Conductivity test in seeds of different passion flower species

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Abstract – The objective of this work was to evaluate the use of the conductivity test as a means of predicting seed viability in seven *Passiflora* species: *P. alata*, *P. cincinnata*, *P. edulis* f. *edulis*, *P. edulis* f. *flavicarpa*, *P. morifolia*, *P. mucronata*, and *P. nitida*. Conductivity of non-desiccated (control), desiccated, and non-desiccated cryopreserved seeds was determined and related to their germination percentage. The obtained results suggest that the electrical conductivity test has potential as a germination predictor for *P. edulis* f. *flavicarpa* seed lots, but not for the other tested species.

Index terms: *Passiflora*, seed cryopreservation, seed desiccation, seed viability.

Teste de condutividade em sementes de diferentes espécies de maracujá

Resumo – O objetivo deste trabalho foi avaliar o uso do teste de condutividade como meio de predição da viabilidade de sementes de sete espécies de *Passiflora*: *P. alata*, *P. cincinnata*, *P. edulis* f. *edulis*, *P. edulis* f. *flavicarpa*, *P. morifolia*, *P. mucronata* e *P. nitida*. A condutividade de sementes não dessecadas (controle), dessecadas e não dessecadas criopreservadas foi determinada e relacionada ao seu percentual de germinação. Os resultados obtidos sugerem que o teste de condutividade elétrica tem potencial como preditor de germinação para os lotes de sementes de *P. edulis* f. *flavicarpa*, mas não para os das outras espécies testadas.

Termos para indexação: *Passiflora*, criopreservação de sementes, dessecação de sementes, viabilidade de sementes.

Passiflora L. is the most representative genus of the Passifloraceae family. *Passiflora* species are commonly known as passion flowers and are widely distributed throughout tropical and subtropical regions (Ulmer & MacDougal, 2004). This genus includes edible (*P. edulis*) and ornamental passion fruit species (Abreu et al., 2009). Seed germination behavior has been studied by several authors, who reported that seeds of numerous *Passiflora* species show a combination of physical and physiological dormancy (Delanoy et al., 2006; Araújo et al., 2007; Barbosa et al., 2012; Veiga-Barbosa et al., 2013). Furthermore, cryopreservation has proven to be a suitable procedure for the long-term conservation of several *Passiflora* species (Meletti et al., 2007; González-Benito et al., 2009; Veiga-Barbosa et al., 2013).

Seed viability indicators are useful for species in which germination is slow or that present dormancy, as it is the case of several *Passiflora* species (Barbosa et al., 2012; Veiga-Barbosa et al., 2013). Seed deterioration during ageing may be associated with biochemical and metabolic alterations that result in a loss of membrane integrity (Mavi et al., 2014). This loss of membrane integrity leads to electrolyte leakage, which increases the electrical conductivity of seed leaching and is associated with viability loss in several species (Mira et al., 2011). In a recent study, Barbosa et al. (2012) showed the efficiency of the electrical conductivity test for yellow passion fruit (*P. edulis* Sims f. *flavicarpa*) seeds.

The objective of this work was to evaluate the use of the conductivity test as a means of predicting seed viability in seven *Passiflora* species: *P. alata*, *P. cincinnata*, *P. edulis* Sims f. *edulis*, *P. edulis* Sims f. *flavicarpa*, *P. morifolia*, *P. mucronata*, and *P. nitida*.

Ripe fruits of two to three wild accessions of seven *Passiflora* species were collected between 2002 and 2010 in the municipalities of Ilheus and Cruz das

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Almas in the state of Bahia, and in the municipalities of Campinas, Jaboticabal, and Piracicaba in the state of São Paulo, Brazil. Seeds were manually separated from the pulp of ripe fruits, washed with room-temperature tap water, and dried in laboratory conditions for 7 days. Seeds were then stored at room temperature, of approximately 25ºC, inside hermetic containers until the beginning of the trials in 2011. Seed lots of 65–70 seeds were desiccated inside plastic containers with silica gel for 72 hours. Non-desiccated seeds of each accession were placed inside polypropylene cryovials and immersed in liquid nitrogen at -196ºC for 1 week. Non-desiccated non-cryopreserved seeds were used as a control.

Electrolyte leakage for non-desiccated non-cryopreserved (control), desiccated, and non-desiccated cryopreserved *Passiflora* seeds was evaluated and related to their germination percentage. For each accession and treatment, three replicates of 20 seeds each were immersed for 24 hours in 10 mL of deionized water at room temperature of approximately 25ºC. Then, electrical conductivity was measured with the EC-meter GLP 31 conductivity meter (Crison: Líderes en Eletroquímica, Alella, Barcelona, Spain). Results are expressed as µS cm^{-1} g^{-1} fw. For each species, the relationship between electrolyte loss and seed germination was analyzed following a linear regression, using SPSS Statistics, version 20 (IBM Corporation, Armonk, NY, USA), with data from the different accessions and treatments. See germination data of the studied *Passiflora* accessions in Veiga-Barbosa et al. (2013).

