

Osmopriming in Seeds of *Helianthus annuus* L.

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Abstract

Osmoconditioning stands out as an alternative treatment that aims to improve seed performance in the field. The process consists of immersing the seed in an aqueous solution containing the osmotically active compound, and thus the process of imbibition begins, which stops as soon as they reach equilibrium with the solution's osmotic potential, allowing only the occurrence of the initial mechanisms of germination. Given the above, the objective of this work was to verify the effect of osmoconditioning on the physiological quality of sunflower seeds (*Helianthus annuus* L.). For that, sunflower seeds of cultivar BRS 323 were used, which were soaked in polyethylene glycol (PEG 6000) solutions at different times of 0, 2, 4 and 6 hours. Then, the seeds were washed in distilled water and sown in trays containing sterilized sand. The following descriptors were evaluated: emergence, first emergence count, emergence velocity index, shoot length, and root length. Sunflower is a plant responsible for osmoconditioning by immersion at a potential of -2 MPa for 3.8 hours. The osmoconditioning of sunflower seeds can efficiently improve seedling performance in the stand, influencing emergence and emergence speed.

Keywords: agronomic performance, oilseeds, physiological quality

1. Introduction

As a result of its high adaptability, the sunflower (*Helianthus annuus* L.) crop is present in the most different regions of the world and is thus characterized as a very important crop from a commercial point of view (Araújo et al., 2018). In this sense, sunflower cultivation proves to be profitable, especially when considering its agronomic characteristics, such as high oil content (Dantas et al., 2015; Catão et al., 2016).

The average sunflower productivity in Brazil is approximately 1,500 kg ha⁻¹ for less technified areas, while producing regions with longer cultivation times and better technical support, the average productivity can reach up to 2,000 kg ha⁻¹ (Viana et al., 2018; Embrapa, 2021). The estimated sunflower planted area in the 2019/2020 crop was 62,000 ha, while the expected yield for the crop was 1,581 kg ha⁻¹, with a production of 98,000 t. The states of Mato Grosso, Goiás, Rio Grande do Sul and Minas Gerais stand out as the largest national producers of sunflower (CONAB, 2020). However, its cultivation requires care regarding its seeds, since they directly affect productivity (Scheeren et al., 2010).

Poor seed performance in the field is one of the main risks that can occur in agricultural production, and if this happens, it will be necessary to replant or choose other crops, which increases production costs and reduces

productivity (Coelho et al., 2019). Highly vigorous seeds generally germinate faster and more uniformly and can better resist the adverse effects of the environment (Scheeren et al., 2010). In this way, presowing treatments become indispensable to obtain a uniform stand, since such treatments can accelerate the germination process (Spadeto et al., 2018).

In this aspect, osmopriming stands out as an alternative treatment that aims to improve seed performance in the field (Lustri et al., 2017). The process consists of immersion of the seed in an aqueous solution containing an osmotically active compound, and in this way, the process of imbibition of the same compound begins, which is paralyzed as soon as it reaches equilibrium with the osmotic potential of the solution, allowing only the initial mechanisms of germination (Silva et al., 2020).

Among the osmotic agents used is polyethylene glycol 6000 (PEG 6000), which satisfactorily promotes the stimulation of the effects of controlled water restriction on seed germination (Breno et al., 2020). Polyethylene glycol (PEG 6000) has been highlighted as an inducer because it acts by controlling and reducing the speed of water absorption, contributing to the activation of biochemical processes, which can increase the vigor and quality of the seeds and can improve the speed, percentage and germination uniformity (Spadeto et al., 2018). These biochemical changes provide greater elaboration of solutes acting in osmoregulation, such as free amino acids, proline and total free sugars, which can improve the initial establishment of the stand (Almeida et al., 2019). Furthermore, it appears that the osmopriming technique proves to be a viable treatment alternative in the presowing phase, since its use results in an increase in the speed and uniformity of seedling emergence (Arin et al., 2011; Queiroga et al., 2011; Gomes et al., 2012; Missio et al., 2018; Silva et al., 2020).

The study of alternatives to increase the uniformity of the stand can contribute to the advancement of new industrial methods that allow the commercialization of high-quality and more vigorous seeds (Breno et al., 2020). Based on the above, the objective of this work was to evaluate the effect of osmopriming on the quality of *Helianthus annuus* L.

