Introduction

All over the world 'tea' is a popular invigorating and refreshing drink having excellent medicinal properties. Tea is a plantation crop growing under monoculture. Tea, *Camellia*

sinensis (L.) O' Kuntze is a native of China and the Chinese are said to have discovered its use nearly 5000 years ago. The word tea is derived from "*t'e*" of the Chinese Fukien dialect. The Dutch introduced it in Europe. In Cantonese, tea is known as Ch'a and this is the name by which this wonderful beverage came to be known in Japan, India, Russia, Iran and the Middle East. The China tea plant, brought to Japan about AD 800, was regarded as a medicine for 500 years, until green tea was developed which became a

popular Japanese beverage. Tea was introduced into Europe in the early 17th century, with the beginning of trade between Europe and the Far East. By 1715 the British East India Company, with a monopoly on overseas trade held over those British companies that were operating in Asia, was firmly established in Canton. Tea is also indigenous to India, and was found in wild condition Assam, never less the Commissioner of Assam, in the 1830's, ordered clearing of the dense forests to make way for planting of tea plants introduced from overseas. Thus began the cultivation of some of the world's greatest black teas fittingly named after Assam and Darjeeling (Anonymous, 1973).

Tea is currently produced in about 30 countries, ranging from Soviet Georgia, latitude 42 degrees N, to South Africa, latitude 29 degrees S. The prime producers are India, Sri Lanka (formerly Ceylon), and China, with Japan, eight African countries,

Caucasia (Soviet Georgia, Turkey, and Iran), and South America produces the remaining production (Plate 1a). Tea cultivation has spread to other countries like Taiwan, Indonesia, and Kenya, Malawi, Mozambique, Tanzania, Uganda and Zaire in Africa. The tea industry is one of the oldest organized industries in India and Indian teas are appreciated world over as health drink for their unique flavour, aroma, and medicinal properties. India produces three special qualities of teas which are exported world over. Tea is cultivated in India in more than 521500 ha and the principal tea growing states are Assam, West Bengal, Tamil Nadu and Kerala (Plate 1b). India contributes about 27.49% of global tea production (ITC-2005) and 78% of Indian tea is harvested from North East India. Of this, 173 and 190 million kg were exported and 697 and 710 million kg were consumed domestically in 2003 and 2004 respectively (Priyakumar, 2005).

According to the statistics of Tea Board, India, there are 308 big and 1232 small tea gardens in North Bengal, of this region the total area under tea is 107479 hectares and in 2003 and total production of made tea was 200 million kg. (Anonymous, 2003). North Bengal produces 23% of total Indian Production.

The commercially cultivated tea plants are divided into the short leaved China plants, *Camellia sinensis*, the Assam plants, *Camellia assamica* (Masters) and the Cambod plants, *Camellia assamica lasiocalyx* (Planchon ex watt) Wight and the numerous hybrids among them.

Three basic requirements must be considered in planning a tea estate: climate, soil acidity, and labour availability. A suitable climate has a minimum annual rainfall of 45 to 50 inches (1140 to 1270 millimeters), with proper distribution. If there is a cool

