Research Journal of Chemical and Environmental Sciences
Res J. Chem. Environ. Sci. Vol 5 [1] February 2017: 63-67
Online ISSN 2321-1040
CODEN: RJCEA2 [USA]

Website: www.aelsindia.com/rjces.htm

RJCES

ORIGINAL ARTICLE

Evaluation of soil fertility status of tasar silk growing fields of Bihar and Jharkhand states for balanced nutrition to tasar host plant, *Terminalia arjuna*

Ajit Kumar Sinha, Prem Prakash Srivastava, T. Pandiaraj* and Susmita Das
Soil Science and Chemistry Section, Central Tasar Research & Training Institute, Piska Nagri, Ranchi-835303, Jharkhand State
*Corresponding address: pandianeagro@gmail.com; Mobile No. +91-9655732168

ABSTRACT
Soil fertility evaluation is an important aspect in context of sustainable tasar sericulture. The macro nutrients govern the fertility of the soils and control the yield goals. In the present study, attempts have been made to evaluate the soil fertility status from Salaiya and Tetariya villages from Bihar state and Dhaka and Digal Pahari villages from Jharkhand state. Seventy five surface soil samples were analyzed for various soil fertility parameters like pH, electrical conductivity, organic carbon, available nitrogen, phosphorus, potassium and sulphur. Most of the soil samples were acid to neutral in pH reaction and higher in organic carbon percentage. Soil samples were low in available nitrogen (97.3% samples) and phosphorus (76.0% samples). Potassium was found in medium (42% samples) and higher (42.67% samples) levels. However, 57.3 and 40.0% soil samples were low and medium in sulphur availability, respectively. Significant positive correlation was observed to exist between all the nutrient parameters of soils under study.
***Key words**: correlation, fertility, major nutrients, soil health, Terminalia arjuna*

Received 01.01.2017 Accepted 29.01.2017

INTRODUCTION

Soil fertility plays a key role in increasing crop production in the soil. It comprises not only in supply of nutrients but also their efficient management. The fertility status of soil indicates their nutrient supplying capability. Moreover fertility of soil is subject to man's control. However, soil degradation is an outcome of depletive human activities and their interaction with natural environments. The evaluation of soil fertility includes the measurement of available plant nutrients and estimation of capacity of soil to maintain a continuous supply of plant nutrients for a crop.

Tasar silk production as a livelihood component of tribal communities motivates to control deforestation and illegal cutting of trees and to regenerate forests. The main tasar growing states are Jharkhand, Chhattisgarh, Odisha, West Bengal, Telangana, Madhya Pradesh and Maharashtra. It is a backbone for tribal development because about 1.25 lakh tribal families are associated with tasar culture in the country [1].

Tasar silkworm (*Antheraea mylitta* D.) is a polyphagous insect feeding primarily on Asan (*T. tomentosa*), Arjun (*T. arjuna*), Sal (*S. robusta)* and secondarily on more than two dozens of food plants [2]. Leaf quality, production rate and gestation period of different forest host plants are influencing the commercial feasibility of *A. mylitta*. The silk quality and quantity of tasar silkworm depend upon nutritional value of their food plants [3]. The growth and development of tasar silkworm larvae and economic characters of cocoons are directly proportional to the nutritional contents of leaves [4]. Good quality of leaves indicates greater possibility of obtaining good cocoon crops. Sahay *et al.* [5] indicated that leaf quality is one of the important factors contributing to success of tasar crops. Further, the quality of tasar food plant leaves depend on the nutritional status of the soil. Subbaswamy *et al.* [6] stated quality of leaves depends on the balanced supply of essential nutrients from soil. Earlier, Sahay and Kapila [7] also stated that the productivity and quality of host plant foliage depend upon a judicious management of inputs such as water and nutrients.

