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Storage temperature effect on seed emergence and substrates during the initial development of yellow passion fruit

Andrés Antonio Monge Vargas[1,*], Adriane Marinho de Assis[1,*], Michele Carla Nadal[1], Márcia Wulff Schuch[1] and Lilian Vanussa Madruga de Tunes[1]

[1]Universidade Federal de Pelotas, Plant Science Deparment, Eliseu Maciel Agronomy College, Campus Universitário Capão do Leão, mailbox 354, Pelotas, RS, CEP 96001-970, Brazil. *Co-corresponding authors, E-mail: amova11@gmail.com ; agroadri17@gmail.com

ABSTRACT

Efficacy in yellow passion fruit (*Passiflora edulis* Sims F. flavicarpa Deg) seedling production may be affected by irregular germination due, mainly, to a short period of seed dormancy, as well as to the use of the wrong substrate. Thus, the objective of this work was to evaluate the effect of three storage temperatures and three substrates during the initial development of yellow passion fruit seedling. The experiment was conducted in an agricultural greenhouse at Universidade Federal de Pelotas, RS. After the removal of the mucilage and drying, seeds were placed in Kraft paper packages and stored at 5 ºC, 10 ºC and room temperature (18 ± 0.6 ºC) for 15 days. Next, they were grown in Amafibra® coconut fiber, carbonized rice husk and S-10Beifort®. Seeds kept at 18 ºC showed shorter length of the longer root, with no difference from those stored at 5 ºC. There was no temperature effect on emergence, shoot length, number of leaves and dry weight biomass of shoot and roots. The highest germination percentage was found in the carbonized rice husk substrate; however, with the exception of the longer root length and the dry weight biomass of shoot and roots, the plant development was superior with the other substrates. Hence, the use of temperature of 10 ºC during storage, as well as coconut fiber and S-10 Beifort® as substrates are the better recommendation to improve the emergence and initial development of the yellow passion fruit.

Key words: *Passiflora edulis*, emergence, dormancy, mucilage.

INTRODUCTION

The use of seedlings of quality is the main factor for the success and production of fruit species. In the case of the yellow passion fruit, the reproduction of these seedlings can be made by asexual multiplication or sexually; and the most used method in commercial production is through seeds propagation (Fachinello et al., 2005; Martins et al. 2010; Aguiar et al., 2014).

Despite the wide use of the seed to obtain seedlings from this species, it is known that the passion fruit shows irregular germination, which may be related to the presence of inhibitor substances in the aryl (Martins et al., 2010), as well as in the mucilage (Pereira and Dias 2000). In addition, the tegument may show thickness between 90 and 130 µm and be constituted of five layers of cells (Cortéz et al., 2005).

It was detected for *Passiflora edulis* a seed dormancy period of 30 days at maximum (Meletti and Maia 1999; Lima et al., 2010), and this period affect the time required by growers to get seedlings quickly. Besides dormancy, other factors such as water, temperature, lighting and seeds quality may influence the success of sexual propagation (Fachinello et al., 2005). Among these, the substrate must show water retention capacity of 500 mL L^{-1}, density lower than 810 g/L (Hidalgo et al., 2009), pH 4.2 and electrical conductivity lower than 3.0 dSm^{-1} (Silva et al., 2010), which are adequate properties for seedlings of passion fruit (Kämpf et al., 2006).

Several materials can be used for propagation of fruit species such as rice husks, coconut fiber and vermiculite (Fernandes et al., 2006; Souza et al., 2006; Díaz et al., 2010; Hussain et al., 2014). However, the employment of agricultural residues, such as carbonized rice husks and coconut fiber, meaning the use of raw material and the contribution to protect the environment, by giving a useful destination to these surplus materials, which, many times are considered inconvenient for some areas of production. In addition, information to the use of substrates made with organic residues based on grape (*Vitis* spp.) seeds and stems, such as the commercial substrate S-10 Beifort® in passion fruit seedlings production is limited.

