Nota Científica / Short Communication

The saturated salt accelerated ageing (SSAA) method seems to act too leniently on carrot (*Daucus carota* L.), lettuce (*Lactuca sativa* L.), and broccoli (*Brassica oleracea* var. *italica* Plenck) seeds germination

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Abstract

The efficiency of the salt saturated accelerated ageing (SSAA) of seeds of lettuce, carrot, and broccoli, as compared to the traditional seed ageing method, was investigated. The salts employed in this investigation were KCl and NaCl. The KCl solution permitted the control of the relative humidity within the inner chamber to values around 86% and that of NaCl to values around 76%. In the traditional method, the control of the relative humidity of the air inside the inner chamber was achieved with pure water. The temperature inside the outer chamber was around 45 °C and the periods of time the seeds were exposed to those conditions were of 0, 12, 24, 36, 48, 60, 72, 84, 96, 108, and 120 hours. The results were evaluated in terms of seed water content and germination. The results indicate that the saturated NaCl or KCl solutions do not seem to be methods capable of reducing the germination of carrot, lettuce, and broccoli seeds to values sufficient to allow the comparison between seed lots. On the other hand, the traditional method did reduce the germination to values potentially capable of discriminating among seed lots.

Additional keywords: vigor tests.

Resumo

RIBEIRO, F. C.; CARVALHO, N. M. de. Nota científica – O teste de envelhecimento acelerado com solução salina saturada parece ter ação muito fraca na germinação de sementes de cenoura (*Daucus carota* L.), alface (*Lactuca sativa* L.) e brócolis (*Brassica oleracea* var. *italica* Plenck). Científica, Jaboticabal, v.33, n.2, p. 208-212, 2005.

Foi pesquisada a eficiência do envelhecimento acelerado com solução salina saturada (SSAA) em sementes de alface, cenoura e brócolis, em comparação com o método tradicional de envelhecimento. Os sais empregados foram KCl e NaCl. A solução de KCl permitiu o controle da umidade relativa dentro da câmara interna até valores de cerca de 86%, e a de NaCl, até cerca de 76%. No método tradicional, o controle da umidade relativa do ar dentro da câmara interna foi obtido com água pura. A temperatura dentro da câmara de envelhecimento esteve em torno de 45 °C, e os períodos de tempo a que as sementes foram expostas a essas condições foram 0, 12, 24, 36, 48, 60, 72, 84, 96, 108 e 120 horas. Os resultados foram avaliados em termos de teor de água e germinação. Os resultados indicam que as soluções saturadas de NaCl ou KCl não parecem ser métodos capazes de reduzir a germinação de sementes de cenoura, alface e brócolis até valores suficientes para permitir a comparação entre lotes. Por outro lado, o método tradicional não reduziu a germinação a valores potencialmente capazes de discriminar lotes de sementes.

Palavras-chave adicionais: testes de vigor.

Introduction

The accelerated ageing test has become one of the most popular vigor tests (JIANHUA & MCDONALD, 1997). Due to the efforts of various investigators and research institutions (McDONALD & PHANEENDRANATH, 1978, TOMES et al., 1988, among others) it is considered to be one of the test in which the degree of standardization has gone farther.

Although highly recommended as a vigour test for large-seeded agronomic crops, recently reported data (POWELL, 1995, JIANHUA & McDONALD, 1997, McDONALD, 1997) seem to indicate that this test would not be equally applicable to small-seeded vegetable, flower, and turf crops. The small size of these seeds would be responsible for too quick an absorption of

water as well as for a large variation in seed moisture content during the exposition to the conditions of the accelerated ageing test.

The controlled deterioration method, proposed by MATTHEWS (1980), is said to require a precise adjustment of moisture content, this being considered a task very difficult to be part of routine testings.

JIANHUA & McDONALD (1997) have thus proposed a procedure to age small seeds which would consist in delaying moisture uptake by the seeds. This is proposed to be achieved by the replacement of water by a saturated salt hydric solution in the bottom of the inner chamber. The salt present in the solution would reduce water evaporation rate and this would result in lower relative humidity values within the inner chamber. Under these conditions, water uptake by the seeds would be slower and more uniform. According to McDONALD (1997), good results have been obtained for impatiens (*Impatiens walleriana* Hook) and pansy (*Viola tricolor* L.) seeds.

