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RESEARCH ARTICLE

FIRST REPORT OF POLYEMBRYONY IN *INGA FEUILLEI* (LEGUMINOSAE, INGEAE)

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ABSTRACT

The genus *Inga* Mill. comprises approximately 300 species with tropical and subtropical distribution from Central America to Argentina, six of them grow in Argentina, *I. feuillei* DC, a species that grow in the rainforests of Ecuador, Peru and Bolivia, but is widely cultivated in the neotropic from Colombia to northern Chile owing to its potential as shade tree, nitrificant of soils, edible seeds and useful wood, is cultivated in northwestern Argentina. Nowadays few cases of polyembryony in species of Inga are reported. Perhaps in the future with more documentation it should be possible to analyze the sense of the polyembryony if only one or none will survive. It can be concluded that *I. feuillei* is viviparous, polyembryony exist; the cotyledons do not photosynthetize, store the reserves with which the embryo or embryos will start to grow; the development of each seedling depend of the competence among sister plants, perhaps during the first steps of the development. The survival of the seedlings do not increases with the existence of polyembryony. There is a negative correlation between the length of a seedling and the existence of sister ones. The length of the fruit determine the number of germinated seeds.

KEY WORDS: *Inga feuillei*, Germination, Polyembryony, Leguminosae.

INTRODUCTION

The genus *Inga* Mill. comprises approximately 300 species with tropical and subtropical distribution from Central America to Argentina, six of them grow in Argentina (Hoc, 1990, 2005; Zapater *et al*., 2014), *I. feuillei* DC, a species that grow in the rainforests of Ecuador, Peru and Bolivia, but is widely cultivated in the neotropic from Colombia to northern Chile owing to its potential as shade tree, nitrificant of soils, edible seeds and useful wood, is cultivated in northwestern Argentina . Some authors analyzed the strategies of dispersion and developing of seeds in tropical forests (Foster, 1986; Fedorov, 1956; Ichne *et al*., 2001). Many species of *Inga* Mill. are tested as multipurpose trees in order to improve the productivity of poor- quality soils (Pritchard *et al.,* 1995). The seeds of some studied species are recalcitrant (Roberts, 1973), retain their viability for a few weeks, also, at low temperatures the chilling stress was proved, and the dessication intolerance of the embryos is a common feature (Pritchard *et al*., 1995). Oliveira (1999) studied the germination and seedling development in species of *Leguminosae* that belong to different Subfamilies, analyzing the germination and development of seedlings of *I. edulis* Mart. Bonjovani (2008) studied the seeds of *Inga vera* Willd.subsp. *affinis* (DC) T. D. Penn. and discovered that the seeds of this species are recalcitrant because do not survive to humidity lower than 35% but tolerate low temperatures (- 2˚C). Lieberg *et al.* (2008) described the seeds, seedlings and the polyembryony in *I. laurina* (S.) Willd., discovering that although the % of germinability was high, the average time of emergence was asynchronous perhaps due to the competition created among the embryos. Nowadays few cases of polyembryony in species of *Inga* are reported.

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Taking into account the ecological value of this fact, the knowledge about the germination and seedling development in *I. feuillei* was the objective of present work.

MATERIALS AND METHODS

The fruits were collected of a cultivated tree at Quinta Agronómica FAZ, UNT, San Miguel de Tucumán, Argentina (Zapater and Lozano 2977, MCNS). The tree is 15 m length and has a broad top. On June of 2014, 20 fruits were selected, which were measured (length, wide, thickness) all the measures were made using a milimeter ruler. The number of seeds in each fruit was recorded (germinated or not). The germinated seeds were removed from the fruit and sown in 20 pots of 20 cm in diameter and filled with a perlite humus mix, in each pot up three seeds were placed. The growing process of each seedling was recorded every week. After 240 days the seedlings were measured and analyzed before the transference to individual pots of the still living ones. All the terminology employed in the citation of the studied material follows to Holmgren *et al*. (1990). The description of the seedlings follows in general to Ducke and Polhill (1981). The statistical analysis was carried out using the http://es.numberempire.com/ statisticscalculator.php.

