

WEED FLORA OF TEA GARDENS OF DARJEELING TERAJ

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A B S T R A C T

Tea is under cultivation in Darjeeling hills since 1835 and in Terai it was introduced in 1862. Any cultivated field in this region is liable to be affected by weed infestation as the local flora is extremely rich. The crop loss in tea gardens of this area is quite considerable and the planters practice a good variety of deweeding techniques. Four tea gardens of Terai, namely (1) Hansqua, (2) Kamalpur, (3) Satvaya and (4) Gulma and Mohorgong Tea Estates were surveyed for flora and phytosociological information. While the existence of a rich and diverse flora has been exposed, the similarity of the weed flora of these gardens is quite high and four weedy species have been recognised which are affecting all these gardens almost uniformly.

INTRODUCTION

Darjeeling is the northernmost district of West Bengal, three of the four sub-divisions of which are part of Eastern Himalaya. The district is located within 26°31'05" and 27°13'10"N latitude and between 87°59'30" and 88°53'E longitude and covers an altitudinal range of ca 132 m (at Siliguri) to 3660 m (at Phalut). Three 'T's, "Tea, Timber and Tourism" formed the economic backbone for the people of this northernmost part of West Bengal that is more popularly referred as North Bengal.

For the Scientists, this northernmost part of the state is also important for its rich biodiversity. Eminent plant explorers, including Sir J.D. Hooker studied the flora of this region. Numerous organisations from far away countries tried to explore the flora of this region which include Tokyo University [*Flora of Eastern Himalaya*] (Hara 1966, 1971; Ohashi 1975), British Museum of Natural History [*Enumeration of the Flowering Plants of Nepal*] (Hara *et al.*, 1978, 1979; Hara & Williams 1982), Royal Botanic Garden, Edinburgh [*Flora of Bhutan* (Grierson & Long 1983, 1984, 1987, 1991, 1999, 2001; Noltie 1994, 2000; Pearce & Cribb 2002)], etc.

Darjeeling is situated almost at the central part of Eastern Himalaya and is equally rich in biodiversity as its western and eastern fringes (Das 1986, 1995; Das & Chanda

1987; Bhujel & Das 2002; Bhujel *et al* 2002). Over 30% species of higher plants (i.e. Angiosperms) of this region are endemic (Grierson & Long 1983; Das 1995; Bhujel & Das 2002). This type of rich vegetation is not restricted to the hill regions only. Different types of vegetation in Terai and Duars are also equally rich. Endemic plants also inhabit the grassland vegetation in Terai (Das 1996; Bhujel *et al* 2002).

Tea Gardens in Darjeeling

In India West Bengal is famous worldwide for its Darjeeling tea. Dr. Campbell first sowed tea seeds in 1835 in an experimental nursery at Lebong. After that, from Darjeeling hills, tea cultivation spread to Terai in 1862. In 1874, the first garden in Duars came up. Since then, in regular intervals, new tea gardens are coming up, sometimes in denuded forestland or by clearing the herbland vegetation. As the herbland vegetation do not produce timber, apparently, those were thought to be useless. Today, in Darjeeling district wide areas are under tea cultivation, and there are at least 102 tea estates situated in Darjeeling district alone. Darjeeling tea has its unique characteristics and natural flavour that made it a national symbol all over world and most of the produce of this area is exported.

Suitability of Climatic Makeup for Weed Infestation :

As it has already been mentioned, the climate of Darjeeling is much favourable for the tea-cultivation. It is also favourable, certainly, for the growth of numerous other plants and it is the common experience of local people that in any cultivated field weed infestation is a great problem in this part of the country. Tea gardens are no exception.

What is a Weed?

Weeds are unwanted plants growing within the cultivation of a particular crop plant. Even if a paddy plant grows in the wheat field - that will be regarded as a weed. So, any other plant, if not grown purposefully, growing in tea gardens, interfering with the growth and yield, whether useful or useless, are treated as weeds, and for the improvement of tea cultivation it is essential to remove them from plantation areas.

Weeds cause loss of crop production (Thakur, 1954) sometimes to the extent of nearly 90% of expectation. These plants create or modify the habitat in such a manner which does not favour the proper growth of crop plants by utilising space and nutrients for their own growth. Like all other crops, tea gardens also are greatly affected by weeds causing qualitative and quantitative loss of crop (Mustafee, 1981, 1998).

