Controlled Deterioration and Accelerated Aging Tests Predict Relative Seedling Emergence Potential of Melon Seed Lots

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Abstract. The emergence of 22 commercial seed lots (12 in 2005 and 10 in 2006) of melon (*Cucumis melo* L.) with laboratory germinations greater than 90% were compared in low temperature (LTE), mechanical stress (MSE), high temperature (HTE), and salt stress (SSE) sowing conditions. The seedling emergence percentage ranged between 18% and 79% for LTE, 15% and 90% for MSE, 27% and 84% for HTE, and 49% and 92% for SSE in 2005; and 43% and 85% for LTE, 30% and 82% for MSE, 56% and 91% for HTE, and 49% and 89% for SSE in 2006. The germination of the lots was determined after controlled deterioration (CD) with 20% or 24% moisture content (MC) and accelerated aging (AA) at 40 and 45 °C in 2005; or at 45 and 47 °C in 2006 for 48, 72, 96, 120, and 144 h. Germination after various combinations of CD and AA was positively and significantly ($P < 0.05$) correlated with LTE, MSE, HTE, and SSE. Correlation values (0.17 to 0.78) of the initial laboratory germination were much lower than those of both aging tests. The optimum CD conditions of 48 h and 20% MC at 45 °C and AA conditions of 120 h at 45 to 47 °C are suggested as vigor tests to estimate relative seedling emergence of melon seeds.

Obtaining optimum and uniform plant stands in the field requires rapid seedling emergence. Various environmental stress factors such as low and high temperatures, mechanical stress, and high salinity affect emergence during stand establishment in melon seeds. Melon seeds are either sown directly or as transplants. Although the optimum temperature for melon seed germination is between 25 and 35 °C (Bates and Robinson, 1995), during transplant production in modules, the temperature range is often suboptimal for germination in early spring in the Mediterranean region. Seeds are sown deeper (7 to 8 cm) in open field direct planting, which allows seeds to use water retained beneath the soil during germination. Then, the germinating seeds are likely to encounter mechanical resistance until they appear to the soil surface. Saline seedbed conditions resulting from aridity or use of saline groundwater can delay and increase the spread of seed germination in the field (Foolad and Lin, 1997).

When field conditions are near optimum, the standard germination may predict relative seedling emergence potential of the lot in the field. However, field conditions are often suboptimal. Seed vigor is composed of var-

ious features of seed quality and is indicative of seed lot performance beyond standard laboratory germination. Vigor tests provide additional information on the rate and uniformity of seedling growth and emergence ability under a wide range of environmental conditions (Powell and Matthews, 2005; TeKrony, 2003).

The controlled deterioration (CD) (Powell and Matthews, 2005) and accelerated aging (AA) (Hampton and TeKrony, 1995) tests have been successfully used to rank and predict relative field emergence potential of seed lots in various crops such as brassicas, onion, carrot (Matthews, 1980; Powell and Matthews, 1981), red clover (Wang et al., 1994), aubergine (Demir et al., 2005), sorghum (Ibrahim et al., 1993), and corn (Bennett et al., 2004; TeKrony et al., 1989). Seeds are subjected to high temperature (40 to 45 °C) at high relative humidity (greater than 95%) in AA or with prearranged high seed moisture content (18% to 24%) in CD for 24 to 96 h before germination testing. It was proposed that environment of 45 °C and 20% seed moisture content for 24 h in CD and 41 to 43 °C for 24 to 72 h in AA is applicable for a large number of species (Hampton and TeKrony, 1995; Matthews, 1993). However, the most appropriate aging environment needs to be determined for each species. CD and AA studies for evaluating vigor and estimating seedling emergence in cucurbit seeds are scarce. Some of the earlier studies indicated that optimum aging conditions varied among cucurbit species such as watermelon (Delouche and Baskin, 1973) melon (Demir et al., 2004; Pesis and Timothy, 1983;

Torres and Marcos-Filho, 2005), pumpkin, and zucchini (Dutra and Vieira, 2006). Most of these studies determined the ranking of the seed lots but did not correlate aging tests results with seedling emergence.

