37 GENETIC IMPROVEMENT IN PARA RUBBER (*HEVEA BRASILIENSIS* (WILLD.) MUELL. –ARG.)

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Introduction

The para rubber tree, *Hevea brasiliensis* (Willd.) Muell. –Arg. is relatively a recent introduction to the modern world. The tree produces natural rubber, chemically known as *cis*-1,4 – polyisoprene, an industrial raw material of high commercial importance. About 99% of the world's natural rubber is produced by this species alone. The tree is introduced to the tropical regions of Asia from its primary centre of origin, Brazil, in the later part of the nineteenth century. The commercial plantations are now distributed in the countries of Malaysia, Indonesia, Thailand, India, Sri Lanka, China, Philippines, Vietnam, Cambodia, Myanmar, Bangladesh, Nigeria, Cameroon, Cote d'Ivoire, Liberia, Brazil and Mexico.

H. brasiliensis is a deciduous perennial tree crop, which is highly cross pollinated. The trees exhibit monoecy. The female flowers are bold and borne on the tip of the inflorescence, and male flowers are borne in numerous numbers below it. The tree comes into flowering after 3 – 4 years after planting and profuse regular flowering occur in trees of more than 6 – 7 years old. Flowering takes place annually during Feb – Mar period, after the annual leaf fall coinciding with the winter period, often called as 'wintering'. Off-season flowering is also reported to occur in India, during Aug – Sep period. The trees can grow for many years under cultivation, however, the economic life span is considered to be between 25 – 30 years.

H. brasiliensis and its congeners

H. brasiliensis belongs to the family Euphorbiaceae. The genus *Hevea* has its origin from the Amazon river basin in South America, covering the countries of Brazil, Bolivia, Columbia, Peru, Ecuador, Venezuela, Surinam and Guyana. There are ten species found to occur under this genus viz., *H. benthamiana, H. camargoana, H. camporum, H. guianensis, H. microphylla, H. nitida, H. pauciflora, H. rigidifolia* and *H. spruciana* other than *H. brasiliensis*. Of the ten species, *H. brasiliensis* is the only one commercially exploited for natural rubber. These species are intercrossable and hence a wide variability of the interspecific progenies exists in the primary centre of diversity. *H. brasiliensis* has a chromosome number of 2n = 36 (Webster and Paardekooper, 1989).

Genetic base and crop improvement:

The attempts to introduce rubber tree to the then British colonies has started as early as mid 1800s. The well documented successful collection of seeds from the wild was made by Sir Henry Wickham from Tapajos river basin in Brazil during 1876. The seeds brought were distributed to Malaysia, Ceylon and other British colonies of the East including India. Many of these were not survived, and the seedling stocks survived at Malaysia had become the base for crop improvement of *Hevea* in 20th century. This base is now known as 'Wickham' base (Simmonds, 1989).

However, the 'Wickham' base being the collection from a small area and comprised of natural hybrids and selfed progenies, the genetic mix-up from the other species in this collection was very meagre (Schultes, 1977). This population was later subjected to very

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intensive selection, thereby erosion of many genes of secondary importance took place as the importance was given for improving the yield alone (Wycherly, 1969).

Advantages and constraints in breeding Hevea

Breeding process in *Hevea* has more disadvantages than advantages. The common advantages are

- Cross pollination is easy owing to the monoecious nature
- Seeds are very bold and can be handled easily
- The progenies selected can be multiplied vegetatively by budding

The constraints are

- Being a tree crop crossing is laborious and time consuming
- The hybrid recovery is very low
- The flowers are susceptible to mechanical manipulation
- Seed viability is very limited
- Handling of breeding population require extensive resources like land and labour
- The long breeding cycle makes generation based improvement and evaluation very difficult
- Genetic base of the breeding stock is very narrow.
- Collection from the wild is very difficult.

Being a tree crop of long duration, the conventional breeding procedures employed in field / annual crops are not exercised in *Hevea* breeding. The common procedures employed are

- Introduction, evaluation, acclimatisation and selection
- Plus tree/ mother tree/ ortet selection
- Hybridisation and selection
- Special breeding techniques
- Molecular approaches in crop improvement

Introduction, evaluation and selection

The narrow genetic base of the modern day cultivated clones of *Hevea* can be traced out to a handful of primary selection made out from the Wickham base. Most of the latter clones are developed from the combinations of clones like Tjir 1, Pil A 44, Pil B 84, PB 24, PB 49, PB 56, PB 86 and Gl 1. This limitation in the basic genetic variation has put forth a major threat of monoculture of related genomes in all the rubber growing areas. Few occurrence of devastating diseases like south American leaf blight (SALB) caused by *Microcyclus ulei* which had almost wiped out the commercial plantations of the American subcontinent, and the outbreak of *Corynespora* leaf fall disease caused by *Corynespora cassiicola* in Sri Lanka called for the necessity of widening the genetic base in the cultivated germplasm. None of the Wickham clones are known to be resistant to SALB (Wycherley, 1977; Ong *et al*., 1983; Simmonds, 1989).

Apart from the successful introduction of Wickham collection during 1876, another large scale organised collection of wild germplasm of *Hevea* was made from selected location of three states of Acre, Rondonia and Mato Grosso of Brazil in 1981 by the International Rubber Research and Development Board (IRRDB). There were also collections of minor importance took place during the period in between (IRRDB, 1978).