In order to verify whether other small-seeded crops would respond similarly to the proposed saturated salt accelerated ageing method, a project was conducted with seeds of carrot, broccoli, and lettuce.

Materials and methods

The carrot, lettuce, and broccoli seeds used were, respectively, of the cultivars 'Brasilia' (around 750 seeds/gram), 'Monalisa' (around 820 seeds/gram), and 'Florida' (around 400 seeds/gram).

Before ageing, the lettuce seeds showed a moisture content of 6%, those of broccoli, 11%, and those of carrot, 7%. As to initial physiological quality, the lettuce, broccoli, and carrot seeds had standard germination values of 100, 99, and 95%, respectively.

Two procedures were used to age these seeds:

1. Traditional method – in this procedure, the ageing of the seeds was conducted according to description found in Association of Official Seed Analysts (1983). Of each one of the species a sample of 2 grams was taken and spread over a wire-mesh tray. To the bottom of the inner chamber, 40 ml of distilled water were added. The outer chamber temperature was maintained at 45 ºC and the exposition periods of time were of 0, 12, 24, 36, 48, 60, 72, 84, 96, 108, and 120 hours.

2. The saturated salt accelerated ageing (SSAA) method – two salts were employed to obtain the solution – either NaCl or KCl. The saturated hydric solutions of both salts were obtained according to procedures found in WINSTON & BATES (1960). The NaCl saturated solution maintained a relative humidity of 76% within the inner chamber and that of KCl, a relative humidity of 86%. The periods of time the seeds were exposed to these conditions were the same as those employed in the traditional method.

Immediately after being taken out of the ageing chamber, the seeds were evaluated as to water content and germination (BRASIL, 1992).

The experimental design was that of a CRD in a factorial arrangement – 11 x 3, that is, 11 ageing periods and 3 ways of maintaining the relative humidity within the inner box.

The germination results were expressed in percentage and to be statistically analysed, they were transformed in arcsin $\sqrt{x/100}$.

Results

The results are presented in the following tables. (Table 1, Table 2, Table 3, and Table 4).

Discussion

The water contents shown by the seeds (Table 1) are a consequence of their being in close contact either with a high relative humidity (water ageing system) or a low relative humidity (saturated salt solution systems) environment. In the pure water system, the seeds reached, after 120 hours, very high moisture levels – 35% the lettuce, 43% the broccoli, and 53% the carrot seeds. When the control of the relative humidity within the inner box was achieved by the saturated salt solutions, the equilibrium moisture contents were, after 120 hours, between 7 and 12%. Tables 2, 3, and 4 show that when the water system was used, the first time the seed germination dropped to half its original value for lettuce and carrot took place between 72 and 84 hours and between 36 and 48 hours for broccoli. When the relative humidity within the inner chamber was controlled by the KCl solution, none of the species reached half of the initial germination value. The largest drop in seed germination when the SSAA system was employed was that brought about by the KCl solution when carrot seeds were being aged. The NaCl solution, due to its resulting in an even lower relative humidity (76%) of the air within the inner chamber, resulted in the highest germination values after the ageing periods. The germination values after 120 hours of ageing was 86% of that of the non-aged seeds of lettuce, 89% of broccoli and 84% of carrot. These drop values in germination are herein supposed to be not large enough to separate seed lots with initial germination values above a given standard value.

In order to differentiate between or among seed lots, the results of the standard germination test run after exposing the seeds to the conditions of the artificial ageing test, should ideally be located in the

Table 1 – Water content (%) before and after 120 hours of artificial ageing of lettuce, carrot, and broccoli seeds under different ageing or relative humidity controlling systems.

