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PRODUCTION OF GUAVA MINI-GRAFTED ON INTRA OR INTERSPECIFIC ROOTSTOCK[1]

GRAZIELLA SIQUEIRA CAMPOS[2], CLÁUDIA SALES MARINHO[3]
CAMILLA RANGEL PORTELLA[4], BRUNO DIAS AMARAL[5]
WALESKA SOARES GOMES DE CARVALHO[6]

ABSTRACT - Mini-grafting is a type of grafting that has been indicated to increase efficiency of forest and fruit species propagation. The aim of this study was to evaluate the mini-grafting technique as a method for propagation of guava grafted on intra or interspecific rootstock. The experimental design was randomized blocks, with four treatments, five replications and plots consisting of ten plants, in a 2^2 factorial arrangement, and factors consisted of rootstocks and canopy cultivars. Rootstocks used were *Psidium guajava* and *Psidium guineense*. The canopy used was Paluma and Cortibel 1 cultivars. Only the canopy used had an effect on the percentage of grafting success of 52, 54, 82 and 84%, respectively, for 'Cortibel 1'/*P. guineense*; 'Cortibel 1'/*P. guajava*; 'Paluma'/*P. guineense*; 'Paluma'/*P. guajava* combinations. Mini-grafting was effective for guava propagation on intra or interspecific rootstocks. The average production time for 'Paluma' and 'Cortibel 1' saplings grafted on *P. guajava* or *P. guineense,* for mini-grafting, was 351 days, so that 'Paluma' seedlings were more vigorous than those of 'Cortibel 1'.
Index Terms: *Psidium guajava*, *P. guineense*, vegetative propagation, softwood grafting.

PRODUÇÃO DE MUDA DE GOIABEIRA POR MINIGARFAGEM SOBRE PORTA-ENXERTO INTRA OU INTERESPECÍFICO

RESUMO - A minigarfagem é um tipo de enxertia que tem sido indicada para aumentar a eficiência da propagação de espécies florestais e frutíferas. Objetivou-se com o presente trabalho avaliar a minigarfagem como método de propagação da goiabeira enxertada sobre porta-enxerto intra ou interespecífico. O delineamento experimental utilizado foi em blocos casualizados, com quatro tratamentos, cinco repetições e parcelas constituídas por dez mudas, em arranjo fatorial 2^2, sendo os fatores constituídos pelos porta-enxertos e cultivares-copa. Os porta-enxertos utilizados foram *Psidium guajava* e *Psidium guineense*. As cultivares-copa foram a Paluma e Cortibel 1. Constatou-se efeito somente da copa utilizada sobre os percentuais de pegamento. Os pegamentos de enxertia observados foram de 52, 54, 82 e 84%, respectivamente, para as combinações 'Cortibel 1'/*P. guineense*; 'Cortibel 1'/*P. guajava*; 'Paluma'/*P. guineense*; 'Paluma'/*P. guajava*. A minigarfagem foi efetiva na propagação da goiabeira, para porta-enxerto intra ou interespecífico. O tempo médio de produção das mudas de 'Paluma' e 'Cortibel 1' enxertadas sobre *P. guajava* ou *P. guineense*, por minigarfagem, foi de 351 dias, com altura média de 48 cm e 18 folhas, sendo as mudas da 'Paluma' mais vigorosas que as da 'Cortibel 1'.
Termos para indexação: *Psidium guajava*, *P. guineense*, propagação vegetativa, enxertia herbácea.