The objective of the present research was to evaluate the conditions for application of CD and AA tests in melon seeds, seeking to associate (i.e., predict) results with not actual but relative seedling emergence potential of seed lots in low and high temperature, mechanical and salt stress sowing conditions.

Materials and Methods

Twelve seed lots in 2005 and 10 in 2006 of melon (*Cucumis melo* L.), variety Kırkagac, were obtained from various commercial sources in Turkey.

The germination of four replicates of 50 seeds from each seed lot was assessed using the between-paper method [International Seed Testing Association (ISTA), 2003] at 25 °C in the dark. The percentage of normal seedlings (ISTA, 2003) was determined after 8 d. Seed moisture content was determined using the high-temperature oven (130 °C, 1 h) method (ISTA, 2003).

The CD test was conducted on samples of the seed lots held at 20% and 24% seed moisture contents (MC) for 48, 72, 96, 120, and 144 h at 40 and 45 °C in 2005 and 45 and 47 °C in 2006. For each temperature and seed moisture combination of each lot, two batches of 800 seeds of known initial moisture content were placed on moist paper and allowed to imbibe to the weight calculated to achieve a 20% MC for one batch and 24% MC for the other. The achievement of this weight was determined by periodic weighing of the batches. Seeds were then kept at 5 °C in laminated foil bags for 72 h to allow moisture equilibration within and among the seeds. Subsamples of 150 seeds/lot/test moisture content/test temperature were sealed in airproof laminated foil bags and incubated at appropriate temperature and aging time. Germination (2-mm radicle emergence) was then tested.

The accelerated aging test was conducted according to the procedure described by Hampton and TeKrony (1995) with modifications for melon. Forty milliliters of distilled water was added to each plastic box (11 × 11 × 4 cm). One hundred fifty seeds were put on a wire mesh tray (10 × 10 × 3 cm) and placed in the box. One box was used for each temperature and time combination in each lot. Seeds were aged at 40 ± 0.1 °C or 45 ± 0.1 °C in 2005, and 45 or 47 °C in 2006, for 48, 72, 96, 120, and 144 h in a water-jacketed incubator. After every aging period, seeds were removed, weighed, and the final seed moisture was calculated according to weight they had reached. The germination test was conducted as described after 3 h of drying at room temperature. The radicle protrusion (physiological germination) was the criterion of germination used.

For the low temperature emergence test (LTE), seeds (four replicates of 50 seeds/lot) were sown 3 cm deep in the experimental

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field of the Department of Horticulture, Faculty of Agriculture, University of Ankara, Turkey, on 15 Apr. 2005 and 22 Apr. 2006. For high temperature emergence test (HTE), seeds were sown on 15 Aug. 2005 and 18 Aug. 2006. The soil was a sandy loam (pH 7.57, N: 0.09, P₂O₅: 5.5%, K: 0.16%, Na: 0.41%, Ca: 6.7%, organic matter: 1.1%). Daily minimum and maximum soil temperatures were recorded throughout both tests and varied between 9 and 27 °C in LTE and 25 and 39 °C in HTE. The number of seedlings emerged, assessed to have occurred when the cotyledons had unfolded above the surface, was counted daily and finally after 30 d in LTE and 20 d in HTE.

The mechanical stress emergence test was carried out by sowing 200 (four replicates of 50 seeds) seeds 8 cm deep on 15 May 2005 and 1 June 2006 in the same field. Depth of sowing was determined by measuring and planting seeds by hand at the same level. Subsequently, irrigation was done regularly three times a week and weeds were removed. Daily minimum and maximum soil temperature varied between 18 and 30 °C during this test. The seedling emergence criterion was the same as in the previous tests.

