ACCELERATED AGING OF MELON SEEDS

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ABSTRACT: Accelerated aging is one of the most useful tests used for the evaluation of seed vigor but it is seldomly used to test melon (*Cucumis melo* L.) seeds. The objective this research was to compare different procedures of the accelerated aging test to evaluate the physiological quality of melon seeds and the efficiency of using saturated salt solution for the control of water uptake by seeds. Five seed lots each of the hybrids AF-646 and AF-682 were tested for germination, seedling emergence, traditional accelerated aging (periods 0f 48, 72 and 96 hours, at 38 or 41°C) and salt saturated accelerated aging. The accelerated aging test (traditional procedure and with salt solution) for 72h and 96h, at 38 or 41°C was sensitive to detect differences in the physiological quality of the seeds. It was also observed that the seed water content after salt saturated accelerated aging was lower and more uniform, thus presenting advantagens in relation to the traditional procedure.
Key words: *Cucumis melo*, physiological quality, vigor

ENVELHECIMENTO ACELERADO EM SEMENTES DE MELÃO

RESUMO: O teste de envelhecimento acelerado é um dos mais utilizados para a avaliação do potencial fisiológico das sementes de várias espécies. Entretanto, estudos com sementes de melão ainda são escassos. Avaliou-se procedimentos para a condução do teste de envelhecimento acelerado para avaliação do potencial fisiológico de sementes de melão (*Cucumis melo* L.), incluindo o uso de solução saturada de sal em substituição à água. Cinco lotes de sementes, dos híbridos AF-646 e AF-682, foram submetidos aos testes de germinação, emergência de plântulas em casa de vegetação e envelhecimento acelerado (períodos de 48, 72 ou 96 horas, a 38 ou 41°C), com e sem o uso de solução saturada de NaCl. O teste de envelhecimento acelerado (procedimento tradicional e com solução salina), conduzido com períodos de exposição de 72h e 96h a 38 ou 41°C, apresentou sensibilidade suficiente para detectar diferenças no potencial fisiológico de lotes de sementes de melão. A utilização de solução saturada de NaCl contribui para reduzir a absorção de água pelas sementes durante o teste de envelhecimento acelerado, permitiu obter resultados menos drásticos e mais uniformes, sem afetar a eficiência do teste.
Palavras-chave: *Cucumis melo*, potencial fisiológico, vigor

INTRODUCTION

Among horticultural species, melons (*Cucumis melo* L.) have been produced in large quantity, especially in Northeastern Brazil, contributing with approximately 95% of the total production; the state of Rio Grande do Norte is the largest producer, producing 66% of all melons of the region (FNP Consultoria & Comércio, 2001). The seeds, which have a high commercial value, deserve special attention as to their physiological potential. However, for this species, research targeted at comparing vigor tests are almost inexistant, particularly under our conditions.

The accelerated aging test is acknowledged as one of the most employed tests to evaluate the physiological potential of various species of seeds, providing information of high degree of consistency (TeKrony, 1995). The principle of the method is based on the artificial acceleration of the deterioration rate of the seeds, by exposing them to high temperature and relative humidity levels, which are considered as the most prominent environmental factors with respect to the intensity and velocity of deterioration (Marcos Filho, 1999b). In this situation, low-quality seeds deteriorate more rapidly than more vigorous ones, presenting a differentiated decrease in viability.

Many factors affect the behavior of seeds that are submitted to the test; the interaction between temperatures/exposure periods is one of the aspects most frequently studied. Some authors have devoted themselves to study this interaction, indicating temperature values of 41°C/72h for onion seeds (TeKrony, 1995); 41°C/72h for green peppers (TeKrony, 1995; Panobianco & Marcos Filho, 1998); 45°C/48h for broccoli (Tebaldi et al., 1999); 41°C/48h for eggplant (Bhéring et al., 2001); 42°C/48h for melon (Cano-Ríos et al., 2000); 41°C/48h for carrot (Rodo et al., 2001) and 41°C/72h for tomato (Panobianco & Marcos Filho, 2001).