Species / ageing status	Relative humidity controlling system		
	Pure water	KCl solution	NaCl solution
Lettuce			
before ageing	5.87	5.87	5.87
after ageing	35.32	8.42	7.27
Carrot			
before ageing	7.23	7.23	7.23
after ageing	53.25	13.96	10.67
Broccoli			
before ageing	10.50	10.50	10.50
after ageing	43.83	12.74	12.05

Table 2 – Standard germination results* (in arcsin $\sqrt{x/100}$) of lettuce seeds before and after several ageing periods under different ageing or relative humidity controlling systems.

Ageing period (hours)	Relative humidity controlling system		
	Pure water	KCl solution	NaCl solution
0	89.59A	89.59A	89.59A
12	82.95A	89.59A	98.59A
24	82.29A	82.95AB	84.88AB
36	55.96B	74.19BCD	89.59A
48	54.47B	82.30AB	84.88AB
60	53.24B	82.95AB	89.59A
72	52.05B	80.17AB	87.66AB
84	24.71C	71.61CD	89.99A
96	27.57C	70.23CD	84.03AB
108	13.42D	68.13D	78.86AB
120	10.21D	68.00D	77.13B

LSD to compare ageing periods: 10.148
CV (%): 8.47
** : values, within the same column, followed by the same letter, do not differ at the 5% level of probability according to Tukey's test.*

Table 3 – Standard germination results* (in arcsin $\sqrt{x/100}$) of carrot seeds before and after several ageing periods under different ageing or relative humidity controlling systems.

Ageing period (hours)	Relative humidity controlling system		
	Pure water	KCl solution	NaCl solution
0	76.91A	76.91A	76.91A
12	72.57A	72.67A	75.41AB
24	69.30AB	72.00AB	74.19ABC
36	63.85BC	68.48ABC	74.19ABC
48	62.04BC	68.48ABC	72.17ABCD
60	60.06C	64.93BCD	69.36ABCD
72	56.59C	63.12CDE	66.96CD
84	38.94D	60.36CDE	64.56D
96	36.22D	58.45DEF	66.53CD
108	26.55E	54.64EF	63.89D
120	7.90F	50.69EF	64.64D

LSD to compare ageing periods: 8.552

* : values, within the same column, followed by the same letter, do not differ significantly at the 5% level of probability, according to Tukey's test.

Table 4 – Standard germination results* (in arcsin $\sqrt{x/100}$) of broccoli seeds before and after several ageing periods under different ageing or relative humidity controlling systems.

Ageing period (hours)	Relative humidity controlling system		
	Pure water	KCl solution	NaCl solution
0	85.73A	85.73AB	85.73AB
12	50.77B	85.00ABC	89.59A
24	44.43BCD	87.66A	82.95ABC
36	46.43BC	82.95ABCD	85.73AB
48	40.10CDE	82.95ABC	85.73AB
60	33.16E	78.94BCD	89.59A
72	17.04E	79.80BCDE	89.59A
84	12.00E	77.75CDE	79.51BC
96	2.34F	77.98CDE	79.36BC
108	0.41F	73.33DEF	77.99BC
120	0.41F	66.63F	76.57C

LSD (5%) to compare: RHCS's : 10.693
ageing periods : 7.731
CV (%): 7.10

central portion of the results that go from 0 to 100%. If, after the artificial ageing of the seed lots (samples), the standard germination test results are too close to the lower (0%) or to the upper (100%) extremity, they will hardly show any statistically significant difference. How can any two seed lots be said to be different if their SGT results are not statistically different? The only possibility of obtaining results statistically different is by lowering the SGT results to values located at the central portion of results between 0 and 100%. This would be the portion of the 0 – 100 scale with room enough to fit aged high vigor lots (whose drop in germination would be less) and low vigor lots (whose drop in germination would be more) thus making possible their being statistically distinguishable. The results obtained in this project show that when the controlling of the relative humidity of the air within the inner chamber was achieved by saturated salt solutions the SGT results following seed ageing in none of the cases dropped to values capable of showing important differences between high standard germination lots. It is arguable whether employing more than 120 hours to make the SSAA system to work for the seeds of these species would be convenient for seed companies.

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Received on February 20, 2005.
Accepted for publication on July 25, 2005.