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[2]MSc student of the Graduate Program in Plant Production, "Darcy Ribeiro" University of Northern State of Rio de Janeiro (UENF), Campos dos Goytacazes-RJ, Email: grasicam@gmail.com
[3]Professor at UENF, LFIT, CEP: 28013-602, Campos dos Goytacazes-RJ, Email: clsmarinho@gmail.com
[4]Master of the Graduate Program in Plant Production, UENF, Campos dos Goytacazes-RJ, Email: camillaportella@gmail.com
[5]Undergraduate Program in Agronomic Engineering, "Darcy Ribeiro" University of Northern State of Rio de Janeiro CEP: 28013-602, Campos dos Goytacazes-RJ, Email: brunodagro@hotmail.com
[6]MSc student of the Graduate Program in Plant Production, "Darcy Ribeiro" University of Northern State of Rio de Janeiro, CEP: 28013-602, Campos dos Goytacazes-RJ, Email: waleska_sgc@hotmail.com

INTRODUCTION

Guava (*Psidium guajava*) can be sexually or asexually propagated, the asexual form being the most used in commercial crops. The cutting of herbaceous branches in environments with high relative humidity has been the most widespread technique for cultivars with high rooting potential, as is the case of Paluma (MILHEM et al., 2014). However, other techniques, such as mini-cutting, have been proposed to facilitate the management of matrixes plants and to increase the rooting of cultivars with lower rooting potential (ALTOÉ et al., 2011). Grafting has shown to be useful when orchards are planted on rootstocks that have some agronomic advantage such as resistance to biotic factors (DEMARTELAERE et al., 2015) and to abiotic stresses (SOARES et al., 2015). Grafting on interspecific rootstocks has been investigated in order to control root system diseases such as guava decline (ROBAINA et al., 2015), but may also interfere with canopy vigor, productivity and fruit quality. In addition, cultivars with greater difficulty in rooting of hardwood cuttings such as Cortibel 1 (ALTOÉ et al., 2011) may also benefit from propagation by grafting.

The propagation of plants by grafting allows the union of more than one genotype, whether belonging to the same species or to different species (HARTMANN et al., 2002). However, grafted guava seedlings may require more than 16 months in the nursery (ROBAINA et al., 2015).

Mini-grafting is a type of grafting that is carried out with mini-cuttings of herbaceous branches, which come from matrixes cultivated in the own nursery in the form of mini-stumps established in pots. Mini-grafting has also been indicated to increase the propagation efficiency of forest and fruit species (KALIL FILHO et al., 2001; WENDLING et al., 2005). Nursery-grown matrixes provide greater efficiency of management activities for irrigation, nutrition and pest and disease control, as well as higher quality of vegetative propagules (Xavier et al., 2003).

Mini-grafting can accelerate the production time of grafted guava seedlings and increase their grafting success percentage. Thus, the aim of this study was to evaluate the mini-grafting technique as a method for the production of 'Paluma' and 'Cortibel 1' guava seedlings grafted on intra or interspecific rootstock.

MATERIAL AND METHODS

The experiment was conducted in a greenhouse covered with agricultural film and coated with polypropylene (Sombrite ® 50%) in Campos dos Goytacazes - RJ. The experimental design was a randomized complete block design, with four treatments, five replications and plots composed of ten seedlings in a 2^2 factorial arrangement, with factors constituted by rootstocks and canopy cultivars. Rootstocks used were produced by seminiferous route using mature *Psidium guajava* 'Paluma' fruits from an access of *Psidium guineense* species with grafting compatibility with 'Paluma' guava, proven five years after planting in the field. Canopy cultivars used were 'Paluma' and 'Cortibel 1'.

Rootstock seeds were obtained from mature fruits collected from matrixes established at the UENF experimental area located at the Antônio Sarlo Agricultural College, Campos dos Goytacazes-RJ. At the time of seed collection, plants were around seven years old and were established with seedlings from herbaceous cuttings obtained in commercial nursery. After extraction, seeds were treated with Captan 750 TS fungicide at concentration of 5 g kg^{-1} and stored for five days in refrigerator until time of sowing. Tubes of 280 cm^3 in volume and three seeds per container were used. Tubes were filled with Basaplant® substrate. The substrate was added of 9.7 g L^{-1} of superphosphate, 30 g L^{-1} of limestone and 6.6 g L^{-1} of Osmocote® slow release fertilizer in 17-07-12 formulation, with mean release time between 8 and 9 months at temperature of 26.7ºC (manufacturer's informations).

