

SEED AND SEEDLING MORPHOLOGY OF TWO SPECIES OF THE GENUS *JATROPHA* L. (EUPHORBIACEAE)

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Abstract: The morphology allows to identify and distinguish characters from the growth phases, as well as supports the studies of seed technology in the adequacy of protocols to evaluate the quality of the seed. The genus *Jatropha* is distinguished by its economic importance and by its diverse uses, mainly as medicinal. Considering their characteristics and economic relevance, we sought to investigate and illustrate the morphology of the seeds and the development of the seedling of *Jatropha gossypifolia* L. and *Jatropha podagrica* Hook and assist in the propagation of the species. The seeds were collected in the city of Boa Vista (RR). The physical and biometric aspects were measured, the morphological characteristics of the seeds were described and illustrated, as well as the seedling development. The seeds of *J. podagrica* are larger than those of *J. gossypifolia*, but they have similar external characteristics, such as hilum position, caruncle, raphe and chalaza, and internal, such as crass and fleshy endosperm, an axial embryo spatulated with foliate cotyledons. Both species have germination of the epigeal-phanerocotyledonary type. Aspects of seedling development differ between species in chronology, shape and position of the hypocotyl, epicotyl and eophyll.

Keywords: germination, medicinal, pião-pajé, pião-roxo.

MORFOLOGIA DA SEMENTE E DO DESENVOLVIMENTO DA PLÂNTULA DE DUAS ESPÉCIES DO GÊNERO *JATROPHA* L. (EUPHORBIACEAE)

Resumo: A morfologia permite identificar e distinguir caracteres das fases de crescimento, bem como apoia os estudos da tecnologia de sementes na adequação de protocolos para avaliar a qualidade da semente. O gênero *Jatropha* distingue-se por sua importância econômica e por seus diversos usos, principalmente como medicinal. Considerando suas características e relevância econômica buscou-se investigar e ilustrar a morfologia das sementes e do desenvolvimento da plântula de *Jatropha gossypifolia* L. e *Jatropha podagrica* Hook e auxiliar na propagação das espécies. As sementes foram coletadas no Município de Boa Vista (RR). Foram mensurados os aspectos físicos e biométricos, descritas e ilustradas as características morfológicas das sementes, assim como o desenvolvimento da plântula. As sementes de *J. podagrica* são maiores que as de *J. gossypifolia*, porém apresentam características semelhantes externas, como posição do hilo, carúncula, rafe e calaza e, internas como

endosperma crasso e carnosos, embrião axial espatulado com cotilédones foliáceos. Ambas as espécies possuem germinação do tipo epígea-fanerocotiledonar. Os aspectos do desenvolvimento das plântulas se diferenciam entre as espécies na cronologia, forma e posição do hipocótilo, epicótilo e eofilo.

Palavras-chave: germinação, medicinal, pião-pajé, pião-roxo.

In the Euphorbiaceae family, several genera stand out for their economic and social importance. Among these, the genus *Jatropha*, the fourth largest genus of the family, presents 175 species distributed in the world, being its main uses, ornamental and therapeutic. In folk medicine it is used as an antipyretic, to cure wart and thrush, laxative, pain in general, sexual stimulant, hallucinogenic, anxiolytic, contraceptive, among others (Hirota et al., 2010; Luz, 2001; Santos et al., 2012). Among the species of this genus, *Jatropha gossypifolia* L. stands out, popularly known as "pião-roxo" or "pinhão-roxo", occurring in the Antilles and America. It has multiple value, the plant being used as a hedge to protect agricultural production, seed oil in the generation of biodiesel, latex used as anticoagulant and hemostatic, in addition to being identified as medicinal in ethnobotanical studies and tested in ethnopharmacological studies to prove the effectiveness of its indications, such as healing, antibacterial, antihypertensive, anti-muscular relaxant and others (Dabur et al., 2007; Rocha & Dantas 2009; Kumar & Singh, 2012). *Jatropha podagrica* Hook. it is popularly known as tartar, jatropha, "batata-do-inferno" or "pião-pajé". Ethnobotanical studies focus on the medicinal potential of the species (Krishnan and Paramathma, 2009; Carniello et al., 2010; Costa & Mitza, 2010) and pharmacological research have tested its actions as antibacterial, insecticide and anti-helminthic (Aiyelaagbee et al., 2007; Aiyelaagbee & Gloer 2008; Bhaskarwar et al., 2008).

