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Gibberellic acid in the emergence and early development of star fruit seedlings

Ácido giberélico na emergência e desenvolvimento inicial de plântulas de caramboleira

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ABSTRACT

Star fruit (*Averrhoa carambola* L.) is an exotic fruit with origin in Southeast Asia and that has seeds with low germination. This study aimed to evaluate the effect of gibberellin on the emergence and initial development of star fruit seedlings. The seeds were removed from the fruits and washed in running water, and placed in gibberellin solution 1,000 mg.L^{-1}, 2,000 mg.L^{-1}, 3,000 mg.L^{-1}, 4,000 mg.L^{-1} and plain water as a witness for 30 minutes. Sowing was carried out by placing 1 seed per 280 mL tube in a substrate containing ravine soil + tanned corral manure (3:1) in a randomized block design. Thirty days after the emergence of the first seedling, the percentage of emergence, emergence speed index and mean time of emergence were evaluated. Ninety days after the emergence of the first seedling, seedling height, stem diameter, number of leaves, root length were evaluated; green and dry mass of the leaves, green and dry mass of the root. The star fruit seed has a low germination percentage, with low emergence rates, and the use of gibberellin was efficient to increase and accelerate the emergence, presenting a positive response to the variables plant height, number of leaves, stem diameter and root length. The treatment with gibberellic acid obtained positive action in the emergence and development of star fruit seedlings, and in the mass production of the leaves and roots, and the concentration of 1,000 mg.L^{-1} presented the best results.

RESUMO

A caramboleira (*Averrhoa carambola* L.), é uma fruta exótica com origem no sudeste asiático e que possui sementes com baixa germinação. Objetivou-se avaliar o efeito da giberelina na emergência e desenvolvimento inicial de plântulas de caramboleira. As sementes foram retiradas dos frutos e lavadas em água corrente, e colocadas em solução de giberelina 1.000 mg.L^{-1}, 2.000 mg.L^{-1}, 3.000 mg.L^{-1}, 4.000 mg.L^{-1} e água pura como testemunha por 30 minutos. A semeadura foi realizada colocando 1 semente por tubete de 280 mL em substrato, contendo terra de barranco + esterco de curral curtido (3:1) em um delineamento experimental em blocos casualizados. Trinta dias após a emergência da primeira plântula foram avaliados porcentagem de emergência, índice de velocidade de emergência e tempo médio de emergência. Noventa dias após a emergência da primeira plântula foram avaliados altura da plântula, diâmetro do coleto, número de folhas, comprimento da raiz; massa verde e seca das folhas, massa verde e seca da raiz. A semente de caramboleira possui baixa porcentagem de germinação, com baixos índices de emergência, e o uso da giberelina foi eficiente para aumentar e acelerar a emergência, apresentando resposta positiva para as variáveis altura da planta, número de folhas, diâmetro do coleto e comprimento da raiz. O tratamento com ácido giberélico obteve ação positiva na emergência e no desenvolvimento de plântulas de caramboleira, e na produção de massa das folhas e raízes, sendo que a concentração de 1.000 mg.L^{-1} apresentou os melhores resultados.

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Introduction

Star fruit (*Averrhoa carambola* L.), is a fruit of the family Oxalidaceae, a medium-sized tree, it´s native to Southeast Asia and needs warm tropical or subtropical climate conditions for its cultivation (Gomes, 1989). Fruits have great importance throughout the world, enabling the rational exploitation of large productive areas, making them profitable. This activity generates jobs throughout its production chain, since it requires a lot of labor (Chitarra; Chitarra, 1990). The pulp can be consumed *in natura*, or in the form of jellies, sauces, jams, pickles, having variation of knowledge from sweet to quite acidic (Donadio, 1998).

Some factors related to the environment in which seeds are sown can slow or prevent seed germination, this phenomenon is known as seed dormancy (Paixão, 2019). Seeds in dormant states are still viable, but even exposed to optimal germination conditions, they do not germinate (Carvalho; Nakagawa, 2012). With seeds in the dormant condition, emergence will be uneven, which will make room for timely plants (Marcos Filho, 2015).

In dormant seeds, the inviability of the embryo to grow back after being submerged to certain substances, can be driven by several factors such as physiological dormancy (Paixão, 2019), this affects carbohydrate metabolism directly and indirectly, in addition to proteins and other energy reserves of seeds during germination (Vieira et al., 2000), and also integumentary dormancy, that does not allow water and gases to enter the embryo (Carvalho; Nakagawa, 2012, Baskin; Baskin, 2004).

