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Clonal evaluation for budding success in *Hevea brasiliensis* Muell. Arg.

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Abstract: *Production of planting materials of natural rubber tree, Hevea brasiliensis is by budding, which is affected by both genetic and environmental factors. This limits production of planting materials for distribution to farmers. This limitation can be addressed through genetic improvement. The objective of the study was evaluation of heritability of budding success among ten improved clones of H. brasiliensis. The study was conducted at the substation of the Rubber Research Institute of Nigeria at Akwete, Abia State, Nigeria. Bud-patch was obtained from ten improved clones and budded onto rootstock. Rootstock consisted of seedlings of mixed clones. First and second inspection of budding success was conducted at 21 and 28 days after budding, respectively. Percent budding success was calculated and transformed used arc-sine transformation. Analysis of variance was conducted with mean separation and calculation of broad sense heritability. There was significant clonal variation for budding success with heritability estimates of 92% to 97%. Budding success was least in NIG 812 (C162) at 2.33% and highest in NIG 813 (C 202) at 71% with eight clones having less than 60% budding success at 28 days after budding. This suggests that clones with low budding success will require high intensity budding to get enough planting materials for farmers. The high heritability provides prospect of high selection progress while breeding for improved budding success.*

Keywords: *Rubber tree, Hevea, budding, variation, heritability*

INTRODUCTION

The centre of origin of *Hevea brasiliensis* is the Amazon basin in South America. The natural rubber tree was introduced into Asia and Africa from 1876 – 1895 in the first instance, where it assumed commercial status as the major source of natural rubber (Omokhafe and Nasiru, 2005; Priyadarshan et al., 2009). The *H. brasiliensis* tree produces viable seeds for propagation, but the use of seeds for propagation is recommended only for development of rootstock nursery. In the case of plantation trees, vegetative multiplication by budding is applied (Cardinal et al, 2007).

Improved varieties of *H. brasilensis* were obtained through direct selection in some cases leading to development of primary cones such as GT 1, PR 107, PB 86 etc (Omokhafe et al, 2017). The common approach in recent times is hybridization followed by selection, locational trials, farm trials, final selection, recommendation, registration and release (NACRAGB, 2016). The use of vegetative propagation is to preserve the genetic potential of the recommended clones because *Hevea* tree is a cross pollinating plant. Improved varieties will produce seeds resulting from segregation and hence not true-to-type with the mother tree.

Budding has been the practice of multiplication of improved materials of *H. brasiliensis* (Omokhafe et al., 2016). It is also for the sake of vegetative propagation that the improved variety of *H. brasiliensis* is referred to as clone. Low budding success is a limitation to production of planting materials of *H. brasiliensis* more so in this era of climate change (Omokhafe et al., 2016). Low budding success may be due to influence of rootstock, scion or combination of rootstock and scion as biological factors. Most times, the discriminatory factor is the scion as rootstock is raised from mixed seed lot. The scion is obtained as bud-patch from recommended clones. The objective of this study was the assessment of heritability of budding success among the ten test clones.

Materials and Method

Bud patch was obtained from nine RRIN developed clones of *H. brasiliensis* with RRIM 600 as control. The RRIM 600 was developed by Rubber Research Institute of Malaysia and it is a commercial clone in Nigeria. The ten clones were budded onto rootstock at the substation of the Rubber Research Institute of Nigeria located at Akwete, Imo State, Nigeria (4° 50' - 4°65' N; 7° 00' - 7°19' E). Budding was conducted as described by Oghide (2016). There were three replications at fifty rootstocks each. The first inspection of budding success was taken 21 days after budding and final inspection was 28 days after budding. Percent budding success was calculated and arc-sine transformation was conducted as recommended by Omokhafe et al (2007). The data collected was subjected to Analysis of Variance followed by mean separation using the Duncan Multiple Range Test. The estimates of broad sense heritability were calculated.

Results and Discussion

Clonal variation for budding success is a factor to determine availability of planting materials of improved clones. Secondly, budding success will serve as a guide to intensity of budding to obtain the required number of planting materials per clone. In addition, the heritability estimates will enhance selection for improved budding success among the test-clones in this study.

