Research Article

Physico-Chemical Properties of Termite Mound Soils and their Foliar Spray on *Terminalia arjuna* Plant

S. Kamaraj[1]*, T. Pandiaraj[2], C. Malliga, P.P. Srivastava[2], K.N. Madhusudhan[3], L. Zuinama[2] and A.K. Sinha[2]

[1]Regional Sericultural Research Station, Salem, Tamil Nadu
[2]Central Tasar Research and Training Institute, Ranchi, Jharkhand
[3]Central Sericultural Research and Training Institute, Mysore, Karnataka

Abstract

The silk quality and quantity of tasar silkworm depend upon nutritional value of their food plants. Good quality of leaves indicates greater possibility of obtaining good cocoon crops. Hence, an experiment was carried out in Central Tasar Research and Training Institute, Ranchi, Jharkhand state to study the effect of termite mound soil solution on the tasar food plant (*Terminalia arjuna*). Termite mound soils were collected from external (above ground) and internal portion (below ground) of a termite mound, tree trunk, cowdung pit and compared with normal soil as control. These collected termite mound soils including control were soaked with distilled water overnight and filtered through whatman no.1 filter paper. The filtered supernatant solution used for foliar spray over the plants. The results revealed that termite mound soils showed higher available nitrogen, phosphorus and potassium content than control soil. Among the termite mound soils, nitrogen, phosphorus and potassium content were observed significant higher in termite mound in tree trunk, internal termite mound and termite mound in cowdung, respectively. The further, result revealed that foliar spray with termite mound in cowdung solution had recorded higher nutrient concentration of *T.arjuna* leaf. Hence, use of termite mound soils may be an alternative to chemical method for better nutrient management with low cost technology and eco-friendly.

Keywords: Foliar spray; Termite; NPK; Nutrient; Tasar

***Correspondence**
Author: S. Kamaraj
Email: skraj1963@gmail.com

Introduction

Tropical tasar silkworm, *Antheraea mylitta* Drury, is a non- mulberry silkworm used for commercial silk production in India. *Antheraea mylitta* is wild and polyphagous. It feeds on primary food plants, viz. *Terminalia tomentosa, T. arjuna and Shorea robusta* and dozens of secondary food plants [1]. The silk quality and quantity of tasar silkworm depend upon nutritional value of their food plants [2]. Good quality of leaves indicates greater possibility of obtaining good cocoon crops. Sahay *et al.*, [3] indicated that leaf quality is one of the important factors contributing to success of tasar crops. Srivastava *et al.*, [4] stated quality of leaves depends on the soil fertility and balanced supply of essential nutrients from soil. However, tasar silkworm's host plants are being grown in rainfed condition, these plants affects due to nutrient stress.

Subsequently, termites formed mound structure is observed higher near the tasar host plant growing areas which may have good source of nutrition. These mound-building termites are recognized as "ecosystem engineers" because they promote soil transformation by disturbance processes. They collect particles from different soil depths and deposit them in mounds, so that contents of organic carbon, clay and nutrients, pH and microbial population are higher in termite mounds than in the adjacent soils unmodified by termites [5]. The accumulated material is later redistributed by erosion causing changes in soil micro-structure and fertility [6, 7]. Although termites are the most important soil fauna in the semi-arid tropics, they are often regarded as pest because they attack roots, and above ground plants, and stored food supplies. As a result, termite research in agro ecosystems, has historically concentrated on the pest management aspects. However, of more than 2500 species [8], relatively few are agricultural pests. Furthermore, pest activity is only a part of the termites' potential role in agro ecosystems. Consequently, subsistence indigenous tribal farmers in India commonly spread termite mound materials in their fields to improve soil conditions and increase plant nutrient availability. They also promote nutrient availability, nutrient cycling and soil physical properties [9]. Although few studies available with termite mound soil application over the field of agriculture crops, there is no evidence on termite mound soil application on tasar food plants. Hence, the aim of the study was to examine the termite mound soil extractant used as foliar spray in tasar host plants.

Materials and Methods
Description of the Study Area

The study area is situated in the Central Tasar Research and Training Institute (CTR&TI.), Piska-Nagri, district of Ranchi, Jharkhand state. Lying between 22^o 30' and 24^o 30' N Latitude and between 83^{o}22' and 85^o 06' E Longitude at an altitude of 651 meters above MSL. The region enjoys a humid to sub-tropical climate and receives a mean annual rainfall of 1323 mm in 100 rainy days. Of this, nearly about 85 per cent is received during south - west monsoon (2nd week of June – 1st week of October), 7.78 per cent during North East monsoon (2nd week October – 3rd week of December), 2.87 per cent during winter (January-February) and 7.48 per cent during summer (March -May). The maximum temperature ranges from 29.3 °C to 36.2 °C and the minimum temperature ranges from 4.5 °C to 19.8 °C.

