH	<6.5	3	0	56	0	0	0	2	34	12
	6.5-7.5	54	96	44	53	9	37	89	66	56
	>7.5	43	4	0	47	91	63	9	0	32
EC (dS/m)	<1.00	99	100	100	100	97	100	100	100	99
	>1.00	1	0	0	0	3	0	0	0	1
OC (%)	<0.65	78	58	76	69	92	82	57	80	74
	0.65-1.00	17	33	22	26	8	17	36	20	22
	>1.00	5	10	2	4	0	1	7	0	4
Avl. N (kg/ha)	<250	56	35	52	46	75	46	36	46	49
	250-500	32	41	46	43	20	44	32	53	39
	>500	12	25	2	12	5	10	32	1	12
Avl. P (kg/ha)	<10	19	21	42	54	28	46	27	12	31
	10-20	22	13	32	25	26	27	25	4	22
	>20	59	67	26	21	46	27	48	84	47
Avl. K (kg/ha)	<110	8	23	0	10	3	4	2	12	8
	110-240	42	40	4	65	29	22	18	58	35
	>240	50	38	96	25	68	74	80	30	58
Avl. S (ppm/ha)	<10	18	12	6	9	10	17	9	18	12
	10-15	27	26	22	24	25	32	23	17	25
	>15	55	63	72	68	65	51	68	65	63

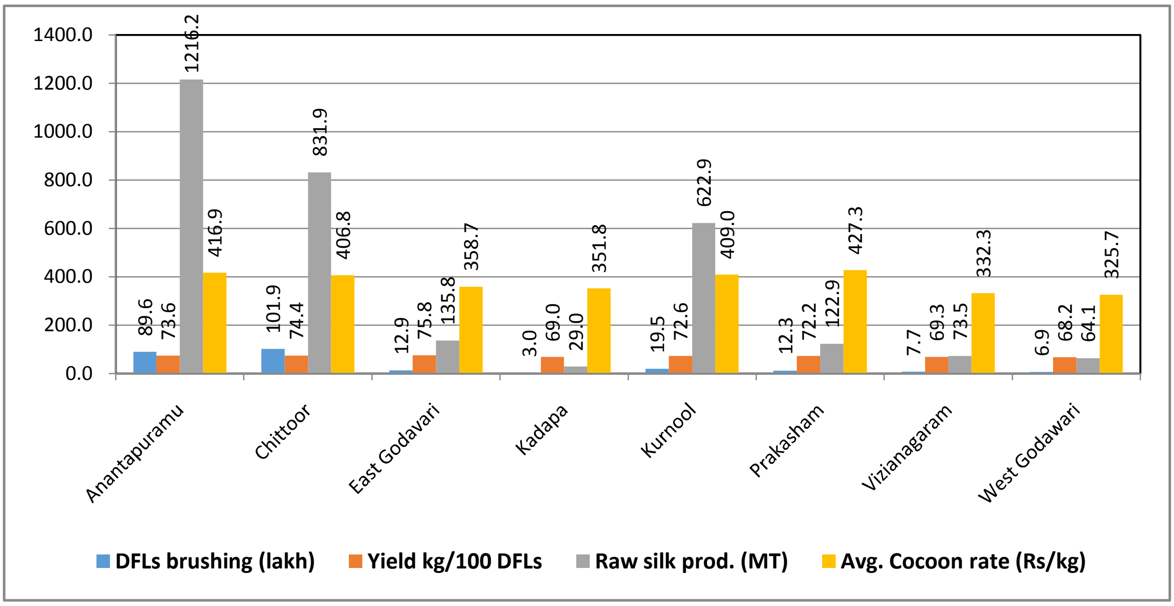

Fig. 1. Improvement of Silkworm rearing commercial characters due to soil amelioration recommendations.

Table 3. DFLs brushing, cocoon yield, market rate and raw silk production as influenced by the soil amelioration of the sericulturists gardens

