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Dormancy overcome and seedling quality of pecan in nursery

Superação de dormência e qualidade de mudas de nogueira-pecã em viveiro

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ABSTRACT

This study evaluated the efficiency of methods to overcome seed dormancy in different storage periods in the production of pecan seedlings. Seeds were submitted to the following treatments: T_1 , T_4 and T_7 - control treatments (seeds with no treatment, stored at room temperature for 30, 60 and 90 days, respectively), T_2 , T_3 and T_8 - stratification (seeds were distributed in boxes with wet sand maintained at a temperature of 4°C for 30, 60 and 90 days, respectively), T_5 , T_6 and T_9 - scarification + stratification (seeds scarified with sandpaper n.80 and stratified by 30, 60 and 90 days, respectively), in completely random experimental design. Plant height, stem diameter, number of leaves, full emergence and emergence speed index (ESI) were evaluated after 14 weeks of sowing. The best development of pecan 'plants, their emergence, and ESI were observed in the stratification treatment for 90 day as well as in the scarification + stratification treatment for 90 day. Storing seeds in uncontrolled environment reduced their viability.

Key words: scarification, stratification, emergence, *Carya illinoensis*.

RESUMO

Neste trabalho, objetivou-se avaliar a eficiência dos métodos de superação de dormência de sementes, em diferentes períodos de armazenamento, na produção de mudas de nogueira-pecã. As sementes foram submetidas aos seguintes tratamentos: T_1 , T_4 e T_7 - testemunhas (sementes sem qualquer método de tratamento, armazenadas em ambiente não controlado por 30, 60 e 90 dias, respectivamente), T_2 , T_3 e T_8 - estratificação (sementes distribuídas em caixas com areia úmida e mantidas em temperatura de 4°C por 30, 60 e 90 dias, respectivamente), T_5 , T_6 e T_9 - escarificação + estratificação (sementes escarificadas com lixa n.80 e estratificadas também por 30, 60 e 90 dias, respectivamente), em delineamento experimental inteiramente ao acaso. Avaliou-se,

após 14 semanas da semeadura, altura das plantas, diâmetro do colo, número de folhas, emergência total e índice de velocidade de emergência (IVE). O melhor desenvolvimento das plantas de nogueira-pecã, bem como sua emergência e IVE foi observado no tratamento com estratificação por 90 dias e quando combinado escarificação e estratificação por 90 dias. O armazenamento das sementes em ambiente não controlado reduz sua viabilidade.

Palavras-chave: escarificação, estratificação, emergência, *Carya illinoensis*.

INTRODUCTION

Pecan [*Carya illinoensis* (Wangenh.) K. Koch, *Juglandaceae*], a fruit species of the temperate climate, have been cultivated in several places around the world, mainly in regions with temperate to subtropical climates. Its cultivation is highly expressive in countries as USA, Mexico, South Africa, Uruguay, Argentina, Australia and Spain. In Brazil, the interest in producing this nut is growing, mainly due to the excellent incomes it promotes (POLETO et al., 2015).

For the establishment of pecan orchards, high quality seedlings are very important (CARGNELUTTI FILHO et al., 2014) since the most indicated propagation way for this culture is the grafting with rootstocks obtained from seeds (GHAZAEIAN et al., 2012). Currently, seedlings production is performed in pots or in bare roots

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nursery. In the last system, seedlings are cultivated directly in the soil and posteriorly transplanted. However, pecan seeds hold substances that inhibit the germination promoting dormancy (EACHERN, 2010), and stimulating factors that are antagonists to a fast and uniform germination. In addition, the hard and lignified seed's tegumen; although, permeable to water and gases, generates mechanical restriction to the root elongation, delaying the germination process (SMITH et al., 1997).

Dormancy is a natural mechanism that allocates the germination through the time to promote and guarantee the species survival in the environment (FERREIRA et al., 2013). However, for the nurserymen, dormancy is considered a barrier to the seedling production due to the long time span needed to start the germination after sowing. So, seeds stay susceptible to pathogenic microorganisms and insects. Moreover, seeds germinate in different periods, originating morphologically uneven seedlings and increasing the costs of maintaining the orchards during this period. Therefore, reducing germination time and increasing the seedlings evenness is an important challenge this species has to transpose.

Different approaches of dormancy overcome have been tested, mainly for forest species seeds. For tegument dormancy, immersion in sulfuric acid is recommended for seeds of *Samanea tubulosa* Bentham (OLIVEIRA et al., 2012a), immersion in boiling water for seeds of *Parkia gigantocarpa* Ducke (OLIVEIRA et al., 2012b) and mechanical scarification for seeds of *Butia capitata* (Mart.) Becc. (FIOR et al., 2011).

