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Articles

Seed quality parameters for selection of *Handroanthus serratifolius* (Vahl) S. Grose mother trees in western Amazonia

Parâmetros de qualidade de sementes para escolha de matrizes de *Handroanthus serratifolius* (Vahl) S. Grose na Amazônia Ocidental

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ABSTRACT

Handroanthus serratifolius is recognized for its timber potential and for planting in urban areas. However, its indiscriminate exploitation threatens the species with extinction. Our objective was to standardize the most representative parameters of quality for the species, which are necessary for the identification of vigor in seedlots. We sought to optimize seed production and minimize losses of genetic material and indicate the best technological, morphological and biometric variables and their correlation with the mother trees. For this, seedlots were collected from 20 mother trees identified in seed collection areas. For each batch, the physical, morphological, dendrometric and technological characteristics of the seeds were analyzed. Via the correlation matrix, it was observed that the dendrometric characteristics did not influence the characteristics of seed vigor. Among the variables analyzed, the weight of one thousand seeds (WTS) correlated with biometric characteristics and seedling formation. Therefore, WTS and biometric characteristics were the variables that best explained the behavior of the population. The repeatability coefficient demonstrated that 14 seeds are sufficient to characterize the biometric characteristics of a seedlot of *H. serratifolius.* Variability was observed within the population, with eight parent trees presenting superior characteristics for vigor and five presented a high value (> 58%) for seedling emergence.

Keywords: Mother tree; Seed vigor; Biometric characteristics

RESUMO

Handroanthus serratifolius é reconhecida pelo potencial madeireiro e na arborização urbana. No entanto, sua exploração indiscriminada tem ameaçado a espécie para risco de extinção. Nosso objetivo foi padronizar os parâmetros mais representativos de qualidade para espécie, os quais são determinantes para o processo de identificação de lotes de sementes vigorosos. Buscamos otimizar a produção de sementes e minimizar perdas de material genético, indicar as melhores variáveis tecnológicas, morfológicas e biométricas e sua correlação com as matrizes. Para isso, os lotes de sementes foram coletados de 20 matrizes identificadas por Áreas de Coletas de Sementes. Para cada lote, foram analisadas as características físicas, morfológicas, dendrométricas e tecnológicas das sementes. Através da matriz de correlação, foi observado que as características dendrométricas não influenciaram nas características de vigor das sementes. Dentre as variáveis analisadas, o peso de mil sementes (PMS) apresentou correlação com as características biométricas e com a formação de plântulas. Sendo, portanto, o PMS e as características biométricas as variáveis que melhor explicaram o comportamento da população. O coeficiente de repetibilidade demonstrou que 14 sementes são suficientes para determinar as características biométricas de um lote de *H. serratifolius*. Houve variabilidade dentro da população, com oito árvores matrizes apresentando características superiores de vigor e cinco apresentaram alto valor (> 58%) para emergência de plântula.

Palavras-chaves: Árvore matriz; Vigor de sementes; Características biométricas

1 INTRODUCTION

Deforestation, global warming and greenhouse gas emissions have always been correlated with the increase in degraded areas, which have had their regenerative process impaired and depend on assistence to resume their forest dynamics (Lima *et al*., 2022). The loss of biodiversity can be mitigated via the recovery of these areas and the restitution of biological diversity through reforestation. However, according to the Brazilian Tree Industry report (2022), the total area planted in Brazil in 2021 was 9.93 million hectares. Of these, about 9.46 million hectares are dedicated to pine and eucalyptus species, which leaves a small proportion of native species.

The Amazon has a biodiversity of around 16,000 tree species (Ter Steege *et al*., 2013), which creates infinite possibilities for increasing biodiversity through reforestation programs. Faced with this challenge, one of the important aspects is to evaluate the quality of the genetic material, and seeds stand out as the main form of propagation of tree species. In addition, the selection of mother trees of high quality and variability favors productive plantations, which ensures success in their establishment (Roveri; Paula, 2017).

Most phenotypic and genotypic characteristics are hereditary; thus, the marking and monitoring of mother trees, so as to ensure the transfer of superior characteristics to their offspring, are essential (Capucho *et al*., 2021). In addition to the dendrometric and dendrological characteristics, the selection of mother trees must take into account the physical and physiological quality of the seeds produced by these individuals. These characteristics can be verified through germination tests, the weight of a thousand seeds, biometrics, and seedling formation, among others.

