EXTENDED ABSTRACT

ACCELERATED AGING TEST FOR THE DETERMINATION OF SEED VIGOUR OF VEGETABLE SPECIES IN SRI LANKA

K.A.I. Lakshani,* H.G.D.N. Senarathne, and N.S. Gama-Arachchige

University of Peradeniya, Sri Lanka.
* lakshikodithuwakku501@gmail.com

(Published)

Abstract

Accelerated aging (AA) test is a robust seed vigour test used throughout the world to test seed vigour of crop species. The present study was conducted to determine the seeds vigour of selected vegetable varieties in Sri Lanka, and correlation between the nursery field emergence (NFE) of the seeds and standard germination (SG) and AA. Seeds were tested for purity, moisture content (MC) and SG. AA tests were performed under different temperatures and time intervals. NFE was determined under glasshouse conditions. The seeds had purity and MC in the range required to perform AA test. Seeds of the tested varieties were identified as high, medium and low vigour seed lots. NFE showed a very high correlation with SG and AA. Therefore, the seed vigour of the tested varieties are variety specific and both SG and AA tests can accurately predict NFE of the tested varieties.

Keywords: Accelerated aging, emergence, seed testing, seed vigour, standard germination.

1. Introduction

1.1 Vegetable and Vegetable Seed Production in Sri Lanka

Vegetables are a primary source of vitamin, dietary fibre, minerals, potassium, and folic acid (Lintas, 1992; Cui et al., 2019; Weerakkody & Mawalagedra, 2020). Around eighty different varieties of fruits and vegetables are grown throughout the country (Export Development Board [EDB], 2021). They produce over 900,000 metric tons of fruits and vegetables per year and distribute both fresh and processed varieties to a number of diverse local and international destinations. Vegetable production is important in Sri Lanka for both local consumption as well as for export. Therefore, it is important for the country that the vegetable seeds produced and released are of high quality.

1.2 Seed vigour testing

Seed testing in Sri Lanka is mainly limited to standard germination and tetrazolium chloride tests. Since, these tests are carried out to test standard seed germination and viability respectively, the test results cannot be used in assessing storability of seed lots or predicting seedling emergence in field conditions. Seed vigour tests are important to predict field emergence, and in seed breeding and production strategies, to determine seed storage conditions, storability, maturity and seed treatments (Delouche & Caldwell, 1960; McDonald, 1995; Baalbaki et al., 2009; Marcos-Filho, 2015).

1.3 Accelerated Aging (AA) Vigour Test

Accelerated aging vigour tests are rapid, objective and useful in predicting potential storability and predicting seedling emergence under wide range of environmental conditions. The AA test subjects seeds to a high temperature (41-45 °C) and high humidity (usually 100%) stress conditions for short duration (48-96 h), followed by standard germination test (Delouche & Baskin, 1973; TeKrony, 2005; Baalbaki et al., 2009). Depending on the crop, AA temperature and duration may vary, and these stress conditions lead to rapid seed deterioration. High vigour seed lots have ability to survive under these high temperature and high humidity conditions (ISTA, 2004; TeKrony, 2005) and they give high germination percentage after aging treatments. However, low vigour seed lots show low germination percentage after aging treatments due to higher deterioration rate. A water-jacketed aging incubator is used to provide uniform and stable environmental conditions for aging treatments (TeKrony, 1993; Baalbaki et al., 2009). The temperature variations within the chamber should not be more than ±0.3 °C, to provide uniform temperature for aging treatment.

1.4 Objectives of the Study

The objectives of this study were to, (1) determine the seed vigour of the selected, commonly consumed Sri Lankan vegetable varieties and (2) determine the correlation between the nursery field emergence (NFE) of the tested varieties with seed germination, and AA vigour.

2. Materials and Methods

2.1 Plant Materials

The experiments were conducted using seeds of twelve commercially available vegetable varieties in Sri Lanka and they were purchased from seed outlets in Kandy. All the seed tests were performed according to ISTA standards.

2.2 Basic Seed Testing

2.2.1 Seed Purity

Four seed samples of 1-1.5 g were weighed from each seed variety and inert matter, other crop seeds and weed seeds were separated from each sample to get pure seeds (AOSA, 2015). Thereafter, the samples were reweighed, and the seed purity (%) was evaluated.

2.2.2 Seed Moisture Content (SMC)

Four untreated seed samples of 1-1.5 g were weighed from each seed variety and oven dried at 120±3°C for 3 hours (Dias, Mondo, & Cicero, 2014). Then, the samples were re-weighed, and seed moisture content (dry weigh basis) was calculated for each variety in percentage values.

2.2.3 Standard Germination (SG) Test

Four replicates of 100 untreated seeds of each variety were distributed on pleated Manila papers moistened with distilled water in plastic boxes and incubated at 25 °C in an incubator (Hinotek, MGC-450 BP, China) (Baalbaki et al., 2009).Germinated seeds were counted daily for 14 days. Seed germination percentages and time to reach 75% germination (G_{75}) were calculated.