2. Method

2.1 Location of the Experiment

The study was carried out in two stages. The first was conducted at the Laboratory of Seed Analysis of Campus Balsas, belonging to the State University of Maranhão. For this, sunflower seeds of the hybrid BRS 323, supplied by Embrapa Soja, produced in 2019 in its experimental field in Londrina, Paraná, were used. At this stage, asepsis and osmoconditioning of the seeds were performed. At this stage, asepsis and osmoconditioning of the seeds were performed. In the second stage, the emergency test was installed in the field in a private area in the city of Goianésia, Goiás, geographic coordinates: Latitude: 15°19'33" South, Longitude: 49°7'2" West, aiming to submit sunflower seedlings to environmental factors without artificial interference.

2.2 Asepsis of Sunflower Seeds

All seeds were initially disinfected. For this, they were immersed in 70% ethyl alcohol for 1 minute and in a 1% sodium hypochlorite solution for 30 seconds, followed by three washes with sterile distilled water (ADE) and drying on sterilized filter paper.

2.3 Osmoconditioning

Osmotic conditioning was performed in polyethylene glycol 6000 solution (PEG 6000) using different levels of osmoconditioning at zero (distilled water), -1, -2 and -3 MPa. The potentials were calculated using the equation proposed by Vilela (1991).

Thus, to obtain the -1 potentials, -2 and -3 MPa were used 39.24, 59.77 and 75.70 g of PEG 6000, each diluted in 500 ml of sterile distilled water. Subsequently, the seeds were placed in Erlenmeyers flasks (500 mL capacity) and immersed in each solution, at four different times of 0, 2, 4 and 6 hours, defined in order not to subject the seeds for more than 6 hours, which could take the seeds to a state of anoxia. Immersion is suggested, as it would be easily performed by farmers in the field. Then, the seeds were washed in distilled water and sown in trays containing sterilized sand.

2.4 Physiological Quality of Osmoconditioned Sunflower Seeds

For the assembly of the emergence test in sand, trays with dimensions of 7 × 21 × 29.5 cm were used, filled with 1,800 kg of sand, with granulometry between 0.05 and 0.8 mm in diameter, and 50 seeds were sown per tray. A total of 4 replicates were used per treatment. The seeds were evaluated through the following tests:

Emergency: In the emergency test, the number of emerged seedlings was determined daily until they achieved complete stabilization. As emerged seedlings, those that presented the first pair of leaflets were considered.

First emergence count: This was conducted together with an emergence test consisting of the percentage of normal seedlings (MAPA, 2009).

Emergence speed index: The seedling emergence speed index was calculated from the data obtained from the daily counts performed in the emergence test, as proposed by Maguire (1962):

Length of shoot: The assessment of shoot growth was performed only on normal seedlings that reached stability after emergence, measuring the length of the shoot with the aid of a ruler graduated in centimeters from the seedling neck to the top of the primary leaf. The results were expressed in centimeters (cm).

Root length: Root length was performed only on normal seedlings that reached stability after emergence, measuring the length of the main root with the aid of a ruler graduated in centimeters from the root tip to the seedling neck. The results were expressed in centimeters (cm)

2.5 Experimental Design and Statistical Analysis

The experimental design adopted was completely randomized, consisting of a 4×4 factorial arrangement, with four osmotic potentials of PEG 6000 (0, -1, -2 and -3 MPa) and four soaking periods: 0, 2, 4 and 6 hours, resulting in 16 treatments with four replications of 25 seeds each. The data obtained were analyzed and submitted to analysis of variance and polynomial regression, and the means were compared by Tukey's test at a 5% probability level. The program AgroEstat-System for Statistical Analysis of Agronomic Trials (Barbosa; Maldonado Junior, 2015) developed by the State University of São Paulo (UNESP) was used.

3. Results and Discussion

Regarding the first emergence count, the -2 MPa concentration provided the best percentage for the analyzed variable when the seeds were submitted to a period of 3.8 hours of osmotic conditioning (Figure 1). In addition, it was possible to verify that the control showed less vigor when not subjected to osmoconditioning, while the others did not differ statistically from each other. According to Bradford (1986) and Khan (1992), the good performance of seeds submitted to osmoconditioning may be related to the fact that during this treatment, several processes are initiated, such as the activation and synthesis of several enzymes, mobilization of reserves, production of ATP, DNA and RNA synthesis, as well as repairs of possible damage suffered during the storage period of these seeds.

Furthermore, at all osmotic potentials, the percentage of emergence was not affected by the different periods of imbibition. However, there was a decrease in the average after 4 hours of imbibition in the percentage of seedlings that emerged at all concentrations.