Handroanthus serratifolius (Vahl) S. Grose is a tree of the Bignoniaceae family that is commonly known in Brazil as ipê-amarelo and occurs throughout Brazil (Lohmann, 2020). According to the Brazilian Biodiversity Information System (SiBBr), it is recognized for its timber potential, as well as for planting in urban areas. However, its indiscriminate exploitation threatens the species with extinction.

In this scenario, the objective of this study was to determine characteristics that demonstrate the most vigorous seedlots of 20 individuals of *Handroanthus serratifolius* that belong to a natural population in the western Amazon. This information is intended to optimize production and minimize losses of genetic material, in addition to indicating the best technological and biometric variables of the seeds and their correlation with the mother trees.

2 MATERIALS AND METHODS

2.1 Origin of genetic material – mother trees

The seedlots used come from 20 trees in a seed collection area that was implemented by the Santa Luzia Forest Nursery, located in the municipality of Apuí, in the state of Amazonas, Brazil. The local climate is of type Am and is characterized by being warm and temperate, in addition to having an average annual rainfall of

1,500 mm (Köppen; Geiger, 1928). The mother trees were identified via the following dendrometric characteristics: diameter breast height (DBH), commercial height (Hm), crown height (Hc), crown diameter (Dc) and characteristics of the environment. Then, the seeds of the 20 trees were homogenized and transported to the Amazonas State Center for Native Seeds (CSNAM) at the Federal University of Amazonas where they were placed in plastic trays on a bench at the CSNAM laboratory for 48 hours in order to standardize their degree of humidity.

2.2 Evaluation of the technological parameters

Initially, before the start of the experiments, the moisture content (MC) of the seeds was determined, which was expressed as a percentage of the average values of two repetitions of 30 winged seeds, using the oven-drying method at 105 ^{o}C for 24 hours (Brasil, 2009). The biometrics of the seeds were determined from 30 units, selected at random, whose measurements of length, width and thickness were measured with the aid of a digital caliper (0.01 mm accuracy). In this study, the length of the seed was considered the dimension between the ends of the wings, i.e., the largest dimensional portion of the seed. The individual weighing of the fresh mass of the seeds was carried out on an electronic scale (0.001 g accuracy).

The weight of one thousand seeds (WTS) was determined via eight weighings (r=8) of 100 seeds and validated by the calculations of variance, standard deviation and coefficient of variation (Brasil, 2009), considering the seeds of *H. serratifolius* with wings, with a coefficient set at 6% variation (Brasil, 2013). All the physical tests were performed with seeds with wings.

The germination test, according to the Rules of Seed Analysis (Brasil, 2013), took place in a BOD-type germination chamber with a constant temperature of 30°C and a photoperiod of 12 hours of light and 12 hours of dark in four repetitions of 25 seeds, which were arranged in rolls of germitest paper previously sterilized for 12 hours in a oven at 40°C. The evaluations were performed daily and lasted for 25 days, using the protrusion of the primary root and the formation of normal seedling as the germination criterion. During the test, the seeds were moistened with distilled water, when necessary.

2.3 Data analysis

A completely randomized design (CRD) was used with 20 treatments (mother trees), each with four replications of 25 seeds. The germination percentages (G%), normal seedling (NS) formation, mean germination time (MGT) and mean emergence time (MET) were analyzed using the equation proposed by Edwards (1934); and the germination velocity index (GVI) and emergence velocity index (EVI) using the Maguire equation (1962).

The Shapiro Wilk normality test was performed with a 1% significance level (W= 0.868) to demonstrate the relevance of the sampling effort. Next, a Pearson correlation was performed between the technological parameters associated with seeds with the dendrometric characteristics of the mother trees, tested at a significance level of 5%. Using the technological parameters, these were submitted to an analysis of variance with comparison of means via the Scott Knott test with a probability of 5% (T= 2.045). The analyses were performed in the statistical program RStudio. The analysis of the principal components to determine the most relevant parameters for the characterization of the species was performed using the statistical program Past 4.13.