Both natural and synthetic hormones also provide some changes in the structural processes of a plant and can be applied to various parts of the plant, such as leaf, seed, fruit, stem, and seed, always aiming at a rapid vegetative development and consequently an anticipation of production (Vieira; Castro, 2003).

Gibberellin, for example, is one of the most used substances, because it provides a greater elongation of the stem, increased cell division (DAVIES, 1995), in addition to accentuating the apical dominance of many species after its application (Cordeiro, 1979; Taiz; Zeiger, 2017). Gibberellin modifies the cell wall resulting in loosening and acidification respectively (Taiz; Zeiger, 2017; Krikorian, 1991).

The objective of this study was to evaluate the effect of gibberellic acid on the emergence and early development of star fruit seedlings.

Material and methods

The experiment was conducted in the seedling production nursery, with 50% shading polyolefin mesh, height of 2.3 meters, of the Federal Institute of Espírito Santo (*Instituto*

Federal do Espírito Santo) (IFES - Santa Teresa Campus), from August to December 2021, located in the Central region of *Espírito-Santense*, Santa Teresa - ES, Brazil, district of *São João de Petrópolis*, geographical coordinates 19°56'12"S and 40°35'28"W, with altitude of 155 m. The climate of the region is characterized as Cwa, mesothermic, with dry season in winter and heavy rainfall in summer (Köppen classification) (Alvares et al., 2013), with average annual rainfall of 1,404.2 mm and average annual temperature of 19.9 °C, with a maximum of 32.8 °C and a minimum of 10.6 °C (Incaper, 2011).

The seeds were removed from fruits harvested in the area of the institute, cabocla species, and washed in running water to remove the mucilage, and placed in gibberellin solution 1.000 mg.L^{-1}, 2.000 mg.L^{-1}, 3.000 mg.L^{-1}, 4.000 mg.L^{-1} and plain water as a witness for 30 minutes. The dosages were determined according to the dosages used in different studies observed in the literature to break dormancy with gibberellin. Sowing was carried out by placing 1 seed per 280 mL tube in a substrate containing ravine soil + tanned corral manure (3:1). Because we don´t have a homogeneous environmental condition, the research was carried out in a randomized block design (DBC), with 5 treatments and 4 replications, and each treatment was composed of 50 seeds and daily irrigation with micro sprinklers.

Thirty days after the emergence of the first seedling, when seedlings were no longer observed to emerge, the percentage of emergence (E), emergence speed index (IVE) and mean time of emergence (TME) were evaluated. Ninety days after the emergence of the first seedling, ten seedlings were randomly removed per repetition and seedling height (AP), stem diameter (DC), number of leaves (NF), root length (CR) were evaluated; green mass of leaves (MVF); leaf dry mass (MSF), green root mass (MVR); dry root mass (MSR).

The experimental data were submitted to analysis of variance by the F test, meeting the assumptions of the model by the Shapiro-Wilk test to verify normality and the means of the treatments were compared by the Tukey test at a level of 5% probability, and linear regression test for the variables that presented statistical differences.

Results and discussion

The emergency began twenty-five days after sowing. According to Table 1 it can be observed that in general, the star fruit seed has a low germination index, with low emergence rates, and the best seedling emergence was found in the dosages of 1.000 mg.L^{-1} and 2.000 mg.L^{-1} of GA3 with statistical difference to the other dosages.

The same can be observed for the emergence speed index and the mean time of emergence, but these dosages do not present statistical difference for the higher dosages used in this research (Table 1). The relationship between IVE and TME appears logically, as the speed of seedling emergence increases, the average time of emergence decreases, but there is

no statistical difference between gibberellin treatments. The use of gibberellin was efficient to break the dormancy of the seeds, increasing and accelerating the emergence, where in all dosages of gibberellin used we observed statistical difference in relation to the control (Table 1).

Table 1.