Another aspect that must be considered in the accelerated aging test, is the difference in water absorption by the seeds which, once exposed to a humid atmosphere, might present marked variations in their moisture content. Research carried out with small-seed

species, such as green vegetables, have not revealed very consistent results due to the strongly marked variation in moisture content in the samples, after aging (Powell, 1995). With that in mind, alternatives have been looked for to conduct accelerated aging with seeds of these species, such as replacing water with saturated salt solutions. Depending on the solution that is used, specific levels of relative humidity can be obtained, allowing the water absorption rate, velocity and intensity of seed deterioration to be varied (Jianhua & McDonald, 1997), without reducing the test sensitivity. Some authors have observed a greater efficiency of the accelerated aging test with the use of salt-saturated solutions for the classification of seed lots; among them, Panobianco & Marcos Filho (1998), with green pepper seeds; Rodo et al. (2000), with carrot; Bhéring et al. (2000), with cucumber; Bennett et al. (2001), with sweet corn, and Panobianco & Marcos Filho (2001), with tomato.

The objective of this work was to study the accelerated aging test methodology to evaluate the physiological potential of melon seeds, establishing a comparison between the traditional procedure and the utilization of a saturated sodium chloride solution.

MATERIAL AND METHODS

The research was carried out in Piracicaba, SP, Brazil during the period March to October, 2000. Treated seeds (Benomyl + Thiram, in the proportion of 2 g 100 kg^{-1}) of two melon hybrids (AF-646 and AF-682) were utilized, each represented by five lots, produced during the 1999/2000 cropping season. Upon receipt, seeds were homogenized in a soil-type divider and placed inside a kraft paper bag, and then stored under controlled conditions (18-20°C and 60% relative humidity), remaining under these conditions until the end of the experimental phase. The seed quality evaluations were performed by the following tests:

Moisture content - carried out in an oven at 105±3°C/ 24h (Brasil, 1992), using two samples of 4.0 g of seeds, for each lot. Results were expressed as mean percentages for each lot (wet basis).

Germination - four replicates of 50 seeds per lot were distributed on germitest paper towel rolls, moistened with an amount of water equivalent to 2.5 times the weight of the dry substrate (Menezes et al., 1993) and placed to germinate at 25°C. The assessments were performed four and eight days after sowing, according to criteria established on "Regras para Análise de Sementes (Regulations for Seed Analysis)" (Brazil, 1992); results were expressed as mean percentages of normal seedlings, for each lot.

Seedling emergence in the greenhouse - four replicates of 50 seeds per lot were utilized, distributed in multi-cell styrofoam trays with individual cells, containing a commercial substrate, consisting of pine bark, coconut fiber, vermiculite and fertilizer (information provided by the manufacturer). The trays were kept between 25 and 30°C, in a greenhouse equipped with an intermittent fogging system.

Counts were made 21 days after sowing, and then the seedling emergence percentages per lot were determined (Nakagawa, 1994).

Accelerated aging (traditional procedure) - was performed according to the method known as "gerbox" (11 x 11 x 3 cm), in a water jacket chamber (model 3015 VWR Scientific); samples containing four grams of seeds were utilized, distributed so as to form a simple layer over the surface of the metallic screen suspended inside each plastic box (internal compartment), containing 40 mL water. The boxes, covered with lids, remained inside the chamber during three aging periods (48, 72 or 96 h), using two temperatures (38°C or 41°C). Seeds were then placed for germination according to methodology described for the germination test. The evaluation was performed four days after sowing and the results were expressed as mean percentage of normal seedlings for each lot. In order to monitor the test, seed moisture content was measured before and after the aging periods.

Accelerated aging (saturated salt solution) - was conducted in a way similar as described for the traditional test, except that the bottom of each plastic box (individual compartment) received 40 mL of a saturated NaCl solution, as a replacement for water. This solution had the proportion of 40 g NaCl 100 mL^{-1} water, thus establishing an environment of 76% relative humidity.

A completely randomized statistical design was used, with the analyses of variance performed individually for each test and hybrid. The data to be tested were transformed by arc sin $\sqrt{x/100}$ and the means were compared by the Tukey test at 5%.

RESULTS AND DISCUSSION

The data relative to seed moisture content were similar for the ten lots (Table 1). This fact is important in order to carry out the tests, taking into account that an uniform seed water content is indispensable to standardize the evaluations and to obtain consistent results (Loeffler et al., 1988; Marcos Filho, 1999b), since, within certain limits, seeds with a higher moisture content are more affected by the accelerated aging conditions.

