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Stock-Scion Interaction Effect on the Quality of Planting Materials of Rubber (*Hevea brasiliensis*)

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Abstract: Stock effect on scion performances is a critical factor to produce quality planting materials, in bud grafting, for rubber industry. Selection suited stock- scion combinations should be done to have a clonal authenticity relevant to a clone for generations. This study was contributed to identify successful stock scion combination/s to produce vigorous plants. Research activities were conducted using 12 budded plant combinations, belonged to most popular seed bearers and clones, as treatments of four stock types *viz*. seedling, PB 86, RRIC 102, RRIC 121 and three scion types *viz*. PB 86, RRIC 102 and RRIC 121 at a site located in RRISL Substation Moneragala (IL1c). Treatments were arranged as two factor factorial experiment in the Randomized Complete Block Design (RCBD) and measurements were taken at monthly intervals up to two leaf whorl stage. Stock diameter and height, scion shoot diameter and height, time taken for bud breaking, leaf chlorophyll content, leaf area, specific leaf weight and leaf thickness were recorded before and after bud grafting. Data was analyzed using SAS (version 9.1) package. And significant means were separated using Duncan Multiple Range Test (DMRT) at the 5% probability level. Results revealed, that clone RRIC 102 is the most suitable stock to increase scion growth, leaf area and specific leaf weight whilst stock type not effect for chlorophyll content and leaf thickness. Although, clonal variations were recorded for leaf area, leaf thickness, specific leaf weight and chlorophyll content of leaves irrespective to the stock type. However, significant stock - scion combinations were identified and further studies are needed to recommend suitable stocks for higher yield and adaptability to the different agro-climatic regions.

Keywords: Bud grafting, Compatibility, *Hevea brasiliensis,* Planting materials, Stock scion combinations

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Introduction

Seeds or vegetative parts are used to produce planting materials of rubber (*Hevea brasiliensis* Mull.-Arg.). Before 1917, in early years of crop, only seeds were used for propagation. At present, seeds are mainly utilized to produce rootstocks because bud grafting has been popularized as asuccessful alternative cloning method for rubber.

When produce a new plant using bud grafting technics, genetic relationship of stock and scion (compatibility) is essential for successful graft union (Simon *et al.* 2016). Degree of compatibility was bring out per perennials; mainly fruit crops, which are mainly propagated by grafting. Modern fruit varieties are extensively used for selecting rootstocks for a variety of purpose, dwarfing, biotic and abiotic stress and disease resistance etc. Gainza *et al*. (2015) explained that incompatibility of graft is a problem in cherry, almond, and apricot than in peach or plum. According to Adams (2016) and Koepke *et al.* (2013), rootstock governs many scion attributes such as growth, stress tolerance, physiology etc. Nevertheless, Alfonso *et al.* (2015) revealed that rootstock × scion × environment interactions will certainly support to growing and exploiting rootstocks for food security.

Rubber rootstocks that are obtained from seeds are highly heterozygous due to the open pollination. Due to rootstock heterogeneity, highest number of intra clonal variation can be observed in the growth and yield of bud grafted rubber clones (Chandraseker *et al.*, 1997; Clement – Demange *et al.*, 2007) and Hua *et al.*(2010)]. In incompatible graft, poor vascular system, its disconnection at the bud union and phloem degeneration was explained by Julia *et al.* (2011).

For plant vigor and growth, significant results, especially growth and physiological attributes were recorded by Ahmud (1999), Martins *et al.* (2000), Ramos (2001) and Sobhana *et al*. (2001). Atila (2007) and Ng *et al*. (1981) reported that there was no rootstock scion interaction but rootstocks could significantly influence the growth and yield of the scion. Strong effect of the stock on the scion yield was reported by Combe and Gerner (1997) and Goncalves and Martins (2002).

However, in Sri Lanka, few studies were conducted for stock scion interaction of limited situations. According to Anon 2010 and 2011, there was no effect for the scion when using the same clone as stock because the highest growth attributes were recorded by best performing clones irrespectively to the stock type. Nevertheless, Samaranayake *et al*. (1980) explained that the rootstock and scion effect for bud emergence in the same climatic condition. Handapangoda *et al.* (2017) explained the clonal characters specially; growth and morphology were tended to be changed. To secure clonal authenticity, it is a difficult task unless proper stock scion combinations are not identified. Hence, this study will be contributed to identify successful stock scion combination/s to produce vigorous plants.

