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RESEARCH ARTICLE

ASSESSMENT OF MICRONUTRIENT STATUS IN RELATION TO SOIL CHARACTERISTICS UNDER TASAR GROWING STATES OF BIHAR AND JHARKHAND

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ABSTRACT

Micronutrient is a vital for improving nutritional status of leaf of tasar host plants and subsequently has impact on silkworm in producing good quality cocoons. In Present day, seventy five surface soil samples representing tasar growing states of Bihar and Jharkhand in India were analyzed for the basic soil parameters viz., pH, EC, OC and available micronutrients (DTPA extractable) viz., Zn, B, Fe, Cu and Mn. The soil reaction of selected sites was neutral to slightly alkaline with low level of electrical conductivity of soils. The micronutrient status and their relationship with soil properties were also studied. Among the micronutrients, Fe was found to be deficient by 4% and sufficient by 87%, Mn was found to be sufficient by 100%, Cu was found to be sufficient by 85%, Zn was found to be in medium range by 68% and 32% sufficient and B was found to be 59% in medium and 37% by sufficient range. Further, most micronutrients showed positive correlation with pH, EC and OC.

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INTRODUCTION

The quality of tasar host plant leaf plays a vital role in successful rearing of the tasar silkworm and cocoon production. The quantity and quality of host plant leaf affect larval growth rate, larval body weight, survival larvae, fecundity, developmental periods of different metamorphic stages and economic cocoon characters. There are several factors which influence quantity and quality of foliage including: soil type, climate, management practices of host plantation (Rafique and Bajwa, 2005). Among these, soil fertility is one of the principal factors controlling the crop yield. Soil associated limitations affecting the crop productivity including nutritional disorders can be determined by assessing the fertility status of the soils. Soil testing provides the information about the nutrient availability of the soil upon which the fertilizer recommendation for maximizing crop yield is made. Micronutrients such as zinc (Zn), copper (Cu), iron (Fe), manganese (Mn) and boron (B) are essential for plant growth, transportation of nutrients, cell formation, uptake and retention of other minerals, transformation of compounds, metabolism and energy cycles. Deficiency in any single micronutrient may impede plant growth and consequently foliage yield (Cioroi and Florea, 2003; Mousavi, 2011). However, total amount is rarely indicative of the availability by plant, because availability depends on soil pH, organic matter content, adsorptive surfaces and other physical, chemical and biological conditions in the rhizosphere. Micronutrient availability to plants can be determined in direct uptake experiments or estimated with techniques that correlate the quantities of micronutrients extracted chemically from the soils (Kabata-Pendias, 2001). Keeping these in view and also lack of information on micronutrients status to identify the emerging micronutrient deficiency or toxicity in the tasar silkworm host plants growing soils, therefore a comprehensive study was undertaken for evaluation of micronutrient status of soils and their relation with some physical properties of soils of tasar host plants growing in Bihar and Jharkhand regions.

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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. All the composite soil samples were air-dried, ground and passed through 2 mm sieve for chemical analysis. Soil pH and electrical conductivity (EC) were determined by potentiometer and direct reading conductivity meter using 1: 2.5 soil water suspensions (Jackson, 1973). The composite soil samples were analyzed for organic carbon (Walkely & Black, 1934). The available Fe, Mn, Cu and 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). 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). The relationship between various soil properties and micronutrients distribution were established by using Pearson correlation coefficient.

RESULTS AND DISCUSSION

Soil Physical Properties

Seventy five surface soils (0-30cm) of Banka district of Bihar and Dumka district of Jharkhand states were investigated. The results of soil pH, EC and organic carbon (OC) are presented in Table 1. Result shows that pH of the soils ranged from 5.18 to 7.58 (mean 7.40), EC varied from 0.01 to 0.13 dS m^{-1} (mean 0.05 dS m^{-1}) and OC content ranged from 0.41 to 1.97% (mean 0.93%). 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). Acidic in reaction of the sampled area might be due to the high rainfall leading to the leaching losses

Table 1. Range and mean values of Physico-chemical properties of soil under study area

Village	No. of samples	pH		EC (dS m^{-1})		OC (%)	
		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
Dhaka	23	5.46-7.58	6.78	0.01-0.10	0.051	0.43-1.41	0.94
Digal Pahari	7	6.25-7.27	6.71	0.020-0.089	0.044	0.54-1.16	0.80
Tetariya	8	6.87-7.50	7.02	0.033-0.079	0.054	0.70-1.97	1.11
Range and Average mean		5.18-7.58	6.85	0.01-0.13	0.051	0.41-1.97	0.93