The germination test allowed to determine that the lots of hybrid AF-646 did not differ among themselves. With regard to hybrid AF-682, lot 10 had inferior quality, while lots 6, 7, 8, and 9 were grouped at the same level, not differing among themselves (Table 1).

All lots presented mean percentages of normal seedlings higher than the minimum (80%) established for melon seed commercialization. It is important and makes sense to compare seed lots with similar germination rates

(Marcos Filho, 1999a) and that are, according to Powell (1986), situated preferably at Stage I of the viability loss curve, since when Stage II is attained, even the germination test (conducted under favorable conditions) is capable of detecting differences in physiological potential in the evaluated samples. This author considers that the position of each lot within Stage I determines its vigor level. In this study, all lots had germinations ranging between 88 and 98%, and are therefore situated at Stage I of the seed viability loss curve, characterized for its relatively long duration and for presenting few dead seeds.

Results from the seedling emergence test in the greenhouse (Table 1) indicated a lower quality of lot 1 (hybrid AF-646), differing from lots 2, 3, 4 and 5. For hybrid AF-682, lots 6 and 10 were highlighted as the ones with the best and worst quality, respectively, and lots 7, 8 and 9 were referred to as having intermediate quality.

Table 1 - Moisture content, germination and emergence of seedlings in the greenhouse for ten lots of melon eeds, hybrids AF-646 and AF-682.

Hybrid	Lot	Moisture content	Germination	Seedling emergence
		---------- % ----------		
AF-646	1	7.2	92 a*	88 b
	2	7.1	98 a	97 a
	3	7.2	98 a	97 a
	4	7.4	98 a	98 a
	5	7.3	98 a	96 a
	C.V.(%)	-	2.4	4.2
AF-682	6	7.0	98 a	97 a
	7	7.0	92 a	90 b
	8	7.0	96 a	94 ab
	9	7.0	92 a	91 b
	10	7.1	88 b	84 c
	C.V.(%)	-	3.2	4.7

*Mean comparisons within each column by Tukey test, 5%.

This test classified the lots with the best and worst performance, in a way similar to that verified in the germination test, especially for the hybrid AF-682. The seedling emergence test is an indicator for the efficiency of tests that evaluate the physiological potential of seed lots (Marcos Filho, 1999a). Therefore, it was observed that this efficiency in safely discriminating lots that exhibit low and high vigor was more evident for lots of the hybrid AF-682, while those of the hybrid AF-646 had a relative uniform quality, and only lot 1 was identified as having a lower physiological potential.

In general, both aging periods (traditional procedure) (Table 2), either at 38°C or at 41°C, presented the identification of lots 1 and 10 as having lower physiological potential, respectively, for hybrids AF-646 and AF-682, in this respect being in agreement with the germination test (hybrid AF-682) and, for both hybrids, with the greenhouse seedling emergence test.

Despite the similar information provided by the aging periods utilized for the hybrid AF-646 (Table 1), indicating the lot with the lowest quality, the 48 hour aging period, in both temperatures, revealed as less efficient to separate lots into different vigor levels (Table 2). Using this same period, at 42°C, in the evaluation of melon seeds, Cano-Ríos et al. (2000), no satisfactory results were also obtained.

In general, the 41°C temperature caused greater reduction of germination than 38°C, especially for seed lots considered as having lower physiological potential; the duration of the aging periods was less severe than the increase in temperature, which is in agreement with the observations of Tomes et al. (1988), that suggested special attention should be paid to temperature monitoring during the test.

In this study, the 72 and 96 hour periods, for both temperatures, had a higher sensitivity in identifying lots that possessed different levels of physiological potential.

Table 2 - Accelerated aging test (traditional procedure) of ten lots of melon seeds, hybrids AF-646 and AF-682.