Materials and Methods

Production Planting Materials

Quality seeds from four seed bearings *viz*. seedling generation of wild rubber (unknown/unselected genotypes of rubber), PB 86, RRIC 102, RRIC 121, were selected and germinated at a site located in RRISL Substation Moneragala (IL1c) in onset of the North East monsoon of 2017. Vigorous plants of each type were transferred to a separate row of 50 poly bags and conducted four replicates according to the Completely Randomized Design (CRD). Manuring, weeding and all agronomical practices were done as recommended by RRISL(Advisory circular, 2009). After 4 months, when they reach 6-9mm diameter, stock plants were bud grafted following combinations using 3 scion types viz. PB 86, RRIC 102 and RRIC 121 at 1cm from the base and after the success growth measurements were taken periodically.

Stock × Scion combinations
Seedling × PB 86
Seedling × RRIC 102
Seedling × RRIC 121
PB 86 × PB 86
PB 86 × RRIC 102
PB 86 × RRIC 121
RRIC 102 × PB 86
RRIC 102 × RRIC 102
RRIC 102 × RRIC 121
RRIC 121 × PB 86
RRIC 121 × RRIC 102
RRIC 121 × RRIC 121

Measurements of Growth (before and after bud grafting)

Growth characters *viz*; diameter of stock, height of stock, diameter of scion, height of scion, time taken for bud breaking, chlorophyll content, leaf area, specific leaf weight, leaf thicknessand florescence meter reading were recorded within two leaf whorl stage.

Data Analyzing

Data was analyzed using SAS (version 9.1) package. Significant means were separated using Duncan Multiple Range Test (DMRT) at the 5% probably level.

Results and Discussion

The main reasons for selecting above mention parameters are related to early girth, vigor and high initial yield. Nugawela (1989) explained that the effect of leaf area and specific leaf weight of immature *Hevea* genotypes for co_2 assimilation rate of mature rubber plant. According to Viktoriya (2017), thicker leaves of tomato plant increase growth in water limited condition. Guendouz (2011) reported that the relationship of chlorophyll content of leaves and grain yield in adverse climatic condition. Girth height and time taken to sprouting are directly related to plant growth and vigor (Akihiro, 2013; Handapangoda *et al.*, 2017).

Within four stock types, seedling and PB 86 recorded the significant highest girth and height increment, which spend minimum time to reach buddable stage as a stock (Table 1), suppose that these seed bearers are more vigorous than new clones which showed low germination ability (Figure 1), whilst adaptability to adverse climatic condition is high in wild type and earliest clone PB 86.

Table 1: Effect of stock type for stock girth and height increment.

Type of stock	Stock girth increment(mm)	Stock height increment(mm)
Seedling	3.15a	317.42ab
PB 86	3.45a	326.94a
RRIC 102	3.02b	283.40b
RRIC 121	2.94b	238.20c

Means with the same letter in a column are not significantly different at $p<0.05$.

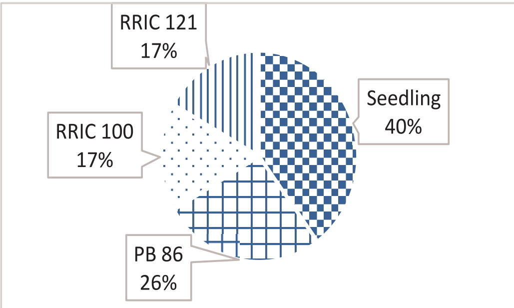

Figure 1: Germination % after 14 days of sawing seed of four types of rubber seed bearers.

In bud grafting process, as stocks, these two types can increase scion height and minimum time taken for bud breaking whilst RRIC 102 and RRIC 121should be used for higher girth which can be reached tappable stage fast (Table 2). As well as Table 3 indicated that types of scion do not show any significant relationship for same attributes. So it can be mentioned that using the clone RRIC 102 as rootstock is better for increasing scion growth irrespectively to a clone.

Table 2: Effect of stock type for time taken for bud breaking, scion girth and scion height increment.

