Chapter 1
INTRODUCTION
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The para rubber tree, *Hevea brasiliensis* (Willd. ex Adr. de Juss.) Muell. Arg. is a perennial tree belonging to the family, Euphorbiaceae and is the major source of natural rubber. Natural rubber is having varied industrial, technological and domestic uses. The unique and versatile properties of this material have made it highly indispensable for the modern life. Among the tree crops, no other plant species has influenced human life as much as natural rubber and the rubber plantation industry has now almost revolutionized the industrial world. Today, natural rubber cultivation is a good preposition of ecologically sustainable, socially acceptable and economically viable agriculture. Apart from latex, the rubber plantation is also being valued for its timber, which reduces the pressure on natural forests for timber and wood (Jacob, 2002).

Natural rubber has been found in the latex of over 2000 species of plants belonging to 311 genera of 79 families. The minor sources of natural rubber are *Manihot glaziovii* (Euphorbiaceae), *Ficus elastica* (Moraceae), *Parthenium argentatum* and *Taraxacum koksaghyz* (Compositae). In addition, many other species like *Castilla elastica* (Moraceae), *Cryptostegia grandiflora* (Asclepiadaceae) and *Funtumia elastica* (Apocynaceae) have been experimented as possible minor sources of natural rubber (Wycherley, 1992). The genus *Hevea* comprises ten species viz., *Hevea benthamiana*, *H. brasiliensis*, *H. camargoana*, *H. camporum*, *H. guinensis*, *H. microphyllla*, *H. nitida*, *H. pauciflora*, *H. rigidifolia*, and *H. spruceana* (Schultes, 1970, 1977, 1987; Wycherley, 1992). Of the above ten species, only *H. brasiliensis*
produces 99 per cent of the world’s natural rubber (Saraswathyamma, 2002). The quality and quantity of natural rubber produced by *H. brasiliensis* is superior to those of all other species.

*H. brasiliensis* is a native to the tropical rain forest of Central and South America and is one of the recently domesticated crop species in the world. *Hevea* is introduced to South East Asia in 1876 by Sir Henry Wickham and has been commercially cultivated in India since 1902 (Nair et al., 1976). The original genetic material of *Hevea* is referred as ‘Wickham gene pool’. Rubber is propagated by generative and vegetative means. Generative method is through seeds and vegetative method is through budgrafting.

The economic life span of the tree is very long with a gestation period of six to seven years (Plate 1). The rubber tree is sturdy, quick growing and tall (Plate 2). A warm humid equable climate (21°C to 35°C) and a fairly distributed annual rainfall of not less than 200 cm are necessary for the optimum growth. The tree grows successfully under slight varying conditions also. The tree is now grown in tropical regions of Asia, Africa, and America. Rubber tree has a well-developed taproot and laterals. The bark on tapping yields latex (Plate 3). Latex present in latex vessel rows in the bark of the tree trunk is exploited commercially for the extraction of latex (Plate 4a and b). The cambium in between wood and bark is responsible for the increase in girth of the tree including bark renewal. The leaves are trifoliate with long stalks. Normal annual leaf fall known as “wintering” occurs in the case of mature trees during the period December to February in South India. Refoliation and flowering follow wintering. Some trees may occasionally show off-season flowering during September - October. The rubber tree is monoecious. Both male and female flowers are seen in the same inflorescence. Male flowers are much more numerous than female flowers which are bigger and found terminating the main branches of the
panicle. Pollination is by insects. Only a small proportion of the female flower set fruits and good number of flowers are shed during tender stage (Saraswathyamma, 1990). The fruits mature in about five to six months after pollination. They are three seeded and burst when mature, scattering the seeds 15 - 18 meters. The seeds weigh four to six grams. They possess a hard brown coat having characteristic mottling. Seeds of seedling trees and different clones vary in size, shape, weight and seed coat markings. The seeds belonging to a clone have characteristic size, shape and seed coat mottlings. It has been reported that seed coat can be utilized for the identification of clones (Polhamus, 1962; Saraswathyamma et al., 1981; Mercykutty et al., 2002 and Sebastian et al., 2002).

