Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

Journal of Pharmacognosy and Phytochemistry

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(4): 1828-1831
Received: 01-05-2018
Accepted: 05-06-2018

Chinmaya
Department of Chemistry, Birla Institute of Technology, Mesra, Ranchi, Jharkhand, India

T Pandiaraj
Soil Science and Chemistry laboratory, Central Tasar Research & Training Institute, Piska Nagri PO, Ranchi, Jharkhand, India

PP Srivastava
Soil Science and Chemistry laboratory, Central Tasar Research & Training Institute, Piska Nagri PO, Ranchi, Jharkhand, India

AK Sinha
Soil Science and Chemistry laboratory, Central Tasar Research & Training Institute, Piska Nagri PO, Ranchi, Jharkhand, India

Correspondence
T Pandiaraj
Soil Science and Chemistry laboratory, Central Tasar Research & Training Institute, Piska Nagri PO, Ranchi, Jharkhand, India

Status and variability of soil nutrients and carbon sequestration with depth in the Tasar host plants growing soils

Chinmaya, T Pandiaraj, PP Srivastava and AK Sinha

Abstract
A study was carried out in different tasar host plants growing locations to assess the status of soil physical properties, soil nutrients and carbon accumulation over the different soil depths. A soil profile was studied at each location and four samples collected at 25 cm interval from top soil to 100 cm soil depth. Standard methods were employed to analyse soil physical and chemical properties. Results showed that pH and EC of selected soils does not follow any particular pattern but varies down the profiles. All the available nutrients both macro and micronutrients except Boron was observed as higher in top soils and declined sharply with increasing depths. However, Boron availability was increased with increasing depth. The surface soil of different places was found to be higher carbon sequestered than lower soil profile. Hence, information on nutrient distribution in different soil depth may provide for best soil nutrient management at different tasar host plants growing soils for sustainable tasar silk productivity.

Keywords: available nutrients, c-sequestration, depth, soil profile, tasar silkworm

Introduction
India has unique distinction of producing all the four varieties of silk i.e. mulberry, eri, tasar and muga. Nearly 90% of our silk is mori silk or mulberry silk produced by the silkworm *Bombyx mori*. Further India has merit of producing two different kinds of tasar silk. Temperate tasar (oak tasar) is finer variety of tasar produced by the silkworm, *Antheraea proylei*, which feed on natural food plants of oak, found in abundance in the sub-Himalayan belt of India covering the states of Jammu & Kashmir, Himachal Pradesh, Uttar Pradesh, Assam, Meghalaya and Manipur. Tasar (Tropical tasar) silk largely found in the tribal habitats of the Gondwana region is peculiarity of India not being found anywhere else in the world. This silkworm is reared in the jungles of central and north-eastern parts of India. In India, tasar silk is mainly produced in the states of Jharkhand, Chhattisgarh and Orissa, besides Maharashtra, West Bengal and Andhra Pradesh. Tasar culture is the main source of income for many tribal communities in India. Around 3,000 tasar rearers, mostly tribals, are dependent on the industry. Tasar silkworm, *A. mylitta* feeds on foliage of many plant species belonging to different families, but it prefers the foliage of *Terminalia arjuna, T. tomentosa* and *Shorea robusta* and these are designated as primary food plants. The other food plants of *A. mylitta* are *T. bellerica, T. chebula, T. catapa and T. paniculata of Combretaceae, Bauhinia variegata, Dalbergia sissoo* and *Hardwickia binata* of leguminosae, *Careya arborea of Myrtaceae, Madhuca latifolia* of Sapotaceae, *Zizyphus mauritiana* and *Zizyphus jujuba* of Rhamnaceae and *Ficus religiosa* of Moraceae. All these plant species are designated as secondary food plants.

