Australian Journal of Basic and Applied Sciences, 11(2) February 2017, Pages: 115-122

AUSTRALIAN JOURNAL OF BASIC AND APPLIED SCIENCES

ISSN:1991-8178 EISSN: 2309-8414
Journal home page: www.ajbasweb.com

Hydrocondicionament and storage of yellow araçazeiro seeds

[1]Marciéli da Silva, [2]Juliana Cristina Radaelli, [3]Gisely Corrêa de Moura, [4]Carlos Kosera Neto, [5]Alberto Ricardo Stefeni, [6]Alexandre Hack Porto, [7]Cassio Fernando Foquesatto, [8]Américo Wagner Júnior

[1]Department of Agronomy, Federal Technological University of Paraná (UTFPR), Pato Branco, PR, 85503-390, Brazil.
[2]Department of Agronomy, Federal Technological University of Paraná (UTFPR), Pato Branco, PR, 85503-390, Brazil.
[3]Department of Agronomy, Federal Technological University of Paraná (UTFPR), Dois Vizinhos, PR, 85660-000, Brazil.
[4]Department of Agronomy, Federal Technological University of Paraná (UTFPR), Pato Branco, PR, 85503-390, Brazil.
[5]Department of Agroecosystem, Federal Technological University of Paraná (UTFPR), Dois Vizinhos, PR, 85660-000, Brazil.
[6]Department of Agronomy, Federal Technological University of Paraná (UTFPR), Pato Branco, PR, 85503-390, Brazil.
[7]Department of Agronomy, Federal Technological University of Paraná (UTFPR), Pato Branco, PR, 85503-390, Brazil.
[8]Department of Agronomy, Federal Technological University of Paraná (UTFPR), Pato Branco, PR, 85503-390, Brazil.

Address For Correspondence:
Department of Agronomy, Federal Technological University of Paraná (UTFPR), Pato Branco, PR, 85503-390, Brazil.
E-mail: marcielidasilva@hotmail.com

ARTICLE INFO

Article history:
Received 18 December 2016
Accepted 16 February 2017
Available online 28 February 2017

Keywords:
Germination, P. cattleianum Sabine, Fruticulture, Native Fruit

ABSTRACT

The genus Psidium contains approximately 130 species distributed in tropical to temperate regions. Araçá is a potentially marketable native fruit, having two different stains in its epidermis, red (P. cattleianum) or yellow (P. cattleianum var. lucidum). With antioxidant activity, these fruits present high fiber content, and the intake of 100g represents 20% of the daily recommendation based on a 2000 Kcal diet. In this way, it has great possibilities of commercialization, both in natura and by the industry. Another advantage is the production of seedlings from seeds, these being apomictic. The objective was to evaluate the germination power of araçazeiro seeds submitted to hydrocondicionament methods. Yellow araçazeiro seeds cv. 'Ya-cy' were manually extracted and dried in the shade for 24 hours and placed in 50mL beakers. A completely randomized design was used in a two-factorial scheme (8 x 4), the first factor being storage time (0, 10, 20, 30, 60, 90, 120, 150 days), and the second, forms of hydrocondicionament (without hydrocondicionament, moistened cotton, 24 hours in the water every 7 days and 24 hours in the water every 14 days), with four replicates of 100 seeds. After each storage period the seeds were seeded in a gerbox® box containing germitest® moistened paper and placed in BOD with a temperature of 25°C. The germination count was performed daily. The germination speed index, average germination time and percentage of germination were evaluated 60 days after the implementation of the experiment. The data were previously submitted to the normality test of Lilliefors. Afterwards, they were submitted to analysis of variance and Duncan averages comparison test ($p \leq 0.05$) using the SANEST® software. All treatments except the seeds that received 24-hour treatment in the water every seven days, maintained the viability for 30 days, after that period there was a decrease in the germination. Regarding the storage time, at 0, 10 and 20 days, there was no statistical difference between treatments. The GSI of the araçazeiro seeds showed a similar result to that occurring in the germination, decreasing the speed as a function of storage time, not statistically differing from the treatment that did not receive water. AGT did not differ statistically between treatments until 30 days of storage. Hydrocondicionament is not indicated for yellow araçazeiro seeds.

