UNIVERSITI PUTRA MALAYSIA

STUDIES ON AGRONOMIC AND GENETIC POTENTIALS OF THE IRRDB '81 HEVEA GERMPLASM IN VIETNAM

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STUDIES ON AGRONOMIC AND GENETIC POTENTIALS OF THE IRRDB '81 *HEVEA* GERMPLASM IN VIETNAM

By

LAI VAN LAM

Thesis Submitted in Fulfilment of the Requirements for the Degree of Master of Agricultural Science in the Faculty of Agriculture Universiti Pertanian Malaysia

June 1995

ACKNOWLEDGEMENTS

The scholarship for my study at Universiti Pertanian Malaysia was granted by the Government of Malaysia under the Technical Assistance Programme (TAP). I would like to express my sincere gratitude to Dr. Abdul Aziz b. Sheik Abdul Kadir, Director of the Rubber Research Institute of Malaysia (RRIM), Dr. Truong Van Muoi, former Director of the Rubber Research Institute of Vietnam (RRIV) and Mr. Mai Van Son, Director of the RRIV for their permission to take the scholarship and study leave. The supports from coordinators of the TAP, Dr. Wan Abdul Rahaman b. Wan Yaacob, Deputy Director (RRIM) and Dr. Mahmud b. Abdul Wahab, Head of Crop Management Division (RRIM) are gratefully acknowledged.

I am particularly grateful to Dr. Ghizan Saleh (UPM), chairman of supervisory committee, and Dr. Tan Hong (RRIM), member of supervisory committee, for their valuable guidance, encouragement and supports throughout the research and preparation of the thesis. My thanks and appreciation also go to Prof. Dr. Yap Thoo Chai (UPM), member of supervisory committee, for his valuable discussions and comments on the thesis.

My special thanks are due to all officers and research assistants of the Breeding and Selection group of the RRIM, especially Dr. Ong Seng Huat, Dr. Ramli Othman, Dr. Masahuling Benong, Messrs. K.P. Chin, A. Gopalan and K. Jayasunthar for their help and assistance throughout my stay in the group.

My thank is also due to Mr. K. Vigneshwaran (RRIM) for his advice concerning the technical aspects of anatomy of rubber tree.

I am indebted to Mrs. Thuy Hoa, Head, Prof. Ngo Van Hoang, former Head, Miss. Thu Ha and all staff of the Breeding and Selection group of the RRIV for their valuable discussions, supports and help in collecting data.

To my wife, Kim Thoa and my daughter, Ngoc Thien, I would like to record my deepest appreciation for their encouragement and understanding throughout this study.

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IRRDB	International Rubber Research and Development Board.
IRCA	Institut de Recherches sur le Caoutchouc au Afrique.
IRSG	International Rubber Study Group
RRIM	Rubber Research Institute of Malaysia.
RRIV	Rubber Research Institute of Vietnam.

Abstract of thesis submitted to the Senate of Universiti Pertanian Malaysia in fulfilment of the requirements for the degree of Master of Agricultural Science.

STUDIES ON AGRONOMIC AND GENETIC POTENTIALS OF THE IRRDB '81 *HEVEA* GERMPLASM IN VIETNAM

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June 1995

Chairman: Dr. Ghizan Saleh.

Faculty: Agriculture.

Studies were conducted to evaluate the agronomic potential and to investigate the genetic structure and variability of the new *Hevea* germplasm which had been collected from the three states of Acre, Mato Grosso and Rondonia in Brazil, South America, by the International Rubber Research and Development Board (IRRDB). A total of 1309 new *Hevea* germplasm clones and 32 Wickham (domesticated) clones was evaluated on agronomic performance, physiological characateristics of latex, bark anatomy and properties of rubber in two field experiments at the Rubber Research Institute of Vietnam (RRIV), Vietnam.

In general, the germplasm clones were far inferior to the Wickham clones in latex productivity, and to a lesser extent, in growth. The germplasm genotypes also possessed undesirable characteristics of crown structure. Studies on physiological characteristics of latex showed that the germplasm clones were poor in the activity of latex regeneration and showed difficulty in the flow of latex. They also had anatomical characteristics of the bark unfavourable towards the productivity of latex. However, properties of rubber derived from the germplasm clones were technically acceptable.

Genotypic and phenotypic coefficients of variation for yield were found very high in the germplasm population. The new germplasm had moderate to very high broad sense heritabilities (h^2_B) for economic characters such as yield, growth, number of latex vessel rings and plugging index. Results of the study on genetic distance showed that there was a great genetic distance between the germplasm clones and the Wickham clones. Based on genetic divergence, the germplasm could be divided into three groups in agreement with their geographical origins, namely Acre, Mato Grosso and Rondonia. For any geographical group, variability due to clones accounted for most of the variabilities for yield and growth.