Leaf quality, production rate and gestation period of different forest host plants are influencing the commercial feasibility of *A. mylitta* (Reddy *et al.* 2010) [13]. Srivastava *et al.* 2017 [14] also substantiated that growth and development of tasar silkworm larvae and economic characters of cocoons are directly proportional to the nutritional contents of leaves. Further, Subbaswamy *et al.* (2004) [15] stated quality of leaves depends on the soil fertility and balanced supply of essential nutrients from soil. Soil is a complex composite of minerals and organic matter that forms over the surface of land. Knowledge of how the physical characteristics of the soil profile are altered by different land use practices is basic to land use planning for soil and nutrient management. The vertical section of the soil showing the various layers from the surface to the unaffected parent material is known as a soil profile. A soil horizon is a layer of soil, approximately parallel to the soil surface, differing in properties and characteristics from adjacent layers below or above it. Practically, soil profile is an important tool for soil classification and nutrient distribution which is applicable for thorough understanding of the soils. Therefore, a sound knowledge about soil profile is very much relevant for knowing nutrient status and fertilizer application in crop husbandry for attaining efficient nutrient management and sustained tasar silk productivity.

Materials and Methods

To characterize the vertical distribution of nutrients and to evaluate nutrient availability, we collected soil samples from tasar host plants growing farmers' fields. Soil samples were collected from research field of Central Tasar Research and Training Institute, Ranchi (Jharkhand) located at 23° 35'N latitude and 85° 06' E longitude at an elevation of about 651 m above mean sea level; Kharswan (Jharkhand) situated at 22° 30' N Latitude and 83°22' E Longitude at an altitude of 302 meters above MSL; Kunkuri in Jashpur district of in Chhattisgarh situated at 22°67' N latitude and 83°82'E longitude and Kapista situated at 23°39'N latitude and 87°16'E longitude.

In these sites, plots were randomly selected for sampling of soils in April-May 2018, soils of 0-25 cm, 25-50 cm, 50-75cm and 75-100 cm of each plot was collected by using core sampler and selected by quartering to 1kg of mixed soil, carried to the laboratory for analysis (Lu 1999) [6]. Soil physical properties such as pH and electrical conductivity (EC) were determined by potentiometer and direct reading conductivity meter using 1: 2.5 soil water suspensions (Jackson, 1973) [3] and organic carbon (Walkely & Black, 1934) [17] was also analysed. The composite soil samples were analysed for available macronutrients such as nitrogen (Subbiah and Asija, 1956) [16], phosphorus (Bray and Kurtz$_{1,}$ 1945) [1] potassium (1N ammonium acetate extractable) and sulphur (turbidimetric method) determined as following the methods described by Page *et al.* (1982) [11]. The available micro nutrients such as Iron (Fe), Manganese (Mn), Copper (Cu) and Zinc (Zn) in soil samples were extracted with a DTPA solution (0.005M DTPA + 0.01 M $CaCl_2$ + 0.1M triethanolamine, pH 7.3 (Lindsay and Norvell, 1978) [5]. The concentration of micronutrients in the extract was determined by atomic absorption spectrophotometer (Agilent AAS-FS 280). The hot water soluble B was estimated by UV-VIS Spectrophotometer (Wear, 1965) [18]. In addition, carbon sequestration or carbon build-up per unit area was calculated using the following equation (Pearson *et al*. 2007) [12].

$$C\ (Mg\ ha^{-1}) = [\text{soil bulk density } (g\ cm^{-3}) \times \text{soil depth (cm)} \times \%\ C] \times 100$$

In this equation % C must be expressed as a decimal fraction; for example, 2.2% C is expressed as 0.022.

Result and Discussion

Physical properties of soil

The value of soil pH, Electrical conductivity and soil organic carbon content of different soil depth of various tasar host plants growing soils are shown in Table 1. Soil pH is vital estimation for soils, determines the magnitude of the acidity and alkalinity and directly influences crop productivity (Mokolobate and Haynes, 2002) [9]. Soil pH in the study area was found to be acidic in reaction. Soil pH of Kunkuri place was highest with mean value of 5.75 followed by Kharshawan (pH 5.67) region. However, soil pH in all the places was considerably not varied as varying the soil depth. Like, electrical conductivity of all the places was behaved as soil pH.