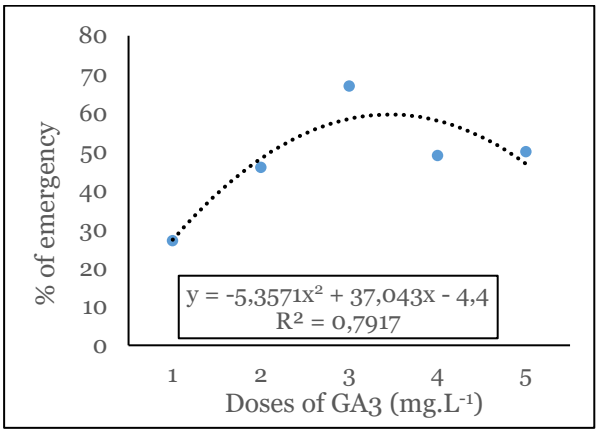
Emergence of star fruit seedlings at different doses of GA3.

Treatment	E (%)	IVE	TME
Witness	27 c	0,764 b	12,611 b
GA3 1.000 mg.L^{-1}	66 a	2,369 a	7,854 a
GA3 2.000 mg.L^{-1}	67 a	2,345 a	8,253 a
GA3 3.000 mg.L^{-1}	49 b	2,366 a	9,237 a
GA3 4.000 mg.L^{-1}	50 b	2,414 a	9,571 a

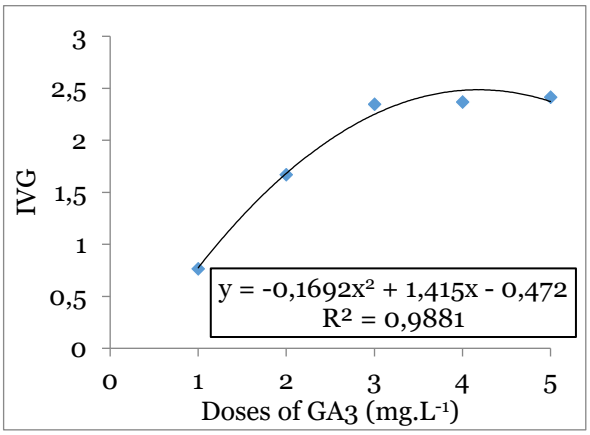
Means followed by the same letters in the columns are statistically equal by Tukey's test at 5% probability. E = seedling emergence (%); IVE = emergency speed index; TME = average emergency time.

According to graph 1, the trend in seedling emergence can be observed where emergence increases up to the dosage of GA3 2.000 mg.L^{-1}, from this dosage begins to decrease, showing that gibberellin acted positively up to this point, the same happening for IVE (Graph 2), where we could consider it to be the ideal dosage for star fruit seedlings.

Graph 1. Trend line for emergence.



Graph 2. Trendline for IVE.



Dosages of GA3: 1= 0,0; 2= 1.000 mg.L^{-1}; 3= 2.000 mg.L^{-1}; 4= 3.000 mg.L^{-1}; 5= 4.000 mg.L^{-1}.

Table 2 shows that the gibberellin solution in the different concentrations used didn´t present a positive response to the variables plant height, number of leaves, stem diameter and root length, with no statistical difference for the control.

The use of gibberellin acted in the breakdown of dormancy accelerating the emergence of seedlings, however, the different concentrations of gibberellin used in this work did not act on the development of plants, where the growth of the shoot and root growth were not altered, as well as the number of leaves produced and the growth of the diameter of the collection did

not present statistical difference in relation to the control treatment that was not used the solution of gibberellin.

Table 2.

Development of star fruit seedlings in different concentrations of GA3

Treatment	AP	NF	DC	CR
Witness	10,19 a	80,0 a	2,52 a	19,98 a
GA3 1.000 mg.L^{-1}	10,96 a	88,3 a	2,67 a	20,01 a
GA3 2.000 mg.L^{-1}	10,88 a	78,2 a	2,59 a	19,82 a
GA3 3.000 mg.L^{-1}	10,44 a	81,2 a	2,74 a	19,54 a
GA3 4.000 mg.L^{-1}	10,76 a	77,2 a	2,51 a	18,95 a
CV (%)	16,6	25,2	14,3	6,2

Means followed by the same letters in the columns are statistically equal by Tukey's test at 5% probability. AP = height of the shoot (cm); NF = number of leaves; DC = stem diameter (mm); CR = root length (cm).