The large genetic variability revealed by the new *Hevea* germplasm clones indicates that they can be used to help broaden the genetic base of rubber in Vietnam. A total of 320 germplasm genotypes were selected to form a working collection of reduced size for further evaluation, genetic improvement and incorporation in the rubber breeding programme in Vietnam. The predicted genotypic gain from selection was rather high for yield but low for growth.

Abstrak tesis yang dikemukakan kepada Senat Universiti Pertanian Malaysia sebagai sebahagian daripada keperluan untuk ijazah Sarjanah Sains Pertanian.

KAJIAN POTENSI AGRONOMI DAN GENETIK TERHADAP GERMPLASMA *HEVEA* IRRDB '81 DI VIETNAM

Oleh

LAI VAN LAM

Jun 1995

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Kajian telah dijalankan untuk menilai potensi agronomi dan meneliti struktur dan kepelbagaian genetik germplasma baru *Hevea* yang telah dikumpulkan dari tiga negeri Acre, Mato Grosso dan Rondonia di Brazil, Amerika Selatan oleh Lembaga Penyelidikan dan Pembangunan Getah Antarabangsa (IRRDB). Sejumlah 1309 klon germplasma baru *Hevea* dan 32 klon Wickham yang telah didomestikasikan dinilaikan untuk prestasi agronomi, ciri-ciri fisiologi lateks, anatomi kulit, dan ciri-ciri getah dalam dua percubaan ladang di Institut Penyelidikan Getah Vietnam (RRIV), Vietnam.

Pada amnya, klon-klon germplasma adalah jauh berprestasi lebih rendah berbanding dengan klon-klon yang telah didomestikasikan dalam pengeluaran lateks, sementara tidak begitu jauh berbeza dalam pertumbuhan. Genotip-genotip germplasma juga mempunyai ciri-ciri struktur jemala yang kurang baik. Kajian ke atas ciri-ciri fisiologi lateks menunjukkan bahawa klon-klon germplasma tidak memperlihatkan aktiviti pembentukan semula lateks yang baik, dan kesukaran dalam aliran lateks. Ianya juga memperolehi ciri-ciri anatomi kulit yang tidak sesuai untuk penghasilan lateks. Walaupun demikian, ciri-ciri getah yang dihasilkan daripada klon-klon germplasma secara teknikalnya boleh diterima.

Pekali-pekali variasi genotip dan fenotip untuk hasil didapati sangat tinggi dalam populasi germplasma. Germplasma baru mempunyai kebolehwarisan luas (h^2_B) yang sederhana hingga sangat tinggi untuk ciri-ciri ekonomi seperti hasil, pertumbuhan, bilangan lingkaran saluran lateks, dan indeks penyumbatan. Keputusan kajian ke atas jarak genetik menunjukkan bahawa terdapat jarak genetik yang besar di antara klon-klon germplasma dan klon-klon Wickham. Berdasarkan kepada pencapahan genetik, germplasma boleh dibahagi kepada tiga kumpulan, Acre, Mato Grosso dan Rondonia, yang selaras dengan punca-punca geografinya. Untuk mana-mana kumpulan geografi, kepelbagaian yang disebabkan oleh klon merupakan sebahagian besar dari keseluruhan kepelbagaian untuk hasil dan pertumbuhan.

Kepelbagaian genetik yang besar yang ditunjukkan germplasma baru *Hevea* menandakan bahawa ia digunakan untuk membantu meluaskan bes genetik getah di Vietnam. Sejumlah 320 genotip germplasma dipilih untuk membentuk koleksi kerja dengan saiz yang lebih kecil untuk penilaian selanjutnya, pembaikan genetik dan untuk di masukkan ke dalam program pembiakbakaan getah di Vietnam. Kemajuan genotip yang diramalkan dari pemilihan adalah agak tinggi untuk hasil tetapi rendah untuk pertumbuhan.

CHAPTER I

INTRODUCTION

By the end of the nineteenth century, the source of natural rubber had shifted from a number of species growing wild in the rain forest of tropical America to organised plantations of *Hevea brasiliensis* in several countries of the Southeast Asia, geographically far apart from the native habitat of the species. Since then, the Para rubber tree, *Hevea brasiliensis* (Muell. Arg.), has become one of the most important plantation crops in the world; and few economic plants have more deeply affected civilization than the rubber tree, the product of which has made possible present-day transportation and much of modern industry and technology. Neither has any other plant product been used in such a wide range of industrial applications as natural rubber.

In 1993, rubber trees in the world covered 9.4 million hectares producing about 5.46 million tons of rubber (IRSG, 1994). Asia, with Thailand, Indonesia and Malaysia as the world's leading producers, produced 94% of the total world rubber production in 1993, followed distantly by Africa, 5% and Latin America, 1% (IRSG, 1994). Vietnam produced 111,000 tons of rubber from 240,000 hectares in 1994 (VNS, 1995).

