THE ROOTSTOCK CLONES IN RUBBER TREE - A NEW VARIETAL TYPE TOWARD THE REJUVENATED BI-CLONE -

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Abstract

Cloning rubber rootstocks by microcutting will remove the genetic variability of the seedling rootstocks; Moreover, it will open the way to the breeding of rootstock clones regarding main challenges as the growth-vigor of the trees, the water stress tolerance or the root diseases tolerance. In other respects, using rejuvenated selected clones for budding will counteract the weakening effect of ageing. The conventional rubber clones are two-parts trees built up by budding mature budwood of selected clones [trunk and canopy] on unselected and uncloned seedling rootstocks [root system]. Outputs from biotechnology on Hevea brasiliensis, make it possible now to create the “rejuvenated bi-clone” associating a new rootstock clone A with a rejuvenated budded clone B. Such “bi-clone” will allow to optimize each part of the tree and their specific interaction; thus making the propagation more reliable and with higher quality regarding growth and rubber yield. This paper gathers laboratory and field data which grounded this project. The cloning of young seedlings by microcutting was previously defined by the CIRAD team in France since 1988 and more than 50,000 vitroplants were produced then. Field development of such self-rooted vitroplants was analysed at the CNRA research centre, in Ivory Coast, during ten years for growth and rubber yield. Results give evidence for the conformity of the root system and for the vigorous development of these trees which could have been used as clonal rootstocks. Work in progress with Michelin shows that rejuvenated budded clones, issued from primary somatic embryogenesis, display higher growth speed than the conventional mature clones. Currently, the IBRIEC and IRRI teams, in Indonesia, are successfully implementing the same microcutting process. The first “bi-clones” have been built and planted at Bogor early in 2008, showing the feasibility of it.

Keywords: Hevea brasiliensis, rootstock, phase change, cloning, microcutting, rejuvenation, micropropagation

INTRODUCTION

The conventional budded clone is a two-part tree. One part is the aerial part (trunk and canopy) which is well known. From the beginning of the last century, breeders provided regularly new high-yielding budded clones to the planters. The
second part is the rootstock which comes from progenies of budded clones, that is genetically heterogeneous seedlings, roughly selected after some months in nursery. For this part, there was no significant improvement for many decades.

It's funny to consider that rubber tree improvement was parallel with the development of the car industry. But can people imagine that all these modern cars still used the same ancient tyres than the first one? What would be their performances? That's the situation in rubber tree.

Improving rubber rootstocks need cloning. It has not been possible with cutting but now biotechnologies can do that and give the right tool to the breeders to select new rootstock clones as it was done for fruit crops\(^{10}\) and also for car industry with modern tyres.

By such a way it will be possible to create a bi-Clone, that is a new rootstock clone A budded with a high yielding clone B. Breeders worry for a long time regarding the rootstock part in rubber tree\(^{15}\). Even then in 1941, Schmöle\(^{8}\) reported field experimentation with hybrid rootstocks from H.b X H.s. providing a yield gain of 20% to 30% on three different budded clones. Bastiah Ahmad\(^{9}\) remind of the hypothesis made in the RRIM annual report in 1958 that “Growth-vigor differences between the clonal seedlings are due to their root features. At the same time (1958), Mc Indoe\(^{6}\) was experimenting on cutting from juvenile seedlings and he proposed “early selection of young seedlings, then rootstock cloning by cutting”.

Unfortunately, we know that cutting has not been efficient enough on rubber tree. But he pointed out the right way: the selection of new specific features on young seedlings for rootstock clones.

**SELF-ROOTED TREES FROM MICROCUTTING**

Thanks to biotechnologies, a new micropropagation process was developed in the 80’s. The initial step devoted to the setting up of the microcutting process has been implemented in 3 French laboratories. Acclimatization and field trials were done mainly in Ivory Coast on two different places but also in Gabon. The final aim at that time was the micropropagation of high-yielding clones\(^{6,10}\). For such plant material rejuvenation was necessary before microcutting implementation. Rejuvenation was assessed by repeated budding, minibudding and microbudding. However, the most efficient way was primary somatic embryogenesis. Main outputs of this project were the production of 50,000 plantlets from seedling clones and 18,000 plantlets from selected clones (IRCA 18, PB 235 and RRIM 600), with the planting of about 16 ha of field trials from 1987 to 1994.

Microcutting from seedling is a robust technique\(^{11}\) composed of 4 steps: 1) The primary culture, 2) the multiplication phase by regular subculture, it provide a multiplication range of 1.5 to 2.3 per month, depending of the genotype, 3) the
conditioning and rooting of the axillary shoots and 4) the last step for acclimatization and nursery, with a global success rate of 70% of plants ready for planting.

