IJIRR

International Journal of Information Research and Review
Vol. 05, Issue, 04, pp.5399-5405, April, 2018

REVIEW ARTICLE

CHEMICAL ANALYSIS AND SUITABLE AMELIORATION OF MULBERRY (*MORUS ALBA* L.) GARDEN SOILS FOR ENHANCED LEAF AND COCOON PRODUCTION

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ARTICLE INFO

Article History:

Received 29th January, 2018
Received in revised form
12th February, 2018
Accepted 24th March, 2018
Published online 25th April, 2018

Keywords:

Mulberry,
Leaf production,
Soil analysis,
Soil fertility,
Organic carbon

ABSTRACT

The fertility of soil in general plays the key role in the development of any crop plants and mulberry is no exception for it. The growth and leaf nutrient status of mulberry plant varies in different geographic locations and geo-climatic conditions as the soil conditions changes. Demand for essential nutrient supply to the soils ever growing due to intensive cropping systems. Therefore, additional supplementation of required organic and inorganic nutrients to retain the desired levels of soil nutrient status in mulberry is imperative for sustainable leaf production. With the above objective in the present study a total of 2067 composite soil samples were collected from the traditional sericultural areas of 20 clusters under Cluster Promotion Programme (CPP) spread over in 13 districts of Karnataka. The same were subjected for their chemical analysis to determine the soil reaction, salinity and nutrient status *viz.* pH, EC, OC, available nitrogen (N), phosphorous (P), potassium (K), sulphur (S) and boron (B), respectively. The perusal of the results indicated that out of the soils received recorded 52% soils were loamy, 28% red, 12% black and 8% was lateritic type of soils. Indicating that, maximum soils are mulberry friendly. In regard to the soil fertility status large no of soils (61%) were in desirable pH (6.5-7.5), 21% with higher pH (>7.5) whereas 18% are low pH (<6.5). All the cluster soils (99%) showed with ideal soluble salts (EC: <1.0 dS/m) indicating that the cluster area soils were normal with respect to soil salinity. Organic carbon (OC) was low in 74% soils (<0.65%) whereas the same medium in 24% (0.65-1.0%) and only 2% soils recorded higher OC content (>1.0%). Available N and B was low (<250kg/ha & <0.5ppm) in 76% and 56%, and medium (250-500; 0.5-1.0) in 23% & 31% soils, respectively. Very few number of soils recorded higher level of N & B (>500kg/ha & >1.0ppm) in 1% & 13% soils. Higher amounts of P, K & S (>25kg/ha, >240kg/ha & >15ppm) was recorded in 36%, 42% & 51% soils respectively and the same P was recorded low (<250kg/ha) in 34% soils whereas K & S was medium level (120-240kg/ha; 10-15ppm) in 40% and 34% soils, respectively. Desired level of P in 30% and low level of K and S was noticed in 18% and 15% soils, respectively.

INTRODUCTION

Mulberry being a perennial plant cultivated and trained as seasonal crop for its foliage to feed silkworm demands high doses of manure and inorganic fertilizers. Accordingly mulberry gardens replenished with recommended NPK @350:140:140kg/ha/yr and 20MT FYM/ha/yr, respectively, for irrigated mulberry gardens to harvest optimum leaf yield in tropical areas of South India (Dandin *et al*., 2003). It is established that mulberry cherish under desirable levels of pH (6.5-7.5), electrical conductivity (EC-<1.00dS/m), organic carbon (OC: 0.65-1.0%), available N (280-560kg/ha), P (15-25kg/ha), K (120-240kg/ha), Sulphur (S: 10-15ppm) and Boron (B: 0.5-1.0ppm).

