ABRATES

Journal of Seed Science

ISSN 2317-1545

www.abrates.org.br/revista

ARTICLE

Journal of Seed Science, v.46, e202446007, 2024

http://dx.doi.org/10.1590/2317-1545v46279725

Standardization of the accelerated aging test for evaluation of wheat seed vigor

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ABSTRACT: The accelerated aging test is widely used to evaluate seed vigor. However, for the wheat crop, discrepancies are found in the literature regarding temperature and period of exposure to stress. This study aimed to evaluate the efficiency of the accelerated aging test in different combinations of time and temperature in seed vigor evaluation in wheat lots and cultivars. The following cultivars were used: Tbio Sintania, Tbio Sossego, Tbio Sinuelo, LG Oro, Tbio Toruk, and CD 150 (Group 1), represented by one lot each, and five lots of the cultivar CD 150 (Group 2). Water content, germination, first count of germination, and seedling emergence in the field were evaluated for characterization of initial physiological potential. Then the accelerated aging test was applied to the lots under the following aging conditions: 41 °C / 48 and 72 h, 43 °C / 40 and 48 h, and 45 °C / 24 and 40 h in plastic boxes, with 40 mL of distilled water and seeds distributed in a single layer on a screen. After aging, the water content and germination of the seeds were determined. Analysis of variance was performed on the data, and the means were compared by Tukey's test, at 5% probability. The simple correlation test (r) was performed between the analyzed variables and the seedling emergence in the field test. The accelerated aging test with the combinations of 41 °C / 72 h and 43 °C / 48 h is efficient for evaluating seed vigor of wheat lots and cultivars. The combination of 43 °C / 48 h provides results more quickly, saving 24 h in relation to the methodology recommended in the literature (41 °C / 72 h).

Index terms: abiotic stresses, deterioration, physiological potential, *Triticum aestivum* L.

RESUMO: O teste de envelhecimento acelerado é amplamente utilizado para avaliação do vigor de sementes, no entanto para a cultura do trigo ainda existe discrepância na literatura quanto aos fatores temperatura e período de exposição ao estresse. O objetivo foi avaliar a eficiência do teste de envelhecimento acelerado, em diferentes combinações de tempo e temperaturas, na avaliação do vigor de sementes de lotes e cultivares de trigo. Foram utilizadas as cultivares: Tbio Sintonia, Tbio Sossego, Tbio Sinuelo, LG Oro, Tbio Toruk e CD 150 (Grupo 1) representadas por um lote cada e por cinco lotes da cultivar CD 150 (Grupo 2). Para a caracterização do potencial fisiológico inicial foram avaliados o teor de água, a germinação, a primeira contagem do teste de germinação e a emergência de plântulas em campo. Após, os lotes foram submetidos ao teste de envelhecimento acelerado nas seguintes condições de envelhecimento: 41 °C / 48 e 72 h, 43 °C / 40 e 48 h e 45 °C / 24 e 40 h em caixas de plástico, com 40 mL de água destilada, e as sementes distribuídas sobre tela em camada única. Foi determinado o teor de água e a germinação das sementes após o envelhecimento. Foi realizada análise de variância dos dados e as médias comparadas pelo teste de Tukey, a 5% de probabilidade. Foi realizado o teste de correlação simples (r) entre as variáveis analisadas e a emergência de plântulas no teste de campo. O teste de envelhecimento acelerado nas combinações de 41 °C / 72 h e 43 °C / 48 h é eficiente para avaliação do vigor de sementes de trigo. A combinação de 43 °C / 48 h favorece a obtenção dos resultados de maneira mais rápida com economia de 24 h em relação à metodologia recomendada de 41 °C / 72 h.

Termos para indexação: estresses abióticos, deterioração, potencial fisiológico, *Triticum aestivum* L.

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Received: 10/20/2023.
Accepted: 01/23/2024.

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INTRODUCTION

Wheat (*Triticum aestivum* L.) is the second most produced cereal crop in the world, which means that it is of great importance in the economy of various countries. It is one of the main food sources in Brazil as it is used in foods such as flour, pasta, cookies/crackers, and a wide variety of other foods. Brazil is among the largest producers of the crop worldwide, and estimates are that 3.4 million hectares of wheat are grown in Brazil, which may result in a harvest of 10.818 million metric tons of the grain (CONAB, 2022).