Hence, evaluation of fertility status of the soils of an area or region is an important aspect in the context of sustainable management [8]. Soil testing describes the current fertility status of soil and provides information regarding nutrient availability in soil which forms the basis for the fertilizer

recommendations for maximizing nutritive and higher yield and to maintain the optimum fertility in soil year after year. Therefore, the present study was undertaken to know the macro nutrient status of farmer's under *Terminalia arjuna* plantation from different locations of Bihar and Jharkhand States and an attempt was also made to correlate macronutrients content of the soils with other soil properties.

MATERIALS AND METHODS

Soil samples were collected from tasar growing farmer's fields under *Terminalia arjuna* plantations. As such fields of Salaiya (Geo-position 23°46' N latitude and 80°42' E longitude) and Tetariya (24°77' N latitude and 86°28' E longitude) village of Katoriya block, Banka district of Bihar state and Dhaka (27°02' N latitude and 87°04' E longitude) and Digal Pahari (24°16' N latitude and 84°26' E longitude) village of Shikaripara block, Dumka district of Jharkhand state were selected for the study. The climate of Katoria and Dumka regions are semi-arid with an annual rainfall of 1200 and 1300mm, respectively.

A total of 75 surface soil samples (0 – 20 cm) were collected from the fields of four villages and composite soil samples were prepared. Soil samples were air dried, processed to pass through 2 mm sieve and analyzed for pH, EC, Organic carbon, available nitrogen [9], phosphorus [22], potassium (1N ammonium acetate extractable) and sulphur (turbidimetric method) were determined following the methods described by Page *et al.*, [10]. The Pearson correlation analysis of data was computed in relation to available nutrient contents with Physico-chemical properties of the soil under study.

RESULT AND DISCUSSION

Soil pH and EC

Data presented in Table 1 show that soil pH varied from 5.18 to 7.58 with an average of 7.4. The minimum value of pH 5.18 was observed in sampling sites of Salaiya village and maximum value of pH 7.58 was observed in Dhaka. According to classification of soil reaction suggested by Brady (1985), 73 per cent soil samples were neutral (pH 6.6 to 7.3), 12 per cent samples were slightly alkaline (pH 7.4 to 7.8) and 8 per cent samples were slightly acidic (pH 6.1 to 6.5) (Table 2). The neutral to acidic pH range in reaction brought out by intense rainfall, soil erosion and consequent leaching of bases in these areas. Application of lower quantity of chemical fertilizers by Tasar sericulture farmers may be attributed to the lower soil pH.

The electrical conductivity of the soils ranged from 0.01 to 0.13 dSm^{-1} with an average of 0.051 dSm^{-1}. On the basis of limits suggested by Muhr *et al*. [11] for judging salt problems of soils, all the samples were found in normal range with respect to electrical conductivity (EC <1.0 dSm^{-1}). The normal electrical conductivity may be due to leaching of soluble salts to lower horizons by high rainfall. The low EC of soils show that the existing environment was not conducive for buildup of salts [12].

Organic carbon

The organic carbon content ranged from 0.41 in Salaiya village to 1.97% in Tetariya village with an average of 0.93 per cent (Table 1). The organic carbon content was high (>0.75%) in 69.3% soil samples, medium (0.50 to 0.75%) in 24.0% soil samples and remaining 6.7% soil samples were low (<0.50%) (Table 2). Maximum amount of mean organic carbon (0.75%) was found in site Tetariya village (1.11%) and minimum in site DigalPahari (0.80%). Since tasar sericulture predominantly carried out in forest trees, direct light transmission on surface ground is minimum leads to high buildup of organic matter in those soils. High levels of organic matter not only provides part of the N requirement of crop plants, but also enhance nutrient and water retention capacity of soils and create favourable physical, chemical and biological environment [13]. Higher organic carbon contents are also possibly because of soils covered with tree litters and biomass causing low soil temperature consequently less oxidation of organic matter. A significant positive correlation relationship was observed between organic carbon and most of the nutrients particularly pH, available nitrogen and sulphur (Table 3). It is attributed to both nitrogen and sulphur which are major part of source of organic matter and the content is directly proportional with organic sources. Inherent low organic matter content and soil conditions favour nitrogen and sulphur leaching losses [14]. pH is primarily determined by organic carbon content of soils. Decomposition of organic matter produces organic acids such humic acid which imparts lower soil pH. Similar result was also described by Pathak, [15]

