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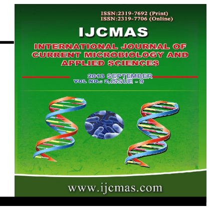

Original Research Article

Impact of soil fertility and leaf nutrients status on cocoon production of Muga silkworm, *Antheraea assamensis* (Helfer) in potential muga growing areas of Assam, India

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A B S T R A C T

Keywords

Muga silkworm; *Antheraea assamensis*; *Persea bombycina*; soil and leaf analysis; cocoon production; correlation

The unique golden yarn producing sercigenous insect muga silkworm, *Antheraea assamensis* (Helfer) is endemic to the Assam, India. The productivity of muga silkworm cocoon is not uniform in different agro-climatic zone. A wide range of variation in total nitrogen, available nitrogen, phosphorus, potassium, organic carbon, pH and electrical conductivity was observed in the soil samples of the three muga growing districts of Assam. An average of 0.031% total nitrogen, 296.18 kg/ha available nitrogen, 82.80 kg/ha available phosphorus, 252.57 kg / ha available potassium, 1.11% organic carbon, a pH value of 4.96 and electrical conductivity of 43.18 sm^{-1} was recorded. Leaf nutrient analysis revealed an average of 0.433% total nitrogen, 2.708% crude protein, 5.651% lipid, 51.973% crude fibre, 3.319% sugar and 31.452% carbohydrate content in the leaves of *P. bombycina*. Correlation between soil and leaf constituents and further soil and leaf constituents with cocoon production did not reveal any definite correlation among and between the parameters under study. However, the pooled data analysis showed positive correlation of available nitrogen of soil with total nitrogen of leaf and leaf sugar with cocoon production.

Introduction

Assam, a province located in the northeastern part of India, (22–29◦ N latitude and 90–97◦ E longitude) is rich in biogeographic resources, surrounded from all sides by neighboring hilly states. Due to its sub-tropical congenial climate, Assam harbours about 19 sericigenous insect species of the world. Among all the state. Over the last decade, production of muga raw silk in the region is fluctuating in between 62 -119 MT, however it is showing a gradual increasing trend in muga silk production (Das and Sarmah, 2011). The current productivity of muga is about 85,000 cocoons corresponding to 17 kg raw silk per hectare. The diversified geological conditions, topographical characteristics, climatic situations and vegetation types favour the formation of different types of soil in the state of Assam resulting to variation in leaf quality, which ultimately influence muga cocoon production and productivity. At present, about 7570 hectares of land is under Muga food plantation in north eastern region. More than 30,000 families are engaged in Muga culture directly and 1 lakh families are involved in the post cocoon sector making it a profit making industry in the region. For undertaking any crop production process, primary knowledge on the nutrient status of the soil system is the first step for planning an effective crop production management system. Thus physico-chemical characterization of soil is an important part of the majority of crop improvement and management systems. Abundant literature is available for several field and horticultural crop (Krishnakumar *et al.,* 1990; Kahle *et al.,* 1992; Curtin *et al.,* 1994). A few reports are available on physico-chemical properties and classification of mulberry garden soils in India (Basavanna & Bose, 1989; Bongale, 1993; Bongale & Siddalingaswamy, 1996; Bongale and Lingaiah, 1998, Thimmareddy *et al.,* 1999; Samanta *et al.,* 2001). Although the soils have great influence on the yield and quality of leaves, no study was so far undertaken to analyze the physical as well as chemical characteristics of soils of potential muga growing areas of Assam. The challenge to any project with an objective to improve the productivity of the area is to have baseline on land productivity and identify soil-related constraints in different zones or ecosystems. The major limiting factors are low organic matter content, high pH etc. Muya *et al.,* (2011). Moreover, growth and development of silkworms and the cocoon crop yield are considerably influenced by the nutritive value of leaf as feed, which even varies from variety to variety of the same species. The importance of good nutrition in mulberry silkworm rearing has been widely recognized (Takeuchi, 1960; Ito and Arai, 1963; Parpiev, 1968; Krishnaswami *et al.,* 1970; Fonseca *et al.,* 1993; Sarkar *et al.,* 1997). Ito and Kobayashi (1978) reported that nutritive value of mulberry leaves varied depending on the season, temperature, nature of soil, kind of fertilizer, method of cultivation etc. Leaf quality of some mulberry genotypes through chemical analysis had been evaluated (Bose *et al.,* 1991; Bongale and Chaluvachari, 1993; Fotadar and Dandin, 1997). Li and Sanu (1984), Tangamani and Vivekanandan (1984) and Chaluvachari and Bongale (1995) observed wide range of variation in mulberry genotype and discussed the importance of quality of mulberry leaves used as feed for silkworm. Several studies on foliar constituents of the food plants of muga silkworm, *A. assamensis* (Dutta *et al.,* 1997; Hazarika *et al.,* 1995), tasar silkworm, *A. mylitta* (Kohli *et al.,* 1969; Sinha and Jolly, 1971; Sinha *et al.,* 1992), oak tasar, *A. proylei* (Sinha *et al.,* 1986; Banerjee *et al.,* 1993) and eri silkworm (Pathak, 1988; Shaw, 1998) had been made. The present paper describes the study undertaken in respect of soil fertility, nutrients status of leaf and their correlation with cocoon productivity in three potential muga growing districts, namely Jorhat, Golaghat and Lakhimpur of Assam. Lakhimpur district of Assam is situated on the north bank of the river Brahmaputra. During 2007, about 7174 families in 761 villages of the district were reported to be involved in muga sericulture; total area under muga food plantation was 1050 hectares and 12.03 MT muga raw silk yarn was produced. Jorhat district is situated on the south bank of river Brahmaputra. About 6715 families in 540 villages of the district were reported to be involved in muga sericulture; total area under muga food plantation was 285 hectares and 3.21 MT muga raw silk yarn was produced. Golaghat, another sericulturally important district of Assam is situated on the south bank of river Brahmaputra. During 2007, about 713 families in 160 villages of the district were involved in muga sericulture; total area under muga food plantation was 325 hectares and 11.26 MT muga raw silk yarns was produced (Source: Statistical Handbook, Assam, 2007)