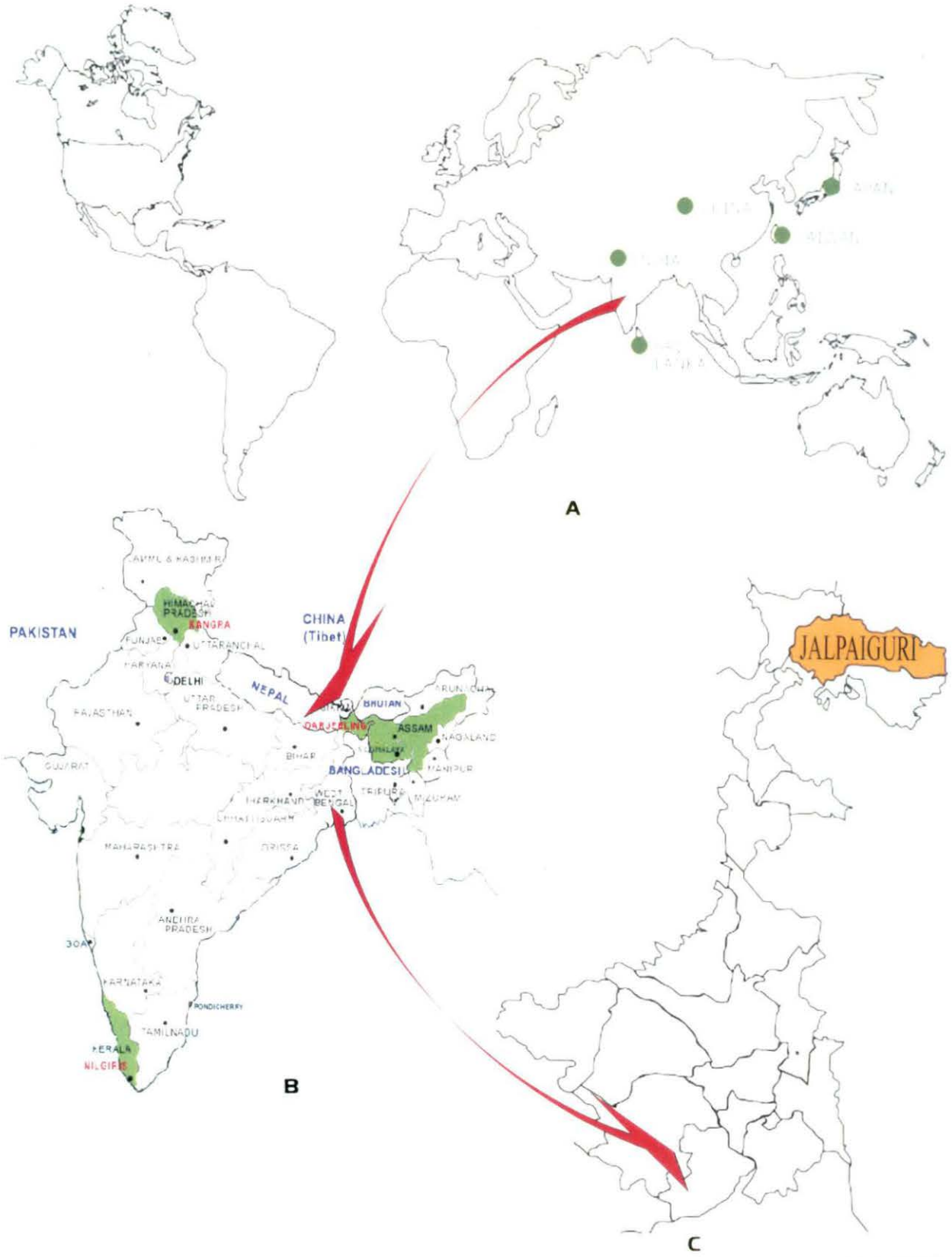


Plate.1 Map related to tea production

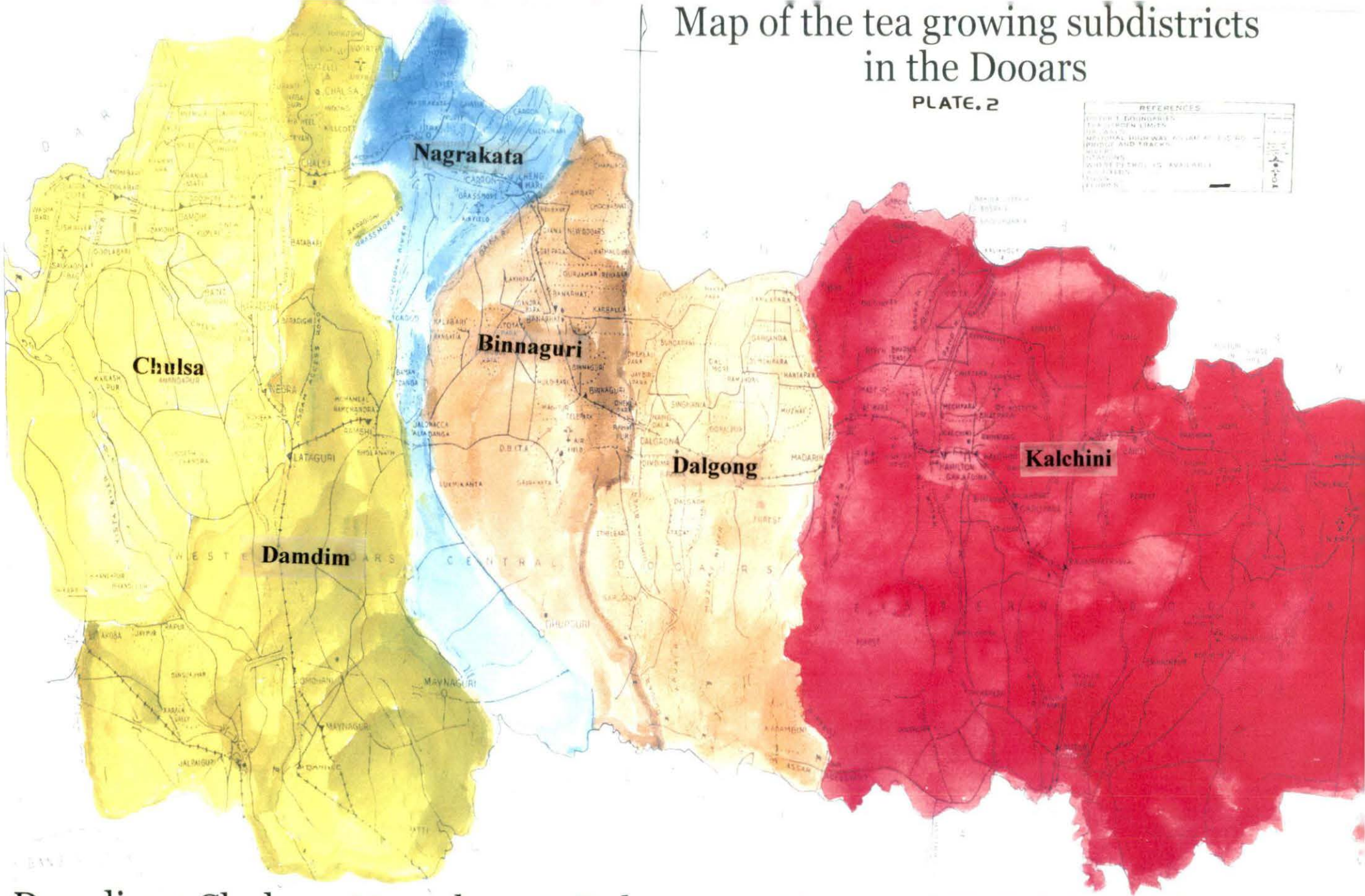
1A. Major tea growing areas of the world (marked green)

1B. Major tea growing areas of India (marked green)

1C. Dooars tea growing Jalpaiguri District in Northern west Bengal, India (marked yellow)

Map of the tea growing subdistricts in the Dooars

PLATE. 2



Damdim □ Chulsa ■ Nagrakata □ Dalgong ■ Binnaguri ■ Kalchini ■

season, with average temperatures 11°C or below the growth rate will decrease and a dormant period will follow. Tea soils must be acidic with a desirable pH value is 5.8 to 5.4 or less (Anonymous, 1973).

The **Dooars** or ***Duars*** area comprises flood plains and the foothills of the eastern Himalayas in North-East India bordering Bhutan. *Duar* means door in both Assamese and Bengali languages which mark the gateway to Bhutan. This region consisting of an area of 8,800 square kilometer (3,400 square-miles) which is located between 26'.16" and 27'.0" North latitude and 88'.4" and 89'.53" East longitude. The altitude of the Dooars area ranges from 90 m to 1750 m. There are innumerable streams and rivers flowing through this fertile plains, the major rivers are the Teesta, Jaldhaka, Torsha, Sankosh, Dyna, Karatowa, Raidak, Kaljani among others (Plate 1c and 2). Most of these rivers mark the borders of the Dooars tea districts mainly stretching within the political district boundaries of Jalpaiguri. Depending on geophysical and climatic condition the Dooars region was divided in to six tea growing subdistrict namely Damdim, Chulsa, Nagrakata, Binnaguri, Dalgong and Kalchini (Plate 2). Average rain fall of the area is about 350 cms. Monsoon generally starts from the middle of May and continues till the end of September. Winters are cold with foggy mornings and nights. Summer is mild and constitutes a very short period of the year.