2.3 Accelerated Aging (AA) Test

To estimate the seed vigor of the tested varieties, four replicates of 100 seeds each from each variety were placed in AA boxes that an each containing 40 mL of distilled water and they were placed in a water jacketed AA chamber incubator (Hinotek – GPH-9270, China) (Baalbaki et al., 2009). Seeds of each variety were aged at different AA conditions, specific to each vegetable species. Following the aging treatments, standard germination tests were carried out according to conditions mentioned above.

2.4 Nursery Field Emergence (NFE)

Four replicates of 100 untreated seeds of each variety were individually planted in plastic trays containing a mixture of soil, sand, and coco-peat (1:1:1) (Kikuti & Marcos-Filho, 2008). The trays were placed in an unheated glasshouse. Number of germinated seedlings was counted 14 days after sowing.

2.5 Data Analysis

All the experiments were repeated twice. The statistical analysis was carried out using Kruskal-Walis Rank Sum Test. RStudio version 3.6.2. The graphs were constructed using Sigma Plot ver. 11.0.

3. Results and Discussions

3.1 Basic seed testing

All the varieties had high purity (>96 %) and seed moisture content in the range required to perform the AA test (Table 1). All the tested varieties resulted in standard seed germination >75%, except beetroot and leeks. G_{75} values of the tested varieties were in the range of <1-9 days. Cucumber and radish demonstrated very high germination rates and 75% germination was achieved in less than one day.

3.2 Accelerated Aging (AA) Test

Seeds of cucumber, pumpkin and radish show germination >75% (high vigour) while bean, brinjal, capsicum, knol-khol, okra, and tomato show germination in between 60-74% (medium vigour) and beetroot, bitter gourd and leeks show germination <59% (low vigour) (Table 1).

3.3 Correlation between SG and AA with NFE

According to the correlation analysis between SG, AA treatments and NFE, both SG (R^2 = 0.9748) and AA (R^2 = 0.9325) exhibit a high correlation with NFE (Fig.1. A & B).

4. Conclusions

Seed vigor of the tested vegetable varieties are variety specific and based on the results of the AA test, seeds can be identified as high vigour, medium vigour and low vigour seed lots. Thus, AA test can be used to screen seed vigour levels of the tested varieties. Both SG and AA exhibit a high correlation with nursery field emergence. Therefore, both SG and AA protocols used in the present study can be recommended to predict seedling emergence of the tested vegetable varieties under nursery conditions. Further studies should be carried out to assess the ability of AA test to predict field emergence of the tested vegetable varieties.

Table 1. Seed purity, seed moisture content (SMC), standard germination (SG), accelerated aging (AA), nursery field emergence (NFE) and germination rate (G_{75}) of the tested vegetable varieties.

Species	Variety	Purity (%)	SMC (%)	SG (%)	AA (%)	NFE (%)	G_{75} (days)
Bean	Mas Mae	99.62 ± 0^{abc}	7.53 ± 0^{abcd}	84 ± 1^{abcd}	66 ± 1^{abcd}	82 ± 1^{abc}	4 ± 0^{abc}
Beetroot	Crimson Glob	99.86 ± 0.06^{abc}	10.66 ± 0.92^{ab}	67 ± 2^{ac}	39 ± 6^{ac}	53 ± 4^{ad}	-
Bitter gourd	Matale Green	97.74 ± 2.26^{ab}	10.43 ± 0.13^{a}	78 ± 1^{abc}	58 ± 4^{abc}	71 ± 3^{abd}	71 ± 3^{bc}
Brinjal	S.M.164	96.98 ± 0.87^{c}	7.07 ± 0.41^{abcd}	86 ± 3^{abd}	61 ± 4^{abc}	75 ± 2^{abd}	6 ± 0^{abc}
Capsicum	C.A.8	99.83 ± 0.10^{abc}	6.67 ± 0.27^{bcd}	88 ± 1^{abd}	68 ± 5^{abd}	81 ± 2^{abc}	8 ± 1^{b}
Cucumber	Kalpitiya White	98.04 ± 1.02^{abc}	6.21 ± 0.23^{cd}	97 ± 1^{d}	91 ± 1^{d}	94 ± 1^{c}	<1
Khol-khol	E.W.V	99.93 ± 0.07^{ab}	6.46 ± 0.47^{cd}	84 ± 1^{abcd}	61 ± 2^{abc}	70 ± 1^{abd}	3 ± 0^{ac}
Okra	Haritha	96.89 ± 2^{abc}	8.52 ± 0^{abc}	93 ± 2^{d}	70 ± 5^{abd}	87 ± 4^{bc}	3 ± 0^{ac}
Pumkin	Padma	96.09 ± 2.06^{bc}	6.88 ± 0.46^{bcd}	90 ± 2^{bd}	76 ± 1^{bd}	86 ± 1^{bc}	4 ± 0^{ac}
Radish	Beeralu	97.27 ± 0.99^{abc}	5.44 ± 0.34^{d}	92 ± 2^{bd}	77 ± 3^{bd}	87 ± 2^{bc}	<1
Tomato	Thilina	99.29 ± 0^{abc}	6.52 ± 0^{bcd}	81 ± 5^{abcd}	62 ± 9^{abd}	74 ± 6^{abcd}	9 ± 1^{abc}
Leeks	Jambo	100 ± 0.00^{a}	7.16 ± 1.23^{abcd}	43 ± 1^{c}	17 ± 1^{c}	12 ± 1^{d}	-