In view of these aspects, the objective of this work was to evaluate the effect of three storage temperatures on seeds dormancy and three substrates on the emergence and initial development of the yellow passion fruit tree.

MATERIALS AND METHODS

The experiment was conducted between the months of June and July of 2014, at Faculdade de Agronomia Eliseu Maciel Plant Science Department from Universidade Federal de Pelotas-RS, located at latitude 31°48'24.8'' S, longitude 52°24'46.1'' O and 13m of altitude.

Seeds from a yellow passion fruit (*Passiflora edulis*) were collected from a single harvest lot purchased in the local market. Fully matured seeds were selected from healthy plants, free of pests and diseases. After the harvest, they were placed in water for four days, in a plastic recipient (with capacity for 1 L), in order to remove mucilage by fermentation. Next, they were washed with running water on a polyethylene sieve, placed on paper towel and dried at room temperature (20 ± 0.2 ºC), for five days.

After the drying process, seeds humidity was determined at 6.5%, according to MAPA (2009). Seed coverings were removed by manual friction and then placed in Kraft paper packages and stored in a BOD (Biochemical Oxygen Demand) germination chamber, at temperatures of 5 ºC, 10 ºC and room (18 ± 0.6 ºC) for 15 days. After this period, they were grown on styrofoam trays of 128 cells, by placing two seeds per cell, 1 cm deep, with three types of substrates: carbonized rice husk, standard 47 coconut fiber Amafibra® and S-10 Beifort® composed of Class A agro-industrial organic residue (seed, grape bagasse and stems, ashes, peat and vegetal charcoal).

Trays were kept in an agricultural greenhouse covered with a polyethylene film, 150 µm thick, and irrigated with around 7 ml of running water, for each cell, three times a week. Next, when the seedlings reached 3.0cm of height, they were thinned, leaving only the most vigorous seedling. During the experiment, average air temperature was 21 ºC and air humidity 62 %.

After 50 days of seeding (Figure 1), the following variables were analyzed: emergence percentage; number of leaves; shoot length (cm); longer root length (cm); dry weight biomass of roots and shoot (g). In addition, this study measured density (g L^{-1}), water retention capacity (mL L^{-1}), pH and electrical conductivity (dS m^{-1}), according to Kämpf et al. (2006). Shoot length and greater root determination was made with the help of a graded rule, using the distance of the root-stem transition to the apical stem until the root system extremity, respectively. To assess the dry weight biomass of roots and shoot, the seedlings were placed in a drying oven at 60º C for 72 hours, when the weight was constant (Souza et al., 2015).