For the production of 'Paluma' and 'Cortibel 1', seedlings from herbaceous cutting were obtained. These seedlings were transplanted into 5.0 L plastic pots, filled with the Basaplant® substrate and fertilized with the same fertilizers and amounts described for the production of rootstocks. The mature tissue of shoots was cut at approximately 20-30 cm from the stem base. Thus, these plants began to constitute mini-clumps for the supply of mini-grafts.

'Paluma' and 'Cortibel 1' guava mini-clumps were pruned about 30 days before grafting for the issue of new shoots and mini-graft production. Mini-grafts were laterally introduced in the rootstock tissues by lateral grafting technique at 200 days after sowing. At that time, *P. guineense* and *P. guajava* rootstocks had stem diameter, measured at 10 cm from the stem base, close to 3.4 and 3.5 mm, respectively. 'Paluma' mini-grafts had mean diameter

and length of 2.1 mm and 5.0 cm, respectively. Cortibel 1 mini-grafts had, on average, 1.9 mm of diameter and 4.0 cm of length.

Mini-grafts were prepared with a pair of leaves that had their limbo reduced to half with the aid of scissors. A node cut approximately 0.5 cm long was made at the bottom with the aid of a sharp stainless pocketknife. To insert the mini-graft in the rootstock, pruning between 10 and 15 cm of the rootstock height was carried out. With a pocketknife, a 0.5 cm cut was made on the side of the rootstock stem. The Mini-graft was introduced so that its cambium was in contact with the rootstock cambium. With the mini-graft correctly adjusted in the cut, the bandage was made with clear plastic tape (Parafilm®). A flexible plastic coated wire was used to better fix the graft. After this operation, the newly grafted seedlings were taken to the intermittent fogging chamber.

The fogging system was mounted with fogger-type micro-foggers and the interval between applications was 10 minutes with duration of 30 seconds for a period of 10 days. Subsequently, the interval was increased to 15 minutes and the duration of applications was reduced to 15 seconds. Five hours of nocturnal application were also removed, which included the period between 11:00 p.m. and 4:00 p.m. Plants were maintained under these conditions for over approximately 40 days. Minimum and maximum humidity maintained in the fogging chamber was 70.5 and 100%, respectively. The minimum and maximum temperatures observed in this period were 17.2 and 37.1°C, respectively. After this period, seedlings were acclimatized.

The beginning of the acclimatization of seedlings was performed by means of the adoption of successive increases in intervals between fogging applications, for a period of 10 days. During the first three days, the intervals were 1, 2 and 3 hours, respectively, for the first, second and third day. The 3-hour application interval was maintained until the tenth day. After this period, the grafted seedlings were removed from the fogging chamber. Plants were transferred to an environment protected by a polypropylene mesh (Sombrite® 50%), inside the greenhouse. Seedlings were irrigated several times a day for 30 days.

In the acclimatization phase, the sprouts emitted by the rootstock were removed, as well as the flexible wire.

The survival and grafting success percentages of grafted seedlings were evaluated at 60 and 120 days after mini-grafting. In the case of grafting success, seedlings were tutored and conducted on a single stem. Top shoots and seedlings were evaluated for height, number of leaves and diameter of shoots at 120 and 150 days after mini-grafting.

Data were submitted to analysis of variance and in case of significance, the means of treatments were compared by the Tukey test at 5% of error probability using the SANEST - Statistical Analysis System.

RESULTS AND DISCUSSION

The highest survival and grafting success percentages were observed for Paluma cultivar (Table 1). There was no effect of rootstock on survival and grafting success percentages at 60 and 120 days after mini-grafting, respectively.

When evaluating inarching under the canopy of 'Paluma' guava, Robaina et al. (2012) found success percentage of 40% when the sub-graft used was of the same species (intraspecific), and between 0 and 20% when using *Psidium cattleyanum* sub-graft (interspecific). In the work above, the lower grafting success percentage verified was associated to the lack of compatibility between the tissues of the two species.

