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ORIGINAL ARTICLE

Status of available Macronutrient and Physical properties of tasar silkworm host plants growing soils of Mayurbhanj district in Odisha

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ABSTRACT
In the present study, attempts have been made to evaluate the soil fertility status from different tasar sericulture practicing regions of Mayurbhanj district, Odisha. Totally, 236 surface soil samples were collected and analysed for various soil fertility parameters like pH, EC, organic matter, available nitrogen, phosphorus, potassium and sulphur. The pH (3.63 to 7.10) and EC (0.01 to 0.66 dSm^{-1}) values indicated that soils were found to be very strongly acidic and non-saline in nature. Organic carbon was evenly distributed to low, medium and high category. The 99 per cent of analysed soil samples were found to be deficient in nitrogen content. Similarly, phosphorus and potassium were low in 51 and 46% of the soil samples, respectively. Deficiency of sulphur was noticed by three-fourth of the tasar regions soils in the Mayurbhanj district. Hence, to overcome the adverse effect of nutrients, complimentary use of biofertilizers, organic manures along with inorganic and balanced fertilization should be incorporated in the nutrient management programme in tasar sericulture for sustained production of quality leaf yield of host plants as well as higher tasar silk cocoon yield.
***Keywords**: Host plants, Mayurbhanj, Nutrients, Organic carbon, Tasar silkworm*

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INTRODUCTION

The tropical tasar is an important vanya silk variety produced by a wild silkworm, *Antheraea mylitta* Drury (Saturniidae: Lepidoptera). Since polyphagous in nature, it host to numerous plants primarily on *Terminalia tomentosa* (Asan), *Terminalia arjuna* (Arjun) and *Shorea robusta* (Sal) [1,2]. Tasar silkworm rearing is part of traditional culture of the tribal communities especially in the districts of Mayurbhanj and Kendujhar in the Odisha. Tasar rearing has always been an important traditional occupation of indigenous communities in north-west Odisha, particularly Kendujhar, Mayurbhanj and Sundargarh districts which contributes 90% of the state's tasar production. A total of 47,284 families are engaged in tasar sericulture as a livelihood in the state which has an annual tasar raw silk production of 107 MT in 2015-16 [3]. The agro climatic conditions and natural resources in the state are suitable for Tasar Silkworm rearing.

The necessity of nutrition quantity and quality are very precise in sericigenous insects for optimal physiological status and sustainable productivity [4]. The availability of essential nutrients in food plant is indispensable for successful life cycle, cocoon quality, metamorphosis to moth stage and their reproductive activity [5,6]. The growth and development of tasar silkworm larvae and economic characters of cocoons are directly proportional to the nutritional contents of leaves [7].

It is well known that the optimum plant growth and leaf yield of host plants depend not only on the total amount of nutrients present in the soil at a particular time but also on their availability which in turn is

controlled by physico-chemical properties like: soil texture, pH, electrical conductivity, soil organic carbon, cation exchange capacity and calcium carbonate [8]. The macronutrients such as nitrogen (N), phosphorus (P) and potassium (K) are taken up by crops in huge quantities from soil therefore, it is necessary to replenish them to sustain the nutrient balance. At the same time, negligence of nutrients application results in gradual depletion in nutrient building capacity of soil both macro and micronutrients apart from decline in soil organic matter content leading to nutrient imbalances and soil fertility degradation [9]. It is therefore, essential that nutrition of the soil should frequently be monitored to sustain and ensure good health of host plant. In order to increase the tasar production, it is vital to assess the soil resource status of these tasar growing regions. Therefore, a detailed survey was conducted at various sites of tasar sericulture regions in Mayurbhanj district, Odisha for assessing essential plant nutrients status of soil.

MATERIAL AND MATERIALS

Study site

A survey was carried out in the different villages of Mayurbhanj district (Fig. 1), which is situated at 21°94'N latitude and 86°72'E longitude with an average elevation of 36 m MSL. Summers are hot and dry with average temperatures ranging from lows of 21.0°C to highs 31.5 °C. Most of the rainfall occurs during the south-west monsoons as average rainfall is 1800mm.

