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PHYSIOLOGICAL QUALITY OF JURUBEBA SEEDS AT DIFFERENT MATURATION STAGES

QUALIDADE FISIOLÓGICA DE SEMENTES JURUBEBA EM DIFERENTES ESTÁGIOS DE MATURAÇÃO

Natan Gabriel Silva Wonsoski
Universidade do Estado de Mato Grosso - UNEMAT, Brasil
Orcid: https://orcid.org/0009-0005-5638-8686
E-mail: natan.wonsoski@unemat.br

Samuel Laudelino Silva
Universidade do Estado de Mato Grosso - UNEMAT, Brasil
Orcid: https://orcid.org/0000-0002-6466-3984
E-mail: samuel@unemat.br

Petterson Baptista da Luz
Universidade do Estado de Mato Grosso - UNEMAT, Brasil
Orcid: https://orcid.org/0000-0003-4067-0087
E-mail: petterson@unemat.br

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E-mail para correspondência:
petterson@unemat.br

Abstract: When seeds reach their point of physiological maturity, they are ready to express their maximum vigor potential. For this reason, seed quality analyses, such as germination and vigor tests, are essential for providing information that enables the selection of the best batches for commercial purposes. Due to its economic potential and cultural value, studies on the physiological quality of Jurubeba seeds are of fundamental importance. This research aims to evaluate the physiological quality of Jurubeba seeds based on three stages of fruit development: green, ripe, and senescent. It also seeks to determine the method that stands out for overcoming seed dormancy. The experiment was conducted at UNEMAT's Seeds and Ornamental Plants Laboratory. Dormancy was overcome using the following treatments: untreated seeds; gibberellic acid and chemical scarification with sulphuric acid. The experiment was conducted in a completely randomized design (CRD) with a 3x3 factorial scheme, comprising three stages of fruit maturation and three methods for overcoming seed dormancy. The comparison of means was performed using the Tukey test at a 5% probability level. It can be concluded that the mature stage showed higher germination rates, regardless of the method used to overcome dormancy. The methods of overcoming dormancy behaved differently within each stage of ripeness, with gibberellin being the one that showed consistently higher rates.

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Keywords: Solanaceae. Dormancy. Germination. *Solanum Paniculatum* L.

Resumo: As sementes quando atingem seu ponto de maturidade fisiológico estão prontas para expressar o seu máximo potencial de vigor. Por isso, análises de qualidade de sementes, como testes de germinação e vigor, são imprescindíveis para o fornecimento de informações que possibilitam a seleção dos melhores lotes para fins comerciais. Devido ao seu potencial econômico e valor cultural, estudos sobre a qualidade fisiológica de sementes de Jurubeba são de fundamental importância, a presente pesquisa tem por objetivo avaliar a qualidade fisiológica de sementes de jurubeba em função de três estádios de desenvolvimento do fruto, sendo eles verde, maduro e senescente, e também determinar o método que se destaca para a superação da dormência de sementes. O experimento foi conduzido no Laboratório de Sementes e Plantas Ornamentais da UNEMAT. A dormência foi superada através dos seguintes tratamentos: sementes sem tratamentos; ácido giberélico e escarificação química com ácido sulfúrico. O teste de germinação foi conduzido em B.O.D., sendo utilizadas 200 sementes em cada estádio de maturação. O experimento foi executado em DIC, em esquema fatorial 3x3, sendo três estágios de maturação dos frutos e três métodos para superação de dormência de sementes, onde a comparação entre as médias foi efetuada pelo teste de Tukey, ao nível de 5% de probabilidade. Conclui-se que o estádio maduro apresentou índices superiores de germinação, independente do método de superação de dormência. Os métodos de superação de dormência se comportaram de maneira diferente dentro de cada estágio de maturação, sendo a giberelina o que apresentou constância de índices superiores.

Palavras-chave: Solanaceae. Dormência. Germinação. *Solanum Paniculatum* L.

