



## Propagation of yellow mombin by stem and root cuttings treated with indolebutyric acid

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### Abstract

Yellow mombin is a fruit species of growing interest in the agro-industrial sector, mainly in the North and Northeast regions of Brazil, although its commercial exploitation is still limited due to the lack of information regarding its propagation, among other factors. In this perspective, this work aimed to study the effect of the application of indolebutyric acid (IBA) in the vegetative propagation of yellow mombin by stem and root cuttings. The experiments were conducted in a plant nursery, under a completely randomized experimental design consisting of six concentrations of IBA (0, 1000, 2000, 3000, 4000 and 5000 mg.kg<sup>-1</sup> in industrial talc), four replications, and ten cuttings per plot. The stem cutting experiment also evaluated the effect of the types of cuttings (tanchan, basal, stratified basal, medial, and apical), with the material being collected from a yellow mombin tree in full vegetative growth. The root cuttings were collected from a matrix plant in the stage of vegetative rest and cut into 15 cm length segments. After 120 days, the following variables were evaluated: percentage of living, sprouted, rooted, and calloused cuttings, and dry mass of roots and sprouts. The cuttings of the tanchan type showed higher survival and sprouting percentages, regardless of the concentration of IBA applied, whereas the rooting rate was low. The application of IBA increased the rooting percentage of the root cuttings until the maximum concentration of 5000 mg.kg<sup>-1</sup>, reaching 77.5%, although it did not influence the other variables analyzed. The root cuttings of yellow mombin exhibit good regeneration capacity.

**Keywords:** growth regulators, seeding production, *Spondias mombim* L., types of cuttings

### Introduction

The genus *Spondias*, a member of the family Anacardiaceae, consists of nearly 18 species, among them the yellow mombin, native to Tropical America and under the process of domestication, with predominantly extractivist exploitation. Its fruits present good commercial acceptance, especially in the North and Northeast regions of Brazil, used for both the *in natura* consumption and for supplying the industry in the production of juice, pulps, jams, ice creams, etc. (Sacramento & Souza, 2009).

The sexual propagation of fruit species is desirable in genetic improvement programs. However, the establishment of commercial orchards faces limitations, such as the long juvenile period of the plants (Dutra et al., 2012). In this perspective, the use of vegetatively propagated seedlings is highlighted for the advantages of anticipating fructification, multiplying the characteristics of a determined genotype, and allowing the homogeneity of production (Véras et al., 2017).

Plant cutting is a propagation technique

whose main objective is to induce the formation of adventitious roots in the stem, leaf, and root segments of a determined matrix plant, under proper environmental conditions (Fachinello et al., 2013). Yellow mombin, such as the remaining species of the genus *Spondias*, can be multiplied either by stem and root cuttings or by grafting. However, the knowledge regarding this technique is still insufficient for the recommendation of a protocol of propagation for the species aiming at the production of commercial seedlings (Almeida et al., 2017).

Stem cuttings of yellow mombin present hard rooting, being little responsive to exogenous auxin (Souza & Lima, 2005). This low rooting capacity is common in stem cuttings of *Spondias* sp., even when treated with growth regulators, not trespassing 12.5% in *S. macrocarpa* (Novelli et al., 2017); from 35 to 43.75% in yellow mombin (*Spondias* spp.) (Bastos et al., 2014, Véras et al., 2018), and 31% in *S. tuberosa* (Rios et al., 2012).

The application of rooting inducers, such as indolebutyric acid, is a commonly employed measure

to stimulate root initiation in cuttings of fruit species, besides accelerating and homogenizing the formation of adventitious roots (Tosta et al. 2012, Vernier & Cardoso, 2013). In addition to the exogenous application of auxins, other factors also influence the regeneration and formation of cutting clones, among them the types (Hussain et al., 2017), length, and diameter of the cuttings (Kielse et al., 2013), age of the matrix plant (Bastos et al., 2009), collection time (Rios et al., 2012), and rooting genetic potential (Nacata et al., 2014).