Materials and Methods

Experiment setting

Before initiation of the experiment, survey was conducted in the selected districts for identification of muga farmers based on some preset benchmarks. Based on the benchmark survey, 60 farmers were selected from four villages of each district having at least one acre of muga food plant Som, *Persea bombycina* King Ex. Kost. Data on cocoon production during two commercial muga silkworm rearing seasons, viz. spring (April-May) and autumn (October-November) were collected from the farmers. Rearing was done following standard package of practices developed by Central Silk Board.

Collection of information on agro-climatic profile of selected districts

To collect the information on agro-climatic profile of selected districts, websites of individual district were taken as base. Besides, concerned sericulture and agriculture departments were contacted to collect the necessary information.

Collection of Soil and leaf samples

Soil and leaf samples of the muga food plantation area were collected following standard sampling method. Soils were collected from the surface layer (0-30 cm depth) from each of the locations.

Analysis of soil fertility and leaf nutrients status

The soil samples were processed and used for physical characterization and analyzing various soil fertility parameters *viz*., pH (1:2.5-Soil: Water), organic carbon content, Cation Exchange Capacity (Meq/100 g), available N (kg/ha), Available P_2O_5 (kg/ha) and available K_2O (kg/ha) following the methods as described by Jackson (1973). Total nitrogen was estimated by the method of Willits and Ogg (1950) using Kel plus automatic nitrogen analysis equipment and Crude protein of leaf was estimated by multiplying the estimated value of the total nitrogen by 6.25; crude fibre by Maynard (1970) and A.O.A.C (1970) and total carbohydrate by Hedge and Hofreiter (1962). All estimations were done on dry weight basis. Anthrone method (Yem and Willis, 1954) was followed to estimate reducing sugar.

Statistical analysis

Data recorded during the course of investigation were statistically analyzed for "Analysis of Variance" technique given by Snedechor and Cochran (1967). The significance of difference was done by 'F' test. When 'F' value was found significant, Critical Difference (CD) was calculated by multiplying S. Ed. (Standard Error) with corresponding't' value at 5% level of probability. When mean difference among the treatments were greater than the CD value the difference was considered as significant. Correlation analysis of soil fertility with cocoon productivity, leaf nutrients with cocoon productivity and soil characters with leaf nutrients were also estimated.

