GENERAL INTRODUCTION

The tea plant, *Camellia sinensis* (L.) O. Kuntze, in its natural condition is an evergreen shrub or small tree. When cultivated, it is a bush kept low by regular pruning and plucking. The young top shoots "two leaves and a bud" normally form the material from which the tea is manufactured.

Tea is now grown over a wide range of latitude from Georgia in South Russia in the north down to Australia, New Guinea, South Africa and Brazil. Its cultivation is also expanding into new areas. The critical requirements are acid soil and rainfall. Tea can stand a cool dry season provided the plant is of a suitable type, but there must be sufficient rain in the hot season. A light sandy loam with plenty of nitrogen is ideal for leaf growth, but many types of soil will support tea with the provision that in common with other species of *Camellia*. Though tea is a very popular beverage, but several unspecific medicinal effects attributed to tea have been described in the literature. Now, indepth research and clinical trials are being done in China, Japan and USA. Green tea polyphenols, according to the work done in Japan, have antimutagenic and anticarcinogenic effects. There are also reports from China to show that the tea reduces serum cholesterol triglycerides. Some of the anaerobically treated teas reduce hypertension. The green tea catechins has profound effect on lipid metabolism. There are reports

of Vitamin E in tea (Agnihothrudu 1991).

From 1850 to 1950, tea bushes were raised from seed only (Goswami 1990). However, tea being a cross-fertilised plant, the progeny varies considerably in their characters from the parent plants. These variation affected the production of crop considerably both in quality and quantity. To overcome this difficulty, vegetative propagation was tried initially in Japan during 1887. In Assam, vegetative propagation, by woody cuttings, was tentatively tried in 1914. However, in 1930 only the problem of vegetative propagation was seriously taken up. The utility and possibilities of propagation by cuttings were explored by Tunstall (1931), Tubbs (1932), and Wellensick (1933). In 1931, Mr. A. C. Tunstall at Tocklai, Assam, standardized the techniques of vegetative propagation in tea. The first batch of three standard clones were released in 1949 from Tocklai, Assam.

Following the recommendations of various committees (P. C. Barua Committee 1969, Lamond Committee 1971) to increase the annual growth rate of production by resorting to higher rates of replantation and extension planting per annum, the tea industry has embarked on a large scale planting programme. However, extension and replantation programmes will prove beneficial only if the areas are planted with planting materials superior to the existing ones. A survey of planting materials available to the tea industry in North-East India shows that none of the seed varieties used earlier posses the level of

yield and quality of proven standard clones which were introduced only from early fifties, thereby leaving the industry with only the choice of making use of improved clonal materials for these purposes (Barua and Choudhury 1968). At present, a large number of proven elite clones selected and released by both Tocklai, Assam and other tea estates of North-East India are available as planting materials. These clones are certified as standard, quality and yield clones as described by Barua and Bezbaruah (1970), Sarkar *et al.* (1975) and Singh (1980). Large number of tea estates of North-East India have already planted considerable areas with these clones. However, Hadfield (1966) has cautioned that clones are different and that each clone must be treated individually in order to realise its full potential. Practically, it will be difficult to treat large number of clones individually in a tea estate as the factor causing differential behaviour of clones even under identical set of cultural practices have not been understood. Investigation leading to categorisation of clones into several types based on similarities in morphological and developmental features, which may influence the differential behaviour (in clones) is very essential in order to exploit the full yielding potential of the clones.

It has been estimated that 25 percent of the total area under tea in Assam and West Bengal has been brought under vegetative clones. Untill 1975, area planted with clones in Japan is estimated about 25 percent (Takeo 1975). In Malawi (South Africa), clonal tea accounts for

about 7 percent of the total area planted till 1983, while in Kenya (East Africa), approximately 50 percent of the 79,000 hectare of tea has been planted with clones. In Sri Lanka, only vegetative clones are being used for commercial propagation due to a legislation introduced during 1958 (Barua 1989). Due to much progres in research and development, genetically improved planting materials of tea differing yield the last 50 years, 30 TV series clones, 135 TRA / Garden series clones and 11 Tocklai biclonal seed stocks, including about 100 industry clones have been released. However it is essential to adopt a sound policy towards the choice of planting materials in order to meet the ever increasing demand of quality and productivity. Since clones are specific for their growing requirements and with narrow genetic base than the seed stock, it is highly desirable that each estate has its own policy of selecting cultivars meeting the quality and productivity requirements in the growing condition. In order to select clones suitable for a particular locality, a number of clones should be grown in that locality and be studied properly on comparative basis. Various lines of investigation involving morphological, anatomical, physiological, biochemical and chemical observations should be taken into consideration.