Seedling emergence under salt stress was determined by sowing seeds 4 cm deep in compost (Plantaflour, Humus-Verkaufs GmbH, Germany) in plastic seedling trays (32 × 6 × 6 cm). The electrical conductivity of the saturated extract of the compost was 0.8 mS·cm⁻¹ before sowing. The trays were placed on a bench in a growing cabinet in which the temperature was maintained at 20 ± 2 °C and salinity was provided by the solution that was used to water the seeds (200 mM, NaCl). Trays were covered with paper until emergence. Subsequently, light was provided at seedling level by cool fluorescent lamps (72 µm·m⁻¹·s⁻¹). Trays were inspected daily, and the relative humidity in the cabinet was kept over 75% to keep evaporation at a minimum. Trays were watered with the same amount of saline solution (100 mL) as needed. The experiment was ended 25 d after sowing.

Results

Initial standard germination percentages of lots ranged between 90% and 100% in 2005 and 95% and 99% in 2006. Seed moisture content ranged between 4.1% and 9.1% (Table 1).

In 2005, emergence at the LTE sowing ranged from 18% (lot 2) to 79% (lot 10), with various significant ($P < 0.05$) differences among lots (Table 2). In the mechanical stress (MSE), emergence ranged from 15% to 85% and 27% to 84% in HTE, 49% to 92% in salt stress sowing (SSE), with lot 2 being the lowest emergence in all stress sowings (Table 2). Several lots in each stress emergence test showed differences in emergence, which were significant ($P < 0.05$), but lots 3, 6, 8, 9, and 10 showed higher emergences than other seed lots in most tests. The lowest emergence values were found in LTE and the highest in SSE, except for a few lots.

In 2006, the lowest emerging lot was 1 and the highest one was 4 in LTE, MSE, HTE, and SSE sowings (Table 2). Several lots in all four stress environments showed differences in emergence that were significant ($P < 0.05$).

The final seedling emergence of the lots at low temperature, high temperature, mechan-

ical and salt stresses in both years was positively correlated with CD germination. Significant correlations were found with emergence in each stress sowing test. However, 45 °C with 20% MC for 48 h consistently gave very high correlation values in all four sowing environments in both years (Table 3).

Table 1. Initial standard germination (SG%) and seed moisture (MC, fwt, %) of melon seed lots used in 2 consecutive years.

2005			2006		
Lot	SG (%)	S.m.c. (%)	Lot	SG (%)	S.m.c. (%)
1	100	7.3	1	97	7.5
2	91	5.8	2	96	7.7
3	99	5.6	3	96	6.5
4	99	5.9	4	99	4.8
5	91	8.1	5	96	7.8
6	100	4.9	6	97	7.3
7	99	4.9	7	97	6.9
8	99	4.1	8	95	7.9
9	96	9.1	9	96	7.4
10	95	3.6	10	98	7.9
11	90	8.0	NA	NA	NA
12	95	7.4	NA	NA	NA

SG = standard germination; S.m.c. = seed moisture content; NA = not available.

Table 2. Seedling emergence at low temperature, mechanical stress, high temperature stress, and salt stress sowings in 2005 and 2006.^a

2005					2006				
Lots	LTE	MSE	HTE	SSE	Lots	LTE	MSE	HTE	SSE
1	55 bc	57 b	70 abc	79 b	1	43 d	30 g	56 c	49 e
2	18 f	15 d	27 d	49 d	2	58 bcd	62 de	72 bc	64 cd
3	50 bcd	81 a	79 ab	91 a	3	51 cd	41 f	65 bc	56 de
4	40 de	50 b	64 bc	88 ab	4	85 a	82 a	91 a	89 a
5	52 bcd	46 b	74 abc	63 c	5	63 bc	61 de	78 b	72 bc
6	63 b	82 a	77 ab	92 a	6	69 b	78 ab	78 b	84 a
7	48 cd	51 b	66 bc	79 b	7	69 b	68 cd	75 b	61 cde
8	61 b	90 a	84 a	88 ab	8	62 bc	75 bc	76 b	80 ab
9	76 a	83 a	70 abc	89 ab	9	59 bcd	59 e	75 b	64 cd
10	79 a	85 a	71 abc	91 a	10	62 bc	55 e	74 b	59 cde
11	32 e	29 c	56 c	61 c	NA	NA	NA	NA	NA
12	46 cd	55 b	58 c	60 c	NA	NA	NA	NA	NA

^aMeans with different letters are significantly ($P = 0.05$) different in the same column.