In the present work, the grafting success percentage ranged from 52 to 83%, when the canopy cultivars used were Paluma or Cortibel 1, respectively, regardless of the rootstock species, evidencing the grafting affinity between *P. guajava* and *P. guineense*. Karnataka (2012) observed very similar values, ranging from 52 to 84% for herbaceous grafting between *P. guajava* cv. Sardar in intraspecific rootstock, at 8 months of age.

The affinity between canopy and rootstock is very important for the grafting success, and consequently for the production of grafted seedlings. The affinity between *P. guajava* and *P. guineense* is corroborated in the work of Oliveira et al. (2014), who verified greater genetic proximity between *P. guajava* and *P. guineense*, when evaluating the genetic divergence between accesses of the genus *Psidium*, via molecular markers.

At 120 days after grafting, the average grafting success percentage of Paluma cultivar was 59.6% higher than that of Cortibel 1. The smallest grafting success percentage observed for 'Cortibel 1' in relation to 'Paluma', regardless of rootstock used, may have been influenced by its anatomical, metabolic or physiological conditions, among other factors. It was observed that, for this cultivar, there was a greater emission of floral buds under the same pruning intensity as 'Paluma'. After the pruning of mini-clumps, Cortibel 1 canopy cultivars emitted

a great amount of branches with floral buds. It is known that flowering plants use their reserves for the formation of the reproductive organs, leaving the cambial tissue with low availability of carbohydrates for the healing during grafting (HARTMANN et al., 2002). Thus, the grafting success of 'Cortibel 1' guava may have been influenced by the differences in the physiological conditions of mini-clumps, even if the mini-grafts used were from non-flowering branches. In addition, for this cultivar, there was greater difficulty in the selection of mini-grafts deprived of flowers for the grafting. Sasso et al. (2010) also observed lower budding percentage of jaboticaba grafts (*Plinia jaboticaba* (Vell) Berg) with the use of grafts removed from plants in the reproductive phase. These authors believe that the removal of grafts at this stage should be avoided, since inhibition of graft budding occurs.

The graft budding diameters evaluated at 120 days after mini-grafting were similar for all types of combinations (Table 2). Similarly, there was no effect of rootstock on the other growth parameters evaluated like height and number of leaves. However, there was an effect of the canopy cultivar, 'Paluma' being more vigorous than 'Cortibel 1'. At 150 days after grafting, higher shoot diameter, height and number of leaves were verified for 'Paluma' guava seedlings, confirming the greater vigor of this cultivar (Table 2).

Altoé et al. (2011) found greater vigor of 'Paluma' mini-clamps compared to Pedro Sato, Cortibel 1 and Cortibel 6 cultivars. They also observed that Cortibel 1 was the cultivar with the lowest vigor of shoots. As for the height of seedlings produced by mini-cutting of these cultivars, the authors above verified height of 44.6 cm for 'Cortibel 1' at 145 days after cutting, and these seedlings had smaller height compared to those of 'Paluma'.

The vegetative growth parameters (height and number of leaves) showed a greater initial vigor with the use of 'Paluma' mini-grafts (Table 2). Similarly as observed for 'Cortibel 1', mother plant cultivars, the presence of flower buds and flowers in grafted 'Cortibel 1' seedlings was observed. Flowering during the seedling formation phase may have influenced sprout vigor due to competition between flower formation and vegetative shoots.

Karnataka (2012) obtained grafted 'Sardar' guava seedlings averaging up to 22 cm in height and 15 leaves at 120 days after herbaceous grafting. These average values are close to those found in this study, which were around 22.2 cm and 14 leaves at 120 days after mini-grafting.

