Growth and yield of *Hevea brasiliensis*: effect of juvenility of source bush nurseries

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ABSTRACT: *Natural rubber tree, Hevea brasiliensis (Willd. ex A.Juss.) Mull. Arg. is being propagated predominantly by asexual methods through patch budding. However, trees exhibit intra-clonal variation in growth and yield which reduces the uniformity of plantations. Commercially, buds were collected from budwood sticks regenerated every year from the same source bush nurseries. The age of source nurseries may vary from one to 20 years. Present study examines the effect of age and juvenility of buds from six source bush nurseries and mature trees on growth and yield of the most popular clone RRII 105. Bud patches were collected from healthy regenerated budwood aged one year, four year and 20 year old budwood nurseries and directly from 10 year old mature trees. These buds were grafted onto healthy stock seedlings raised in the nursery. The resultant plants were evaluated in a field trial during 2006 to 2014 following standard field practices. Girth of trees in the seven treatments varied during early growth phase. However, in the seventh and eighth year after planting, except the plants raised directly from 10 year old trees, growth of trees did not show any statistically significant difference. Trees raised from mature trees (34.0 cm) compared to those from regenerated budwood nurseries aged one year, four year and 20 years (girth ranged from 40.0 to 46.3 cm). The results indicated that trees originated from all rejuvenated bud sources viz., one, four and 20 years old budwood stocks registered significantly higher rubber yield (ranging from 31.0 to 37.0 gram/tree/tapping). However, trees originated from buds of mature trees registered significantly ($p<0.05$) inferior growth, tappability (8.0%) and dry rubber yield (28.0 grams per tree per tapping) compared to other treatments. Moreover, buds of mature tree branches recorded higher intraclonal variation in girth than that of trees raised from budwood nurseries. Results of this study demonstrate that the age of budwood sources ranging from one to twenty years does not appear to have any significant role in determining intraclonal variability in growth and yield of rubber and strongly suggest avoiding use of buds directly from mature trees for commercial propagation.*

***Key words*:** *Hevea brasiliensis*, Propagation, Juvenility, Age of budwood, Source bush nurseries, Budding

Introduction

Natural rubber tree, *Hevea brasiliensis* is being propagated predominantly by asexual methods through patch budding. However, this tree crop exhibit intra-clonal variation in growth and yield which reduces the uniformity of plantations (Jayasekera and Senanayake 1971; Senanayake 1975; Senanayake et al. 1975). There were many attempts to investigate this issue by establishing the role of different factors like stock-scion interaction (Gireesh et al. 2012) and graft incompatibility (Mercykutty and Gireesh 2015). Source and juvenility of vegetative propagules plays an important role in the success of vegetative propagation. Seneviratne (2000) and Senevirathna et al. (2007) studied quality of planting materials with respect to

growth variation of the trees and reasons for not achieving the potential rubber yield. This could be circumvented to a limited extent by adopting standard management practices but most of the growers are doubtful about the role of age of budwood source bush nurseries. Many commercial nurseries now generate budwood repeatedly from same stock for over 20 years and in certain cases buds are harvested directly from the mature trees for bud grafting. Reestablishment of source bush nurseries has been practised (Seneviratne et al. 2000) but causing huge spending on man power and time. Juvenility of source budwood stocks from which buds are harvested for multiplication, is as important as any other factors which contributes to the success of bud grafting as well as uniformity and growth of plants in later stages. Present study examines the effect of age and juvenility of buds sourced from different source bush nursery plants and mature trees on long term growth and yield of the most popular clone RRII 105.