Rubber plantation industry in India has registered commendable growth in production and productivity. India has attained the first position in terms of productivity with 1576 kilograms per hectare per year (Desalphine, 2002). The country holds third position in terms of production (631,400 t) covering an area of 566,558 ha and fourth in consumption of natural rubber (Krishnakumar, 2003). This achievement is mainly due to the development and proper utilisation of genetically improved planning materials. The development and release of RRII 105, the outstanding high yielder has contributed substantially for this progress. The potential and realised yield of some other RRII clones, also showed that a few of them perform extremely well in certain areas (Mathew, 2002).

Genetic improvement programme in tree crops, especially Hevea is laborious and a minimum period of 20 - 25 years is required for the evaluation and release of a clone. Earlier selections were made among the trees obtained from seeds that produced only 200 - 300 kilogram per hectare per year (kg ha⁻¹ yr⁻¹). Later, new clones were developed adopting various genetic improvement programmes. These selections boosted annual production
to 2000 kg ha\(^{-1}\) yr\(^{-1}\). Now there are clones having a production potential of around 4000 kg ha\(^{-1}\) yr\(^{-1}\) (Saraswathyamma, 2002). Today India accounts for nine per cent of the world production of NR (Rubber Board, 2003).

There are several problems that hamper breeding and quick release of cultivars for large scale planting. They include seasonal nature of flowering and low fruit set, long breeding and selection cycle, lack of fully reliable early selection methods, etc. In India, flowering is restricted to a short period of two to three months; however, all the clones do not flower simultaneously (George et al., 1967). This non-synchronization of flowering in some of the parent clones selected, limits the possibility of attempting all possible cross combinations.

During the past, the main objective in breeding was to improve productivity. Subsequently, improvement of secondary characters became one of the objectives in *Hevea* breeding programme. Yield in *Hevea* is determined by the volume of latex and the percentage of rubber it contains. The rubber yield in *H. brasiliensis* is a complex multifactorial trait and is a manifestation of various morphological, anatomical, physiological and biochemical characters of the tree (Pollinere, 1966). The choice of a suitable breeding method for improvement of yield and its components depends on genetic variability, association between characters, heritability and the value of expected genetic advance under selection.

Attempts have been made to study the relationship between yield and yield attributing factors and several yield components have been identified (Swaminathan, 1977; Markose, 1984; Simmonds, 1989; Saraswathyamma, 1990; Premakumari, 1992; Mydin, 1992; Licy, 1997). However, a dearth of knowledge still exists on the nature and extend of genetic and environmental control of these traits. Moreover, in-depth information on the performance of many of the exotic clones in local agroclimatic region of India is scanty. Hence the
The present investigation was taken up including a set of 13 *Hevea* clones (12 introduced clones along with RRII 105) with the following objectives:

- To evaluate the performance of a set of 12 exotic clones in the local agroclimatic condition.
- To examine the genetic variability for yield and yield components among these clones along with indigenous clone, RRII 105.
- To assess the relationship between yield and factors contributing to yield.
- To select genetically divergent genotypes for the utilization of them in the hybridization programme in future.
- To identify prepotent clones based on performance of seedling progenies for their utilization in polyclonal seed gardens.
- To study latex and rubber properties of the above 13 clones.
- To identify clones having high yield and desirable secondary attributes in comparison with outstanding clone RRII 105.

Selections based on the information obtained from genetic studies on yield and yield components can provide better candidates in the crop improvement programme in this species.
Plate 1. An immature Hevea plantation with cover crop
Plate 2. A view of the mature Hevea plantation
Plate 3. A mature tree under tapping
Plate 4. (a) Radial longitudinal section of *Hevea* bark showing the latex vessel rows
(b) Transverse longitudinal section of *Hevea* bark showing interconnections of latex vessels