Table 3 shows positive effects of gibberellin when evaluating the production of green and dry mass of leaves and roots. Although no statistical difference was observed for leaf and root growth, for all variables evaluated in the production of green and dry mass, the control presented inferior results to the treatments with gibberellin, with statistical difference. For green and dry mass of the leaves and root the concentration of GA3 1.000 mg.L^{-1} presented the highest absolute values without statistical difference for green and dry mass of the leaves in the concentrations of 2.000 mg.L^{-1} and 3.000 mg.L^{-1}, however, with statistical difference for green and dry mass of the roots in the concentration of 4.000 mg.L^{-1}, and for the witness without gibberellin.

Table 3.

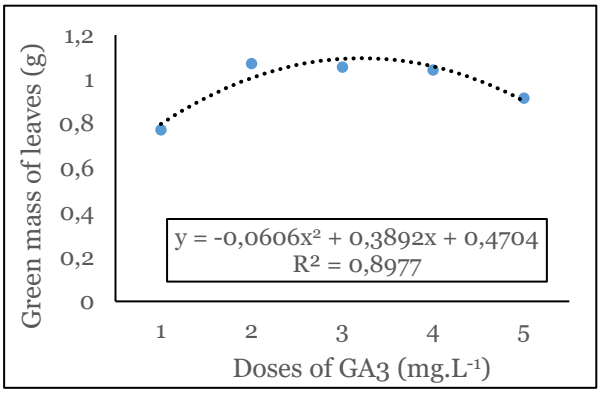
Green and dry mass of star fruit seedlings in different concentrations of GA3.

Treatment	MVF	MVR	MSF	MSR
Witness	0,773 c	0,801 c	0,363 c	0,265 c
GA3 1.000 mg.L^{-1}	1,071 a	1,184 a	0,529 a	0,454 a
GA3 2.000 mg.L^{-1}	1,056 a	0,967 b	0,526 a	0,326 b
GA3 3.000 mg.L^{-1}	1,043 a	0,775 c	0,518 a	0,387 b
GA3 4.000 mg.L^{-1}	0,916 b	0,691 d	0,453 b	0,322 b
CV (%)	42,3	49,7	38,9	37,4

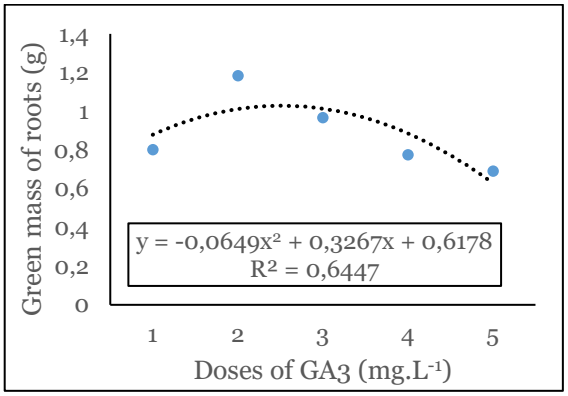
Means followed by the same letters in the columns are statistically equal by Tukey's test at 5% probability. Saint Teresa (2018). MVF = green mass of leaves (g.pl^{-1}); MVR = green mass of roots (g.pl^{-1}); MSF = dry mass of leaves (g.pl^{-1}); MSR = dry mass of roots (g.pl^{-1}); CV = coefficient of variation.

The trend lines for green mass of leaves and roots show that the ideal concentration is between 1.000 mg.L^{-1} and 2.000 mg.L^{-1}, being the dosage of 1.000 mg.L^{-1} the one that presented the best results for the production of green and dry mass of the leaves and roots (Graphs 3 and 4).

Graph 3. Regression for green mass of leaves.



Graph 4. Regression to green mass of roots.



Dosages of GA3: 1 = 0,0; 2 = 1.000 mg.L^{-1}; 3 = 2.000 mg.L^{-1}; 4 = 3.000 mg.L^{-1}; 5 = 4.000 mg.L^{-1}

These results show that the use of gibberellin GA3 was efficient in the production of green and dry mass of leaves and roots, with greater development of shoots and roots, for the production of a healthier seedling.

Dormancy is a good mechanism for seed development in unfavorable environments, and they can stay in the seed flock of the soil and germinate only when the ideal conditions appear for the establishment of seedlings (Ohashi, 2005), but when it comes to the production of seedlings, these become unwanted because it can create a great loss to nurseries by the loss of most of the seeds used.