2.4 Optimization of the biometric characters

The repeatability coefficient was estimated according to the biometric characters of the seeds, based on principal components and matrices of phenotypic variances and covariances. The minimum number of measurements necessary to predict the true value of genotypes was evaluated based on a coefficient of determination of 95%, as described in Valente *et al*. (2017). These analyses were performed using the genetics and statistics computational program GENES version 6.1

3 RESULTS AND DISCUSSIONS

3.1 Physical characteristics of the seedlots assessed

The dendrometric values of the mother trees observed in this study fall into the category of medium canopy, according to the intervals found by Azevedo *et al*. (2008) for *Handroanthus serratifolius*. The evaluated mother trees reached a DBH of 13.0 to 64.0 cm, a commercial height ranging between 6.0 and 20.0 m, and a crown diameter of 4.0 to 9.0 m (Table 1).

Table 1 – Dendrometric characteristics of 20 mother trees of *H. serratifolius* located in Apuí (Amazonas)

ID	DBH (cm)	Commercial height (m)	Crown height (m)	Crown diameter (m)
1	25.5	8.0	5.0	4.0
2	20.7	8.0	5.0	6.0
3	38.2	18.0	8.0	8.0
4	46.2	12.0	10.0	6.0
5	41.4	15.0	10.0	7.0
6	32.5	13.0	7.0	6.0
7	19.7	6.0	4.0	4.0
8	22.3	7.0	5.0	5.0
9	28.6	9.0	5.0	6.0
10	28.6	10.0	5.0	5.0
11	43.0	15.0	6.0	7.0
12	63.7	20.0	10.0	9.0
13	22.3	8.0	5.0	5.0
14	30.2	10.0	5.0	6.0
15	25.5	10.0	6.0	5.0
16	12.7	8.0	3.0	4.0
17	47.7	20.0	12.0	8.0
18	46.2	20.0	12.0	7.0
19	36.6	17.0	5.0	6.0
20	33.4	20.0	5.0	7.0
Average	33.2	12.7	6.7	6.1
Max	63.7	20.0	12.0	9.0
Min	12.7	6.0	3.0	4.0
SD	12.4	4.9	2.7	1.39
CV (%)	36.8	39.3	40.6	23.1

Source: Authors (2020)
In where: DBH = diameter at breast height; Max = Maximum; Min = minimum; SD = standard deviation; CV = coefficient of variation.

The knowledge of the dendrometric characteristics of the mother trees is important when defining the desirable standards in future trees of different species, i.e., they produce high quality seeds, whether for conservation, genetic improvement or restoration initiatives. Mother trees with good dendrometric characteristics must be conserved to produce superior quality seeds and maintain population diversity *(Felix et al*., 2021).

It is known that the moisture content (MC) of the seed is the factor that controls all metabolic activities and, therefore, becomes the most important factor for maintaining seed viability during storage; storage is understood to be all post-harvest stages. According to the study conducted by Gonçalves *et al*. (2015), the seeds of *H. serratifolius* are tolerant to drying to 5% moisture, with a high germination rate; however, slow drying compromises the quality of the seeds.

It is observed that the lack of monitoring of the seeds of the different batches, from the time of collection to the beginning of the experiments, interfered in the initial MC of the seeds of this study, justifying the homogenization of the batches (Table 2). When not properly dried and not kept in hygroscopic equilibrium, orthodox seeds quickly lose viability by increasing the level (state) of deterioration (Marcos-Filho, 2015).

Table 2 – Technological parameters of seedlots of 20 *H. serratifloius* mother trees located in Apuí (Amazonas)