Electrolyte leakage of control seeds varied highly among species, considering the average of accessions from each species, ranging from 182 to 826 µS cm^{-1} g^{-1} fw (Figure 1). *Passiflora edulis* and *P. edulis* Sims f. *flavicarpa* showed the lowest conductivities in all treatments, whereas *P. mucronata* showed very high conductivity values (Figure 1). Within species, there was no significant effect of treatments on conductivity.

The relationship between electrolyte loss and seed germination was analyzed for each species with data from the different accessions and treatments (Figure 2). Electrolyte leakage was significantly related to a decrease on seed germination capacity only in *P. edulis* Sims f. *flavicarpa* (R^2=0.743; p=0.03); for *P. edulis* seeds, that relationship was not significant (R^2=0.404; p=0.066). For these taxa, the values of seed electrolyte leakage for highly viable seeds were under 100 µS cm^{-1} g^{-1} fw. A decrease in seed viability resulted in a progressive increase in conductivity, to values above 250 µS cm^{-1} g^{-1} fw for germination percentages under 50%. No significant linear regression was observed between conductivity and germination in the rest of the studied species (Figure 2). In addition, conductivity and germination had a proportional increase in *P. nitida*.

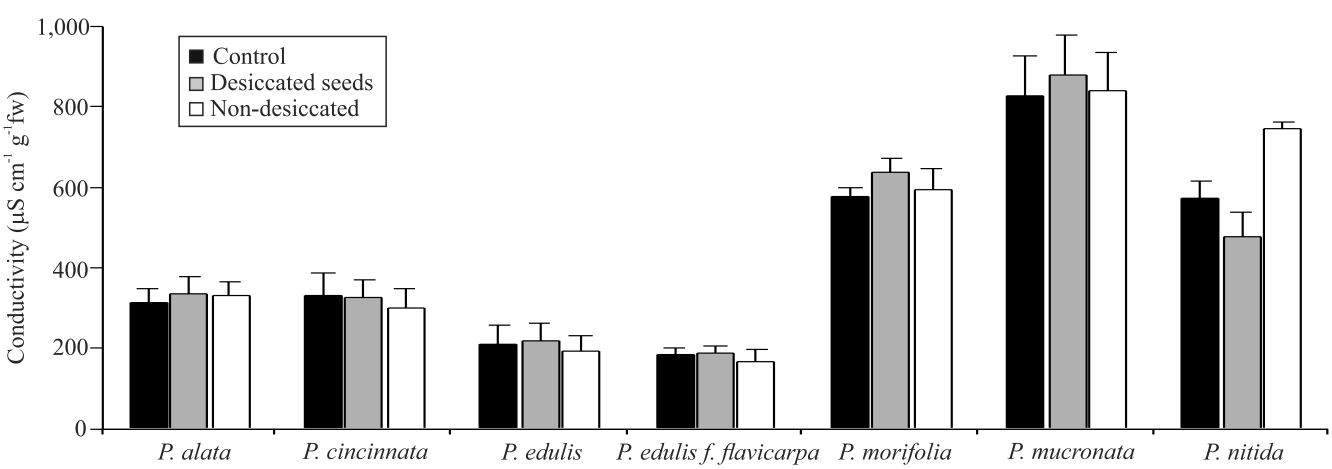

Figure 1. Electrolyte leakage of seeds of seven *Passiflora* species after three conservation treatments: non-desiccated non-cryopreserved seeds (control), desiccated seeds, and non-desiccated cryopreserved seeds. Bars represent standard errors. Conductivity means are the average of three accessions, except for *P. morifolia* and *P. nitida* for which two accessions were studied.