Materials and methods

Well grown one year old budwood of the clone RRII 105 were collected from young and mature budwood nurseries. Different age of budwood nurseries viz., one, four and twenty year old from three different locations (A, B & C) were chosen for the study. The appearance of three types of budwood is illustrated schematically in the Fig. 1. Buds were collected from budwood sticks and grafted onto stock seedlings of one year old seedlings raised in the ground of Central Nursery, Karikkattoor. Buds collected from the terminal branches of 10 year old mature trees of RRII 105 were also bud grafted on to the stock seedlings.The seven treatments are detailed in the Table 1. Successful bud grafts were raised in top soil filled black low density poly bags (55 x 25 cm size lay flat size with 400 gauge thicknesses) and later when the plants attained 2-3 whorls stage, field planting was done. The trial was laid out in randomised block design with 3 replications with nine plants per plot in each treatment. Field experiment was conducted at the Central Experimental Station of Rubber Research Institute of India at Chethackal in Central Kerala. All recommended field management practices were followed throughout the experiment.

Girth at breast height of trees in the field was recorded annually from the third year of planting onwards and estimated the tappability of trees during 7th year after planting. Dry rubber content of latex from each tapping was determined at monthly intervals and expressed as gram per tree per tapping (g/t/t). Tapping system followed was S/2 d/3 6d/7 (once in three days).

Figure 1: Progression of budwood nursery over years. Schematic representation of a budwood nursery, each branching point indicates cut back point where one year old branches were pruned for collecting new shoots every year.

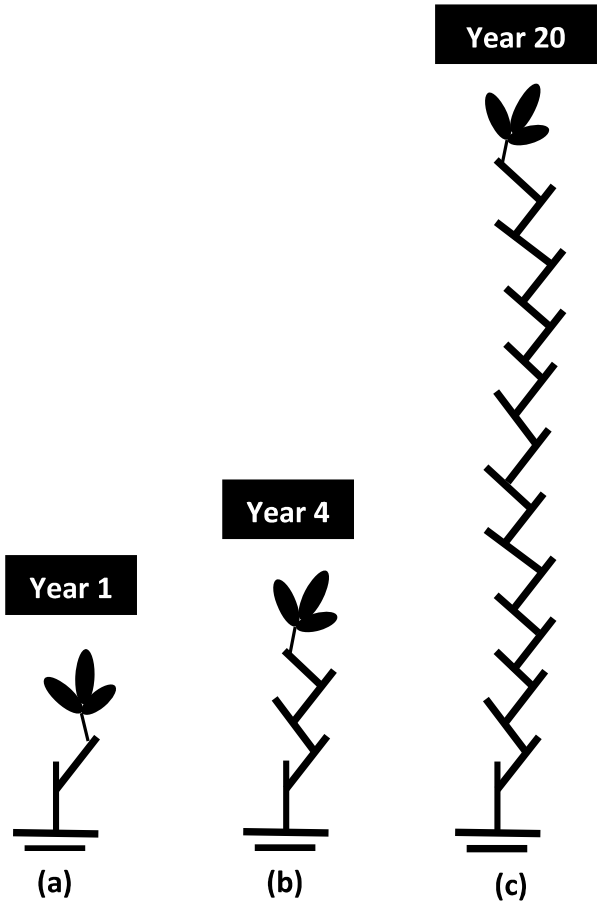

Table 1: Details of treatment combinations

Treatments	Age of bud source	Locations
T1	20 year old budwood plants	Nursery A
T2	4 years old budwood plants	Nursery A
T3	4 year old budwood plants	Nursery B
T4	4 year old budwood plants	Nursery C
T5	20 year old budwood plants	Nursery C
T6	10 year old trees	Plantations
T7	1 year old budwood plants	Nursery B

Results and discussion

Budwood plants are pruned in Sept-Oct every year and a length of 15 cm was retained for regeneration of new shoots. One or two shoots in each branch is allowed to grow for harvesting budwood. This practice was being continued for different time periods ranging from one year to 20 years. In certain cases, source bush will remain for more than 20 years (Fig. 1). Juvenility and vigour of buds and its potential to become successful plantation was tested in this long term study.