The study sites (CTR&TI., Ranchi) were selected because of widespread termite mounds in these areas. In each sample location, replications of three termite mounds were selected on a uniform slope from normal field, cowdung pit and termite mounded tree's trunk. In the termite mounded in normal plain areas, external and internal mounds were sampled separately after destruction of termite mound. The external/wall of the termite mounds were sampled after scratching and removing the outer surface of mound materials. The internal termite mound (chamber) with thin structure was sampled separately. Simultaneously, termite mound samples were also collected from cowdung pit and trees trunk. Collected termite mound soils were separately packed and processed in the soil analysis laboratory, CTR&TI., Ranchi. Termite mound soils were soaked overnight in distilled water followed by filtered through whatman no. 01 filter paper. The filtered solution was used for foliar spray on tasar host plant (*Terminalia arjuna*). The foliar spray with termite mound filtered solution was done in two times with fortnight week interval.

The soil samples were air dried ground, mixed well and passed through a 2 mm sieve for analysis. Soil chemical properties such as pH [10] and soil organic carbon (SOC) [11] were analysed. The composite soil samples were analysed for available macronutrients such as nitrogen [12], phosphorus [13] potassium (1N ammonium acetate extractable). Leaf samples were harvested after one month of the second spray has been done on plants. These leaf samples were processed and analyzed for total nitrogen, phosphorus and potassium concentration as per the standard procedures.

The nutrients content of soil and leaf data was analysed using SPSS software. One way ANOVA was used to compare the mean data among different termite mounds samples. Differences were considered significant only when p values were lower than 0.05.

Results and Discussion
Mound soil parameters

The pH of termite mounds of various zones was not significantly different in relation to the control (**Figure 1**). The result is in agreement with study conducted by Brossard *et al* [14] i.e. termite activity did not affect the soil pH.

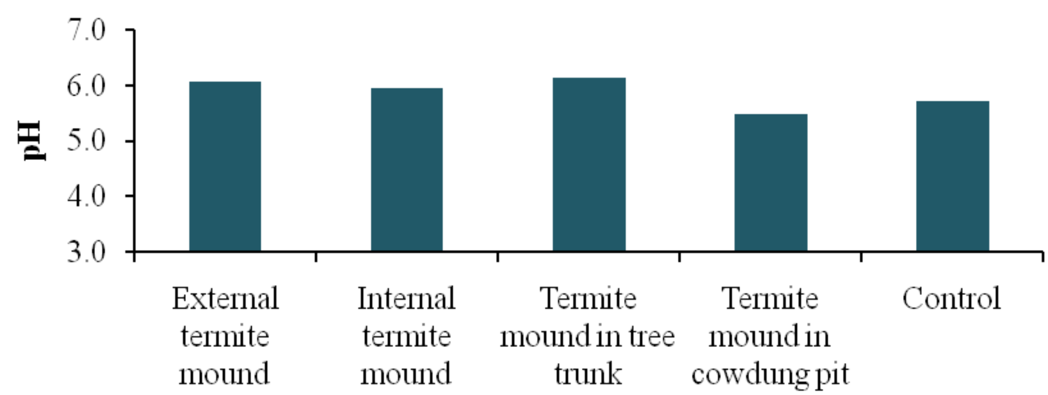

Figure 1 pH status of different source of termite mound soil

The SOC content of external mound was significantly lower than internal, tree trunk, cowdung pit and control at sampled site (**Figure 2**). Termite mounds in cowdung pit samples showed higher SOC (1.34%) followed by control (0.68%). The decrease in SOC in termite mounds in relation to the control soil could be attributed to termite SOC depletion potential with other soil microorganisms [15]. Some researchers argue that the low SOC content in termite mound could be due to low SOC from subsoil used for mound construction [16]. Higher SOC for even control soil was obtained by Jouquet *et al*., [17] in relation to the termite mound. The significantly lower organic matter content in the termite mound compared to the surrounding top soil (0- 15cm) was an indication that the termite mound was built with subsoil [18, 19].