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Even though 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 at the farmers level resulting in low mulberry yield and low soil fertility (Sarkar, 2000). Further, hectic crop schedules and frequent harvesting (5 crops/yr) of leaf shoot biomass @ 80-100mt/ha/yr it is imperative that depletion of soil fertility status of mulberry gardens is a regular phenomenon. Therefore, frequent supplementation of essential nutrients along with manuring for conditioning soils and balancing the soil nutrient status for enhanced quality mulberry leaf production is essential. Earlier workers emphasized on the need of balanced fertilization and their impact on quality mulberry and cocoon production (Fang Chen *et al,* 2009). Moreover, potentiality of leaf yield and quality of mulberry leaves are greatly influenced by the genotypes, cultivation practices adopted soil moisture and nutrient status of the mulberry garden soils. Several workers have reported the physio-chemical properties and fertility status of soils under mulberry vegetation in Southern parts of India (Bongale and Siddalingaswamy, 1996, Bongale and Lingaiah, 1998; Prabhuraj *et al*., 2003). Though since 4 decades the mulberry garden soils of Karnataka are utilized for the production and harvesting of leaf, but efforts to detect the soil fertility status and recommending suitable analysis based soil amelioration prescriptions for enhanced mulberry leaf and cocoon production are limited (Bongale *et al.*, 1999; Bose *et al.* 2008; Kar *et al.,* 2008; Subbaswamy *et al*., 2001; Sudhakar *et al.*, 1999). Therefore, emphasis to study the cluster soils fertility status for their soil reaction, salinity, organic carbon and other available nutrients for targeted yields and need to find out the soil test based amelioration recommendations become the priority of the farming in the recent past (Bose *et al.,* 2008; Lal, 2004; Mishra and Sharma, 1997). Moreover, the soil fertility status assessment of the mulberry soils in totality in an integrated approach for bivoltine sericulture development in Karnataka is still remained an unattempted field of research. India being the largest consumer of natural silk in the world and demand for quality bivoltine raw silk has been increasing in the country gradually over the years. Though the annual raw silk production was crossing >24,000MT but did not suffice the actual requirements of the country. As a result, India had to import >6000MT of raw silk (Sudhakar *et al.,* 2018). This situation could be overcome with increased production of bivoltine silk in the country. In this direction out of the many technologies and strategies adopted as extension approaches like CDP, IVLP, and TVDP etc. Cluster Promotion Programme (CPP) was implemented under 12th five year plan during 2012-2017 in India for boosting the bivoltine sericulture with a target of >5000MT/yr raw silk production.

For which the state and Central Govt. jointly organised 174 clusters all over the India out of which 46 clusters were implemented in Karnataka. Even though with all the above efforts we could successfully achieve the targeted bivoltine raw silk production, but still we are lagging behind in succeeding the 3A & above grade silk production and not gaining anticipated market rates by the sericultural farming community. The reasons are many, but low level adoption of recommended package of practices in mulberry cultivation is the predominant reason.

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) & either supplementing or not the required doses of manures and fertiliser leading to depletion of soil nutrient status. Further, draining of soil nutrients due to heavy and untimely rains, drought spell situations limiting the nutrients uptake and lacking the technical knowhow of adoption of soil testing and imparting analysis based amelioration of garden soils are the main reasons. Therefore, in the present study an effort was made to assess the current soil nutrient status of prominent bivoltine sericultural areas under CPP in 13 Districts of Karnataka and extending soil analysis based amelioration recommendation in the form of **'**Soil Health Cards' for improving their mulberry soils for enhanced quality mulberry and cocoon production.