In Darjeeling hill, a few reports on tea research available which may be regarded as insufficient in comparison to other three Tea Research Institutes of India. Most of the fields are occupied with the botanical as well as biochemical works and the scientific reports are

still remain very unclear concerning to tea clones of Darjeeling hills. Only limited fields of research have been undertaken by the Tea Research Institutes of Darjeeling, namely, Tea Research Association, (Ging), Darjeeling, and Darjeeling Tea Research Centre, under Tea Board, (Kurseong), Darjeeling, where most of the cardinal questions in the field of Botany, such as morphology, anatomy, some part of biochemistry and plant physiology of tea plant still remain unanswered. A few handy and non-technical informations to the tea planters of Darjeeling were provided, where the scientific art and essential botanical aspects, most of the time did not come into limelight in comparison to other Tea Research Institutes of the world and some of the Institutions in North-East India (Tocklai), South India (UPASI) and Northern India (Palampur). Many facets of the tea clones, for example, botanical, chemical and biochemical works are yet to be carried out. Only a few reports have been published from Clonal Proving station (Ging), Darjeeling under Tea Research Association, Tocklai, Assam; and in recent decades, Darjeeling Tea Research Centre (Kurseong) Darjeeling under Tea Board of India have contributed some valuable reports in respect to clonal tea of Darjeeling hills, though suffers from insufficiency in the light of classical botanical aspect. Most of the scientific reports published from the DTRC (Kurseong) Darjeeling based on commercial aspect of tea manufacture, planters manuals etc., appears to be related to Tea Research Institute in a regulated way. Obviously,

most valuable investigations of botanical, organoleptic studies, essential physiological and vital biochemical aspects of tea often ignored, with the logic, that some of the classical botanical aspects are not relevant to the tea cultivation proper or often cited as feebly related to quality and gross productivity of tea in the light of commercial exploitation only. In this part of work much emphasis has been given on identification of five different clones of tea grown in the same environment of Darjeeling hills for their purposeful utilisation in this region. Previously general identification of 30 released clones for Darjeeling hills was provided for the planters use only (Singh 1989), which does not content any correct scientific norms.

A geographical survey (Abney-Level survey) of the Clonal Proving Station, Ging, is provided with the correct location of the tea clones of Darjeeling cultivated in identical agro-climatic conditions including surroundings of this experimental station. This type of survey work provides a knowledge of the experimental station and positions of clones under study. It is often noticed that the geographers make Abney Level survey of the hill areas where the tea plants are generally grown. Following such trends, the present author has undertaken such methodology in locating five selected clones in the ecological condition of Clonal Proving Station (Ging), Darjeeling.

Now-a-days Pharmacognosy is defined as the study of any plant yielding natural products having bioactivity and organoleptic study as a

part of it and specially deals with the identification of plants. Organoleptic studies of tea mostly confined to the tender shoot, that is, 'two leaf and a bud' due to its commercial importance. In the context of the present work, more or less all details of anatomical studies have been undertaken, where some aspects, such as, vein-islet, vein termination pattern, palisade ratio, petiolar and foliar sclereids etc. have been investigated first time in Darjeeling hills. Previously leaf sclereids have been studied in details as to its importance in taxonomy of tea plant. However, the present investigations are based on all the anatomical fecets of different leaf status including tender leaves, to fulfil the norms of anatomical studies as prescribed in pharmacognosy. In the works of previous investigators of tea, anatomical studies of matured and old leaves of tea, often ignored due to its non-commercial importance. Present studies are specially designed in systematic studies on tea leaves at clonal levels, so that anatomical conclusions may be drawn specially for their identification. An attempt has been made for incorporating a tentative anatomical key based on different aspects of internal morphology of all fractions of clonal tea leaves of Darjeeling hills.

