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ARTICLE

Emergence of *Coccoloba gigantifolia* Melo, Cid Ferreira & Gribel seedlings as a function of raceme and fruit maturation

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ABSTRACT: *Coccoloba gigantifolia* fruits show uneven maturation within each raceme, which can affect the quality of the seeds. This study aimed to characterize racemes, fruits, and seeds, after harvest, and evaluate the physiological performance of the seeds as a function of the fruit maturation stage. After characterization, two experiments were set up. In the first, a completely randomized design was used, in a 4 (racemes) x 4 (fruit maturation stages: green, half-green, red, and purple) factorial scheme, with 4 replications. In the second, a randomized block design was adopted, in a 4 (fruit maturation stages) x 2 (with and without seed drying) factorial scheme, with 4 replications. Fruit maturation occurs progressively within each raceme, with fruits from completely green to completely purple in color existing at the same time. In propagation, preference should be given to harvesting racemes with a greater number of fruits in the half-green, red, and purple stages, since seeds from green fruits have low physiological quality. In addition to the variation in emergence as a function of fruit maturation, the seeds of the different racemes also showed different behaviors, which seems to be associated with different levels of seed dormancy.

Index terms: fruit color, germination, seed quality, Polygonaceae.

RESUMO: Os frutos de *Coccoloba gigantifolia* apresentam maturação desuniforme dentro de cada racemo, o que pode afetar a qualidade das sementes. O objetivo deste trabalho foi caracterizar racemos, frutos e sementes, após a colheita, bem como avaliar o desempenho fisiológico das sementes em função do estádio de maturação dos frutos. Após a caracterização, foram instalados dois experimentos. No primeiro foi utilizado o delineamento inteiramente casualizado, em esquema fatorial 4 (racemos) x 4 (estádios de maturação dos frutos: verde, meio-verde, vermelho e púrpuro), com 4 repetições. No segundo foi adotado o delineamento em blocos casualizados, em esquema fatorial 4 (estádios de maturação dos frutos) x 2 (com e sem secagem das sementes), com 4 repetições. A maturação dos frutos ocorre de maneira progressiva dentro de cada racemo, existindo, ao mesmo tempo, desde frutos completamente verdes até inteiramente de cor púrpura. Na propagação, deve-se dar preferência à colheita de racemos com maior número de frutos nos estádios meio-verde, vermelho e púrpuro, pois as sementes provenientes de frutos verdes apresentam baixa qualidade fisiológica. Além da variação na emergência em função da maturação dos frutos, as sementes dos diferentes racemos também tiveram comportamentos distintos, o que parece estar associado a diferentes níveis de dormência das sementes.

Termos para indexação: cor do fruto, germinação, qualidade da semente, Polygonaceae.

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INTRODUCTION

Coccoloba gigantifolia Melo, Cid Ferreira & Gribel – Polygonaceae (*Cocoloba-folha-grande* in Portuguese) is a species that occurs in the central and southwestern parts of the Brazilian Amazon, particularly in the Madeira River basin, and is considered endangered due to the expansion of the agricultural frontier and the construction of highways and hydroelectric power plants in the region (Melo et al., 2019).

A peculiar characteristic of the plant is the size of its leaves, which can reach lengths of 0.6 to 2.5 m and widths of 0.5 to 1.6 m (Melo et al., 2019), being one of the largest among Dicotyledons. Combined with this, the architecture of the plant enhances its economic use for ornamental and landscape purposes. However, to stimulate planting, whether in economic activity or in forest recomposition, it is necessary to develop methods and techniques related to seedling formation, including seed production, since the sexual pathway is the only mode of propagation of the species known to date.