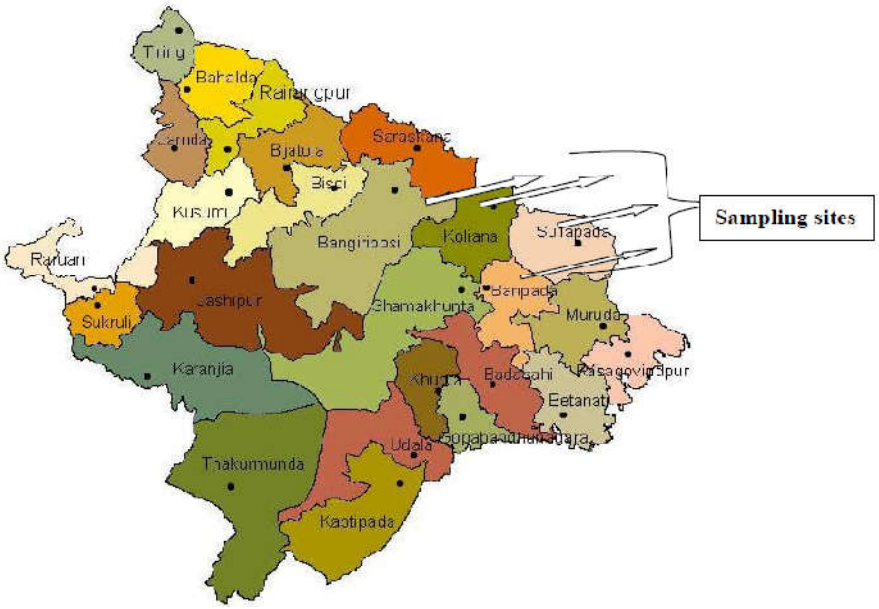

Fig. 1 Geographical location of soil sampling sites of Tasar sericulture practicing in Mayurbhanj district

Soil sampling and analysis

A total of 236 soil samples were collected at depth intervals of 0-30 cm from the eighteen villages of Mayurbhanj district, Odisha where tasar sericulture is dominating. The soil samples were air dried, milled and passed through 2 mm sieves in order to run the analysis. The analysis of soil samples has been done by using standard methods. Soil Reaction (pH) and Electrical Conductivity (EC) was determined by using 1:2.5 soils: water suspension with the calibrated pH and conductivity meter by following the method given by Jackson [10].

Organic Carbon was determined by following modified Walkley and Black [11] method. Available nitrogen was determined by alkaline permanganate method as described by Subbiah and Asija [12]. Available Phosphorous was determined by spectrophotometer by following Bray and Kurtz [13] method. Available Potassium was determined by Flame Photometer with 1N neutral ammonium acetate as an extractant by following Hanway and Heidel [14] method. Available Sulphur was determined by following Turbidimetric Chesin and Yien [15] method.

For evaluation of the soil fertility of the study area, the spatial distribution for each parameter attribute was assessed using descriptive statistics [16]. The coefficient of variation was ranked according to the procedure of Aweto [17] where, CV < 25% = low variation, CV >25 ≤ 50% = moderate variation, CV >50% = high variation.

RESULT AND DISCUSSION

Physical Properties of Soil

The availability of plant nutrients and consequently the fertility of the soil are affected by pH. The solubility of nearly all nutrients differs in response to pH. As acidity increases, the loss of these nutrients by leaching increases and their availability to plants decreases. The quantity of some nutrients may rise so greatly under acidic and alkaline conditions that they become toxic to plants [18]. Therefore, it is very crucial to adjust soil pH between 6.5 and 7.5 where most of the nutrients are available to plants for maintaining soil fertility [19]. In the present study, pH ranges from 3.63 to 7.10 with a mean of 5.30 reflecting acidic nature of soils (Table 1). In soils of Chadhepahadi and Dhobanisole show high pH values than soils of other villages whereas, Kuabuda region showed lower in soil pH. It is interesting to observe a narrow range (10.62%) of variation in pH among the soil samples. This can be attributed to high buffering capacity of the soils and presence of carbonate in the saturation extract [20]. According to classification of soil reaction suggested by Brady [21], 31.4 per cent soil samples were strongly acidic (pH 5.1 to 5.5) and 25.0 per cent samples very strongly acidic (pH 4.6-5.0) (Fig.2). Acidity of the sampled area might be due to the high rainfall leading to the leaching losses of bases [22].

The distribution of EC in the study area indicates that an average value of EC was 0.085 dS m^{-1} and varied from 0.01 to 0.66 dS m^{-1} having highest coefficient of variance is 86.80% shown in Table 1. Where EC has less than 1 dS m^{-1} meant that the soils are free from salinity, which account for 100% of entire study area. The considerably maximum value (0.207 dS m^{-1}) obtained in the Chadhepahadi (0.193 dS m^{-1}) and Dhobanisole villages (0.157 dS m^{-1}) and minimum in Bhorsole and Rathasole places.