Hybrids	Lot	Accelerated aging (tratitional)					
		38°C			41°C		
		48h	72h	96h	48h	72h	96h
		---------- % germination ----------					
AF-646	1	88 b*	86 c	80 c	80 b	78 c	70 c
	2	96 a	96 a	94 a	96 a	94 a	90 a
	3	95 a	90 ab	94 a	95 a	94 a	92 a
	4	97 a	98 a	96 a	96 a	96 a	94 a
	5	92 a	90 b	86 b	88 b	84 b	80 b
		C.V. (%) = 4.3					
AF-682	6	96 a	96 a	93 a	94 a	96 a	95 a
	7	91 ab	88 b	86 b	82 b	82 b	82 b
	8	91 ab	89 b	89 ab	94 a	92 a	86 b
	9	88 b	86 b	86 b	86 b	86 b	84 b
	10	86 b	70 c	68 c	80 b	68 c	70 c
		C.V (%) = 3.8					

*Mean comparisons within each column by Tukey test, 5%.

Thus, for hybrid AF-646, lots 2, 3 and 4 were those with the best physiological potential; lot 1 had the worst quality, and lot 5 was of intermediate quality. These results agree with those obtained for the greenhouse seedling emergence test, as it indicated the inferiority of lot 1 (Table 1). Results of the hybrid AF-682 indicate that lots 6 and 10 had the best and worst qualities, respectively; in general, lots 7, 8 and 9 revealed as having intermediate quality, and in that respect results are in agreement with the preliminary evaluation of the seed lots (Table 1). Using 72 or 96-hour periods has the advantage of allowing faster responses on the quality of lots than the 192-hour aging period, at 42°C, which is suggested by Pesis & Timothy (1983), also for melon seeds.

The 38°C/72 and 96 hours, and 41°C/72 and 96 hours, were the most efficient combinations in identifying differences between lots being assessed. These results are, in a way, in conformity with those found by some authors for cucurbit seeds, involving different periods and temperatures, among which are noteworthy those for watermelon seeds, 45°C/144h (Delouche & Baskin, 1973), 41°C/48 or 72h (Trigo & Trigo, 1995a); cucumber, 41°C/48h (Trigo & Trigo, 1995b; Bhéring et al., 2000).

The seed moisture content, after the traditional aging periods (Table 3), ranged between lots from 0.8 to 2.3 percentage points, depending on the period/ temperature utilized combination. This relatively small variation in seed moisture content was probably due to the size of the melon seeds, which are larger in relation to most vegetables. In this respect, Panobianco & Marcos Filho (1998), working with green pepper seeds, detected a marked elevation in moisture content after accelerated aging, reaching values between 29.5 and 37.8%. Rodo et al. (2000), however, verified variations from 4.0 to 9.2 percentage points in carrot seeds, considered to be excessive, by the end of the accelerated aging period.

It is interesting to compare samples that present similar moisture contents before aging, even though differences between 1 and 2% are not compromising (Marcos Filho, 1999b). In this study, the initial seed moisture content was practically the same (Table 1). On the other hand, one of the most important indicators of uniformity of conditions in accelerated aging is the seed moisture content at the end of the test, since variations from 3 to 4% between samples are deemed as tolerable (Tomes et al., 1988; Marcos Filho, 1999b); it was observed that the maximum variation found was 2.3 percentage points, i.e., below the tolerable limits (Table 3), assuring the consistency of the obtained information.

For the accelerated aging test with saline solution, using two temperatures and three conditioning periods, for hybrids AF-646 and AF-682, (Table 4), the 48-hour period, at both temperatures, in general revealed results similar to those obtained with the traditional aging (Table 2), despite the lower efficiency in lot discrimination. It was, therefore, consonant with the greenhouse seedling emergence test (Table 1) in terms of identification of lots with lower physiological potential.

On the other hand, the 72 and 96-hour periods, at both temperatures, had a more evident hability for the classification of lots into different vigor levels. Thus, for hybrid AF-646, lots 2, 3, and 4 were pointed out as the most vigorous, and lot 1 was indicated as having the worst quality. For hybrid AF-682, lot 6 was identified as having the highest physiological potential, while lot 10 was confirmed as having the worst quality. In general, these results agree with those obtained in the greenhouse seedling emergence test (Table 1) and traditional accelerated aging (Table 2) for hybrid AF-682. In the case of hybrid AF-646, results also agreed with the traditional accelerated aging test (Table 2) and the inferiority of lot 1 was confirmed, as detected by the greenhouse seedling emergence test (Table 1).