ID	MC* (%)	WTS (g)	Length (mm)	Width (mm)	Thickness (mm)	Weight (mg)
1	10.12	12.943 h	20.6663 f	6.0513 g	0.3760 f	11.90 e
2	9.79	12.373 h	24.8453 e	7.9230 d	0.3383 f	12.60 e
3	8.27	13.749 h	27.0540 d	7.2643 f	0.4510 f	14.30 e
4	8.05	43.752 e	35.5097 a	7.9350 d	0.8457 d	46.40 c
5	10.84	8.820 j	25.3460 e	8.0167 d	0.2907 g	11.90 e
6	9.33	3.280 l	25.1950 e	7.0870 f	0.1673 g	7.10 e
7	10.35	55.058 c	35.3713 a	9.0227 c	1.3240 a	60.30 b
8	10.18	39.128 f	20.6230 f	7.6560 e	0.4353 f	14.40 e
9	8.79	28.494 g	31.9230 c	7.9243 d	0.8357 d	32.90 d
10	9.62	13.584 h	33.9040 b	8.9710 c	0.9210 c	32.80 d
11	9.87	6.2200 k	25.0767 e	7.5077 e	0.2500 g	7.50 e
12	9.92	8.8950 j	28.7250 d	7.6250 e	0.4443 f	18.00 e

To be continued ...

Table 2 – Conclusion

ID	MC* (%)	WTS (g)	Length (mm)	Width (mm)	Thickness (mm)	Weight (mg)
13	10.85	42.244 e	37.5183 a	10.6613 a	0.6857 e	43.20 c
14	9.69	58.043 b	34.2937 b	9.6017 b	0.6857 e	64.70 b
15	9.86	46.954 d	36.4407 a	7.9470 d	0.9350 c	50.10 c
16	9.53	38.944 f	35.7740 a	9.3617 b	0.9500 c	47.90 c
17	10.71	11.448 i	24.7063 e	7.2314 f	0.3637 f	14.30 e
18	10.03	11.070 i	17.6650 g	8.1440 d	0.4283 f	9.90 e
19	7.03	64.224 a	34.7413 b	9.2360 b	1.1430 b	74.40 a
20	8.21	56.129 c	34.5777 b	8.7603 c	1.1160 b	56.60 b
Mean	9.55	28.768	29.4978	8.1963	0.6493	31.56
Max	10.85	64.220	37.5200	10.6600	1.3200	74.40
Mín	7.03	3.280	17.6700	6.0500	0.1700	7.10
SD	1.01	20.5724	6.1874	1.0546	0.3393	22.0159
CV (%)	10.6	71.5	21.0	12.9	52.3	69.8

Source: Authors (2020)

In where: MC= moisture content; WTS= weight of a thousand seeds; Max = Maximum; Min = minimum; SD = standard deviation; CV = coefficient of variation. Length, width and thickness measured in millimeters. (*) = homogenized variable not requiring a comparison of means. Different letters in the column indicate that there was a statistical difference between treatments according to the Scott Knott test ($p<0.05$).

Regarding the physical characteristics of the seeds, the weight of one thousand seeds (WTS) presented the greatest variation, from 3.3 to 64.2 g, with a mean of 28.8 g. In ascending order, the seedlots from trees 19, 14 and 20 presented the highest values, and seedlots 6, 11 and 5 the lowest values. The WTS value for the species associated with the name ipê-amarelo is scarce and, in addition, there is a large variation in the mean of this variable. In the studies of Leão *et al*. (2015), the mean value for WTS of 33.7 g was observed and Lima Júnior (2016) cites 7.2 g. Some characteristics inherent to the species may have contributed to this great variation, such as polyembryony, aborted seeds (without embryo), as well as loss of part of the wing during seed handling. Other factors related to seed production that can influence the value of WTS in native species are the stage of maturation of the fruits and seeds, position of the seed in the fruit and age of the individual, as observed in *Mimosa scrabella* (Menegatti; Montavani; Navroski, 2019).

The biometric characteristics of the seeds showed little variation between the lots, ranging from 17.6 to 37.5 mm in length, 6.1 to 10.7 mm in width, 0.17 to 1.32 mm in thickness and 7.10 to 74.40 mg in weight. Tree 13 produced the seeds with the highest values for length and width, and trees 7 and 19 the highest values for thickness and weight, respectively. Tree 18 presented the lowest value in relation to length, tree 1 the smallest width, tree 6 the smallest thickness and the lowest weight. The biometric characterization of seeds, even though it is easy to perform, is still little explored in the evaluation of seedlots of native species. Guollo, Menegatti *et al*. (2016) state that the biometric characteristics of the seeds help in the identification of genetic variation between individuals. Therefore, seed biometrics is an important physical characteristic in the evaluation of lots from different trees in the same population.