MATERIALS AND METHODS

A research programme entitled **"**Soil health cards for sericulture farmers in Southern States**"** was initiated at Central Sericultural Research and Training Institute (CSRTI), Central Silk Board (CSB), Mysore, Karnataka and its sister units of Regional Sericultural Research Stations (RSRSs) located at Bangalore (Karnataka), Salem (Tamil Nadu) and Ananthapur (Andhra Pradesh) for the period 2016-19. Under the above research programme soil samples were received from 20 Clusters earmarked for the bivoltine sericultural development programme scattered in 4 corners of the Karnataka state i.e. North (12 clusters), South (2 clusters), East (2 clusters) and West (4 clusters) distributed in eco-geographically varied 13 districts *viz.* Bangalore Rural (12º58'N-77º38'E), Bellari (15º09'N-76º55'E), Bidar (16º50'N-75º47'E), Bijapur (16º50'N-75º47'E), Chikkaballapur (13º26'N-77º46'E), Chitradurga (14º14'N-76º42'E), Gadag (15º30'N-76º36'E), Haveri (14º33'N-75º41'E), Kolar (13º16'N-78º39'E), Koppala (15º20'N-76º13'E), Ramanagaram (12º54'N-78º02'E), Tumkur (13º20'N-77º08'E) and Yadagiri (15º5'N-74º34'E). A total of 2067 soil samples with varied heterogeneity were received from the above clusters during 2016-17 and analysed for their soil reaction (pH), electrical conductivity (EC) and other macro and micronutrients such as available N, P, K, S & B at Soil Testing Laboratory, RSRS, CSB, Kodathi, and Bangalore. 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 enhanced quality mulberry leaf and bivoltine cocoon production.

Though, all the clusters are falling in the same tropical geo-climatic zones but are typically varied soil characters and textures. Soils received from the cluster areas includes loamy, red, lateritic and black soils with varied soil reaction (pH), salinity (EC) and nutrient parameters. Soil samples received from the sericulture farmers at 0-30cm depths were air-dried in shade, powdered, passed through a 10µ mesh sieved and stored in a fresh polythene covers with proper labelling following the standard procedures (Dandin *et al.,* 2003). Soil characters like pH, EC, organic carbon (OC%), available nitrogen (N/ha), phosphorous (P/ha), potassium (K/ha), sulphur (S-ppm) and boron (B-ppm) were determined by using the standard methods (Subbaiah and Asija, 1956; Jackson, 1973).

RESULTS AND DISCUSSION

The perusal of the data presented in the Fig. 1 mentioned are the mean values of 20 clusters demarcated under 13 Districts under Karnataka as enlisted above, soil types, reaction, salinity and nutrient status of the sericultural farming community are revealed the following:

Soil type, pH, EC and OC status: Out of the soils analysed (2067) large number of soils 1075 recorded as clay loamy (52%) indicating as the most favourite soils for plants because of their richer in plant nutrients, humus and will retain more water. This may be the reason that sericulture has become main and major cultivation and flourishing in Karnataka giving the credit of highest raw silk producing state in India. Whereas, 579 (28%) are red soils followed by 248 soils (12%) are black and only 165 (8%) were recorded as lateritic soils. In case of soil reaction (pH) 61% of the soils analysed indicated desired level of pH (6.5 to 7.5%) for mulberry, 21% high (>1.0%) and 18% are with low pH (<0.65%). The pH is an excellent single indicator of general health of soil and its conditions (Tisdale *et al.,* 1985). Maximum soils (99%) showed low and ideal electrical conductivity (EC <1.0m.mohs/cm) for mulberry

Table 2: Clusters wise trends of soil pH, reaction (EC) and nutrient (OC, available N, P, K, S and B) status under various clusters