The *C. gigantifolia* plant blooms from March to June, with ripe fruits (anthocarps) appearing in September, during the dry period, when they show a red, vinaceous, or purple color (Melo et al., 2019). From the collection of fruits with color ranging from 50% red to completely purple, it was found that the seeds of the species are recalcitrant, with marked loss of viability at moisture contents below 19.5%; in addition, it was observed that the reduction in the initial seed moisture content, from 49.3 to 25.2%, favored the percentage and speed of seedling emergence, probably due to overcoming of primary dormancy (Ferreira et al., 2021).

When obtaining *C. gigantifolia* seeds for propagation, it is difficulty to establish the ideal moment to harvest the racemes, which would provide a higher yield of viable seeds, capable of generating morphologically normal seedlings and, consequently, well-developed, and vigorous seedlings for planting. It is considered important to know the development process of fruits of native species, as this contributes to obtaining high-quality seeds (Barbosa et al., 2015). When harvest is carried out at an inadequate moment, there is a significant reduction in seed quality, besides resulting in quantitative losses (Barroso et al., 2022). In recalcitrant seeds, such as those of *C. gigantifolia* (Ferreira et al., 2021), which have shorter longevity due to their inability to tolerate water losses, this may be even more significant (Silva et al., 2018).

Morphological aspects of the plant, fruits and seeds are often important parameters for assessing the physiological maturity of seeds (Amaro et al., 2021). Changes in fruit and/or seed color are also excellent indicators of maturity for various species, usually when they reach maximum values of dry mass, germination and vigor (Bareke, 2018). In this context, the color of the fruits has been confirmed as a good indicator of the maturity of seeds of tree species, such as *Allophylus edulis* (A. St.-Hil., A. Juss. & Cambess.) Hieron. ex Niederl. (Kaiser et al., 2016), *Albizia hasslerii* (Chod.) Burkart (Ristau et al., 2020) and *Anadenanthera colubrina* (Vell.) Brenan (Cruz et al., 2021).

In *C. gigantifolia*, empirically, racemes are harvested when most of the fruits show a red to purple color, which highlights the heterogenous maturation of fruits in the racemes and, consequently, of seeds. In view of the above, the aim of this study was to characterize racemes, fruits and seeds of *C. gigantifolia*, after harvest, and evaluate the physiological performance of the seeds as a function of the maturation stage of the fruits.

MATERIAL AND METHODS

Origin, processing and characterization of racemes, fruits, and seeds

The anthocarps (fruit + perianth) of *C. gigantifolia* came from four racemes of a plant cultivated at the *Instituto Nacional de Pesquisas da Amazônia*, Campus III (3°5’33.12” S; 59°59’35.36” W), in Manaus, AM, Brazil, harvested at the same time. The climate of the region is Af type, with average annual temperature of 26.7 °C and average annual rainfall of 2,420 mm (Alvares et al., 2013).

In each raceme, the anthocarps were separated into stages according to the color of the perianth (Figure 1): green – completely green in color; half-green – green color, with small red spot, to half red and half green; red – red color, with small green spot, to completely red; purple – purple color, with small red spot, to completely purple. Then, the following evaluations were performed, hereinafter considering the anthocarp as a fruit unit: total fresh mass of fruits; fresh mass of one hundred fruits; total number of fruits; and percentage of fruits of each stage in the raceme, based on the total fresh mass and the number of fruits.

The extraction of the nucule (pericarp + seed) was manual, by friction of the fruits under running water. Then, the nucules were treated with sodium hypochlorite (0.5%) for 15 minutes and rinsed under running water in order to eliminate residues from the product. Then, considering the nucule as seed unit from this point on, the fresh mass of one hundred units, seed moisture content and seed dry mass were determined, the last of which by drying in an oven at 105 ± 3 °C, for 24 h (Brasil, 2009), using four replications of five seeds, for each combination of racemes and stages of fruit maturation. Subsequently, two experiments were set up, as described below:

Emergence as a function of raceme and fruit maturation stage

The experiment was in a completely randomized design, in a 4 (racemes) x 4 (fruit maturation stages) factorial scheme, with 4 replications of 25 seeds. Sowing was carried out in drained plastic boxes (60 x 40 x 8 cm), containing medium-texture vermiculite, kept in a greenhouse (minimum and maximum average temperatures of 26.1 ± 0.4 °C and of 37 ± 2.6 °C, respectively). Irrigation was performed whenever necessary, so as to keep the substrate moist. The seeds were placed in the substrate at a depth equal to their diameter.