Emergence (%) at LTE = low temperature; MSE = mechanical stress; HTE = high temperature; SSE = salt stress; NA = not available.

Table 3. Correlation coefficient values calculated for laboratory germination and controlled deterioration test as predictors of melon seedling emergence percentages at low temperature (LTE), mechanical (MSE), high temperature stress (HTE), and salt stress (SSE) sowings in 2005 and 2006.

2005							2006						
Temp	S.m.c.	Period	LTE	MSE	HTE	SSE	Temp	S.m.c.	Period	LTE	MSE	HTE	SSE
40 °C	20%	48	0.66	0.74	0.92	0.77	45 °C	20%	48	0.86	0.96	0.90	0.92
		72	0.53	0.73	0.65	0.87			72	0.83	0.88	0.82	0.68
		96	0.66	0.83	0.70	0.90			96	0.86	0.89	0.93	0.84
		120	0.49	0.70	0.52	0.77			120	0.84	0.96	0.87	0.82
		144	0.56	0.75	0.64	0.81			144	0.80	0.91	0.84	0.80
		48	0.69	0.75	0.61	0.90			48	0.65	0.70	0.73	0.59
	24%	72	0.72	0.82	0.80	0.88		24%	72	0.90	0.93	0.89	0.77
		96	0.70	0.82	0.76	0.93			96	0.85	0.85	0.81	0.76
		120	0.73	0.76	0.79	0.79			120	0.89	0.85	0.94	0.78
		144	0.83	0.82	0.73	0.79			144	0.81	0.90	0.77	0.77
		48	0.71	0.86	0.80	0.90			48	0.79	0.83	0.81	0.66
		72	0.47	0.69	0.56	0.68			72	0.88	0.94	0.93	0.83
45 °C	20%	96	0.62	0.77	0.73	0.83	47 °C	20%	96	0.88	0.93	0.90	0.80
		120	0.66	0.81	0.70	0.72			120	0.93	0.93	0.91	0.79
		144	0.53	0.67	0.54	0.61			144	0.93	0.94	0.92	0.78
		48	0.70	0.81	0.75	0.81			48	0.77	0.84	0.80	0.84
		72	0.64	0.75	0.57	0.61			72	0.87	0.93	0.92	0.86
		96	0.64	0.78	0.54	0.77			96	0.86	0.92	0.89	0.76
	24%	120	0.63	0.75	0.47	0.70		24%	120	0.86	0.96	0.92	0.87
		144	0.75	0.85	0.65	0.78			144	0.84	0.79	0.86	0.60
		SG	0.42	0.63	0.59	0.78			SG	0.54	0.17	0.38	0.18

2005: $r \geq 0.58$, $P < 0.05$; $r \geq 0.71$, $P < 0.01$; $r \geq 0.82$, $P < 0.001$; 2006: $r \geq 0.63$, $P < 0.05$; $r \geq 0.77$, $P < 0.01$; $r \geq 0.87$, $P < 0.001$.

S.m.c. = seed moisture content.

A large number of time and temperature combinations after AA were also significantly correlated with stressed emergence (Table 4). The highest values were observed after 120 h at 45 °C in 2005 and at 47 °C in 2006. Correlation values between emergence in four different environment sowings in both years and germination after these accelerated aging conditions were consistently significant ($R^2 = 0.71-0.85$, five at $P < 0.01$, three at $P < 0.05$). As indicated in Tables 5 and 6, the range of germination after various aging conditions for AA and CD tests increased with increasing time in the aging conditions. The range was widened as seeds were aged longer.