According to Costa et al. (2013) the morphogenetic responses of the different tissues to environmental and endogenous stimulations are determined by the competence of the target-cells. In this context, this work aimed to evaluate the effect of the application of indolebutyric acid (IBA) in the vegetative propagation of yellow mombin by stem and root cuttings, as well as to study the influence of the type of cutting in the regeneration and formation of seedlings, aiming at the creation of protocols of multiplication for the species.

## Material and Methods

Two experiments were performed in the Seridó Ecological Site, located in the municipality of Rio Branco - AC, 9° 53' 16'' S latitude, 67° 49' 11'' W longitude and elevation of 170 m. The first experiment was installed at the end of July 2015, using stem cuttings collected from matrix plants in the vegetative stage. The experimental design was completely randomized (RBD) with four replications and ten cuttings per plot, in a 5 x 6 factorial scheme, consisting of five types of stem cuttings and six concentrations of IBA.

The stem cuttings were of the following types: tanchan (60 cm length and 38.41 mm  $\pm$  11.15 mm of mean diameter), basal, stratified basal (20 cm length and 11.32 mm  $\pm$  1.39 mm) of mean diameter, medial (15 cm and 8.22 mm  $\pm$  1.21 mm of mean diameter), and apical (12 cm and 7.33 mm  $\pm$  0.71 mm of mean diameter). In the preparation of the basal stratified cuttings, the cuttings were covered for 30 days with wetted mulch and later placed in tubes containing vermiculite, with the same proceeding for the remaining cuttings.

The concentrations of indolebutyric acid (IBA) used in both experiments were: 0, 1000, 2000, 3000, 4000, and 5000 mg.kg<sup>-1</sup> of powdered auxin mixed with industrial talc. The bases of the cuttings were cut in a beveled edge, immersed in water at 2/3 of their lengths, and later treated with the concentrations of IBA. The rooting environment was a plant nursery covered by an additive film with 100 $\mu$  thickness and under it a 50% shading screen, with the

laterals protected by an anti-aphid screen. The irrigation was performed via intermittent misting, controlled by a temporizer, regulated to mist for 2 minutes at 40-minute intervals.

The second experiment was installed at the beginning of September 2017, with the root cuttings being harvested from a two-year-old yellow mombin tree, which was leafless, in the final stage of vegetative rest. The experimental design was completely randomized, with six concentrations of IBA and four replicates, each plot consisting of ten cuttings. The cuttings were standardized with 15 cm length and 1.20  $\pm$  0.05 cm diameter and later beveled cuts were made in the basal extremities. After the application of IBA, the cuttings were placed in plastic bags (18.0 cm x 25 cm x 0.15 $\mu$ ) containing an organic substrate composed of an organic compound, soil, Ouricuri palm (*Siagrus coronata*) conditioner, 1.0 kg m<sup>-3</sup> of limestone, and 1.5 kg m<sup>-3</sup> of thermophosphate. In this experiment, the laterals of the plant nursery were protected by a shading screen, and the irrigation was performed by manual aspersion with the aid of a watering can.

After 120 days of the preparation of the cuttings, the following variables were evaluated: percentage of living, calloused, and rooted cuttings, root dry mass (MSR) and sprout dry mass (MSB). For the evaluation of the dry matter, roots and sprouts were removed from the cuttings with the aid of a pruning shear and placed in identified paper bags, then taken to a forced-air circulation oven at 65 °C and kept until reaching constant weight.

For the statistical analysis of the data, the following tests were applied: Grubbs' test for detecting outliers, Shapiro-Wilk's test for the verification of normality of residuals, and verification of homogeneity of variances through Bartlett's test. For not meeting the assumptions of the analysis of variance, the data from the stem cutting experiment were subjected to the non-parametric test of Kruskal-Wallis for all variables. Since the variables regarding the shoot dry mass of the root cuttings did not meet the assumptions of the analysis of variance, the transformation for log was performed. After verifying the assumptions, the root cutting data were subjected to analysis of variance through the F and regression tests using the SISVAR software.