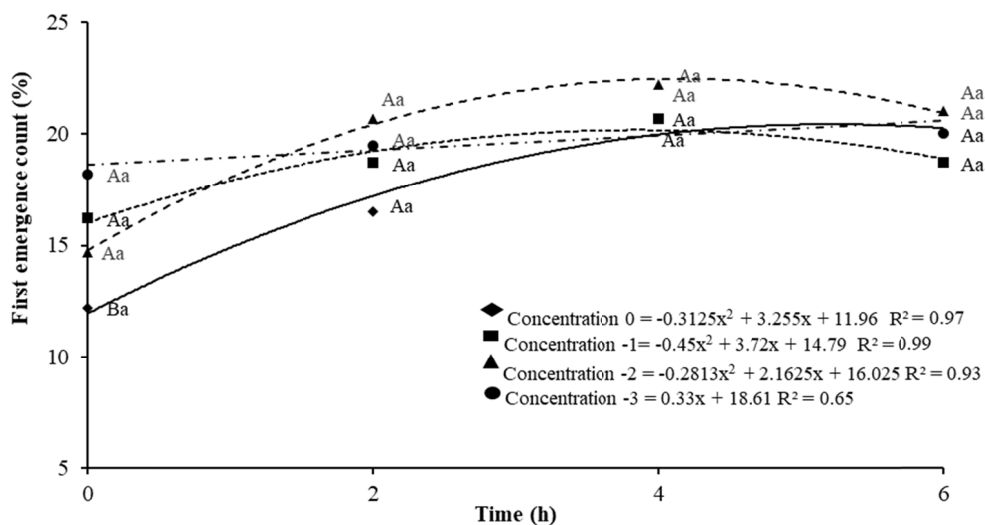


Figure 1. First emergence count (%) of sunflower seeds submitted to different osmoconditioning periods (0, 2, 4 and 6 hours) and different osmotic concentrations (0, -1, -2 and -3 MPa). Means followed by the same lowercase letter on the same line and capital letters between lines do not differ at 5% probability by Tukey's test

The process of seed hydration makes it possible to increase the speed and rate of germination, standardize emergence, and increase the seedlings' resistance to environmental weather (Marcos Filho & Kikuti, 2008).

In this sense, when observing the emergence speed index, it was found that the imbibition time increased, and an increase in the vigor of osmoconditioned seeds was also observed (Figure 2). The technique of seed osmopriming has played an important role in the activation and reorganization of cellular processes that are inactive and disorganized as a result of the seed dehydration process, which may increase the percentage and speed of seedling emergence (Guimarães et al., 2008). Several studies have shown the influence of osmopriming with polyethylene glycol (PEG 6000) in improving the speed and uniformity of germination of guava seeds (Araujo et al., 2011), gherkin (Fanan & Novembre, 2007), beetroot (Albuquerque et al., 2009), eggplant (Caseiro & Marcos Filho, 2005), pepper (Kikuti & Marcos Filho, 2009), onion (Lima & Marcos Filho, 2009), and cauliflower (Paiva et al., 2012).

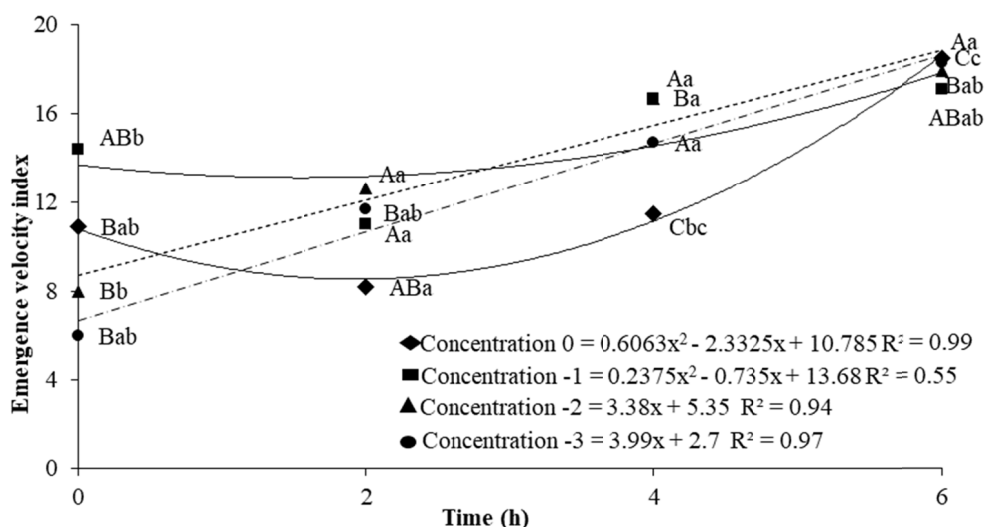


Figure 2. Emergence velocity index of sunflower seeds submitted to different periods of osmopriming (0, 2, 4 and 6 hours) and different osmotic concentrations (0, -1, -2 and -3 MPa). Means followed by the same lowercase letter on the same line and capital letters between lines do not differ at 5% probability by Tukey's test