The standard germination correlated with emergence in some stress conditions such as MSE and SSE in 2005, but failed to correlate significantly ($P > 0.05$) in only three instances for the eight sowings over 2 years. The correlations with standard germination were much lower than those for aging conditions we proposed (Tables 3 and 4).

Germination after CD (45 °C, 20%, 48 h) in both years and AA (45 °C, 120 h in 2005; 47 °C 120 h in 2006) were significantly related to emergence at LTE, HTE, MSE, and SSE. The R^2 values of aging test environments ranged from 0.49 to 0.91. The lower the CD and AA germination for the lots, the lower their emergence at low and high temperatures and in mechanical and salt stress conditions. Laboratory germination was only significantly correlated with MSE ($R^2 = 0.40$, $P < 0.05$), SSE ($R^2 = 0.60$, $P < 0.01$), and HTE ($R^2 = 0.35$, $P < 0.05$) in 2005, but it showed very low R^2 and insignificant values ($R^2 = 0.03-0.29$, $P > 0.05$) in the rest (Fig. 1). The separation of lots after aging was always greater than that for standard germination.

Discussion

The results of the present work indicated that CD and AA tests not only successfully ranked seed lots, but also predicted relative seedling emergence potential of melon seed lots under stress conditions. The best temperature, time, and aging durations were found as 45 °C, with 20% for 48 h in CD, 45 to 47 °C, 120 h in the AA test. Laboratory germination estimated emergence potential in some (2005 results), but its correlation values were lower than aging tests in most cases (Tables 3 and 4).

The CD test has been proposed to be a more suitable vigor test for small seeds (Powell and Matthews, 2005). Successful prediction of relative seedling emergence percentages in the field or in plug trays by CD test were in agreement with the conclusions of a number of studies, particularly in small-seeded vegetables (Basak et al., 2006; Demir et al., 2005; Strydom and Van de Venter, 1998), grass, and cereals seeds (Marshall and Naylor, 1985; Steiner and Stahl, 2002; Wang et al., 1994). Matthews (1993) proposed that 45 °C with 20% MC for 24 h can be a universal aging regime for small-

Table 4. Correlation coefficients calculated for laboratory germination and the accelerated aging test as predictors of melon seedling emergence percentages at low temperature (LTE), mechanical (MSE), high temperature (HTE), and salt stress (SSE) sowings in 2005 and 2006.

2005						2006					
Temp.	Period (h)	LTE	MSE	HTE	SSE	Temp.	Period (h)	LTE	MSE	HTE	SSE
40 °C	48	0.36	0.61	0.42	0.76	45 °C	48	0.33	0.25	0.35	0.04
	72	0.31	0.56	0.43	0.76		72	0.49	0.40	0.41	0.14
	96	0.48	0.68	0.61	0.85		96	0.67	0.40	0.63	0.33
	120	0.67	0.78	0.83	0.91		120	0.44	0.50	0.41	0.29
	144	0.66	0.74	0.68	0.87		144	0.79	0.64	0.73	0.50
45 °C	48	0.45	0.70	0.70	0.79	47 °C	48	0.60	0.57	0.67	0.36
	72	0.57	0.75	0.62	0.85		72	0.71	0.52	0.70	0.31
	96	0.60	0.77	0.69	0.81		96	0.59	0.74	0.48	0.70
	120	0.71	0.77	0.74	0.85		120	0.80	0.72	0.72	0.71
	144	0.50	0.59	0.40	0.68		144	0.68	0.61	0.63	0.62
	SG	0.42	0.63	0.59	0.78		SG	0.54	0.17	0.38	0.18

2005: $r \geq 0.58$, $P < 0.05$; $r \geq 0.71$, $P < 0.01$; $r \geq 0.82$, $P < 0.001$; 2006: $r \geq 0.63$, $P < 0.05$; $r \geq 0.77$, $P < 0.01$; $r \geq 0.87$, $P < 0.001$.