The tea industry has set production target of 1200 million kilograms of made tea by 2000 A. D. This target has to be met through increasing productivity of the existing tea areas as well as through developmental plans of rejuvenation, infilling, replanting and extension

plantings. Among the various factors influencing production, soil and the plant itself plays a major role. Since improvement of soil is a slow process, major increase in productivity could be achieved by use of improved planting material suited to a particular locality. Genetically improved planting materials differing in yield and quality potential are now available because of the release of a large number of tea clones. It is essential to adopt a sound policy towards the choice of planting materials in order to meet the ever increasing demand of quality and productivity. Since clones are specific for their growing requirements and with narrow genetic base than the seed stock, it is highly desirable that each estate has its own policy of selecting cultivars meeting the productivity requirements in that growing condition. But the productivity of tea is very much dependent on the physiological status of the source plant. Sometimes tea plant has to face various types of stress but the plant has in built mechanism to overcome the stress to a certain extent basically through osmotic regulation conserving the water use and this is being done with the help of transpiration. Transpirational water loss takes place through the stomatal pores, lenticels and cuticular cracks. Due to transpiration pull, nutrients are absorbed and translocated from the roots to the top of the plant and all these phenomenon are very much related to the normal maintenance of productivity of plant. In this part of work, much emphasis has been given on estimation of transpiration rate, productivity and survival capacity in a comparative

way amongst the clones that are taken into consideration. Biochemical studies of tea is an essential work as to its relation to commercial impact on tea quality. From the earlier times to recent decades, many scientific reports are available. The basic material here again is the leaf with its biochemical variations and attributes. Good tea is the product of good leaf, having high polyphenol content, high enzyme activity and is physically amenable to adequate rupture of cells essential for enzymological changes during fresh tea leaf processing. Though we need to know more about tea quality, there is always a gap between what is ideal and what is needed. Good leaf will give good quality - but both are very relative and subjective terms. The challenge, therefore, is to define precisely those parameters and biochemical constituents that promote quality in different types of tea leaves. More than 300 chemicals in different phases of interactions influence building up of quality during tea processing. But very little is known of the more important of them, their pathways and fate during tea manufacturing. Whether or not this range would vary between tea varieties, or if the processing technology would have to be recast to suit the need of different types of leaf, are still not known.

Most of the common and important biochemical aspects were undertaken in this present work, to evaluate or to assess an overall biochemical activities in fresh tea leaves of different fractions (young, matured and old) quantitatively. This type of work was not yet

reported elsewhere excepting young leaves. The botanical aspect and perspective of experimental designs as adopted in the present investigations are significantly distinct and different from limited biochemical studies, which are generally practiced in most of the Tea Research Institutions.

Therefore, present investigations on the various biochemical parameters are based on a very subjective term and some information out of the present investigations may be linked to the quality components of tea, which decides ultimately the marketability of tea.

In the past, different methodologies had been proposed to estimate different biochemical components of tea during different phases of tea processing. Some of the improved methods in this connection are being reported by Tea Research Institutions and other faculties of science.

Caffeine is regarded as a major purine responsible for the taste and briskness of tea. Different methods are proposed at different times to estimate this important biochemical component of tea appeared during withering process. In the present investigation special emphasis has been given to the estimation of caffeine with the help of easily available colorimeter so that rapid quantitative estimation can be effected, at any tea gardens with a very low cost and practically less infra-structural facilities. It is common to every tea garden as to their dependency on the Tea Research Institutes, where some of the tea

gardens in Darjeeling have a considerable distance to the nearest Tea Research Institutes to obtain necessary scientific facility for their respective tea gardens.

With this background, five genetically different clones of tea, HV-39, T-78, B-157, TV-19 and Thurboo-9 have been selected and grown in the same agro-climatic condition of Clonal Proving Station, Ging, Darjeeling under Tea Research Association, Tocklai, Assam. Different lines of investigation on ecology, physiology, biochemistry, chemistry and pharmacognosy of all the clones have been undertaken with a view to selecting the best one suitable for Darjeeling hills. The knowledge derived out of it will be of much help for purposeful utilisation of selected clone to boost up the economy of this region.