There was significant clonal variation for budding success in each inspection and combined data (Tables 1 and 2). This clonal response to budding suggests adequate attention and high intensity budding for low responding clones that may be preferred by farmers. In this regard, low responding clones that will require extra attention are C 143, C 162, C 76, C 150, C 145 and RRIM 600 with budding success rate of 2.33% to 10% in final budding success (Table 3). There were clones with high budding success, which were C 202 (71%) and C 83 (61%) in final budding success (Table 3). It is noteworthy that C 202 and C 83 have the same parentage of RRIM 600 x PR 107. This favourable combination of RRIM 600 x PR 107 may be investigated in further studies through analysis of combining ability of parents-in-crosses for budding success. The trend of clonal budding success is important as several of these Nigerian clones are among the multilateral clone exchange of the International Rubber Research and Development (Omokhafe et al., 2018). These results of budding success may serve as a guide to the receiving country/Institute to ensure that the materials are well managed to minimize possible loss of the genetic materials. Wide range of clonal budding success is a common feature in *H. brasiliensis* (Udayakumara and Seneviratne, 2005; Esekhade et al, 2013).

Table 1. Mean squares of analysis of variance of budding success among ten clones of *H. brasiliensis* (First and second opening)

		First opening	Second opening	
S.V.	df	Mean squares	Mean squares	Expected MS
Replicate	2	2.97	7.60	
Clone	9	1471.13***	925.37***	Ve + rVg

Error	18	17.30	21.05	Ve
$h^2_{(B)}$		0.97	0.93	

***: Significant at p = 0.001 (F-test)

The significant clonal variation was further supported by high heritability of 0.92 to 0.97 (Tables 1 and 2). This suggests high selection progress when selecting for clonal budding success. In addition, it suggests that the clones may maintain their character of budding success as the heritability was close to fixation. This is of concern as the average budding success was 26.92% (Table 3), suggesting that many of the clones have low budding success and will require intensive budding to obtain sufficient planting materials for distribution to farmers. Narrow sense heritability analysis may be conducted using appropriate mating design to check the heritability of budding success in *Hevea brasiliensis*. Similar result of high heritability estimates in *H. brasiliensis* was reported by Goncalves et al. (2005).

Table 2. Mean squares of analysis of variance of budding success among ten clones of *H. brasiliensis* in combined data

S.V.	df	Mean squares	Expected MS
Rep/Inspection	4	5.245	
Inspection	1	637.46**	
Clone	9	2333.68**	Ve + rVci + riVg
Clone x Inspection	9	62.82**	Ve + rVci
Error	36	19.17	Ve
$h^2_{(B)}$		0.92	

**: Significant at p = 0.01 (F-test)

There was significant inspection followed by reduced budding success in second inspection (Tables 2 and 3). This may suggest loss of successful buds after first inspection, which may be due to influence of weather factors (Omokhafe et al., 2016). The significant clone x inspection (Table 2) is a reflection of genotype (g) x environment (e) interaction which is a common feature in *H. brasiliensis* (Omokhafe, 2004). In this case, two clones showed marginal evidence of g x e interaction with C 162 having 4% and 2.33% budding success in first and second inspections respectively. In addition, there was evidence of g x e interaction in C 145 with 19% and 9.67% budding success in first and second inspections respectively. The significant clone x inspection obtained will be further investigated, using stability analysis, to detect clear cases of cross performance between first and second inspections.

Table 3. Mean separation of percent budding success among ten clones of *H. brasiliensis*

Clone		Parentage	% Budding success*, +		
Field Code	National Code		A	B	C
C83	NIG 801	RRIM 600 x PR 107	81.33a	61.00a	71.17ab
C154	NIG 811	RRIM 501 x RRIM 628	61.67b	27.30b	44.49bc
C143	NIG 808	RRIM 501 x RRIM 628	4.43f	4.33cd	4.38e
C162	NIG 812	RRIM 501 x RRIM 628	4.00f	2.33d	3.17e
C76	NIG 800	RRIM 501 x Har 1	5.33ef	2.67d	4.00e
C202	NIG 813	RRIM 600 x PR 107	85.00a	71.00a	78.00a
C159	NIG 810	RRIM 501 x RRIM 628	36.67c	29.33b	33.00cd
C150	NIG 809	RRIM 501 x RRIM 628	11.33e	10.00c	10.67e
C145	NIG 807	RRIM 501 x RRIM 628	19.00d	9.67c	14.34de
RRIM 600	NA	Tjir 1 x PB 86	6.33ef	5.67cd	6.00e
Overall mean		NA	31.69	22.3	26.92

* A: First inspection; B: Final inspection; C: Combined data;
+: Mean separation based on DMRT at 5%

In conclusion, there was evidence of clonal variation for budding success among the ten clones evaluated. This was accompanied by high heritability. Careful handling will be necessary for materials that are desired by farmers but have low budding success. The high heritability may lead to selection for clonal budding success with expected high selection progress.

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