Soil nutrients	Status	Soil Samples supplied Cluster Details																			
		Aro-halli (Hkt)	Aro-halli, (KKP)	Andara lahalli	Aurad	Bija-pur	Ch.R. Pattana	Gulbarga (Kbg)	Hiri-yuru	Humna-bad	Jama-khandi	Kud-lagi	Rani bennur	Rav-godlu	Sha-pur (Klr)	Shaha-pur (Ygr)	Shira-hatti	Tuba-gere	Tum-kuru	Y.N. Hosa kote	Yelb-urga
Soils (no)	2067	178	78	70	40	103	164	208	35	63	100	134	79	100	146	132	35	125	123	87	67
pH	Min	5.54	5.49	6.98	6.48	6.42	5.57	6.20	7.09	5.75	5.92	6.19	6.16	6.16	5.89	6.46	6.08	5.76	6.20	5.75	5.90
	Max	7.1	7.55	8.22	7.89	7.97	8.11	8.12	8.30	8.05	8.73	7.94	8.29	7.54	7.91	8.22	7.10	8.86	7.93	7.84	7.60
	Avg	6.32	6.52	7.60	7.19	7.20	6.84	7.16	7.70	6.90	7.33	7.07	7.23	6.85	6.90	7.34	6.59	7.31	7.07	6.80	6.75
EC (dS/m)	Min	0.21	0.11	0.11	0.07	0.11	0.07	0.15	0.29	0.08	0.06	0.096	0.085	0.061	0.03	0.111	0.217	0.048	0.048	0.12	0.16
	Max	0.71	0.97	1.29	0.78	0.39	0.69	0.89	0.76	0.93	1.86	0.900	1.450	0.640	0.86	1.287	0.515	0.896	0.810	0.52	0.76
	Avg	0.46	0.54	0.70	0.43	0.25	0.38	0.52	0.53	0.51	0.96	0.50	0.77	0.35	0.45	0.70	0.37	0.47	0.43	0.32	4.23
OC (%)	Min	0.06	0.06	0.12	0.12	0.06	0.06	0.13	0.79	0.06	0.11	0.061	0.112	0.064	0.06	0.117	0.164	0.057	0.113	0.06	0.06
	Max	1.04	0.96	1.14	1.05	1.05	1.50	0.90	1.08	0.82	0.99	0.873	0.923	1.596	0.92	1.143	0.982	1.302	0.983	1.14	0.89
	Avg	0.39	0.51	0.91	0.59	0.38	0.44	0.52	0.52	0.44	0.41	0.446	0.446	0.520	0.38	0.551	0.495	0.463	0.544	0.52	3.29
Avl. N (kg/ha)	Min	150.5	175.6	50.2	25.1	100.4	26.5	108.0	25.1	98.2	150.5	175.6	138.0	175.6	100.4	50.2	175.6	100.4	150.5	175.6	175.6
	Max	301.1	276.0	376.3	276.0	539.4	602.1	386.0	275.9	376.3	376.3	276.0	225.8	388.9	276.0	376.3	250.9	376.3	326.1	338.7	376.3
	Avg	221.3	217.6	290.8	150.6	214.5	221.8	248.0	229.4	237.3	210.6	231.8	180.9	236.7	211.1	220.4	203.9	217.0	237.0	212.9	52.87
Avl. P (kg/ha)	Min	0.45	4.7	2.69	1.57	0.67	0.45	12.99	2.73	3.58	6.27	4.26	1.57	2.69	3.58	2.69	12.99	2.46	3.58	2.33	1.57
	Max	96.1	127.7	147.6	91.39	123.2	109.9	69.4	22.2	147.6	135.5	79.7	126.6	69.4	96.54	147.6	68.54	91.39	111.8	69.44	147.6
	Avg	24.3	15.98	57.7	46.48	27.2	17.97	41.20	10.9	75.6	14.2	27.6	25.6	17.99	23.35	25.9	35.64	19.73	24.3	14.63	55.97
Avl. K (kg/ha)	Min	179.0	376.3	224.0	215.0	143	134.4	134.0	224.0	179.0	142.0	215.0	134.0	107.5	268.8	179.0	161.3	89.6	215.0	179.0	134.4
	Max	672.0	860.2	1075.0	582.0	1613	941.0	582.0	448.0	986.0	1344.0	483.8	1254.0	1290.2	582.0	1075.0	967.7	986.0	591.4	806.0	967.7
	Avg	425.5	618.3	649.5	398.5	878.0	537.7	358.0	336.0	582.5	743.0	349.4	694.0	698.9	425.4	627.0	564.5	537.8	403.2	492.5	114.2
Avl. S (ppm)	Min	8.44	10.4	12.5	8.44	7.64	6.85	10.8	9.24	9.24	8.44	10.8	12.3	10.43	9.24	11.5	12.82	14.41	13.6	14.5	9.24
	Max	30.7	120.3	105.3	110.0	88.1	61.8	213.1	35.1	120.5	100.8	124.3	110.0	40.29	213.1	120.5	82.09	41.48	264.4	150.5	213.1
	Avg	17.2	35.2	28.4	59.2	23.4	17.3	111.9	16.9	64.9	22.2	26.1	32.0	18.05	27.72	29.9	30.32	23.2	34.6	55.3	113.9
Avl. B (ppm)	Min	0.02	0.09	0.02	0.10	0.05	0.02	0.10	0.04	0.10	0.09	0.10	0.15	0.05	0.09	0.02	0.19	0.13	0.04	0.10	0.04
	Max	1.93	1.41	0.96	0.96	6.85	2.91	0.96	1.71	2.49	10.3	1.52	2.44	1.91	2.49	0.96	0.83	12.31	1.61	1.50	1.41
	Avg	0.76	0.55	0.68	0.53	0.58	0.60	0.53	0.49	1.29	0.96	0.72	0.89	0.60	0.72	0.29	0.42	1.34	0.34	0.42	104.1