It was observed that there was no significant interaction between osmotic conditioning (PEG 6000) and imbibition times for the variable seedling emergence after 2 hours of osmotic conditioning for all concentrations evaluated. The best physiological potential of the seeds was reached when they were conditioned in an osmotic potential of -2 MPa in a period of 4.4 hours of imbibition, providing 87.7% of emergence of the evaluated seedlings (Figure 3). A similar result was found by Rabbani et al. (2013) when studying the effect of osmotic conditioning in sunflower seeds (*Helianthus annuus* L.) found that when submitted to a period of 4 hours of imbibition, osmoconditioned seeds provided a better percentage of emergence.

Seed germination is an essential biological mechanism for the survival of plant species, starting with the process of seed imbibition (Sales et al., 2015), and it is possibly the first stage that will stimulate metabolic processes within the seeds. Furthermore, the reduction in the water potential of the medium reduces the speed of water absorption by the seeds, causing an increase in the period necessary for it to reach the minimum water content necessary for the beginning of germination (Sarmiento et al., 2021). Thus, very negative osmotic potentials tend to impair water absorption by seeds, decreasing and delaying emergence (Bradford, 1986), as well as the emergence speed.

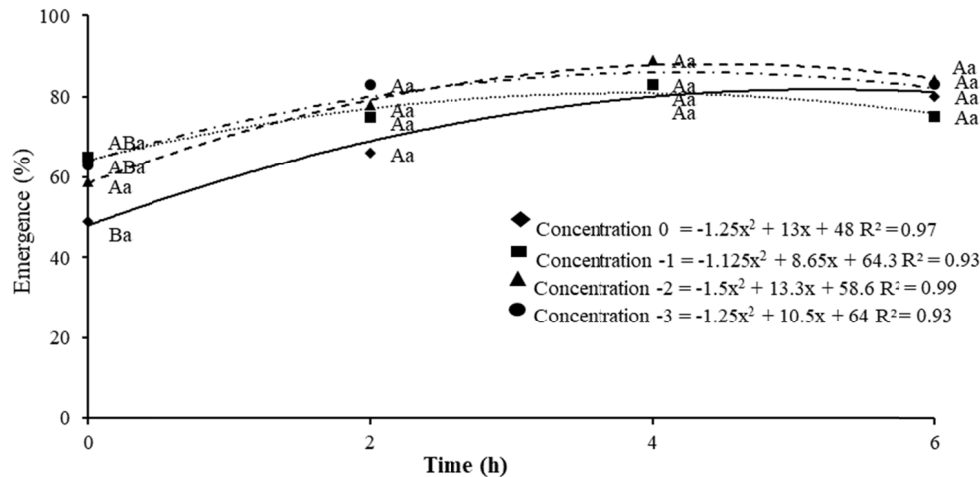


Figure 3. Emergence (%) of sunflower seeds submitted to different periods of osmopriming (0, 2, 4 and 6 hours) and different osmotic concentrations (0, -1, -2 and -3 MPa). Means followed by the same lowercase letter on the same line and capital letters between lines do not differ at 5% probability by Tukey’s test

Regarding root length, it was possible to verify that the osmotic potential of 0 MPa provided an increase in root length as the soaking period increased (Figure 4). In addition, a reduction was observed for the seeds primed at a concentration of -1, resulting in a minimum length of 8.57 cm in 2.5 hours of priming, returning to higher values in the following times and reaching the maximum length of priming. root in the soaking period of 6 hours, resulting in 11.9 cm in length for the same concentration, not differing from the control in this period.