The studies using these introduced materials have proved that they harbour large scale variability, of which a major contribution is from the natural interspecific crosses. Apart from the wild germplasm; the cultivated germplasm are also exchanged bilaterally between rubber growing countries.

Plus tree or mother tree or ortet selection

This is the oldest and most exercised method of improvement done in *Hevea* in early years. The selections made out through this method are known as ortet clones. Here the selections were made by rigorous screening of seedling stocks derived from the natural out crossing among the introduced population. Many important varieties like Tjir 1, GT 1, PB 86, PB 28/59, Mil 3/2, Hil 28 etc., were derived through this method. This method is however still employed in a limited scale, in selecting high yielders and better performers in the non-traditional areas where the crop is still being introduced, and the species faces many abiotic stress factors like low temperature and moisture stress.

Hybridisation and selection

The development of hybrids in *Hevea* has also been performed as early as the commencement of crop improvement. The selected parents were usually high yielders in early years, and later on clones with other beneficial attributes such as disease resistance, compact canopy etc., were used in crossing programmes. Many high yielding selections are made out through this method. Popular hybrid clones, which are still under cultivation, are RRII 105, RRIM 600, PB 235 etc.

Special methods of breeding

Due to the great success of alternate breeding approaches like mutation and polyploidy breeding in field crops, these methods were also attempted in *Hevea* improvement. However, the success of economic importance through these methods is hardly available, though few mutants (compact canopy, variegated leaf) and polyploids (natural and artificial triploids and tetraploids) are available.

Prepotent clones are those throw out a good proportion of better performing vigorous seedlings on outcrossing. These clones are believed to harbour more additive genes of importance. They are grown in seed gardens under specialised designs such as honey comb or two-dimensional design. The clones are allowed to open pollinate themselves with equal opportunity and the seeds are collected and bulked. Such gardens are known as polyclonal seed orchards and the seedlings raised from the collected seeds are called polyclonal seedlings. They are found to survive better in non-traditional regions where the crop is introduced without any previous evaluation and acclimatisation (Mydin *et al*., 1990).

Breeding for resistance

To improve the quality of the planting stock to be grown in the non-conventional as well as conventional areas of rubber growing it is very essential to improve the ability of the genotypes to withstand the stress offered by various biotic and abiotic factors. Major adverse factors affecting *Hevea* are,

a. Abiotic factors

Temperature stress

Moisture stress

Mechanical stress (like wind)

b. Biotic factors

Major biotic factors that adversely affect *Hevea* are diseases. Major diseases are as follows.

South american leaf blight – *Microcyclus ulei*

Abnormal leaf fall – *Phytophthora* spp.

Powdery mildew – *Oidium heveae*

Corynespora leaf fall – *Corynespora cassiicola*

Gloeosporium leaf spot – *Colletotrichum gloeosporoides*

Though a native of the humid tropics, now in China, clones that could withstand temperature at –2°c were developed. The clone SCATC 93/114 is known to withstand cold effectively (Lin *et al.,* 1994). Similarly clones PR 107 and PB 5/51 are known to withstand heavy wind without producing considerable damage.

Genotype x Environment interaction

Hevea exhibits wide range of variation over environments. Thus it has become imperative to study the genotype x environment interaction in *Hevea*, to select clones which are suited to specific environments. Also there are clones which are phenotypically plastic, otherwise called as widely adapted genotypes, which could withstand various environments to a greater extend to produce uniform performance. The clones RRIM 600 and PB 86 are known to be widely adapted. Such clones are highly desired for the blanket recommendation of clones to non-traditional regions.

Molecular techniques:

The modern molecular techniques like restriction fragment length polymorphism (RFLP), amplified fragment length polymorphism (AFLP) and random amplified polymorphic DNA (RAPD) are now being used to quantify the genetic variability in the *Hevea* germplasm. The technique of genome analysis, development of c-DNA libraries and genome sequencing are also in progress. The employment of advances in tissue culture techniques has now enabled the development of transgenic *Hevea* plants, using *Agrobacterium* mediated genetic transformation and also using microprojectile techniques.

Recent advances and future prospects in quality improvement:

The major thrust of quality improvement in *Hevea* does not orient to the quality of rubber, but on the quality of secondary products like *Hevea* wood. Rubber trees produce enormous quantity of semi-hardwood at every replanting cycle. The shrinking availability of natural timber from the forests has made this so valuable. The wood on appropriate chemical treatment could be used as a best substitute for timber for furniture making and for similar uses. The treated wood is now being used to produce very high quality furniture, panel boards, house-hold articles and for flooring purpose.

Owing to the growing importance of rubber wood, the improvement in the direction of developing timber – latex clones is in progress. The clones combining better yield, high vigorous growth, short life span, high quality strong wood, free from diseases and with good branching habits are preferred.

Rubber tree is a prolific producer of honey. Honey is produced on extrafloral nectaries located on the *Hevea* leaves. High honey production can give additional income to plantation sector, and population that yield more honey are preferred.

Though rubber products are being used for so many decades, recently, the problem of latex protein allergy has emerged mainly in America. The allergy is reported to be caused by the proteins present in the latex, which are found in traces in the finished products. However, the allergy reported is mainly of type IV allergy of cutaneous origin. There are several processing methods available for the deproteinisation of the rubber products. However, it would be better to look out for genotypes, which do not accumulate harmful proteins in the latex.

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