According to the statistics of Tea Board (India), there are 158 big tea gardens in the Dooars and total area under tea is 92095 hectares. Total production of made tea was 167 million kg and average yield per ha was1816 Kg. Beside these 1,67,245 number small tea gardens were also recorded in the Dooars and its adjoining areas in West Bengal (Anonymous, 2003).

Every part of tea plant is subjected to attack of pest. It is estimated that 1034 species of arthropods and 82 species of nematodes infesting tea all over the world (Chen and Chen, 1989 a and b), though only about 300 species of insect are recorded from India in that 167 species from North-East India (Das,1965), resulting in 11 to 55% annual loss in yield. In North-East India, tea plant is chiefly colonized by insect and mites such as, tea mosquito bug, red, pink and purple mites, thrips, termites, red slug catterpiller, looper caterpillar, green leaf hopper etc (Gurusubramanian *et al.*, 2005) (Plate 3).

Tea mosquito bug, *Helopeltis theivora* Waterhouse (Hemiptera: Miridae) is considered as one of the most notorious pests causing considerable economic loss up to 25% to 50% (Prasad, 1992; Barbora and Singh, 1994; Subramaniam, 1995). Out of a total 4.36 lakh hectares in India, 3.49 lakh hectares (80%) of tea plantations suffer from *Helopeltis theivora* (Bora and Gurusubramanian, 2007).

The tea mosquito bug *Helopeltis theivora* Waterhouse (Hemiptera: Heteroptera: Miridae), the concerned pest species of the present study, is known from the early days of tea cultivation (Peal, 1873; Wood-manson, 1884). Different species of tea mosquito bug (TMB) causes various biotic stresses to tea in different countries. Though commonly called "tea mosquito" these are true bugs belonging to the family Miridae of order Heteroptera. In early years of tea cultivation, planters mistook this pest for a mosquito and hence this name. Both nymph and adult mosquito bugs have sucking mouthparts like a sharp drinking straw. They use their mouthparts to pierce the young parts of the plant (young leaves or buds) and suck the sap of the plant. The part of the plant where a mosquito bug has sucked develops a circular stain that is