Of the main Brazilian agricultural products, wheat has one of the widest ranges of uses in the market and extensiveness in the technological aspect of production, in insertion in regional production systems, in aggregating income to farm properties, in the aspect of domestic food supply, and in the role of a product relevant to Brazilian commercial transactions with other countries. Thus, seed production companies have worked to produce seeds with high physiological potential that favor adequate plant stand and plants with high yield performance.

The physiological potential of wheat seeds is routinely evaluated through the germination test, which favors the expression of the maximum germination potential of a seed lot by offering optimal conditions of moisture and temperature necessary for seedling growth. To provide information complementary to the germination test, research institutions have striven to develop tests that evaluate seed vigor (AOSA, 2009; ISTA, 2019; Krzyzanowski et al., 2020a). These tests offer additional information, such as the potential for storage with minimum deterioration and production of normal seedlings under adverse edaphic and climatic conditions during crop establishment (Marcos-Filho, 2015).

Among the tests most used for the evaluation of seed vigor of various species is the accelerated aging test (Hampton and Tekrony, 1995). The principle of this test is the increase in seed deterioration under conditions of exposure to high temperature and moisture. Thus, low-quality seeds deteriorate more quickly than more vigorous ones, with a sharp reduction in their viability (AOSA, 2018), which is detected by the germination test after exposure to these types of stress.

Various studies have been conducted aiming at the refinement of methodologies for carrying out this test in various crops, such as soybean, maize, and wheat (Hampton and Tekrony, 1995; Dutra and Vieira, 2004; Lima et al., 2006; Ohlson et al., 2010; Marcos-Filho, 2020). Many of these studies evaluate the factors that affect the standardization and reliability of test results, such as the initial water content of the seeds, the genotype, moisture, temperature, and the period of exposure to stress conditions in the aging chamber.

Divergences have been found in the literature regarding the methodology used for conducting the accelerated aging test in wheat seeds. The methodology currently suggested in the manual of vigor tests of the Association of Official Seed Analysts (AOSA, 2009) recommends aging seeds at 41 °C for 72 h. However, Modarresi et al. (2002) observed that this combination did not adequately separate the seed lots into vigor levels, and they reported that the test was more efficient when conducted at 43 °C or 45 °C / 72 h, suggesting future investigations regarding the results obtained in the test in relation to seedling performance in the field.

Using alternative methodologies, Maia et al. (2007) studied the effect of artificial aging on wheat seeds with different combinations of temperatures and exposure periods. They considered that the temperatures of 41 °C for 24 and 48 h, and 43 °C for 24 h were efficient for the evaluation of physiological potential. Using a saturated NaCl solution, Pedroso et al. (2010) and Meriaux et al. (2007) recommended the combinations of 42 °C / 96 h and 41°C for 120 h, respectively. However, a long period is required to carry out either of those combinations.

Lima et al. (2006), just as Fanan et al. (2006) and Ohlson et al. (2010), suggested the combination of 43 °C and 48 h to evaluate the physiological potential of wheat seeds, which was considered more efficient by presenting results similar to those of the seedling emergence in the field test.

Based on the literature cited, there is a clear discrepancy among the methodologies recommended for the wheat seed vigor test based on accelerated aging, which may be related to factors such as genotype. In this context, this study was carried out with the aim of evaluating the efficiency of the accelerated aging test under different combinations of exposure time and temperatures in the evaluation of seed vigor of different wheat seed lots and cultivars.

MATERIAL AND METHODS

Wheat seeds of the following cultivars were used: 1 - Tbio Sintonia, 2 - Tbio Sossego, 3 - Tbio Sinuelo, 4 - LG Oro, 5 - Tbio Toruk, and 6 - CD 150 (Group 1), represented by one seed lot each, and five seed lots of the cultivar CD 150 (Group 2). The lots received were divided into four replications by means of the Boerner sample homogenizer and divider. The seeds were then placed in cold and dry storage (10 °C, 50-60% relative humidity - RH) throughout the period of carrying out the experiment.