Districts of Andhra Pradesh	DFLs brushed (Lakh)			Total (lakh)	Yield /100dfls (kg)			Average (kg)	Raw Silk Production (RSP/MT)			Total RSP (MT)	Avg. Cocoon rate (Rs/ kg)			Average (Rs/kg)
	2016-2017	2017-2018	2018-2019		2016-2017	2017-2018	2018-2019		2016-2017	2017-2018	2018-2019		2016-2017	2017-2018	2018-2019	
Anantapuramu	22.35	32.50	34.73	89.58	70.88	74.73	75.13	73.58	507.81	344.34	364.01	1216.16	415.7	486.3	348.7	416.9
Chittoor	28.67	34.05	39.16	101.88	70.76	73.1	79.18	74.35	289.81	355.59	186.5	831.90	416.5	460.5	343.5	406.8
East Godavari	3.63	4.31	4.99	12.93	71.6	76.11	79.81	75.84	37.16	46.83	51.81	135.80	488.0	250.0	338.0	358.7
Kadapa	0.90	0.99	1.09	2.98	68.05	69.05	70.01	69.04	8.75	9.63	10.59	28.97	350.0	345.5	360.0	351.8
Kurnool	5.42	6.51	7.56	19.49	72.48	70.96	74.38	72.61	48.75	68.37	505.8	622.92	420.0	455.5	351.5	409.0
Prakasham	3.43	4.07	4.84	12.34	68.39	72.87	75.33	72.20	33.51	42.41	46.96	122.88	420.0	497.0	365.0	427.3
Vizianagaram	2.44	2.51	2.70	7.65	66.99	70.31	70.58	69.29	22.97	25.24	25.24	73.45	312.0	401.0	284.0	332.3
West Godawari	2.16	2.30	2.40	6.86	67.26	68.3	68.97	68.18	20.73	22.46	20.89	64.08	327.0	370.0	280.0	325.7
Total/Avg	69.0	87.2	97.5	253.7	69.6	71.9	74.2	71.9	969.5	914.9	1211.8	3096.2	393.7	408.2	333.8	378.6

DFLs = Disease Free Layings; RSP = Raw silk production.

Remaining 50% soils of all the districts recorded in desired quantities of nitrogen (250-500kg/ha). Very few percent of soils of the districts recorded in excess quantities of available Nitrogen (>500kg/ha).

Available Phosphorous (P_2O_5): Among the districts of Andhra Pradesh the cluster soils registered minimum level of available phosphorous ranging from 0.50 to 4.50 kg/ha. Maximum number of soils of the state sericulturists gardens registered high quantities of available Phosphorous ranging from 44.0 to 235.0kg/ha. The mean values of available phosphorous was recorded in the range of 11.97 to 82.33kg/ha. Lower quantities of available phosphorous (<10kg/ha) was recorded among the soils in the range of 1% to 54%. Higher number of soils recorded with lower quantity of available phosphorous in Kadapa district (54%) followed by Prakasham (46%), East Godawari (42%) where as other districts recorded in nominal percent of available nitrogen ranging from 12-28%. Very few number of soils were recorded desired levels of available Phosphorous (10-20kg/ha) ranging in 4% to 32% only. Among them West Godawari (4%) and Chittoor districts recorded meager doses of potassium (13%). Rest of the districts showed the desired levels of Phosphorous in the range of 22% to 27%. Absorbent levels of available Phosphorous (>20kg/ha) was recorded in the districts of West Godawari (84%) followed by Chittoor (67%), Ananthapuramu (59%), Vizianagaram (48%) and Kurnool district (46%). However other districts recorded in the range of 21-27%. The results indicates that most of the districts soils of the Andhra Pradesh 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 among the districts mulberry farming soil samples of Andhra Pradesh ranging from 17.0 to 134.4 kg/ha, where as the maximum levels of the same was recorded in the range of 672.0 to 1590.4kg/ha. The mean value of the available potassium was recorded high (>240kg/ha) among all the districts indicating all the state sericulture farming soils are rich in potassium content ranging between 210.1 to 437.9 kg/ha. The K nutrient distribution registered that large number of soils recorded rich in potassium content (>240kg/ha) ranging from 25% to 96%. Moderate number of soils showed desired range of potassium (110-240kg/ha) in between 4% to 65%. However, very few number of soils among the districts registered low level of potassium (<110kg/ha) in between 0% to 23%. East Godawari district registered 96% soils high in potassium followed by Vizianagaram (80%), Prakasham (74%), Kurnool (68%) and Anantapuramu (50%). The other districts have registered equal ratio of desired as well as high quantities of potassium among the state. 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 (Pradhan *et al.,* 1992). Prasad *et al.* (1992) 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 (1993) 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 (Maschner, 1983) and ultimately biomass production. Absorption of phosphorous in plants depends on the source of nitrogen (Scott V. Eaton, 1922). Under P-deficient conditions, even if sufficient nitrogen is applied, argentine is accumulated in plants, which lead to reduced protein synthesis (Subbaswamy *et al.,* 2001). Kurose (1966) opined that silkworms fed on Phosphorous 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.