After grafting, guava seedlings should be about 40 to 50 cm high to be planted in a definitive location (BASTOS and RIBEIRO, 2011). At 150 days after mini-grafting, seedlings had mean height of 48 cm and 18 leaves, and 'Paluma' guava seedlings were more vigorous than 'Cortibel 1' seedlings (Table 2). Vigorous seedlings make it possible to anticipate planting and reduce production cost during the nursery phase.

The time of production of 'Paluma' and 'Cortibel 1' seedlings grafted on *P. guajava* or *P. guineense* using the mini-grafting technique was 351 days. Robaina et al. (2015) obtained seedlings produced by the top-filled cut grafting with production time of 480 and 570 days after sowing, and mean heights of 73.9 and 39.9 cm when the rootstock used was *P. guajava* and *P cattleyanum*, respectively.

The use of interspecific rootstocks has been evaluated for guava culture in order to select genotypes resistant to *Meloidogyne enterolobii* Yang & Eisenback nematode (Meloidogyne *mayaguensis* Rammah & Hirschmann), which has been a threat and one of the main factors limiting guava production in several cultivation areas (PEREIRA et al., 2009).

Resistance to the nematode has not yet been found in *P. guajava*; however, it has been found in cattley guava, tress of the genus *Psidium* (FREITAS et al., 2014; BIAZATTI et al., 2016), indicating that grafting on resistant rootstocks may be a strategy to overcome this problem. Thus, guava seedlings produced by herbaceous cuttings, which has been used in recent years as a simple and relatively fast technique, can be replaced by seedlings grafted on resistant rootstocks.

The results of this work demonstrated that the production of guava seedlings grafted by mini-grafting technique on *P. guajava* or *P. guineense* rootstocks is feasible and with potential to reduce the production time of seedlings grafted by conventional grafting.

TABLE 1 - Grafting survival and success percentage among different combinations of guava cultivars and rootstocks at 60 and 120 days after grafting by mini-grafting technique.

	Survival at 60 days after grafting (%)			Grafting success percentage at 120 days after grafting (%)		
Rootstocks	Canopies		Means*	Canopies		Means
	'Paluma'	'Cortibel 1'		'Paluma'	'Cortibel 1'	
P. guajava	90	64	77 A	84	54	69 A
P.guineenses	94	74	84 A	82	50	66 A
Means	92 a	69 b		83 a	52 b	
VC	16			25.4		

* Averages of the same characteristic followed by the same uppercase letter in columns and lower case in rows do not differ by the Tukey test at 5% error probability.

TABLE 2 – Diameters of grafting shoots, height and number of leaves of seedlings at 120 and 150 days after mini-grafting for different combinations between canopy and rootstock.

120 days after the mini-grafting						
	Diameter (mm) Canopy		Height (cm) Canopy		Number of leaves Canopy	
Rootstock	'Paluma'	'Cortibel 1'	'Paluma'	'Cortibel 1'	'Paluma'	'Cortibel 1'
P. guajava	2.90 a A*	3.18 a A	26.4 a A	20.1 b A	16.2 a A	12.1 b A
P.guineenses	2.80 a A	2.92 a A	23.1 a A	18.5 b A	16.6 a A	10.1 b A
VC (%)	11.9		19.1		29.9	
150 days after the mini-grafting						
	Diameter (mm) Canopy		Height (cm) Canopy		Number of leaves Canopy	
Rootstock	'Paluma'	'Cortibel 1'	'Paluma'	'Cortibel 1'	'Paluma'	'Cortibel 1'
P. guajava	4.30 a A	4.01 b A	51.6 a A	41.6 b A	21.7 a A	16.4 b A
P.guineenses	4.04 a B	3.48 b B	50.9 a A	40.0 b A	20.8 a A	16.3 b A
VC (%)	10.0		13.1		12.4	

* Averages of the same characteristic, in each time, followed by the same capital letter in columns and lowercase in rows do not differ by the Tukey test at 5% error probability.

CONCLUSION

Mini-grafting was effective in the propagation of 'Paluma' and 'Cortibel 1' guava using intra or interspecific rootstock.

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