Seedling emergence was evaluated every five days for 120 days. From these data, the emergence speed index was calculated (Ranal and Santana, 2006). The emergence values were transformed into arcsine $\sqrt{[(x+0.5)/100]}$, while those of emergence speed index were transformed into $\sqrt{(x+0.5)}$. In the presentation and discussion of the results, the means of the original data, without transformation, were used. The analysis of variance and means comparison of the data were performed in the ASSISTAT program version 7.7 (Silva and Azevedo, 2016).

Emergence as a function of fruit maturation and seed drying

The design used was randomized blocks, in a 4 (fruit maturation stages) x 2 (with and without seed drying) factorial scheme, with 4 replications of 25 seeds. The blocks corresponded to the four racemes harvested. Half of the seeds of

Figure 1. Raceme (left), fruits (anthocarps) at different maturation stages (in the center) and seeds (nucules) (right) of C. gigantifolia, harvested in Manaus, AM, Brazil. Photos: Cid Ferreira (left) and S. A. N. Ferreira (center and right).

each stage of fruit maturation were not subjected to drying, while the other half was dried in BOD chamber (temperature of 30 °C and relative humidity around 40%, in the absence of light), for 15 hours. The procedures from sowing to data analysis were similar to those of the previous experiment.

RESULTS AND DISCUSSION

In *C. gigantifolia*, the total fresh mass, fresh mass of one hundred units and total number of fruits differed according to raceme and maturation stage (Table 1). Considering all stages, the fresh mass of fruits per raceme ranged from 1,005 to 2,055 g, while the number of fruits per raceme varied between 1,656 and 2,900 units. In each raceme, the total fresh mass of fruits per stage was higher in the green stage, followed by the purple, red and half-green stages, except in raceme 2, which showed a higher proportion (50% of the total fresh mass and 44% of the number of fruits) corresponding to ripe fruits (purple color). Thus, the anthesis of raceme 2 may have occurred well earlier than that of the other racemes. In any case, the positive relationship between the variables number of fruits and total fresh mass of fruits was evident, because the increase in the number of fruits corresponded to the increase in the total fresh mass of fruits, both between the racemes and between the maturation stages in each raceme. The increase in the number of fruits per plant can also increase the fraction of dry matter allocated to fruits, at the expense of the growth of the vegetative parts of the plant (Andriolo and Falcão, 2000).

Table 1. Characteristics of racemes, fruits, and seeds of *C. gigantifolia* as a function of the maturation stage of the fruits, harvested in Manaus, AM, Brazil.

Raceme - Maturation	TFMF (g)	FMHF (g)	TNF (unit)	FSR (%)	FMHS (g)	SMC (%)	SDM (g.seed^{-1})
1 - GR	886.3	65.4	1,356	43 (49)	20.7	55.2	0.096
1 - HG	121.7	76.9	158	6 (6)	21.7	53.3	0.108
1 - RD	368.9	81.1	455	18 (17)	22.1	49.2	0.110
1 - PU	677.9	87.6	774	33 (28)	22.9	47.9	0.116
2 - GR	519.1	48.3	1,075	31 (37)	21.0	60.5	0.089
2 - HG	121.0	55.3	219	7 (7)	19.2	51.6	0.093
2 - RD	196.5	57.9	339	12 (12)	19.0	48.4	0.099
2 - PU	821.3	64.8	1,267	50 (44)	19.6	47.6	0.101
3 - GR	471.6	54.9	858	47 (52)	17.7	57.6	0.072
3 - HG	113.8	60.9	187	11 (11)	17.9	50.7	0.087
3 - RD	187.3	64.6	290	19 (17)	18.1	49.2	0.098
3 - PU	232.6	69.5	335	23 (20)	17.9	45.2	0.098
4 - GR	427.5	56.5	757	40 (46)	24.2[1]	53.1	0.104
4 - HG	118.7	64.8	183	11 (11)	21.6	43.4	0.116
4 - RD	131.3	68.3	192	12 (11)	22.0	45.0	0.124
4 - PU	390.0	74.4	524	37 (32)	22.2	43.7	0.122

