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Accelerated aging to assess parsley seed vigor

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ABSTRACT

There are many gaps for the assessment of seed vigor in vegetable crops, among these the parsley. In this context, the accelerated aging test is recognized as one of the most widely used to evaluate seed physiological potential of various crop species, being able to provide information with a high degree of consistency. Thus, the objective of the present study was to evaluate the methodology of accelerated aging test to check parsley seed vigor, as well as verify the possibility of using NaCl solutions as an alternative to control seed water uptake during the aging period without reducing test sensitivity. Four lots of parsley seeds were tested for germination, seedling emergence, and accelerated aging for 48, 72 and 96 h (traditional and NaCl solutions). The use of NaCl solutions reduces water uptake by parsley seeds during the accelerated aging test, resulting in less pronounced and drastic deterioration rates and more uniform results. The exposure of the *P. sativum* seeds for a period of 48 h is a promising option for the evaluation of parsley seed vigor by the accelerated aging test.

Keywords: *Petroselinum sativum*, germination, SSAA, vegetables, vigor.

RESUMO

Envelhecimento acelerado para avaliação do vigor de sementes de salsa

Muitas são as lacunas referentes à avaliação do potencial fisiológico de sementes de espécies olerícolas, dentre essas a salsa. Nesse contexto, o teste de envelhecimento acelerado é reconhecido como um dos mais difundidos para a avaliação do vigor das sementes de várias espécies cultivadas, sendo capaz de proporcionar informações com alto grau de consistência. Assim, o presente trabalho teve por objetivo estudar a metodologia do teste de envelhecimento acelerado para avaliação do potencial fisiológico de sementes de salsa, bem como, verificar a possibilidade do uso de soluções de NaCl como alternativas para o controle da velocidade e intensidade de absorção de água pelas sementes durante a realização do teste, sem reduzir sua sensibilidade. Quatro lotes de sementes foram submetidos aos testes de germinação, emergência de plântulas e envelhecimento acelerado, empregando-se os períodos de envelhecimento de 48, 72 e 96 h (tradicional e com o uso de soluções de NaCl). A utilização de solução não saturada de NaCl diminui a velocidade de absorção de água pelas sementes de salsa durante o teste de envelhecimento acelerado, acarretando redução da taxa de deterioração e resultados mais uniformes. A exposição por 48 h, utilizando solução salina saturada constitui opção promissora para a avaliação do potencial fisiológico das sementes.

Palavras-chave: *Petroselinum sativum*, solução salina, germinação, vigor, hortaliça.

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High quality seed is the basis for increasing agricultural productivity, however seed lots are subjected to various degenerative changes after maturity, and this fact requires care from users and determines that it is the subject of numerous studies. However, there are still many gaps, especially in evaluating the physiological potential of seeds of vegetable crops, including the parsley.

Seed physiological quality has been characterized by germination and vigor. Seed vigor is a sum of those properties that determine the activity and level of performance of seed lots of acceptable germination in a wide range of environments. Seed vigor is not a single measurable property, but is a concept describing several characteristics associated with the following aspects of seed lot performance such as rate and uniformity of seed germination and seedling growth, emergence ability of seeds under unfavorable environmental conditions and performance after storage, particularly the retention of the ability to germinate. A vigorous seed lot is one that is potentially able to perform well even under environmental conditions that are not optimal for the species (ISTA, 2012).

Accelerated aging test is recognized as one of the most widely used to evaluate seed vigor of many crop species, being capable of providing information with high consistency (Hampton & Tekrony, 1995). There are several previous definitions about this test but Rossetto & Marcos Filho (1995) mentioned that this test is based on the response of seeds to relatively high temperature and relative humidity close to 100%, for a specific exposure period; the deterioration rate increases considerably when seeds are exposed to such conditions (Nakagawa, 1999). Thus, lots with low vigor show higher decrease in its viability after exposure to artificial aging stress (Marcos Filho, 1999), so that there is possibility of establishing differences in the physiological potential of seed lots (Panobianco & Marcos Filho, 2001).

An important aspect to be considered in accelerated aging test is the difference in water uptake by seeds that, exposed to humid atmosphere, may show marked variations in moisture content. Research conducted with species of small-sized seeds, like many vegetables, have shown inconsistent results due to very sharp variation of moisture content of samples after aging (Ramos *et al*., 2004). Accordingly, alternatives have been suggested for conducting accelerated aging with seeds of these species, such as replacing water by saline solutions. It is achieved in specific levels of relative humidity, depending on solution and concentration used. Also, it was possible reducing the rate of water absorption, speed and intensity of seeds deterioration (Jianhua & McDonald, 1996) without reducing the sensitivity of the test.

Parsley (*Petroselinum sativum*) has great value and commercial importance, due to its use in seasoning, widespread in Brazil (ISLA, 2008). This species is the most widely used spice in Brazil, regardless of the country region.

Thus, the objective of this research was to study the accelerated aging test methodology, to evaluate physiological potential of parsley seed, as well as to verify the possibility of using NaCl solution as an alternative for control of water uptake by seeds during the test.