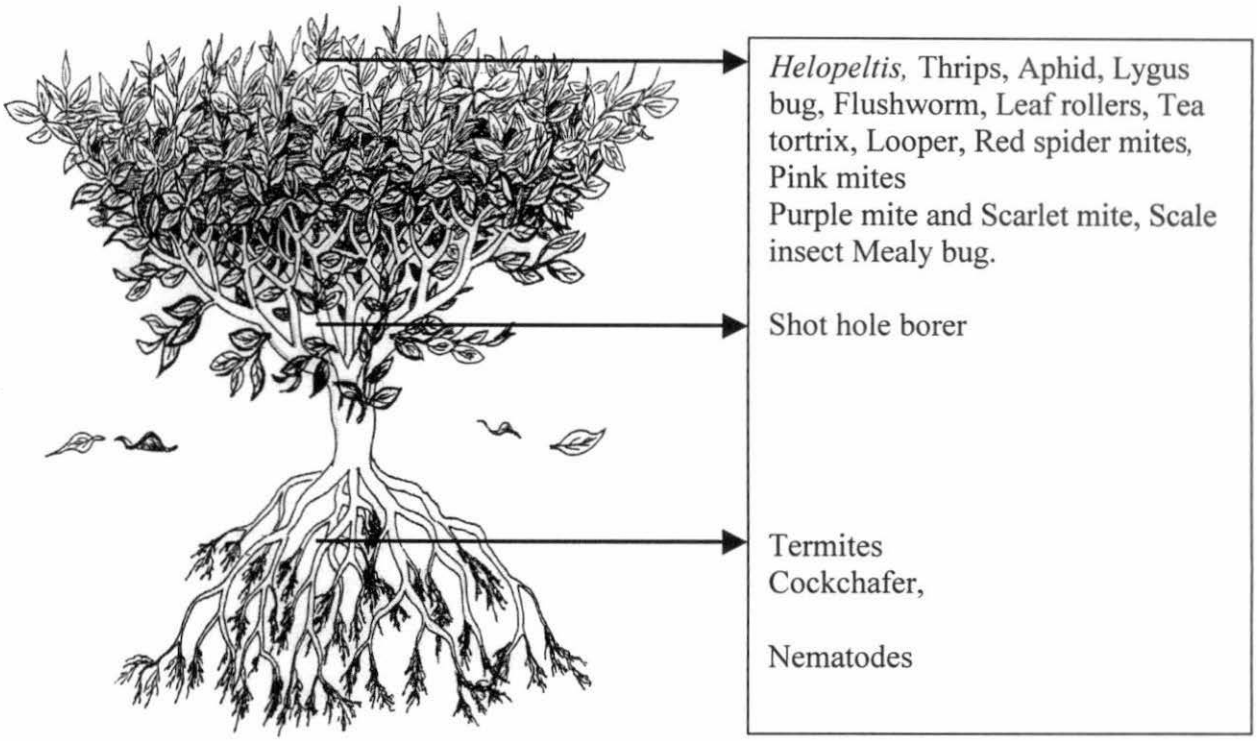
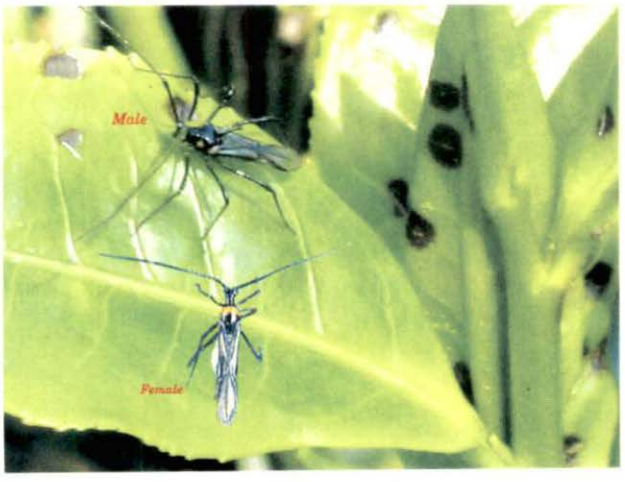


Plate. 3. Spatial Distribution of pests in a bush

dark brown or black circular ring (Plate 4). Nymphs make smaller but more numerous sucking stains than adults. Tea buds, shoots and tender leaves with many sucking stains become curled, dried, and black, producing no yield. Some farmers call this "foggy burning disease". Damaged buds cannot be plucked, which affects the next flush of shoots. In addition, affected buds and shoots often become infected with the disease of tea stem leprosy (die back), in which the stems become covered with many small dark pimples, or with swollen trunk disease. Swollen trunk disease often appears about two months after a heavy attack by mosquito bug. The most seriously affected tea plants have darker green color and are stunted. Mosquito bugs often start from a small area in the tea field and attack a group of neighboring plants. This gives the tea field the appearance of uneven development (Das, 1965).

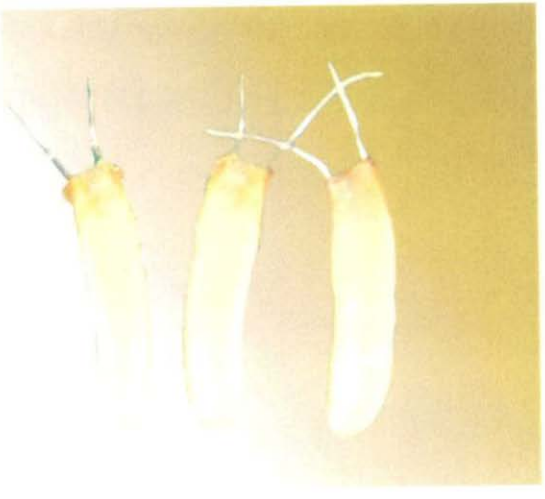
This pest (*H. theivora*) is the major limiting factor of tea production in the Dooars region of North Bengal (Barbora and Singh, 1994). This key pest appears with menacing regularity in a large belt, especially in the main cropping season in the Dooars (Somchowdhury, 1993).