Maturation stages: green (GR) – completely green color; half-green (HG) – green color, with small red spot, to half red and half green; red (RD) – red color, with small green spot, to completely red; purple (PU) – purple color, with small red spot, to completely purple. Characteristics: total fresh mass of fruits (TFMF); fresh mass of one hundred fruits (FMHF); total number of fruits (TNF); percentage of fruits of each stage in the raceme (FSR), based on the total fresh mass and number of fruits (value in parenthesis); fresh mass of one hundred seeds (FMHS); seed moisture content (SMC); seed dry mass (SDM). [1]Seed extraction was more difficult, resulting in permanence of perianth residues adhered to the seed (nucule).

When the *C. gigantifolia* racemes were harvested, they contained fruits at different maturation stages (Table 1 and Figure 1), ranging from unripe (completely green) to ripe (completely purple) at the same time, with distinct variation in the proportion for each stage between the racemes (green, 37 to 52%; half-green, 6 to 11%; red, 12 to 17%; and purple, 20 to 44%). Regarding the variations in the proportions of the stages between the racemes, it is suggested that these are due, in part, to the distinct moments of anthesis of the racemes, which was not measured in the present study. In palm trees, the occurrence of fruits and seeds at several maturation stages in the same plant hinders the determination of the best fruit maturation stage for the harvest of vigorous seeds (Zuffo et al., 2022).

Within each raceme of *C. gigantifolia*, it was observed that fruit maturation occurs progressively, advancing in the stages over time (from green to purple). At the end of maturation in the raceme, many of the fruits that matured first end up being consumed (or dispersed) by birds or fall to the ground after abscission. In this phase, it was possible to observe the presence of birds, such as the *Thraupis episcopus* L. (*Sanhaçu-da-amazônia* in Portuguese) and *Cacicus cela* L. (*Japiim* in Portuguese), consuming ripe fruits and possibly contributing to the dispersal of the seeds of this species. In *Coccoloba uvifera* L., ripe fruits also have purple color and seeds are dispersed by birds (Parrotta, 1994) and/or bats (Madriz and Ramírez, 1996/1997).

From the mass of one hundred fruits of *C. gigantifolia*, it was observed that the fresh mass of the fruits increased as maturation progressed, with different values for each raceme. The ripe fruit (completely purple) is about 0.5 to 0.8 cm long (Melo et al., 2019) and weighs around 0.7 to 0.9 g, with smaller dimensions and lower fresh mass than those of other species of the genus, such as *Coccoloba uvifera*, whose fruit measures around 2 cm in diameter and weighs about 4.8 g (Parrotta, 1994). In *Physalis peruviana* L., fresh mass also increased significantly during fruit maturation (Barroso et al., 2022). Fruit development occurs through cell division and expansion, probably regulated by hormones such as auxin and/or cytokinin and/or gibberellin (McAtee et al., 2013).

With the advance of the maturation stages of the *C. gigantifolia* fruits, the fresh mass of seeds did not always show the same trend of increase observed in the fresh mass of fruits. On the other hand, seed moisture content decreased with fruit maturation, also showing different values between the racemes: in green fruits, seed moisture contents ranged from 53.1 to 60.5%, while in purple fruits the values were between 43.7 and 47.9%. Seed dry mass, in turn, increased with the maturation of the fruits.