RESULTS

Fruits and number of seeds

The measures of the collected fruits are shown in Table 1 and Fig. 1. As shorter the fruit is, lesser is the number of germinated seeds. In average the number of germinated seeds is significatively lower than the total of produced seeds (Fig. 2), (t value = 11,41; t from tables = 2,57 for ν= 225, p = 0,005). however, exist a positive correlation between the lower number of seeds produced with their development (Fig. 3) .

Table 1. Dimensions of the fruits; number of total and germinated seeds

N°	Lenght (cm)	wide (cm)	depth (cm)	Nº of seeds	Nº germinated seeds
1	25	2,5	3	12	5
2	25	3	3	18	2
3	21	3	3	9	5
4	20	2,5	2,5	9	9
5	16	3	3	6	5
6	20	2,5	3	9	8
7	22	3	2, 5	9	4
8	25	2	3,5	12	4
9	16	2	3	6	5
10	8,5	2,5	4	4	0
11	6	2,5	3,5	3	0
12	16	2,5	4	4	0
13	18	2	2,5	7	3
14	17	2,5	3	6	2
15	20	3	3	10	3
16	17	2	3	7	3
17	16	2,5	3	8	4
18	18	2,0	2	7	3
19	18	2,5	2	7	2
20	16	2,5	4	5	2
Average	17,38	3,06	3,32	7,9	3,45
Total				158	69
SD	5,39	1,44	1,01	3,33	2,31

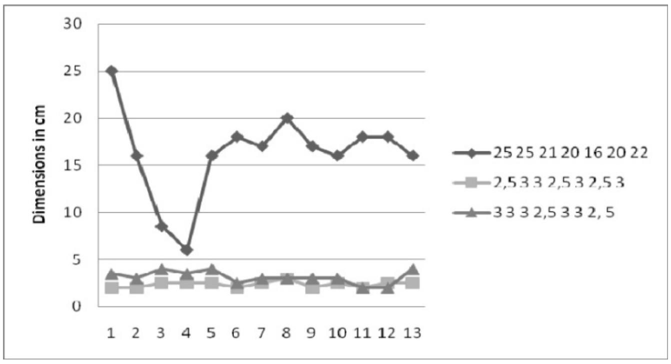

Fig. 1. Dimensions of the fruits of I. feuillei. Rhombus = length; grey squares = width; deep grey triangles = depth

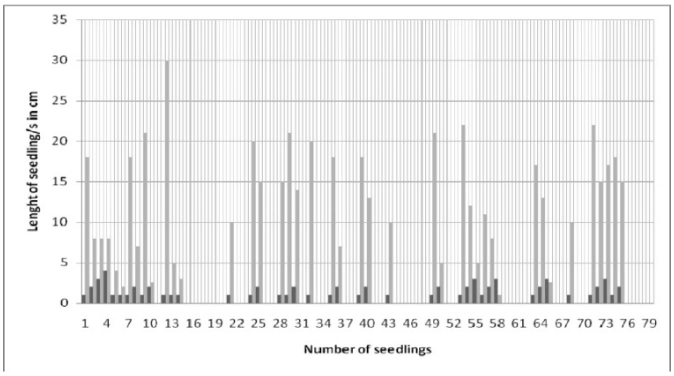

Fig. 3. Number of seedlings/seed and their length. Black bar = number of seedlings/seed; grey bar =length of each seedling

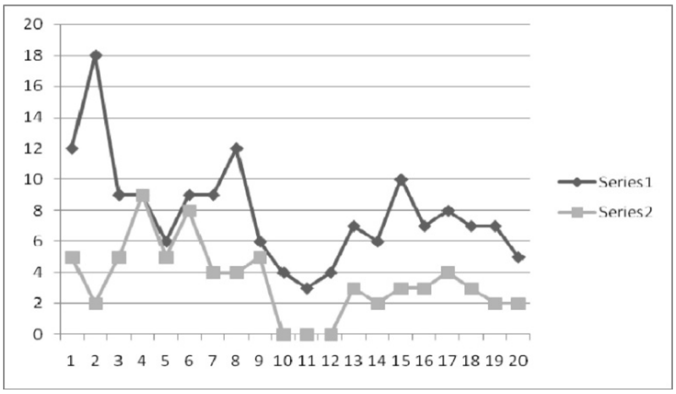

Fig. 2 . Number of seeds in each fruit of I. feuillei. Rhombus = total number of seeds; squares = number of germinated seeds