Table 1: Soil physical properties of selected places at different soil depth

Place	Soil depth (cm)	pH	EC (dS m^{-1})	Organic carbon (%)
Ranchi	0-25	5.11	0.065	0.45
	26-50	5.17	0.050	0.37
	51-75	5.10	0.060	0.29
	76-100	5.27	0.060	0.27
	Mean	5.16	0.059	0.35
Kharshawan	0-25	5.72	0.079	0.62
	26-50	5.63	0.063	0.51
	51-75	5.82	0.058	0.47
	76-100	5.51	0.056	0.46
	Mean	5.67	0.064	0.52
Kunkuri	0-25	5.87	0.061	0.61
	26-50	5.69	0.053	0.52
	51-75	5.72	0.049	0.50
	76-100	5.70	0.046	0.49
	Mean	5.75	0.052	0.53
Kapistha	0-25	5.38	0.074	0.58
	26-50	5.26	0.058	0.52
	51-75	5.41	0.065	0.46
	76-100	5.30	0.049	0.44
	Mean	5.34	0.062	0.50

Variability of soil organic carbon was an important and sensitive indicator to nutrient availability and climate change. The multiple comparison data showed that the difference of soil organic carbon content were considerable in all the places. Mean value of soil organic carbon content in Ranchi was lowest (0.35%) than others. Studies on soil organic carbon content of different tasar growing regions showed that organic carbon decreased with soil depth. The soil organic carbon content of surface soil was more (1.0-1.2 times) than that of the bottom layer. The soil organic carbon content in surface soil (0-25 cm) depth of all the places was higher and it decreased with increasing depth of soil. This implies that the surface soil layer is the most biologically active of the soil profile. The litter on the soil surface beneath different canopy layers and high biomass production caused high biological activity in the topsoil layer (Morgan, 2005) [10]. Further, change of soil organic carbon content was steadily decreased from 0 to 75 cm soil depth. After 75 cm soil depth, changes of organic carbon content were almost absent and remain the same. The reason may be that the mineralization of soil organic matter and some of the original plant residues decomposition. Host plants leaves and other parts are cuts away and/or falls in the field, and these residues gradually formed litter to soil surface and the results increased soil organic matter with herbs by microbial decomposition. Host plants roots concentrated in 30-50cm deep and even deeper, where a large number of plants absorbed nutrients, so the performance of soil nutrient contents at this level was low.

Available macronutrients

Variability of soil available nitrogen as could be seen from Table 2. Available N of 0-25 cm depth was 159.3 kg ha^{-1} and highest in Kapistha. The lowest of soil available N was found at Kunkuri and Ranchi as 128.1 and 128.6 kg ha^{-1}, respectively. The available N content of surface soil in all the places was conspicuously higher than that of lower soil layer. The variation of available N was higher from 0 to 50 cm soil depth but thereafter changes of N was negligible and decreased slowly in changes of available N content in deeper soil layer. Available N is higher in topsoil than in the subsoil probably be as a result of losses in organic matter by mineralization in the subsoil. The same result was also reported by Hall, 2008 [2].

The available phosphorus content was showed with a mean value of 8.18 kg ha^{-1} in Ranchi, 4.97 kg ha^{-1} in Kharshawan, 9.40 kg ha^{-1} in Kunkuri, 7.56 kg ha^{-1} in Kapistha (Table 2). The soil available P contents in these plots were lower than the target that the critical value of soil available P was 25 kg ha^{-1}. This was found probably due to the deficiency of the soil to absorb or retain phosphorous since soils of the study area are acidic and clayey; its deficiency also attributed to human management systems such as deforestation, overgrazing, over cultivation and erosion which in turn, reveals the prevalence of land degradation (McAlister *et al*. 1998; Brady and Weil, 1999) [8]. Available P decreased with soil depth in all the places. Available P content of surface soil (0-25 cm) was 1.2 to 1.6 times more than that of succeeded soil depth. The tasar host plant growing soil should be added P fertilizer in time and enhanced P element supply capacity. Multiple comparison data showed that soil available P was significant difference of 0-25cm and 26-50 cm. This finding also corroborates the reports of similar and recent studies (Woldeamlak and Stroosnijder, 2003; Yifru and Taye, 2011) [19, 20].

