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Original article

Relation between size, weight and germination in *Juglans jamaicensis* C. DC (walnut)

Relación talla, peso y germinación en *Juglans jamaicensis* C. DC (nogal del país)

Relação de tamanho, peso e germinação em *Juglans jamaicensis* C. DC (nogueira do campo)

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ABSTRACT

The study of the relationship between the forestry seeds quality and their germination brings key information for the conservation of these species and the establishment of management programs. *Juglans jamaicensis* C. DC (walnut) is an endangered species, located in the main mountain systems of Cuba. Populations of this species have suffered a drastic reduction due to different natural and anthropic factors. The aim of this study was to determine the relationship between the seed quality parameters (size and weight) of *J. jamaicensis* and its germination. The seeds were collected in San Blas and El Nicho, located in the Guamuhaya Mountain, south central Cuba, which were measured and weight. After that, the germination time and its average of germinated seeds were determined. It was determined if there was a relation between the size and weight of the seeds with the location a and the percentage germinated seeds. The average weight of the seeds was 4,84 g and the average size was 22,93 mm. The average germination time was 39,99 days, while

the success was 37,4%. Both height, weight and germination time were different among locations; while the first two influenced the germination time. The results obtained confirm that *J. jamaicensis* has an erratic germination, where the seed quality is an element to be considered in the breeding and recovery programs of the species in the natural environment.

Keywords: *Juglans jamaicensis*; Seeds quality; Germination; Time for germination.

RESUMEN

El estudio de la relación entre la calidad de las semillas forestales y su germinación aporta información clave para la conservación de dichas especies y el establecimiento de programas de manejo. *Juglans jamaicensis* C. DC (nogal del país) es una especie en peligro, localizada en los principales sistemas montañosos de Cuba, cuyas poblaciones han sufrido una drástica reducción, debido a diferentes factores naturales y antrópicos. El presente estudio tuvo como objetivo determinar la relación entre los parámetros de calidad de las semillas (talla y peso) de *J. jamaicensis* y su germinación. Se colectaron semillas en San Blas y El Nicho, localidades ubicadas en el Macizo Montañoso Guamuhaya, centro sur de Cuba, las que fueron medidas y pesadas. Posteriormente, se determinó el tiempo de germinación y porcentaje de semillas germinadas. Se comprobó si existía relación entre la talla y el peso de las semillas con la localidad, el éxito y el tiempo de germinación. El peso medio de las semillas fue de 4,84 g y la talla media fue de 22,93 mm. El tiempo promedio de germinación fue de 39,99 días, mientras que el éxito fue de un 37,4 %. Tanto la talla, el peso y el tiempo de germinación fueron diferentes entre localidades. El tiempo de germinación fue influenciado por la talla y el peso. Los resultados obtenidos confirman que *J. jamaicensis* tiene una germinación errática, donde la calidad de la semilla es un elemento a considerar en los programas de reproducción y recuperación de la especie en el medio natural.

Palabras clave: *Juglans jamaicenis*; Calidad de la semilla; germinación; Tiempo de germinación.

RESUMO

O estudo da relação entre a qualidade das sementes florestais e a sua germinação fornece informações fundamentais para a conservação destas espécies e para o estabelecimento de programas de gestão. Juglans jamaicensis C. A DC (nogueira) é uma espécie ameaçada, localizada nos principais sistemas montanhosos de Cuba, cujas populações sofreram uma redução drástica, devido a diferentes fatores naturais e antrópicos. O presente estudo teve como objectivo determinar a relação entre os parâmetros de qualidade das sementes (comprimento e peso) de J. jamaicensis e a sua germinação. As sementes foram recolhidas, medidas e pesadas em San Blas e El Nicho, ambas localizadas na Serra de Guamuhaya, no centro-sul de Cuba. Subsequentemente, foram determinados o tempo de germinação e a percentagem de sementes germinadas. Foi testada a relação entre o tamanho e o peso das sementes e a localidade, o sucesso e o tempo de germinação. O peso médio das sementes era de 4,84 g e o seu tamanho médio de 22,93 mm. O tempo médio de germinação foi de 39,99 dias, enquanto o sucesso foi de 37,4 %. Tanto a duração, como o peso e o tempo de germinação eram diferentes entre as localidades. O tempo de germinação foi influenciado pela altura e pelo peso. Os resultados obtidos confirmam que a J. jamaicensis tem uma germinação errática, em que a qualidade

da semente é um elemento a considerar nos programas de reprodução e recuperação da espécie no ambiente natural.