To Cite This Article: Marciéli da Silva, Juliana Cristina Radaelli, Gisely Corrêa de Moura, Carlos Kosera Neto, Alberto Ricardo Stefeni, Alexandre Hack Porto, Cassio Fernando Foquesatto, Américo Wagner Júnior., Hydrocondicionament and storage of yellow araçazeiro seeds. ***Aust. J. Basic & Appl. Sci.,*** *11(2): 115-122, 2017*

INTRODUCTION

The genus Psidium contains approximately 130 species distributed in tropical to temperate regions (Drehmer and Amarante, 2008; Reitz and Klein, 1997). Among the species of this genus, the most prominent are guava (Psidium guajava L.) and araçazeiro (*P. cattleianum Sabine*) (Lorenzi, 2008). In Brazil, the distribution of araçá covers the Atlantic coast, from Bahia to Rio Grande do Sul, also occurring in Uruguay (Radeira *et al*., 2004; Brack *et al*., 2007; Donadio *et al*., 2002).

Araçá is a potentially marketable native fruit, having two different stains in its epidermis, red (P. cattleianum) or yellow (*P. cattleianum* var. *lucidum*) (Lisbôa, *et al*., 2011; Franzon *et al*., 2009).

In the South of Brazil, araçazeiros are low heights in relation to other regions, reaching up to 3m. It produces sweet, succulent fruits rich in minerals such as calcium, phosphorus and iron (Giacobbo *et al*., 2008; Donadio *et al*., 2002), as well as high vitamin content, with slight astringency and low acidity (Galho *et al*., 2007), with a moisture content close to 86% and sugar estimated at 7% (Coradin *et al*., 2011). The fruit is also rich in phenolic compounds that are positively correlated with antioxidant activity (Sandri *et al*., 2014). These fruits present high fiber content, and the intake of 100g represents 20% of the daily recommendation based on a 2000 Kcal diet (Silva *et al*., 2014).

In this way, it has great possibilities of commercialization, both in natura and by the industry. Another advantage is the production of seedlings from seeds, these being apomictic (Raseira *et al*., 2011). And this process plays an important role in plant breeding, as it provides an opportunity for cloning through the seed (Hanna, 1987).

Due to the vegetative propagation don't present good results for the araçazeiro, with average near to 33% of rooting of cuttings, its propagation is restricted to the seeds (Manica, 2000). However, in order to be successful in the sexual propagation, it is necessary to use methods that aim to break the physical barrier of these seeds, which have a hard and impermeable tegument, which makes the germination difficult, making it slow and uneven, being an obstacle to obtain commercial cultivars (Cisneiros *et al*., 2003).

In order for the germination process to be triggered, hydration of the seed tissues is necessary, which is influenced by several factors such as its initial water content, temperature, imbibition velocity (Ferreira *et al*., 2006), the osmotic potential of the solution (Miranda *et al*., 2010; Balestrazzi *et al*., 2011), seed origin (Mataruga *et al*., 2010) and intrinsic characteristics, such as size (Duarte *et al*., 2010) and permeability of the protective coating (Guimarães *et al*., 2011).

The physiological conditioning or pre-treatment of seeds, allows the rehydration of the seed to promote metabolic processes normally activated during the initial germination phase, but preventing the protrusion of the radicle (Bewley *et al*., 2013, Paparella *et al*., 2015).

Hydrocondicionament is the method where the seeds are immersed in water for a pre-established period of time and temperature, so that the amount of water absorbed by the seed is regulated, causing stages I and II of the germination, paralyzing the imbibition before the stage of protrusion of the primary root (Posse *et al*., 2002).

The use of this technique has demonstrated practical results of great agronomic importance, such as the increase of germination rate, germination speed and emergence of seedlings, as well as uniformity. These factors may result in the best establishment of the crop under stressful conditions and thus achieve high levels of yield (McDonald, 2000; Basra *et al*., 2005; Bewley *et al*., 2013; Paparella *et al*., 2015).

After the physiological conditioning, as seeds that perform relatively high water contents and unsuitable for a conservation of the physiological potential does not proceed from the storage (ARAÚJO *et al*., 2011). Thus, drying must be done adequately for a probability of reversal of the beneficial effects of treatment (MARCOS FILHO, KIKUTI, 2008).

In a study carried out by Pinedo and Ferraz (2008), they observed that hydrocondicionamento proved to be the best method for emergence and formation of Parkia pendula seedlings. It is worth noting that it is a more economical and easy to apply treatment in the nursery.

Using the technique of hydrocondicionamento in seeds of Poncirus trifoliata (L.) Raf. (3% m / v), gelatin and uncoated seeds, Pirola *et al.* (2016) verified that the application of biofilm based on cassava starch proved viable for hydrocondicionadas seeds of P. trifoliata when stored up to 30 days without damaging the germinative potential.