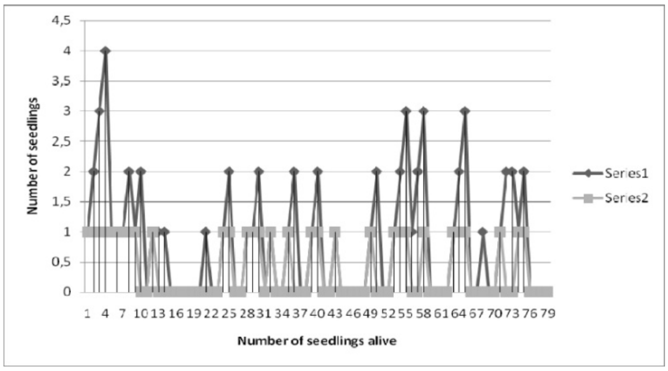

Fig. 4. Survival of seedlings. Black rhombus = number of seedlings/seed; grey squares = number of alive seedlings

Seeds

Each one has a sarcotesta and two cotyledons which protect one or more embryos (Fig. 5), as the polyembryony is common, it can be distinguished two or more embryo apices and their respective radicles. The total amount of sown germinated seeds by fruit was high (75), but in most of them with two or more embryos they do not continue their development (Table 2).

Seedlings

In natural conditions it is possible to see the first steps of seedlings development inward the fruit. The first protophyllous are opposite, bifoliolate (occasionally up to 4-foliolate), and develop after 60 days since the sown. The cotyledons are consumed and fall (Fig. 6).The root have nodules. The plants of 240 days have 2 protophyllous 2-foliolate and opposite, the third, fourth and fifth (eophylls) are alternate and 4-foliolate, their leaflets are lanceolate in shape.

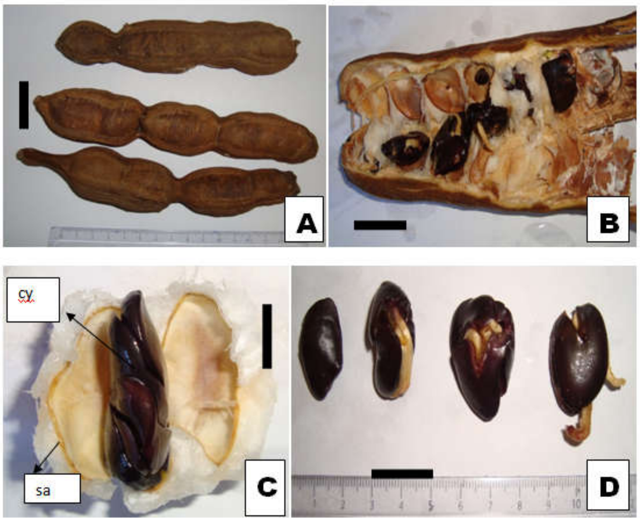

Fig. 5. A, fruits; B, longitudinal section of a fruit showing the seeds; C, Seed, cy = cotyledons, sa = sarcotesta; D, germinated seeds. Scales: A, B, C, bar = 1 cm; D, bar = 2 cm