Table 2. Range and mean values of micro-nutrient available status of soil under study area

Village	Zn (ppm)		B (ppm)		Fe (ppm)		Mn (ppm)		Cu (ppm)	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Salaiya	0.83-8.39	2.27	0.5-1.9	0.78	4.2-35.72	17.04	15.1-84.58	45.64	0.26-1.62	0.84
Dhaka	1.2-8.58	2.31	0.5-2.6	1.01	3.25-25.92	14.74	14.15-85.9	43.21	0.23-1.4	0.59
Digal Pahari	1.09-1.96	1.59	0.51-1.59	1.05	8.25-24.64	16.81	20.3-62.25	36.36	0.3-0.84	0.45
Tetariya	0.91-8.58	2.88	0.59-1.23	0.98	4.45-31.34	13.46	5.7-77.18	34.27	0.51-1.35	0.92
Range and Mean	0.83-8.58	2.29	0.47-2.64	0.90	3.25-35.72	15.93	5.7-85.9	42.81	0.23-0.84	0.74

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

Parameters	pH	Electrical Conductivity	Organic Carbon	Zinc	Boron	Iron	Manganese	Copper
pH	1	-0.536**	0.049	-0.093	0.181	0.248*	0.150	0.095
Electrical Conductivity		1	0.013	-0.096	0.191	-0.162	0.016	0.074
Organic Carbon			1	0.039	0.030	0.066	0.055	0.236*
Zinc				1	0.073	-0.053	0.031	0.098
Boron					1	-0.227	-0.075	-0.130
Iron						1	0.502**	0.279*
Manganese							1	0.440**
Copper								1

**. Correlation is significant at the 0.01 level
*. Correlation is significant at the 0.05 level

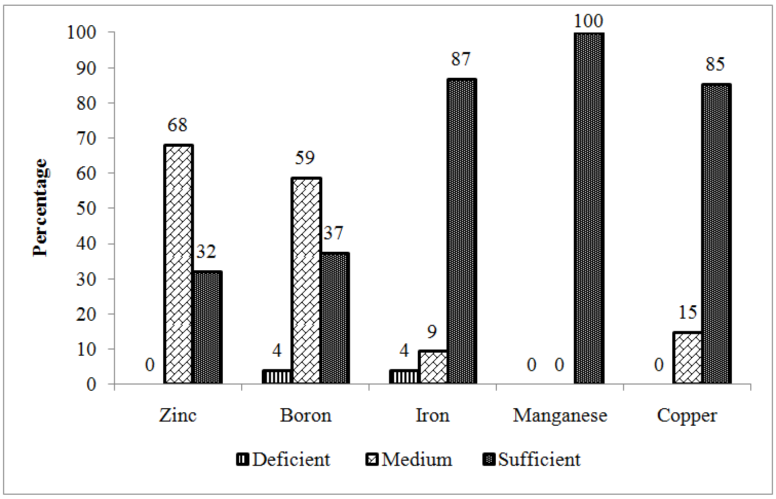

Fig. 1. Percentage of nutrient status of various Tasar growing regions soil on the basis of different category

of bases from the surface soils. Availability of abundant organic matter in tasar silkworm host plants growing areas resulted in decomposition of organic residues hasten the lower soil pH. On the basis of limits suggested by Muhr *et al*. (1965), all the samples were exhibited in normal range with respect to electrical conductivity (EC <1.0 dSm^{-1}). The wide variation of EC of the soils is might 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 (Roy *et al*., 1962). 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%). The high organic content in the soils is due to luxuriant availability of organic matter like litters, grasses along with slow seasonal decomposition of organic matter (Kavitha and Sujatha, 2015).

Available Micronutrient Status

Zinc (Zn)

Available Zn in the studied surface soils varied from 0.83 to 8.58 mg kg^{-1} with a mean value of 2.29 mg kg^{-1} (Table 2). On the basis of critical limit suggested by Takkar and Mann (1975) as considering 0.5 to 2.0 mg kg^{-1}, 68% samples were medium and 32% of the samples were sufficient (Fig. 2), so continuous addition of manures and fertilizers might have increased the adequate levels of Zn in these soils. Interestingly, out of 75 soil samples collected in Bihar and Jharkhand states not even a single sample was found to be Zn deficient category against national average of 40% in deficiency range. Average Zn showed positive correlation coefficient with pH (r= 0.093), OC (r= 0.039), B (r= 0.073), Mn (0.031) and Cu (r= 0.098). The average of Zn increased with increase in OC (r= 0.039) whereas, reduced with increase in pH (r= -0.093), and EC (r= -0.096) (Table 3). This finding is in agreement with the earlier findings of Venkatesh *et al* (2003) and Sharma and Chaudhary (2007). Amount of Zn required for alleviating the Zn deficiency varied with severity of Zn deficiency soil types and nature of plants. In the majority of instances 5.5 kg Zn ha^{-1} was found to be ideal dose.