MATERIAL AND METHODS

The research was conducted at a laboratory of Department of the Universidade Federal de Santa Maria, Rio Grande do Sul state, Brazil. We used four seed lots of parsley, Lisa Comum cultivar.

The following tests were conducted to evaluate water content and the physiological potential of parsley seed lots:

Water content (WC) - with 5 g of seeds and four replications, by oven method at 105±3ºC during 24 h (Brasil, 2009);

Germination (G) - conducted with two replicates of 50 seeds per lot, sown in plastic boxes, on three sheets of blotter paper moistened with sterile and distilled water, equivalent to 2.5 times the mass of dry paper. Germination boxes were kept in a chamber at 20-30ºC with photoperiod of 8 h. Counts were performed at 10 and 28 days after sowing, according to criteria established by Regras para Análise de Sementes (Brasil, 2009). Results were expressed as percentage of normal seedlings;

Seedling emergence (SE) - conducted with four replicates of 25 seeds per lot, sown in plastic trays containing sand and kept in an incubator at 30ºC. Irrigations were made when necessary and evaluation occurred 22 days after sowing, when there was no more emergence, computing the percentage of normal seedlings emerged (Nakagawa, 1999).

Speed index of seedling emergence (ESI) - by daily counts of the number of seedlings until stabilized emergence. For each replicate, we calculated the ESI, by the sum of the number of emerged plants each day, divided by number of days elapsed from sowing, as Maguire (1962), by formula:

$$ESI = \frac{E1}{N1} + \frac{E2}{N2} + \frac{E3}{N3} \ldots + \frac{En}{Nn}$$

Where: ESI= speed of seedling emergence index; E1, E2, En= number of emerged plants, computed in the first, second, and at last counts; N1, N2, Nn= number of days from sowing to first, second and last counts.

Traditional accelerated aging test - carried out using plastic boxes containing 40 mL of water on an aluminum screen tray on which 4 g of seeds were distributed in a single layer. Boxes were kept in a BOD chamber at 42ºC for 48, 72 and 96 h. After each aging period, four replicates of 50 seeds were subjected to germination test, following methodology described above, with evaluation on 10th day after sowing. In addition, the water content was determined after each aging period to check the uniformity of test conditions (Marcos Filho, 1999).

Accelerated aging test using unsaturated NaCl solution (NSSAA) - performed similarly to traditional accelerated aging, but adding to the bottom of the plastic boxes 40 mL unsaturated salt solution (11 g NaCl, diluted in 100 mL water), establishing an environment with approximately 94% relative humidity, adapting the methodology described by Jianhua & McDonald (1996) and determined according to Van't Hoff equation described by Salisbury & Ross (1992).

Accelerated aging test using saturated NaCl solution (SSAA) - performed similarly to traditional accelerated aging, but adding to the bottom of the plastic boxes 40 mL of saturated NaCl solution (40 g NaCl, diluted in 100 mL water), establishing an environment with approximately 76% relative humidity, following the methodology described by Jianhua & McDonald (1996).

For the statistical procedure there was used the completely randomized design with four replications. Statistical analyzes vere not performed for the determination of water contet. The results were submitted to ANOVA and means compared by Tukey test (α = 0.05), using the Sisvar program (Ferreira, 2000).

RESULTS AND DISCUSSION

The data from water content before accelerated aging of parsley seeds were similar for four lots (Table 1). According to Pedroso (2009), when seeds have a relatively low water content, as observed in the parsley seed lots, the usual is a greater reliability of results obtained in tests to evaluate seed physiological potential.

Results of germination test (Table 1) did not indicate significant differences between seed lots of parsley. Percentage and speed of seedling emergence showed that lots 1 and 4 were higher in vigor than lots 2 and 3.

Parsley seeds aged in traditional procedure, reached higher water contents and wider variations among lots, differing up to 7.3% (Table 2), which exceed allowable limits of 3.0-4.0% indicated by Marcos Filho (1999). Likewise, Rodo *et al.* (2000) found for carrot seeds, variations from 5.0 to 9.2% by the end of accelerated aging test, considered excessive.

Moreover, the use of unsaturated saline solution reduced the rate of water absorption by seeds during aging period, not exceeding the variation of 2.7% of water content among samples of aged lots. The same occurred on the aging test with the use of saturated NaCl solution (SSAA), with maximum variation of 2.1%. The conditions of accelerated aging test with unsaturated and saturated NaCl solution promoted less drastic effects on seeds than the traditional procedure; therefore, to achieve lower water content (Table 2), the degree of deterioration was attenuated compared to that normally observed with the use of the traditional method. This was also observed by Torres & Marcos Filho (2001), working with gherkin seeds.

Similar results were found by Torres (2004), using the NaCl saturated solution accelerated aging test with fresh grass seeds in that the decrease of speed of water absorption by the seeds resulted in less drastic deterioration rates, and more uniform performance than those subjected to the traditional procedure. This method also showed to be efficient for vigor evaluation of cucumber seeds (Bhering *et al.*, 2000), tomato (Panobianco & Marcos Filho, 2001), melon (Torres & Marcos Filho, 2003) and rocket salad (Ramos *et al*., 2004).

