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Shade trees in tea plantations in different soil conditions of North Bengal

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Abstract

The paper reported the occurrence of 24 species of shade trees in tea plantations on various soil conditions in North Bengal region. The prevailing soil types and different soil characteristics have been recognized in the area. Suggestions related to the proper selection of shade trees also have been provided.

***Key words*:** Shade tree, soil conditions, North Bengal

INTRODUCTION

The indigenous Assam tea was found in the understorey of the forest. From this basic knowledge it was assumed that tea plants are grown ideally in shade environment. Most of the tea plantations therefore maintain a partial shade condition. Shade trees canopy protect tea bushes from excessive radiation or heat and efficiently conserves soil moisture (Ripley 1967). In drought prone areas, deep rooted shade tree species are loped acropetally from lower branches which are very useful to protect the tea bushes below. Shallow rooted species seriously compete with tea for moisture in the dry season and are loped at frequent interval to ensure a single leaf canopy. A happy balance between the temporary and permanent shade trees maintain proper light quality and ensure better photosynthesis. Sunlight is also associated with heat and these two factors affect plants in very different ways when considered in isolation. But under natural conditions sunlight and heat always go together.

It appears that the primary function of a shade tree is merely to prevent excessive heating up of tea leaves by "trapping" some of the infra red rays from the sun before they reach the tea bushes. In this process some of the useful visible spectrum of light might also be trapped by shade trees which the tea bush requires for photosynthesis. Practically, it is the balance between the amount of heat removed and the amount of light let through which determines the efficiency of a shade tree. In North-East India, only 20 to 30 % of the sunlight of clear sunny day of June was utilized by tea plants and 0.2 to 0.3 cal/ cm^2 /min is sufficient for maximum photosynthesis. Light intensity above 0.4 cal/ cm^2/ min depresses photosynthesis in tea leaves due to photobleaching.

Soil is the mother of all living creature. Selection of soil is crucial for the growth and development of any plant species. Sometimes, wrongly selected place of planting of shade trees causes economic damage. Therefore, it is important to select appropriate soil before plantation for better adaptability of shade trees.

Information regarding suitability of shade trees in different soil status is scanty and yet to attract much attention of botanists or even tea scientists. There is no account of this type in Champion's (1936) survey.

The present studies have been undertaken to gather information about different species of shade trees grown in different soil conditions of North Bengal tea gardens for determining their suitability of plantation.

MATERIALS AND METHODS

Characterizations of soil

Soil samples were collected from the different tea growing regions of North Bengal namely, Terai, Dooars (divided in to three zones: eastern, middle and western) and Darjeeling hills (lower, middle

and higher elevation areas) as per method prescribed by Misra *et al*. (2009). The moisture content, *pH* and textural class of the soil samples were analyzed at least thrice in a year following Jackson (1978).

Fig. 1: The study area

Documentation of shade trees

Different Tea Gardens in the study area have been visited in different seasons during 2007 – 2008. Voucher specimens have been collected and processed into mounted herbarium sheets using conventional methodology (Jain & Rao 1977). Specimens were identified in the Taxonomy and Environmental Biology Laboratory, Department of Botany, University of North Bengal. All voucher specimens have been kept in the museum of the Department of Tea Management, University of North Bengal. The identified species have been enumerated here in tabular form, family wise following Bentham and Hooker's (1862 – 1883) system of classification. The soil types of the habitat of the recorded species also have been presented in a table.

RESULTS AND DISCUSSION

Soil characteristics of different locations of North Bengal

Most of the tea growing areas of North Bengal receive heavy rain fall, but due to the porous nature of soil of Terai and Hilly region, ordinarily water does not accumulate for long and, therefore, large marshy or swampy areas do not exist in this region. However, at some places of Terai and Dooars seepage or drainage water from tea gardens some ephimeral swamps are created at some low lying places. Some of these dry up soon after monsoon, but permanent soggy and swamps are quite often met with. But, such swamps, soggy and dry areas are not restricted to any particular region. Dry, sandy riverine soils are sandy soils with pH > 4.5, a good soil structure, and high infiltration capacity and with poor fertility status. These types of tea soils are found in Uttardinajpur, Jalpaiguri and Darjeeling districts in the main catchments of the rivers Mahananda, Balaon, Teesta, Torsha, Jaldhaka and Kaljani.

Alkali soils are clay soils with high pH, a poor soil structure, and low infiltration capacity. Often those have a hard calcareous layer i.e. Kankar. Due to poor infiltration capacity, rain or flood water stagnates on such soils easily. Surface water logging is its usual phenomenon due to high silt fraction, larger specific surface smectite clay. The alkalinity is associated with the presence of dolomite (Calcium magnesium carbonate) in the soil either as a result of natural weathering of the soil particles or brought in by flood water. Most of the tea areas adjacent to Bhutan are having this

type of soil. Denudation occurs mostly in the hills, slopy areas of Darjeeling due to erosion and weathering, slash-and-burn practices, certain forms of intensive farming. These involve removal of both solid particles and dissolved materials in the soils. The studies were carried out over a number of places scattered all over the tea growing areas in different seasons and on the basis of moisture contents, water table, *pH*, clay, sand silt fractions of the soil and may be classified as in Table 1.