For the initial characterization of the physiological potential of the seeds of Groups 1 and 2, the following evaluations were made:

Water content (WC): obtained using the laboratory oven method at 105 ± 3 °C for 24 h (Brasil, 2009), with two subsamples per replication per lot.

Germination (G): conducted with four subsamples of 50 seeds per replication per lot. The seeds were distributed in rolls of "Germitest" germination testing paper moistened with a water volume equivalent to 2.5 times the weight of the dry substrate. The rolls were kept in cabinets within a germination chamber at a temperature adjusted to 20 °C. Evaluations were made on the fourth day (first count of germination) and eighth day after sowing, and the results were expressed in percentages of normal seedlings (Brasil, 2009).

Seedling emergence in the field (SEF): the test was conducted with four subsamples of 100 seeds per replication per lot. The seeds were manually distributed in furrows of 4-m length and 3-cm depth at a spacing of 50 cm between seeds. Emerged seedlings were counted at 14 days after sowing, and results were expressed in the percentage of emerged seedlings (Krzyzanowski et al., 2020b). The data of maximum and minimum temperatures, rainfall, and relative humidity in the period of evaluation of the test are shown in Figure 1. Due to the absence of rain, irrigation was applied twice: on the day of setting up the experiment (12 mm) and on the third day after sowing (10 mm).

Accelerated aging (AA): the seeds were distributed on stainless steel screens in a single layer within a plastic box (11.0 × 11.0 × 3.5 cm) containing 40 mL of water at the bottom. The boxes with lids were kept in a jacketed aging chamber using the following combinations of temperatures and exposure periods: 41 °C / 48 and 72 h, 43 °C / 40 and 48 h, and 45 °C / 24 and 40 h, defined as based on the recommendations available for wheat in the literature. After

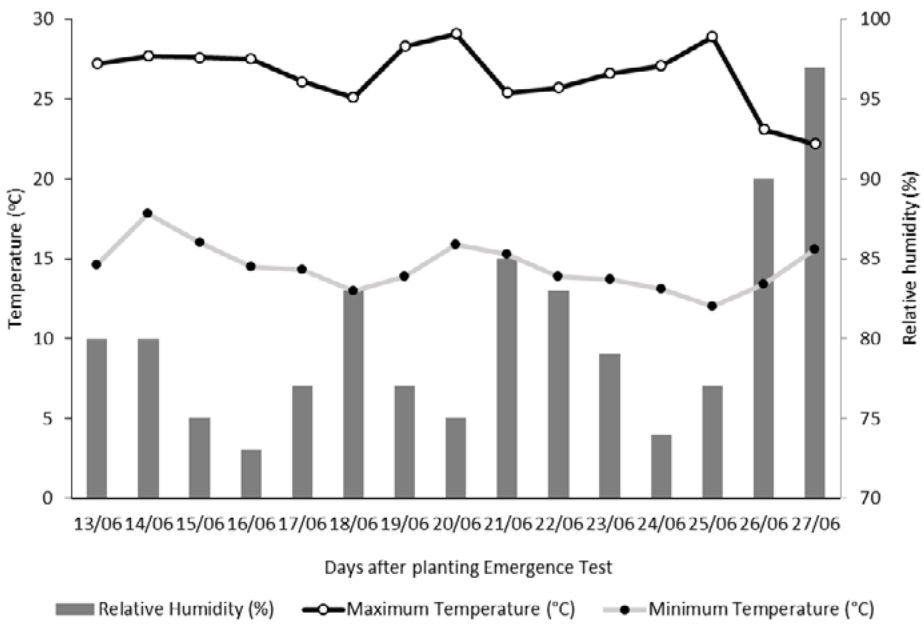

Figure 1. Relative humidity, maximum and minimum temperatures observed in Londrina, PR, in the perio d of conducting the seedling emergence in the field test for wheat.

seed aging, the germination test was conducted on four subsamples of 50 seeds per replication per lot, according to the method already described, with evaluation on the fourth day after setting up the test. The water content of the seeds was also determined, using the laboratory oven method (Brasil, 2009) before and after the aging period to check the quality of conducting the test in regard to the imbibition rate and deterioration rate of the seeds (Marcos-Filho, 2020).

