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Spondias rootstock in the formation of seedlings of the yellow mombin[1]

Porta-enxertos de *Spondias* na formação de mudas de cajazeira

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ABSTRACT - The aim of this study was to determine the effect of *Spondias* rootstock on the formation of grafted seedlings of the yellow mombin. The experiment was set up in the Experimental Area of Embrapa, in Pacajus, in the state of Ceará (CE), in a completely randomised design with four treatments (rootstocks), five replications and ten seedlings/plot. Ungrafted rootstock of *S. tuberosa* and of three species of mombin (*S. macrocarpa*, *S. mombin* and *S. venulosa*) were grown in polyethylene bags (15 x 28 cm x 0.15 mm), filled with a mixture of quartz sand + hydromorphic soil + rotted cattle manure (2:2:1, v/v). The cleft graft was made 6 cm from the root collar of 80-day-old rootstock. The scions were taken from the apical branches of mature deciduous plants of the Itaitinga clone of the yellow mombin. After grafting, the scions were protected with transparent plastic bags (4 x 16 cm), and the seedlings remained in the nursery shaded with 50% sombrite for 64 days, when the percentage of grafts, seedlings suitable for planting, and the number of leaves and leaflets were determined. Grafting success and the percentage of seedlings suitable for planting was 90% on rootstock of *S. tuberosa*, *S. mombin* and *S. venulosa*, and showed no statistical difference. The greatest grafting success with seedlings suitable for planting was on *S. tuberosa*, *S. mombin* and *S. venulosa*. Grafting success on *S. macrocarpa* was extremely low due to incompatibility, and this should not be used as rootstock for the yellow mombin.

Key words: Propagation. Grafting. Yellow mombin.

RESUMO - O objetivo deste trabalho foi determinar o efeito de porta-enxertos de *Spondias* na formação de mudas enxertadas de cajazeira. O experimento foi instalado no Campo Experimental da Embrapa, em Pacajus-CE no delineamento inteiramente casualizado, com quatro tratamentos (porta-enxertos), cinco repetições e dez mudas/parcela. Os porta-enxertos de pé-franco de umbuzeiro (*S. tuberosa*) e das cajazeiras (*S. macrocarpa*, *S. mombin* e *S. venulosa*) foram formados em sacos de polietileno (15 x 28 cm x 0,15 mm), cheios com mistura de Areia Quartzosa+solo hidromórfico+esterco bovino curtido (2:2:1, v/v). A garfagem foi feita a 6 cm do colo de porta-enxertos com 80 dias de idade. Os garfos foram retirados de ramos apicais de plantas adultas caducas de cajazeira do clone Itaitinga. Após as enxertias, os garfos foram protegidos com sacos plásticos transparentes (4 x 16 cm) e as mudas permaneceram em viveiro coberto com sombrite 50% por 64 dias, quando avaliaram-se as percentagens de enxertos pegos, de mudas aptas para plantio, número de folhas e folíolos. O pegamento da enxertia e a percentagem de mudas aptas para plantio foi de 90% sobre os porta-enxertos de umbuzeiro e das cajazeiras (*S. mombin* e *S. venulosa*), as quais não diferiram estatisticamente entre si. O maior pegamento de enxertos e de mudas aptas para plantio foi sobre umbuzeiro (*S. tuberosa*) e as cajazeiras (*S. mombin* e *S. venulosa*). A pega da enxertia sobre *S. macrocarpa* foi baixíssima em razão de alguma incompatibilidade e não deve ser usado como porta-enxerto da cajazeira.

Palavras-chave: Propagação. Enxertia. Cajá Taperebá.

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INTRODUCTION

The yellow mombin (*Spondias mombin* L.) is a tropical fruit in the phase of domestication; deciduous and tall, its fruit has high agro-industrial value. The plants obtained from seeds are heterozygous, with high genetic variability and a long juvenile phase (SOUZA, 2000). Hence the need for viable techniques of vegetative propagation to obtain superior and earlier clones.

In fruit farming, selecting rootstock is as important as selecting scion clones, and interspecific grafting is successfully employed in several fruit genera such as *Vitis*, *Malus*, *Annona*, *Citrus* and *Prunus* (ALMEIDA; ALENCAR; YAMANISHI, 2010; AULER *et al*., 2011; CAMARGO, 2003; DENARDI, 2006; GONZATTO *et al.*, 2011; LEÃO, 2010) and between cultivars of the same species, showing good healing and compatibility between the grafted parts, and forming vigorous and productive plants.

The genus *Spondias* has ten native neotropical species (MITCHELL *et al*., 2012), and these few species have been used, both as rootstock and scion, in research into propagation by grafting.