Thus, the objective of this work was to evaluate the germination power of araçazeiro seeds submitted to different methods of hydrocondicionament during storage.

MATERIAL AND METHODS

The experiment was carried out at the Laboratóriod e Fisiologia Vegetal da Universidade Tecnológica Federal do Paraná, campus Dois Vizinhos. There were used yellow araçazeiro seeds cv. 'Ya-cy', from the orchard of the same institution.

The seeds were manually extracted by means of friction in a fine mesh sieve with virgin lime and then washed in running water to remove the residues. And dried under shade paper towels for 24 hours, after this period they were properly separated and placed in 50ml plastic cups.

It was used a completely randomized design with two-factorial (8 x 4), the first factor was the storage time (0, 10, 20, 30, 60, 90, 120, 150 days) and the second, forms of hydrocondicionament (without hydrocondicionament (without water), with wet cotton, 24 hours in the water every 7 days and 24 hours in the water every 14 days), with four replicates of 100 seeds. After each storage period the seeds were seeded in a gerbox® box containing germitest® paper moistened as a substrate and placed in BOD with a temperature of 25°C with no light. The germinated seeds were counted daily, being considered the ones that presented radicle.

The percentage of germinated seeds, germination speed index (GSI) and average germination time (AGT) were evaluated 60 days after the experiment. The data of the evaluated variables were previously submitted to the normality test of Lilliefors, where it showed the need to transform the data of the three variables, using sine arc $\sqrt{x}/1$ for germination and $\sqrt{x+1}$ for GSI and AGT. Afterwards, they were submitted to analysis of variance and Duncan averages comparison test ($p \leq 0.05$) for the qualitative variables and regression for the quantitative variables using the SANEST® software.

RESULTS AND DISCUSSION

The germination, germination speed index and average germination time were influenced by the periods of hydrocondicionament and storage, as well as their interaction.

All treatments except the seeds that received 24-hour treatment in the water every seven days, maintained the viability for 30 days, after that period there was a decrease in the germination (Table 1), because the excess moisture in the seed, may have caused deterioration of embryo reserves, drastically reducing germination.

The percentage of germination of seeds hydrocondicionated for 24 hours every 14 days and without hydrocondicionament, when stored for 20 days, obtained the greater germination rate, not statistically differing of 10 and 30 days of storage. For hydrocondicionament during 24 hours every seven days, the highest percentages of germination occurred at 10 and 20 days of storage. With the use of moistened cotton to maintain seed viability, storage times of 0, 10, 20 and 30 days did not differ statistically from each other at 5% error probability level. At 150 days, there was no germination in any of the treatments (Table 1).

Regarding the storage time, at 0, 10 and 20 days, there was no statistical difference between treatments. At 30 days, when seeds were hydrocondicionate for 24 hours every seven days, the lowest average was obtained in relation to the other treatments. At 60 days of storage, the lowest percentage of germination was observed with the use of hydrocondicionament for 24 hours every 14 days and with the use of moistened cotton, however at 90 days the higher germination rate was through hydrocondicionament for 24 hours every 14 days. In 120 days, the seeds presented the highest germination rate with the hydrocondicionament during 24 hours every 7 days (Table 1).

Table 1: Percentage of germination of yellow araçazeiro seeds after the period of storage and hydroconditionament. UTFPR, Dois Vizinhos, 2017

Storage time	Without water			24 hours in water every seven days			24 hours in water every fourteen days			Moistened cotton		
0 day	67,03	a	A	73,19	a	A	69,45	A	A	70,67	a	A
10 days	52,00	a	A	67,83	a	A	57,00	A	A	53,01	ab	A
20 days	58,60	a	A	63,33	a	A	66,08	A	A	51,00	ab	A
30 days	55,02	a	A	7,54	c	B	57,01	A	A	39,40	b	A
60 days	12,83	b	AB	27,69	b	A	3,71	cd	B	7,99	c	B
90 days	0,78	c	B	0,18	d	B	20,83	B	A	1,95	cd	B
120 days	NG			32,44	b	A	7,07	bc	B	0,06	d	C
150 days	NG			NG			NG			NG		
CV(%)	30,69											

*Averages followed by distinct letters, lowercase in the column and upper case in the row, within the same cicle, differ from each other at 5 %, by Duncan's test. NG: did not germinate.

According to Marcos Filho (2005), the rapid absorption of water can cause seed, metabolic processes and respiration injuries, thus reducing the percentage of germination (Figliolia *et al*., 1993).