For the tests performed in the laboratory, statistical analysis was conducted in a completely randomized design, with four replications. For the seedling emergence in the field test, a randomized block design was adopted, with four replications. Group 1 (six cultivars) was analyzed apart from Group 2 (five seed lots of the cultivar CD 150) in each analysis, to isolate and evaluate a possible genetic effect. Analysis of variance was performed on all the tests, and means were compared by Tukey's test at 5% probability using the SISVAR statistical program (Ferreira, 2011). Simple Pearson correlation analysis (r) was performed on the data obtained in the laboratory and on the seedling emergence in the field data using the BioEstat 5.0 software.

RESULTS AND DISCUSSION

The data referring to the initial water content (WCI) of the seeds were similar for the seed lots of the six cultivars (Group 1) and for the five lots of the cultivar CD 150 (Group 2), ranging from 10.0 to 11.4 % and from 10.1 to 11.1 % moisture content, respectively (Tables 1 and 2). Variation of up to 2.0 percentage points among the samples is an important aspect of quality control to be considered prior to evaluation in the accelerated aging test, since the wetter seeds are more sensitive to the stress conditions of the test and undergo greater deterioration (Marcos-Filho, 2015). The variations in the mean data of water content after the aging periods of Group 1 and Group 2 seeds (Tables 1 and 2)

Table 1. Initial water content (WCI), in %, and water content after periods of accelerated aging of seeds of six wheat cultivars (Group 1).

Cultivar	WCI	41 °C		43 °C		45 °C	
		48 h	72 h	40 h	48 h	24 h	40 h
1-Tbio Sintonia	11.0	27.4	28.7	27.0	28.7	24.5	28.2
2-Tbio Sossego	10.6	27.9	29.3	27.5	28.9	25.6	27.7
3-Tbio Sinuelo	10.0	27.2	29.1	26.1	27.2	24.3	26.7
4-LG Oro	11.4	28.6	28.8	28.1	29.3	25.9	28.6
5-Tbio Toruk	11.2	28.4	29.3	27.2	28.9	25.0	26.5
6-CD 150	10.2	26.6	28.1	26.9	27.3	24.3	28.7

Table 2. Initial water content (WCI), in %, and water content after periods of accelerated aging of seeds of five lots of the wheat cultivar CD 150 (Group 2).

Lot	WCI	41 °C		43 °C		45 °C	
		48 h	72 h	40 h	48 h	24 h	40 h
1	10.2	26.5	28.1	26.9	27.3	24.3	28.3
2	10.1	26.7	28.2	25.7	27.2	23.1	26.4
3	11.1	26.8	28.3	26.3	29.2	24.0	27.7
4	10.4	26.5	28.5	26.3	28.3	25.0	26.7
5	10.9	26.8	27.4	26.6	27.9	24.0	27.8

also did not exceed 2.0 percentage points, indicating uniformity in carrying out the test procedures, as recommended by Marcos-Filho (2020).

A summary of the analysis of variance showed significant statistical differences ($p \leq 0.01$) among the seed lots of the Group 1 cultivars in the initial quality characterization tests (Table 3).

The initial physiological quality characterization of the seed lots is shown in Tables 3 and 4. The germination test (G) indicated that the cultivar 1 lot had lower quality and the lots of the other cultivars had higher quality (Table 4). The first count of germination (FC) test led to the classification of the cultivar lots in three vigor levels, and it indicated that the cultivar 1 lot had lower vigor, the cultivar 4 lot had intermediate vigor, and the other lots (cultivars 2, 3, 5, and 6) had high vigor. Seedling emergence in the field (SEF) classified the cultivars 1 and 4 lots as lower vigor, 2 and 3 as intermediate vigor, and 5 and 6 as high vigor.

The mean squares referring to the analysis of variance of the Group 2 lots are shown in Table 5. There was a difference among the lots of the CD 150 cultivar in the initial physiological quality characterization tests.

The initial physiological quality of the lots is characterized in Table 6. The germination test (G) classified lots 3 and 4 as lower quality and lots 1, 2, and 5 as higher quality (Table 3 and 6). The first count of germination (FC) differentiated

Table 3. Summary of analysis of variance of the following variables: germination (G), first count of germination (FC), and seedling emergence in the field (SEF) of seeds of six wheat cultivars (Group 1).