The study of the morphology of fruits, seeds and seedlings in the early stages of development contributes to the characterization of families, genera and until species; to the knowledge of the reproductive process, since they have different characters in their growth phases; provide subsidies for standardization of germination tests in the laboratory, identifying the better treatments for increasing the percentage of germination and vigor, high purity, etc; and for understanding the establishment and regeneration of the plant under natural conditions (Guerra et al., 2006; Castellani et al., 2008; Oliveira, Silva & Chagas, 2018; Soares et al., 2019; Moura et al., 2020). In this way, we sought to investigate and illustrate the morphology of the seeds and the seedling development of *J. gossypifolia* and *J. podagrica* as a subsidy

for the propagation of specie.

The seeds of both species of *Jatropha* were collected directly from the matrices (10 for each species), when the process of dehiscence of the fruits started, in the City of Boa Vista, Roraima. The identification of the botanical material was carried out at the Herbarium of the Integrated Museum of Roraima (MIRR) and the Herbarium of the Federal Institute of Amazonas (EAFM), included in the collection with the registration numbers: *Jatropha gossypifolia*: MIRR_9625; EAFM_6932 and EAFM_6934; *Jatropha podagrica*: MIRR_9632; EAFM_6933.

The physical and biometric evaluation of the seeds was carried out in the Seed Laboratory, of the National Institute of Research of the Amazon (INPA), where it was determined, the degree of humidity, the mass of a thousand seeds and the number of seeds per kilo according to Brazil (2009). The biometric characteristics were obtained from a sample of 100 seeds for each species, where the length (from the base to the apex), width and thickness (median line of the seeds) were measured with the aid of a digital caliper (precision of 0.01 mm) and the mass on a scale (accuracy of 0.001 g) (Dataset available in the figshare repository, see in box at the end). Simple arithmetic means, standard deviation and amplitude of variation were obtained. The morphology of the seeds was described from a sample with 50 seeds, for each species with the aid of a stereoscopic microscope. The observed and described external characteristics were: type, color, shape, surface, texture and consistency of the integuments and position of the appendages present. After soaking the seeds for 24 h, cuts were made with a steel blade to observe the characteristics of the endosperm and embryo. The terminology used in the descriptions was according to Corner (1976), Werker (1997) and Barroso et al. (1999).

To describe the aspects of seedling development, 100 seeds per species were used. Sowing was carried out in plastic trays with vermiculite; arranged on a cement bench, in a nursery covered with transparent fiberglass tile, at INPA. The irrigation was carried out daily, and the observations for the recording of the seedling development phases were during the period of 40 days, registering as the final germination the phase in which the cotyledon lea-

ves were open and for the seedling the complete expansion of the eophyll. The descriptive terminology used was according to Duke (1969), Garwood (1996) and Oliveira (2001).

The seeds can be differentiated by biometric characteristics, *J. gossypifolia* have, on

average, 7.8 mm of length, 4.6 mm of width and 3.3 mm of thickness and *J. podagrica* have, on average, 11.6 mm of length, 6.1 mm of width and 4.48 mm of thickness (Tab. 1). They present average values of close dimensions, for width and thickness, however the seeds of *J.*

Tab. 1. Dimensions and mass of the seeds of *Jatropha gossypifolia* L. and *Jatropha podagrica* Hook. (N=100).

Variables	Mean	Standard deviation	Range of variation
<i>Jatropha gossypifolia</i> L.			
Length (mm)	7.81	0.32	6.43 - 8.55
Width (mm)	4.64	0.18	3.97 - 5.03
Thickness (mm)	3.37	0.14	2.66 - 3.67
Weight (g)	0.056	0.013	0.013 - 0.077
<i>Jatropha podagrica</i> Hook.			
Length (mm)	11.67	0.48	9.71 - 12.47
Width (mm)	6.19	0.24	5.23 - 6.58
Thickness (mm)	4.48	0.23	3.03 - 4.96
Weight (g)	0.152	0.020	0.095 - 0.181

podagrica presented larger values, in relation to the length and weight. These differences can also be compared, due to physical characteristics. *J. gossypifolia* seeds with a moisture content of 9.8%, had a weight of 64.06 g, and a number of seeds per kilo of 15,611. While seeds of *J. podagrica* with a moisture content of 7.5%, had a weight of one thousand at 148.50 g and a number of seeds per kilo of 6,734.