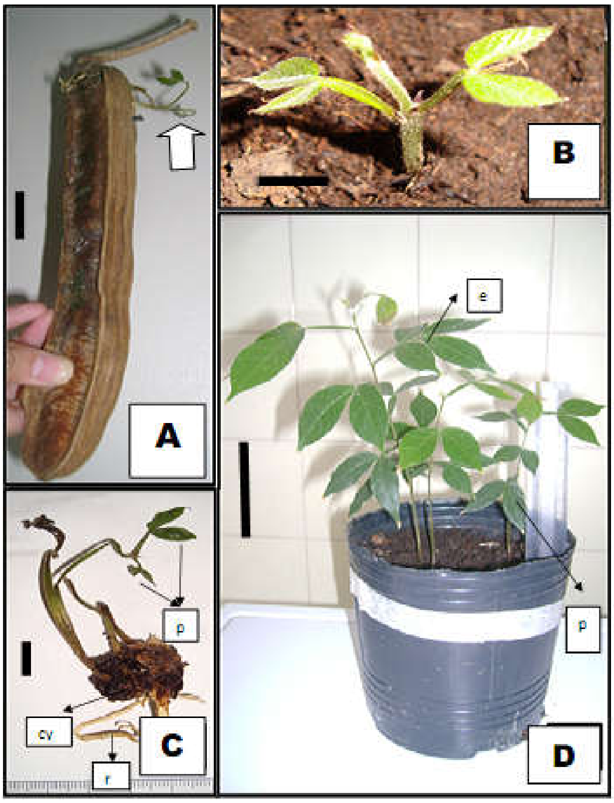

Fig. 6. A, fruit with seedling arising; B, seedling with two protophylles unifoliolate; C, seedling 60 days after germination with cotyledons (cy), two protophylls (p) and roots; Plants 240 days after germination, cotyledons fallen, it can be distinguished the protophyllous (p) and the eophylls (e). Bars: A, bar = 2 cm; B, C, bar = 1 cm; D, bar = 10 cm

Survival

The survival of the seedlings apparently has correlation with the polyembryony, at least during the first steps of their development (Table 2, Fig. 4). The seedlings that reached alive the 240 days were 31 (the 41,33%), while the percent of death ones constitute the 58,666 %. The results of the t test show that the differences are not significant (t value = 1,4 , t from tables = 2,64 for v = 73, p = 0,005).

Table 2. Survival of seedlings

Number of seedlings	Number of live seedlings	Number of dead seedlings
1	1	0
2	1	0
3	1	0
4	1	0
1	1	0
1	1	0
1	1	0
2	1	0
1	1	0
2	0	0
0	0	0
1	1	0
1	0	0
1	0	0
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
1	0	1
0	0	1
0	0	1
1	1	0
2	1	0
0	0	1
0	0	1
1	1	0
1	1	0
2	1	0
0	0	1
1	1	0
0	0	1
0	0	1
1	1	0
2	0	1
0	0	1
0	0	1
1	1	0
2	1	0
0	0	1
0	0	1
1	1	0
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
1	1	0
2	0	1
0	0	1
0	0	1
1	1	0
2	1	0
3	1	0
1	0	1
2	0	1
3	1	0
0	0	1
0	0	1
0	0	1
0	0	1
1	1	0
2	1	0
3	1	0
0	0	1
0	0	1
1	0	1
0	0	1
0	0	1
1	1	0
2	0	1
2	0	1

.... *Continued*

1	1	0
2	1	0
0	0	1
0	0	1
0	0	1
0	0	1
Total = 75	Total = 31	Total = 44
Average	0,392	0,56
Standard deviation	0,49	0,5

DISCUSSION AND CONCLUSION

Oliveira (1999) studied the germination and seedling development in species of *Leguminosae* that belong to different Subfamilies, analyzing the germination and development of seedlings of *I. edulis* Mart. The results obtained with *I. feuillei* agree generally with his observations, but here the authors conclude that if the seeds germinate inside the fruit it is impossible to qualify the germination as cryptohypogeous, more on, because of the vivipary exist in this plants. Bonjovani (2008) analysed the seeds of *Inga vera* Willd.subsp. *affinis* (DC) T. D. Penn., reporting them as recalcitrant but tolerant to low temperatures (-2˚C). Nowadays few cases of polyembryony in species of *Inga* are reported, for example: *I. laurina* (Lieberg and Joly, 1993), *I. uruguensis* and *I. affinis* (Roberts, 1973) . Assuming the ecological and evolutionary relevance of the viviparous mode of germination and the polyembryony, in this work it was studied one of the more used species of *Inga* with the hope that in the future the knowledge of this aspect in the genus should be completely known. In the present study the seeds and seedlings of *I. feuillei* were analyzed. Perhaps in the future with much more documentation it should be possible to analyze the sense of the production of many embryos per seed if only one or none will survive. It can be conclude that in *I. feuillei* the seeds germinate inside the fruit, the cotyledons do not photosynthetize, store the reserves with which the embryo or embryos will start to grow; exist polyembryony; the development of each seedling depend of the competence among sister plants, perhaps during the first steps of the development. The survival of the seedlings do not increases with the existence of polyembryony. There is a negative correlation between the length of a seedling and the existence of sister ones. The length of the fruit determine the number of germinated seeds.