Source of Variation	Mean Squares		
	DF	G	FC
Cultivar	5	14.34	239.58
Error	18	1.90	4.76
F-test (Cal)	-	7.54**	50.29**
		SEF	*F*-test (Cal)
Cultivar	5	141.07	26.12**
Block	3	3.83	0.71ns
Error	15	5.40	-

**Significant at 1% probability by the *F*-test; ns not significant.

Table 4. Mean values of germination (G), first count of germination (FC), and seedling emergence in the field (SEF) in characterization of initial physiological quality of seeds of six wheat cultivars (Group 1).

Cultivar	G	FC	SEF
	----------%----------		
1-Tbio Sintonia	88 b*	66 c	76 d
2-Tbio Sossego	92 a	85 a	84 bc
3-Tbio Sinuelo	92 a	86 a	87 ab
4-LG Oro	91 a	81 b	79 cd
5-Tbio Toruk	93 a	86 a	90 a
6-CD 150	93 a	86 a	91 a
CV (%)	1.51	2.68	2.75

*Mean values followed by different letters in the column differ from each other by Tukey's test ($p \leq 0.05$).

Table 5. Summary of analysis of variance of the following variables: germination (G), first count of germination (FC), and seedling emergence in the field (SEF) in the characterization of the initial physiological quality of seeds of five lots of the wheat cultivar CD 150 (Group 2).

Source of Variation	Mean Squares		
	DF	G	FC
Lot	4	57.43	1754.63
Error	15	5.68	7.10
F-test (Cal)	-	10.10**	247.13**
		SEF	*F*-test (Cal)
Lot	4	158.55	19.45**
Block	3	3.73	0.46 ns
Error	12	8.15	-

** Significant at 1% probability by the *F*-test; ns not significant.

Table 6. Mean values of germination (G), first count of germination (FC), and seedling emergence in the field (SEF) in the characterization of the initial physiological quality of seeds of five lots of the wheat cultivar CD 150 (Group 2).

Lot	G	FC	SEF
	----------%----------		
1	93 a*	86 a	91 a
2	95 a	86 a	92 a
3	86 b	51 b	79 b
4	88 b	43 c	79 b
5	94 a	82 a	87 a
CV (%)	2.62	3.83	3.33

* Mean values followed by different letters in the column differ from each other by Tukey's test ($p \leq 0.05$).

the lots into three vigor levels and indicated lot 4 as lower vigor; lot 3 as intermediate vigor; and lots 1, 2, and 5 as high vigor. Seedling emergence in the field (SEF) classified lots 3 and 4 as low vigor and lots 1, 2, and 5 as high vigor.

The variations tested in the combinations of times and temperatures for the methodology of the accelerated aging test were for the evaluation of wheat cultivar vigor (Table 7). The mean data of the percentage of normal seedlings obtained after exposure of the seeds (Group 1) to the combinations of times and temperatures of accelerated aging are shown in Table 8.

The combinations of 41 °C / 72 h and 43 °C / 48 h separated the seed lots of the cultivars into four vigor levels, and likewise classified the cultivar 1 lot as low vigor, followed by the cultivar 4 lot. Lots 3, 5, and 6 were classified as high vigor, and the cultivar 2 lot as intermediate vigor. Nevertheless, a high reduction is seen in the percentage of germinated seeds in the period of 72 h. This result is similar to the results found by Ohlson et al. (2010) using the same combination of temperature and aging period in seeds from two wheat cultivars. The combinations of 41 °C / 48 h, 43 °C / 40 h, and 45 °C / 40 h stratified the seed lots of the cultivars into three vigor classes and indicated the lots of cultivars 1 and 4 as lower vigor, 5 and 6 as high vigor, and 2 and 3 as intermediate vigor.

The combination of 45 °C / 24 h was less rigorous in differentiating the lots of the Group 1 cultivars into vigor levels. However, it indicated the lots of cultivars 1 and 4 as lower vigor and the rest as higher vigor. The lots of cultivars 1 and 4 were classified as low vigor in all the combinations evaluated, just as observed in the first count of germination and seedling emergence in the field tests (Table 4).

Table 7. Summary of analysis of variance of the accelerated aging test in different combinations of temperatures and exposure times of seeds of six wheat cultivars (Group 1).