Sometimes physiological conditioning does not change the percentage of germination, authors such as Kikuti and Marcos Filho (2008) studying cauliflower seeds and Gurgel Júnior (2009) with cucumber seeds confirm this report, since they did not find significant differences for this variable.

Schwember and Bradford (2010) working with the hydroconditioning of lettuce seeds in distilled water for 6 hours and osmoconditioning for 24 hours, obtained germination values at 20°C of 96% and 100% respectively. The seeds of araçazeiro obtained the highest averages of germination when submitted to hydrocondicionament every seven days until completing 10 days of storage, after a decrease in the germination of this treatment.

Yeh *et al*. (2005) working with são-caetano-melon seeds, verified that germination is higher when submitted to conditioning compared to the control, however the treatment made them more susceptible to deterioration during prolonged storage, the same was demonstrated in this study because the seeds of araçazeiro submitted to 60 days of storage with hydrocondicionament were losing the viability and drastically reducing the percentage of germination.

The beneficial effects of osmotic conditioning can be altered by the duration of the treatment, type of solution and the characteristics of the seed lots used, as observed for beet seeds (Costa and Vilela, 2006) and onion (Caseiro and Marcos Filho, 2005). Whose conditioning reduced germination and seed performance under the conditions evaluated.

Germination and germination speed index show the seed viability (Rodrigues *et al*., 2012). The GSI of the araçazeiro seeds showed a similar result to that occurring in the germination, decreasing the speed as a function of storage time, (Table 2), not statistically differing from the treatment that did not receive water.

All treatments obtained the highest GSI at time zero, after their average values did not differentiate from the treatment that did not receive water. At 150 days, as there was no germination, the values for the GSI were also zero (Table 2).

Up to 30 days of storage, treatments did not differ statistically from each other, after this period the lowest GSI average was found in the treatment of 24 hours in the water every seven days.

Table 2: Germinatios speed index of yellow araçazeiro seeds after the period of storage and hydroconditionament. UTFPR, Dois Vizinhos, 2017

Storage time	Without water			24 hours in water every seven days			24 hours in water every fourteen days			Moistened cotton		
0 day	3,41	a	A	3,66	a	A	3,54	a	A	4,04	a	A
10 days	1,45	b	A	2,21	b	A	1,61	b	A	1,47	b	A
20 days	1,88	b	A	2,21	b	A	2,25	b	A	1,44	b	A
30 days	1,71	b	A	0,31	c	B	2,00	b	A	1,24	b	A
60 days	0,42	bc	A	0,72	c	A	0,13	cd	B	0,25	c	AB
90 days	0,02	d	B	0,01	d	B	0,54	c	A	0,03	cd	B
120 days	NG			0,85	c	A	0,13	cd	B	0,00	d	B
150 days	NG			NG			NG			NG		
CV(%)	17,25											

* Averages followed by distinct letters, lowercase in the column and upper case in the row, within the same cicle, differ from each other at 5 %, by Duncan's test. NG: did not germinate.

The germination of araçazeiro seeds was higher at zero time for all treatments, starting approximately 15 days after planting, being similar to the periods of 10, 20 and 30 days maintaining a high germination rate, except for the treatment with 24 hours in the water every 7 days that presented a high germination drop at 30 days. At 30 days all treatments evaluated had lower germination percentages (Figure 1).

Thus, it was possible to verify that the treatment that did not receive water maintained its results similar to the others, indicating the need of hydrocondicionament for yellow araçazeiro seeds (Figure 1).