According to Souza, Innecco and Rossetti (2002), Araújo and Oliveira (2008), Lima Filho and Santos (2009), Souza and Costa (2010), and Souza and Oliveira (2014), interspecific grafting and the formation of grafted seedlings is possible in various species of *Spondias*, notably with yellow mombin on *S. tuberosa*, on *S. dulcis* and on the yellow mombin itself, and also with *S. tuberosa* as rootstock for other species of *Spondias*.

Hence the need for continued research to identify compatible combinations, as grafting, besides being used for preserving superior genotypes, has great practical utility, which results from the effect that the rootstock can have on graft growth, precocious flowering and fruiting, fruit quality, resistance to pests and diseases, and various other desirable characteristics. The phenotype of a grafted plant is not only the result of the unilateral effect of one part on the other, but rather of the interaction between the scion genotype and that of the rootstock, and the mutual influence of the parts involved. Desirable results are only obtained in the long term, and depend on the rootstock-graft combination, the environment, soil and climate factors, and management techniques, which also affect the production, quality and shape of the plant and phenotypic traits (HARTMANN *et al*., 2011).

Even so, modern fruit farming has a limited number of cultivated species, and genotypes, cultivars or clones, both for rootstock and scion clones recommended for cultivation, especially with reference to *Spondias*. There is therefore a need to facilitate vegetative propagation in the yellow mombin through grafting on rootstock of species of the same genus. This study was carried out to determine the effects of different species of *Spondias* rootstock on the formation of seedlings of the yellow mombin.

MATERIAL AND METHODS

The experiment was set up in a completely randomised design, with four treatments, five replications and ten seedlings/plot. The treatments consisted of full-cleft grafting of scions of the Itaitinga scion clone of the yellow mombin on rootstock of ungrafted *S. tuberosa* and of *S. macrocarpa*, *S. mombin* and *S. venulosa*. The rootstock were produced in black polyethylene bags, 15 x 28 cm x 0.15 mm, containing a substrate composed of quartz sand + hydromorphic soil+ rotted cattle manure in the proportion 2:2:1 (v/v). The rootstock were vigorous with developed leaves, those of *S. tuberosa* had a mean stem diameter of 6.8 mm at the point of grafting, those of yellow mombin had a diameter of 7.1 mm, those of *Spondias venulosa*, 7.4 mm and of *Spondias macrocarpa*, 7.3 mm (Figure 1).

Figure 1 - Detail of the ungrafted rootstock of (from left to right) *S. macrocarpa*, *S. mombin*, *S. venulosa* and *S. tuberosa*. Pacajus, CE

The full-cleft grafting included scions removed from apical branches of adult plants of the Itaitinga clone of the yellow mombin, ten years of age and in the vegetative rest stage, grown in Pacajus, CE. The diameters of the scions corresponded to those of the rootstock.

The full-cleft grafts were made about 6 cm above the collar of the rootstock stems, which were around 80 days old. After grafting, the scions were covered with

clear 4 x 16 cm plastic bags to prevent dehydration. The seedlings were kept in a nursery covered with 50% sombrite for 64 days, when the percentage of successful grafts (grafts with healed joints, visible callus formation and bud emergence) and of seedlings suitable for planting (vigorous seedlings with more than four developed leaves) was recorded, as well as the number of leaves and leaflets that characterise seedling vigour. Analysis of variance of the data was by Snedecor's F-test, using procedures from the SAS® System statistical-analysis software (SAS INSTITUTE, 2002). The mean values of the rootstock variables were tested by Duncan's test ($p<0.05$).

RESULTS AND DISCUSSION

The results of the analysis (Table 1) by F-test show a significant effect of the rootstock on the percentage of successful grafts, seedlings suitable for planting, number of leaves and leaflets/seedlings. It can also be seen that the coefficients of variation ranged from 10.67% to 13.10%, indicating low relative dispersion of the data in relation to the mean for the four variables under evaluation.

From Table 2, a significant difference can be seen by Duncan's test ($p<0.05$) between rootstocks for the mean values of the percentages of successful grafts, seedlings suitable for planting, and number of leaflets and leaves.

The percentage of successful grafts was 92.0% in the grafts carried out on *S. venulosa* rootstock, 90.0% on *S. tuberosa* and 88.0% on *S. mombin*, with no statistical difference, and only 10.0% on *S. macrocarpa*, an extremely low value, and significantly different from those of the other rootstocks. The results obtained with the *S. venulosa*, *S. tuberosa* and *S. mombin* rootstock were higher than those obtained by Souza (2000) when full-cleft grafting yellow mombin on yellow mombin and *S. tuberosa*. The higher percentage of grafting success in this study is largely explained by the phenological stage of the clone-scion plants - the end of vegetative rest, with no leaves and swollen buds - when the propagules were removed for grafting. Scions removed from plants at this stage rapidly initiate bud differentiation and shoot emission, which begin to produce photoassimilates and hormones that favour the healing and success of the grafts. These results confirm the affirmations of such authors as Souza, Innecco and Rossetti (2002), Araújo and Oliveira (2008), Souza and Costa (2010), and Souza and Oliveira (2014) concerning the viability of interspecific grafting of *Spondias*.