Due to year-round infestation of this major pest, the consumption of insecticides has reached up to 8.20-16.94 liter/ hectares and cost increased by Rs.2500-Rs.6000/- during last five years. The dimension of *H. theivora* infestation is increasing alarmingly, and the consumption of toxic chemical pesticides has also doubled (Gurusubramanian *et al.*, 2005). One of the aspects of the present study is to bring to light and evaluate the repeated complaints form the planters that most insecticides are becoming less effective against the *H. theivora* in the Dooars and the measures adopted for combating this notorious pest are not satisfactory. As a consequence of



Adult *H.theivora* showing dimorphism especially in pronotal colouration

Copulation of *H.theivora*



Eggs

Nymph

Plate 4. Life Stages of *H.theivora*

the large scale use of insecticides resistance may have developed, which calls for adoption of an effective management strategy of the pest.

In spite of lot of disadvantages of chemical control, the use of chemical pesticides remains one of the obligatory and most widely used pest control tactics because:-

1. Pesticides provide quick control of pests where no other effective tactics are available.
2. Pesticide use may be economical and may require less energy than other management tactics to achieve a given level of control.
3. Pesticide often provides a surer and effective remedial action in dampening the population of a target pest.

In North East India, Tocklai Experimental Station of Tea Research Association (TRA), Jorhat, Assam, is the premier institute to test and certify the plant protection chemicals for use in tea plantations. Earlier, TRA recommended different pesticides [endosulfan, quinalphos, phosphomidon, phosalone, acephate, dimethoate, chlorpyrifos, monocrotophos, oxydemeton methyl, λ-cyhalothrin, β-cyfluthrin, etofenprox, cartap hydrochloride, alphamethrin, cypermethrin, deltamethrin, profenfos, thiomethoxam, imidacloprid, dicofol, ethion, propargite, fenazaquin, sulfur and neem formulations] for controlling tea pests (Anonymous, 1993 and 1999). During the last several decades, the control of pests, diseases and weeds in tea fields are predominantly done by the use of synthetic chemicals. From the recent survey in tea gardens of the Dooars, it was observed that synthetic pesticides constituted 85% of the total pesticides used, wherein, acaricides and insecticides accounted for 25%

(3.60 l/ha) and 60% (8.46 l/ha) respectively. Within the synthetic insecticides, organophosphate compounds (64% - 5 rounds per year) were most preferred followed by organochlorine (26% - 2 rounds/year) and synthetic pyrethroids (9% - 7 rounds per year) (Sannigrahi and Talukdar, 2003). The latest surveillance report of the European Community (EC) indicating the presence of residues in Indian tea is a matter of great concern. Indian tea continues to record high pesticide residue values. This is because of the use of DDT (10.4 to 47.1%), endosulfan (41.1 to 98.0%), dicofol (0.0 - 82.4%) and cypermethrin (6.0 - 45.1) at a greater proportions during 2001 to 2004 in different tea growing areas of North-East states of India (Anonymous, 2001, 2002, 2003a and 2004). *H. theivora* has become a menace round the year despite regular application of insecticides, which further indicates a decrease in susceptibility of *H. theivora* to different classes of insecticides (Sarker and Mukhopadhyay, 2003, 2006a, 2006b; Rahman *et al.*, 2006a and 2007; Sarmah *et al.*, 2006; Bora *et al.*, 2007a and 2007b and 2008).

On account of complex pest situations, total avoidance of pesticides in tea is not possible; nevertheless due to the sensitive nature of the crop, health, and environmental issues, pesticide used must be minimal. A strong suspicion is looming that whether this pest has developed a change in its susceptibility towards different class of insecticides.

The main objective of this programme is to find out the efficacy of chemical and herbal pesticides under various conditions. This is studied with an eye to minimize the pesticide load and develop region specific management package for conventional commercial tea gardens of the Dooars region of North Bengal.