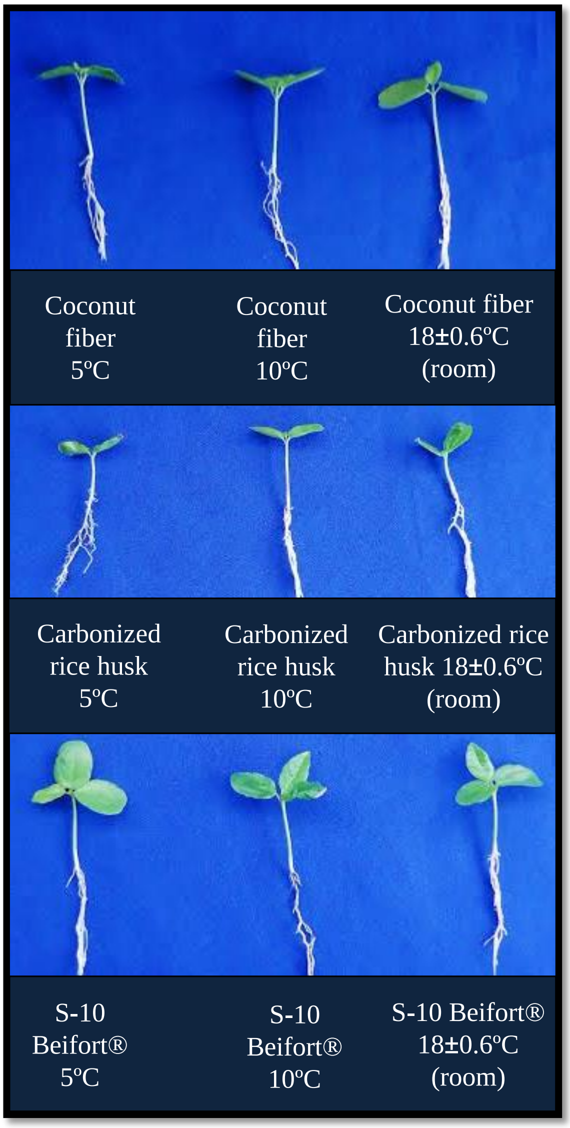

Figure 1. Yellow passion fruit seedlings (*Passiflora edulis* Sims F. flavicarpa Deg) 50 days after the establishment of the experiment. Pelotas, RS, Brazil. 2014.

The experimental design was in a completely randomized design with four replications and 50 seeds per replication and arranged as a factorial 3 x 3 with two factors (three storage temperatures and three kinds of substrates). Data were submitted to analysis of variance (ANOVA) and means were compared by the Tukey test at 5% of probability.

RESULTS AND DISCUSSION

All variables showed no significant interaction between the two studied factors, storage temperature and kinds of substrates, indicating that they act independently on germination and the initial development process of the seedlings, respectively (Table 1).

Table 1. Average percentage values for emergence, shoot length (cm), number of leaves per plant, longer root length (cm), dry weight biomass of roots and shoot (g) of yellow passion fruit, in response of seed storage and substrates. Pelotas, RS, Brazil. 2014.

Storage Temperature (ST)	Emergence (%)	Shoot length (cm)	Number of leaves per plant	Longer root length (cm)	Dry weight biomass of shoot (g)	Dry weight biomass of roots (g)
5º C	66 a*	2.79 a	0.76 a	4.72 ab	0.018 a	0.006 a
10º C	57 a	2.77 a	0.78 a	4.99 a	0.017 a	0.007 a
Room 18±0.6ºC	60 a	2.74 a	0.82 a	4.62 b	0.016 a	0.006 a
F	0.74 ns	0.15 ns	0.14ns	3.86 **	0.49 ns	0.43ns
Kind of substrates (KS)						
CRH	73 a	2.35 b	0.18 b	4.83 a	0.013b	0.007 a
Coconut fiber	54 b	2.88 a	1.02 a	4.63 a	0.017 a	0.005 a
S-10 Beifort®	54 b	3.07 a	1.16 a	4.87 a	0.019 a	0.007 a
F	4.44 **	28.59 **	35.51 **	1.68 ns	11.54**	1.88 **
F (ST X KS)	1.11 ns	0.75 ns	0.47 ns	2.98 ns	0.92 ns	1.12 ns
CV (%)	29.48	8.72	39.32	7.08	19.14	30.94

*Means followed by the same lowercase letter in the columns do not differ among them by the Tukey test at 5 % of significance. ns= non-significant. CRH= carbonized rice husk.
**Significant ($p<0.01$).

There were no significant differences for plants emergence percentage among the storage temperatures (Table 1). Nevertheless, it is known that the use of temperatures between 5 and 10 ºC has a beneficial effect on passion fruit germination (Pereira et al., 2011). However, in a study conducted by Meletti et al. (2002), seeds stored for 10 days at 10 ºC showed 8% of germination and 95% 30 days under storage, breaking this temporary dormancy.

According to Mabunza et al. (2010), one of the most important factors in breaking dormancy is the temperature. In the case of passion fruit seeds, the use of alternate temperatures, such as 20-30ºC was recommended for *Passiflora alata* species. However, these authors verified that freshly harvested passion fruit showed temporary dormancy between 8 and 33%, which may be break with storage in a controlled environment for a period of up to 40 days (Meletti and Maia 1999; Meletti et al., 2002).