Available Sulphur (S): In case of micronutrient Sulphur minimum level was recorded in between 6.0ppm to 18.0ppm among the districts of Andhra Pradesh. Maximum quantity of Sulphur nutrient was recorded in between 50.2 to 224.2 ppm/ha. Similarly the average values of Sulphur quantity determined among the soils of farmer mulberry garden resulted in 7.66 to 32.8 ppm/ha. The distribution of Sulphur nutrient noticed that less than the desired quantity of Sulphur (<10 ppm/ha) was recorded among the limited number of soils ranging from 6% to 18%. Desired levels of available Sulphur (10-15ppm/ha) was recorded between 17 to 32% soils among the districts. However, maximum number of soils of the cluster farmers among the districts recorded higher quantity of available Sulphur (>15ppm/ha) ranging from 51 to 68%. This indicates that maximum number of cluster farmers mulberry garden soils showing rich in sulphur content. Therefore, all the districts sericulture farming 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 any sulphur deficiency and congenial for silkworm rearing. Significance of micronutrients on crop plants and their influence on the crop yield and production was extensively studied by several workers (Bose *et al.,* 2008; Fageria *et al.,* 2002; Govindaraj *et al.*, 2011; Singh, 2008). In the recent past efforts have been made to increase crop production by altering the soil fertility status and bringing them to desired levels to favour for plant growth. All these approaches including the heavy use of chemical fertilizers, was successful in improving soil properties and increasing crop productivity (Yu and Rengel, 1999). Researchers 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 (Fageria *et al*., 2002). In mulberry farming micronutrients deficiency is a regular phenomenon as because, mulberry too is cultivated for its foliage and harvested leaf 5-6 times (@ 60MT/ha/crop leaf) annually. Dandin *et al*. (2003) has detailed the importance of macro and micronutrient deficiencies in mulberry and their impact on silkworm rearing and quality cocoon production. Thus the compilation of soil test results showed that majority of the mulberry growing bivoltine sericulture cluster areas of 8 districts under Andhra Pradesh were optimal for mulberry growth. However, the soils of the many districts showing low in organic carbon level (OC), low to medium in available nitrogen (N) and phosphorous (P), whereas moderate to high in available potassium (K) and sulphur (S) contents. Hence, the sericulture farming community of Andhra Pradesh were advocated to enhance 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 enhancement of soil organic carbon (OC) and organic matter (OM) for improving and retaining the soil fertility and soil health. Further, the farmers also advised to impart the application of recommended doses of nitrogen (N), phosphatic (P) fertilizer along with 25% reduced levels of recommended potassium (K) is a must to maintain the desired levels of soil fertility and to meet the requirement of plants for generating enhanced nutrient rich leaves suitable for quality Bivoltine cocoon production. Further, bivoltine sericultural farming community of Andhra Pradesh are also advised to take up time to time soil chemical analysis of their garden soils at least once in a year or once in two years and impart soil analysis based soil amelioration recommendations for correcting the soil health (basing on Soil Health Cards) and maintain desired levels of soil nutrient status for cherishing mulberry with enhanced quality mulberry leaf production thereby improving Bivoltine cocoon production (Sudhakar *et al.,* 2019).

In continuation of the above the impact of the post soil amelioration processes advocated by the cluster farmers were studies compiling the 3 years Bivoltine sericulture scenario in the state (Table 3). It was noticed that after the meticulous incorporation of the soil correction processes by the farming community the Bivoltine DFLs distribution and brushing was raised from 69.0 lakh (2016-17) to 97.5 lakh by 2018-19 with a total of DFLs 253.7 lakh brushing in a span of 3 years period. The cocoon yield has shown marked increase from 69.6kg (2016-17) to 74.2kg per 100 DFLs brushed (2018-19) with an average yield of 71.9kg/100 DFLs. This was further reflected on the increase of raw silk production ranging from 969.5MT (2016-17) to 1211.8MT during 2018-19 with a total of 3096.2MT during 3 years period in the state. Further to emphasis that the soil analysis based mulberry farming has also reflected on the increased market rates among the clusters under different districts of Andhra Pradesh (Table 3, Fig. 1). However it is needless to draw any conclusions between soil amelioration by the farming community and Bivoltine sericulture development as because it is imperative that, soil fertility and productivity is directly proportional to the enhanced quality cocoon production (Sudhakar *et al.,* 2018).

Conclusion

Soil test based fertilizer prescription necessitates avoiding over use or under use of fertilizers for crop requirement (Anonymous, 2015). Therefore, soil analysis based prescriptions are necessary to improve crop productivity and to increase nutrient use efficiency. Hence, the sericultural farming community is advised to take up time to time soil chemical testing of their garden soils for cherishing mulberry with enhanced quality mulberry leaf production leading to enhanced quality cocoon production.