The reduction in moisture content during the maturation of the seeds is natural, even in recalcitrant seeds, such as those of *C. gigantifolia*, in which the reduction is less accentuated (Marcos-Filho, 2015). The moisture content, when associated with other indicators such as dry mass and color of fruits and seeds, has been considered to be among the important indices of the maturation process and physiological conditions of the seeds; normally, moisture content and dry mass are related, and at the point of maturity these parameters usually reach their minimum and maximum values, respectively (Barbosa et al., 2015).

Studies with other species, which have fleshy fruits, have similarly shown that seed moisture content remains high after maturity, even with significant reduction during fruit maturation, as in *Allophylus edulis* (Kaiser et al., 2016) and *Physalis peruviana* (Barroso et al., 2022). Ferreira et al. (2021), using *C. gigantifolia* fruits with color ranging from half red and half green to completely purple, recorded a seed moisture content of 49.3%, which was intermediate to the values found in the present study.

The seed of the ripe fruit of *C. gigantifolia* weighed about 0.2 g, with moisture content around 44 to 48%, and approximately 5,000 fresh seeds.kg^{-1}. In *Coccoloba uvifera*, the seed weighs between 0.7 and 1.0 g, with moisture content of 38 and 47%, respectively, and about 1,040 to 1,400 fresh seeds.kg^{-1} (Parrotta, 1994).

The emergence of *C. gigantifolia* seedlings showed an effect of interaction between the factors “racemes” and “fruit maturation stages”, that is, for each raceme the behavior was different between the levels of the fruit maturation stage factor (Figure 2). In general, the means of emergence for seeds from green fruits were extremely low (1 to 6%). On the other hand, although with wide variation between the racemes, seeds from half-green and red fruits had the highest values of seedling emergence (3 to 82% and 16 to 69%, respectively). Finally, except for raceme 1, seeds from