Available Nitrogen

Available nitrogen status varied from 92.9 to 327.6 kg ha^{-1} with an average value of 196.5 kg ha^{-1} (Table 1). On the basis of the rating suggested by Subbiah and Asija [9], 97.33% of the soil samples were found to be low (280 kg ha^{-1}) and remaining in the category of medium (280-560 kg ha^{-1}) (Table 2). Low nitrogen status in the soil could be due to less oxidation and mineralization rate of organic matter which could be due to less penetration of sunlight on the soil surface. Farmers are not applying any organic and nitrogen base fertilizer in field. A significant positive correlation (r=0.297) was found between organic carbon and

available nitrogen (Table 3). Since most of the soil nitrogen is found in organic form, therefore, this relationship was observed. Available nitrogen was negatively correlated (r=-0.511) with pH. Similar result was also reported by Verma *et al*. [16].

Available Phosphorus

The available phosphorus content varied from 1.9 to 43.3 kg ha^{-1} in Salaiya village with a mean value of 9.91 kg ha^{-1} (Table 1). On the basis of the limits suggested to Muhr *et al*., [11] most of the soil samples (76%) were low (<10 kg ha^{-1}) in available phosphorus status, 14.67 percentage samples were under medium (10-25 kg ha^{-1}) and rest (9.33%) were under high (25 kg ha^{-1}) category (Table 2). A significant positive correlation (r=0.259) was observed between organic carbon and available phosphorus (Table 3). This indicates that presence of organic matter increases the availability of phosphorus in soil. According to Tisdale *et al*., [17] about 50% of phosphorus is found in organic form and decomposition of organic matter produces humus which forms complex with Al and Fe and protects the phosphorus fixation. Available phosphorus and electrical conductivity was found to be positively correlated with each other because the retention of added phosphorus increased with electrical conductivity of soils up to certain limits.

Available potassium

Status of available potassium in the soils ranged between 95.2 (Salaiya) to 616 kg ha^{-1} (Digal Pahari) with an average of 300.6 kg ha^{-1} (Table 1). According to Muhr *et al*., [11], most of the soil samples (56%) were found under medium and 42.67% samples under high range (Table 2). A highly positive correlation (r=0.168) was observed between pH and available potassium content (Table 3). This might be due to release of K from clays under high pH conditions. Low and high soil pH cause leaching of K^+ salts from soils. Similarly, positive correlation was also found between available potassium and organic carbon. It might be due to creation of favourable soil environment with presence of organic matter. Similar relation was also reported by Chauhan [18].

Available Sulphur

The available sulphur status varied from 0.23 to 96.98 ppm (Dhaka) with a mean value of 8.38 ppm (Table 1). Plant roots absorb sulphur in the form of SO_4^{2-} from the soil solution. Keeping this fact in view, the soils under study may be classified as deficient (<10 ppm), medium (10-20 ppm) and sufficient (>20 ppm) category as per the categorization given by Hariram and Dwivedi [19]. According to this category, 57.3% samples were found under deficient and 40% samples were found under medium category (Table 2). Thus, the soils of all the sites are likely to respond sulphur fertilization. A significant and positive correlation (r=0.174) was observed between organic carbon and available sulphur content (Table 3). This relationship was existed because most of the sulphur is associated with organic matter [20]. These results were also supported by Kumar *et al*. [21]. On the contrary, negative correlation was observed between phosphorus and available sulphur. This might be due to competition occurs for fixation site against sulphur in the soils.