Boron (B)

Hot water soluble B content of the soils of various tasar eco-systems varied from 0.47 to 2.67 mg kg^{-1} with a mean value of 0.90 mg kg^{-1} (Table 2). The range of average B in soils of different states of India varied from traces to 12.2 mg kg^{-1} (Das, 2000). Among the micro nutrients, deficiency of B was one of the severe limiting nutrient after Zn in the study area, might be due to leaching by high rainfall coupled with low levels of cation exchange capacity. In general, management of B in the soils is difficult because of its high mobility and fixation at high pH (Saleem *et al*, 2010). The data depicted that 4% of the soil samples were deficient, 59% were medium and 32% were sufficient in availability B content (Fig. 1) considering 0.5 mg kg^{-1} as critical range. The average B inversely proportional to most of the micronutrient except Zn since positive charge of micronutrients like Fe, Mn and Cu are influencing antagonist for the availability of non metal B ion to the plants. These results were also supported by Kumar *et al* (2013).

Iron (Fe)

Available iron content in the surface soils ranged from 3.25 to 35.72 mg kg^{-1} with an average of 15.93 mg kg^{-1} (Table 2). Data on available Fe in soil samples indicated that 4, 9 and 87% soil samples were deficient, medium and sufficient range of DTPA Fe content, respectively (Fig. 1). It showed that all the soils had significant amount of Fe considering 4.8 mg kg^{-1} as critical limit as suggested by Lindsay and Norvel (1978). It is illustrated positive and significant correlations with pH (r= 0.248^{*}), Mn (r= 0.502^{*}) and Cu (r= 0.279^{*}) and negative correlations with EC (r= -0.162), Zn (r= -0.053) and B (r= -0.227) (Table 3). Soils with acidic pH range leads higher solubility could be resulted in higher availability of Fe content. Therefore, iron availability is generally high in acid soils. This is supported by the findings of Methe *et al*. (2012)

Manganese (Mn)

The DTPA Mn in the soil samples varied from 5.7 to 85.9 mg kg^{-1} with an average value of 42.81 mg kg^{-1} (Table 2). Considering 2.0 mg kg^{-1} as critical limit for Mn deficient (Sakal *et al*, 1985), here all the 100% samples were sufficient in availability (Fig. 1). In simple correlation coefficient studies (Table 3), average Mn showed significant and positive correlation coefficient with Fe (r= 0.502^{**}) and Cu (r= 0.440^{**}) and also positively correlated with most of the parameters and inversely proportional to B (r= -0.075), suggested variation in their distribution dependent up on common soil factors (Follect and Lindsay, 1970).

Copper (Cu)

The DTPA extractable Cu in soils of selected sites ranged from 0.23 to 0.84 mg kg^{-1} with a mean value of 0.74 mg kg^{-1} (Table 2). The data indicated that higher Cu content was recorded in Tetariya (0.92 mg kg^{-1}) and lower in Dhaka village (0.59 mg kg^{-1}). Further, the data indicated that 15% of the soil samples were medium range in availability of copper and 85% were sufficient (Fig. 1) considering 0.2 to 0.4 mg kg^{-1} as critical limit for Cu deficiency (Lindsay and Norvel, 1978). The micronutrient cation showed significant and positive correlation coefficient with Mn (r= 0.440^{**}), Fe (r= 0.279^{*}) and OC (r= 0.236^{*}) and indirectly proportional to B (r= -0.130) (Table 3). Chelating agent like Cu^{2+} firmly hold by organic carbon resulted in higher Cu content with increasing organic matter. This finding was in conformity with that of Singh *et al*. (2006); Verma *et al*. (2007) and Bassirani *et al*. (2011).

Conclusion

It is evidence that from this study, soil fertility status of selected tasar growing sites not varied significantly between various tasar ecosystems. The extractable Mn, Fe and Cu were optimum. Conversely, extractable Zn and B were below the sufficient level throught the study area. The soil reaction mostly varied from neutral to slightly alkaline. Status of OC was totally optimum in all soil samples collected. However, site and crop specific amendments/ nutrient inputs are suggested for enhanced productivity in all the tasar ecosystems.

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