CONTENTS

Declaration
Certificate
Acknowledgement
Abstract
Preface

Title                                                                 Page No.
Contents                                                                    1
List of tables                                                              9
List of figures                                                             11
Abbreviations/Acronyms                                                    17

• Chapter 1 GENERAL INTRODUCTION                                           19-25
  1.1 Hevea brasiliensis - The Para rubber tree                              21
  1.2 Rubber                                                                 21
  1.3 History of commercial NR cultivation                                 22
  1.4 Rubber plantation in India                                            22
  1.5 Tapping panel dryness (TPD)                                           23
  1.6 Economic impact of TPD                                                23
  1.7 Clone RRII 105                                                        24
  1.8 Objectives of the study                                              24

• Chapter 2 SYMPTOMS OF TPD                                                27-61
  2.1 INTRODUCTION                                                          29
    2.1.1 First reports                                                     29
    2.1.2 Scenario in India                                                29
    2.1.3 Symptoms reported                                                29
  2.2 MATERIALS AND METHODS                                                33
    2.2.1 Design of experiment                                              33
      2.2.1.1 Location                                                      33
      2.2.1.2 Age of the plants                                             33
      2.2.1.3 Observations                                                 34
      2.2.1.4 Categorization of TPD trees                                   34
  2.3 RESULTS                                                               36
    2.3.1 Symptoms on tapping cut                                           36
      2.3.1.1 Primary symptoms and appearance of TPD                       36
        2.3.1.1.1 Dryness in the entire stretch of tapping panel           36
        2.3.1.1.2 Intermittent dry and wet zones on the tapping panel     37
      2.3.1.2 Endurance of TPD                                             39
    2.3.2 Symptoms on the bark                                              40
      2.3.2.1 Abnormal colouration of the bark                             40
      2.3.2.2 Bark thickening                                               40
2.3.2.3 Cracking and flaking 40
2.3.2.4 Necrosis 42
2.3.2.5 Burr formation 44
2.3.2.6 Symptomless bark 45
2.3.2.7 Symptoms on untapped trees 46
2.3.2.8 TPD symptoms on trees tapped in different tapping panels 47
2.3.3 TPD and latex volume 49
2.3.4 TPD and Dry Rubber Content (DRC) 51
2.3.5 Symptoms on the root system 54
2.4 DISCUSSION 58
2.5 CONCLUSION 61

• Chapter 3 INCIDENCE OF TPD 63-93
  3.1 INTRODUCTION 65
  3.2 MATERIALS AND METHODS 67
    3.2.1 Design of experiment 67
      3.2.1.1 Location 67
      3.2.1.2 Age of the plants 67
      3.2.1.3 Recording of observations 69
  3.3 RESULTS 70
    3.3.1 Incidence of TPD in small holdings 70
      3.3.1.1 Incidence of TPD in different years of tapping 70
      3.3.1.2 Incidence of TPD in different panels 77
      3.3.1.3 Forward spread of TPD 77
    3.3.2 Incidence of TPD in estate sector 82
      3.3.2.1 Incidence of TPD in different years of tapping 82
      3.3.2.2 Status of TPD in the same trees as the tapping progress 83
      3.3.2.3 Incidence of TPD in different panels 84
      3.3.2.4 Forward spread of TPD 84
    3.3.3 Management of TPD trees 87
      3.3.3.1 Smallholdings, Location : Meenachil Taluk 87
      3.3.3.2 Management of TPD in estate by adopting upward system of tapping 89
  3.4 DISCUSSION 90
  3.5 CONCLUSIONS 93

• Chapter 4 MOLECULAR STUDIES ON THE BIOTIC ETIOLOGY OF TPD 95-136
  4.1 INTRODUCTION 97
    4.1.1 Anatomic studies 97
    4.1.2 Climatic factors 98
    4.1.3 Clonal variation/genetic characters 99
    4.1.4 Edaphic characters 99
    4.1.5 Biomass 100
    4.1.6 Stock-scion incompatibility 100
    4.1.7 Impaired cyanide metabolism 101
4.1.8 Tapping intensity 101
4.1.9 Physiological factors 102
4.1.10 High yield and TPD 104
4.1.11 Bark grafting 105
4.1.12 Biotic etiology 105
4.1.13 Stress induced by pathogens 105
4.1.14 Occurrence of TPD in clusters 106
4.1.15 Forward spread of TPD in the direction of tapping 107
4.1.16 Increase in TPD intensity with age 107
4.1.17 Change over tapping 107
4.1.18 Search for common pathogens 107

4.2 MATERIALS AND METHODS 109
4.2.1 Selection of plants 109
4.2.2 Types of tissues 110
4.2.3 Analysis of nucleic acid 110
  4.2.3.1 Extraction of total nucleic acid (TNA) 110
  4.2.3.2 Return Poly Acrylamide Gel Electrophoresis (R-PAGE) 111
  4.2.3.3 Silver staining 111
  4.2.3.4 Elution of LMW RNA from gel 112
  4.2.3.5 Amplification of LMW RNA 113
    4.2.3.5.1 Design of viroid specific primers 113
    4.2.3.5.2 cDNA synthesis 113
    4.2.3.5.3 RT-PCR 113
    4.2.3.5.4 Specific PCR 114
    4.2.3.5.5 Agarose gel electrophoresis 114
    4.2.3.5.6 Purification of amplified product 114
    4.2.3.5.7 Molecular cloning 115
    4.2.3.5.8 Preparation of competent cells 115
    4.2.3.5.9 Preparation of transformation plates with selective media 115
    4.2.3.5.10 Master plating 116
    4.2.3.5.11 Sequencing 116
    4.2.3.5.12 Sequence analysis 116

4.3 RESULTS 117
4.3.1 Analysis of nucleic acid 117
  4.3.1.1 Extraction of RNA and R-PAGE analysis 117
  4.3.1.2 Viroid nature of the isolated RNA 118
  4.3.1.3 Presence of LMW RNA in different plant parts 118
  4.3.1.4 R-PAGE tests on trees under various tapping stages at different locations 119
  4.3.1.5 Repeated R-PAGE tests on trees under tapping at RRRII Farm 119
  4.3.1.6 Presence of LMW RNA in trees showing different TPD symptoms 120
  4.3.1.7 Detection of LMW RNA in TPD affected trees of different clones 120
  4.3.1.8 R-PAGE tests on seedlings 121