Table 2: Variability of Soil available macronutrients (kg ha^{-1}) of selected study area at different soil depth

Place	Soil depth (cm)	Nitrogen	Phosphorus	Potassium	Sulphur (ppm)
Ranchi	0-25	169.3	12.39	278.9	7.09
	26-50	121.7	7.62	257.6	6.32
	51-75	114.2	6.78	246.4	4.89
	76-100	109.1	5.93	201.6	3.92
	Mean	128.6	8.18	246.1	5.56
Kharshawan	0-25	187.4	9.28	212.3	9.33
	26-50	148.7	6.33	189.5	7.81
	51-75	135.3	5.19	177.1	3.69
	76-100	131.6	4.97	164.8	3.17
	Mean	150.8	6.44	185.9	6.00
Kunkuri	0-25	153.9	16.34	267.2	11.37
	26-50	132.7	9.27	239.9	8.36
	51-75	114.6	6.16	197.3	5.18
	76-100	111.3	5.81	181.3	4.09
	Mean	128.1	9.40	221.4	7.25
Kapistha	0-25	176.8	13.59	229.3	12.81
	26-50	159.1	8.36	176.1	8.89
	51-75	152.5	4.29	156.9	4.97
	76-100	148.7	3.98	143.5	4.43
	Mean	159.3	7.56	176.5	7.78

Likewise, soil available potassium content decreased with soil depth. Status of K in the soil samples had a mean value of 245.98, 185.93, 221.43 and 176.45 kg ha^{-1} in Ranchi, Kharshawan, Kunkuri and Kapishta, respectively. In the 0-25 cm soil layer, soil available K in Ranchi was significantly higher than other places and lowest in Kapistha. The similar trend was observed for all the study places in different soil layer. The highest variability of K with depth under different places may be attributed to biomass and litters being covered to the topsoil (Korkanc *et al*. 2008) [4].

The available sulphur content varied from 5.56 ppm to 7.78 ppm in the selected study area. The highest mean value of available S content was observed in Kapistha (7.78 ppm) region followed by Kunkuri (7.25 ppm). Like other macronutrients, available S content was also found to be highest in surface soil (0-25 cm) and S content was decreased with increasing soil depth.

Available micronutrients

The DTPA extractable copper in soils of selected sites ranged from 0.55 to 0.73 ppm with highest content in Kunkuri (0.73 ppm) and lowest in Kharshawan (0.55 ppm). Being as cation, higher Cu content was existed in surface soil (0-25 cm) depth followed by 26-50 cm soil layer (Table 3). Top soil had recorded significant amount of available Cu in all the places but Cu content was decreased with increasing the depth.

Like copper, available Zn content also decreased with increasing soil depth. The higher mean value (1.58 ppm) of available Zn was recorded in Kunkuri and lower (0.85 ppm) in Ranchi regions. The soil available Zn content was found to be increased upto 25cm soil depth. However, Zn content in soil of Ranchi showed less variance between 0-25 cm and 26-50 cm soil depth.

Higher mean content of available manganese with the value of 53.19 ppm was observed in Kharshawan and lower mean value in Kunkuri region (35.17 ppm). Top soil (0-25cm) of all the study area was recorded higher available Mn content and its content was decreased with increasing the soil depth; however, variation of Mn content was less after 75 cm soil depth.

Regards available mean content of iron is showed that soil of Ranchi was found to be higher as 23.45 ppm followed by Kharshawan (20.43 ppm). The lower mean value of available Fe content (13.08 ppm) was recorded in Kunkuri region. While, surface soil (0-25 cm) was showed higher available Fe content and it was decreased with increasing the soil depth in all the study places. However, considerable changes of Fe content is not noted after 75 cm soil depth meant iron distribution and transformation exists only on surface soils.