One of the field trial, BM-OM2, was composed of 18 genotypes that is juvenile seedlings, with 2 treatments: the budded control and the self-rooted microcutting, with 24 trees per elementary plot. Ten years after planting, the density of the trial was still very high (99%). The trees in the two treatments display the same conicity angle in the foot part of the trunk (Figure 1). This trait is not surprising since the mother trees are juvenile in the two treatments.

During the immature time, the girth of the trunk was similar for the two treatments. Opening the trees, 5.5 years after planting, lowered the growth. This effect was stronger on the budded control; so nine years after planting, the growth of the self-rooted trees was significantly higher: 5% more. This effect is regular. The microcutting treatment was always better or at least similar for all the genotypes (Figure 2). Deep experimentations were made in parallel, from others trials, to check the quality of the root system: it has been concluded that self-rooted trees from microcuttings had a well developed pseudo tap-roots and lateral root system, with architecture similar to that of plants obtained from seed.

DEVELOPMENT OF ROOTSTOCK CLONES BY MICROCUTTING

The consistent data from microcutting process and from field trial led to start a new collaborative research programme with Indonesian teams, for demonstrating the “Feasibility of rootstock clone propagation by microcutting”.

This new project was implemented through a collaborative research program between IBRIEC, IRRI and CIRAD. Funding was from public agencies. The main outputs of this second step were: 1) The renovation of the in vitro culture laboratory at Bogor 2) The selection of 100 candidates for rootstock clones 3) The technology transfer and the training of the IBRIEC team for microcutting process 4) The routine production and acclimatization of about 400 plantlets/month 5) The successful budding on microcutting rootstock with conventional PB 260.

Now, the next challenge will be to increase enough the mastering and the global yield of the process to be able to enter the pilot phase.

The pilot phase means the simulation of commercial production to assess the quality, the homogeneity of the plants and their cost price. In parallel, field trial will be established with clonal rootstocks for studies on the rootstock interaction with high-yielding scion clones and early selection of candidate rootstock clones. That's why development of rootstock clones is a multi-faceted challenge,
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Figure 1: Field trial BMOM2a, 6.5 years after planting (CNRA/Ivory Coast) - Angle of the trunk conicity from 25 cm to 170 cm high, depending of the propagation method: self-rooted clones by microcutting (M) or juvenile budded clones (C). Tapping area disrupts the curves at 100-125

Figure 2: Field trial BMOM2a, 10 years after planting (CNRA/Ivory Coast) Mean girth of the trunk at 50 cm high (no trouble with tapping panel) for the 18 seedling clones depending of the propagation method: self-rooted clones by microcutting (M) or juvenile budded clones (C). Advantage is for M trees in 17 clones out of 18
involving micropropagation, selection and biology of development. All these data will then support the starting of commercial production and scale-up.

REJUVENATED CLONES

One complementary concern of the project is related to the question: “why to go on using mature conventional budded clones instead of rejuvenated clones?”

In rubber tree, there is no change in the leaves shape in the course of ageing, like in most conifers or *Eucalyptus sp* for instance, but some morphological traits related to the phase change can be find with the conicity angle in the foot part of the trunk, with the color of the sprout, with the angle of the sprout also.

For fruit crops, mature traits must usually be maintained because they were in relation with the earliness of fruit harvest. However for forest trees, juvenility means easy propagation and higher growth-vigor, and it is a huge advantage. It is well-known that in vitro culture, mainly somatic embryogenesis, can produce rejuvenation, that is reversion of the usual physiological ageing process.

In rubber tree, there has been three completely independent experiments on the effects of juvenility - by Dutch, Chinese and French teams - at different time, - in different countries, - with different clones. All the conclusions backed each others showing the superiority of the juvenile or rejuvenated clones over conventional mature ones: superiority regarding growth and latex yield.

The Figure 3 displays the data from current field trials in Africa with 5 different clones. In all of them the rejuvenated trees grow faster than the mature conventional control.

CONCLUSION

The great length of the vegetative cycle in rubber tree, as for most forest trees, constitutes a handicap to assess new ways for vegetative propagation. Remember that more than 30 years were necessary last century to leave seedlings and develop the budded clones. Field experiments, which have been reported here, gave the demonstration of the root system conformity and the high growth vigour of the juvenile self-rooted clones from microcutting. They validated the plant material from microcutting. That is why such material is good candidate for rootstock cloning. Main targets for the root system breeding will be increasing the global sturdiness of the budded tree, the drought tolerance and the root disease tolerance.

Moreover, agronomic validation of rejuvenated budded clones is in progress. So, creating the “rejuvenated bi-clone” is just to gather the pieces of the jigsaw: microcutting of rootstock clones will lead to the selection of rootstock clones thanks to the budding with high-yielding clones previously rejuvenated through
primary somatic embryogenesis. Then, scale-up will lead progressively to commercial micropropagation of the rootstock clones. And that's could be a great, nice challenge.

REFERENCES


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