Chapter 1

GENERAL INTRODUCTION

1.1 *Hevea brasiliensis* - The Para rubber tree

Hevea brasiliensis (Willd. ex A. Juss.) Muell.Arg., originally a forest tree indigenous to the tropical rain forests of Central and South America and the only major commercial source of natural rubber (NR), is one of the most recently domesticated crop species in the world. The genus *Hevea*, belonging to the family Euphorbiaceae, grows wild in the Amazon River basin and in the surrounding regions. The genus was introduced into parts of Asia and Africa where large plantations were established (Fig. 1.1). Although NR has been found in the latex of other plants belonging to 311 genera of 79 families, 99 per cent of the global natural rubber production is from *H. brasiliensis*, the Para rubber tree. Latex containing vessels are present in all parts of the tree except wood.

1.2 Rubber

Rubber is a constituent of latex, a milky substance produced in the laticiferous tissues. Even though latex is present in almost all parts of the plant, the laticifers exploited commercially are from the bark. The latex vessels are developed by the activity of vascular cambium (Premakumari and Saraswathyamma, 2000). Latex is obtained by controlled wounding of bark of rubber tree, termed as tapping (Fig. 1.2). Trained workers do the tapping, using special knives, by controlled wounding during which a thin layer of bark consisting of the hard bast and major part of the soft bast is removed.

Fig. 1.1 Rubber plantation

Fig. 1.2 Rubber tapping

1.3 History of commercial NR cultivation

The modern age of natural rubber started during the 1870s when the British successfully transported *Hevea* seeds from Brazil for planting in the British India (Markham, 1876; Petch, 1914). The original genetic material of the Para rubber tree, referred to the 'Wickham gene pool' was introduced to South East India by Sir Henry Wickham in 1876.

1.4 Rubber plantation in India

The cultivation of rubber in India began in 1878 from the rooted cuttings imported from Royal Botanic Gardens, Heneratgoda, Ceylon (RBGK, 1898; Petch, 1914). The growth of the Indian rubber plantation industry has been mainly through the expansion of rubber cultivation in Kerala. The British planters initiated rubber cultivation on a plantation scale and the state administration encouraged them by providing land, labour, capital and trade facilities.

Rubber cultivation on a plantation scale was initiated in India only during 1902. Within a period of 100 years the country has emerged as the fourth largest producer of natural rubber in the world (Table 1.1).

Table 1.1 Natural rubber: Area and production in major producing countries (2012).

Country	Area ('000 ha)	Production ('000 tonnes)
Thailand	2785	3512
Indonesia	3484	3015
Malaysia	1041	925
India	759	919
Vietnam	911	864
China	1110	795
Sri Lanka	131	152
Philippines	179	111

Source: 'Rubber Statistical Bulletin'- Rubber Board

1.5 Tapping panel dryness (TPD)

The disorder derives its name from the obvious symptom of the tapping panel going dry which can be partial or total. TPD, a commonly known disorder of *Hevea* trees continued to remain unresolved despite extensive research by many workers over several decades. TPD is characterized by the gradual or sudden drying up of the latex vessels near the tapping panel resulting in abnormally low yield or complete stoppage of latex production. The disease was reported for the first time in Brazil in 1887 (Rutgers and Dammermann, 1914). This was reported in plantations in Asia since the beginning of the 20th century (Rands, 1921). Panel dryness is of economic importance as it renders the trees non-productive.

1.6 Economic impact of TPD

As rubber is a perennial tree crop with a production span of nearly 25 years, the loss due to TPD is enormous especially if a tree is affected early in its economic life. TPD syndrome of rubber has resulted in considerable losses to the rubber plantation industry in all the rubber producing countries. It is estimated that the global annual loss due to this disorder is US $ 900 million (Sethuraj, 1998). TPD incidence is on the increase, particularly in areas where high yielding clones such as RRII 105 are being used for commercial plantations. An annual crop loss of 10-15 per cent due to this disorder is estimated (Sethuraj, 1998). However there are reports of variations in the intensity of TPD in relation to the age of the plant, stages of tapping and systems of tapping.

At an estimated incidence of 15 per cent, the crop loss due to TPD in India is 320 kg/ha/year resulting in a loss of Rs. 24.2 billion per year (Table 1.2).

Table 1.2 Estimated revenue loss due to TPD in India

Total rubber area under tapping (ha)	504000
Total production of natural rubber (Tonnes)	913700
Productivity (yield) (kg/ha)	1813
Yield potential (in the absence of TPD) (kg/ha)	2133
Yield loss due to TPD@15% (kg/ha)	320
Total yield loss (Tonnes)	161250
Price of natural rubber RSS 4 (Rs/kg) (approximate)	150
Loss to India per year (Billion, Rs)	24.2

1.7 Clone RRII 105

Clone RRII 105 is the first indigenously evolved high yielding hybrid clone of India. This clone is widely cultivated across the country in more than 85% of the area under small holdings and estates. Net revenue added per annum by cultivation of this clone is Rs.2856 crores (US$ 571 million). More than 80 per cent of the rubber plantations in India are under smallholdings sector. The incidence of TPD in this clone adversely affects the economic sustainability of the small farmers.

1.8 Objectives of the study

Tapping panel dryness syndrome of rubber has been reported from the plantations from the very early stages of rubber cultivation in different rubber clones. Although several reports are available on the symptoms of TPD in clone RRII 105 a systematic study from different locations and at various stages of rubber cultivation is lacking. Hence, one of the objectives of the study was to understand different symptoms in untapped as well as trees from the first to the last year of tapping in clone RRII 105. Identification of symptoms on different plant parts like roots which were not studied in detail earlier and symptoms on trees tapped on different tapping panels like virgin/renewed and controlled upward tapping (CUT) panels were attempted. Different easily noticeable external symptoms like cracks and bulges and internal symptoms which were difficult to identify such as bark necrosis on trunk and root required detailed study. Variations in total latex volume and DRC at different intensities of TPD were analysed.

There are reports of variations in the incidence of TPD with regard to clone, age of the plant, stages of tapping, system of tapping etc. Hence, another objective of the study was to assess the actual extent of TPD in clone RRII 105 in different years of tapping at various locations both from the small holdings as well as large estates. An attempt was also made to study various management practices adopted, their feasibility and success in containing TPD. The spread of TPD from the affected to the nearby trees was also investigated.

Various factors which were assumed to be the cause of TPD could not conclusively prove its etiology. Occurrence of TPD in adjacent trees in the same line, consistent increase in the incidence with age, similarity in symptoms and anatomical abnormalities to some known diseases, inability to revive the affected trees by resting and the presence of dry rubber trees from the start of exploitation prompted studies on biotic etiology for TPD. Investigations on the association of LMW RNA in different tissues of TPD trees and characterization of the LMW RNA utilizing the molecular biological tools now available formed the third objective.

The fourth objective of the present study was to investigate the pathogenicity of the LMW RNA isolated from TPD affected rubber trees, thus verifying biotic nature of causal agent.