Unlike other micronutrients, available content of Boron was observed as higher in deeper soil depth and it content was positively increased with increasing soil depth. The same trend was observed in all the study places. Moreover, higher mean content of B was observed in Kunkuri (9.21 ppm) followed by Kharshawan (6.55 ppm) and lower mean content of B recorded in Kapistha soils (3.25 ppm).

Table 3: Variability of Soil available micronutrients (ppm) of selected study area at different soil depth

Place	Soil depth (cm)	Copper	Zinc	Manganese	Iron	Boron
Ranchi	0-25	0.85	0.93	87.80	30.55	3.83
	26-50	0.57	0.92	53.20	23.45	3.95
	51-75	0.51	0.83	30.95	21.00	3.99
	76-100	0.45	0.71	25.10	18.80	4.12
	Mean	0.60	0.85	49.26	23.45	3.97
Kharshawan	0-25	0.78	1.69	63.18	26.18	5.39
	26-50	0.53	0.97	56.52	22.62	6.71
	51-75	0.48	0.83	49.11	19.21	6.99
	76-100	0.41	0.78	43.96	13.69	7.12
	Mean	0.55	1.07	53.19	20.43	6.55
Kunkuri	0-25	1.09	2.19	42.39	19.68	7.28
	26-50	0.83	1.41	35.11	15.21	9.35
	51-75	0.52	1.38	33.96	9.22	9.89
	76-100	0.46	1.33	29.20	8.19	10.31
	Mean	0.73	1.58	35.17	13.08	9.21
Kapistha	0-25	0.78	1.94	56.23	23.71	2.69
	26-50	0.62	1.63	43.58	17.63	3.12
	51-75	0.57	1.28	39.17	14.08	3.43
	76-100	0.49	1.19	33.69	12.72	3.77
	Mean	0.62	1.51	43.17	17.04	3.25

Carbon sequestration/ carbon build-up

Carbon sequestration is the long-term storage of carbon in oceans, soils, vegetation (especially forests), and geologic formations. Soil is an ideal reservoir for storage of organic C since soil organic C has been depleted due to land misuse and inappropriate management through the long history. The soil organic carbon concentration differed considerably among the treatments and depth. The highest total mean of carbon accumulation was observed in the surface layer (0-25cm) followed by 26-50 cm (Fig.1). Then SOC concentration was sharply declined after 50 cm soil layer. The relatively near-surface higher water content and the favorable temperature of undisturbed soils during the growing season might have provided a favorable environment for SOC accumulation in the surface soil. Luo *et al*. 2010 [7] also observed higher carbon buildup upto 45 cm soil depth.

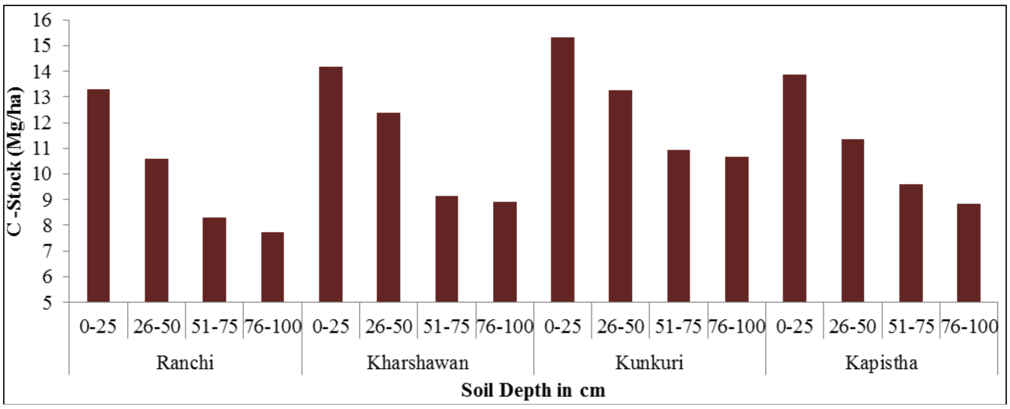

Fig 1: Variation of organic carbon buildup in soil at different soil depth

Conclusion
The objective of this study was to investigate depth distribution of physical properties, available nutrients and carbon sequestration. Soil pH and EC of selected soils does not follow any particular pattern but varies down the profiles. All the available nutrients both macro and micronutrients except Boron was observed as higher in top soils and declined sharply with depths. However, Boron availability was increased with increasing depth. The surface soil of different places sequestered higher carbon than lower soil profile.

