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THE ACCURACY OF ACCELERATED AGING TEST FOR EVALUATING THE PHSIOLOGICAL QUALITY OF SEEDS

Mersal, I.F.
Seed Technology Res. Department, Field Crops Research Institute, ARC

ABSTRACT

Accelerated aging test results were found to be affected by many factors namely; relative humidity, temperature degrees, exposure periods and seed chemical composition. Therefore, precaution should be taken when utilizing this test for evaluating seed viability. This study was carried out at Seed Technology unit, Mansoura, Dakhlia Governorate during 2010 and 2011 years, to determine the value of accelerated aging test conditions for evaluating seed vigour and its relationship to chemical composition of the tested seeds (wheat, soybean and sunflower). The main results could be summarized as follows: Conducting the accelerated aging test at the highest surrounded relative humidity level (100%) led to increasing seed moisture content and the increase was more rapidly comparing to conducting the test with using saturated salt solutions (SSAA) such as sodium hydroxide (75%Rh.). Increasing temperature degrees during the aging test release seed water absorption specially at saturated relative humidity (100%). Seed moisture contents increased as the exposure period to accelerated aging conditions was increased. Also soybean seed was more sensitive to the accelerated aging conditions especially relative humidity comparing to sunflower and wheat seed. So, the results suggest conducting the accelerated aging test for soybean seed at relative humidity 75% and temperature degrees not excesses 44C^{o} for 72hour., (100% relative humidity, 41C^{0} for 72 hour) for wheat and (100% relative humidity, 44C^{0} for 72 hour) for sunflower.

INTRODUCTION

The standard germination test is conducted under optimum conditions for germination consequently, when field conditions at planting are near optimum the results usually correlated well with field emergence (McDonald, 1995). However, this test does not demonstrate the same efficiency in estimating seed performance after sowing since field emergence results are frequently lower than those observed in laboratory germination (Marcos-Filho, 1999). Vigor tests were introduced to predict stand establishment under a wide range of environmental conditions, accelerated aging test is one of the accepted vigor tests while this test exposes seeds for short periods of time (3 to 4 days) to high relative humidity (100%) and temperature degrees (41C^{o}), followed by standard germination test, (ISTA, 1999). These conditions are considered the most prominent environmental factors with respect to the intensity and vicinity of seed deterioration (Marcos Filho 1999), so low quality seeds deteriorate more rapidly than more vigorous ones, presenting a differentiated decrease in viability. Hampton and Tekrony, (1995); Tekrony, (1995); Egli and Tekrony, (1996), reported that the accelerated aging test is considered standardized and correlates well with field emergence under a variety of seedbed conditions. However, accelerated aging test does not demonstrate some efficiency in estimating seed performance after sowing, science seedling field emergence results are

frequently lower than those observed in laboratory germination (Marcos-Filho, 1999).

The variation in the results may refer to the test conditions ; high relative humidity and temperature degrees However, it had some limitations when it was used for small seed due to rapid absorption of water during aging (Jianhua and McDonald 1997). While, (Torres *et al.*, 2004) reported that, many factors affect the behavior of seed that are submitted to the test, interaction between temperatures /exposure periods is one of the aspects. The variation of test results may be due to the chemical composition of the tested seeds (Marcos-Filho, 1999), reported that the chemical composition of seeds affects water holding capacity while proteins having high affinity for water and they thus considered hydrophilic. In contrast, lipids have fewer attraction points with water making lipids hydrophobic. The slower moisture absorption by soybean seed in spite of major portion of protein, which are hydrophilic on the other side. Sunflower seed contains a large proportion of oil which being hydrophobic in nature, don't allow quick absorption unless the relative humidity is sufficiently high (Walters and Hill, 1998). However, at higher relative humidity e.g. 90% or more protein rich soybean seed absorbed greater amount of moisture attaining a higher moisture content values than maize and safflower. Also, Torres, (2004) reported that the differences in water absorption by the seeds which once exposed to a humid atmosphere during the accelerated aging test, might present marked variation in their moisture content. Jianhua and McDonald (1997), proposed a new method of aging called the saturated salt accelerated aging test (SSAA). The use of saline solutions contributed to slow down water absorption by seeds in the accelerated aging test. The use of salt standard solutions contributed markedly to reduce or prevent the development of microorganisms, thus minimizing the inter face of an additional factor in test result (Jianhua and McDonald, 1997). The saturated salts accelerated aging technique would reduce seed micro flora growth due to the lower relative humidity levels using Nacl or Mgcl solution. This may be due to the excellent seed treatments which were commercially applied to seed samples. Also, Boersma *et al.*, (1996) concluded that the vigor test which gave the best indicator of performance under average of different fed bed moisture and temperature conditions was the modified accelerated aging test using a 72h incubator period.

The objective of this work was to study the accelerated aging test methodology to evaluated the physiological potential of wheat, soybean and sunflower seeds and role of the seed chemical composition in the test results, establishing a comparison between the traditional procedure and the utilization of saturated salt solutions.