Result and Discussion

Agro-climatic profile of selected districts

Jorhat District is located between the Brahmaputra river on the north and Nagaland the south. This district is situated at around 26° 46' north latitude and 96° 16' north longitude in the central part of Brahmaputra Valley. Jorhat is an important agricultural town for Assam. Jorhat is rich in natural resources, minerals, forests and water and has vast tracts of fertile land. It is primarily an agrarian economy, with 74% of its population engaged in agriculture and allied activities. The Economy of Jorhat is mainly dependent on Tea & Agriculture. The entire district is surrounded by tea plantations. There are about 135 tea gardens surrounded in Jorhat district. Cereals like paddy, wheat are grown extensively. Jorhat district experiences moderate climate. The temperature varies between 9°C to 39°C. The district receives rainfall on an average at 2244 mm with north-west monsoon contributing a major share. Golaghat district covers the total area of 3502 sq. km. and is located 100 meter above the sea level. It lies between 93° 16' East to 94° 10' East Longitude and between 25° 50' north to 26° 47' North Latitude. The climate is tropical with a hot and humid weather prevailing most of the summer and monsoon months. Total average annual rainfall is 1300 mm. Maximum precipitation occurs in June and July. Maximum temperature is 38.0°C in June and minimum temperature is 10.0°C in December. The district is bounded by Brahmaputra River on the North, Jorhat, Nagaland on the East, Karbi Anglong and Nagaland state on the South and Nagaon, Karbi Anglong on the West Golaghat district. The economy of Golaghat district is chiefly dependent on agriculture. Crops grown in the district are Sugarcane, and Tea, Rice. Lakhimpur District is situated on the North East corner of Assam. The district lies between $26^0$48' and $27^0$53' northern latitude and $93^0$42' and $94^0$20' east longitude (approx.) In this district paddies are grown abundantly. Besides, the soil of the district is alluvial and fertile for which crops flourish without use of any artificial manure or hard labour. Besides, paddy mustard, wheat, vegetables are the main agricultural crop of this district. Muga sericulture is predominant in this district. The climate is subtropical, humid characterized by high rainfall. The average annual rainfall is around 2830mm as against 2300mm of the state. The annual average humidity varies from 74 to 89 percent with a mean of 81 percent. The maximum temperature goes up to 35^{o}C during June / July and minimum temperature falls to 8^{o}C in December and January. The sunshine hours on the hand ,is very low showing two peak period with an average of 6-7 hours /day during October/February and 4-4.5 hours /day during March /September.

Soil sample analysis of different districts

The range and mean of total nitrogen content, available nitrogen, available phosphorus, available potassium, organic carbon, pH and electrical conductivity (EC) of the soils collected from Jorhat, Golaghat and Lakhimpur districts are depicted in Table 1. The range of total nitrogen content in the soils of muga food plant grown areas collected from farmers' field was 0.02-0.21% in Jorhat; 0.05-0.19% in Golaghat district and 0.02-0.14% in Lakhimpur district. Mean nitrogen content was recorded highest from soils of Lakhimpur district (0.065%) and the lowest was from Jorhat district (0.014%). Range of available nitrogen was recorded highest in case of Jorhat district soils (178.75-611.52 kg/ha) with a mean value of 314.47 Kg/Ha which was significantly higher over other districts. The highest level of available phosphorus content was recorded from soils of Lakhimpur district (130.33%), while mean was significantly higher in Golaghat soils (94.03%). On the other hand, available potassium content was significantly the lowest in Lakhimpur soils (225.20%). Organic carbon of different soil samples ranged from 0.024% of Jorhat to 2.56% of Lakhimpur soils. Mean organic carbon content was recorded highest in the soils of Lakhimpur district (1.422%) and minimum in Golaghat soils (0.896%). The pH value of soils of the selected locations varied from 4.06 in Golaghat soils to 6.08 in Jorhat soils. Soils of Golaghat and Lakhimpur were more acidic compared to Jorhat soils. Electrical conductivity was found significantly higher in the soils of Jorhat and Lakhimpur soils compared to those of Golaghat soils.