Type of stock	Time taken for bud breaking (days)	Scion girth increment(mm)	Scion height increment(mm)
Seedling	12.35b	1.67bc	214.04a
PB 86	13.75ab	1.49c	178.90ab
RRIC 102	14.45a	2.07a	165.15b
RRIC 121	14.28a	1.94ab	158.74b

Means with the same letter in a column are not significantly different at $p<0.05$.

Table 3: Effect of scion type for time taken for bud breaking, scion girth and scion height increment.

Type of scion	Time taken for bud braking (days)	Scion girth increment(mm)	Scion height increment(mm)
PB 86	14.32a	1.67a	183.33a
RRIC 102	13.08a	1.77a	191.29a
RRIC 121	13.26a	1.77a	175.12a

Means with the same letter in a column are not significantly different at $p<0.05$.

Table 4 and 5 show the chlorophyll content and leaf thickness. According to the results, stock types were not affected and scions of PB 86 and RRIC 121 increased these attributes significantly but decreased by RRIC 102. As in the table 6, the highest chlorophyll content and leaf thickness values were recorded by PB 86 and RRIC 121 comparable to RRIC 102 when they bud graft into any stock type relevant to selected combinations. However the best combination relevant to the chlorophyll content is indicated by PB 86 × RRIC 121 and RRIC 121 × RRIC 102 showed the lowest. Nevertheless the lowest combination for leaf thickness is showed by RRIC 102× RRIC 102. According to Anon (2017), recorded that assessment such as photosynthesis rate, chlorophyll content and leaf thickness of a clone varied from agro-climatic region to region.

Table 4: Effect of stock type for chlorophyll content and leaf thickness.

Type of stock	Chlorophyll content (SPAD unit)	Leaf thickness(mm)
Seedling	43.06a	0.21a
PB 86	45.34a	0.22a
RRIC 102	45.06a	0.21a
RRIC 121	40.76a	0.21a

Means with the same letter in a column are not significantly different at $p<0.05$.

Table 5: Effect of scion type for chlorophyll content and leaf thickness.

Type of scion	Chlorophyll content (SPAD unit)	Leaf thickness(mm)
PB 86	44.76a	0.22a
RRIC 102	39.82b	0.20b
RRIC 121	46.09a	0.22a

Means with the same letter in a column are not significantly different at $p<0.05$.

Table 6: Effect of stock –scion combination for chlorophyll content and leaf thickness.

Type of stock	Type of scion	Chlorophyll content (SPAD unit)	Leaf thickness(mm)
Seedling	PB 86	43.75	0.21
Seedling	RRIC 102	40.43	0.22
Seedling	RRIC 121	45.01	0.22
PB 86	PB 86	41.53	0.23
PB 86	RRIC 102	42.00	0.22
PB 86	RRIC 121	52.50	0.21
RRIC 102	PB 86	47.71	0.23
RRIC 102	RRIC 102	44.07	0.18
RRIC 102	RRIC 121	43.41	0.22
RRIC 121	PB 86	46.04	0.21
RRIC 121	RRIC 102	32.79	0.20
RRIC 121	RRIC 121	43.45	0.22
		LSD=7.33	LSD=0.02

Table 7 explained that leaf area, leaf length and mean leaf width of scion would be increased by seedling and RRIC 102 when they used as stocks. But relevant to scion types, RRIC 102 increased leaf area and mean leaf width whilst there was no significant difference for leaf length (table 8). As well as significant stock scion interaction are shown in table 9. It is clear that leaf size of clone RRIC 102 is larger than other two clones whilst this value tends to increase when it is bud grafted to the same clone (bud grafted to the stock which generated from clonal seed of the RRIC 102) or to the seedling stock (stock generated from a seed of mother seedling tree). According to the table 9, this attribute was minimized by stock types of PB 86 and RRIC 121 in other clones as well as in RRIC 102 also.

Table 7: Effect of stock type for Leaf Area, leaf length and Mean leaf width.

Type of stock	Leaf Area(**cm^2**)	leaf length **(cm)**	Mean leaf width ***(cm)***
Seedling	86.80a	17.08ab	4.94a
PB 86	71.13b	15.65bc	4.53b
RRIC 102	93.84a	17.69a	5.21a
RRIC 121	66.85b	15.23c	4.38b

Means with the same letter in a column are not significantly different at p<0.05.

Table 8: Effect of scion type for Leaf Area, leaf length and Mean leaf width.