Table 1: Range and mean values of Physico-chemical properties and available nutrient status of soil under study area

Village	No. of samples	pH		EC (dS m^{-1})		OC (%)		N (kg ha^{-1})		P (kg ha^{-1})		K (kg ha^{-1})		S (ppm)	
		range	Mean	range	Mean	range	Mean	range	Mean	range	Mean	range	Mean	range	Mean
Salaiya	37	5.18-7.51	6.90	0.010-0.130	0.058	0.41-1.49	0.85	92.9-298.8	173.6	1.90-43.30	7.44	95.2-590.2	270.4	2.08-20.53	9.33
Dhaka	23	5.46-7.58	6.78	0.01-0.10	0.051	0.43-1.41	0.94	150.6-327.6	209.8	3.20-40.16	11.81	166.1-566.7	285.9	0.23-96.98	11.19

Digal Pahari	7	6.25-7.27	6.71	0.020-0.089	0.044	0.54-1.16	0.80	178.2-256.1	206.9	5.20-24.80	14.69	112.0-616.0	319.3	1.30-14.73	7.88
Tetariya	8	6.87-7.50	7.02	0.033-0.079	0.054	0.70-1.97	1.11	144.4-262.4	195.7	3.50-15.10	5.71	136.6-441.8	326.9	1.00-11.05	5.10
Range and Average mean		5.18-7.58	6.85	0.01-0.13	0.051	0.41-1.97	0.93	92.9-327.6	196.5	1.9-43.3	9.91	95.2-616	300.6	0.20-96.98	8.38

Table 2: Nutrient status of different soils on the basis of category

Parameters	Low		Sinha *et al* Medium		High	
	No. of samples	Percentage	No. of samples	Percentage	No. of samples	Percentage
OC (%)	5	6.67	18	24.00	52	69.33
Available N (Kg ha^{-1})	73	97.33	2	2.67	-	0.00
Available P (Kg ha^{-1})	57	76.00	11	14.67	7	9.33
Available K(Kg ha^{-1})	1	1.33	42	56.00	32	42.67
Available s (ppm)	43	57.33	30	40.00	2	2.67

Table: 3 Pearson correlation matrix for the selected soil fertility parameters in various places

Parameters	pH	EC	Organic carbon	Available Nitrogen	Available Phosphorus	Available Potassium	Available Sulphur
pH	1	-0.536**	0.049	-0.511**	-0.195	0.168	-0.078
EC		1	0.013	0.388**	0.022	-0.029	0.000
Organic Carbon			1	0.297**	0.259*	0.136	0.174**
Available Nitrogen				1	-0.149	0.035	-0.083
Available Phosphorus					1	0.089	-0.041
Available Potassium						1	0.078
Available Sulphur							1

**. Correlation is significant at the 0.01 level

*. Correlation is significant at the 0.05 level

CONCLUSION

The results of the present investigation indicate soils of all the four villages are acidic to neutral in reaction due to presence of high to medium organic matters. The available nitrogen and phosphorus in most of the soils falls under low category. However, medium to high content of potassium existed in the soils. The sulphur content in the soils varied from low to medium. The regular rearing practice of tasar sericulture without fertilization of soils may further deplete the soils which are just sufficient to cater the need for another few years. Thus, regular and site specific nutrient management are suggested for enhanced leaf yield and production of quality tasar cocoons in all selected regions. Hence, a balanced use of nutrients in organic and inorganic source seems to be essential for sustainable productivity and soil health in tasar growing regions.

REFERENCES

1. Rai, Shruti K, Aggarwal K and Babu C R (2006). Tasar sericulture: an emerging discipline for conservation and sustainable utilization of natural resources, Discourse on development in Asia, Pacific and Africa. pp-3
2. Gupta V P and Sinha M K. (2013). Food plant maintenance, silkworm rearing and seed production, Illustrated Manual of Tropical Tasar Culture Technology.
3. Singhvi N R. (2014). Effect of vermicompost application on leaf yield in *terminalia tomentosa* W & A and tasar cocoon production, *Plant Archives* Vol. 14 (1): 97-99.
4. Sinha A K, Sinha U S P, Banerjee N D, Prasad J and Brahamchari, B N. (2002). Effect of foliar spray of micronutrients on leaf yield of *Terminalia arjuna* and quality of cocoons produced on them. *Plant Archives*, 2(2): 151–155.