Introduction

Jurubeba (*Solanum paniculatum* L., Solanaceae), also known as: juribeba, jurubeba-veradeira, jupeba, is found throughout Brazil, from Rio Grande do Sul to Rio Grande do Norte and is easily found throughout tropical America [(1)]. It is considered a native, wild plant that survives in places with low soil fertility and on different types of soil [(2)].

Given the increase in the consumption of plants for medicinal purposes and, above all, with high levels of nutritional value, it is essential to study species such as Jurubeba. The species is widely used in Brazilian folk medicine due to the presence of active compounds and secondary metabolites, such as steroids, saponins, alkaloids and glycosides, of pharmacological importance [(3)]. As well as being a rustic, drought-resistant plant with low soil fertility requirements, its fruit has the potential to be exploited and generate income, being sold to the beverage industry [(4)]. Everything from the Jurubeba plant can be used: root, stem, leaves, flowers and fruit, for both medicinal and culinary purposes [(5)].

Jurubeba fruits are characterized by small green spheres that turn whitish when ripe, grow in the shape of a cluster and have a bitter taste. Harvesting begins six months after planting and can be extended for the same period. The bunches with the fruit are picked while they are still green, as the seeds from ripe fruit are very hard and fibrous. These fruits are used for human consumption, mainly in Goiás and Minas Gerais, in the Triângulo Mineiro region [6].

Like the main species in the Solanaceae family, *Solanum paniculatum* L.'s main form of propagation is via seeds and its main form of dispersal is by animals, i.e. zoochoric dispersal. High seed quality is of fundamental importance for establishing populations in the field. For this reason, seed quality analyses, such as germination and vigor tests, are essential for providing information that enables the selection of the best batches for commercial purposes. In this context, fast, accurate and simple methods are desirable, capable of assessing the physiological potential of seeds in a way that facilitates decision-making regarding the management of seed lots [7].

Preliminary laboratory tests with jurubeba seeds have led to the hypothesis that dormancy is present due to the low germination of this species under controlled conditions. This seed dormancy can be imposed by the embryo, the tissues surrounding the embryo or both. Garcia *et al.* [8] believe that the mucilage surrounding jurubeba seeds has chemical components that act as germination inhibitors. According to Taiz *et al.* [9], secondary metabolites, such as tannins, phenolic acids and coumarins, present in the coating and/or inside the seeds can inhibit germination.

A very important factor when choosing a seed undoubtedly knows whether it has reached its point of physiological maturity. When seeds reach their point of physiological maturity, they are ready to express their maximum potential vigor [10]. However, one of the major obstacles knows when the seed has reached its physiological maturity, depending on its stage of development.

According to Popinigis [11], physiological quality is defined as the ability to perform vital functions, determined by germination, longevity and vigor, which has a direct influence on when the crop is to be placed in the field. One of the tests responsible for assessing the physiological quality of seeds is the germination test, which evaluates a batch of seeds and determines the quantity of seeds that will germinate and produce normal plants under normal ecosystem circumstances [11, 12].

Based on this assumption, the aim of this research is to evaluate the physiological quality of jurubeba seeds according to three stages of fruit development: green, ripe and senescent, and also to determine the best method for overcoming dormancy using the germination test.

Methodology

The experiment was conducted in the state of Mato Grosso in the municipality of Cáceres-MT. The characteristic climate of the region, according to the Köppen classification, is tropical, hot, humid and dry winter (Awa), with a rainy season from October to March and a dry season from April to September [(13)].

Fruits were collected from five jurubeba plants (*Solanum paniculatum* L.) located in the urban region of Cáceres - MT, and these fruits were collected at three stages of ripeness: green, ripe (70% of the fruit had changed green) and senescent. These fruits were then taken to the laboratory and processed for the germination test. The parent plants were marked, and the fruits were protected with kraft paper. The progression of the fruit maturation stage was monitored daily.

At the beginning of the experiment, the water content of the seeds was determined according to the Rules for Seed Analysis [(14)], using the oven method (105 ± 3 °C for 24 hours), and then weighed on an analytical balance.