## Results and Discussion

The stem cuttings of the tanchan type presented higher survival (50 to 100%) and sprouting (37.5 to 75%) percentages in spite of the concentration of IBA applied (Table 1). These results might be related to the greater

amount of reserves that they contain, allowing greater survival and, consequently, the formation of sprouts (Delgado & Yuyama, 2010, Fachinello et al., 2013).

In spite of the high sprouting percentage, the rooting capacity was low, varying from 0 to 25%, not being influenced by the concentrations of IBA and the types of cuttings (Table 1). Similar results were obtained by Souza & Lima (2005) in apical yellow mombin cuttings, presenting high sprouting rates (65 to 73.3%) and low rooting (8.33 a 23.3%) in spite of the application of IBA. In contrast, V eras et al. (2017) obtained higher rooting percentages in stem cuttings of yellow mombin without using ethephon in the matrix plant (45.83%) and with the application of 3000 mg.L<sup>-1</sup> of IBA (31.94%).

The types of cuttings and the concentrations of IBA did not influence ( $p>0.05$ ) the percentage of calloused cuttings (0 to 37.5%) and the dry mass of roots and sprouts (Table 2). The low rooting capacity in woody cuttings, such as those of yellow mombin, might be related to internal factors, such as the age of the matrix

plant, the collection time of the propagules, hormonal balance, or even environmental factors of conditioning (Han et al., 2009).

In stem cuttings, the sprouts appear before the roots, which is disadvantageous since these structures drain the reserves of the cuttings to the detriment of the rooting. If there is not root emission, the sprouts dry up and die due to the depletion of the reserves (Souza & Lima 2005). Since the survival of the *tanchan* cuttings at the end of the 120 days was significant, maybe for these it should be necessary to increase the time for rooting, since the organic reserves are greater and will allow maintaining the metabolic and morphogenetic processes.

In the root cutting experiment, the IBA linearly increased the rooting percentage until the maximum concentration of 5000 mg.kg<sup>-1</sup> (Figure 1), although it did not influence the remaining variables analyzed (Table 3). High concentrations of IBA increase the rooting of stem cuttings of yellow mombin, reaching a maximum of 43.8% with the application of 6000 mg.L<sup>-1</sup> (V eras et al., 2018).

**Table 1.** Mean percentages of living, sprouted, and rooted stem cuttings of yellow mombin as a function of the concentrations of IBA and types of cuttings.

Type of cutting	Concentration of IBA (mg.kg <sup>-1</sup> )					
	0	1000	2000	3000	4000	5000
Sprouted cuttings (%)						
Apical	0 Aa	2.75 Aab	2.75 Aab	0 Aa	2.75 Aab	0 Aa
Medial	0 Aa	1.0 Aa	2.75 Aab	1.0 Aab	0 Aa	0Aa
Basal	2.75Aab	2.75Aab	1.0 Aab	2.75Aab	2.75 Aa	10 Aa
Tanchan	50 Ab	75 Ab	75Ab	50Ab	100 Ab	75 Ab
Stratification	0 Aa	1.0 Aa	0 Aa	1.0 Aab	0 Aa	0 Aa
Sprouted cuttings (%)						
Apical	0 Aa	2.75 Aa	2.75 Aa	0 Aa	5.5 Aa	0 Aa
Medial	0 Aa	0 Aa	2.75 Aa	5.5 Aa	0 Aa	2.75 Aa
Basal	0 Aa	2.75 Aa	8.5 Aa	0Aa	0 Aa	2.75 Aa
Tanchan	50 Aa	62.5 Aa	62.5 Aa	37.5 Aa	50Aa	75Ab
Stratification	0 Aa	0 Aa	0 Aa	0 Aa	0 Aa	0 Aa
Rooted cuttings (%)						
Apical	0 Aa	0 Aa	0 Aa	0 Aa	0 Aa	0 Aa
Medial	0 Aa	2.75 Aa	0Aa	0 Aa	0 Aa	0 Aa
Basal	0 Aa	0 Aa	0 Aa	0 Aa	0 Aa	0 Aa
Tanchan	0 Aa	0 Aa	25 Aa	25 Aa	25 Aa	12.5 Aa
Stratification	0Aa	0 Aa	0 Aa	0 Aa	0 Aa	0 Aa