Table 5. Maximum, minimum, and mean germination percentages of the melon seed lots after controlled deterioration test at 20% and 24% moisture content and aging temperature (40 and 45 °C in 2005; 45 and 47 °C in 2006) and periods (h).

2005					2006				
40 °C	20%		24%		45 °C	20%		24%	
	Hours	Range	Mean	Range		Hours	Range	Mean	Range
40 °C	48	51-99	88	47-96	79	48	64-95	83	71-97
	72	42-99	81	39-97	81	72	60-93	80	67-92
	96	55-97	80	44-93	77	96	60-96	82	63-96
	120	50-97	76	37-93	76	120	42-91	73	52-90
	144	39-100	75	20-92	66	144	20-85	63	38-86
45 °C	20%		24%		47 °C	20%		24%	
	Hours	Range	Mean	Range		Hours	Range	Mean	Range
45 °C	48	45-99	80	70-100	88	48	60-96	82	77-97
	72	49-100	77	52-100	84	72	57-93	81	62-94
	96	22-99	69	41-99	76	96	43-92	76	59-94
	120	7-99	57	31-95	67	120	43-89	70	53-89
	144	3-96	51	14-92	57	144	22-90	62	48-84

Table 6. Maximum, minimum, and mean germination percentages of the melon seed lots after the accelerated aging test at various aging temperatures (40 and 45 °C in 2005; 45 and 47 °C in 2006) and periods (h).^a

2005					2006				
40 °C			S.m.c. (%)		45 °C			S.m.c. (%)	
	Hours	Range	Mean	Range		Hours	Range	Mean	Range
40 °C	48	53-100	88	16.1-21.8	19.2	48	76-92	85	17.4-20.1
	72	58-100	89	15.7-23.4	20.0	72	75-91	84	16.6-22.2
	96	58-99	86	12.5-23.2	18.9	96	64-95	82	15.4-23.6
	120	59-100	90	14.1-26.2	19.1	120	51-91	77	16.8-24.3
	144	57-100	85	16.7-28.9	21.5	144	34-95	69	17.8-26.0
45 °C			S.m.c. (%)		47 °C			S.m.c. (%)	
	Hours	Range	Mean	Range		Hours	Range	Mean	Range
45 °C	48	62-100	86	14.9-21.8	19.4	48	78-95	89	12.2-24.5
	72	50-100	85	15.0-23.9	19.1	72	76-94	86	12.6-20.7
	96	34-99	81	14.6-21.7	19.3	96	65-91	79	15.6-26.7
	120	30-98	77	14.2-25.4	19.6	120	55-94	70	17.2-22.9
	144	24-94	64	14.1-21.2	20.2	144	40-85	62	16.3-24.6

^aRange and the mean values of seed moisture contents after each aging time were also shown.

S.m.c. = seed moisture content.

seeded species. Our previous experience showed this aging environment is not sufficient to discriminate winter squash seed lots, particularly when the initial laboratory germination is very high (greater than 95%) (Mavi and Demir, 2005). This obviously indicates that the optimum aging environment is a species-specific phenomenon and needs to be determined for each species.

The AA test was initially developed to determine seed storage potential (Delouche and Baskin, 1973); it has evolved into a

commonly used seed vigor indicator for many large-seeded crops and has been successfully used in ranking the seed vigor of various crops (Hampton and Bell, 1989; Hampton et al., 2004; Hampton and TeKrony, 1995; TeKrony et al., 1989, 2005). Pesis and Ng (1983) reported that vigor of the two muskmelon varieties were not separated by aging at 45 °C 100% relative humidity for 96 h. However, extending the aging time to 192 h provided a good separation. Our results agree with this work. Extended aging period

Fig. 1. Relationship between controlled deterioration (CD) at 20% moisture content (MC) for 48 h at 45 °C (△), accelerated aging (AA) for 120 h at 45 °C in 2005 and 47 °C (▲) in 2006 and seedling emergence percentage at low temperature (LTE), mechanical (MSE), high temperature (HTE), and salt stresses (SSE) and laboratory germination (●) of melon seed lots in 2005 (left column) and 2006 (right column). R² values were based on regression equations (*, **, ***, ****, *****Significant at $P \leq 0.05$, 0.1, and 0.01, respectively).