Palavras-chave: *Juglans jamaicensis*; Qualidade da semente; Germinação; Tempo de germinação.

INTRODUCTION

Seed quality is the sum of the genetic, physiological, physical and health attributes responsible for the capacity and level of productivity of the seed. This implies the integrity of the structures and physiological processes that allow the seed to maintain high rates of viability (Antuna *et al*., 2013).

Most tropical forest species are propagated through sexual seed and their quality significantly influences the success of plantations (Espitia *et al.,* 2016). Therefore, the use of quality seeds is a determining factor in the success of these plantations (Bonilla, 2014). Its germination depends on different abiotic factors, such as temperature and humidity (Lamarca *et al*., 2013) and among the parameters that define the quality of the seed are size and weight (Fors, 1967). Information on the relationship between these variables and germination parameters is fundamental for forest species conservation strategies and programs. The analysis of the germination behavior of seeds from different regions can provide important information regarding the degree of interference from the environment on the characteristics of the seeds formed (Lamarca, 2013).

Juglans jamaicensis is an endemic species of the Greater Antilles (Cuba, Hispaniola and Puerto Rico), belonging to the family Juglandaceae. It is a tree that can reach up to 30 m in height (Bisse, 1981), considered a rare species of the humid mountain forests, which produces an edible nut (Francis and Alemañy, 1994). Its wood is appreciated for carpentry and joinery work, like that of other walnut species (Soler, 2013). In Cuba, it is usually found in the humid variety of semideciduous forest, on diverse soils (Bisse, 1981).

There are discrepancies among the various authors about the taxonomical status of *J. jamaicensis*. Shaarschmidt (2002), based on the external morphology of the seeds, recognizes two subspecies: *J. jamaicensis subsp. jamaicensis* C. DC, distributed throughout the central and eastern part of the island of Cuba, and *J. jamaicensis* subsp. *insularis* (Griseb.) H. Schaarschm, present in the west. This criterion has been accepted by González-Torres et al. (2016). While for Acevedo and Strong (2012) it is a single species *J. jamaicensis* C. DC; opinion shared by Rodríguez (2015) and Rodríguez *et al.,* (2017).

Their conservation status has been addressed by different authors (Fors, 1967; Becquer, 2013; Rodríguez, 2015), who refer to the decline of their populations due to the influence of different factors such as the transformation of their habitat for coffee cultivation and livestock, indiscriminate logging, avalanches on mountain slopes and the presence of invasive exotic species.

González-Torres *et al.,* (2016) consider *J. jamaicensis subsp. jamaicensis* to be endangered [B2ab(ii,iii,v)] and *J. jamaicensis subsp. insularis* to be critically endangered [B2ab(ii,iii);C2a(i)]. In both cases, it is suggested that this is due to the

fact that the area of occupation is severely fragmented and that there is a decrease in the extension of the area of occupation and the number of individuals, in addition to the small population sizes. Other elements observed that could influence the conservation of *J. jamaicensis* are the genetic depression of the populations (Rodríguez, 2015), the scarce natural regeneration (Rodríguez and Aguilar, 2019) and the physiological alterations, related to reproduction (Hechavarria *et al.,* 2008). The latter authors recommend the study of the germination capacity of *J. jamaicensis* seeds, in order to identify the most viable reproductive material in terms of conservation.

Consequently, the present study aimed to determine the relationship between seed quality parameters (size and weight) of *J. jamaicensis* and its germination, with the objective of contributing to the recovery of natural populations of the species.