Weeds are neither strangers nor a special group of plants, which grow only in cultivated fields. In fact, most of these plants are coming from the local vegetation. But, they can survive in the tea gardens due to their adaptive features and broad ecological amplitude. Most of the weeds are supposed to be high reproducers, i.e. with high reproductive potential and must be hardy plants.

Harmful Effects of Weeds on Tea

Weeds grow abundantly in tea estates and their harmful effects include:

1. In young tea, weeds remove as high as 270 kg Nitrogen per ha.
2. Some species of weeds serve as hosts for pests (Red spider, Tea mosquito bug, Root knot nematode, etc.).
3. About 6-15% crop loss due to competition by weeds.
4. Weeds compete with tea not only for nutrients but also for moisture and light.
5. Some weeds grow on tea bushes absorb nutrients and fuse with the tissue of tea plants.
6. Epiphytic ferns and orchids also affect tea plants due to their luxuriant growth.
7. Some weeds, specially climbers, grow over the tea bushes and reduce the speed of plucking.
8. The foetid smell of some weeds can also reduce the quality of tea.

Usefulness of Weeds:

Besides many harmful effects of weeds, many of these also have some beneficial effects:

1. Weeds minimise the force of falling raindrops.
2. Check soil erosion on sloping land mainly in hilly terrains.
3. Many weeds have medicinal importance.
4. Some of the weeds used as food and fodder.
5. Weeds add good amount of humus into the soil.
6. Weeds retain the actual soil structure or even improve the situation.
7. Some weeds fix atmospheric nitrogen in soil.
8. Weeds help to maintain a balanced structure of ecosystem.
9. Some weeds provide food and shelter for numerous local animals; etc.

Previous Work:

Realising the problem many authors, tried to explore the weed flora in tea gardens in Northeast India (Mustafee, 1972, 1988). Late Prof. A.C. Datta (of Cotton College, Guwahati) established one rich and beautiful 'Tea-Weed Herbarium' at the Tocklai Tea Research Centre at Jorhat, Assam (Dutta, 1983).

Not only in this eastern and northeastern part of the country, similar works have been done also in the Nilgiris. In all these areas existence of rich flora inside the plantations has been recorded (Harikrishnan 1978; Ramachandran 1978; Haridas & Sharma 1972; Haridas & Venkataramani 1972; Rahaman 1975).

There is much difference between the flora of Assam or other states of North-east India and Darjeeling (including Terai) and, it is expected that the weed flora also will be quite different as weedy plants come mostly from the local flora and enter the crop fields through different channels.

The Present Work:

The present work is designed mainly to evaluate the richness of the weed flora of tea gardens in the Darjeeling part of Terai. This part of Terai include the whole of Siliguri subdivision and small slices of Kurseong subdivision (both of Darjeeling district) and of West Dinajpur district. The moderate summer and chilling winter, slightly to moderate acidic sandy loam soil with good water holding capacity and the well distributed high annual rainfall (200 to 360 cm/ annum) in the area favours tea cultivation. There are 62 gardens in this region and the total area under tea production is *ca* 20356 ha. This is a very high productive region with the average yield of 1717 kg/ ha.

Four tea gardens of Terai (1) Hansqua Tea Estate [125 m amsl; 26° 37.784' N Latitude & 88° 19.068' E Longitude] (2) Kamalpur Tea Estate [154 m amsl; 26° 42.341' N Latitude & 88° 18.428' E Longitude] (3) Satvaya Tea Estate [152 m amsl; 31° N Latitude & 88° 12' E Longitude] and (4) Gulma & Mohorgong Tea Estate [168 m amsl; 26° 47.203' N Latitude & 88° 22.866' E Longitude] [A GPS (GARMIN 12CX) was used to determine the altitude and location of these gardens].

All these gardens are nicely maintained and are productive. Though dweeding is a regular practice in these gardens, even then luxuriant shade loving mesophytic vegetation is found to develop there. To cover all types of perennial and seasonal elements, detailed survey was made in these gardens in three different seasons (i) Winter (ii) Pre-monsoon and (iii) Post-monsoon.

For the floristic survey different weedy species of plants were spotted and collected at random. Specimens were processed and identified in the Taxonomy & Environmental Biology Laboratory of the Department of Botany, University of North Bengal and are preserved in the 'NBU-Herbarium'. Phytosociological studies were also conducted using 1 x 1 m quadrat sampling for determination of Relative Density (RD), Relative Frequency (RF) and Relative Abundance (RA) of different weedy species. Index Value (IV) was calculated by summing up the values of RD, RF and RA of different species.