To overcome the dormancy of Jurubeba seeds, the following treatments were performed on seeds collected from fruits at the three different maturation stages: seeds without treatment; seeds soaked in gibberellic acid (GA_3) at a concentration of 300 mg L^{-1}, at 30 °C, in the absence of light, for 5 hours; and chemical scarification with sulfuric acid (H_2SO_4 – 99%) for 3 minutes at room temperature.

After overcoming dormancy, the germination test was carried out in a Biochemical Oxygen Demand (B.O.D.) germination chamber with an alternating temperature of 20/30º C and a 12-hour photoperiod. The seeds were placed on blotting paper in a transparent acrylic box (gerbox) moistened to 2.5 times the weight of the dry substrate. 200 seeds were used at each stage of ripeness, divided into 4 replicates of 50 seeds.

All the germination parameters in this study were calculated using the GerminaQuant 1.0 software (Marques *et al.* [(15)] where, at the end of the observations, the following were calculated: GERM - germination percentage, TMG - mean germination time (Labouriau, [(16)]), VMG - Mean Germination Velocity (Maguire, [(17)]), U - germination uncertainty, a measure that indicates whether or not the process has occurred (Labouriau e Valadares, [18]) and, Z - germination synchrony, which indicates when at least two seeds germinate together [19]).

The experiment was carried out in a completely randomized experimental design (DIC), where the averages of the batches at each stage of maturity and each dormancy overcoming method were compared using the Tukey test at a 5% probability level.

Results and Discussion

Jurubeba seeds had an average percentage water content of 11.76, 10.65 and 11.85% for the green, mature and senescent stages of ripeness, respectively. This result is very similar to that observed by Silva *et al*. [20] who obtained seeds with an initial water content of 9%, which is a characteristic factor for classifying orthodox seeds, as their low water content tolerates prolonged periods of storage.

There was an interaction between the stage of maturity and the treatments for overcoming seed dormancy for the variables germination percentage, average germination time and average germination speed (Table 1). The different maturation stages behaved differently for the evaluated parameters, just as the treatments used to overcome dormancy worked differently, depending on the maturation stage of the seeds.

Table 1. Treatments to overcome dormancy (TRAT), Germination Percentage (GERM), Mean Germination Time (MTG) and Mean Germination Speed (VMG) of seeds according to three stages of fruit ripeness of *Solunum paniculatum* L.

Germination Percentage			
	Ripening		
Overcoming dormancy	Green	Mature	Senescent
No treatment.	50 A b	76 A a	47.5 B b
GA_3	60 A b	91 A a	70 A b
H_2SO_4	31.5 B b	81.5 A a	21.75 C b
CV (%)		15,69	
Average germination time			
No treatment.	20.61 B b	21.12 B b	9.11 A a
GA_3	9.37 A b	12.42 A b	10.5 A b
H_2SO_4	17.63 B b	18.19 AB b	20.88 B b
CV (%)		23,08	
Average twinning speed			
No treatment.	0.04 B a	0.04 B a	0.11 A b
GA_3	0.10 A a	0.08 A a	0.10 A a
H_2SO_4	0.05 B a	0.05 AB a	0.06 B a
CV (%)		25,24	

Averages followed by the same uppercase letter vertically and lowercase letter horizontally do not differ by the Tukey test at 5% probability.

Source: Prepared by the authors (2024).

As far as germination is concerned, jurubeba seeds behaved differently at each stage of maturity, with the mature stage showing the highest germination percentage, reaching 91% when seed dormancy was overcome with gibberellic acid.

For fruit harvested at the green ripeness stage, the untreated seeds and those treated with GA_3 showed statistically equivalent percentages when compared to those subjected to H_2SO_4. Seeds at the mature stage, on the other hand, showed no statistical difference between the three treatments. The method of overcoming dormancy with gibberellin (GA_3) showed superior germination at the senescent stage, with sulphuric acid (H_2SO_4) showing the lowest germination.

All of these treatments have advantages and disadvantages, so each one should be studied, taking into account the cost effectiveness and ease of implementation. In addition, there may be seeds with different levels of dormancy in the same batch. Therefore, the method used must be effective in overcoming dormancy, without harming seeds with less severe dormancy [21].