Table 3. Percentage distribution of soils basing on the soil pH, reaction and nutrient status of CPP farmers under Karnataka

Nutrients	Ranges	% off soil nutrient distribution among the mulberry garden soils of cluster farmers.																			
		Andara lahalli	Aurad	Bija pur	Ch.R Pattana	Gulbarga	Aro halli (Hkt)	Aro halli, (KKP)	Hiri yuru	Humna bad	Jama khandi	Kuda lagi	Rani benn-ur	Ravgo dlu`	Sha Pur (Klr)	Shaha pur (Ygr)	Shira hatti	Tuba gere	Tum kuru	Y.N. Hosa kote	Yelbur ga
No. of soils	2067	70	40	103	164	208	178	78	35	63	100	134	79	100	146	132	35	125	123	87	67
pH	<6.5	--	12	1	--	21	01	27	23	18	24	--	1	31	27	2	71	18	10	14	10
	6.5-7.5	31	70	75	31	71	75	56	61	70	75	71	62	68	64	35	29	68	69	78	86
	>7.5	69	18	24	69	8	24	17	16	12	1	29	37	1	9	63	--	14	21	8	4
EC (dS/m)	<1.00	98	100	100	98	100	100	100	100	100	100	100	91	100	97	98	100	100	100	100	100
	>1.00	2	--	0	2	--	0	--	--	--	--	--	9	--	3	2	--	--	--	--	--
OC (%)	<0.65	69	79	81	68	69	81	77	87	66	70	65	86	64	94	67	83	78	61	66	62
	0.65-1.00	28	18	18	28	27	18	21	12	22	30	26	14	35	6	29	17	19	39	32	38
	>1.00	3	3	1	4	4	1	2	1	12	--	9	--	1	--	4	--	3	--	2	0
Avl. N (kg/ha)	<250	77	69	83	76	81	82	77	71	66	86	54	100	62	86	74	97	78	53	90	66
	250-500	23	31	16	24	18	16	22	29	28	14	46	--	38	14	26	3	22	47	10	34
	>500	0	--	2	0	1	2	1	0	6	--	--	--	--	--	--	--	--	--	--	--
Avl. P (kg/ha)	<10	43	42	41	43	39	41	43	34	48	27	43	24	38	23	16	--	29	21	36	31
	10-20	20	38	18	20	41	18	36	13	28	56	43	27	32	32	35	23	31	14	50	43
	>20	37	20	41	37	20	41	21	53	24	17	14	49	30	45	49	77	40	65	14	26
Avl. K (kg/ha)	<110	2	39	0	2	18	0	--	12	27	14	18	24	20	66	--	23	26	18	23	18
	110-240	8	51	13	8	48	13	50	65	42	57	37	58	50	21	6	65	55	60	49	52
	>240	90	10	87	90	34	87	50	23	31	29	45	18	30	13	94	12	19	22	27	30
Avl. S (ppm)	<10	31	19	27	31	21	27	12	7	19	17	6	32	--	2	26	--	0	0	8	11
	10-15	31	50	27	31	62	27	48	31	51	34	43	35	27	40	45	--	3	3	29	21
	>15	38	31	46	38	17	46	40	62	30	49	51	33	73	58	29	100	97	97	63	68
Avl. B (ppm)	<0.5	75	64	59	74	65	59	41	24	76	49	63	29	39	30	78	77	16	82	63	55
	0.5-1.0	25	28	30	26	28	30	48	49	23	43	26	23	49	47	22	23	52	17	29	36
	>1.0	0	8	11	0	7	11	11	27	1	8	11	48	12	23	--	--	32	1	8	9