Paixão (2019), mentions that the seed to germinate needs a germination promoter, without this germination does not occur, and if a germination blocker is present, it must have more than one inducer. The low germination index and seedling emergence in the control treatment suggests the inexistence or low concentration of germination promoters, which may cause seed dormancy.

Gibberellins are synthesized by the embryo and transported to the starchy endosperm by the scutella, following to the aleurone layer which are stimulated to synthesize secrete α-amylase, degrading the macromolecules into smaller molecules, being absorbed by the scutellum and transported to the growing embryo, nourishing it and stimulating it to germinate. When we submitted the seeds to gibberellin solution, it provided the breakdown of dormancy with increased germination index, with positive consequences on the emergence of seedlings and production of green and dry mass of leaves and roots.

Conclusion

The treatment with gibberellic acid obtained positive action in the emergence and development of star fruit seedlings, when the mass production of the leaves and roots is evaluated, and in general, the concentration of 1.000 $mg.L^{-1}$ presented the best results, and the production of seedlings of this species may be recommended in the aid.

REFERENCES

Alvares, C. A., Stape, J. L., Sentelhas, P. C., Gonçalves, J. L. M. & Sparovek, G. (2013). Köppen's climate classification map for Brazil. *Meteorologische Zeitschrift*, 22(6), 711-728.

Baskin, J.M. And Baskin, C.C. (2004). A classification system for seed dormancy. *Seed Science Research*. 14, 1-16.

Carvalho, N.M.; Nakagawa, J. (2012). *Sementes:* ciência, tecnologia e produção. Jaboticabal: Funep, 588p.

Chitarra, M. I. F; Chitarra, A. B. (1990). *Pós-colheita de frutos e hortaliças:* fisiologia e manuseio. Lavras: UFLA.

Cordeiro, J. A. D. (1979). *Crescimento, diferenciação e produção em plantas de sorgo granífero Sorghum bicolor (L.) Moench, trataradas com os ácidos giberélico-3 e anaftalenoacético*. 50f. Dissertação (Mestrado em Fitotecnia) Universidade Federal do Ceará, Fortaleza.

Davies, P. J. (1995). The plant hormones: their nature, occurrence, and functions. In: Davies PJ (2 Ed) *Plant hormones*: physiology, biochemistry and molecular biology. London, Kluwer Academic Publishers. 1-13.

Donadio, L.C.; Nachtigal, J.C.; Sacramento, C.K. (1998). *Frutas exóticas*. Funep, Jaboticabal, SP. 279p.

Gomes, R. P. (1989). *Fruticultura brasileira*. Nobel, São Paulo. 446p

Incaper. (2011). *Planejamento e programação de ações para Santa Teresa*. Programa de assistência técnica e extensão rural PROATER, Secretaria de Agricultura, Santa Teresa: SEAG, 33p.

Krikorian, A. D. (1991). Medios de cultivo: generalidades, composición y preparación. In: Roca, W. M.; Mroginsky, L. A. (Eds.). *Cultivo de tejidos em la agricultura:* fundamentos y aplicaciones. 41-77, Cali: CIAT.

Marcos Filho, J. (2015). *Fisiologia de sementes de plantas cultivadas*. Londrina: Abrates. 659p.

Ohashi, S. T. (2005). *Varianilidade genética e fenotípica entre procedências de paricá Schizolobium parahyba var. amazonicum (Huber ex Ducke) Barneby visando seleção*

de materiais genéticos para sistemas agroflorestais. 107 f. Tese (Doutorado em Ciências Agrárias) – Universidade Federal Rural da Amazônia, Manaus.

Paixão, M.V.S. (2019). *Propagação de plantas*. 2.ed. Santa Teresa: Ifes, 230p.

Taiz, L.; Zeiger, E. (2017). *Fisiologia vegetal*. 6.ed. Porto Alegre: Artmed, 722 p.

Vieira, E. L.; Castro, P. R. C. (2003). Ação de bioestimulante na cultura do feijoeiro (Phaseolus vulgaris L). In: Vieira L & Castro PRC (1 Ed), *Feijão Irrigado Tecnologia & Produtividade*. Cosmópolis, STOLLER. 73-100.

Vieira, A.R.; Vieira, M. Das G.G.C.; Oliveira, J.A. Santos, C.D. (2000). Alterações fisiológicas e enzimáticas em sementes dormentes de arroz armazenadas em diferentes ambientes. *Revista Brasileira de Sementes*, 22(2), 53-61.