VIGOR TESTS ON LETTUCE SEEDS AND THEIR CORRELATION WITH EMERGENCE

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INTRODUCTION

Seed value has increased significantly in the recent decades. As result, seed consumers are imposing high quality standards and seed producers are trying to satisfy these demands. Consequently, seed vigor evaluation has become very important. Seed vigor was defined by AOSA (1983) as "those properties of seeds that determine the potential of rapid, uniform, emergence and development of normal seedlings under a wide range of field conditions". Several methods for seed vigor testing have been proposed, and their use has been extensively evaluated in agronomic crops such as maize and soybean. However, reports of their use in vegetable and ornamental crops are scarce and indicate inconsistent results. The main objective of this study was to evaluate some of the available seed vigor tests to predict lettuce (*Lactuca sativa* L.) seedling emergence.

MATERIALS AND METHODS

Eight lettuce seed lots that corresponded to four botanical varieties (A and B, var. *capitata*; C and D, var. *acephala*; E and F, var. *crispa*; G and H, var. *longifolia*) were evaluated by the following laboratory tests:

a) Standard germination (GT): 400 seeds per lot, placed in pleated paper at 20°C. Counts were made 4 and 7 days after planting. Only normal seedlings that were free of necrotic spots or with incipient cotyledon necrosis were considered as germinated. Data from the first count of this test were considered as a possible parameter of seed vigor, and were analyzed separately.

b) Accelerated aging test (AA): Seeds were placed over a plastic mesh, inside sealed plastic jars containing water, and in a chamber at 40°C and ~100% RH for 72 h. After aging, seed germination of 400 seeds per lot was tested as described for GT.

c) Saturated salt accelerated aging test (SSAA): Procedures were similar to AA, but inside the jars a solution of water saturated with NaCl was used instead of water alone.

d) Conductivity test (EC): For each lot, four replications of 0.1 g of seeds were immersed in 50 ml of distilled water for 24 h at 20°C before testing to determine the electrical conductivity of the seed leachate. Real conductivity was calculated by subtracting the control value (distilled water only) from the conductivity determined for each solution.

e) Seed vigor imaging system (SVIS): This procedure was described by Sako et al. (2001) and basically consists of the analysis of the scanned images of 50 seedlings, which are taken after 3 days of germination at 20°C. Based on seedling growth, a customized software computes a growth and an uniformity index, both varying from 0 to 1000 (see Fig 1A). Finally, the software computes a vigor index which in this study is the sum of the growth index (70%) and the uniformity index (30%). Four replications of 50 seeds each were used for this test.

Additionally, the percentage (EP) and speed (ES) of the seed lots emergence were evaluated under each of three conditions: a) seedling trays (ST) filled with a mixture of peat (80%) and perlite (20%), b) boxes with clay loam soil (BS), and c) boxes with a mixture of clay loam soil (66%) and sand (34%, BSS). For the ST test, each seed lot was planted in two trays of 128 cells. For the BS and BSS, each one of three boxes was planted with 40 seeds of each lot in randomly distributed 4 cm-spaced rows. For ST, BS and BSS tests, emerged seedlings (expanded cotyledons) were counted at 7, 11 and 14 days after planting. Emergence speed (ES) was calculated by the algebraic sum of the ratio of emerged seedlings and days after sowing at the count moment. Correlation coefficients among the laboratory and emergence test results were calculated.

Figure 1. A. Seed vigor imaging system; **B**. Fungus presence in lettuce seeds after accelerated aging; **C**. Lettuce emergence in clay loam soil (left) and clay loam soil + sand (right) conditions; **D**. Emergence of lots A and B in seedling trays (left) and boxes with clay loam soil + sand (right).

Table 1. Germination and emergence indices of lettuce seed lots under different sowing conditions (ST: seedling trays with a peat + perlite mix, BSS: boxes with clay loam soil + sand mix, and BS: boxes with clay loam soil).