Table 4: 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)	Avl. B (ppm)	*DFLs brushed (Lakh)*	*Yield/ 100dfls (kg)*	*Rate/ (Rs/kg)*	*Est. raw silk (MT)*
Arohalli (Hkt)	178	6.3	0.46	0.39	221.3	24.3	425.5	17.2	0.76	2.13	65.3	393.7	21.60
Arohalli (Kkp)	78	6.5	0.54	0.51	217.6	15.98	618.3	35.2	0.55	2.75	64.37	404.3	24.29
Andaralahalli	70	7.6	0.70	0.91	290.8	57.7	649.5	28.4	0.68	1.90	66.6	352.2	14.45
Aurad	40	7.2	0.43	0.59	150.6	46.48	398.5	59.2	0.53	0.59	71.6	296.8	4.90
Bijapur	103	7.2	0.25	0.38	214.5	27.2	878.0	23.4	0.58	1.13	66.9	353.4	11.26
Ch.R.Pattana	164	6.8	0.38	0.44	221.8	17.97	537.7	17.3	0.60	1.09	58.8	376.6	10.53
Gulbarga (Kbg)	208	7.2	0.52	0.52	248.0	41.20	358.0	111.9	0.53	1.96	61.0	322.1	16.58
Hiriyur	35	7.7	0.53	0.52	229.4	10.9	336.0	16.9	0.49	2.14	65.8	397.5	21.67
Humnabad	63	6.9	0.51	0.44	237.3	75.6	582.5	64.9	1.29	0.85	69.0	341.2	8.75
Jamkandi	100	7.3	0.96	0.41	210.6	55.97	743.0	22.2	0.96	3.25	67.8	375.6	31.70
Kudligi	134	7.1	0.50	0.45	231.8	14.2	349.4	26.1	104.1	5.26	62.6	381.0	50.96
Ranibennur	79	7.2	0.77	0.45	180.9	27.6	694.0	32.0	0.72	3.02	70.3	314.6	29.08
Ravgodlu	100	6.9	0.35	0.52	236.7	25.6	698.9	18.05	0.89	0.75	75.4	332.8	9.30
Shahapur, Ydgr	132	6.9	0.45	0.38	211.1	17.99	425.4	27.72	0.60	0.68	61.58	278.7	6.43
Shapur (Klr)	146	7.3	0.70	0.55	220.4	23.35	627.0	29.9	0.72	4.71	70.8	419.9	46.39
Shirahatti	35	6.6	0.37	0.50	203.9	25.9	564.5	30.32	0.29	2.22	63.9	370.2	22.28
Tubagere	125	7.3	0.47	0.46	217.0	35.64	537.8	23.2	0.42	1.18	73.6	419.2	12.66
Tumkur	123	7.1	0.43	0.54	237.0	19.73	403.2	34.6	1.34	3.65	74.50	396.2	35.45
Y.N. Hosakote	87	6.8	0.32	0.52	212.9	24.3	492.5	55.3	0.34	8.91	67.9	387.2	88.90
Yelburga	67	6.8	4.23	3.29	52.87	14.63	114.2	113.9	0.42	1.44	64.7	340.3	14.49
20 clusters	2067	7.0	0.69	0.64	212.3	30.11	521.70	39.38	5.84	49.61	67.12	362.68	481.67