5. Sahay, Alok, Sahay D N and Thangavelu, K. (2001). Disease management during tasar seed production. Workshop on Tasar seed production, planning and grainage. Central Tasar Research and Training Institute, Ranchi. June, 14 – 16. pp32- 45.
6. Subbaswamy M R, Singhvi N R, Naidu B V, Reddy M M, Jayaram H and Suryanarayan N. (2001). Effect of source of nitrogen on phosphorus uptake and arginine content in mulberry. *Indian Journal of Sericulture*. 40:182–184.
7. Sahay Alok and Kapila M L. (1993). Role of nutrition in synthesis of tasar silk. *Indian Silk*, 30(2): 8–11.
8. Medhe S R, Tankankhar V G, and Salve A N. (2012). Correlation of chemical properties, secondary nutrients and micronutrient anions from the soils of Chakur Tahsil of Latur district, Maharashtra. *Journal of Trends in life sciences*. 1(2).
9. Subbiah B V and Asija H L (1956). A rapid procedure for estimation of the available nitrogen in soils. *Current Science.* 25: 259–260.
10. Page A L, Miller R H and Keenay D R. (1982). Methods of Soil Analysis. Part -2. Soil Society of America, Inc. Publishers, Madison, Wisconsin, USA.
11. Muhr G R, Datta N P, Sankarasubramany H, Dever F, Laley V K and Donahue R L. (1965) Critical test values for available N, P and K in different soils. Soil Testing in India. 2nd edn. U.S. Agency for International Development, New Delhi
12. Roy B B and Landey R I. (1962). Studies on red and lateritic soils of Mond watershed area of Raigarh district. *Indian Journal of Agricultural Sciences* 32(6): 294-302.
13. Kavitha C and Sujatha M P. (2015). Evaluation of soil fertility status in various agro ecosystems of Thrissur District, Kerala. *International Journal of Agriculture and Crop Sciences*. 8(3): 328-338.
14. Ghosh G K and Sarkar A K. (1994). Availability of sulphur and some micronutrients in acid sedentary soils of Chotonagpur region. *Journal of Indian Society of Soil Science*, 43: 464 – 466.
15. Pathak H. (2010). Trend of fertility status of Indian soils. *Current Advances in Agricultural Sciences* 2(1): 10-12.
16. Verma L P, Tripathi B R and Sharma D P. (1980). Organic carbons an index to assess the nitrogen status of the soils. *Journal of Indian Society of Soil science*. 28: 138-140.
17. Tisdale S L, Nelson W L, Beaton J D and Havlin J L. (1993). Soil Fertility and Fertilizers, 5th Edition, Macmillan Publishing Co., New Delhi. pp: 144, 180, 198, 201.
18. Chauhan J S. (2001). Fertility status of soils of Birla panchayath samiti of Jodhpur district (Rajasthan). Msc. (Ag.) Thesis, MPUAT, Udaipur.
19. Hariram and Dwivedi K N. (1994). Delineation of sulphur deficient soil groups in the central alluvial tract of Uttar Pradesh. *Journal of Indian Society of Soil Science*. 42: 284-286
20. Nor Y M. (1981). Sulphur mineralization and adsorption in soils. *Plant soil*. 60: 451-459.
21. Kumar P, Kumar A, Dyani B P, Kumar P, Shahi U P, Singh S P, Kumar R, Kumar Y and Sumith R. (2013). Soil fertility status in some soils of Muzaffarnagar District of Uttar Pradesh, India, along with Ganga canal command area. *African Journal of Agricultural Research*. 8(14): 1209-1217.
22. Bray R H., Kurtz L T. (1945). Determination of total organic carbon and available forms of phosphorous in soils. *Soil Science*. 59: 39-45.

CITE THIS ARTICLE

Ajit Kumar Sinha, Prem Prakash Srivastava, T. Pandiaraj and Susmita Das. Evaluation of soil fertility status of tasar silk growing fields of Bihar and Jharkhand states for balanced nutrition to tasar host plant, *Terminalia arjuna*. Res. J. Chem. Env. Sci. Vol 5 [1] February 2017. 63-67