However, for embryonic dormancy, the change of some seed components is necessary, promoting physiological modifications in the embryonic axis. Scarification is a largely employed method because it works changing the nature and level of the promoter and inhibitor hormones involved on the processes of seed dormancy and germination (CAMPANA et al., 1993; WAGNER JUNIOR et al., 2007). Following this rationality, the present study aimed to evaluate the efficiency of different approaches for seeds dormancy overcome, intending the production of pecan seedlings.

MATERIALS AND METHODS

The study was performed in the municipality of Anta Gorda, High Taquari's Valley, Rio Grande do Sul State, Brazil (28°53'S, 52°02'W, at 537m above sea level). The climate of the region is Cfa, according to Köppen classification (subtropical

moist, with hot summers, without dry season) and a mean annual precipitation of 1,800mm (MORENO, 1961). According to the Brazilian soil classification (SANTOS et al., 2013), the soil is a Chernossolo Argilúvico (Typic Argiudo II) (STRECK et al., 2002). The experiment was implemented in a 40m² area with homogeneous edafoclimatic conditions.

Seeds were sampled from five mother-trees of the Barton cultivar, distributed in commercial orchards of Anta Gorda municipality, in May 2013. Seeds were standardized employing in the experiment only seeds with mass above 10 grams. Seeds were washed to eliminate residuals of pulp and dried in non-controlled shaded conditions during three weeks.

The experiment was conducted using a completely randomized design with nine treatments (Table 1), consisting of nine replicates of three seeds for each treatment, totalizing 405 sample unities.

In the control treatments T₁, T₄ and T₇, seeds were maintained in paper bags and stored at room temperature in the Phytopathology Laboratory of the Universidade Federal de Santa Maria – UFSM, for 30, 60 and 90 days respectively, without any supplementary method for dormancy overcome.

For treatments T₂, T₅ and T₈, seeds were subjected to the stratification process for 30, 60 and 90 days, respectively. Seeds were placed in alternated 5.0cm layers of sand within wood boxes and maintained in a cold chamber at 4±0.1°C. Moisture excess was drained through an inferior opening in the boxes.

Treatments T₃, T₆ and T₉, consisted in scarification of the seeds in their apical portion with sandpaper n.80 (FERREIRA et al., 2009), and posterior stratification as previously described.

Sowing was performed in the orchard after the timespan of each treatment was reached. Seeds were disposed in 3.0cm deep spots, with a distance of 80cm between rows and 20cm between spots. Irrigation was performed through a dripping system, and weeds were manually controlled.

Fourteen weeks after sowing, plantlet emergence (%), plant height (cm), stem diameter (mm), and ratio between plant height and number of leaves (H/D) were recorded for all plants. Plant emergence was checked weekly, from the beginning of the first week after sowing. The emergence speed index was estimated according to MAGUIRE (1962).

Analysis of variance was performed to compare the effect of treatments on the evaluated parameters and the Scott-Knott test, at 5% probability, was used to compare differences between the means of treatments, using the software SISVAR 5.3

Table 1 - Description of the treatments employed in the experiment of pecan's seedling orchard.

Treat	Treatment description	Code
T ₁	Seeds at environmental temperature for 30 days (control)	Con30
T ₂	Seeds stratified for 30 days	Stra30
T ₃	Seeds scarified and stratified for 30 days	Scar+Stra30
T ₄	Seeds at environmental temperature for 60 days (control)	Con60
T ₅	Seeds stratified for 60 days	Est60
T ₆	Seeds scarified and stratified for 60 days	Scar+Stra60
T ₇	Seeds at environmental temperature for 90 days (control)	Con90
T ₈	Seeds stratified for 90 days	Est90
T ₉	Seeds scarified and stratified for 90 days	Scar+Stra90

(FERREIRA, 2008). Data on total emergence and emergence speed index were transformed by $\sqrt{(x+0.5)}$ prior to statistical analysis.

RESULTS AND DISCUSSION

For the seeds subjected to stratification for 90 days or for the combined use of scarification and stratification for 90 days, the emergence started around seven days after sowing, with climax between 14 and 21 days and stabilization in the sixth week. Contrarily, seeds maintained in stratification for 30 or 60 days started emergence later, about 35 days after sowing, following up to the end of the evaluation period, generating plants with high morphological variability. The emergence of the plants not subjected to dormancy overcome treatments (control) started between the sixth and the eighth weeks and there was no stabilization of this variable up to the end of the experiment (Figure 1).

According to the Scott-Knott test ($P < 0.05$), there was significant difference among treatments. For the emergence, this test separated the means of the treatments into three groups. The best treatments presented emergence of 87 to 98%. In the intermediary group the results were lower, with emergence ranging from 73 to 78%. For control treatments T₁, T₄ and T₇, emergence was much lower in comparison to other treatments (Table 2). Similar results were observed by ADAMS & THIELGES (1978), who demonstrated that pecan seeds can germinate without dormancy-overcome processes, but the germination is low and uneven.