Table 3 - Moisture contents obtained after accelerated aging periods-AA (traditional procedure) of ten lots of melon seeds, hybrids AF-646 and AF-682.

Hybrids	Lot	Moisture content after traditional test					
		38°C			41°C		
		48h	72h	96h	48h	72h	96h
		%					
AF-646	1	27.0	29.0	29.8	26.4	27.8	28.3
	2	26.6	29.1	29.8	25.9	29.0	28.0
	3	26.9	29.0	29.4	25.4	28.0	28.6
	4	27.6	30.5	31.0	26.6	28.2	28.8
	5	25.4	29.0	30.0	25.6	27.6	26.3
AF-682	6	25.7	27.8	28.8	26.4	27.8	28.2
	7	26.9	28.1	28.8	27.2	29.0	30.1
	8	25.8	27.8	28.4	26.4	28.0	29.4
	9	26.0	29.1	29.0	27.1	29.2	29.8
	10	26.7	27.7	29.3	26.6	27.6	28.2

Table 4 - Accelerated aging test with saline solution, in ten lots of melon seeds, hybrids AF-646 and AF-682.

Hybrids	Lot	Accelerated aging (with saline solution)					
		38°C			41°C		
		48h	72h	96h	48h	72h	96h
		%					
AF-646	1	88 b*	78 c	75 c	87 b	78 c	72 c
	2	95 a	96 a	94 a	96 a	96 a	94 ab
	3	96 a	95 a	94 a	94 ab	92 ab	90 ab
	4	96 a	98 a	96 a	96 a	96 a	96 a
	5	92 a	88 b	84 b	92 ab	88 b	87 b
		C.V. (%) = 3.4					
AF-682	6	96 a	94 a	95 a	94 a	92 a	90 a
	7	90 ab	84 bc	83 b	86 b	84 b	82 b
	8	90 ab	89 ab	86 b	90 ab	86 b	88 ab
	9	82 b	80 c	83 b	84 b	82 b	82 b
	10	82 b	70 d	68 c	85 b	72 c	70 c
		C.V (%) = 3.7					

*Mean comparisons within each column by Tukey test, 5%.

Table 5 - Moisture contents obtained after accelerated aging periods-AA, with saline solution, in ten lots of melon seeds, hybrids AF-646 and AF-682.

Hybrids	Lot	Moisture content after test with saline solution					
		38°C			41°C		
		48h	72h	96h	48h	72h	96h
		% germination					
AF-646	1	9.2	10.2	10.2	8.6	9.4	9.2
	2	9.2	9.9	10.2	8.4	9.0	9.2
	3	9.5	10.2	9.8	7.6	9.8	9.9
	4	9.4	10.1	9.6	9.0	9.6	9.4
	5	9.6	9.8	9.9	8.2	9.4	9.2
AF-682	6	9.2	10.2	10.2	8.6	9.5	9.4
	7	9.3	10.1	10.2	8.4	9.6	9.8
	8	9.6	9.8	9.6	8.4	9.4	9.8
	9	9.3	10.2	9.8	9.0	9.9	9.3
	10	9.2	9.9	9.7	9.1	9.9	9.9

With regard to seed moisture content after the aging periods (Table 5), results were in general similar for the ten lots under study. The moisture content of seeds exposed to the NaCl saturated solution presented smaller and more uniform values, after the aging periods, as compared to those observed for seeds aged by the traditional procedure (Table 3); this indicates that the use of saline solution contributed to slow down water absorption by seeds in the accelerated aging test. The use of salt-saturated solutions contributed markedly to reduce or prevent the development of microorganisms, thus minimizing the interference of an additional factor in test results (Jianhua & McDonald, 1997).

The information here obtained should help in the decision making process at different stages of seed production and utilization, including operations for the selection of lots for sowing, evaluation of storage potential, use in quality control programs, and also as an aid in developing selection methods to be used in plant breeding.

CONCLUSIONS

The accelerated aging test (traditional procedure and with saline solution) conducted with exposure periods of 72 and 96 h at 38°C or 41°C presents enough sensitivity for the physiological potential evaluation of melon seeds.

The use of a NaCl-saturated solutions slows down the velocity and the intensity of water absorption by melon seeds during the accelerated aging test, leading to a less intense deterioration rate, and yielding results that are less severe and more uniform.

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