Source of Variation	DF	Mean Squares					
		41 °C 48 h	41 °C 72 h	43 °C 40 h	43 °C 48 h	45 °C 24 h	45 °C 40 h
Cultivars	5	262.54	1533.34	75.47	566.44	258.34	643.44
Error	18	3.90	5.24	5.00	5.15	2.13	2.93
F-test (Cal)	-	67.27**	292.84**	15.09**	109.93**	121.57**	219.56**

** Significant at 1% probability by the *F*-test.

Table 8. Mean values of the percentage of normal seedlings obtained after accelerated aging in different combinations of temperatures and exposure times of seeds of six wheat cultivars (Group 1).

Cultivar	41 °C		43 °C		45 °C	
	48 h	72 h	40 h	48 h	24 h	40 h
1-Tbio Sintonia	65 c*	14 d	75 c	55 d	68 b	57 c
2-Tbio Sossego	82 b	55 b	86 a	77 b	85 a	78 b
3-Tbio Sinuelo	84 ab	57 ab	85 ab	82 a	84 a	78 b
4-LG Oro	82 b	31 c	80 b	67 c	70 b	56 c
5-Tbio Toruk	87 a	60 a	86 a	85 a	85 a	82 a
6-CD 150	87 a	62 a	84 ab	85 a	85 a	85 a
CV (%)	2.44	4.94	2.72	3.02	1.84	2.36

* Mean values followed by different letters in the column differ from each other by Tukey's test ($p \leq 0.05$).

Table 9. Summary of analysis of variance of the variables of the accelerated aging test in different combinations of temperatures and exposure times of seeds of five lots of the wheat cultivar CD 150 (Group 2).

Source of Variation	DF	Mean Squares					
		41 °C 48 h	41 °C 72 h	43 °C 40 h	43 °C 48 h	45 °C 24 h	45 °C 40 h
Lot	4	994.93	1104.93	592.45	1307.70	457.68	1603.00
Error	15	5.02	6.22	6.53	4.87	1.70	4.65
F-test (Cal)	-	198.32**	177.74**	90.68**	268.71**	269.22**	344.73**

** Significant at 1% probability by the F-test.

There was a difference in the combinations of periods and temperatures in the accelerated aging test for the lots of the CD 150 cultivar (Group 2) (Table 9). The mean data of the percentage of normal seedlings obtained after exposure of the seeds of the cultivars (Group 2) to the combinations of aging times and temperatures are shown in Table 10.

With the combination of the temperature of 43 °C in the period of 48 h and 45 °C for 40 h, the lots were classified into four vigor levels. Lots 1 and 2 exhibited superior vigor, lot 5 intermediate vigor, and lots 3 and 4 lower vigor. The combinations of 41 °C / 48 h, 43 °C / 40 h, and 45 °C / 24 h classified the lots into three vigor levels, indicating lots 1, 2, and 5 as high vigor, lot 4 as medium vigor, and lot 3 as low vigor. In the combination of 41 °C / 72 h, superior vigor was observed in lots 1, 2, and 5 and lower vigor for lots 3 and 4. Just as in Group 1, a reduction is seen in the percentage of normal seedlings with longer exposure time.

Table 10. Mean values of the percentage of normal seedlings obtained after accelerated aging in different combinations of temperatures and exposure times of seeds of five lots of the wheat cultivar CD 150 (Group 2).

Lot	41 °C		43 °C		45 °C	
	48 h	72 h	40 h	48 h	24 h	40 h
1	87 a*	62 a	84 a	85 a	85 a	85 a
2	86 a	62 a	87 a	83 a	85 a	85 a
3	51 c	33 b	58 c	42 d	60 c	36 d
4	70 b	30 b	80 b	60 c	80 b	68 c
5	87 a	62 a	87 a	75 b	84 a	75 b
CV (%)	2.95	5.03	3.24	3.20	1.66	3.09

* Mean values followed by different letters in the column differ from each other by Tukey's test ($p \leq 0.05$).

Table 11. Estimated Pearson simple correlation coefficients (r) between the seedling emergence in the field test and the variables germination, first count of germination, and accelerated aging of seeds of six wheat cultivars (Group 1) and five lots of the cultivar CD 150 (Group 2).