(120 h at 45 °C), longer than the suggested period for most species (Hampton and TeKrony, 1995) is needed to get an ideal separation in melon seeds. More recently, Torres and Marcos-Filho (2005) used the traditional AA test at 41 °C for 72 h and were able to separate five melon seed lots in each of two cultivars. However, they used normal seedling evaluation in their work, and the range in five lots of each cultivar changed only between 76% and 92% in one cultivar and

80% and 94% in the other. In our work, the range of the germination percentages was much larger in both aging tests (Tables 5 and 6). The physiological germination (2-mm radicle length) is easy to use in aging tests (Powell and Matthews, 2005). The capability for normal development seedling proceeds ahead of radicle emergence during the deterioration period and its evaluation can be subjective. In the same family but in different species, Dutra and Vieira (2006) reported that

the combination of 41 °C/96 h of the AA test can be used to evaluate the physiological vigor potential of pumpkin and zucchini seeds. In this study, seed lots were just ranked according to their germination percentage after aging. However, in our work, we also correlated vigor test results with field emergence.

Hampton and TeKrony (1995) suggested at 41 to 43 °C temperature and 24 to 72 h of aging in AA for a large number of species seeds. However, our results indicated that melon seeds are reasonably resistant to aging and require longer periods to get a clear separation. One hundred twenty hours of aging at 45 to 47 °C in an accelerated aging test is required to differentiate melon seed lots successfully (Table 4). Germination after this aging environment was clearly related ($R^2 = 0.49$ – 0.72) to LTE, HTE, MSE, and SSE in both years (Fig. 1). A longer duration (144 h) at both temperatures of 45 °C in 2005 and 47 °C in 2006 reduced germination percentages after aging to a greater extent, but the correlation values were reduced.

The stronger relationship of CD with emergence could well result from the greater accuracy of this test in comparison with the AA test. Controlled deterioration has precise control of seed moisture content with all seed lots having the same moisture content throughout the deterioration period. In contrast, the moisture content during AA increases during the test. Thus, some seed lots may increase in moisture more rapidly than others and hence age more in the 120-h period. This difference in moisture uptake from high humidity could occur even when seeds have the same initial seed moisture content.

In conclusion, both CD and AA tests can be used for predicting relative seedling emergence potential of melon seed lots in a range of stress conditions. The optimum aging environments on the bases of correlation values were found to be 45 °C for 48 h with 20% MC in CD and 45 to 47 °C for 120 h in AA tests.

Literature Cited

- Basak, O., I. Demir, K. Mavi, and S. Matthews. 2006. Controlled deterioration test for predicting seedling emergence and longevity of pepper (*Capsicum annuum* L.) seed lots. *Seed Sci. Technol.* 34:723–734.
- Bates, M.D. and R.W. Robinson. 1995. Cucumbers, melons and watermelons, p. 89–97. In: Smartt, J. and N.W. Simmonds (eds.). *Evolution of crop plants*. 2nd ed. Longman Scientific & Technical, Essex, UK.
- Bennett, M.A., E.M. Grassbaugh, A.F. Evans, and M.D. Kleinhenz. 2004. Saturated salt accelerated aging (SSAA) and other vigor tests for vegetable seeds. *J. Seed Technol.* 1:67–74.
- Delouche, J.C. and C.C. Baskin. 1973. Accelerated aging techniques for predicting the relative storability of seed lots. *Seed Sci. Technol.* 1:427–452.
- Demir, I., S. Ermis, G. Okcu, and S. Matthews. 2005. Vigor tests for predicting seedling emergence of aubergine (*Solanum melongena* L.) seed lots. *Seed Sci. Technol.* 33:481–484.