The seeds of both species are stenospermal, with no variation in form. The seeds of *J. gossypifolia* are oblong with apex slightly truncated (Fig. 1A-B) and *J. podagrica* elliptical, with apex and base slightly acute (Fig. 2A-B); both with mixed color convex backs, varying in light brown to dark tones, in *J. podagrica* it is marbled (Fig. 1A and 2A). The seeds of both species are bitegumented, smooth, with a cartaceous consistency when dry and hydrated. The seeds, when hydrated, allow easy detachment of the forehead, exposing the black inner coat in *J. gossypifolia* and brown and *J. podagrica* (Fig. 1C and 2C). The hilar area is sub-basal, with the hilum, micropyle and caruncle structures, positioned in the ventral part of the

seed; the raphe is linear and well defined longitudinally, extending from the hilum to the chalaza, printed on *J. gossypifolia* and prominent on *J. podagrica* (Fig. 1A-B and 2A-B).

The seeds are endospermatic, with a thick, fleshy endosperm, white in color and accompanying the shape of the seeds, in both species (Fig. 1-2D). The embryo is axial, foliate, spatulated; straight, cylindrical hypocotyl-radicule axis, with more conical root apex in *J. gossypifolia*, undifferentiated plumule; fine cotyledons, oval in *J. gossypifolia* and oblong in *J. podagrica* (Fig. 1E-F and 2E-F).

Both species showed fanerocotyledonous germination (Fig. 3A-B and 3E-F); the protrusion starts with the elongation of the hypocotyl, after the elongation of the primary root occurs at three days after sowing (DAS); with the elongation of the primary root, four adventitious roots are formed around the stem base. Germination is completed between 10 to 14 DAS with the opening of the petiolated cotyledons (Fig. 3B-F). At 24 DAS, a pair of alternate eophylls for *J. gossypifolia* and an eophyll in *J. podagrica* are fully expanded (Fig. 3C-G). The

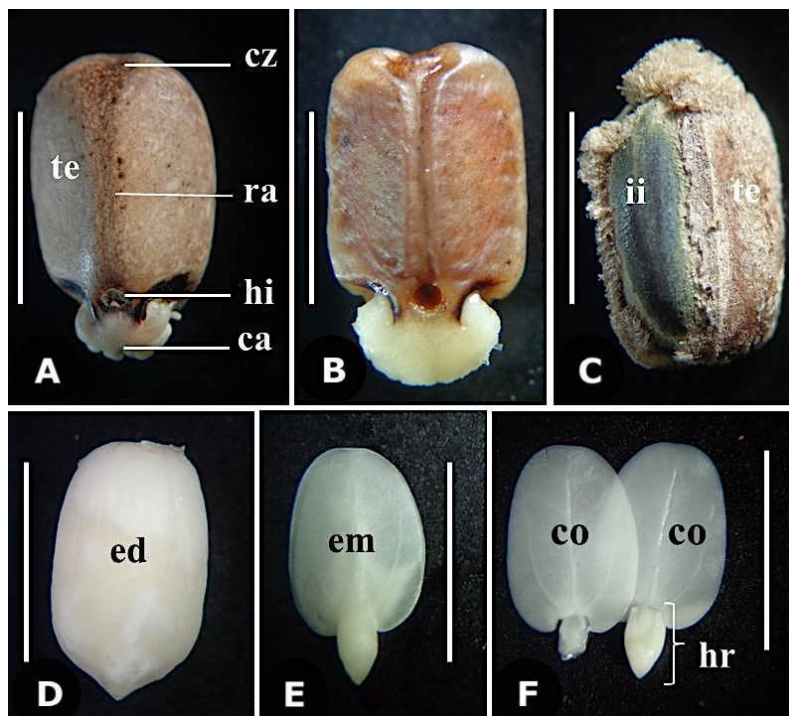


Fig. 1. Morphological aspects of the seed of *Jatropha gossypifolia* L. A. Dry seed. B. Hydrated seed. C. Seed coat. D. Endosperm. E. Embryo. F. Detail of the embryo. ca - caruncle, co - cotyledon, cz - chalaza, ed - endosperm, em - embryo; hi - hilum, hr - hypocotyl-radicle axis, ra - raphe, te - testa, ii - internal integument. Bar = 5 mm.