MATERIALS AND METHODS

The seeds were collected from subpopulations of *J. jamaicensis* located in El Nicho (22° 01' 58'' N and 80° 06' 47'' W) and in San Blas (21° 58' 55,9'' N and 80° 14' 24.2'' W) at 576 and 450 m.a.s.l, respectively. Both subpopulations are composed of three individuals in El Nicho and 14 in San Blas. These two locations are located in the Guamuhaya Mountain Massif, in the Cienfuegos Province. The seeds collected came from individuals located within the montane rainforest, in the case of El Nicho and the mesophilic semideciduous forest in San Blas.

The climate in the study area is tropical-humid, with a markedly seasonal rainfall regime. There is a rainy or humid period from mMay to October and a slightly rainy period from November to April, with annual average relative humidity values above 80 % (Barcia and Castillo, 2015). Average annual rainfall for San Blas is 1946.1 mm (Vasallo, 2019) and 1818,3 mm for the Niche (González-Fernández *et al.,* 2016); while average temperatures for this mountainous area range from 16 to 21°C, with January and July being the coldest and hottest months, respectively (Barcia and Castillo, 2015).

The experiment was carried out in the nursery of the Jardín Botánico de Cienfuegos (22° 07' 00'' N and 80° 20' 00'' W). Each one of the 516 seeds (identified with an alpha-numeric code) was measured (with a 0,01 mm precision caliper) and weighed (with a Gram balance, Series HB of 0,02 g precision). Later, they were sown at a depth of 1 cm, in black polyethylene bags of 25 x 30 cm, under 70 % of zaram and daily irrigation. The substrate used was composed of 50 % red soil, 25 % organic matter and 5 % sand.

Daily monitoring was carried out to determine the exact date of germination. To do this, germinated seeds were considered those that presented radicle emerged through the germinal cover, according to the criterion of Sotes *et al.,* (2013), applied by Rodríguez (2015).

When applying the Kolmogorov-Smirnov test it was observed that the data did not follow a normal distribution, therefore non-parametric tests were used for the subsequent analyses. The relationship between seed weight (g) and seed length (understood as the length of the seed in mm) with the time of germination (Spearman's Rho) was evaluated. Subsequently, it was determined whether there were differences in weight, size, time and germination success (%), given by the percentage of seeds that germinated, considering the location of origin of the seeds,

with the Krukal-Wallis test. The PAST program, version 3.10, was used to process the data (Hammer *et al.,* 2001).

RESULTS

The average weight of the seeds was 4.84 ±1.62 g (CV=0.33; N=516) and the average size was 22.93 ± 2.68 mm (CV=0.12; N=516). The average germination time was 39.99 ± 20.22 days (CV=0.51; N=516) and 37.4 % of seeds germinated. The analysis by localities (Table 1) showed that in El Nicho the highest values were obtained for the measured variables, except for the germination time, where it was lower.

Table 1. - Descriptive statistics of the variables weight (g), size (mm), germination time (days) and % of germination of *J. jamaicensis*, considering the collection location

	weight	size	germination time	% of germination
San Blas	4,30±1,31 (CV=0,304)	22,13±1,86 (CV=0,084)	58,89±19,93 (CV=0,338)	31,77
El Nicho	5,20±1,58 (CV=0,304)	24,02±2,71 (CV=0,113)	27,73±3,78 (CV=0,136)	53,79

Legend: values between brackets are the coefficient of variation

When comparing the two evaluated localities, it was found that they differed significantly with respect to the size (K-W: chi-square=35,372; gl=1; *P*=0,00) and weight (K-W: chi-square=16,657; gl=1; *P*=0,00) of the seeds; as well as for the time it takes for them to germinate (K-W: chi-square=23,094; gl=1; *P*=0,00). This last variable (germination time) was shown to be negatively correlated with seed size (Spearman's Rho=-0.124*; *P*=0.022; N=342).

The percentage of germinated seeds was significantly different between the seeds from San Blas and El Nicho (chi-square=30,340; gl=1; *P*=0.00) and did not show to be influenced by the weight and size of the seeds (*P*>0.05).