- Demir, I., Y.S. Ozden, and K. Yilmaz. 2004. Accelerated aging test of aubergine, cucumber and melon seeds in relation to time and temperature variables. *Seed Sci. Technol.* 32:851–855.
- Dutra, A.S. and V.D. Vieira. 2006. Accelerated aging test to evaluate seed vigor in pumpkin and zucchini seeds. *Seed Sci. Technol.* 34:209–214.
- Foolad, M. and G.Y. Lin. 1997. Genetic potential for salt tolerance during germination in *Lycopersicon* species. *HortScience* 32:296–300.
- Hampton, J.G. and D.D. Bell. 1989. Seed quality and storage performance of prairie grass. *N.Z. J. Agr. Res.* 32:139–143.
- Hampton, J.G., B.J. Brunton, G.M. Pemberton, and J.S. Rowarth. 2004. Temperature and time variables for accelerated aging vigour testing of pea (*Pisum sativum* L.) seeds. *Seed Sci. Technol.* 32:261–264.
- Hampton, J.G. and D.M. TeKrony. 1995. Handbook of vigour test methods. Intl. Seed Testing Assn., Zurich, Switzerland.
- Ibrahim, A., D.M. TeKrony, and D.B. Egli. 1993. Accelerated aging techniques for evaluating sorghum seed vigour. *J. Seed Technol.* 17: 29–37.
- International Seed Testing Association. 2003. International rules for seed testing. Intl. Seed Testing Assn., Zurich, Switzerland.
- Marshall, A.H. and R.E.L. Naylor. 1985. Seed vigour and field establishment in Italian ryegrass (*Lolium multiflorum* Lam.). *Seed Sci. Technol.* 13:781–794.
- Matthews, S. 1980. Controlled deterioration: A new vigour test for crop seeds. In: Hebblethwaite P.D. (ed.). *Seed production*. Butterworths, London.
- Matthews, S. 1993. Aging tests as a basis for the evaluation of seed quality. *Acta Hort.* 362:251–262.
- Mavi, K. and I. Demir. 2005. Controlled deterioration for vigour assessment and predicting seedling growth of winter squash (*Cucurbita maxima*) seed lots under salt stress. *N. Z. J. Crop Hort. Sci.* 33:193–197.
- Pesis, E. and T. Ng. 1983. Viability, vigor and electrolytic leakage of muskmelon seeds subjected to accelerated aging. *HortScience* 18:242–244.
- Powell, A.A. and S. Matthews. 1981. Evaluation of controlled deterioration, a new vigour test for crop seeds. *Seed Sci. Technol.* 9:633–640.
- Powell, A.A. and S. Matthews. 2005. Towards the validation of the controlled deterioration vigour test for small seeded vegetables. *Seed Testing Intl. ISTA News Bul.* 129:21–24.
- Steiner, A.M. and M. Stahl. 2002. Vigour rating of rye varietal categories (*Secale cereale* L.) using controlled deterioration testing. *Seed Sci. Technol.* 30:219–222.
- Strydom, A. and H.A. Van de Venter. 1998. Comparison of seed vigour tests for cabbage (*Brassica oleracea* var capitata). *Seed Sci. Technol.* 26:579–585.
- TeKrony, D.M. 2003. Precision is an essential component in seed vigour testing. *Seed Sci. Technol.* 31:435–447.
- TeKrony, D.M., D.B. Egli, and D.A. Wickman. 1989. Effect of corn seed vigour on no-tillage field performance: Field emergence and stand. *Crop Sci.* 29:1525–1528.
- TeKrony, D.M., T. Shande, M. Rucker, and D.B. Egli. 2005. Effect of seed shape on corn germination and vigour during warehouse and controlled environmental storage. *Seed Sci. Technol.* 33:185–197.
- Torres, S.B. and J. Marcos-Filho. 2005. Physiological potential evaluation in melon seeds. *Seed Sci. Technol.* 33:341–350.
- Wang, Y.R., J.G. Hampton, and M.J. Hill. 1994. Red clover vigour testing—Effects of three test variables. *Seed Sci. Technol.* 22:99–105.