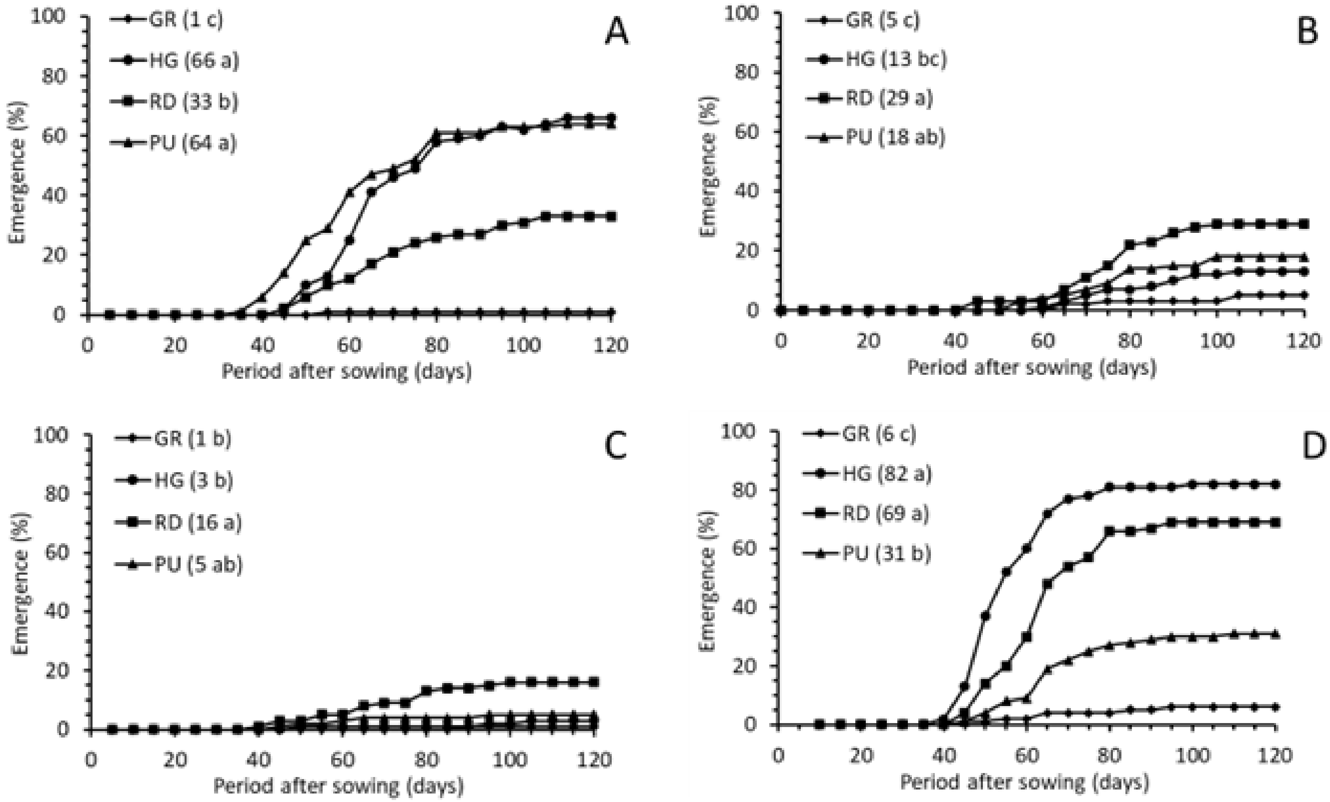

Figure 2. Cumulative emergence of C. *gigantifolia* as a function of raceme (raceme 1 - figure 2A, raceme 2 - figure 2B, raceme 3 - figure 2C and raceme 4 - figure 2D) and maturation stage of fruits (GR - green, HG – Half-green, RD - red and PU - purple), harvested in Manaus, AM, Brazil. Final means of emergence (%) followed by the same letter, within each raceme, did not differ significantly by the Tukey test at 5% probability level. Coefficient of variation (%) = 23.2; F test of Raceme x Maturation interaction = 14.9** (significant at 1% probability level).

purple fruits showed lower values of seedling emergence (5 to 64%), compared to the results of the previous stage (red). This was likely due to primary dormancy, considered as a germination inhibition mechanism that occurs during seed maturation, which may be associated with increased abscisic acid (McAtee et al., 2013), and which is still poorly understood from the genetic and molecular point of view (Chahtane et al., 2017). This type of dormancy has already been reported for *C. gigantifolia* seeds, and germination has been favored with seed desiccation for one day, increasing from 35 to 58% emergence (Ferreira et al., 2021). In *Coccoloba uvifera* seeds, germination can reach between 60 and 88%, during the period from 18 to 50 days (Parrotta, 1994). The distinct behavior of raceme 1, with no reduction of emergence or presence of dormancy in seeds from ripe fruits (purple), may be due to the genetic variability of the species, as observed among different progenies of *Solanum sessiliflorum* Dunal (Batista et al., 2020).

During the emergence test, the seedlings were infected by the fungus *Ceratobasidium* sp., regardless of raceme and stage of fruit maturation, and the symptoms were manifested around 50 days after sowing and lasted for more 70 days, until the end of the experiment. The symptoms were characterized by initial wilting and dryness of the ends of cotyledonary leaves, advancing through the petiole and the hypocotyl, until reaching the root system. In all, 27% of emerged seedlings were compromised, which eventually died with the progression of the disease. There are reports stating that several species occurring in the Amazon are host of *Ceratobasidium* spp. and that high temperature and humidity favor the occurrence and dissemination of this pathogen (Melo et al., 2018).