Type of scion	Leaf Area(**cm^2**)	leaf length **(cm)**	Mean leaf width ***(cm)***
PB 86	78.02b	16.71a	4.56b
RRIC 102	93.70a	17.12a	5.42a
RRIC 121	69.73b	15.65a	4.39b

Means with the same letter in a column are not significantly different at p<0.05.

Table 9: Effect of stock–scion combination for Leaf Area, leaf length and Mean leaf width.

Type of stock	Type of scion	Leaf Area(cm^2)	leaf length (cm)	Mean leaf width (cm)
Seedling	PB 86	85.67	17.24	4.88
Seedling	RRIC 102	108.82	19.01	5.66
Seedling	RRIC 121	62.05	14.70	4.15
PB 86	PB 86	60.50	16.05	3.75
PB 86	RRIC 102	87.07	15.98	5.50
PB 86	RRIC 121	67.59	15.17	4.42
RRIC 102	PB 86	97.08	18.72	5.10
RRIC 102	RRIC 102	94.54	17.08	5.50
RRIC 102	RRIC 121	89.27	17.08	5.06
RRIC 121	PB 86	61.54	14.28	4.24
RRIC 121	RRIC 102	77.01	15.44	4.94
RRIC 121	RRIC 121	62.00	15.96	3.96
		LSD=47.93	LSD=7.00	LSD=1.44

According to Tables 10 and 11, stock types of PB 86, RRIC 102 and RRIC 121 have increased specific leaf weight values and it was decreased by seedling as stocks whilst when used PB 86 and RRIC 121 as scions this values were increased. Nevertheless significant stock–scion interaction hasbeen showed in Table 12. This table indicates that specific leaf weight is tend to be decrease when use RRIC 102 as scion and seedling use as stock. But when use PB 86 and RRIC 121 as scions in other combinations show better results.

Table 10: Effect of stock type for Specific leaf weight.

Type of stock	Specific leaf weight (g/cm^1)
Seedling	0.0141b
PB 86	0.0151a
RRIC 102	0.0147ab
RRIC 121	0.0145ab

Means with the same letter in a column are not significantly different at $p<0.05$.

Table 11: Effect of scion type for Specific leaf weight.

Type of scion	Specific leaf weight (g/cm^1)
PB 86	0.0150a
RRIC 102	0.0134b
RRIC 121	0.0154a

Means with the same letter in a column are not significantly different at $p<0.05$.

Table 12: Effect of stock –scion combination for Specific leaf weight.

Type of stock	Type of scion	Specific leaf weight (g/cm
Seedling	PB 86	0.0128
Seedling	RRIC 102	0.0143
Seedling	RRIC 121	0.0150
PB 86	PB 86	0.0160
PB 86	RRIC 102	0.0138
PB 86	RRIC 121	0.0158
RRIC 102	PB 86	0.0145
RRIC 102	RRIC 102	0.0140
RRIC 102	RRIC 121	0.0158
RRIC 121	PB 86	0.0170
RRIC 121	RRIC 102	0.0115
RRIC 121	RRIC 121	0.0152

LSD=0.0018

Florescence meter reading is a better assessment for plant stress but there are no significant relations for all stock and scion types as table 13 and 14. But for taking complete idea it is better to examine number of stock scion combinations for this measurement in same and varying climatic conditions.

Table 13: Effect of stock type for Florescence meter reading.

Type of stock	Florescence meter reading
Seedling	0.78a
PB 86	0.76a
RRIC 102	0.75a
RRIC 121	0.76a

Means with the same letter in a column are not significantly different at $p<0.05$.

Table 14: Effect of scion type for Florescence meter reading.

Type of scion	Florescence meter reading
PB 86	0.77a
RRIC 102	0.74a
RRIC 121	0.77a

Means with the same letter in a column are not significantly different at $p<0.05$.

Conclusions

According to the experiment results, interactions between stock and scion are affected for scion growth and quality. Seedling and clone PB 86 are important as vigorous rootstocks and early sprouting of scion and increase height of scion than other clones. But stock type did not effect for photosynthesis rate or mean leaf thickness of a scion. Within selected stock type RRIC 102 is utmost important for scion girth, leaf area and specific leaf weight. Nevertheless further research work should be done to select suitable stock scion combination for yield improvement and adaptability in varying agro-climatic regions.

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