Another factor that can affect emergence is room temperature, since it promotes the enzymes and regulates the speed of the biochemical reactions that occur on passion fruit seeds after soaking (Gutiérrez et al., 2011). For passion fruit, minimum temperature at 5º C and maximum at 15º C delayed maximum germination up to 45 days, when 40% of germination was reached (Santos et al., 1999). Shoot length, number of leaves per plant, dry weight biomass of roots and shoot showed no significant differences in regards to the temperatures used for seeds storage (Table 1). However, Alves et al. (2006), found differences for the same variables tested in this experiment, when seeds were stored for 20 days at 8º C, reporting higher values when was compared to the room temperature (20 ºC), showing the beneficial effect of the low temperature.

For the greater root length, 10 ºC promoted a higher value (4.99 cm), when was compared to 18 ºC (4.62 cm), showing no statistical difference from 5 ºC with 4.72 cm (Table 1). Research made by Pereira et al. (2011) showed that exposure of passion fruit seeds to low temperatures (5-10 ºC) before seeding stimulated seedlings growth, and this response was also observed in this work for root length, when seeds were exposed to 10 ºC. Other authors report that the use of gibberellins at the concentration of 250 mgL^{-1} may substitute the need for low temperature (8 ºC), since it has the same beneficial effect (Alves et al., 2006).

In kind of substrates were detected significant differences for the following variables: emergence percentage, shoot length, number of leaves and dry weight biomass of roots and shoot (Table 1). Emergence was 74% in carbonized rice husk, being this value higher than the other substrates, in which emergence was 55% (Table 1). Carbonized rice husk is a substrate with high draining (Saidelles et al., 2009) and porosity (Guerrini and Trigueiro 2004), which give it greater aeration for the germination process.

In this experiment, shoot length means, number of leaves and dry weight biomass of roots and shoot were superior for coconut fiber and S-10 Beifort® substrates, when was compared to carbonized rice husks (Table 1). These results are similar to those verified for the same species by Aguiar et al. (2014), where the coconut fiber showed the better initial development.

The results of number of leaves and dry weight biomass of roots and shoot were similar to those obtained for shoot length, i.e., coconut fiber substrates and S-10 Beifort® promoted higher means, differing significantly from the carbonized rice husk (Table 1). Thus, these substrates with better photosynthetic material will have the advantage of improving or increasing the photosynthetic and transpiration process, improving the capacity of these plants to exchange gases between plant and environment (Jesus et al., 2001).

For the longer root length and dry weight biomass of the roots variables did not show significant differences (Table 1). Similar results were obtained by Wagner Júnior et al. (2007), who found passion fruit (*P. alata*) roots of 4.88 and 5.20 cm, 48 days after sowing. In addition, Aguiar et al. (2014) also found differences for yellow passion fruit in dry weight biomass of roots when were tested several substrates during an asexual propagation.

The physical and chemical properties of the substrates (Table 2), S-10 Beifort® showed greater density while the water retention capacity in carbonized rice husk was lower than the other substrates. Therefore, it is possible to infer that although the emergence percentage in carbonized rice husk was superior, the lowest water retention by this substrate may have compromised the initial development of the plants, considering the lowest means obtained by most variables (Table 1).

Table 2. Physical and chemical properties of the coconut fiber, carbonized rice husk and S-10 Beifort® substrates. Pelotas, RS, Brazil. 2014.

Substrate	Density (g L^{-1})		Water retention capacity (mL L^{-1})		pH		Electrical conductivity (dS m^{-1})	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Coconut fiber	169.0	2.83	752.0	0.85	5.19	0.21	0.88	0.20
Carbonized rice husk	223.0	5.66	544.0	2.40	6.13	0.47	1.03	0.02
S-10 Beifort®	370.0	12.73	657.0	3.75	4.73	0.02	0.80	0.15

Among these, the substrate must have water retention capacity of 500 mL L^{-1}, lower density of 810 g/L (Hidalgo et al., 2009), pH 4.2 and an electrical conductivity lower than 3.0 dSm^{-1} (Silva et al., 2010) satisfactory for this species (Kämpf et al., 2006).