The better results for emergence were observed in the treatments combining scarification and stratification, or only seed stratification. Seed storing at non-controlled conditions lowered the emergence percentage, revealing decrease of the

emergence percentage with the increase of the storage period.

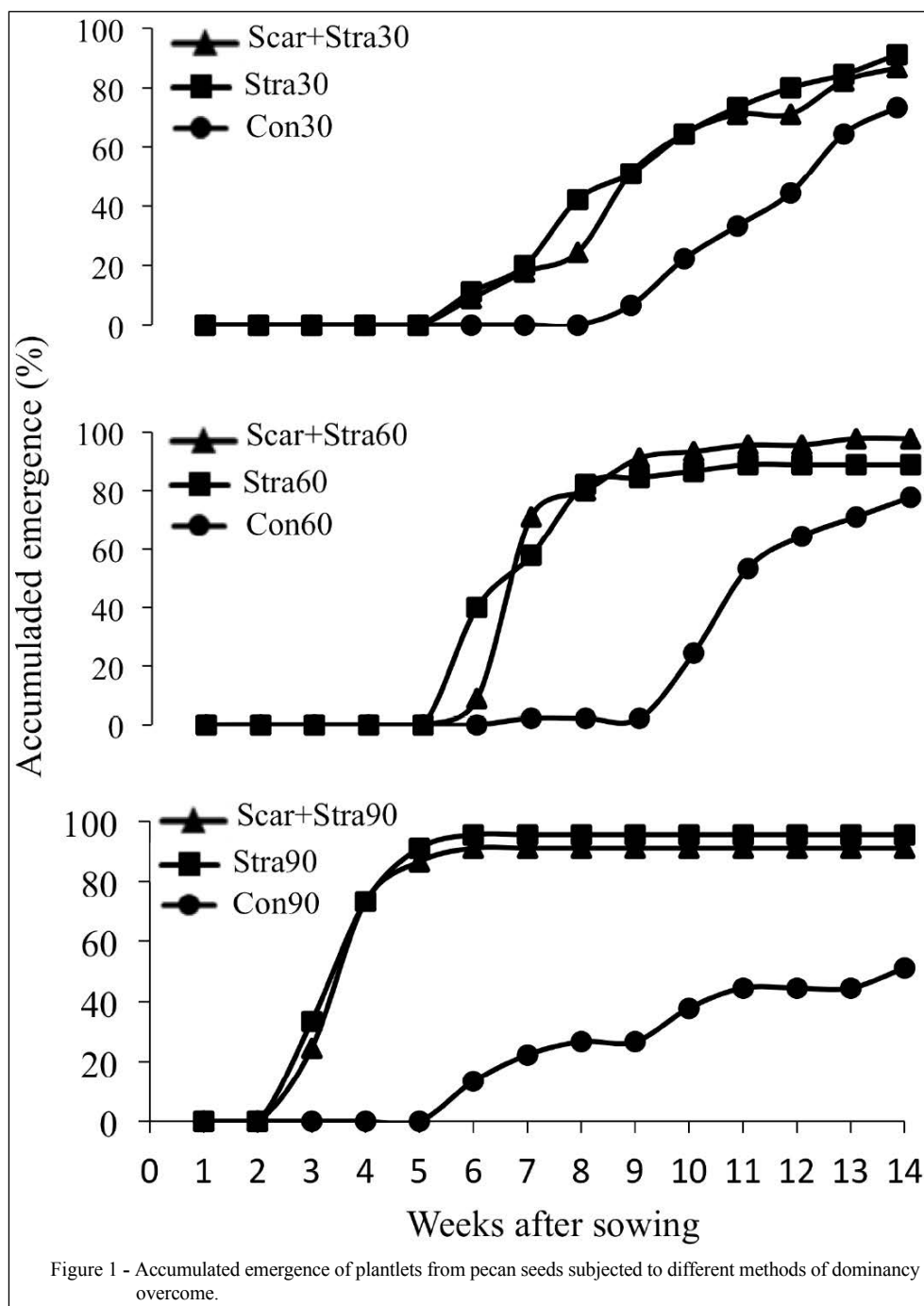
Storage periods longer than four months decreased seeds germination of *Macadamia integrifolia* Maiden and Betcheo, reaching values near zero after 10 months, when stored in protected environment (ONO et al., 1993). Amylaceous seeds generally present higher longevity in comparison to oil seeds (FACHINELLO et al., 2005), as the pecan ones.

Concerning the emergence speed index (ESI), the larger values were observed in the treatments in which the seeds were stratified for 90 days (ESI=20.0) and scarified followed by stratification for 90 days (ESI=18.9). As for emergence, maintenance of seeds in non-controlled conditions led to poor results of ESI, ranging from 2.8 to 4.3 (Table 2).