Means followed by distinct lowercase letters in the columns and uppercase letters in the rows are statistically different through the non-parametric test of Kruskal-Wallis ( $P<0.05$ ).

**Table 2.** Mean percentages of calloused cuttings and mean root and sprout dry masses of root cuttings of yellow mombin, as a function of the concentrations of IBA and types of cuttings.

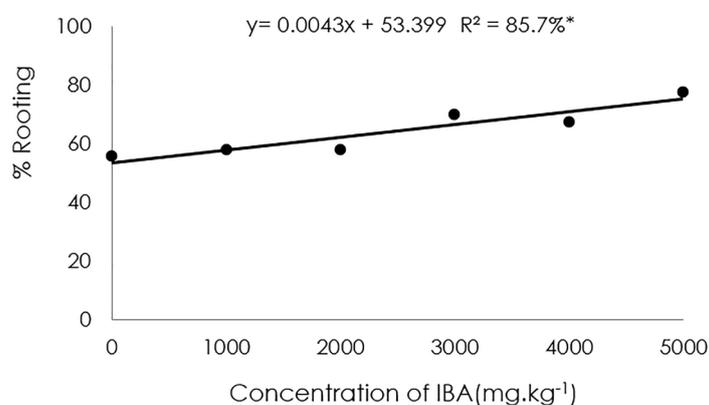
Types of cuttings	Concentrations of IBA					
	0	1000	2000	3000	4000	5000
Calloused cuttings (%)						
Apical	0 Aa	2.75 Aa	2.75 Aa	0 Aa	0 Aa	0 Aa
Medial	0 Aa	0 Aa	0 Aa	0 Aa	0 Aa	0 Aa
Basal	0 Aa	0 Aa	0 Aa	0 Aa	0 Aa	0 Aa
Tanchan	25Aa	25 Aa	37.5 Aa	37.5 Aa	37.5 Aa	25Aa
Stratification	0 Aa	0 Aa	0 Aa	0 Aa	0 Aa	0 Aa
Root dry mass (g)						
Apical	0 Aa	0 Aa	0 Aa	0 Aa	0 Aa	0 Aa
Medial	0Aa	0,002 Aa	0 Aa	0 Aa	0 Aa	0 Aa
Basal	0 Aa	0 Aa	0 Aa	0 Aa	0 Aa	0 Aa
Tanchan	0 Aa	0 Aa	0.267 Aa	0.243 Aa	0.172 Aa	0.326 Aa
Stratification	0 Aa	0 Aa	0 Aa	0 Aa	0 Aa	0 Aa
Sprout dry mass (g)						
Apical	0 Aa	0.032 Aab	0.002 Aab	0 Aa	0.001 Aa	0 Aa
Medial	0 Aa	0 Aa	0.023 Aab	0.036 Aab	0 Aa	0.028 Aa
Basal	0 Aa	0.045 Aab	0.025 Aab	0 Aa	0 Aa	0.003 Aa
Tanchan	0.457 Ab	3.449 Ab	3.192 Ab	1.246 Ab	4.071 Ab	2.164 Ab
Stratification	0 Aa	0Aa	0Aa	0Aa	0 Aa	0 Aa

Means followed by distinct lowercase letters in the columns and uppercase letters in the rows are statistically different through the non-parametric test of Kruskal-Wallis ( $P < 0.05$ ).

**Table 3.** Mean percentage of living, sprouted, and calloused cuttings and dry mass of roots and sprouts of yellow mombin root cuttings as a function of the concentration of IBA.