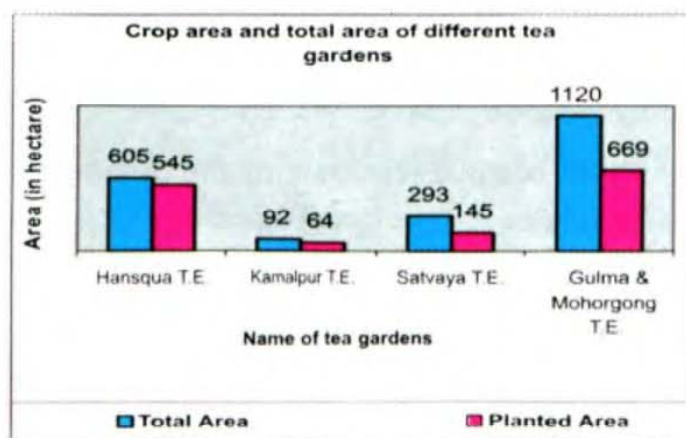


Fig. 1: Sizes of different tea estates under study: total area and the area under plantation

RESULTS AND DISCUSSION

The four tea gardens are situated mostly in similar climatic condition. Though de-weeding is a regular operation in these gardens but a large number of weedy plants are growing there. From all these gardens well over 190 species of weedy flowering plants have been recorded (Table 1). Gulma and Mohorgong T.E. appeared to be the most weedy garden with the record of 194 species of plants and is followed by Satvaya T.E. (152 spp.) and Kamalpur T.E. (145 spp.). Considering the diversity in generic and familial level also Gulma and Mohorgong T.E. showed the highest diversity. It is also interesting that the plants of diverse habit groups are growing in these gardens including trees, shrubs, climbers, annual and perennial herbs including geophytic and epiphytic ones. Many climbing plants like *Ichnocarpus frutescens*, *Mikania micrantha*, *Trichosanthes tricuspidata*, *Stephania japonica*, *Pericampylus glaucus*, *Ipomoea nil*, *Ipomoea purpurea*, *Pueraria phaseoloides*, *Mukia maderaspatana*, *Zanonia indica*, *Luffa aegyptiaca*, *Argyreia roxburghii*, *Natsiatum herpeticum*, *Passiflora foetida*, *Cucumis melo*, *Paederia foetida*, *Mimosa* sp., etc. are abundant in these gardens. But the most interesting group must be the epiphytes. Common epiphytes like *Lepisorus involuta*, *Lepisorus scolopendrinum*, *Drynaria quercifolia*, *Bulbophyllum bisetum*, etc. are commonly found on tea plants. But, at the same time a good number of other terrestrial plants like *Borreria ocymoides*, *Oxalis corniculata*, *Typhonium trilobatum*, *Peperomia pellucida*, *Diplazium esculentum*, *Cheilanthes argentea*, *Selaginella ciliaris*, *Gnaphalium polycaulon*, *Ixeris polycephala*, *Hedyotis corymbosa*, *Axonopus compressus* and *Digitaria ciliaris* are found growing on wounds or branch axils of tea plants as false epiphytes.

Table 1: Numerical records of taxa in different tea gardens.

Gardens		No. of Families	No. of Genera	No. of Species
1.	Hansqua Tea Estate	44	102	139
2.	Kamalpur Tea Estate	46	111	145
3.	Satvaya Tea Estate	47	111	152
4.	Gulma & Mohorgong Tea Estate	50	131	194

Similar environmental conditions generally lead to the formation of similar type of vegetation along with the high degree of similarities in flora. As these gardens are experiencing almost similar type of environmental conditions, a high degree of similarities in their weed-flora was expected and Table 2 presents the degree of such similarities among the gardens under study. Kamalpur T.E. and Satvaya T.E. showed highest similarities (98%) in their weed flora.

Table 2 : Similarities in flora (in %) among the gardens under study.

↓ Gardens →		G-1	G-2	G-3	G-4
G-1	(Hansqua T.E.)	x	93	93	81
G-2	(Kamalpur T.E.)		x	98	82
G-3	(Satvaya T.E.)			x	84
G-4	(Gulma & Mohorgong T.E.)		x		

Apart from the flowering plants, a good number of non-flowering plants are also recorded from these gardens. The pteridophytic flora is quite rich (with 18 spp. under 14 genera) and many of them are dominating elements like *Diplazium esculentum*, *Lygodium flexuosum*, *Selaginella ciliaris*, etc. The tea plants are maintained as small bushes, with around 90 cm height only. Even then a good number of epiphytic ferns are found growing on them. The climbing fern genus *Lygodium* sometimes grows luxuriantly on tea-bushes and is represented by two species, *L. flexuosum* and *L. microphyllum*. The occurrence of *Gleichenia linearis* in Hansqua and Kamalpur Tea Estates is interesting as it is one well-known temperate plant.