Record of cocoon production

The cocoon production during two commercial crop of muga silkworm rearing, viz. spring (April-May) and autumn (October-November) were collected from the 60 farmers of 3 districts. Muga silkmoth lays eggs in a traditional egg laying device made up of thatch grass, termed as *Kharika*. A moth generally lays egg within the range of 140-180 nos. during commercial rearing season. The cocoon production in terms of number was recorded and high range of variation was observed in the egg laying and cocoon production ratio (Fig.1).

Biochemical analysis of leaf samples

The range of total nitrogen content in the leaves of *P. bombycina* collected from farmers' field was 0.30-0.53 in Jorhat and Lakhimpur districts and 0.30-0.92% in Golaghat district. Significantly highest total nitrogen content was recorded from Golaghat district (0.485%), followed by that of Lakhimpur (0.426%) and the lowest was from Jorhat district (0.390%) (Table 2). The same trend was recorded for crude protein also. Lipid content of the leaves ranged from 1.18-9.50% in Jorhat, 1.650-9.30% in Golaghat and 1.83-9.80% in Lakhimpur district. Mean lipid content was recorded the highest in Golaghat district (5.691%), but no significant variation was observed among the districts with regards to lipid content. The range of fibre constituent was 37.0-68.4%, 33.4-69.21% and 33.90-68.40% in Jorhat, Golaghat and Lakhimpur districts, respectively. In the present investigation, total sugar of leaves varied from 0.89% in Jorhat district, 0.89-4.39% in Golaghat district and 2.45-4.88% in Lakhimpur district. Mean sugar was highest in Lakhimpur district (3.26%), followed by that of Golaghat (3.22%) and lowest in Jorhat district (3.099%) although they were not significantly different. Mean carbohydrate content also showed the same trend highest being in Lakhimpur district (32.746%).

Correlation coefficient analysis

In Jorhat district correlation coefficient analysis showed positive correlation between total nitrogen (R^2 =0.139), available nitrogen (R^2 =0.710) available phosphorus (R^2 =0.238) and

Table.1 Range and mean of NPK content and other characteristics of soils collected from selected farmers of different Districts

Parameters	Range / Mean	District					
		Jorhat	Golaghat	Lakhimpur	Overall mean	S. Ed. (±)	$CD_{0.05}$
Total Nitrogen (%)	Range	0.02-0.21	0.05-0.19	0.02-0.14			
	Mean	0.014	0.015	0.065	0.031	0.002	0.004
Available Nitrogen (Kg/ha)	Range	178.75-611.52	137.72-570.75	150.52-570.75			
	Mean	314.47	289.09	284.98	296.18	2.58	5.17
Available Phosphorus (Kg/ha)	Range	61.48-90.57	64.75-127.66	61.07-130.33			
	Mean	69.74	94.03	84.62	82.80	3.63	7.28
Available Potassium (kg/ha)	Range	180-380	220-320	180-340			
	Mean	267.00	265.50	225.20	252.57	5.13	10.28
Organic Carbon (%)	Range	0.024-1.57	0.39-1.67	0.59-2.56			
	Mean	1.023	0.896	1.422	1.11	0.05	0.13
pH	Range	4.58-6.08	4.06-5.31	4.18-5.42			
	Mean	5.47	4.54	4.86	4.96	0.32	0.65
Electrical Conductivity ($S.m^1$)	Range	10.0-84.0	15.0-58.0	16.0-97.0			
	Mean	46.80	36.19	46.55	43.18	1.89	3.81

Table.2 Contents of biochemical constituents of leaf samples collected from selected farmers of different Districts

Parameter Parameters	Range / Mean	District					
		Jorhat	Golaghat	Lakhimpur	Overall mean	S. Ed.(±)	$CD_{0.05}$
Total Nitrogen (%)	Range	0.30-0.53	0.30-0.92	0.30-0.53			
	Mean	0.390ab	0.485a	0.426a	0.433	0.03	0.06
Crude protein (%)	Range	1.875-3.313	1.875-5.750	1.875-3.313			
	Mean	2.438b	3.028a	2.659b	2.708	0.195	0.390
Lipid (%)	Range	1.18-9.50	1.650-9.300	1.83-9.80			
	Mean	5.636	5.691	5.628	5.651	NS	NS
Crude fibre (%)	Range	37.0-68.4	33.40-69.21	33.90-68.40			
	Mean	52.055	51.425	52.440	51.973	NS	NS
Sugar (%)	Range	0.89-4.88	0.89-4.39	2.45-4.88			
	Mean	3.099	3.220	3.260	3.139	NS	NS
Carbohydrate (%)	Range	11.64-43.91	11.15-44.30	24.50-43.52			
	Mean	30.317	31.473	32.746	31.452	NS	NS

Figure.1 Variation in range of cocoon production rate at 60 farmers' level in 3 Districts of Assam.

