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BENCH GRAFTING IN RUBBER (*HEVEA BRASILIENSIS*)

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ABSTRACT

Bench grafting using brown buds and 10 month old stock plants was attempted for the first time in *Hevea brasiliensis* with a view to assessing the feasibility of adopting this technique for the propagation of the crop. Stocks raised from assorted seeds were budded with scions from clones RRII 105, RRII 118, RRII 203, RRII 208 and GT 1. Simultaneously, conventional budding was carried out in the nursery using same scions and similar stocks for comparison. The experiment was laid out by employing completely randomized design with 35 replications. The characters recorded were budding success, establishment success and growth characters. The experiment was repeated over three consecutive years. Budding and establishment success was 83.60% and 55.40% respectively for bench grafting when compared to 94.73% and 80.80% for nursery grafting. A pooled analysis of the data on growth characters revealed bench grafts to be significantly superior to nursery grafts in height, diameter, number of whorls and number of leaves. Significance of bench grafting in *Hevea* is discussed.

INTRODUCTION

The term bench grafting refers to any method of grafting performed on a work bench inside covered structures like glass houses and sheds (Mahlstede and Haber, 1966; Macdonald, 1986). This technique is adompted under adverse climatic conditions such as severe cold, extreme summer and heavy rain which are not conducive for outdoor grafting. Under such circumstances due to the favourable environmental conditions that exist inside covered structures grafting could be undertaken more successfully. Bench grafting is widely adopted for the propagation of many cultivated plant spp. like apple, citrus, (Mahlstede and Haber, 1966) teak (Kedharnath, 1985) pine, *Magnolia*, oak, *Rhododendron* (Macdonald, 1986) and *Picea* (Macdonald, 1990). Multiplication of rubber for commerical planting is carried out by budgrafting stock plants raised in nurseries or field with buds taken from selected source plants showing desirable attributes (Edgar, 1956). Among the two types of budding viz., green budding and brown budding, the latter is more commonly adopted in India. Under our conditions optimum time for brown budding is the rainy period May-December (Manttukalam and Premakumari, 1982). However, during this period budding cannot be carried out on many days due to the interference of heavy rain. If budding is attempted when it rains, water gets into the budding panel and spoil the budding (Dijkman, 1951). Due to this limitation on many occasions budding could not be carried out as programmed up- setting the scheduled production targets for budded plants.

In cases where scions are brought from distant places undue delay caused in using them due to the interference of rain can even result in their spoiling. If brown budding is carried out indoor adopting bench grafting technique all these problems can ben solved. But no attempt has so far been reported in this line from any country. Therefore, this study was undertaken as a pioneer effort to assess the feasibility of bench grafting in rubber. If found successful it is also envisaged to compare this technique with conventional outdoor budding with respect to budding and establishment success as well as subsequent growth of the scions.

MATERIALS AND METHODS

Ten month old stock plants and brown coloured buds collected from one year old scion shoots were used for this study. Buds were taken along with a patch/shield of bark and grafted to the stock plant, a little above the collar adopting the commonly followed technique which is a modified form of Forkert method of patch budding (Teoh, 1972; Webster, 1989). Budding was conducted during June and both types of grafting were done on the same day. The design adopted was completely

randomized, with 35 replications. In the case of bench grafting, stock plants were pulled out from the nursery, stumped in the case of budded stumps (Manattukalam *et al.* 1980), brown budding carried out indoor and planted in polybag nursery outdoor on the same day. Nursery budding, the control, was done *in situ* during rain free intervals. The polythene bandage covering the bud patch was removed from both materials after 20 days and initial budding success was recorded. Ten days later final success also was noted. Control plants were then pulled out from the nursery, stumped and planted in the same polybag nursery. All the plants were maintained in the polybag nursery adopting necessary cultural operations recommended for the same (Potty, 1980; Manattukalam, 1981). Ten months after the date of budding, establishment success of the plants in bag as well as growth characters of the scion such as height, basal diameter, number of leaf whorls and total number of leaves were recorded. The study was repeated over three consecutive years, 1986 to 1988. The data on growth characters were analysed for test of significance by analysis of variance.

RESULTS AND DISCUSSION

Percentage budding success for bench grafting was comparatively less than nursery grafting during all the three years. Mean values for bench grafting was 83.61 and that for nursery grafting was 94.7 (Table I). All clones showed the same trend. Higher budding success obtained for the control may be due to the fact that this was done during rain-free intervals following the commercial practice. As a result the adverse effects caused by the interference of rain has not influenced the budding success. If budding was done in rain the success rate would have been much lower.