Regardless of raceme and maturation stage, the mean times for the beginning and end of the emergence period of *C. gigantifolia* seedlings were 54.2 ± 13.3 days and 90.5 ± 19.4 days, respectively (Figure 2). Particularizing, and with respect to the beginning of the emergence, seeds from raceme 1 had the shortest mean time (47.3 ± 6.7 days) and those from raceme 3 had the longest mean time (61.8 ± 21.5 days); on the other hand, raceme 3 showed the shortest time (79.1 ± 24.2 days) and raceme 2 showed the longest time (96.9 ± 17.0 days) for the end of seedling emergence. It is worth noting that raceme 3, whose seeds took longer to start and less time to end seedling emergence, was also the one with the lowest emergence value for all stages of fruit maturation, consequently having lower sampling in relation to the initial and final times of seedling emergence. As observed for emergence, the times for the beginning and end of this process also seem to be influenced by the different degrees of dormancy between the racemes, already reported previously, so further investigations are needed to confirm or reject this hypothesis.

The emergence speed index also showed a significant effect of interaction between the factors (racemes x fruit maturation stages), with behavior similar to that observed for the emergence of *C. gigantifolia* seedlings (Table 2). Regardless of raceme, the values of the emergence speed index were extremely low in seeds from green fruits, more pronounced in seeds from fruits in the intermediate stages of maturation (half-green and red), and, except for raceme 1, were lower in seeds from purple fruits, when compared to those of the previous maturation stage (red). As mentioned above, the distinct behavior of raceme 1 may be due to the genetic variability of the species, manifested among the studied racemes.

The high seed moisture content (53.1 to 60.5%; Table 1), the low percentage of emergence (1 to 6%; Figure 2) and the lowest seedling emergence speed index (0.011 to 0.094% day^{-1}; Table 2), referring to green fruits, indicate that the low vigor of seeds at this stage was due to physiological immaturity, as observed in *Allophylus edulis* (Kaiser et al., 2016), *Dovyalis hebecarpa* (Gardner) Warb. (Villa et al., 2019), *Albizia hasslerii* (Ristau et al., 2020), *Anadenanthera colubrina* (Cruz et al., 2021) and *Physalis peruviana* (Barroso et al., 2022).

The external color of *C. gigantifolia* fruits proved to be a good indicator to determine the harvest point. Therefore, when obtaining seeds for propagation, it is necessary to harvest the racemes when they have a smaller number of green fruits and a higher percentage of half-green, red and purple fruits, although the seeds from the latter do not have the same behavior as that of the intermediate stages, but they stand out when compared to seeds from green fruits. Moreover, it is not recommended to wait until most of the fruits in the raceme are completely ripe (purple color), as this would increase the chances of these fruits being consumed (or dispersed) by birds or falling to the ground after abscission.

Emergence and seedling emergence speed index showed significant differences between the levels of the factors "fruit maturation" and "seed drying", and no effect of interaction between the factors was detected (Table 3). Both for emergence and for emergence speed index, the results of seeds from half-green and purple fruits were higher and did not differ from each other but were significantly higher than those of seeds from green fruits.

Table 2. Emergence speed index (% day^{-1}), referring to seeds of *C. gigantifolia* as a function of raceme and the maturation stage of the fruits, harvested in Manaus, AM, Brazil.

Maturation stage (M)	Raceme (R)				
	1	2	3	4	Mean
Green	0.018 aC	0.063 aC	0.011 aB	0.094 aD	0.047 C
Half-green	1.011 bA	0.167 cBC	0.040 cB	1.497 aA	0.679 A
Red	0.502 bB	0.402 bcA	0.249 cA	1.112 aB	0.566 AB
Purple	1.128 aA	0.245 cAB	0.085 cAB	0.476 bC	0.484 B
Mean	0.665 b	0.219 c	0.096 d	0.795 a	-
CV (%) = 6.3; F test (R) = 121.8**; F test (M) = 90.4**; F test (RxM) = 30.2**					

** significant at 1% probability level by the F test; means followed by the same uppercase letter in the columns and the same lowercase letter in the rows do not differ significantly by Tukey test, at 5% probability level. CV: coefficient of variation.