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REFERENCES

Anonymous, 2011. Methods Manual-Soil Testing in India. Published by Dept. of Agriculture and Co-operation. Ministry of Agriculture, Govt. of India, New Delhi. Pp. 1-208.

Bennet, W.E. 1993. Nutrient Defficiencies and Toxicities in Crop Plants. The American Phytopathological Society. St. Paul. Minnesota, USA.

Bose, P.C., Das, B.D. and Kar, R. 2008. Soil test based phosphorous and potassium fertilizer prescription for targeted yields of S1635 mulberry (Morus albla L.) under rainfed cultivation in eastern ghat region of Orissa. Indian J. of Seric., 47(1): 60-63.

Dandin, S.B., Jayaswal, J. and Giridhar, K. 2003. Handbook of Sericulture Technologies. Central Silk Board, Bangalore, India. Pp. 1-259.

Fageria, N. K., Baligar, V.C. and Clark, R.B. 2002. Micronutrients in crop production. Advances in Agron., 77: 185-268.

Fang Chen, Jianwel Lu, Mingchu Zhang, Kaiyuan Wan and Dongbi Liu. 2009. Mulberry nutrient management for silk production in Hubei Province of China. J. of Pl. Nutr. and Soil Sci.172(2): 245-253.

Govindaraj, M., Pandian, K., and Arunachalam, P. 2011. Implication of Micronutrients in Agriculture and Health with Special Reference to Iron and Zinc. Int. J. of Agric. Management & Development. 1: 207-220.

Kar, R., Bose, P.C., Majumdar, S.K. and Dutta, R.N. 2008. Physical characterization of mulberry (*Morus sp.*) growing soils in four states of eastern India in relation to their organic carbon and available nutrient contents. Indian J. of Seric., 47(1): 126-129.

Kurose, T. 1966. Studies on dietetical value of phosphorus deficient mulberry leaves. VI. Influence of arginine on the growth of silkworm larvae. *J. Seric. Sci. Jpn.,* 35(2): 121-124.

Maschner, H. 1983. General introduction to the mineral nutrition of plants. In: *Inorganic plant nutrition.* Encyclopedia of Plant Physiology, New Series Vol.15A. A. Lauchli and R.L. Bieleski (Eds.), Springer-Berlin, Germany. p.13.

Pradhan, L., Dixit, L., Rout, D. and Misra, A. 1992. Effect of source of nitrogen and yield of groundnut (*Arachis hypogea*) in acid lateritic soils of Orissa. Indian J. Agron., 37(2): 273-275.

Prasad, R., Sharma, S.N., and Singh, S. 1992. Fertilizer nitrogen Interaction in crop production. *Fert. News*, 37(4): 75-83.

Sarkar, A. 2000. Improvement in mulberry-current status and future strategies, Lead paper In: *Natl. Conf. Strat. Seric. Res.,*Central Sericultural Research and Training Institute, Mysore, India, pp. 1-11.

Scott V. Eaton, 1922. Sulphur content of soils and its relation to plant nutrition. Bot. Gazette. Vol 74(1): 32-58.

Singh M.V. (2008) Micronutrient Deficiencies in Crops and Soils in India. In: Alloway B.J. (eds) Micronutrient Deficiencies in Global Crop Production. Springer, Dordrecht

Subbaswamy, M.R., Singhvi, N.R., Naidu, B.V., Reddy, M.M., Jayaram, H. and Suryanarayana, N. 2001. Effect of source of nitrogen on phosphorus uptake and arginine content in mulberry. Indian J. of Seric., 40(2): 182-184.

Sudhakar, P., Sobhana, V., Swamy Gowda, M.R., Jalaja S Kumar and Sivaprasad, V. 2018. Soil fertility status of mulberry (*Morus alba* L.) soils under bivoltine sericultural areas of north, south and eastern regions of Karnataka. *Int. J of Adv. Res.,* 6(4): 132-140.

Sudhakar, P., Sobhana. V., Sibayan Sen., Sneha, M.V. Swamy Gowda, M.R., Jalaja S Kumar and Sivaprasad. V. 2019. Nutrient status of mulberry soils of sericulturists under varied bivoltine sericultural clusters of Karnataka. Int. J. Cur. Res., 11(03): 2351-2357

Yu. Q and Rengel, Z. 1999. Micronutrient Deficiency Influences Plant Growth and Activities of Superoxide Dismutases in Narrow-leafed Lupins. Annals of Botany 83: 175-182.

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