In regards to chemical properties, it is well known that the pH is the great importance for plant growth, due to its effect on nutrients availability (Cavalcante et al., 2009). In this study, pH values varied between 6.13 and 4.73, for the electrical conductivity, the lowest mean was obtained by S-10 Beifort® substrates, which do not affect the quality of yellow passion fruit seedlings (Silva et al., 2010). In concerns to yellow passion fruit sensibility and salinity (Cavalcante et al., 2009), this study verified that an increase in salinity levels in the water may reduce growth during the development of seedlings (Mesquita et al., 2012). However, electrical conductivity values observed in this work for the three substrates are lower than those that could cause damage to this crop (Silva et al., 2010).

In general, coconut fiber and S-10 Beifort® substrates improve the initial development of passion fruit seedlings. They are obtained from agro-industrial residues and represent a promising alternative to reduce seedlings production costs, contributing to the preservation of the environment, due to the used of these materials. In addition to the S-10 Beifort®, for being a regional product, it is of easy access in Rio Grande do Sul, representing a significant advantage for growers in the region.

CONCLUSION

Seeds storage temperature at 10 ºC, for 15 days, as well as the coconut fiber and S-10 Beifort® substrates are the most recommended practices for the initial development of the yellow passion fruit.

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REFERENCES

Aguiar RS, Yamamoto LY, Preti EA, De Souza GRB, Sbrussi CAG, Oliveira EAD, De Assis AM, Roberto SR and Neves CSVJ (2014) Extração de mucilagem e substratos no desenvolvimento de plântulas de maracujazeiro-amarelo. Ciências Agrárias 35: 605-612.

Alves CZ, Sá ME, Corrêa LS and Binotti FFS (2006) Efeito da temperatura de armazenamento e de fitoreguladores na germinação de sementes de maracujá doce e desenvolvimento inicial de mudas. Acta Scientiarum Agronomy 28: 441-448.

Cavalcante LF, Da Silva G, Gheyi HR, Dias TJ, Jailson DC, Alves JC, Antonio DPM and Da Costa APMC (2009) Crescimento de mudas de maracujazeiro amarelo em solo salino com esterco bovino líquido fermentado. Revista Brasileira de Ciências Agrárias 4: 414-420.

Cortéz SP, Escala M and Tillett S (2005) Anatomia de la cubierta seminal en ocho especies de *Passiflora* l., subgénero passiflora. Acta Botánica Venezolana 28: 337-348.

Díaz LA, Fischer G and Pulido SP (2010) La fibra de coco como sustituto de la turba en la obtención de plántulas de uchuva (*Physalis peruviana* L). Revista Colombiana de Ciencias Hortícolas 4: 153-162.

Dos Santos CM, De Souza GRL and Da Silva JR (1999) Efeitos da temperatura e substrato na germinação da semente de maracujá (*Passiflora edulis* f. *flavicarpa* Deg.). Revista Brasileira de Sementes 21: 1-6.

Fachinello JC, Hoffmann A and Nachtgal JC (2005) Propagação de plantas frutíferas. Embrapa Uva e Vinho, Bento Gonçalves, Embrapa Informação Tecnológica, Brasília, 221p.

Fernandes C, Corá JE and Braz LT (2006) Alterações nas propriedades físicas de substratos para cultivo de tomate cereja, em função de sua reutilização. Horticultura Brasileira 24: 94-98.

Guerrini IA and Trigueiro RM (2004) Atributos físicos e químicos de substratos compostos por biossólidos e casca de arroz carbonizada. Revista Brasileira da Ciência do Solo 28: 1069-1076.

Gutiérrez MI, Miranda D and Cárdenas JFH (2011) Efecto de tratamientos pre germinativos sobre la germinación de semillas de gulupa (*Passiflora edulis* Sims.), granadilla (*Passiflora ligularis* Juss.) y cholupa (*Passiflora maliformis* L.). Revista Colombiana de Ciencias Hortícolas 5: 209-219.