Apart from pteridophytes, numerous species of mosses, liverworts and fungi are also recorded from these gardens. Among algae the epiphytic *Trentepohlia* sp. and parasitic *Cephaleurus* sp. are quite common.

Among the recorded 53 dicotyledonous families, most dominating ones are Asteraceae, Rubiaceae, Euphorbiaceae and Scrophulariaceae. And, out of 10 monocotyledonous families Poaceae is most dominant which is followed by Cyperaceae and Araceae. Table 3 presents the ten dominating families recorded from these Tea Estates.

Among these, the highest number of taxa has been recorded for Poaceae. Probably the life-forms of these plants are helpful to sustain against the deweeding practices. However, Asteraceae generally remains as a dominating family in herbaceous vegetation which is also true in these tea gardens. The speedy dispersal mechanism, broad ecological amplitude, etc. generally help them to thrive in many inhospitable environments. Plants of Araceae are found to be quite successful with their underground rhizome in most of the cases. Most of the deweeding practices can damage only the aerial parts of plants and not the underground perennating organ.

It is reported that some taxa like, *Borreria alata*, *Dryopteris filix-mas*, *Polygonum hydropiper*, *Polygonum chinense*, *Mikania micrantha*, *Ageratum houstonianum*, *Ageratum conyzoides*, *Cynodon dactylon*, *Imperata cylindrica* and some species of *Cyperus* create major problem in tea gardens and are difficult to control. These taxa are now almost resistant to chemical herbicides, spreading very fast and are responsible for decreasing the production of crop.

Table 3: List of ten dominating families recorded from the tea gardens of Terai.

Sl. No.	Families	No. of genera	No. of species
1.	Poaceae	23	32
2.	Asteraceae	20	29
3.	Rubiaceae	10	18
4.	Cyperaceae	05	15
5.	Euphorbiaceae	07	13
6.	Fabaceae	07	13
7.	Scrophulariaceae	06	12
8.	Araceae	04	08
9.	Acanthaceae	07	07
10.	Polygonaceae	01	07

From the phytosociological analysis, RF, RD, RA and IV of different species of weeds have been determined. Tables 4, 5, 6 & 7 presents 10 species with determined high values of IV from each of these four gardens under study.

It interesting to note that though there is very high degree of similarities in the floras of these four gardens but the dominating species are not same. Only four species, *Borreria alata* (Average IV:60.04), *Ageratum conyzoides* (Average IV: 36.2), *Gnaphalium polycaulon* (Average IV: 30.5) and *Oxalis corniculata* (Average IV: 29.09) are common dominating weeds in these four gardens.

It is quite interesting that three other species like, *Borreria ocymoides*, *Digitaria ciliaris* and *Cynodon dactylon* are highly dominant in three of these gardens. *Ageratum houstonianum*, a naturalised exotic, is dominant in two gardens and another thirteen species were found dominating in any one of these gardens only. However, all of these dominating 21 species are present in all the four gardens under study.

The flora of open areas inside the gardens and flora inside plantations are slightly different, but most of the species also grow among the bushes but with different vigour, frequency and density.

Among these weedy species, some plants like, *Polygonum barbatum*, *Polygonum orientale*, some ferns have preference to grow in wet places. But, plants like *Borreria alata*, *Borreria ocymoides*, *Mitracarpus verticillatus*, *Hedyotis corymbosa*, *Oxalis corniculata*, *Phyllanthus reticulatus*, prefer to grow in dry habitat. During the period of January–February, *Gnaphalium polycaulon*, *Pseudognaphalium affine*, *Oxalis corniculata*, become much dominant. But during May–June, *Borreria alata*, become most abundant. Some other plants like *Hedyotis corymbosa*, *Pouzolzia zeylanica*, *Rungia pectinata* etc. are found to be abundant during October–November.

If all the species are analysed for Raunkaier's (1934) life-form classes then one can notice that all classes (Phanerophytes, Chamaephytes, Cryptophytes, Hemicryptophytes and Therophytes) are available among the weeds. However, Therophytes, Hemicryptophytes and Cryptophytes are dominating as these can save themselves more effectively against different types of deweeding practices adopted in these gardens.

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