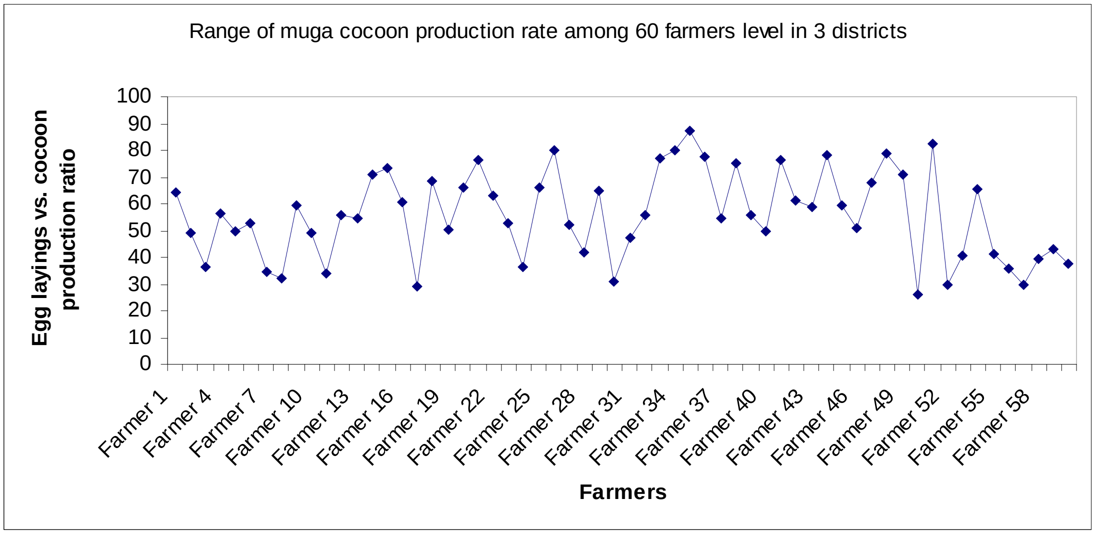
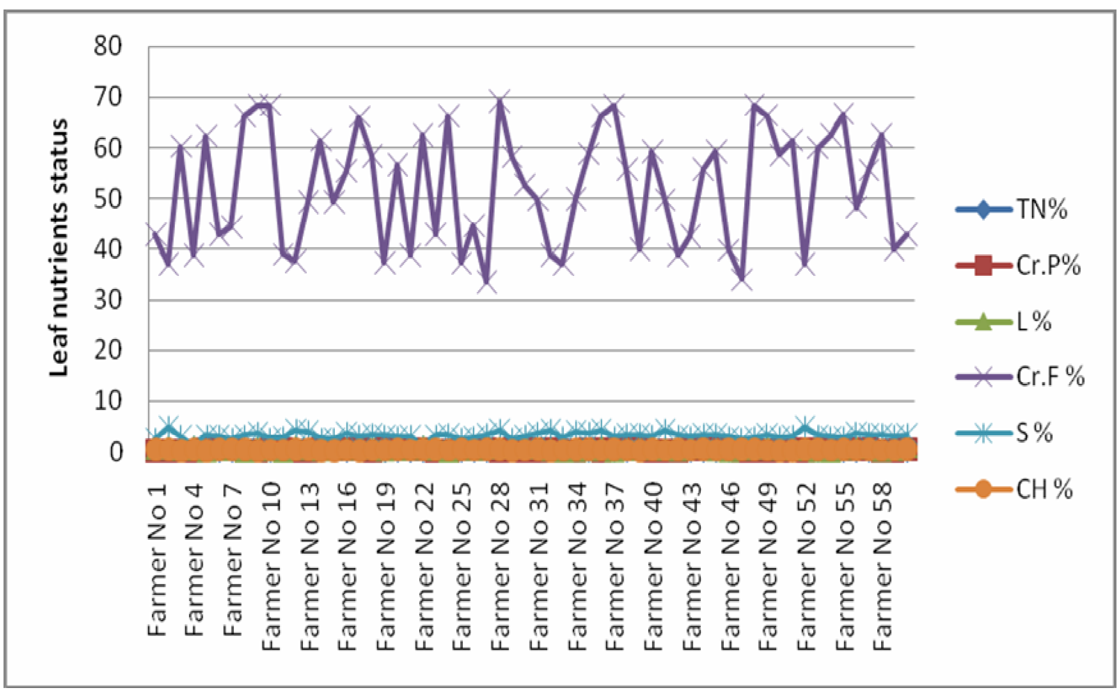