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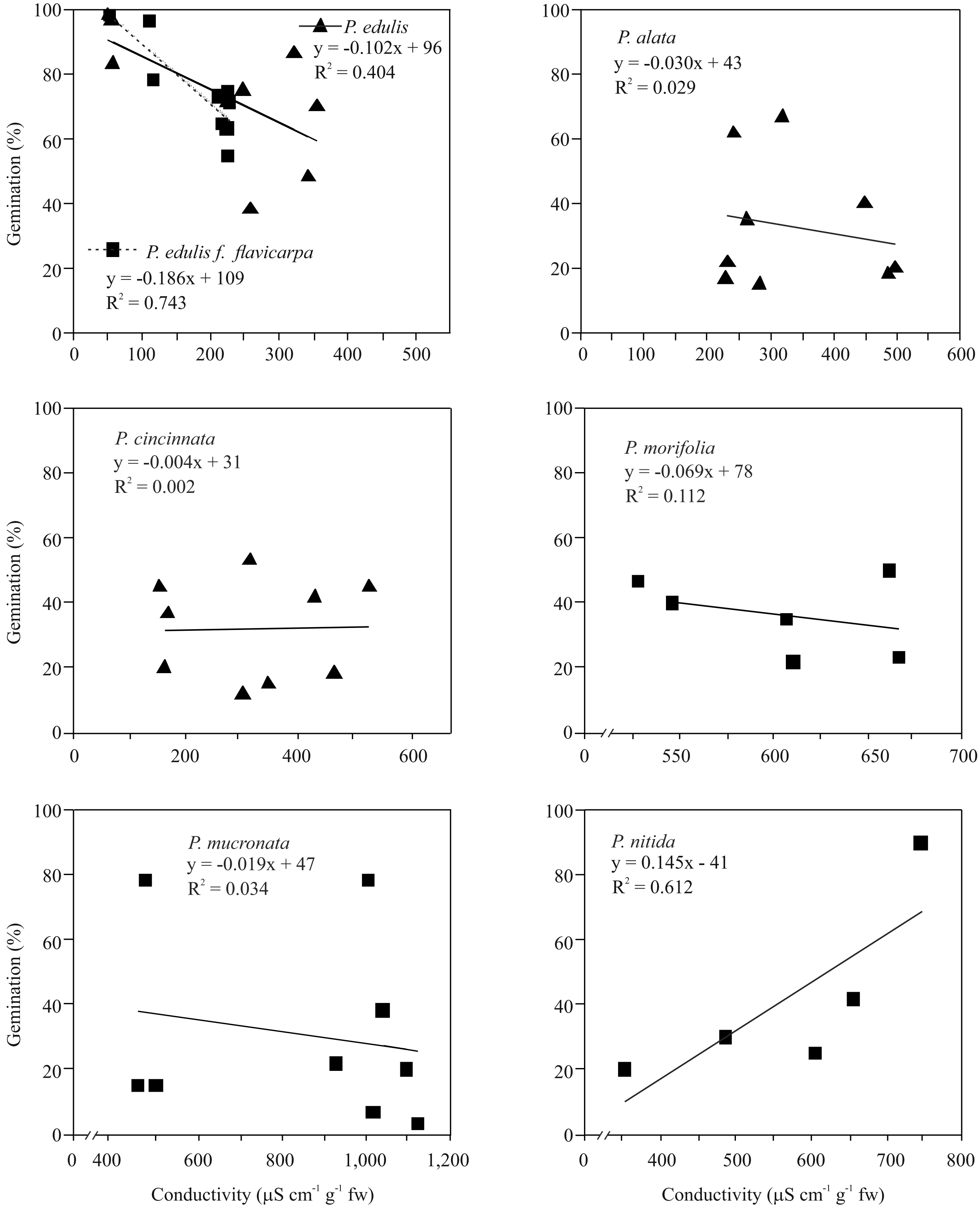

Figure 2. Relationship between electrolyte leakage of seeds from seven *Passiflora* species and the final germination percentages reached by three or two accessions of each species after three conservation treatments: non-desiccated non-cryopreserved seeds (control); desiccated seeds; and non-desiccated cryopreserved seeds. Values are the averages of three replicates. Linear regression curves were fitted for each species and were significant (p=0.03) only for *P. edulis* Sims f. *flavicarpa*.

Delanoy et al. (2006) found that the final germination percentages of *P. mollisima*, *P. tricuspis*, and *Passiflora nov* sp. seeds were below the percentage of viable embryos obtained by the germination of excised embryos. Before the present study was carried out, previous trials were performed in seeds from these *Passiflora* accessions with the tetrazolium viability test, which also did not give reliable results. Therefore, the effectiveness of another viability test, the electrical conductivity test, was explored in the present study. The obtained results showed high variability in conductivity among *Passiflora* species. Moreover, *P. mucronata* showed very high conductivity values in all treatments compared to other species, and this species produced mucilage secretion after imbibition, which could have increased considerably electrolyte leakage. Despite this, it seems unlikely that the test could be applied for the whole *Passiflora* genus. At the species level, membrane integrity loss was related to seed viability in the different accessions of *P. edulis* Sims f. *flavicarpa* studied. It has been previously reported that *P. edulis* Sims f. *flavicarpa* germination and seedling emergence was related to electrical conductivity (Araújo et al., 2007; Barbosa et al., 2012). However, in the present work, no significant linear relationship was found in *P. edulis* seeds.

The obtained results suggest that the electrical conductivity test has potential as a germination predictor for *P. edulis* Sims f. *flavicarpa* seed lots, but not for the other tested species.

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