Hidalgo PRL, Vielma MS and Marín C (2009) Evaluación de sustratos a base de vermicompost y enmiendas orgánicas líquidas en la propagación de parchita (*Passiflora edulis* v. *flavicarpa*) en vivero**.** UDO Agrícola 9: 126-135.

Hussain I, Assis AM, Yamamoto LY, Koyama R and Roberto SR (2014) Indole butyric acid and substrates influence on multiplication of blackberry ‘Xavante’. Ciência Rural 44: 1761-1765.

Jesus JRWC, Vale FXR, Coelho RR and Costa LC (2001) Comparison of two methods for estimating leaf area index on common bean. Agronomy Journal 93: 989-991.

Kämpf AN, Takane RJ and De Siqueira PTV (2006) Floricultura tropical: técnicas de preparo de substratos. LK Editora, Brasília, 132p.

Lima PO, Lira LM, Lopes KP and Barbosa RCA (2010) Armazenamento de sementes de maracujá-amarelo. Revista Verde 5: 102-109.

Mabundza RM, Wahome PK and Masarirambi MT (2010) Effects of different pre-germination treatment methods on the germination of passion (*Passiflora edulis*) seeds. Journal of Agriculture and Social Sciences 6: 57-60.

MAPA Ministério de Agricultura, Pecuária e Abastecimento (2009). Regras para análise de sementes. MAPA/DAS/ACS, Brasília, 395p.

Martins CM, Vasconellos MAD, Rossetto CAV and De Carvalho MG (2010) Prospecção fitoquímica do arilo de sementes de maracujá amarelo e influência em germinação de sementes. Ciência Rural 40: 1934-1940.

Meletti LMM, Furlani PR, Álvares V, Soares-Scott MD, Bernacci LC and Azevedo Filho JA (2002) Novas tecnologias melhoram a produção de mudas de maracujá. O Agronômico 54: 30-33.

Meletti LMM and Maia ML (1999) Maracujá: produção e comercialização. Boletim Técnico, 181, Instituto Agronômico, Campinas, 64p.

Mesquita FO, Cavalcante LF, Pereira WE, Rebequi AM, Neto AJL and Nunes JC (2012) Produção de mudas de maracujazeiro amarelo submetidas à salinidade em solo como biofertilizante bovino. Ciencia Del Suelo 30: 31-41.

Pereira KJC and Dias DCFS (2000) Germinação e vigor de sementes de maracujá-amarelo (*Passifora edulis* Sims. f. *favicarpa* Deg.) submetidas a diferentes métodos de remoção da mucilagem. Revista Brasileira de Sementes 22: 288-291.

Pereira WVS, Vieira LM, Ribeiro LM, Mercante-Simões MO and Oliveira TGS (2011) Armazenamento de sementes de maracujazeiros. Pesquisa Agropecuária Tropical 41: 273-278.

Saidelles FLF, Caldeira MVW, Schirmer WN and Sperandio HV (2009) Casca de arroz carbonizada como substrato para produção de mudas de tamboril-da-mata e garapeira. Semina: Ciências Agrárias 30: 1173-1186.

Silva EA, Maruyama WI, Mendonça V, Francisco MGS, Bardiviesso DM and Tosta MS (2010) Composição de substratos e tamanho de recipientes na produção e qualidade das mudas de maracujazeiro ‘amarelo’. Ciência Agrotecnologia 34: 588-595.

Souza PVD, Carniel E and Fochesato ML (2006) Efeito da composição do substrato no enraizamento de estacas de maracujazeiro azedo. Revista Brasileira de Fruticultura 28: 276-279.

Souza RR, Matias SSR, Silva RR, Silva RL and Barbosa JSM (2015) Qualidade de mudas de mamão produzidas em substrato com esterco caprino e doses de superfosfato simples. Revista Agrarian 8: 139-146.

Wagner Júnior A, Santos CEM, Alexandre RS, Silva JOCS, Negreiros JRS, Pimentel LD, Álvares VS and Bruckner CH (2007) Efeito da pré-embebição das sementes e do substrato na germinação e no desenvolvimento inicial do maracujazeiro-doce. Revista CERES 54: 1-6.

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