Figure.2 Variation in soil nutrients status among 60 farmers of 3 districts of Assam [TN=Total Nitrogen; Av.N=Available Nitrogen; Av. P =Available Phosphorus; Av.K =Available potash; OC=Organic Carbon; EC= Electricalconductivity.]



pH (R^2 =0.072) with cocoon production though all were in insignificant level. Non-significant negative correlation was observed between available potash (R^2 = -0.211), organic carbon (R^2 = - 0.122) and electrical conductivity (EC) (R^2 = - 0.021) with cocoon production (Table 3). In Golaghat district correlation coefficient analysis showed insignificant positive correlation between available nitrogen (R^2 =0.776), available phosphorus (R^2 =0.292), organic carbon (R^2 =0.122) and pH (R^2 =0.098) with cocoon production. Non-significant negative correlation was observed between total nitrogen (R^2 =--0.294), available potash (R^2 = - 0.162) and electrical conductivity (EC) (R^2 = - 0.266) with cocoon production (Table 3, Fig. 1). In Lakhimpur district correlation coefficient analysis showed insignificant positive correlation between total nitrogen (R^2 = 0.232) and available nitrogen (R^2 = 0.110) has non significant positive correlation with cocoon production. While available phosphorus (R^2 =-0.075), available potash (R^2 = - 0.020), organic carbon (R^2 = - 0.159), pH (R^2 = - 0.093) and electrical conductivity (EC) (R^2 = - 0.070) negatively correlated with cocoon production (Table 3). Pooled data of all the three districts also showed similar trend like Lakhimpur district (Table 3). Correlation coefficient of leaf nutrients with cocoon production in all three districts was also studied and depicted in Table 4 and Fig 2. In Jorhat district, crude protein content of leaf showed significant positive correlation (R^2= 0.543) with cocoon production. Like wise Sugar had significant positive correlation (R^2= 0.983) with cocoon production. Other parameters showed negative correlation with cocoon production. In Golaghat district except crude protein all leaf nutrients were negatively correlated with cocoon production. In Lakhimpur district lipid (R^2= 0.322), crude fibre (R^2=0.307), sugars (R^2= 0.070) were positively correlated with cocoon production, but non significantly. Other nutrients showed negative correlation with cocoon production. Pooled data analysis of 3 districts showed positive correlation of sugar with cocoon production in 1% level of significant. Crude protein, lipid and crude fibre showed insignificant positive correlation with cocoon production. Total nitrogen and carbohydrates negatively correlated with cocoon production (Table 4). Graphical representation depicted clearly correlation of each leaf parameter with cocoon production (Fig. 1). While soil nutrients data were correlated with leaf nutrients data positive correlation coefficient was observed between available nitrogen of soil (R^2=0.305) with total nitrogen of leaf. Similarly electrical conductivity (EC) of soil also positively correlated (R^2=0.320*) with leaf carbohydrate. Insignificant correlation among other soil characters and leaf nutrients was observed (Table 5). The role of proteins and amino acids in silkworm nutrition has been emphasized by Fukuda et al. (1959) and Takeuchi (1960). Nitrogen is the most distinguishing chemical element present in proteins which in turn are the most ubiquitous organic nitrogenous compound in food stuff and in all living cells. In fact they appear to be involved in practically all the structure and functions of all cells (Mallette *et al.*, 1960). The green leaves of plants are good sources of protein and may supply most of the essential amino acids. Nitrogen as protein and non-protein nitrogenous matter present in the food plant leaves are responsible for healthy