Growth variation in the trees reflected in the girth measurements from three years after field planting. Difference in the growth was significant until fifth year across the treatments. Table 2, shows that trees originated from buds of old trees without rejuvenation lagged in growth behind all other age groups significantly throughout the period under observation. Initially trees raised from young budwood nursery (T2, T3, T4 and T7) recorded a mean girth of 16.3, 16.8, 16.2 cm and 17.2 cm respectively and the treatments were on par, while better initial growth (17.2 cm) was registered by trees raised from young bud source (one year). However, the difference among other treatments narrowed down and no significant difference was noticed in 6th and 7th year after planting. Annual girth increment rate and uniformity of trees are also considered as an important growth parameter which determines the commercial success of plantations. This study illustrates that trees raised from young budwood stock plants showed better growth parameters in the initial growth phase and the differences were subsequently narrowed down. The results suggest that age factor in the budwood nurseries doesnot influence the growth of trees in later stages. General understanding is that when the harvesting point moves away from the base of the tree the plants may have lost juvenility and results in lack of vigour of progenies. But it is true in the case of buds collected from the tree top (un- rejuvenated) as the resultant trees showed significantly less vigour.

Table 2: Growth of trees over seven years

	Treatments	Mean girth (cm)				
		yr. 3	yr. 4	yr. 5	yr. 6	yr. 7
T1	20yr. nursery A	15	22.7	30.8	35.5	42.0
T2	4yr. nursery A	16.3	24.9	33.8	37.0	46.3
T3	4yr. nursery B	16.8	25.6	34.1	38.5	46.2
T4	4 yr. nursery C	16.2	24.1	32.4	38.8	44.5
T5	20 yr. nursery C	16.1	24.4	30.3	35.2	42.5
T6	10 yr.trees	11.03	16.4	23.0	26.2	34.0
T7	1yr.nursery B	17.2	25.2	32.7	36.8	45.1
	CV	6.4	5.3	7.4	8.2	6.9
	CD($p<0.05$)	1.4	1.8	1.9	4.2	4.3

Early tapping and high precocious yield from trees is important when discounted cash flow and return on the investment is considered (Wycherley 1969; Mydin and Mercykutty 2007). Tappability is an important parameter which determines the commencement of tapping in plantations. Opening of trees for tapping require a minimum girth of 50 cm at breast height. Earlier attainment of tappability ensures higher initial returns to growers.The tappability percentage of trees among different treatments (Table 3) illustrates that highest score (70.7%) was registered by trees originated from young budwood source (T3) while others are also observed to fall in an acceptable range of 51 to 60%. Only 14% of the trees attained tappability in T6, where the trees were raised from the un-rejuvenated buds collected from 10 year old trees. This result clearly indicates that the buds from old trees should never be used for raising planting materials. Earlier reports by Mercykutty et al. (2014) also support these findings.

Rubber yield is the most important economic trait of rubber trees. Table 3 illustrate the average yield potential of trees originated from different categories of bud wood. Young budwood originated trees (1 year old, T7) registered highest mean yield of 37 gram/tree/tapping compared to 20 year old trees (T1 and T5) which recorded 31 to 32 gram/tree/tapping respectively. Lowest yield (34 gram/tree/tapping) was recorded by the trees originated from the buds of 10 year old trees. To minimise the immaturity period and increase the uniformity of stand, raising quality planting material from a young healthy budwood source is very crucial. The study suggests that there was no wide difference between the age group of budwood nurseries. Results of this study demonstrate that the age of budwood sources ranging from one to twenty years was not significant in determining intraclonal variability in the growth and yield of rubber. The study also strongly suggests that use of buds directly from mature trees for commercial propagation could not be advocated.

Table 3: Tappability and yield over two years

	Treatment description	Tappability (%)	Mean yield over two yrs. (gram/tree/tapping)
T1	20yrs. nursery A	59.5	31.8
T2	4yrs. nursery A	59.3	33.1
T3	4yrs. nursery B	70.7	34.7
T4	4 yrs. nursery C	51.3	34.7
T5	20 yrs. nursery C	38.5	30.6
T6	10 yrs.trees	8.0	28.2
T7	1yr.nursery B	59.3	37.0
	CV	--	8.7
	CD($p<0.05$)	--	4.2

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