Seed	Germination[1] (%)		Emergence (%)			Emergence speed		
Lot	Normal[2]	Total[2]	ST[2]	BSS[2]	BS[2]	ST[3]	BSS[3]	BS[3]
A	96 a	100 a	98 a	99 a	83 a	17.8 ab	5.5 a	12.7 a
B	78 b	89 d	88 bc	83 bc	83 a	15.7 cd	4.6 bc	11.8 a
C	66 c	95 c	80 c	88 b	74 a	14.5 d	4.8 b	11.4 a
D	13 e	82 d	66 d	71 cd	55 b	11.6 e	3.6 d	8.0 a
E	72 bc	88 d	86 bc	81 bc	73 a	15.4 cd	4.0 cd	9.3 a
F	37 d	68 e	63 d	59 d	50 b	10.0 e	2.4 e	5.8 a
G	96 a	99 ab	98 a	99 a	83 a	17.8 a	5.6 a	11.2 a
H	42 d	97 bc	92 b	78 bc	77 a	16.3 bc	4.0 cd	10.5 a

[1] *Normal= % of normal seedlings; total= % of normal and abnormal seedlings.*
[2] *Values of a same column followed by the same letter did not show significant differences according to analysis of proportions with 95% of confidence.*
[3] *Values of a same column followed by the same letter did not show significant differences according to LSD test (p= 0.05).*

Table 2: Test results for five vigor tests used to evaluate eight lettuce seed lots (GT: germination, AA: accelerated aging, SSAA: salt saturated accelerated aging, EC: conductivity, SVIS: seed vigor imaging system).

Lot	1st count GT[1] %	AA[1] %	SSAA[1] %	EC[2] µS cm^{-1} g^{-1}	SVIS[2] Vigor Index
A	96 a	46 b	88 b	10.2 cd	495 c
B	72 b	6 d	53 c	16.6 e	401 c
C	59 c	0 f	46 cd	9.3 c	446 c
D	6 e	1 ef	12 f	17.3 e	293 d
E	65 bc	17 c	27 e	8.0 b	426 c
F	30 d	5 de	8 f	8.0 b	133 e
G	95 a	71 a	98 a	4.3 a	753 a
H	30 d	4 de	40 d	11.1 d	601 b

[1]: *Values of a same column followed by the same letter did not show significant differences according to analysis of proportions with 95% of confidence.*
[2]: *Values of a same column followed by the same letter did not show significant differences according to LSD test (p= 0.05).*

RESULTS AND DISCUSSION

Germination percentages along with EP and ES values for each lettuce seed lot and each sowing condition are shown in Table 1. Significant differences among lots were observed for each parameter. Based on EP and ES values, ST and BSS were the best conditions for seed performance. Results from the five vigor tests evaluated in the lab illustrate ranking differences among the lots (Table 2). The presence of fungal growth over seed surfaces was observed after the AA test (Figure 2B) which complicated subsequent germination evaluations, and could explain low germination values for seeds after AA. Seeds from the SSAA test did not present this problem.

Relationships among laboratory and emergence tests also presented significant differences (Table 3). The correlation coefficients between EC results and each emergence parameter were not significant, while AA results were only significantly correlated with the emergence percentage for BSS. GT values and emergence results were significantly correlated in all cases. SSAA results were equally or more positively correlated than GT results with the EP and, for the three sowing conditions, they were more correlated with the ES than GT values. Vigor index results from the SVIS were significantly correlated with both emergence parameters, and its correlation with ST emergence (EP and ES) was greater than GT values. The results of this study showed that SSAA and SVIS were the best laboratory tests for lettuce seed vigor evaluation, especially for seed lots to be used for plug seedling production.

Table 3. Correlation coefficients among emergence parameters and laboratory tests (GT: germination, AA: accelerated aging, SSAA: salt saturated accelerated aging, EC: conductivity, SVIS: seed vigor imaging system).

Emergence parameter[1]	GT	1st count GT	AA	SSAA	EC	SVIS
Emergence (%)						
Seedling tray	0.82*	0.80*	0.67	0.87**	-0.32	0.88**
SS-box	0.85**	0.86*	0.73*	0.93**	-0.31	0.81*
S-box	0.83*	0.81*	0.52	0.84**	-0.17	0.81*
Emergence speed						
Seedling tray	0.82*	0.80*	0.66	0.88**	-0.28	0.89**
SS-box	0.82*	0.82*	0.70	0.93**	-0.22	0.81*
S-box	0.75*	0.74*	0.42	0.82*	-0.00	0.72*

[1] SS: clay loam soil + sand; S: clay loam soil.
*, ** *Significant with p< 0.05 y p< 0.01, respectively*

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