The success in the remarkable development of the rubber tree, from a wild jungle tree to a major domesticate, has been largely attributed to the systematic exploitation of agricultural research, and one of the most important components is breeding.

Although the progress in yield improvement through *Hevea* breeding and selection is remarkable, problems associated with the process have also been recognized as factors hampering the future progress of rubber breeding. These problems include the narrow genetic base, long breeding and selection cycle, selection for multiple characters, choice of parents, genotype-environment interaction, and others (Wycherley, 1968; Ho, 1979; Tan, 1987). Among them, the problem associated with narrow genetic base in the East has been singled out as an important one encountered in *Hevea* breeding.

Efforts were taken by *Hevea* breeders to correct the situation by introducing wild genotypes from South America, the native habitat of the genus, and the most significant event has been the expedition organized by the International

Rubber Research and Development Board (IRRDB) to collect new *Hevea* germplasm in the three states of Acre, Mato Grosso and Rondonia of Brazil in 1981 (Ong, 1982; Ong et al., 1983), with the aim of broadening the genetic base to enhance the future progress of *Hevea* breeding. Thousands of *Hevea* genotypes were collected and then multiplied and distributed to all member countries of IRRDB.

Vietnam received more than 3000 genotypes from the Asian *Hevea* germplasm centre in Malaysia between 1984 and 1987; and many of them are in trials for evaluation.

The objectives of the present investigation were: i) to evaluate the performance of the new IRRDB '81 *Hevea* germplasm for agronomic, physiological and anatomical characters, and for properties of rubber under the ecological conditions of Vietnam, ii) to evaluate the genetic divergence between these new germplasm and those of the Wickham group, and iii) to study the variability due to the geographical origins of the germplasm. The ultimate goal of the study was to form a working population of reduced size from the germplasm, and to help set up a breeding programme of new *Hevea* germplasm in Vietnam.

CHAPTER II

REVIEW OF LITERATURE

Origin of Rubber Trees

The rubber tree, *Hevea brasiliensis*, is a species of the genus *Hevea*, family *Euphorbiaceae*. The species together with nine other species of the genus *Hevea* is indigenous to the great Amazon basin, South America, and has not been found in any other parts of the world either in a wild or semi-wild state (Schultes, 1990). The geographical distribution of the species covers many Latin American countries including Bolivia, Brazil, Colombia, Peru and Venezuela (Wycherley, 1978 cited by Ho, 1979). According to Schultes (1956), *Hevea brasiliensis* is less variable than other *Hevea* species.

Genetics of *Hevea brasiliensis*

Cytogenetics

Hevea brasiliensis and other *Hevea* species are known diploid with 2n = 2x = 36. Due to its possible tetraploid origin, its basic chromosome number is probably x = 9 (Ong, 1979). There are no cytogenetic barriers to interspecific hybridization among species, and interspecific hybrids have been found in nature as well as produced in breeding programmes.

There is so far no evidence of self-incompatibility in rubber trees although they usually set more fruits when cross-pollinated than when selfed. Male sterility in rubber trees was first reported in 1935 (Ferwerda, 1969) and was ascribed to irregularities in the meiosis of pollen mother cells. However, Saraswathy et al. (1988) and Saraswathy and Panikkar (1989) recently reported that sterile male flowers showed normal meiosis up to the tetrad stage, but pollen grains were found to be empty. After the tetrad stage, the microspores showed abortion and further development was completely blocked. The genetic control of male sterility could be totally determined by cytoplasmic factors which are transmitted through the egg. Only a few clones, such as GT 1, Ch 2 and RRII 35 were recorded as male sterile (Saraswathy and Panikkar, 1989).

Inheritance of Characters

Economic characters in rubber, such as vigour, yield, disease resistance and some technological characteristics of raw rubber, are polygenically controlled (Tan et al., 1975; Tan and Subramaniam, 1976; Tan, 1977, 1978a,b, 1981, 1987, 1994). Biometrical genetic studies conducted in the Rubber Research Institute of Malaysia (RRIM) during the past two decades revealed that variation in the main characters could largely be accounted for by additive genetic variance (Tan, 1987). Gilbert et al. (1973) reported that general combining ability (GCA) accounted for 63-81% and 82-86% of the total genetic variabilities for yield and girth of mature trees, respectively. GCA values of 87% and 88% were reported by Tan and Subramaniam (1976) for yield and girth of nursery seedlings, respectively. Narrow sense heritability values ranging from 11% to 56% and from 9% to 56% were reported for yield and girth, respectively, at RRIM (Nga and Subramaniam, 1974; Tan and Subramaniam, 1976; Tan, 1978a, b). Recent studies also revealed that GCAs of other characters, such as disease resistance and technological characteristics of