Competing interests

The authors declare that they have no competing interests.

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REFERENCES

Bonjovani, H. R. and Barbedo, C. J. 2008. Tolerancía de embriôes de ingá a bajas temperaturas. *Revista Brasil. Bot*. 31 (2) : 345 – 356.

Ducke, J. A. and Polhill, R. M. 1981. Seedlings of Leguminosae: 941 - 949. In: R. M. Polhill and P. H. Raven (eds.): Advancesd in Legume Systematics. Vol. II. Kew, Royal Botanic Gardens.

Faria, J. M. R., Van Lamneren, A. A. M. and Hielhorst, H. W. 2004. Dessication sensibility and cell cycle aspects in seed of *Inga vera* subesp. *affinis*. *Seed Sci. and Research*. 14 : 165 – 178.

Fedorov, A. A. 1966. The structure of the tropical rainforest and speciation in humid tropics. *J. Ecol*. 54: 1 -11.

Foster, S. A. 1986. On the adaptive value of large seeds for tropical moist forest trees: A review and Synthesis. *The Bot. Rev.* 52 (3): 261 – 299.

Hoc, P.S. 1990. Las especies argentinas de *Inga* (Leguminosae, Mimosoideae). Darwiniana/ IBODA-CONICET. ISSN: 0011-6793. 30: 237-258.

Holmgren, P. K., Holmgren, N. H. and Barnett, L. C. 1990. Index Herbariorum. Part I: The Herbaria of the world. 8˚ ed. *Regnum Veg*. 120: 1 – 693.

Ichie, T., Ninomiya, I. and Kazuiko, O. 2001. Utilization of seeds reserves during germination and early seedling growth by *Dryobalanops lanceolata* (Dipterocarpaceae). Journ. Trop. Ecol. 17 (3) : 371 – 378.

Lieberg, S. A. and Joly, C. A. 1993. Inga affinis DC (Mimosaceae): germination and growth of submerged seedlings. Rev. Bras. De Bot. 16 : 175 – 179.

Oliveira, D. M. 1999. Morfología de plántulas de Leguminosae. *Acta Bot. Bras*. 13 (3): 263 – 269.

Pennington, T. D. 1997. The genus *Inga*. Royal Botanic Gardens, Kew. 844 pp.

Pritchard, H. W., Haye, A. J., Wight, W. J. and Steadman, K. J. 1995. A comparative study of seed variability in *Inga* species: dessication tolerance in relation to the physical characteristics and chemical composition of the embryo. *Seed Sci. and Technol.* 23: 85 – 100.

Roberts, E. H. 1973. Predicting the storage life of seeds. *Seed. Sci. and Technol*. 1: 499 – 514.

Zapater, M. A., Hoc, P. S., Lozano, E. C. and Sühring, S. S. 2014. Delimitación de las especies argentinas del género *Inga* (Mimosoideae) mediante técnicas numéricas. *Darwiniana*, nueva serie 2(2): 248.

Hoc, P. S. 2005. Insert this reference below Hoc, P. S. 1990. 2005. Flora Fanerogámica Argentina.128.Fabaceae, parte 14. Subfam. Mimosoideae, parte 5. Tribu VIII. *Ingeae.* P. Programa PROFLORA.CONICET, ISSN: 0328-3453. Fascículo 93: 1-25.

http://es.numberempire.com/statisticscalculator.php.

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