The soil organic matter (SOM) is a very important store of plant nutrients. It facilitate to maintain soil fertility by improving soil structure, increasing water holding capacity, retention of mineral nutrients, aeration and root penetration and drainage. Therefore, the SOM is a significant contributes to soil fertility. The soils organic carbon (SOC) in different tasar growing places of Mayurbhanj district ranged from 0.03 to 2.10% with an average of 0.69% having high coefficient of variance (55.74%). Chadhepahadi (1.13%) and Dhobanisole villages (1.07%) were recorded higher SOC content while lower SOC content in Asansil village (Table 1). All the soils of the study regions were almost equally distributed in low (34%), medium (33%) and high (33%) category (Fig.3). Continuous cultivation leading to high plant removal might be accountable for the medium to low SOC content indicative of samples from these villages. The decreases in SOM at majority locations might be associated with factors like high temperature (more organic matter decomposition) and erosion of soil due to high rainfall. Choudhary and Yadav [23] also reported that high temperature and rainfall may like to cause low organic matter of top soil.

Table 1 Physical properties of tasar host plants growing soils of Mayurbhanj districts in Odisha

Village	No. of Samples	pH	EC	OC
Rangamatia	11	5.09	0.052	0.54
Asansil	05	5.24	0.049	0.26
Partuka	10	5.02	0.053	0.40
Bhorsole	05	4.99	0.040	0.82
Kuabuda	17	4.33	0.061	0.54
Sangma Nagha	04	5.15	0.057	0.61
Keutunimari	01	4.86	0.069	0.69
Jhini	05	4.93	0.054	0.56
Chandua	16	5.18	0.043	0.64
Kakharusole	18	4.98	0.067	0.48
Gadargadi	26	4.93	0.053	0.38
Badatilou	23	5.46	0.046	0.56
Rathasole	04	5.83	0.041	0.90
Koilisuta	13	5.53	0.054	0.73
Pariakuli	06	5.31	0.058	0.83
Balikhanina	13	5.77	0.117	0.59
Dhobanisole	43	5.90	0.157	1.07
Chadhepahadi	16	6.21	0.193	1.13
Mean		*5.35*	*0.085*	*0.69*
Minimum		*3.63*	*0.010*	*0.03*
Maximum		*7.10*	*0.660*	*2.10*
SD		*0.57*	*0.07*	*0.38*
CV		*10.62*	*86.80*	*55.74*

Chemical Properties of Soil

Widespread deficiency of nitrogen (N) is common in Indian soils. Thus, application of nitrogen is essential for plant growth and high yield. Nevertheless, N is an essential plant nutrient and it should be available in the soil in suitable proportion for proper growth of plants. Considering such a unique magnitude of N for the growth of plants, an effort has been made to study available N from the soils in the tasar sericulture regions in Mayurbhanj district. The available N in the tasar sericulture regions of Mayurbhanj district ranges from 40.2 to 531.0 kg ha^{-1} with an average value of 147.1 kg ha^{-1} (Table 2). The coefficient of variance of sampling sites showed medium as 33.32%. The significantly higher mean value of available N found in Dhobanisole (181.4 kg ha^{-1}) and Keutunimari (180.8 kg ha^{-1}) villages. Rangamatia and Partuka villages showed lower available N as 78.7 and 78.6 kg ha^{-1}, respectively. It proves the soils from the area have low N status. This evidence is further confirmed by comparing the estimated values of N with critical limits for delineation of soil fertility [24]. It is interesting to note that 99% of the sampled soils have low to very low available N (Fig.3). During the monsoon period in 2017, heavy rainfall occurred in the Mayurbhanj district might be caused leaching of N into the downstream of soil. Consequently, low N condition was observed from the sampled areas. Similar results were also reported by Rajeshwar *et al*., [25].

The importance of phosphorus (P) in plant nutrient is many folds. In the present study, mean available P ranges from 2.1 to 22.4 kg ha^{-1} with a mean value of 10.3 kg ha^{-1}(Table 2). The low to medium status of available P was found nearly in all the soils in the tasar growing areas of Mayurbhanj district. Among the study places, villages such Chandua (12.7 kg ha^{-1}) and Balikhanina (12.6 kg ha^{-1}) were recorded higher available P. This is possibly attributable to strongly acid condition of the soil (pH < 6.5) besides high content of Al and Fe. In strongly acid soils, the concentration of Fe and Al ions greatly exceeds, forming insoluble compounds with $H_2PO_4^-$ rendering it unavailable [26]. Comparing the P values with the critical limits of P (Table 3) also supports this inference by Pathak [27]. Nearly all the soil samples have been shown low (51%) to medium (49%) category of P in the area (Fig.3). Pandiaraj *et al*., [28] also reported P-availability decreased with increasing acidity of the soil.