Table 1: Soil classification as per soil test report

Range of moisture contents (%), oven drying	Water Table (Meter)	*pH* range	% of sand fraction	% of clay fraction	% of silt fraction	Soil texture	Soil type
19.35 – 20.12	Within 5-6	4.80-5.60	81	14	5	Sandy	Dry, sandy riverine soil
39.48 – 44.25	8-10.2	3.90-4.50	27	63	10	Clayey	Swampy soil
31.26 – 35.26	10.6-12.3	4.00-4.65	23	59	18	Clayey	Moist soil
23.15 – 20.31	13.8-15.6	7.60-8.00	20	55	25	Clayey	Alkali soil
20.65 – 19.65	Not done	4.90-5.50	42	34	24	Sandy clay	Denuded hill slope
22.32 – 18.69	Not done	4.50-5.30	51	32	17	Sandy clay	Land slide prone hill slope

Documentation of shade tree species grown in different types of soil

Camellia sinensis is planted in Darjeeling on different types of soil namely riverine soil, swampy, soggy and alkaline denuded hill slope soils and shade trees are widely planted in most of these plantations. Tea plants occupy the lower stratum in such artificial plant community and are generally not mixed with any other species. Shade trees in Tea Gardens form a open canopy and this stratum is usually a mixed community. 24 species of such trees recorded from the areas under study have been presented in Table 2 along with the soil and land types where they are grown. Many of these plants are deciduous trees and their leafless period has also been recorded in this table.

For the selection of shade tree species apart from soil conditions some other factors are also need to be considered like: (i) shape of the canopy, (ii) economic life, (iii) pest and disease resistance, (iv) hardiness, (v) depth of root system, and (vi) foliage retention (Singh 2005). These factors have definite bearing on the management of the shade trees and help to determine spacing, amount of lopping required and rotation. The more resistant the trees to pests, diseases and storm damage, the easier will be their maintenance. A deep rooted system of shade trees is desirable as it can explore the soil below the rhizosphere depth of the tea roots. However, it should be noted that a high water table will restrict the root development of shade trees.

Table 2 also shows the leafless period of different recorded shade trees. Rejected leaves, after receiving irrigation water or few showers of rain, gets decomposed and enrich the soil. Further, it reduces heat of the soil, loss of soil moisture and improves the physical properties of soil. On the basis of leafless period and the agro-climatic conditions, the intimate mixtures of shade trees are helpful. This type of mixtures for Dooars and Terai may be *Dalbergia sissoo, Adenanthera pavonina, Albizzia odoratissima, Albizzia lebbek* and *Indigofera teysmanii* (TRA 1995). It is the well established fact that in the plains of North East India, provision of some form of shade by planting shade trees is a must for better growth and production of tea.

Table 2: Shade tree species in different soil [DSR = Dry, sandy & riverine]

Importance of shade trees

It is a well known fact that with increase in elevation, there is a decrease in temperature. With every 100 meters increase in altitude, there is a decrease in temperature by 0.6°C-0.7°C. This together with the fact that wind speed in the hills are usually greater than on the plains, shade trees for reducing leaf temperature will not be required above certain elevations in Darjeeling. Other than very young tea bushes, the leaves of the same bush provide shade to each other and the lower leaves in a canopy rarely receive anything like one quarter of the optimum light intensity during the day. Therefore, by shading the upper leaves with a shade tree, the majority of leaves do not have sufficient light for maximum photosynthesis. The amount of light reaching the bottom of the bush stratum depends mainly on the type of tea bush. In case of large horizontal leaf types, it would be less than that of semi-erect hybrid type which would be much greater. This is known that by of reflection from the more upright leaves, more light would be reflected on the down ward canopy. As both non-heating and heating lights get reflected, upright leaves do not get as overheated as horizontal leaves under normal conditions. The main reason why exposed leaves in N.E. India (except Darjeeling) become excessively hot is that in general our wind speeds are very low during the hottest times of the year. Wind is very effective in removing excess heat. Therefore, growing shade trees in tea gardens are very much essential as a means of reducing the deleterious effects of heating from sunlight.

Name of shade trees [Exsiccata]	Family	Soil type	Land type	Deciduous period	Used in
Millingtonia hortensis L.f. [*Tarun 015, 032*]	Bignoniaceae	Swampy	Plains	Jan – March	Plantation, nursery
Neolamarkia cadamba (Roxburgh) Bosser [*Tarun 017, 046*]	Rubiaceae	Moist	Plains	–	Plantation, nursery
Trema orientalis (L.) Blume [*Tarun 028*]	Ulmaceae	DSR	Plains	–	Plantation

CONCLUSION

The listed species of shade trees can be used in different soil conditions and should be planted in advance, before planting tea plants. During rehabilitating old tea lands, shade trees should be planted at the beginning. These plants are to be selected judging the soil condition of the area under consideration.

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