DFLs = Disease free laying

growth indicating that most of the soils are favourable for mulberry with ideal pH and salinity. However, rest of the soils reaction can be corrected by incorporating integrated nutrient management (INM) components such as farmyard manure (FYM), green manuring and trenching mulching practices instead chemical correction (Jaishankar and Dandin, 2005). Organic carbon (OC %) was considered as the soil fertility indicator of mulberry gardens. But the same was recorded low (<0.65%) in 74% soils indicating that ¾th soils received are poor in OC content and needs improvement in organic matter, whereas 24% soils recorded desired level of OC% (0.65-1.0%).

It is surprising to know that neglected level (2%) of mulberry gardens showed higher OC (>1.0%) indicating that Karnataka soils are deficient in OC content needs improvement of OC (Fig. 1).

Soil macro and micro nutrient status: Soil macronutrients (available N,P & K) status was recorded as 76% soils are low in available N (<250kg/ha) and 23% soils showed desired level of N (280-560kg/ha) indicating that mulberry garden soils of Karnataka where bivoltine is reared indicating deficient in available N. Available phosphorous (P) was high (>25kg/ha) in 36% soils followed by low in 34% (<15kg/ha) and the same was recorded desired level in 30% soils (15-25kg/ha).

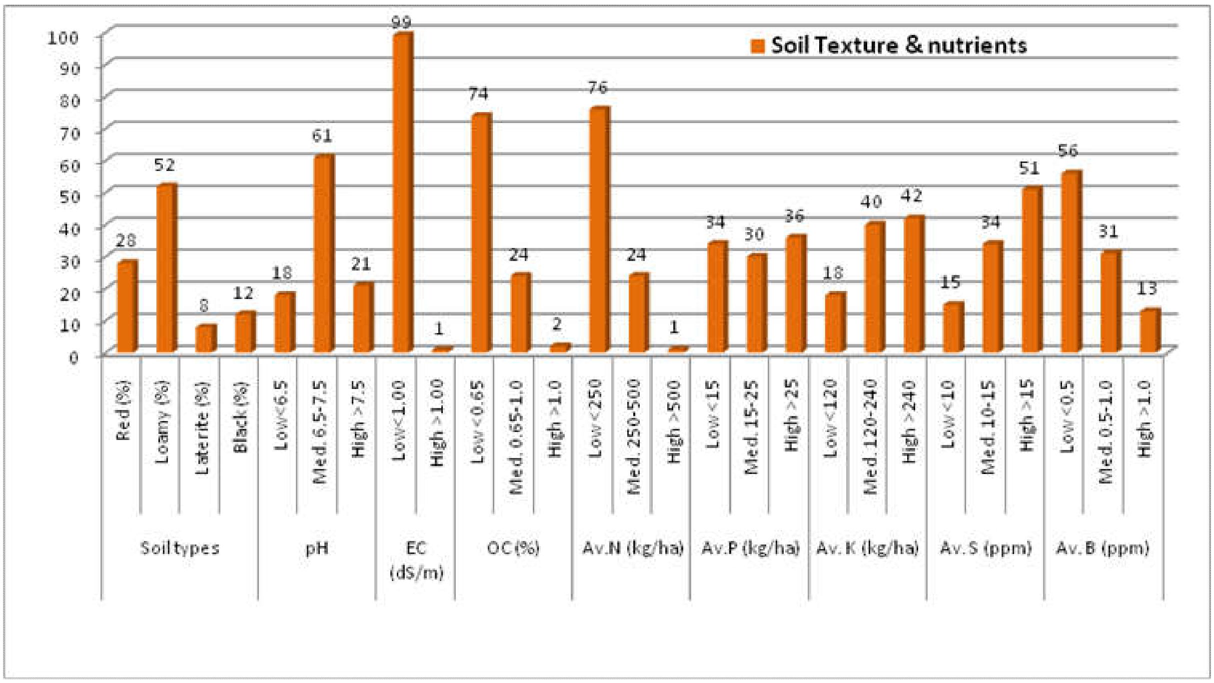

Fig. 1. Distribution of soil nutrient parameters of mulberry gardens among the cluster farmers

Potassium content was high in 42% soils (>240kg/ha) followed by medium level in 40% high (120-240kg/ha) and the same was least in 18% soils (<120kg/ha. Nitrogen and phosphorous 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. 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. 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 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 (Aruga, 1994). In case of secondary nutrients sulphur was recorded high (>15ppm) in 51% soils followed by 35% soils medium (10-15ppm) and 15% soils are low (<10ppm). The presence of K and S were observed to be either high are moderate indicating congenial for mulberry. However, micronutrient of boron (B) was low (<0.5ppm) in 56% soils followed by 31% soils desired level (0.5-1.0ppm), whereas the same was showed high (>1.0ppm) in 13% soils. Bennet (1993) gave a detailed account on the chlorosis occurrence due to sulphur deficiency which further encounters in a number of nutrient disorders. Deficiency which further encounters in a number of nutrient disorders Clusters wise soil fertility distribution status, nutritional