Table.3 Correlations between soil nutrients with cocoon production

Parameter Parameters	Correlation co efficient (R^2)			Correlation co efficient (R^2) of pooled data of three districts
	Jorhat District	Golaghat district	Lakhimpur district	
Total Nitrogen vs cocoon production	0.139	-0.294	0.232	0.008
Available Nitrogen vs cocoon production	0.710	0.776	0.110	0.124
Available phosphorus vs cocoon production	0.238	0.292	-0.075	-0.032
Available potash vs cocoon production	-0.211	-0.162	-0.020	-0.079
Organic carbon vs cocoon production	-0.122	0.465	-0.159	-0.020
pH vs cocoon production	0.072	0.098	-0.093	-0.016
EC vs cocoon production	-0.021	-0.266	-0.070	-0.049

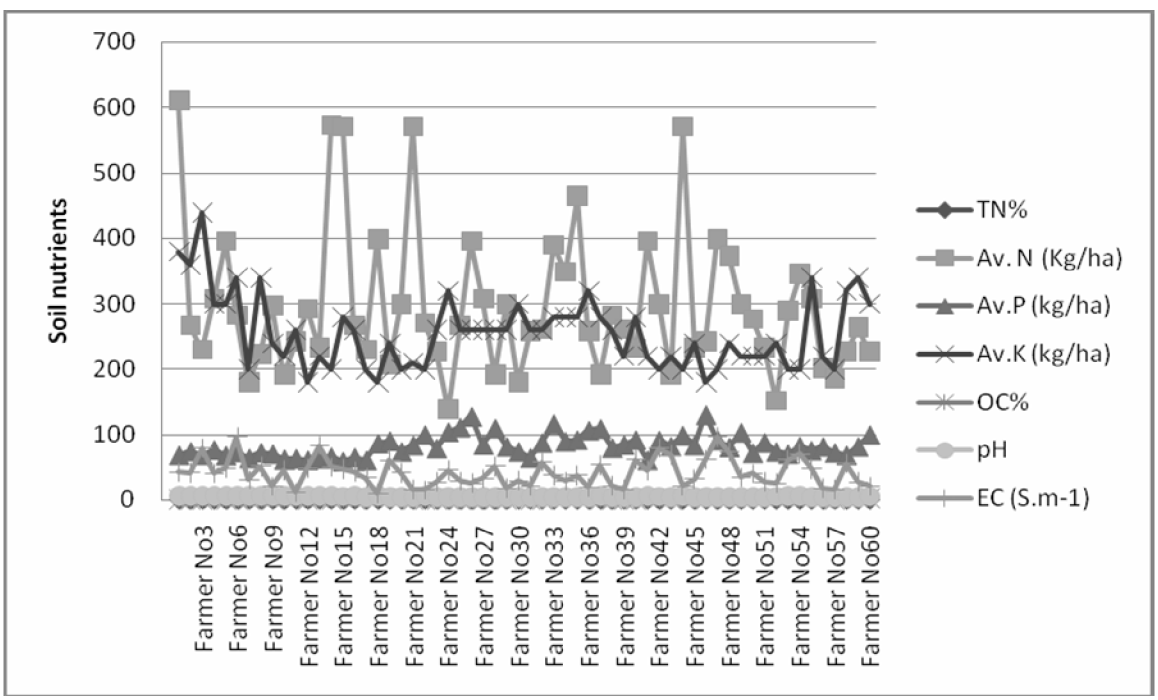
Table.4 Correlations between leaf nutrients with cocoon production of different district

Parameter Parameters	Correlation coefficient(R^2)			Correlation co efficient (R^2) of pooled data of three districts
	Jorhat District	Golaghat district	Lakhimpur district	
Total Nitrogen vs cocoon production	-0.049	-0.158	-0.049	-0.041
Crude Protein vs cocoon production	0.543 *	0.231	-0.412	0.013
Lipid vs cocoon production	-0.103	-0.203	0.322	0.105
Crude fibre vs cocoon production	-0.309	-0.189	0.307	0.034
Sugar vs cocoon production	0.983**	-0.009	0.070	0.548**
Carbohydrate vs cocoon production	-0.070	-0.044	-0.129	-0.068