MATERIALS AND METHODS

This study was carried out at Seed Technology Unit, Mansoura, Dakhlia Governorate during 2010 and 2011 years in Randomized Complete Design. Wheat (starch rich); soybean (protein-lipid rich) and sunflower (lipid

rich) seeds were supplied by Field Crops Research Institute, Agriculture Research Center. The following tests were utilized.

Germination test:- Four replicates for each crop seeds were germinated at 20C^{o} for wheat (c.v. Gemmiza 10) and 25C^{o} for soybean (C.v. Crawford) and sunflower (C.v. Giza 2). Germination percentage was recorded as the normal seedlings after 8 days for soybean and 7 days for wheat and sunflower according to the rules outlined by (ISTA, 1999).

Seed moisture content:- The initial moisture content for each crop seeds was determined using the method of ISTA., (1999). Wheat, sunflower and soybean seed were placed in an oven at temperature of 103C^{o} for 18 hours. The percentage of seed moisture content was determined by this formula: (fresh mass basis):

$$\% \text{ Fresh mass} = \frac{\text{Mass before drying} - \text{mass after drying}}{\text{Mass before drying}} \times 100$$

Accelerated Aging Test (Traditional method): Seeds of each crop (wheat - soybean - sunflower) were weighted, placed on a screen tray and speared in a single layer and placed in plastic boxes (inner chamber) containing 40 ml of distilled water (100% relative humidity). The inner chambers and screen trays were washed thoroughly in 20% sodium Hypo-chlorite and then dried. This was done after each use to prevent fungal concentration. The inner chambers were placed in covered water bath room (outer chamber) and the seeds were aged at 38, 41, 44 and 47 C^{o} for 48, 72 and 96 hours. To maintain uniform and constant temperature, the door of the incubator remained closed for the entire aging period.

Accelerated Aging Test (Modified methods): This test is a modification method to the traditional accelerated aging method according to Tekrony, (1995) and (Jianhua and McDonald 1997), while 300 seeds from (wheat, soybean and sunflower) were weighted, placed on a screen tray and speared in a single layer and placed in plastic boxes (inner chamber) containing 40 ml of the saturated salt solutions of sodium chloride (Nacl) which give (75% relative humidity). The inner chambers and screen trays were washed thoroughly in 20% sodium Hypo-chlorite and then dried. This was done after each use to prevent fungal concentration. The inner chambers were placed in covered water bath room (outer chamber) and the seeds were aged at 38, 41, 44 and 47 C^{o} for 48, 72 and 96 hours. After these aging periods, seeds were removed from the inner chamber, the moisture content of the seed was determined and the slandered germination test was conducted as described above.

Speed of germination: It was calculated as described in the Association of Official Seed Analysis (AOSA,1983) by following formula:

$$SGI = \frac{\text{No. of germinated seed}}{\text{Days of first count}} + \ldots\ldots\ldots\ldots + \frac{\text{No. of germinated seed}}{\text{Days of final count}}$$

The seeds were considered germinated when the radical was at least 2 mm. long.

Mean germination time (MGT): It was calculated based on the following equation of Ellis and Roberts (1981).

$$MGT = \Sigma Dn / \Sigma n$$

Where (n) is the number of seeds, which were germinated on day D and D is number of days counted from the beginning of germination.

All data of characters were subjected to the statistical analysis according to the technique of analysis of variance (ANOVA) of completely randomized design, as described by Gomez and Gomez (1984).

RESULTS AND DISSCUION

Data in Tables 1, show the effect of interaction among relative humidity, temperature degrees and exposure periods on seed moisture contents of wheat, soybean and sunflower seed. Seed moisture contents significantly affected by this interaction. In general, at 100% relative humidity as the temperature degrees and exposure periods increased seed moisture contents of wheat, soybean and sunflower increased compared to the unaged seed (control), while seed moisture content of wheat seed increased from 13.4% to 22.9%, 26.3% and 27.9% at 38C^{o} after 48h, 72h and 96h, respectively.

Table (1): Effect of interaction among relative humidity, temperature degrees and exposure period during acceleration aging test on wheat, soybean and sunflower seed moisture content.

Treatments			Wheat	Soybean	Sunflower
Relative humidity (%)	Temperature degrees (C^{o})	Exposure periods (h.)			
Control			**13.4**	**13.8**	**10.6**
75%	38C^{o}	48	14.6	14.8	11.5
		72	15.2	16.3	13.2
		96	15.0	16.2	13.4
	41C^{o}	48	15.2	15.5	12.9
		72	15.7	16.1	14.1
		96	15.6	15.9	14.0
	44C^{o}	48	15.7	17.0	13.6
		72	16.0	16.2	14.4
		96	15.4	15.9	14.0
	47C^{o}	48	17.4	18.6	13.8
		72	15.8	16.2	14.0
		96	15.5	15.9	14.1
100%	38C^{o}	48	22.9	23.6	15.6
		72	26.3	27.2	19.2
		96	27.9	29.9	21.2
	41C^{o}	48	25.8	29.5	19.1
		72	30.0	32.9	22.5
		96	31.0	34.6	24.8
	44C^{o}	48	28.1	32.1	22.0
		72	31.5	34.0	26.5
		96	32.1	35.2	26.1
	47C^{o}	48	30.8	33.6	25.4
		72	33.3	37.5	28.8
		96	32.9	36.8	29.2
LSD at 0.05%			0.1	1.9	2.3

