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BREEDING STRATEGIES FOR *HEVEA* IMPROVEMENT

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ABSTRACT

The paper briefly discusses the constraints involved in *Hevea* breeding and suggests a modified approach to shorten the breeding cycle and enrich genetic variability. A multi-disciplinary approach for early evaluation is proposed. Conservation of available germplasm, genetical studies on yield components to aid directive breeding and location specific breeding programmes are emphasised.

INTRODUCTION

Since the introduction of *Hevea brasiliensis* to the East in 1876, the growth of the rubber plantation industry has been at a tremendous pace and the crop now covers over 7.5 million hectares over the globe (Rubber Statistical Bulletin 1983). Although it is the youngest major crop of the world domesticated only about a century back its enormous success can mainly be attributed to the vital strategic importance of natural rubber, its increasing demand and evolution of high yielding planting materials. The progress of the rubber plantation industry owes a lot to pioneering work of Crammer (1914) and Whitby (1919) in this regard, who showed the wide variability among seedling populations in yield. Subsequently the development of clonal propagation methods of selected genotypes helped in narrowing down the variability among the population and increasing the yield per unit area.

Tree improvement in Hevea can be attempted by different approaches. In brief these can be grouped under (a) ortet selection and further evaluation of selected genotypes, (b) induction of genetic variability, both in the seed material as well as in clonal populations, through artificial means and (c) hybridisation between selected genotypes. While many of the popular clones like GT 1, PR 107, Gl 1, Tjir 1, PB 86 etc., have been evolved through ortet selection, the success with regard to artificial induction of genetic variability has been only little. In this regard it may be remembered that only limitted attempts have been made in mutation breeding in Hevea. One of the major constraints that can be attributed for this is the perennial nature of the crop and related problems, although vegetative propagation is an attribute of advantage. Most of the high yielding clones developed by the different rubber research organisations over the globe from time-to-time have been evolved through breeding and selection.

EXPOSITION

Hevea cultivation in the East began with the seedlings of Wickham collection planted in the Botanic Gardens at Heneratgoda near Colombo and a few of them at Peradeniya, near Kandy in Sri Lanka, and small batches sent to Burma, Java and Singapore (Browne, 1912). Both in Sri Lanka and Singapore flowering started in 1881. From these stocks of plants started Hevea cultivation in the East. Improvement in the planting material was then concentrated upon, taking advantage of the genetic variability and successful method of vegetative propagation, employing both generative and vegetative methods. However, the emphasis had been on the yield potential. This reveals two aspects of importance. Firstly the genetic base available initially were limited. Secondly improvement was directed upon yield alone. As such genetic variability with regard to other characters were not exploited and there might naturally had been certain amount genetic erosion.

One of the major bottlenecks in the evaluation of new genotypes is the perennial nature of the crop and another, the large space required for experimentation. The works on early evaluation of new materials from the morphological, anatomical and physiological aspects have not so far identified a very reliable juvenile character which can be fully relied upon for selection of the best types. This naturally necessitates in carrying a sizable progeny for evaluation throughout the economic life span at least in the small-scale trial and to some extent in further trials.

Genetic studies in Hevea are only limited and as such much information is not available for appropriate choice of parents for a directive breeding programme. Physiological investigations have identified that initial flow rate, plugging index, dry rubber content and length of the tapping cut are the major yield contributing components (Sethuraj 1977, 1981). With the identification of these it would be rewarding to take up detailed genetic studies for appropriate selection of parent materials.

Even under the best conditions, the final success of crossing in Hevea is generally less than 5%. A recent study (Harihar and Yeang 1984) indicates that insufficiency of pollen grains and their uneven deposition on the stigma lobes are probable causes. It is likely that there may be many factors which are responsible for the low seed availability about which information is lacking.

The conventional breeding programme takes 30 to 32 years from nursery stage to the final recommendation. Selection and cloning of the best one percent of the seedlings at the fifth year followed by regional clone trials in the 6th year has been suggested as a new approach to shorten the breeding cycle by about ten years and also to save land (Subramaniam 1980). It, however, suggests utilisation of nine percent of superior seedlings for simultaneous evaluation. Any attempt to shorten the breeding cycle will be of advantage in evolving superior planting materials. A possible phase at which the time span can be reduced is between the preliminary selection stage and large-scale/task-wise trials in commercial plots. Establishment of a replicated field trial with polybag plants at the third year of hand pollination and selection of the best genotypes based on available information and yield for atleast three years, to the extent of five to ten percent of the genotypes is worth considering. These genotypes can be further multiplied and utilised for task-wise trials in commercial plots, in another two years time. Such trials, if possible, can be distributed in different locations. A final selection can be made from these trials based on yield for atleast five years of tapping and other characteristics. The original replicated yield trial will provide data on yield and other secondary characteristics for about 15 years in the mature stage. Simultaneously progeny testing and genetic analysis for combining ability, heritability, genetic advance etc. of various characters can be carried out from the replicated field trial. These informations could be utilised for intensification of characters by appropriate selection of parent genotypes. Useful variability can be employed in laying out a seed garden, the progeny from which will constitute a further reservoir of genotypes. In this programme, however, active involvement of the planting community, especially the estate sector, is necessary.

In many countries pressure on land and other socioeconomic constraints necessitate the expansion of rubber cultivation to nontradiational tracts. Naturally, the constraints at such locations will be totally different compared to those in conventional tracts. Depending on the agroecologic situations, an analysis of the constraints and location specific breeding programmes will be necessary. Emphasis will have to be given to disease, drought, cold, wind, etc.

PROGRAMMES FOR CONSIDERATION

1. Conservation of genetic resources:

   Simultaneous with the emphasis on furtherance of the genetic base from germplasm collection from the centre of origin, attempts have to be made to conserve the germplasm already available.

2. Early evaluation:

A multidisciplinary approach, from the anatomical, physiological, biochemical and morphological aspects, has to be taken up for early evaluation of genotypes to save time and space.

3. Genetic studies:

Detailed studies on the genetical aspects, particularly with regard to the major yield component characteristics, and also secondary characteristics are necessary. Such studies will help in knowing the genotypic value of existing materials and aid directive breeding programmes.

4. Low fruit set:

Studies will be necessary to identify the factors responsible for low fruit set and means to overcome the constraints.

5. Modified approach to breeding programme:

Attempts will be necessary to reduce the breeding cycle. Establishment of replicated field trials in the third year and task-wise trials, if possible in different locations, during the 12th year is suggested. Planting recommendation would be possible at 24-25 years, with the active involvement and co-operation of the estate sector.

6. Location specific breeding programmes:

With the expansion of *Hevea* cultivation to nontraditional tracts, location specific breeding programmes will be necessary.

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