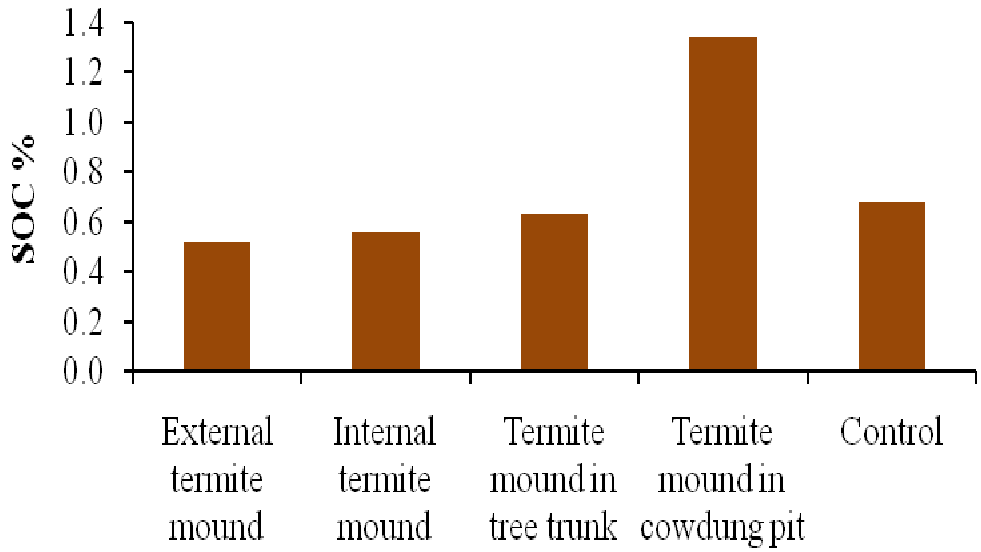

Figure 2 Soil Organic carbon (SOC) in percentage status of different termite mound soils

The available nitrogen, phosphorus and potassium status of termite mound samples is presented in **Table 1**. The result shows that termite mound from cowdung pit had significantly higher available nitrogen than all other samples. The lower amount of nitrogen was observed with external termite mound and control samples. The higher available nitrogen status of termite mound in cowdung pit might be due to the considerable mineralization rate of cowdung organic matter. Ackerman *et al*., [20] obtained higher available nitrogen content in termite mound than control.

Table 1 Available nutrient status of different termite mound soils collected form CTR&TI., Ranchi

Sample	Nitrogen	Phosphorus	potassium
External termite mound	163.07c	21.70b	201.79b
Internal termite mound	113.60d	16.50d	146.81d
Termite mound in tree trunk	204.47b	19.10c	164.57c
Termite mound in cowdung pit	246.21a	86.22a	278.63a
Control	163.07c	10.20e	143.10d

The available phosphorus content of termite mound in cowdung pit (86.22 kg ha^{-1}) sample was significantly higher followed by external termite mound (21.70 kg ha^{-1}) and termite mound in tree trunk (19.10 kg ha^{-1}) than control. Higher availability of readily phosphorus content in cowdung pit sample could be the reason for higher P. The feeding habit of termite and materials used for construction of mound can have significant impact on phosphorus sorption affecting availability of phosphorus for plant uptake [21].

Status of available potassium content in termite mound soils ranged from 143.10 kg ha^{-1} to 278.63 kg ha^{-1}. Termite mound in cowdung pit had significant higher available potassium (278.63 kg ha^{-1}) followed by external termite mound (201.79 kg ha^{-1}) in relation to control. However, internal termite mound and control were not significantly varied with each others. This result is consistent with study conducted by Jouquet *et al*. [22]. According to the rating by Jones [23], the available potassium content of samples is medium. This might be due to release of potassium from termite soils under higher aeration and porous conditions and creation of favourable soil environments with presence of organic matter.

Leaf samples

In **Table 2** the effect of foliar spray with solution of termite mound and control soil on nutrient content of *T.arjuna* leaf. The nitrogen content in plant by spraying with different termite mound soil solution varied from 0.60 to 1.12%. The significant maximum nitrogen content (1.12%) in leaf was obtained from the treatment of spray with termite mound in tree trunk followed by termite mound in cowdung pit solution. The lower nitrogen content was observed with external termite mound solution spray on the plant. The higher content of total nitrogen observed with termite mound in tree trunk and in cowdung pit solution might be due to these mound soils were higher concentration of available nitrogen content. Total phosphorus contents varied from 0.44% to 0.64% in treated plants. Plant treated with internal termite mound solution spray had significantly higher total phosphorus content followed by termite mound in cowdung pit solution spray. However, termite mound in tree trunk and external termite mound spray found significant similar with each other. The lower content of total phosphorus was obtained with treatment of control. Potassium content in treated leaf samples ranged from 0.71 to 0.53%. The higher potassium content significantly recorded with termite mound in cowdung (0.71%) followed by internal termite mound (0.68%) and external termite mound soil solution spray. Plant treated with control was recorded lower potassium content (0.53).

Table 2 Nutrient concentration of leaf (*T. arjuna*) after spraying with different termite mound soil solution

Samples	Nitrogen	Phosphorus	Potassium
External termite mound	0.60e	0.44c	0.62c
Internal termite mound	0.75d	0.64a	0.68b
Termite mound in tree trunk	1.12a	0.48c	0.59d
Termite mound in cowdung pit	1.05b	0.57b	0.71a
Control	0.96c	0.45c	0.53e

Conclusion

It could be concluded that use of termite mound soil is a one of alternative to chemical method for better nutrient management. Termite mound soils help to improve the physical and chemical properties of soils in cultivable lands. In future, amount of termite mound materials that should be incorporated to soil to increase crop yield and socio economic factors that influence the use of termite materials as soil amendment should be studied.

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