± values indicate the standard error. Different simple letters along a column indicate significance difference in response among the varieties ($p<0.05$).

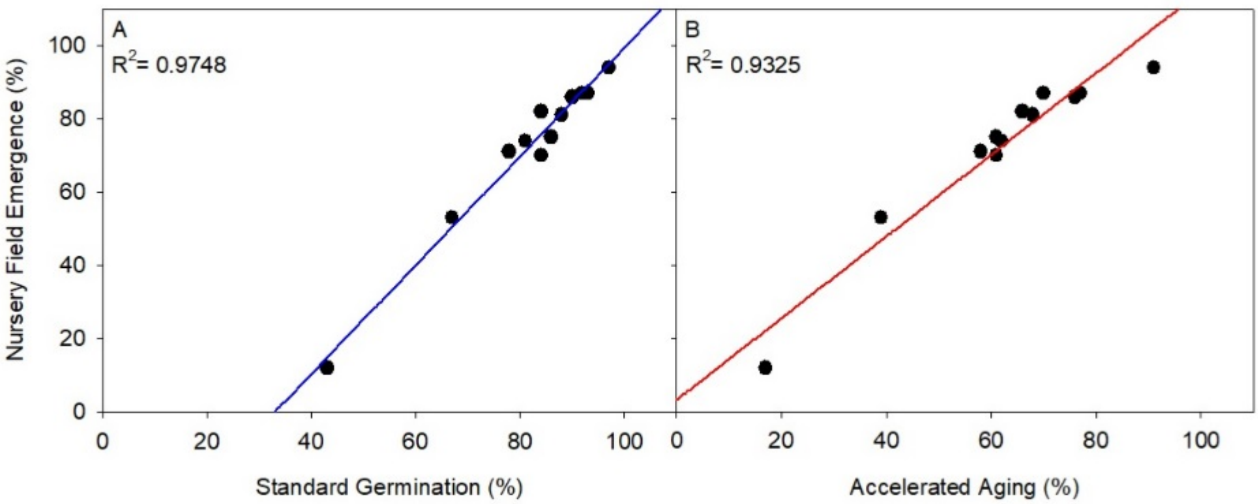

Figure 1. Correlation between (A) standard germination (SG) and nursery field emergence (NFE) and (B) accelerated aging (AA) germination and nursery field emergence (NFE) of the tested vegetable varieties.

References

AOSA (Association of Official Seed Analysts). (2015). *AOSA Rules for Testing Seeds: Principles and Practices* Association of Official Seed Analysts, Washington, DC.

Baalbaki, R., Elias, S., Marcos-Filho, J., & McDonald, M.B. (Eds.), (2009). Seed Vigor Testing Handbook. *Association of Official seed analysts* Ithaca, New York.

Cui, J., Lian, Y., Zhao, C., Du, H., Han, Y., Gao, W., Xiao, H., & Zheng, J. (2019). Dietary fibers from fruits and vegetables and their health benefits via modulation of gut microbiota. *Comprehensive reviews in food science and food safety* 18(5): 1514–1532.

Delouche, J.C., & Caldwell, W.P. (1960). Seed vigor and vigor tests. *Proceedings of the Association of Official Seed Analysts* 50(1): 124–129.

Dias, M. A. N., Mondo, V. H. V., & Cicero, S. M. (2014). Recent approaches for bell pepper seed vigor testing. *Acta Scientiarum, Agronomy* 36(4): 483-487.

ISTA. 2004. International Rules for Seed Testing Annexes 2004. *International Seed Testing Association (ISTA)* Zurich, Switzerland.

Kikuti, A. L. P., & Marcos-Filho, J. (2008). Physiological potential of cauliflower seeds. *Scientia Agricola* 65(4): 374-380.

McDonald, M.B. (1995). Standardization of Seed Vigor Tests. Seeds: Trade, Production and Technology; *Proceedings of the Congress of the International Seed Testing Association* 200–208).

Weerakkody, W. A. P., & Mawalagedera, S. M. M. R. (2020). Recent developments in vegetable production technologies in Sri Lanka. In *Agricultural Research for Sustainable Food Systems in Sri Lanka* 189-214.