References
1. Bray RH, Kurtz LT. Determination of total organic carbon and available forms of phosphorous in soils. Soil Science. 1945; 59:39-45.
2. Hall R. Soil Essentials: Managing your Farm’s Primary Asset, Landlinks Press, Collingwood, 2008.
3. Jackson ML. Soil chemical analysis, Prentice Hall of India Pvt. Ltd., New Delhi, 1973, 498.
4. Korkanc SY, Ozyuvaci N, Hizal A. Impacts of land use conversion on soil properties and soil erodiblity, J Environ. Biol. 2008; 29:363-370.
5. Lindsay WL, Norvell WA. Development of DTPA soil tests for Zn, Fe, Mn and Cu. Soil Science Society of America Journal. 1978; 42:421-428.
6. Lu RK. Soil Agricultural Chemical Analysis Method. Beijing: China Agricultural Sci-Tech. Press, 1999.
7. Luo ZK, Wang E, Sun OJ. Soil carbon change and its responses to agricultural practices in Australian agro-ecosystems: a review and synthesis. Geoderma. 2010; 155:211-223.
8. McAlister JJ, Smith BJ, Sanchez B. Forest clearance: impact of land use change on fertility status of soils from the Sao Francisco Area of Niteroi, Brazil, Land Degrad. Dev. 1998; 9:425-440.
9. Mokolobate Haynes. Comparative liming effect of four organic residues applied to an acid soil. Biology and Fertility of Soils. 2002; 35(2):79-85.
10. Morgan PC. Soil Erosion and Conservation, 3rd edn. Blackwell Publishing, Malden, 2005.
11. Page AL, Miller RH, Keenay DR. Methods of Soil Analysis. Part-2. Soil Society of America, Inc. Publishers, Madison, Wisconsin, USA, 1982.
12. Pearson RH, Timothy Brown Sandra L, Richard A Birdsey. Measurement Guidelines for the Sequestration of Forest Carbon. USDA forest service publication. Newtown Square, 2007, 29-31.
Accessed from http://www.nrs.fs.fed.us/
13. Reddy RM. Silkworm food plants apply dimension under Indian condition-time for utility optimization and value addition. Sericologia. 2010; 50(1):1-17.
14. Srivastava PP, Pandiaraj T, Susmita Das, Sinha SK, Sinha AK. Characteristics of Soil Organic Carbon, Total Nitrogen and C/N Ratio in Tasar Silkworm Growing Regions of Jharkhand and Bihar States. Imperial Journal of Interdisciplinary Research. 2017; 3(5):426-429.
15. Subbaswamy MR, Singhvi NR, Naidu BV, Reddy MM, Jayaram H, Suryanarayan N. Effect of source of nitrogen on phosphorus uptake and arginine content in mulberry. Indian Journal of Sericulture. 2004; 40:182-184.
16. Subbiah BV, Asija HL. A rapid procedure for estimation of the available nitrogen in soils. Current Science. 1956; 25:259-260.
17. Walkley AJ, Black IA. Estimation of soil organic carbon by chromic acid titration method. Soil Sci. 1934; 37:29-38.
18. Wear Boron JI. In: Methods of Soil Analysis (C.A. Black *et al*. Eds.), Part II. American Society of Agronomy Madison, Winconsin, USA, 1965.
19. Woldeamlak B, Stroosnijder L. Effects of agro-ecological land succession on soil properties in the Chemoga watershed, Blue Nile Basin, Ethiopia, Geoderma. 2003; 111:85-89.
20. Yifru A, Yaye B. Effects of land use on soil organic carbon and nitrogen in soils of Bale, Southwestern Ethiopia, Tropical and Subtropical Agroecosystems. 2011; 14:229-235.