Establishment success in polybag nursery was also considerably higher for nursery grafts than those grafted indoor, throughout the period of study. Over the three years bench grafts recorded a mean establishment success of 55.4% in comparison to 80.8% for nursery grafts (Table I). The low success rate of bench grafts was mainly due to the large scale drying of buds after recording the final budding success. This indicates that unlike the normal pattern, the process of bud union was not completed within 30 days after budding in bench grafts. The possible explanation for this is the poor growth activity in these plants. It may be recalled that these plants were grafted after stumping, resulting in the loss of most of the photosynthetic organs. Formation of new cells and tissues are essential for the union of bud with the stock plant (Hartman and Kester, 1968). In the absence of enough photosynthetic activity supply of food materials to the newly formed cells and tissues might have been at reduced

Table I. Clonewise performance of bench grafts and nursery grafts in different years with respect to (a) budding success (%) and (b) establishment success (%)

Clones	Bench grafts								Nursery grafts							
	1986		1987		1988		Mean over three years		1986		1987		1988		Mean over three years	
	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b
RRII 105	71	51	67	40	83	66	73.6	52.3	94	78	89	71	94	86	92.3	78.3
RRII 118	85	65	74	40	77	29	78.6	44.6	97	75	86	80	94	86	92.3	80.3
RRII 203	97	78	89	54	80	69	88.6	67.0	100	80	91	71	97	80	96.0	77.0
RRII 208	97	73	88	46	80	46	88.3	55.0	100	85	97	60	94	94	97.0	79.6
GT 1	97	66	86	31	83	77	88.6	58.0	100	83	94	89	94	94	96.0	88.6
Mean	89	67	81	42	81	57	83.6	55.4	98	80	91	74	95	88	94.7	80.8

rate resulting in their poor development, which in turn, slowed down the stock scion union. As a result, when the protecting cover of polythene bandage was removed, the stress exerted on the buds by adverse climatic conditions might have caused damage to them resulting in their drying. However, further studies including anatomical observations are required to arrive at definite conclusions.

Regarding the growth of scion, bench grafted plants in general performed better than the control. Height of the scion was significantly higher in the case of bench grafts (88.59cm) compared to the nursery grafts (68.44 cm) the difference being highly singnificant during the first two years (Table II). Among the five clones budded RRII 203 recorded the highest (107.68 cm) and RRII 105 the lowest (72.84 cm) values for this character among bench grafts. In the case of nursery grafts highest (80.14 cm) and lowest (56.83 cm) heights were attained by RRII 203 and GT 1 respectively (Table IV).

In the case of the diameter of the scion also, performance of benchgrafts was significantly higher than the control, the values being 11.07 mm and 9.56 mm respectively for the two materials. The trend persisted throughout the period of study (Table II). RRII 203 which recorded a diameter of 12.43 mm and GT 1 recording 9.74 mm occupied the highest and lowest ranks respectively among bench grafts. Among nursery grafts highest diameter (10.68 mm) and lowest diameter (8.31 mm) were recorded by RRII 203 and GT 1 respectively (Table IV).

Total number of leaf whorls per scion was another aspect in which bench grafted plants retained supremacy over nursery grafts. Highly significant difference was observed between bench grafts (2.10) and nursery grafts (1.96) regarding the number of leaf whorls. Superiority of the bench grafts was maintained during all the years of the study (Table III). Among the clones studied, RRII 118 recorded the maximum and GT 1 the minimum values for both bench grafts and nursery grafts (Table V).

In the case of total number of leaves per plant also bench grafts were found to be significantly superior (4.61) to nursery grafts (3.96). This superiority was maintained throughtout the duration of the experiment (Table III).

Table II. Height and diameter of bench grafts and nursery grafts

Year	Height (cm)			Diameter (mm)		
	Bench grafts	Nursery grafts	Variance ratio	Bench grafts	Nursery grafts	Variance ratio
1986	89.81	65.19	75.00**	10.54	8.86	34.94**
1987	71.18	43.37	82.18**	9.93	7.54	71.60**
1988	99.93	92.98	1.23	12.57	11.99	39.34**
Mean over three years	88.59	68.44	61.97**	11.07	9.56	37.31**

** Significant at 1% level.

Table III. Number of leaf whorls and number of leaves of bench grafts and nursery grafts

Year	Number of leaf whorls			Number of leaves		
	Bench grafts	Nursery grafts	Variance ratio	Bench grafts	Nursery grafts	Variance ratio
1986	3.82	3.21	37.73**	22.63	18.89	22.67**
1987	3.21	2.68	18.88**	22.28	12.45	93.63**
1988	4.87	4.21	15.96**	19.76	15.99	15.65**
Mean over three years	3.97	3.37	70.08**	21.56	15.78	115.69**

** Significant at 1% level.

Table V. Clonewise performance of bench grafts and nursery grafts in different years with respect to (a) number of leaf whorls * (b) number of leaves