Table.5 Correlations between soil characters with leaf nutrients

Soil characteristics	Correlation co efficient(R^2)					
	Leaf nutrients					
	Total Nitrogen	Crude protein	Lipid	Crude fibre	Sugar	Carbohydrate
Total Nitrogen	-0.244	-0.048	-0.092	0.121	0.032	-0.300
Available Nitrogen	0.305*	-0.017	0.113	-0.087	-0.137	-0.086
Available phosphorus	-0.057	0.033	0.045	0.004	-0.018	0.048
Available potash	0.070	-0.081	-0.041	0.113	-0.043	-0.088
Organic carbon	0.002	0.055	-0.172	0.061	0.056	0.042
pH	-0.012	-0.115	0.170	-0.154	-0.096	0.226
EC	-0.020	-0.014	-0.200	0.034	0.054	0.320*

Figure.3 Variation in leaf nutrients status among 60 farmers of 3 districts
[TN=Total Nitrogen; Cr.P=Crude Protein; L =Lipid;
Cr.F =Crude Fibre; S=Sugar; CH= Carbohydrate].



growth of silkworm as silk substances consists of protein. Nitrogen in the presence of adequate phosphorus and potassium stimulates canopy growth, leaves and branches. This is through production of extra leaves and branches, extension of leaf area duration and expansion of leaf area. Nitrogen needs to be present from emergence to flowering to promote rapid canopy growth White *et al.,* (2007) and Muthoni and Kabira (2011).

The role of proteins and amino acids in silkworm nutrition has been emphasized by Fukuda et al. (1959) and Takeuchi (1960). Nitrogen is the most distinguishing chemical element present in proteins which in turn are the most ubiquitous organic nitrogenous compound in food stuff and in all living cells. In fact they appear to be involved in practically all the structure and functions of all cells (Mallette *et al.,* 1960). The green leaves of plants are good sources of protein and may supply most of the essential amino acids. Nitrogen as protein and non-protein nitrogenous matter present in the food plant leaves are responsible for healthy growth of silkworm as silk substances consists of protein. Nitrogen in the presence of adequate phosphorus and potassium stimulates canopy growth, leaves and branches. This is through production of extra leaves and branches, extension of leaf area duration and expansion of leaf area. Nitrogen needs to be present from emergence to flowering to promote rapid canopy growth White *et al.,* (2007) and Muthoni and Kabira (2011). Crude fibre is the ash free material and reduction in the fibre content had been established as an advantage for better silkworm crop yield. It comprises largely of cellulose and lignin and these substances belong to carbohydrate, but cannot be digested by silkworm larvae. Fibre is not grouped under nutrients, but its intake along with all diet is essential because of regulatory function and help to maintain the normal peristaltic movement of the intestine to remove waste product from the intestine. Reduction in total mineral and fibre content had been established as an advantage for better silkworm crop yield (Vasuki and Basavanna, 1969). Carbohydrates, particularly reducing sugars are very important for growth and development of silkworms. Carbohydrates are utilized by the silkworms for energy source and for synthesis of both lipid and amino acids. These are very important for healthy growth of silkworm; especially they are effective for keeping healthy growth of infant larvae. Some sugars possess a gustatory stimulation effect on larval feeding on larval feeding of the silkworm (Ito, 1960). In case of eri silkworm (*Samia ricini*, Donovan) feeding with castor (*Ricinus communis* L) leaves a nonlinear regression equation was estimated with larval and cocoon weight and ERR as dependent variable and leaf biochemical parameters as independent variables (Sarmah *et al.,* 2011). The carbohydrates are generally the most effective in increasing fat body glycogen. The degree of increase of fat body glycogen and haemolymph trehalose is also dependent on the content of carbohydrate in diet (Horie, 1978).

Thus, from the present study, it can be inferred that, there existed a wide variation of nutrient status of soil (Fig 2) under the *P. bombycina* plantation in the three districts of the state which influence the nutrient content in its leaf (Fig 3), which in turn affect overall cocoon crop productivity. Proper fertilization and soil amendment practices based on soil nutrient status for enhancing leaf quality which has a direct bearing on cocoon production and productivity will be an essential step for increasing muga silkworm cocoon production in the state.

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