In order to overcome the dormancy of pecan seeds, EACHERN (2010) suggested adopting stratification at 3 to 5°C. In *Cupressus lusitania* Mill, cold stratification combined to seeds soaking in water promoted higher percentage and germination speed, being efficient to overcome their dormancy (XAVIER et al., 2012).

When pecan seeds were subjected to stratification for 90 days and scarification for the same period, plantlets with higher height and stem diameter were observed, in comparison to other treatments. In the control treatments, the lowest values of plantlet height were observed. Treatments with stratification for 30 and 60 days and scarification followed by stratification for 30 and 60 days revealed intermediary values, without significant difference among them (Table 3).

Obtaining vigorous high quality seedlings is vital for the success of plantations establishment. In the study of McGilvray & Barnett (1981) *apud* CARNEIRO (1995) with different forest species, the height, stem diameter, root mass and aerial



mass were recorded and correlated with field performance. Authors concluded that plantlet height has the highest correlation with field performance. CARNEIRO (1995) suggested that there is a close relationship among stem diameter, survival and seedling grown after the field establishment. RITCHIE et al. (2010) suggested that the stem

diameter is the variable that better described the after-establishment performance of the plants.

The dormancy overcome in peach seeds was ascribed to modifications in the balance between promoters and inhibitors of growth (CAMPANA et al., 1993). Thus, we suppose that the constant temperature of 4°C contributed to the acceleration of the hormonal

Table 2 - Emergence (%) and emergence speed index (ESI) of the plantlets from pecan seeds subjected to different methods of dormancy overcome.

Treatments ^a	Variables ^b	
	Emergence (%)	ESI
Con30	78 b	2.8 d
Stra30	91 a	6.9 c
Scar+Stra30	87 a	6.3 c
Con60	73 b	3.5 d
Est60	89 a	10.3 b
Scar+Stra60	98 a	10.3 b
Con90	51 c	4.3 d
Est90	95 a	20.0 a
Scar+Stra90	91 a	18.9 a
VC(%) ^c	15.2	17.0

^aSee the meaning of codes in table 1. ^bMeans followed by the same letter are statistically different according to the Scott-Knott test at 5% error probability. ^cVC: variation coefficient.

balance alteration, supporting the beginning of the germination process in pecan seeds and, consequently, contributing to the plant development.

Studies performed by SELIM et al. (1998) cited by WAGNER JUNIOR, et al (2007) demonstrated that during the stratification of peach seeds at 5°C, there was an increase in the content of gibberellins seeds and indole-acetic acid (growth promoters) and a decrease in the content of abscisic acid (growth inhibitor).

The number of leaves measurements revealed results similar to the other variables, with higher number of leaves observed in the treatments with stratification for 90 days and scarification plus

stratification for 90 days (Table 3). Treatments with seed stratification for 30 and 60 days and scarification followed by stratification for 30 and 60 days presented intermediary values. The number of leaves in the control treatments was smaller among all treatments. There was no significant difference among treatments for the measures of height/diameter ratio.

The results obtained in this study evidenced the need of seed stratification for 90 days or to combine scarification and stratification for 90 days for better germination and seedling development in pecan. These processes promote increased germination and potentiate plants growth. For the

Table 3 - Plantlet height (cm), stem diameter (mm), height/diameter ratio (H/D) and number of leaves in plantlets, from pecan seeds subjected to different methods of dormancy overcome.

Treatments ^a	Variables ^b			
	Height (cm)	Diameter (mm)	Nº of leaves	H/D ratio
Con30	9.2 c	2.5 c	3.3 d	3.7 a
Stra30	15.9 b	3.5 b	4.6 c	4.5 a
Scar+Stra30	14.9 b	3.5 b	4.6 c	4.3 a
Con60	8.8 c	2.3 c	3.2 d	3.8 a
Est60	16.7 b	3.6 b	5.8 b	4.6 a
Scar+Stra60	16.8 b	3.8 b	5.9 b	4.4 a
Con90	8.1 c	2.1 c	3.1 d	3.9 a
Est90	20.7 a	4.9 a	9.3 a	4.2 a
Scar+Stra90	18.9 a	4.3 a	8.4 a	4.4 a
VC (%) ^c	46.6	43.3	46.4	44.4

^aSee the meaning of codes in table 1. ^bMeans followed by the same letter are statistically different according to the Scott-Knott test at 5% error probability. ^cVC: variation coefficient.

nurserymen it means reduction in the production cycle and costs, and increase in the seedlings quality.

CONCLUSION

The combination of stratification and scarification for 90 days or the stratification alone for the same period fosters the seeds germination and a better development of the seedlings (rootstocks) of pecan in nursery environment. Storing pecan seeds in non-controlled environment decreases their viability.

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