The morphological characteristics of the seeds of the species of the genus *Handroanthus* influence the way one measures the biometric parameters, especially for length and width. For *H. serratifolius*, Leão *et al*. (2015) found values for seed length of 8.5 mm, width of 24.79 mm and thickness of 1.34 mm.

The germination percentage (G%), over 60%, occurred in the lots from trees 1, 2, 3, 4, 8, 10, 14, 17, 19 and 20, representing 50% of the lots (Table 3). However, among these lots, there was no formation of normal seedlings (NS%). In trees 1, 2, 3, 10 and 17, WTS was the limiting factor for seedling formation, since only seeds with values over 39 g managed to reach the seedling stage (4, 8, 14, 19 and 20). Despite this, the lots with a low germination percentage, lots 7, 13 and 15, achieved seedling formation because their WTS exceeded the limiting value.

Table 3 – Technological parameters of seedlots of 20 maother trees of *Handroanthus serratifolius* located in Apuí (Amazonas)

ID	G(%)	GVI	MGT (days)	NP (%)	EVI	MET (days)
1	86 a	6.20 a	3.8 a	00 b	0.00 d	0.00 d
2	72 a	5.76 a	3.5 a	00 b	0.00 d	0.00 d
3	78 a	6.66 a	3.2 a	00 b	0.00 d	0.00 d
4	63 b	4.64 b	3.6 a	58 a	1.64 b	8.97 a

To be continued ...

Table 3 – Conclusion

ID	G(%)	GVI	MGT (days)	NP (%)	EVI	MET (days)
5	53 c	2.61 d	5.2 b	00 b	0.00 d	0.00 d
6	00 g	0.00 e	0.0 c	00 b	0.00 d	0.00 d
7	27 d	1.02 e	6.7 b	26 a	0.51 c	13.41 b
8	74 a	4.32 b	4.5 a	71 a	1.66 b	10.89 a
9	06 e	0.16 e	7.9 b	02 b	0.03 d	10.00 a
10	80 a	5.92 a	3.8 a	00 b	0.00 d	0.00 d
11	03 e	0.09 e	6.5 b	00 b	0.00 d	0.00 d
12	50 c	3.71 b	3.6 a	00 b	0.00 d	0.00 d
13	14 e	0.28 e	7.8 b	11 a	0.10 d	19.63 c
14	82 a	5.48 a	3.8 a	82 a	2.21 a	9.49 a
15	15 e	0.48 e	8.4 b	11 a	0.12 d	16.83 c
16	00 g	0.00 e	0.0 c	00 b	0.00 d	0.00 d
17	66 b	3.82 c	4.9 a	00 b	0.00 d	0.00 d
18	47 c	3.45 b	3.6 a	00 b	0.00 d	0.00 d
19	85 a	3.26 b	6.8 b	82 a	1.53 b	13.83 b
20	88 a	3.55 b	6.6 b	85 a	1.64 b	10.66 a
Mean	49	3.07	4.7	21	0.47	5.68
Max	88	6.66	8.4	82	2.21	19.63
Mín	00	00	00	00	00	00
SD	32.74	2.34	2.33	33.12	0.77	6.87
CV (%)	66.2	76.3	49.4	154.8	162.6	120.8

Source: Authors (2020)

In where: G = germination; GVI = germination velocity index; MGT = mean germination time; NS = normal seedling formation; EVI= emergence velocity index; MET= mean emergence time; Max = Maximum; Min = minimum; SD = standard deviation; CV = coefficient of variation. G and NS are shown as a percentage; MGT and MET are shown in days.

Germination is the only direct way to evaluate the viability of a seedlot (Haesbaert *et al*., 2017). But the GVI is the variable that best demonstrates the vigor of a seedlot, since its variation explains germination along with the time related to this germination process, and is an efficient test to project the success of new seedlings (Vieira; Carvalho, 1994).