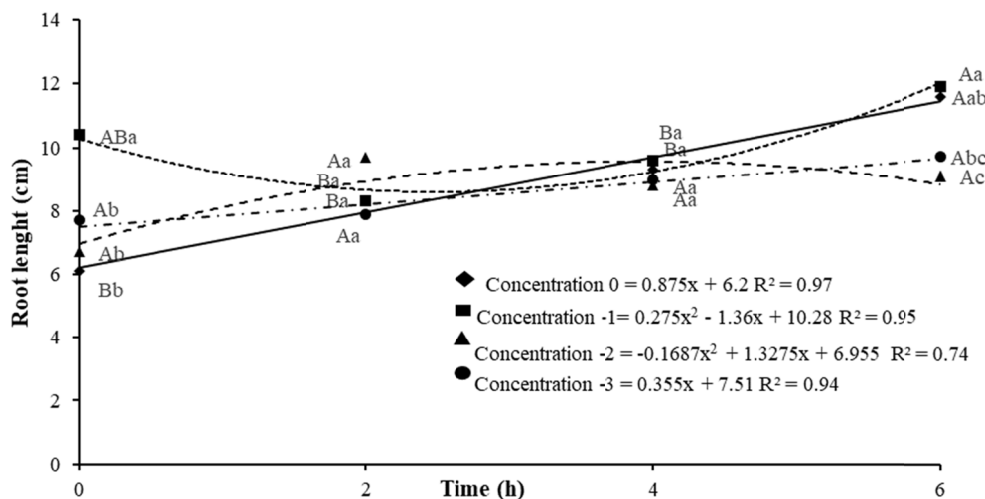


Figure 4. Root length (cm) of sunflower seedlings submitted to different periods of osmopriming (0, 2, 4 and 6 hours) and different osmotic concentrations (0, -1, -2 and -3 MPa). Means followed by the same lowercase letter on the same line and capital letters between lines do not differ at 5% probability by Tukey’s test

Using an osmotic potential of -3 MPa with 4 hours of imbibition, a greater length of shoot was achieved, resulting in a length of 12.9 cm (Figure 5). Furthermore, an increase in shoot length was observed as the osmoconditioning period at an osmotic potential of -1 MPa increased. Additionally, the reduction in osmotic potentials of -2 and -3 MPa in the period of 6 hours, when compared to the other concentrations, negatively influenced the length of the shoot, providing less growth, approximately 7 and 8.4 cm, respectively. This result corroborates the data revealed by Sarmento et al. (2021) when evaluating the effect of osmopriming with polyethylene glycol 6000 in seeds of guava-serrana (*Acca sellowiana* O. Berg.) which showed that there was no significant increase in seed length. aerial part of seedlings from osmoconditioned seeds compared to untreated seeds. Higher concentrations and longer periods of imbibition can cause a reduction in seedling growth, since

there will be a decrease in seed metabolism due to the lower availability of water for digestion of reserves and translocation of metabolized products (Bewley & Black, 1994).

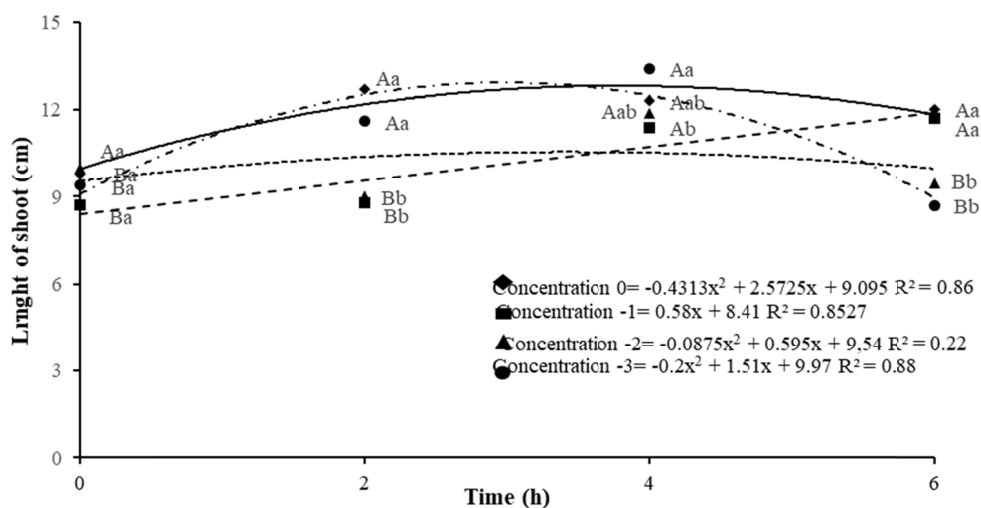


Figure 5. Length of shoot (cm) of sunflower seedlings submitted to different osmoprimer periods (0, 2, 4 and 6 hours) and different osmotic concentrations (0, -1, -2 and -3 MPa). Means followed by the same lowercase letter on the same line and capital letters between lines do not differ at 5% probability by Tukey's test

4. Conclusion

Sunflower is a plant responsible for osmoprimering by immersion at a potential of -2 MPa, promoting a better percentage of first count and emergence.

Osmotic concentrations and very high imbibition periods tend to reduce root and shoot length.

Osmoprimering of sunflower seeds can efficiently improve the performance of seedlings in the stand, influencing the emergence speed.

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