DISCUSSION

The average value obtained from the size of the seeds (22,93 mm=2,3 cm) was higher than those observed by Schaarschmidth (2002) and lower than those found by Álvarez *et al.,* (2006), who reported 1,8 and 3,5 cm, respectively, in *J. jamaicensis*. The average weight of the seeds (4,84 g) was higher than the 3,9 g obtained by the latter authors. The study conducted by Rodríguez and Aguilar (2019), in populations of this species in Turquino National Park, gave similar values to those obtained in the study area, finding an average size of 2,32±0,18 cm and an average weight of 4,91±1,48 g.

This variability in the weight and size of the seeds is also present in different plant species. In different subpopulations of *J. jamaicensis* in the Sierra Maestra, Rodríguez (2015) observed variation in seed size and weight. This behavior has been reported in other Cuban forest species such as *Pinus tropicalis* (Bonilla, 2014) and this influence of the origin of the seeds has also been detected in different tropical forest or shrub species (Correa *et al.,* 2013; Zohra *et al*., 2014; Barboza-Nogueira *et al.,* 2014).

According to the results obtained by Lamarca *et al.* (2013), germination depends on the origin of the material, which may be related to the water and thermal variations in the environment during the development and maturation of the seed. The speed of germination can be related to the size of the seeds and determine the possibility that the plants are more competent at the seedling stage, coinciding with Mostacedo and Pinard (2001). The negative correlation between germination time and size could justify that seeds collected in El Nicho Niche germinate faster, given their size and weight, related to higher reserves. According to Rodríguez (2015), a species with a faster germination time may have the opportunity to make better use of the resources and conditions of its microhabitat. The differences observed between seeds from El Nicho and San Blas reflect the marked variability in the morphology of *J. jamaicensis* seeds, which had already been described by Rodríguez *et al*., (2017) for this species in Parque Nacional Turquino.

This high variability in the size of the seeds of the species under study is also given by the trees of origin, as their germination potential is significantly different according to the tree from which they come, according to Rodríguez and Aguilar (2019).

The differences found with respect to the germination time, according to the collection location, agrees with Rodríguez (2015), who catalogues it as a species with erratic germination values. Similar results were obtained by Rodríguez and Aguilar (2013), who observed the beginning of germination after five days. While Castillo *et al.,* (2002) determined the germination time between 11 and 53 days, without a germination peak, with 83 % germination. In contrast, Rodríguez and Aguilar (2019) observed an average germination time of 5,21±1,8 days.

The percentage of germinated seeds was lower than reported by Rodríguez and Aguilar (2019) and did not show to be related to seed size and weight. This could be influenced by the genetics of the populations studied, which regulate enzymatic activity, respiratory metabolism and the translocation and assimilation of food reserves in the growing regions of the embryo (Rodríguez and Aguilar, 2019). Another element that was not evaluated and that could be influencing is the loss of genetic variability to which the species is prone, according to the results of Rodríguez (2015) in populations of *J. jamaicensis* studied in the Sierra Maestra, eastern Cuba (albinism, stem and seed malformations).

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REFERENCES

ACEVEDO-RODRÍGUEZ, P. y STRONG, M.T., 2012. *Catalogue of seed plants of the West Indies. Smithsonian Contributions to Botany*. Washington D. C: Smithsonian Institution Scholarly Press. Disponible en: https://repository.si.edu/handle/10088/17551

ÁLVAREZ, A.F., CASTILLO, E. y HECHAVARRÍA, O., 2006. *Especies protegidas por la Ley Forestal de Cuba*. La Habana, Cuba: Agrinfor.

ANTUNA, O., F. RINCÓN, E. GUTIÉRREZ DEL RÍO, N. RUIZ Y C. BUSTAMANTE. 2013. Componentes genéticos de caracteres agronómicos y de calidad fisiológica de semillas en líneas de maíz. Revista Fitotécnica Mexicana. vol 26, no 1, bpp. 11-17.