Variables	Seedling emergence in the field	
	Group 1	Group 2
Germination	0.91*	0.93*
First Count of Germination	0.83*	0.97**
Accelerated Aging 41 °C / 48 h	0.84*	0.86 ns
Accelerated Aging 41 °C / 72 h	0.95**	0.95*
Accelerated Aging 43 °C / 40 h	0.84*	0.72 ns
Accelerated Aging 43 °C / 48 h	0.97**	0.93*
Accelerated Aging 45 °C / 24 h	0.91*	0.78 ns
Accelerated Aging 45 °C / 40 h	0.94*	0.83 ns

** significant at 1% probability by the *t*-test; * significant at 5% probability by the *t*-test; ns not significant.

The results of the linear correlation between the seedling emergence in the field test and the variables of germination, first count of germination, and the methodologies tested in the accelerated aging test are shown in Table 11.

A positive linear correlation is observed between seedling emergence in the field test and the tests of germination and first count of germination for the cultivars of Group 1 and the lots of Group 2 (Table 11).

For the lots of the Group 1 cultivars, there was a positive linear correlation between seedling emergence in the field and all the combinations made of the accelerated aging test (Table 11). For the lots of Group 2, only the combinations of 41 °C / 72 h and 43 °C / 48 h exhibited significant correlation ($p \leq 0.05$), with r = 0.95 and 0.93, respectively. Although the other combinations (41 °C / 48 h, 43 °C / 40 h, 45 °C / 24 h, and 45 °C / 40 h) were not correlated with emergence, it is noteworthy that they showed strong correlations and high values even when they were not significant. Among the combinations evaluated, the result of the accelerated aging test at 43 °C / 48 h was significant at 1% probability, with the highest r value (r = 0.97) for Group 1, more closely corresponding to the results observed for seedling emergence in the field. Lima et al. (2006), Fanan et al. (2006), and Ohlson et al. (2010) likewise found high correlations between the results of the accelerated aging test and those of seedling emergence in the field using the combination of 43 °C / 48 h for wheat seeds.

Although it was correlated with seedling emergence in the field, the combination of 41 °C / 72 h recommended by the Association of Official Seed Analysts (AOSA, 2009) was less efficient in differentiating the seed lots of the CD 150 cultivar (Group 2) in vigor levels (Table 10) than the combination of 43 °C / 48 h. In addition, for the percentage of normal seedlings, a more drastic reduction is seen in both groups for these combinations than for the other combinations (Tables 8 and 10). Modarresi et al. (2002) observed that the combination of 41 °C / 72 h was not efficient in separating three lots of soft red winter wheat seeds into vigor levels. Ransom and Sebesta (2008) likewise concluded that the combination of 41 °C / 72 h for aging hard red spring wheat and durum seeds was not a good predictor of seedling emergence in the field.

The results of this study indicate that combinations of exposure period and temperature in the accelerated aging test can affect the germination response of seeds, especially low vigor seeds; and they show that different cultivars can react in different ways to imposed stress combinations. Groups 1 and 2 had similar responses to the combinations of 41 °C / 72 h and 43 °C / 48 h, indicating that the different genotypes were adequately evaluated by these combinations and that the difference in genotypes did not affect the results of the test. This is an important factor to consider in recommending a vigor test, such that a vigor test should be recommended for a species and not only for a cultivar.

It is noteworthy that, in general, the methodology recommended by Marcos-Filho (2020) for carrying out the accelerated aging test (41 °C / 72 h) had an effect on the reduction in the seed germination percentage. That may be related to the size of the seeds and the period in which they remained exposed to high relative humidity (100%). Thus, the results found in this study suggest that the official recommendations can be adjusted to the combination of 43 °C for the period of 48 h, which favors faster delivery of results, saving 24 h. That way, wheat seed production companies can be benefitted by obtaining results in a shorter time.

CONCLUSIONS

The accelerated aging tests with the combinations of 41 °C / 72 h and 43 °C / 48 h are efficient for the evaluation of wheat seed vigor.

The combination of 43 °C / 48 h favors faster delivery of results, saving 24 hours compared to the recommended methodology (41 °C / 72 h).

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