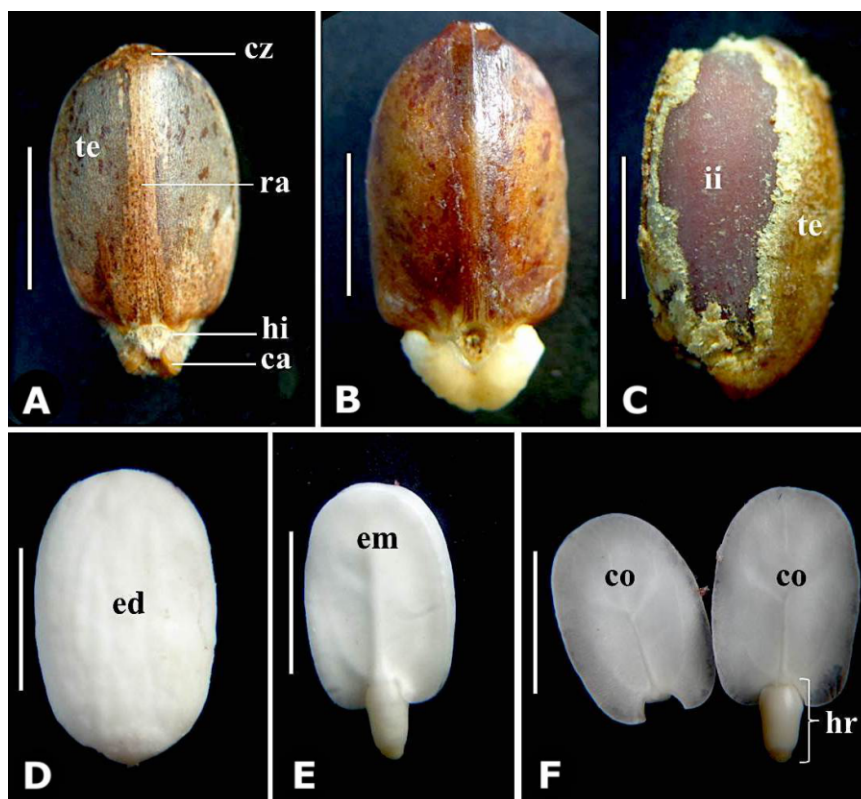


Fig. 2. Morphological aspects of the seed of *Jatropha podagrica* Hook. A. Dry seed. B. Hydrated seed. C. Seed coat. D. Endosperm. E. Embryo. F. Detail of the embryo. ca - caruncle, co - cotyledon, cz - chalaza, ed - endosperm, em - embryo; hi - hilum, hr - hypocotyl-radicle axis, ra - raphe, te - testa, ii - internal integument. Bar = 5 mm.