Grafting success is measured by formation of the callus and healing of the cuts in the grafted parts, and by the emission of shoots, leaflets and leaves by the graft, all of which are indicative of successful grafting (Figure 2). The high mean values for grafting success on their own do not mean much, since over time, the successful grafts can produce a vigorous seedling, suitable for planting in the field, or development may stop, i.e. the buds, leaflets and leaves of the graft begin to yellow and wither, followed by senescence of all the grafted parts (graft and rootstock). This occurred with the seedlings grafted on *S. macrocarpa* rootstock. The high mortality and low percentage of grafting success on *S. macrocarpa* rootstock was probably due to some type of incompatibility in the graft-rootstock combination, since initially grafting was successful, with budding which then yellowed and dried.

From the total of successful grafts on *S. venulosa* rootstock, 92.0% produced vigorous seedlings that were suitable for planting in the field 64 days after grafting; for *S. tuberosa* this value was 90%, and for *S. mombin*, 88.0%; while on *S. macrocarpa*, only 2.0% of the seedlings were suitable for planting, albeit with slow development and low vigour.

It can further be seen from Table 2 that the seedlings produced on *S. venulosa* rootstock were the most vigorous, as they presented the highest mean values for leaves and leaflets, even differing statistically from those of the other rootstocks. However, the *S. tuberosa* and *S. mombin* rootstock also produced vigorous seedlings, with no statistical difference in the mean values for leaves or leaflets.

Table 1 - Analysis of variance of the percentage of successful grafts, seedlings suitable for planting, number of leaves and leaflets in grafted seedlings of the Itaitinga clone of the yellow mombin on *Spondias* rootstock. Pacajus, CE

Source of variation	DF	Mean Square			
		Percentage		Number	
		Successful grafts	Seedlings suitable for planting	Leaves	Leaflets
Rootstock	3	80.13**	96.93**	7,588.31**	787,022.06**
Residual	12	0.84	0.56	43.44	5,947.23
CV (%)		13.10	10.98	10.67	12.42

** Significant at 1% probability by F-test

Table 2 - Mean percentage of successful grafts, seedlings suitable for planting, and number of leaves and leaflets in grafted seedlings of the Itaitinga clone of the yellow mombin on *Spondias* rootstock. Pacajus, CE

Rootstock	Percentage		Number	
	Successful Grafts	Seedlings suitable for planting	Leaves	Leaflets
S. macrocarpa	10.00 b	2.00 b	0.50 c	3.92 c
S. mombin	88.00 a	88.00 a	7.38 b	73.60 b
S. tuberosa	90.00 a	90.00 a	7.44 b	77.60 b
S. venulosa	92.00 a	92.00 a	9.38 a	93.16 a
Overall mean	70.00	68.00	6.17	62.07

Mean values followed by the same letter in a column do not differ by Duncan's test ($p<0.05$)

Figure 2 - Partial view of the grafting trial of the Itaitinga clone scion of the yellow mombin. In the centre, five plots of ten seedlings each, with successful grafts in full bud, leaflet and leaf development. Pacajus, CE

It was found that during the first week after grafting, the grafts initiate bud emission, followed by the development of leaflets and leaves. Figure 2 shows seedlings of the yellow mombin grafted with the Itaitinga clone in formation, 27 days after grafting.

It should be noted that the mortality of grafts on *S. macrocarpa* rootstock was very high (90.0%), differing significantly from those of the other rootstocks. In the rootstock of *S. mombin*, mortality was 12%, in *S. tuberosa* 10.0% and in *S. venulosa* 8.0%, values far lower than those seen by Souza, Innecco and Rossetti (2002) when grafting the yellow mombin. It was found that some grafted seedlings of yellow mombin emitted inflorescences while still in the nursery. This flowering occurred due to the forks of these seedlings having been removed from adult branches that had buds destined to flower, i.e. despite being removed from the mother plant and grafted on juvenile rootstock that was not producing any floral stimulation, they still flowered (TAIZ; ZEIGER, 2009). The occurrence of nematodes attacking the root system of some seedlings without causing economic loss was also found. It is therefore suggested that sterile or pasteurised substrate be used in the formation of *Spondias* seedlings and that the seedlings be grown in beds suspended above the ground to avoid infestation in the nursery.

CONCLUSIONS

1. The formation of yellow mobin seedlings by grafting on rootstocks of *S. mombin*, *S. tuberosa* and *Spondias venulosa* is viable;
2. *Spondias macrocarpa* has some type of incompatibility, and should not be used as rootstock for the yellow mombin;
3. The rootstocks of *S. tuberosa*, *S. mombin* and *S. venulosa* form vigorous seedlings when cleft-grafted with the yellow mombin.

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