Table 2 Chemical properties of tasar host plants growing soils of Mayurbhanj districts in Odisha

Village	No. of Samples	N	P	K	S
Rangamatia	11	78.7	5.1	109.4	4.70
Asansil	05	97.7	4.6	126.6	6.01
Partuka	10	78.6	4.8	121.7	5.40
Bhorsole	05	82.6	7.9	135.3	1.58
Kuabuda	17	136.8	12.0	138.3	2.66
Sangma Nagha	04	168.5	12.0	242.5	5.61
Keutunimari	01	180.8	12.2	285.6	6.15
Jhini	05	140.3	12.3	205.0	8.20
Chandua	16	165.6	12.7	126.4	8.52
Kakharusole	18	131.1	11.0	99.4	7.81
Gadargadi	26	164.3	10.0	111.3	8.38
Badatilou	23	165.9	11.2	103.4	8.37
Rathasole	04	124.9	9.3	156.2	8.38
Koilisuta	13	134.8	11.7	133.6	9.98
Pariakuli	06	129.7	11.0	106.0	9.83
Balikhanina	13	159.1	12.6	240.3	7.72
Dhobanisole	43	181.4	10.0	104.6	10.41
Chadhepahadi	16	142.9	10.8	350.6	13.47
Mean		*147.1*	*10.3*	*142.7*	*8.18*
Minimum		*40.2*	*2.1*	*53.8*	*0.68*
Maximum		*531.0*	*22.4*	*537.6*	*48.63*
SD		*49.02*	*3.71*	*85.88*	*5.50*
CV		*33.32*	*35.96*	*60.19*	*67.23*

Similar to P, available potassium (K) also noted low to medium nearly in all the soils. The sampled sites reveal a range from 53.8 to 537.6 kg ha^{-1} with mean value of 142.7 kg ha^{-1} and high (60.19%) variability among the tasar host plants growing sites of Mayurbhanj district (Table 2). The available K content is significantly high in Chadhepahadi (350.6 kg ha^{-1}) and Keutunimari (285.6 kg ha^{-1}) villages. Status of K distributed as illustrated in Fig. 3 showed that about 46 percent of area show low and 45 percent show

medium content of potassium and just about 8 percent of samples with high potassium content. Low to medium level of available K in the soils of the study areas may be attributed to the leaching of large portion of K^+ ion due to high rainfall occurred during sampling period. Besides, fine texture soils as predominant in the tasar growing regions of Mayurbhanj district may hold more exchangeable potassium. The available sulphur (S) status varied from 0.68 to 48.63 ppm with a mean value of 8.18 ppm (Table 2). Chadhepahadi and Dhobanisole villages had recorded higher available S content with 13.47 and 10.41 ppm, respectively. Bhorsole site showed lower S content. Further, distribution of available S content was highly varied (67.23%) among the tasar growing sites of Mayurbhanj district. Plant roots absorb S in the form of SO_4^{2-} from the soil solution. Based on the critical limits given by Hariram and Dwivedi [29], about three-fourth of total soils was found under deficient (76%) and 22% samples were found under medium category (Fig. 3). Most of the S is firmly bound with organic matter present in the forest soil rendering organic S. Besides, adsorbed sulphate is an important fraction in sampled site of acid soils containing large amounts of hydrous oxides of iron and aluminium. These results were also supported by Kumar *et al.,* [30].