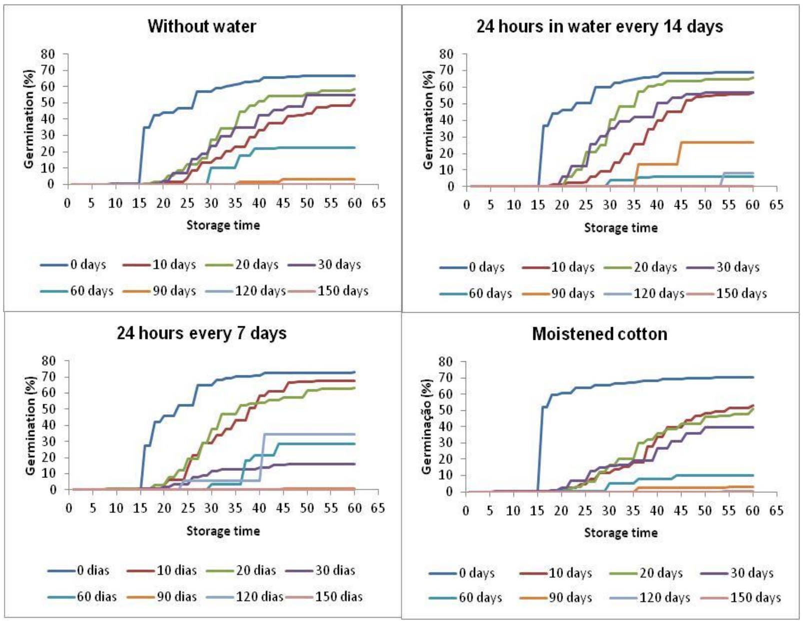

Fig. 1: Percentage of yellow araçazeiro seeds germination after the hydroconditionament period, in function of time. UTFPR, Dois Vizinhos, 2017

GSI may or may not be affected by pre-imbibition because this treatment depends on the type of seed, the characteristics of the species, the seed lot and genetic characteristics to be efficient for this variable (Nascimento, 2004). Angelim-saia seeds (Parkia pendula), when submitted to longer periods of hydrocondicionament, presented a reduction in the rate of germination and also in the homogeneity of the germination, showing sensitivity to this treatment (Pinedo and Ferraz, 2008), being similar to results found in this work for the araçazeiro seeds.

In order to evaluate the influence of physiological conditioning on carrot seeds submitted to a germination test at 20 and 30°C, there was no difference between conditioned and unconditioned seeds for both germination percentage and GSI (Costa *et al*., 2011). The same can be observed for the araçazeiro, since that until 20 days the treatments did not differentiate.

AGT did not differ statistically between treatments until 30 days of storage. The treatment of 24 hours in the water every 14 days was superior to the others with 30 and 90 days with averages of 30.47 and 44.87 respectively. On the other hand, the treatment with moistened cotton had the best average at 60 days of storage with AGT of 31.19.

All treatments presented higher AGT in function of storage time, being at the zero time the highest averages (Table 3).

Table 3: Average germination time of yellow araçazeiro seeds after storage and hydroconditionament period. UTFPR, Dois Vizinhos, 2017

Storage time	Without water			24 hours in water every seven days			24 hours in water every fourteen days			Moistened cotton		
0	21,27	e	A	21,41	d	A	20,95	e	A	18,35	c	A
10	38,28	cd	A	32,62	c	A	37,23	cd	A	38,36	b	A
20	32,73	d	A	31,18	c	A	30,56	d	A	37,23	b	A
30	34,40	bd	A	43,49	b	A	30,47	d	B	35,21	b	A
60	46,16	bc	A	37,55	bc	AB	39,91	c	AB	31,19	b	B
90	54,98	ab	AB	56,04	a	A	44,87	bc	B	52,75	a	AB
120	60,00	a	A	39,26	bc	B	54,00	ab	A	58,47	a	A
150	NG			NG			NG			NG		
CV(%)	7,75											

*Averages followed by distinct letters, lowercase in the column and upper case in the row, within the same cicle, differ from each other at 5 %, by Duncan's test. NG: did not germinate.

The average time for normal seedling formation was significantly reduced by hydroconditioning. In this case, there was a average decrease from 11.4 to 8.5 days in freshly harvested seeds, as well as in stored seeds from 11.4 to 9.1 days after partial soaking of 20% (Pinedo and Ferraz, 2008). These results indicated that adequate hydrocondicioning can increase the speed of germination of the seeds of Parkia pendula (Bradford, 1995; Nascimento, 2004).

Contrasting with the results obtained in this study, Farooq *et al*. (2006) observed that the hydrocondicionament of rice seeds caused a decrease in AGT, an increase in germination and vigor of seedlings, results also obtained in hydrocondicionated seeds of maize (Moradi and Younesi, 2009).

Conclusion:

All treatments except the seeds that received 24-hour treatment in the water every seven days, maintained the viability for 30 days, after that period there was a decrease in the germination.

The percentage of germination of seeds hydrocondicionated for 24 hours every 14 days and without hydrocondicionament, when stored for 20 days, obtained the greater germination rate, not statistically differing of 10 and 30 days of storage.

The GSI of the araçazeiro seeds showed a similar result to that occurring in the germination, decreasing the speed as a function of storage time, not statistically differing from the treatment that did not receive water.

AGT did not differ statistically between treatments until 30 days of storage.

The hydrocondicionament during the period of storage is not indicated for seeds of yellow araçazeiro.

Future Work:

It would be interesting to combine the hydrocondicionamento different temperatures of drying, or even the application of gibberilines or other phytoregulator in different dosages to accelerate and standardize the germination of these seeds.

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