The Ministry of Agriculture, Livestock and Supply (MAPA) has recommendations for the species with regard to the germination test, indicating 8 repetitions with 50 seeds, and these can be distributed in different substrates such as sand, paper roll and on vermiculite, at a temperature between 25 to 30 °C, whereby such seeds germinate between 14 and 28 days (Brasil, 2013). For Lima Júnior (2016), the processes involving the production of seeds and seedlings of *H. serratifolius* are well-known and easy to perform, but they do need careful monitoring. Since it is a species that has a dehiscent fruit and the parameters for the recognition of the maturation point are fundamental for the optimal harvesting time, this will reflect on the peak of the viability and vigor of the individuals (Justino *et al*., 2015).

3.2 Demonstration of patterns of viability

The variables that behaved outside of normality were canopy height, emergence, EVI and MGT, demonstrating that the sampling effort of 20 individuals was not sufficient to represent the population (Table 4).

Table 4 – W values per variable and their respective p-values according to the Shapiro-Wilk test

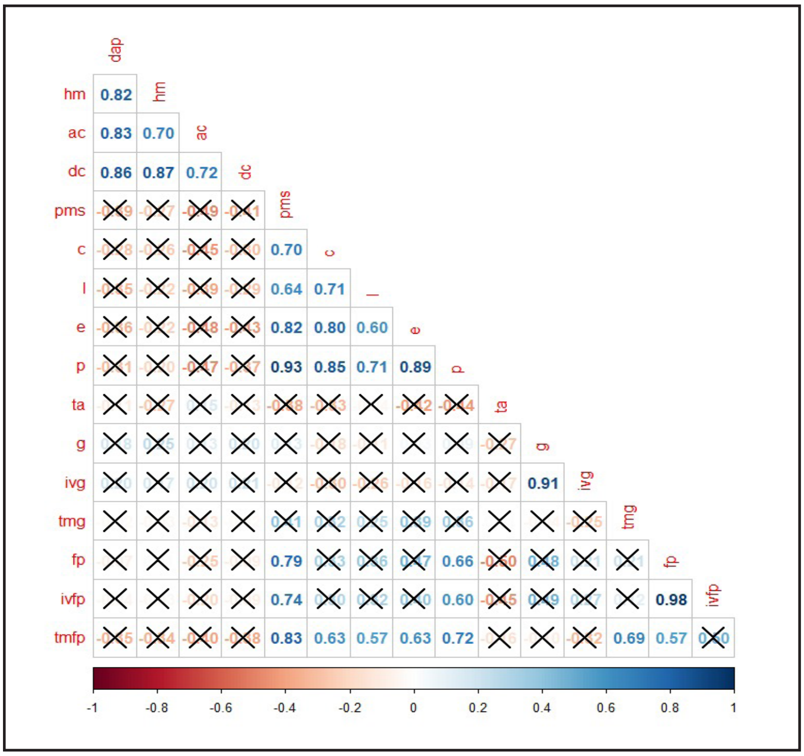
	DBH	**Hm**	**Hc**	**Dc**	**WTS**	**L**	**Wi**	**Th**
W calc	0.9635	0.8801	0.8286	0.9422	0.8728	0.9003	0.9642	0.9305
p-value	0.616	0.018	0.002	0.264	0.013	0.042	0.632	0.158
	We	**MC**	**G**	**GVI**	**MGT**	**NS**	**EVI**	**MET**
W calc	0.8780	0.8691	0.8691	0.8975	0.9234	0.6637	0.646	0.7760
p-value	0.016	0.064	0.011	0.037	0.116	< .001	< .001	< .001

Source: Authors (2023)

In where: L = length, DBH = diameter at breast height, Dc = crown diameter, Th = thickness, NS = normal seedling formation, G = germination percentage, Hc = crown height, Hm = commercial height, GVI = germination velocity index, EVI = emergence velocity index, W = width, WT = weight, WTS = weight of a thousand seeds, MGT = mean germination time, MET = mean emergence time.

It is understood that even a strong correlation between the dendrometric characteristics does not guarantee dependence between the variables but demonstrates proportional growth of the inherent characteristics of the tree (Figure 1). The uniform growth pattern in the formation of individuals and the characteristics of the mother tree do not interfere with the success of the germination process and the formation of seedlings.