BARBOZA-NOGUEIRA, F.C., LOBO-PINHEIRO, C., MEDEIROS-FILHO, S. y DA SILVA MATOS, D.M., 2015. Seed germination and seedling development of Anadenanthera colubrina in response to weight and temperature conditions. *J. Plant Sci*, vol. 2, no. 1, pp. 37-42. Disponible en: http://www.sciencepublishinggroup.com/journal /paperinfo?journalid=215&doi=10.11648/j.jps.20140201.17

BARCIA, S. y CASTILLO, C., 2015. *Atlas Climático de la Provincia Cienfuegos*. Cienfuegos: Centro Meteorológico Provincial de Cienfuegos.

BÉCQUER, E., 2013. Junglans jamaicensis C DC. Top 50. Las 50 plantas más amenazadas de Cuba. *Bissea*, vol. 7, no. 1.

BISSE, J., 1981. *Árboles de Cuba*. La Habana, Cuba: Editorial Científico-Técnica.

BONILLA, M., 2014. Variación del peso y viabilidad de las semillas de Pinus tropicalis para diferentes procedencias. *Revista Cubana de Ciencias Forestales*, vol. 2, no. 1, pp. 89-96. Disponible en: http://cfores.upr.edu.cu/index.php/cfores/article/view/133

CASTILLO, E.L., SORDO, A. y GARCÍA, E.I. del P., 2002. Manejo de frutos y semillas de Juglans jamaicensis subsp. jamaicensis C. DC. y su manejo en viveros. *Contribución a la conservación de biodiversidad de 18 taxa arbóreas en Cuba*. La Habana, Cuba: s.n., pp. 32.

CORREA, E.M., ESPITIA, H., ARAMÉNDIZ, O. y MURILLO, E.I., 2013. Variabilidad genética en semillas de árboles individuales de Tectona grandis L.f, en la conformación de lotes mezclados en Córdoba, Colombia. *Rev. U.D.C.A Act. & Div*, vol. 16, no. 2, pp. 379-389. Disponible en: http://www.scielo.org.co/scielo.php?script=sci_abstract&pid=S0123-42262013000200012

ESPITIA, M., CARDONA, C. y ARAMÉNDIZ, H., 2016. Pruebas de germinación de semillas de forestales nativos de Córdoba, Colombia, en laboratorio y casa-malla. *Revista U.D.C.A Actualidad & Divulgación Científica*, vol. 19, no. 2, pp. 307-315. Disponible en: http://www.scielo.org.co/scielo.php?pid=S0123-42262016000200007&script=sci_abstract&tlng=es

FORS, A., 1967. *Manual de Selvicultura*. La Habana, Cuba: INDAF.

FRANCIS, J.K. y ALEMAÑY, M.S., 1994. *Juglans jamaicensis* C. DC. Nogal. SO-ITFSM-73. *US Department of Agriculture. Forest Service, Southern Forest Experiment Station*, pp. 4.

GONZÁLEZ-FERNÁNDEZ, C., FERRÁS-NEGRÍN, Y., CALZADA-RODRÍGUEZ, L. y GONZÁLEZ-OLIVERA, A., 2016. Características del régimen pluviométrico de una zona cafetalera de la empresa Cumanayagua. *Café Cacao*, vol. 15, no. 1, pp. 74-77.

GONZÁLEZ-TORRES, L.R., A PALMAROLA, L., GONZÁLEZ-OLIVA, L., BÉCQUER, E.R., TSTÉ, E. y BARRIOS, D., 2016. Lista Roja de la Flora de Cuba. *Bissea.*, vol. 10, no. (NE-1), pp. 1-352.