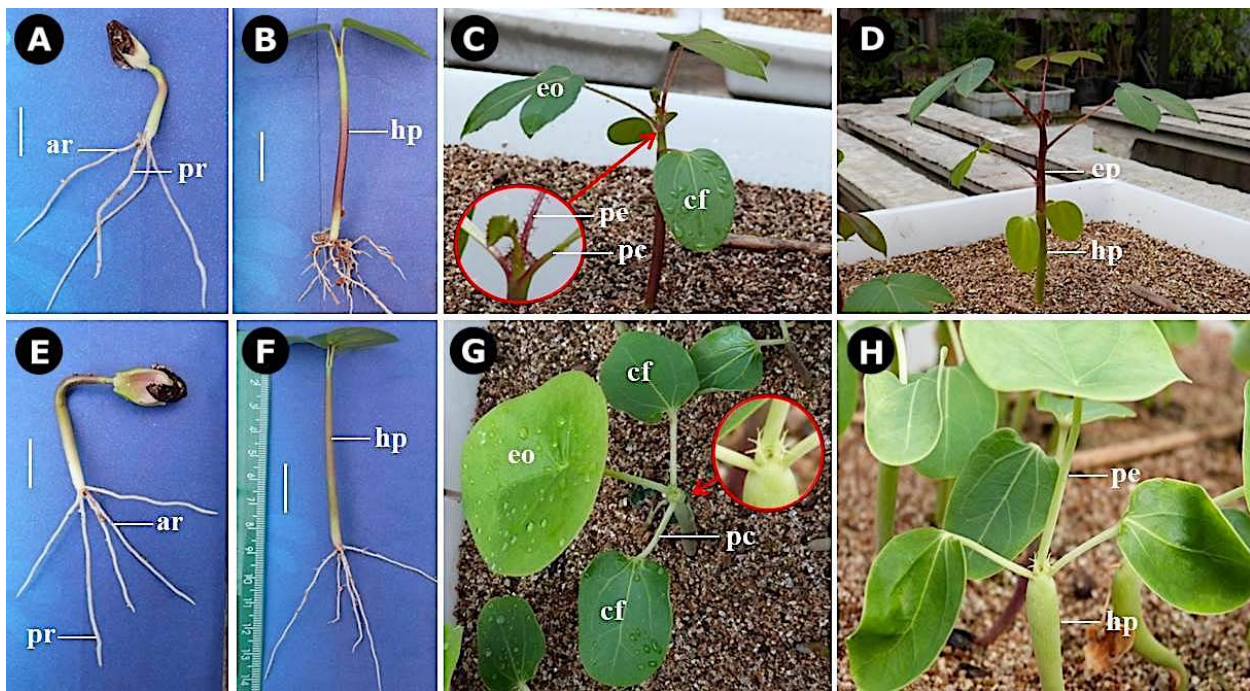


Fig. 3. Morphological aspect of seedling development. *Jatropha gossypifolia* L. (A-D). *Jatropha podagrica* Hook. (E-H). A. Emergency (7 to 10 days). B. Opening of cotyledon leaves (11 to 14 days). C. Expansion of the eophyll (24 to 28 days). D. Elongation of the epicotyl and emergence of protophylls (at 38 days). E. Emergency (5 to 7 days). F. Opening of cotyledon leaves (11 to 17 days). G. Expansion of the eophyll (24 to 28 days). H. Increased eophyll size and thickening of the hypocotyl (at 38 days). cf - cotyledon foliaceus (paracotyledon), eo - eophyll, ep - epicotyl, hp - hypocotyl, pc - cotyledon petiole, pe - eophyll petiole, ar - adventitious root, pr - primary root. Bar = 2 cm.

eofilo of *J. gossypifolia* is simple, long-petiolated with a pair of glandular trichomatous stipules; fluted purple petiole, with glandular trichomes throughout; blade is 3-lobed, with acute apex, raised base, serrated margin and webbed nerves (Fig. 3C-D). In *J. podagrica* the eophyll is simple, long-petiolated; cylindrical, greenish and glabrous petiole; the limb is peltiform and glabrous, with an acute apex and a peltated base, with a smooth margin and a webbed nerve (Fig. 3G-H). At 38 DAS, the foliate cotyledons persist, however the seedlings of *J. gossypifolia* continue their development with the lengthening of the epicotyl and the emergence of protophylls; whereas in *J. podagrica* the eophyll only increases in size, the hypocotyl thickens with a convex aspect and the development of an epicotyl does not occur (Fig. 3D-H).

The seeds of *J. gossypifolia* have dimensions similar to those of *J. ribifolia* (Pohl) Baill. (Lyra et al., 2012) and *J. elliptica* (Pohl) Oken (Añez et al., 2005). While, *J. podagrica* resembles *J. curcas* L. (Nunes et al., 2009) and, they are larger than the others mentioned above. Therefore, the study of the dimensions of the seeds stands out to differentiate species of the same genus, as well as other characteristics such as shape, texture, coloring that support

the seed technology, as presented in studies of the genus *Jatropha* (Virgens et al., 2017; Souza & Cavalcante, 2019).

The external and internal morphological aspects of the seeds of both species under study are similar to the species *J. elliptica*, *J. ribifolia* and *J. curcas*, in relation to the position of the hilum, caruncle, raphe, chalaza, abundant endosperm, embryo spatulated with foliaceous cotyledons (Añez et al., 2005; Lyra et al., 2012; Nunes et al., 2009). Silva et al. (2016) report in a study on the genus *Euphorbia*, that more micromorphological studies on seed diversity are needed, especially in the light of the phylogenetic framework to distinguish taxa.

The species *J. elliptica* and *J. curcas* also presented germination of the epigeal-phanerocotyledonary type (Añez et al., 2005; Nunes et al., 2009), different from *J. multifida* that has epigeal-phanerocotyledonary germination (Paria & Bose, 2017). From the more advanced stages of seedling development, they showed differences between the studied species and could not be compared with the literature, being therefore unprecedented for the genus and essential for the proper management of species in the nursery.

The seeds of *J. gossypifolia* and *J.*

podagrica differ in physical and biometric aspects and although they are similar in general aspects, they can be identified by shape and color. Both species have epigeal-phanerocotyledonary germination, but the aspects of seedling development differ in the chronology, shape and position of the hypocotyl, epicotyl and eophyll.

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