Figure 1 – Correlation matrix tested at a significance level of 5%



Source: Authors (2023)

In where: Hm = commercial height, Hc = crown height, Dc = crown diameter, WTS = weight of a thousand seeds, L = length, Wi = width, Th = thickness, We = weight, MC = moiture content, G = germination, GVI = germination velocity index, MGT = mean germination time, NS = normal seedling formation, EVI = emergence velocity index, MET = mean emergence time. (X) = indicates p-values below the significance level.

The WTS was the variable that presented the highest number of significant correlations, with emphasis on the variables that indicate seedling formation, in addition to the strong link with biometric variables. In the germinal characteristics, the variable did not present any significant correlation.

The nutritional reserve is directly related to the seed size, as well as to the process of seedling formation, and larger seeds have high seedling growth rates, with better use in the formation of seedlings, as they have better use of their nutritional reserves, which reflects in a rapid growth of roots and leaves (Lucena *et al*., 2017).

The relationship between the biometric variables is evident in the homogeneous and proportional development that occurs in the maturation process with the formation of fruits and seeds. Dias (2001) explains that, at the beginning of the process of photosynthesis, the seed receives products that are invested in the formation of new cells, tissues and nutritional reserve, which promotes an increase in seed mass and size, and this process only ends when there is a natural shutdown of the mother plant.

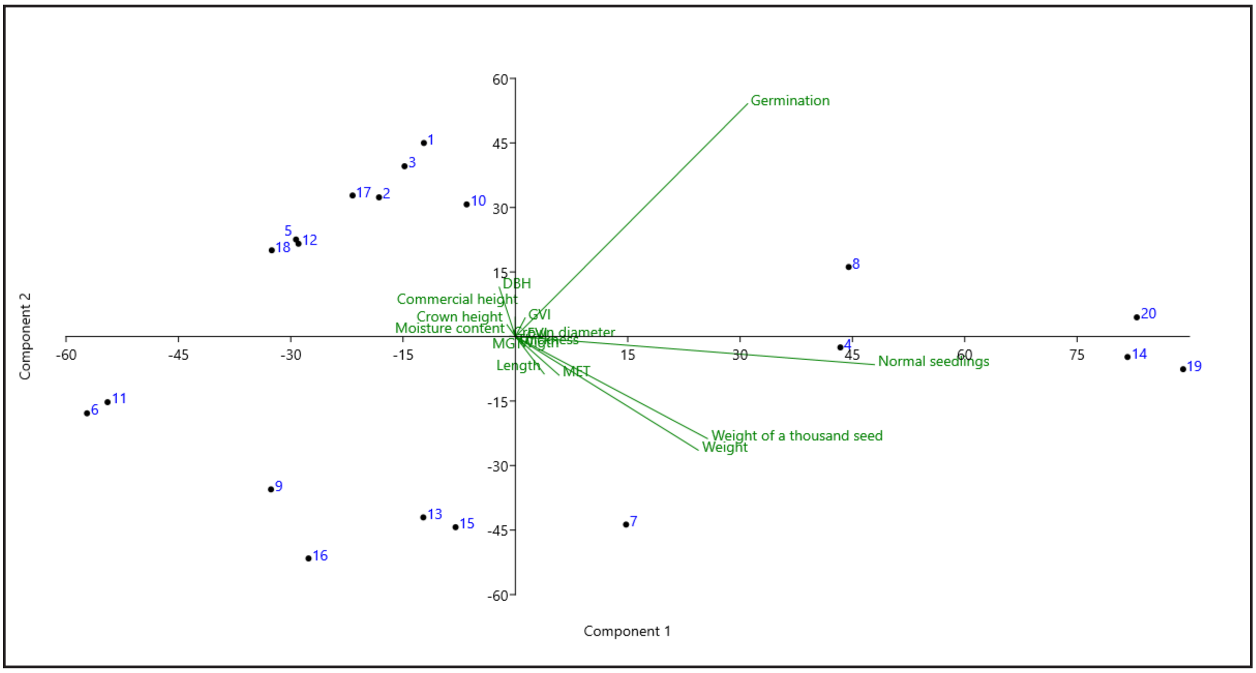
The variables that are independent of germination had no significant correlation with the germination process and its complementary variables, which leads us to understand that germination is dependent on physiological events that are influenced by factors such as water, light, temperature and the substrate, among others (Silva *et al*., 2020), which reinforces the idea that it is the only variable that demonstrates the viability of a seedlot.