Assuming that there was an interaction between the dormancy overcoming treatments and the stages of maturity, it is important to note that the mature stage was the one with the highest germination percentage regardless of the dormancy overcoming method used. This is due to the fact that the seeds have reached their point of physiological maturity, at which point the seeds undergo all the morphological, physiological and functional transformations from the fertilization of the ovule to the point of maximum dry matter in the seeds [10].

In terms of mean germination time (GMT), the seeds treated with GA_3 had a faster germination rate in the green stage than the other treatments. In the mature stage, GA_3 also stood out, and sulphuric acid did not differ statistically from the untreated seeds and those treated with gibberellin. On the other hand, seeds in the senescent stage, untreated and treated with GA_3, germinated in a shorter time and were statistically equal.

Gibberellins stand out for their efficiency in promoting the overcoming of dormancy in seeds, as they are hormones that are involved in modulating the development of the plant cycle, increasing the growth of the embryo and controlling the growth of the embryonic axis [9, 22].

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According to Stenzel *et al.* [23], germination due to the exogenous application of GA_3 is stimulated by the synthesis of enzymes such as β-amylase, which degrades the energy reserves of the seed's endosperm, giving rise to nucleic acids, amino acids and, above all, sugars that are translocated to the embryo's development regions, which leads to cell elongation and the tegument being broken by the root, providing more uniform germination.

When comparing the effect of the dormancy overcoming method within each stage of ripeness, it can be seen that untreated seeds germinated in fewer days in the senescent stage; on the other hand, seeds submitted to GA_3 and H_2SO_4 did not differ statistically within this stage of ripeness.

The same behavior can be observed for the variable average germination speed, where, in general, seeds treated with gibberellin and sulphuric acid showed statistically higher rates within the ripening stages, only for untreated seeds in the senescent stage this rate was lower.

Average Germination Time (AMT), Germination Percentage (GERM %) and Average Germination Speed (AMS) are parameters that serve as a basis for evaluating the germination performance of seeds, where AMT and AMS are tests related to germination speed, the higher the IVG and the lower the TMG, the higher the germination speed of the sample of seeds pre-treated with gibberellic acid, which allows us to analyze the efficiency of GA3 in overcoming the dormancy of jurubeba seeds [24].

According to Ranal e Santana [25], with regard to germination uncertainty and synchrony, it is worth noting that uncertainty is related to the distribution of germination frequency, i.e. a low value for uncertainty indicates that germination is more concentrated at a given time. When we refer to synchrony, we are referring to the degree of overlapping germination, when two or more seeds germinate at the same time (Table 2).

Table 2. Germination Uncertainty (U) and Germination Synchronicity (Z) of seeds as a function of three stages of fruit ripeness and the treatments carried out to overcome the dormancy of *Solunum paniculatum* L.

Stage of ripeness	U (bis)	Z
Green	2,64 a	0,191 b
Mature	3,06 b	0,144 b
Senescent	1,31 a	0,408 a

TREAT		
No treatment.	2.34 ab	0,264 a
GA_3	1,98 a	0,366 a
H_2SO_4	2,69 b	0,113 b
CV (%)	22,94 %	58,16

Averages followed by the same letter vertically do not differ by the Tukey test at 5% probability.
Source: Prepared by the authors (2024).

Based on this principle, we can see that seeds in the green and senescent stages of ripeness showed lower uncertainty values, and the same was seen when the seeds were treated with gibberellic acid, which indicates that germination occurred in a more concentrated manner at a given time.

As for germination synchrony, seeds at the senescent stage of maturity, which were soaked in gibberellic acid and also those which were not subjected to any dormancy overcoming treatment, showed higher overlap germination values.

Final Considerations

The mature stage showed higher germination rates, regardless of the dormancy overcoming method used on the Jurubeba seeds, with an average of 83% germination.

The methods of overcoming dormancy behaved differently at each stage of ripeness, with gibberellin (GA_3) being the one that showed consistently higher rates.

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