Table 3. Emergence and emergence speed index, referring to seeds from *C. gigantifolia* fruits at different maturation stages, without and with seed drying, harvested in Manaus, AM, Brazil.

	Fruit maturation (M)			
	Green	Half-green	Red	Purple
	7.5 b	42.0 a	41.5 a	38.0 a
	Seed drying (D)			
Emergence (%)	Without		With	
	26.0 b		38.5 a	
	Block/Raceme (B)			
	1	2	3	4
	42.5 ab	22.0 bc	6.0 c	58.5 a
CV (%) = 38.8	F test (M) = 8.9**	F test (D) = 4.8*	F test (MxD) = 0.1^{ns}	F test (B) = 14.7**
	Fruit maturation (M)			
	Green	Half-green	Red	Purple
	0.124 b	0.735 a	0.716 a	0.664 a
	Seed drying (D)			
Emergence speed index (% day^{-1})	Without		With	
	0.410 b		0.709 a	
	Block/Raceme (B)			
	1	2	3	4
	0.710 ab	0.354 bc	0.103 c	1.072 a
CV (%) = 14.8	F test (M) = 7.6**	F test (D) = 7.5*	F test (MxD) = 0.3^{ns}	F test (B) = 14.6**

* and **: significant at 5 and 1% probability levels by the F test, respectively. ^{ns}: not significant at 5% probability level by the F test. Means followed by the same letter in the rows do not differ significantly by the Tukey test, at 5% probability level. CV: coefficient of variation.

Regardless of fruit maturation stage, fresh seeds contained about 50.1 ± 4.9% of water, which decreased to 32.8 ± 2.8% after drying, corresponding to a reduction equivalent to 34.5% of the initial moisture content. For the "seed drying" factor, seeds that had a reduction in moisture content showed better performance, both in relation to emergence and seedling emergence speed index (Table 3). Therefore, seeds subjected to drying showed an increase in emergence of approximately 48% compared to fresh seeds. Similar and more pronounced behavior was reported by Ferreira et al. (2021), who observed that the reduction of moisture content in *C. gigantifolia* seeds from 49.3% to 25.2% resulted in a 66% increase in emergence, from 35% to 58% of emerged seedlings. It is worth noting that *C. gigantifolia* seeds are considered recalcitrant, or sensitive to water loss (Ferreira et al., 2021), but, despite that, they tolerate a certain degree of desiccation, with benefits on germination. In *Sorghum bicolor* (L.) Moench seeds, a beneficial effect of seed drying was also observed, which favored the overcoming of dormancy and increased the germination of this species (Almeida et al., 2016). In *C. gigantifolia*, it is still necessary to investigate the tolerance to desiccation as a function of the maturation stage of fruits/seeds, associated with storage conditions, as well as the causes of dormancy in the seeds.

In the present experiment, considering that the blocks were represented by the racemes, it was found that the results of emergence and emergence speed index obtained in seeds from racemes 1 and 4 were similar to each other and significantly higher than those of the others, and seeds from raceme 2 led to more favorable results than those from raceme 3, of poorer performance (Table 3). Thus, ratifying the results observed in the previous experiment (Figure 2; Table 2), the existence of differences in the germination potential of seeds from different racemes of the same plant and produced at the same time has been proven. According to Barbosa et al. (2015), in forest species there can be great diversity regarding the development of the seed maturation process in plants.

CONCLUSIONS

The maturation of *C. gigantifolia* fruits occurs progressively within each raceme, with fruits ranging from completely green (unripe) to completely purple (ripe) in color existing at the same time.

C. gigantifolia seeds from green fruits have low physiological quality. Thus, when obtaining seeds for propagation of this species, preference should be given to harvesting racemes with a higher number of fruits in the half-green, red, and purple stages.

C. gigantifolia seeds, besides having variation in emergence as a function of fruit maturation, also showed different behavior in relation to racemes, which seems to be associated with different dormancy levels.

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