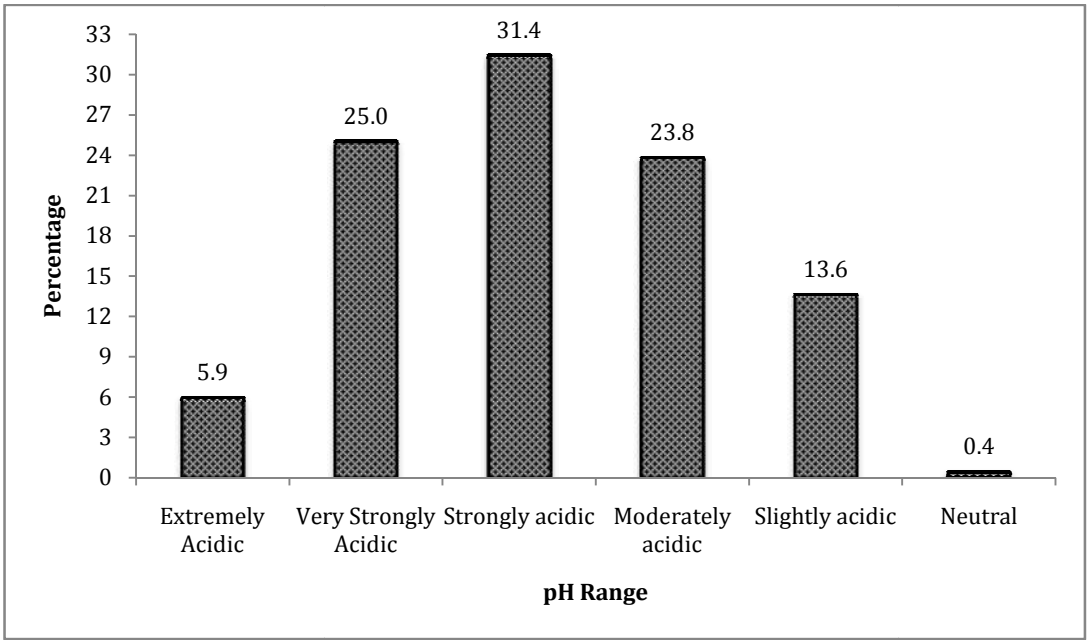

Fig.2 Percentage of soil pH in different category under sampling area

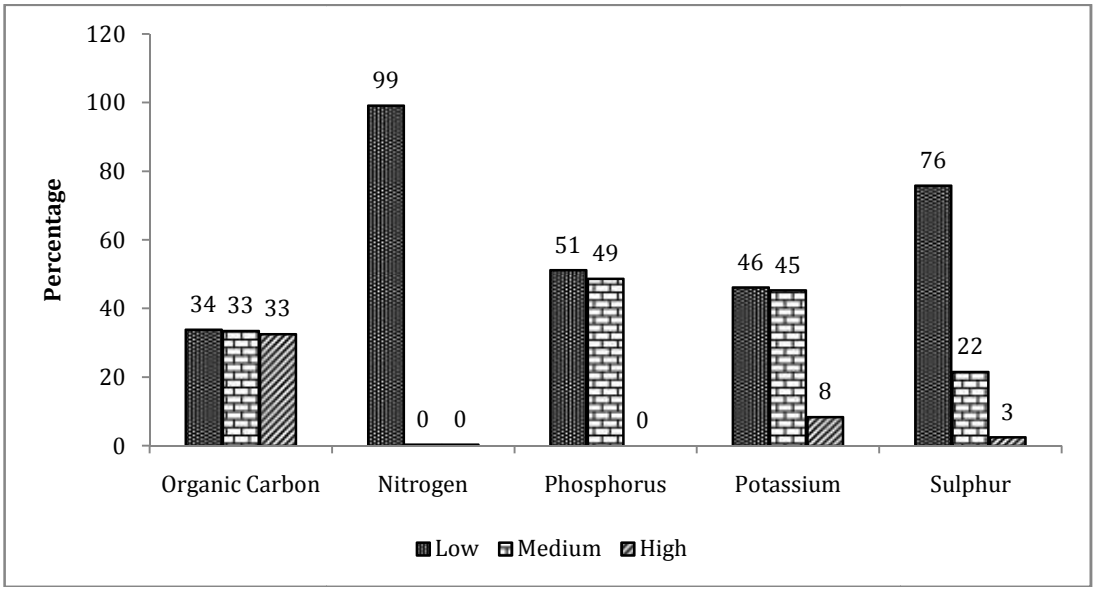

Fig. 3 Percentage of SOC and Macronutrients in different category under sampling area

CONCLUSION

The results of the study indicate tasar growing soils of Mayurbhanj region are very strongly acidic to slightly acidic in reaction. The organic carbon content of the soils should be improved since most of the soils are mow to medium category. The available N, P, K and S contents of majority of soils fall under low category. The continuous rearing practice of tasar sericulture with no fertilization of soils can further deplete the soil fertility which is just adequate to provide the need for another few years. The condition therefore, demands the adoption of appropriate management practices such as site specific nutrient management, increased use of organic nutrient sources and intercropping with leguminous crops appropriate agronomic practices in order to enhance the fertility status.

CONFLICT OF INTEREST

The authors have declared that no competing interest exists.

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