Clones		Bench grafts							Nursery grafts						
		1986 Mean ± SE		1987 Mean ± SE		1988 Mean ± SE		Mean over three Years	1986 Mean ± SE		1987 Mean ± SE		1988 Mean ± SE		Mean over three years
RRII 105	a	2.05	0.05	1.76	0.06	2.21	0.06	2.01	1.92	0.04	1.73	0.04	2.09	0.05	1.91
	b	4.47	0.16	3.91	0.22	3.85	0.19	4.08	4.15	0.12	3.25	0.17	3.98	0.17	3.97
RRII 118	a	2.17	0.04	1.99	0.06	2.51	0.09	2.22	1.96	0.04	1.85	0.04	2.24	0.05	2.02
	b	5.12	0.13	4.76	0.22	5.17	0.29	5.02	4.48	0.12	3.58	0.16	3.84	0.17	3.97
RRII 203	a	2.05	0.04	2.03	0.05	2.35	0.06	2.14	1.92	0.04	1.76	0.04	2.24	0.05	1.97
	b	4.80	0.12	5.34	0.19	4.83	0.19	4.99	4.48	0.12	3.53	0.17	4.43	0.17	4.15
RRII 208	a	2.09	0.04	1.86	0.06	2.51	0.07	2.15	1.89	0.03	1.81	0.05	2.17	0.05	1.96
	b	4.92	0.13	4.19	0.21	4.20	0.23	4.44	4.38	0.12	3.68	0.18	3.98	0.16	4.01
GT 1	a	1.96	0.04	1.88	0.07	2.12	0.05	1.99	1.90	0.03	1.72	0.04	2.04	0.05	1.89
	b	0.14	0.06	0.25	4.34	0.17	4.54	4.28	0.12	3.51	0.15	3.55	0.16	3.78	
Mean	a	2.06		1.90		2.34		2.10	1.92		1.77		2.16		1.95
	b	4.70		4.65		4.48		4.61	4.35		3.51		3.96		3.94

* Means are square roots of actual values.

Table IV. Clonewise performance of bench grafts and nursery grafts in different years with respect to (a) plant height (cm) and (b) basal diameter (mm)

Clones		Bench grafts							Nursery grafts						
		1986 Mean ± SE		1987 Mean ± SE		1988 Mean ± SE		Mean over three years	1986 Mean ± SE		1987 Mean ± SE		1988 Mean ± SE		Mean over three years
RRII 105	a	82.14	5.64	57.43	5.63	78.96	10.19	72.84	61.89	4.30	42.16	4.21	78.43	8.93	60.83
	b	10.18	0.56	9.56	0.52	11.99	0.98	10.58	9.10	0.43	7.67	0.39	12.35	0.85	9.71
RRII 118	a	94.71	4.69	72.75	5.63	131.30	15.46	99.59	64.98	4.37	46.98	3.98	98.28	8.93	70.06
	b	11.37	0.47	9.69	0.52	16.19	1.48	12.42	8.71	0.44	7.86	0.37	12.87	0.85	9.81
RRII 203	a	94.15	4.30	87.71	4.83	141.17	9.98	107.68	69.14	4.23	43.02	4.21	128.25	9.24	80.14
	b	10.69	0.43	11.49	0.45	15.12	0.95	12.43	9.72	0.42	7.92	0.39	14.39	0.88	10.68
RRII 208	a	91.22	4.44	65.13	5.27	95.59	12.22	83.98	63.91	4.10	43.24	4.60	89.64	8.51	65.60
	b	10.13	0.44	9.09	11.99	1.17	10.40	8.35	0.41	7.06	0.42	11.17	0.81	8.86	
GT 1	a	82.67	4.99	66.95	6.35	72.09	9.41	73.90	64.12	4.16	41.47	3.78	64.89	8.51	56.83
	b	10.22	0.50	9.19	0.59	9.81	0.90	9.74	8.14	0.42	7.15	0.35	9.65	0.81	8.31
Mean	a	88.98		69.99		103.82		87.61	64.81		43.37		91.90		66.69
	b	10.52		9.80		13.02		11.11	8.80		7.53		12.09		9.47

Among the bench grafted clones, RRII 118 and RRII 105 recorded the highest and lowest valuess respectively for this character. Highest value was observed for RRII 203 and lowest value for GT 1 among nursery grafts (Table V). However, differences between clones were relatively low in the case of number of leaf whorls and total number of leaves.

Better growth attained by the scion of bench grafted plants could be probably due to the reason that these plants were established in bags 30 days before the control plants and as such growth activities might have been initiated in them earlier resulting in early growth of the bud shoots. This aspect also requires further investigation to arrive at conclusive inferences.

Present investigations clearly establish the feasibility of bench grafting in rubber. Under comparable climatic conditions, bench grafting shows less budding success and nursery establishment vis-a-vis nursery grafting undertaken as per the commercially accepted practice. However, growth vigour of the scion shoot was significantly better in the case of bench grafts. In general, all clones showed the same trend in their performance. Consistent results were obtained during all the three years of the study.

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DISCUSSION

K.K.N. NAMBIAR : The terminology used here is "bench grafting", but you have used only budding. Please explain.

J.G. MARATTUKALAM : Bench grafting is a general term used to refer to any kind of grafting (bud grafting, or branch grafting) carried out in covered structures.