Table 1. Initial quality of parsley seed lots by water content (WC), germination (G), seedling emergence (SE) and emergence rate index (ERI) [qualidade inicial de lotes de sementes de salsa, pelo teor de água (WC), germinação (G), emergencia de plantulas (SE) e razão do índice de emergencia (ERI)]. Santa Maria, UFSM, 2010.

Lots	WC	G	SE	ERI
	(%)			
1	8.1	88a	78a	11.7a
2	8.3	80a	53b	9.1b
3	8.3	82a	48b	7.2b
4	7.9	85a	81a	11.2a
CV (%)		8.5	11.5	14.2

*Means followed by the same letter in column do not differ by Tukey test at 5% probability (medias seguidas por mesma letra na coluna não diferem; Tukey, 5%).

Table 2. Water content (WC) of parsley seeds after traditional accelerated aging test (traditional) and accelerated aging test using unsaturated NaCl solution (NSSAA) and saturated NaCl solution (SSAA) under different aging periods (48, 72 and 96 h) [teor de água (WC) de sementes de salsa após envelhecimento acelerado tradicional (traditional) e teste de envelhecimento acelerado usando solução de NaCl não saturada (NSSAA) e solução saturada de NaCl (SSAA) em diversos periodos de envelhecimento (48, 72 e 96 h)]. Santa Maria, UFSM, 2010.

Lots	Traditional			NSSAA			SSAA		
	48 h	72 h	96 h	48 h	72 h	96 h	48 h	72 h	96 h
	(%)								
1	20.42	33.47	36.02	15.62	13.15	12.85	11.23	11.09	11.89
2	20.30	35.42	40.12	18.35	13.11	13.44	12.52	11.56	14.12
3	25.38	36.03	42.41	18.33	14.01	14.83	11.10	13.23	14.25
4	18.23	30.25	35.12	16.23	12.27	12.55	11.09	11.78	12.45

Table 3. Germination of parsley seeds after traditional accelerated aging test (traditional), accelerated aging test using unsaturated NaCl solution (NSSAA) and saturated NaCl solution (SSAA) under different aging periods (48, 72 and 96 h) [germinação de sementes de salsa após teste de envelhecimento acelerado (tradicional), teste de envelhecimento acelerado usando solução insaturada de NaCl (NSSAA) e solução saturada de NaCl (SSAA), sob diversos periodos de envelhecimento (48, 72 e 96 h)]. Santa Maria, UFSM, 2010.

Lots	Traditional			NSSAA			SSAA		
	48 h	72 h	96 h	48 h	72 h	96 h	48 h	72 h	96 h
	(%)								
1	73a	65a	27a	70a	80a	75a	85a	81a	77a
2	52b	28b	8b	57b	60b	55b	63b	53b	50b
3	42b	19b	1c	42b	51c	51b	55c	47b	44b
4	73a	51a	19a	73a	83a	76a	81a	75a	75a
CV(%)	8.0	10.2	13.9	4.3	4.9	3.1	5.5	5.7	4.4

*Means followed by the same letter in column do not differ by Tukey test at 5% probability (medias seguidas por mesma letra na coluna não diferem; Tukey, 5%).

Examining the results of accelerated aging tests (Table 3), the three methodologies allowed the classification of lots for differences in vigor of parsley seeds, providing the same separation of lots checked by seedling emergence and emergence rate index (Table 1).

Results obtained in accelerated aging test, conducted by the traditional procedure (96 h), with unsaturated solution (72 h) and saturated NaCl solution (48 h) separated lots in several levels of vigor, also indicating lots 1 and 4 as higher in physiological potential, and also detecting differences between lots 2 and 3, not observed in the test of normal seedlings. However, values of germination after the traditional accelerated aging test provided high reduction on number of the seedling emergence, indicating that the procedure using seed exposition for 96 h is not as suitable for parsley seeds. Rodo *et al*. (2000), Ramos *et al*. (2004), Torres (2005), Nascimento *et al*. (2007), Costa *et al*. (2008), Torres & Bezerra Neto (2009) and Tunes *et al.* (2009) also found that the stress caused by traditional accelerated aging test at 42ºC for 96 h caused a significant reduction in germination of salad rocket, carrots and barley.

The period of 48 h of aging with the use of saturated NaCl solution proved to be the most appropriate, for the shortest period of performance which is a desirable feature in a seed vigor test that allows for energy saving by the equipments, and provides results in a shorter period of time.

Results from the present study confirmed that the use of NaCl solutions contributes to improve the methodology of accelerated aging test to evaluate physiological potential of seeds because, in addition to using the same equipment as the traditional procedure, it provides conditions for absorbing less water and more uniformly by seeds.

In summary, the use of unsaturated and saturated NaCl solutions reduces water absorption and rate of deterioration of parsley seeds during accelerated aging test and the seed exposure for 48 h aging period is a promising option to evaluate the physiological potential of parsley seeds.

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