Concentration of IBA (mg.kg <sup>-1</sup> )	Living cuttings	Sprouted cuttings (%)	Calloused cuttings	Root dry mass (g.plant <sup>-1</sup> )	Sprout dry mass
0		68.9	71.7	0.598	5.50
1000		62.5	67.5	0.593	12.50
2000		70.0	62.5	0.460	9.50
3000		70.0	82.5	0.936	14.50
4000		55.0	77.5	0.794	11.50
5000		72.5	85.0	0.804	18.75
Mean		66.48	74.45	0.697	13.708
QMr		198.158 <sup>ns</sup>	255.935 <sup>ns</sup>	0.2420 <sup>ns</sup>	55.208 <sup>ns</sup>
C.V. (%)		21.17	21.49	70.58	54.20

QMr= Mean square of residuals; C.V = Coefficient of variation; <sup>ns</sup> = not significant by the F test ( $P > 0.05$ )

**Figure 1.** Rooting percentages of root cuttings of yellow mombin subjected to treatments with different concentrations of IBA.

The rooting of the root cuttings increases with the increase in the concentration of IBA, from 55% in the absence of auxin to 77.5% at the maximum concentration (5000 mg.kg<sup>-1</sup>). The rooting percentage was above ( $p < 0.05$ ) that observed by Souza et al. (2017), when studying the effects of the position and length of root cuttings of yellow mombin not treated with IBA, obtaining a maximum rooting of 20% in 10 cm cuttings prepared in the horizontal position.

The survival (72.5% to 89.7%) and sprouting rates (55 to 72.5%) of the root cuttings can be considered as high after 120 days in spite of the concentration of IBA applied. The dry masses of roots and sprouts were also not influenced by the concentrations of IBA, and presented means of 0.697 g.plant<sup>-1</sup> and 13.708 g.plant<sup>-1</sup>, respectively (Table 3). Similar results were found by Andrade (2018) in cuttings of *umbugueira* (*Spondias* sp.) and by Gomes et al. (2005) in *Spondias bahiensis*, in which they did not observe significant effects of the concentrations of IBA for these variables.

The root cuttings used in this experiment were collected in the stage of vegetative rest, a period in which there is no translocation and mobilization of photoassimilates for the formation of drainage organs, therefore, there occurs an accumulation of carbohydrates in the root system of the donor plant (Ky-Dembele et al., 2010, Snedden et al., 2010). This accumulation of organic reserves might have influenced the high sprouting and survival percentages of the cuttings (Fachinello et al., 2013).

When evaluating the propagation of black mulberry by stem and root cuttings, Campagnolo & Pio (2012) observed that the root cuttings presented greater sprouting and rooting capacity than the stem cuttings when these were collected in the stage of vegetative rest, cold-stored, and not treated with IBA.

The mean percentage of callouses was 74.45%, not influenced by the concentrations of IBA (Table 3). The high percentages of living and calloused cuttings observed after 120 days allow the increase in the time of permanence of the root cuttings in the plant nursery. However, from the technical and economic perspectives, this situation is unfavorable for increasing the production cost of the seedlings.

These results demonstrate that the root cuttings of yellow mombin present good competence in forming adventitious roots and sprouts. Therefore, it is necessary to perform further studies, evaluating different harvest times and higher concentrations of IBA, since it was not possible to estimate the maximum concentration, to clarify the

influence of these and other factors in the process of regeneration and formation of seedlings by this type of propagule.

## Conclusions

The rooting of the stem cuttings is low and is not influenced by the type of cutting or by the application of IBA.

The tanchan cuttings present the highest survival and sprouting rates.

The application of growing concentrations of IBA increases the rooting of root cuttings of yellow mombin until the maximum value of 5000 mg kg<sup>-1</sup>.

Root cuttings of yellow mombin present good capacity for the formation of adventitious organs (callouses, sprouts, and roots), with their use being viable for the production of seedlings of this species.

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