HAMMER, Ø., HARPER, A.T. y RYAN, P.D., 2001. PAST: Paloetological Statistics Sofware package for education and data analysis. *Paloentologia Electronica*, vol. 4, no. 1, pp. 1-9. Disponible en: https://palaeo-electronica.org/2001_1/past/issue1_01.htm

HECHAVARRIA, O., ÁLVAREZ, A.R. y MONTALVO, J.M., 2008. Respuesta fenológica de Juglans jamaicensis subsp. jamaicensis al aumento de la temperatura en bosque pluvial montano. *Revista Baracoa*, vol. 27, no. 2, pp. 81-89. Disponible en: http://agris.fao.org/agris-search/search.do?recordID=CU2010800009

LAMARCA, E., BONJOVANI, M.R., ROCHA, J.M. y BARBEDO, C.J., 2013. Germinação em temperatura sub-ótima de embriões de Inga vera subsp. affinis obtidos sob diferentes condições ambientais. Rodriguésia, vol. 64, no. 4, pp. 877-885. Disponible en: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S2175-78602013000400015

MOSTACEDO, B. y PINARD, M., 2001. *Ecología de semillas de plántulas de árboles maderables en bosques tropicales de Bolivia*. Santa Cruz: El País.

RODRÍGUEZ, J.L., 2015. *Contribución a la conservación de Juglans jamaicensis C. DC. en el Parque Nacional Turquino*. Tesis Doctoral. Pinar del Río, Cuba: Universidad de Pinar del Río "Hermanos Saíz Montes de Oca". Disponible en: http://rc.upr.edu.cu/jspui/handle/DICT/2184

RODRÍGUEZ, J.L. y AGUILAR, C., 2019. Estructura morfológica, germinación y vigor de semillas de Juglans jamaicensis C. DC. del Parque Nacional Turquino. *Revista Cubana de Ciencias Forestales*, vol. 7, no. 3, pp. 297-304. Disponible en: http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S2310-34692019000300283&lng=es&nrm=iso&tlng=es

RODRÍGUEZ, J.L., AGUILAR, C. y VALDÉS, E.Y., 2017. Relación entre morfología y dispersión de Juglans jamaicensis C. DC con la distancia al curso de agua. *Revista Cubana de Ciencias Forestales*, vol. 5, no. 1, pp. 27-32. Disponible en: http://cfores.upr.edu.cu/index.php/cfores/article/view/217

RODRÍGUEZ, J.L. y AGUILAR, E.C., 2013. Germinación de Juglans jamaicensis C. DC. subsp. jamaicensis, en vivero. *Revista Cubana de Ciencias Forestales*, vol. 1, no. 1. Disponible en: http://cfores.upr.edu.cu/index.php/cfores/article/view/41/194

SCHAARSCHMIDT, H., 2002. Flora de la República de Cuba. Juglandaceae. Koeltz Scientific Book. *Königstein*, pp. 176. Disponible en: https://books.google.com.cu/books/about/Flora_de_la_Rep%C3%BAblica_de_Cuba.html?id=3ReFuQEACAAJ&redir_esc=y

SOLER, M., 2013. *Mil maderas IV*. Valencia: Manuel Soler Burillo.

SOTES, G., BUSTAMANTE, R. y HENRÍQUEZ, C., 2013. Distribución de plántulas y germinación de semillas de lúcumo chileno (Pouteria splendens) en Los Molles, Chile. *Revista Chilena de Historia Natural*, vol. 86, pp. 337-344. Disponible en: https://scielo.conicyt.cl/scielo.php?script=sci_arttext&pid=S0716-078X2013000300010

VASALLO, L., 2019. *La crisis de la producción del sistema agroforestal cafetalero en Cuba y su relación con la conservación de la biodiversidad*. Tesis doctoral. España: Universidad de Alicante. Disponible en: https://dialnet.unirioja.es/servlet/tesis?codigo=233251

ZOHRA, B., ALI, M. y MOULAY, B., 2014. Germination tests of seeds of argan tree (Argania spinosa (L.) Skeels) of two sources (Tindouf and Mostaganem) in the semi-arid western Algerian. Afr. J. Plant Sci, vol. 8, no. 6, pp. 260-270. Disponible en: https://www.researchgate.net/publication/287343864_Germination_tests_of_seeds_of_argan_tree_Argania_spinosa_l_skeels_of_two_sources_Tindouf_and_Mostaganem_in_the_semi -arid_western_Algerian

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The authors declare not to have any interest conflicts.

Authors' contribution:
The authors have participated in the writing of the work and analysis of the documents.