ranges and mean values of the same recorded from the soils of the sericulturists mulberry gardens in Karnataka and presented in Table 2 and 3 also resulted similar trend as depicted earlier. Most of the cluster soils under the districts exhibited ideal pH, EC, low level of OC, low level of available N, P and Sulphur where as increased level of potassium and Boron. In case of minimum, maximum and mean values of soil pH, EC and other macro (N, P and K), secondary (S) and micro (B) nutrients among the respective clusters revealed that all the districts soils shown desired levels of average values of soil reaction and nutrient status. However, maximum levels of potassium sulphur and boron was noticed where as the other soil reaction and nutrient parameters were recorded in the admissible ranges indicating congenial conditions for mulberry cultivation. However, no correlation was drawn in regard to soil reaction and nutrient parameters compared to the performance of silkworm rearing i.e. cocoon yield, silk production and market rate among the 20 clusters under 14 District soil samples of sericultural farmers garden soils. Irrespective of soil nutrient status all the cluster farmers harvested appreciable cocoons ranging from 61.6kg to 71.2kg/100dfls with a market rate of Rs. 279/- to Rs. 404/- per kg. Further, clusters situated under Tumkur District has contributed significantly in brushing of highest no. of DFLs (12.56 lakhs) with 124.35mt raw silk where as Yadagiri District has resulted in brushing of least no. of DFLs (0.68 lakhs) with 6.43mt raw silk production (Table 4).

Conclusion

A detailed account on the influence of nutrients (macro, secondary & micronutrients) and consequences on their excess and deficiencies was discussed by several workers (Anonymous, 2011). Blanket recommendation of fertilisers leads to over or under use of fertilisers ultimately deterioration of soil health (Anonymous, 2015). Soil test based fertilizer prescription necessitates avoiding over use or under use of fertilizers for crop requirement. 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 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 desired levels of soil nutrient status for cherishing mulberry with enhanced quality mulberry leaf production leading to flourishing with enhanced quality cocoon production.

Acknowledgements: The authors are expressing their sincere thanks to the Laboratory staff for extending all their co-operation and regards to the authorities for extending their support throughout the work.

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