The WTS and seed weight had a strong correlation with seedling formation and its correlated variables. This provides us with the possibility of creating a standard or confidence interval that demonstrates a profile of the weight of a thousand seeds or biometric characters with a satisfactory degree for the success or conduct of seedling establishment.

There is variability within the population, with *H. serratifolius* mother trees presenting different characteristics of vigor and emergence for normal seedlings, which reinforces the recommendation of selecting other variables for application in future studies, as variables related to seedling biometrics or morphophysiological tests in monitored progenies can indicate the vigor and physiological quality of this species, in order to achieve the selection of superior mother trees.

Figure 2 shows the variation of the principal components. We analyzed 16 variables, which were distributed in the four quadrants. This variation, "loadings", is measured from zero to 1, and a value closer to 1 means greater representativeness of this variable towards the population. The first two coefficients (PC1 and PC2) represented 88.58% of all the variation involved between the analyzed variables. For the first component (PC1, horizontal) the variation of seedling formation (0.70), germination (0.45) and WTS (0.37) were significant, demonstrating that in 59.35% of cases the behavior of the species is explained by these variables. On the other hand, the characteristics of the mother trees and the moisture content had a negative correlation with the first component. In the second component (PC2, vertical), germination (0.80), DBH (0.16) and commercial height (0.06) were significant and, in 28.99% of cases, these variables explain the behavior of the species, but show that seedling formation had a negative correlation in this component.

Figure 2 – Analysis of the principal components of the technological variables of the seedlots of 20 *H. serratifolius* mother trees



Source: Authors (2023)

In the case of the principal components, it is interesting to highlight that the axes with the groupings of the variables are independent of each other, and do not suffer any variation in the variables (Fraga *et al*., 2016). This behavior of the components served to indicate the relevance of WTS and seedling formation as characteristics of vigor for the species, placing germination as a background variable. In addition to identifying the relevance of the variables, it provides the possibility of selecting individuals that are grouped by the general variation of their characteristics, which demonstrates the behavior of the population and not only per individual (Hongyu; Sandanielo; Oliveira-Jr, 2016)entre as técnicas de multivariadas, a análise de componentes principais (ACP.

3.3 Optimization of biometric characters

The classification of seeds by size or weight is a strategy that can be adopted to standardize the emergence of seedlings and obtain seedlings of similar size or greater vigor (Carvalho; Nakagawa, 2000). It is worth noting that biometric variations are related to the environment of origin of the tree plus the existing genetic variations, which causes variations within and between individuals (Cunha *et al*., 2006).

In order to optimize production and reduce the sample size to determine biometric standards, the coefficient of repeatability was determined, which ranged from 0.5892 for width to 0.7357 for thickness. Capucho *et al*. (2021) indicate that high values of the estimation of character repeatability demonstrate that it is possible to predict the real value of the individual with a relatively small number of measurements. By studying *Ormosia discolor,* they demonstrated that 18 repetitions would be sufficient to predict the biometric characters with 95% accuracy. Therefore, for this work, 14 seeds were sufficient to compose a sample to scale the biometric characters, with a percentage of certainty of 98% (Table 5).

Table 5 – Biometric standards and coefficient of repeatability of seedlots of 20 Handroanthus serratifolius mother trees located in Apuí (Amazonas)

Biometric characters	**GMS**	**Overall mean**	**CV_e (%)**	**Repeatability via principal components and covariance matrix**		
				r	**R^2**	**No. of evalualtions for R^2 = 0.95**
Wet Weight	0.01454**	0.031	46.61	0.6968	0.985705	9
Length	1148.5313**	29.498	13.71	0.7228	0.987378	8
Width	33.3461**	8.197	10.92	0.5892	0.977286	14
Thickness	3.4545**	0.649.	31.98	0.7357	0.988168	7

Source: Authors (2023)

In where: GMS - genotypic mean square.

4 CONCLUSIONS

The characteristics that define a vigorous batch of *Handroanthus serratifolius* seeds are germination, the weight of a thousand seeds and the biometrics. In addition, the correlation of the weight of a thousand seeds with the formation of seedlings evidences the possibility of creating of a new quality standard in seed analysis

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