Further increase in seed moisture content with increasing temperature degree to 47C^{o} and prolong the exposure periods to 48h, 72h, and 96h., while seed moisture content reached its highest mean 33.3% at 47C^{o} after 72h. On the other side, conducting the accelerated aging test at relative humidity 75%, the increase in seed moisture content not excess 4% after exposure for 48 hour to the higher temperature degree 47C^{o} comparing the unaged wheat seed. Soybean seed moisture content, had the same trend as was observed wheat seed, but the increase in soybean seed moisture content was greater and faster comparing to wheat ,while at 100% relative humidity soybean seed moisture content increased rapidly and reached 37.5% when aging for 72h at temperature degree 47C^{o}. Conducting the aging test for soybean seed at relative humidity 75% increased seed moisture content up to 18.6% at temperature degree 47C^{o} after exposure period 48 hours. Moisture content of sunflower seed increased from 10.6% (control) to 21.2% after exposure for 96 hour to 38C^{o} at 100% relative humidity and reached its highest level after 96 hour from exposure to 47C^{o} . On the other side, the highest increase in sunflower seed moisture content not excess 14.4% after 72 hour at surrounded relative humidity 75% and temperature degree 44C^{o}.

Data in Table 2 , show standard germination of wheat, soybean and sunflower seed after aging test was significantly affected by the interaction among the test conditions i.e. (relative humidity, temperature degrees and exposure period). Seed germination percentage of accelerated wheat seed for 96 hours at conditions of 100% relative humidity and temperature degree 47C^{o} recoded the lowest mean comparing with unaged wheat seed. On the other side, the decrease in germination of wheat seed after aging at 75% relative humidity at temperature degree 38C^{o} for any time not pass the significant levels at 0.05% comparing with unaged seed. Wheat seed after aging at 75% relative humidity showed the highest decrease in seed germination and it was noticed at temperature degrees 47C^{o} after 96 hours. Germination percentage of soybean seed after exposure to aging conditions including surrounded relative humidity 100% was decreased gradually as the temperature degree and exposure period increased comparing with the control treatment. While it decreased from 90% to 54% at temperature degree 41C^{o} after exposure period 96 hours, further decrease to 27% and 11% with increasing temperature degrees to 44C^{o} and 47C^{o}, respectively after 96 hours. With decreasing the surrounded relative humidity to 75%, the decrease in seed germination percentage after exposure to different test condition was less than of 100% relative humidity. The same trend was recoded for sunflower seed as in Table, 2.

Table (2): Effect of interaction among relative humidity, temperature degree and exposure period during aging on germination (%) of wheat, soybean and sunflower seed.

Treatments			Wheat	Soybean	Sunflower
Relative humidity (%)	Temperature degrees (C°)	Exposure periods (h.)			
Control			**96**	**90**	**87**
75%	38C°	48	96	90	86
		72	95	90	86
		96	95	90	90
	41C°	48	93	89	86
		72	91	86	85
		96	88	86	85
	44C°	48	90	84	84
		72	86	81	84
		96	81	77	83
	47C°	48	88	79	83
		72	78	73	79
		96	76	70	76
100%	38C°	48	91	78	79
		72	89	74	74
		96	84	72	74
	41C°	48	83	63	76
		72	77	56	70
		96	71	54	68
	44C°	48	78	48	68
		72	71	37	65
		96	63	27	61
	47C°	48	64	25	64
		72	43	12	63
		96	32	11	61
LSD at 0.05%			1.7	0.5	2.8

Data in Table 3, show, speed of germination of wheat, soybean and sunflower seeds significantly decreased with increasing relative humidity, temperature degrees and exposure period during aging test. While germination speed of the studied crops decreased to the lowest means with increasing both of relative humidity, temperature degree and exposure periods. Opposite trend was recorded for the mean germination time as demonstrated in Table 4, while as the relative humidity, temperature degree and exposure period during aging test increased seed vigour of tested seeds decreased.

From this study, conducting the accelerated aging test at the highest surrounded relative humidity (100%) led to increasing seed moisture content and the increase was more rapidly as compared with conducting the test with using saturated salt solutions (SSAA) such as sodium hydroxide (75%Rh.). While, Bennett (2001) reported that, the saturated salt solution should reduce water uptake, minimize microflora growth and slow overall seed deterioration while, Roda and Marcos-Filho, (2003) concluded that, no fungal

growth in onion seeds when seeds were aged using saturated salt solutions of Nacl. Also, no fungal growth was observed in impatiens seeds after aging with Nacl, Kcl and NaBr, Jianhua and McDonald (1997). On the other side increasing temperature degrees during the aging test release seed water absorption specially at relative humidity (100%) as a result of this, seed moisture content increased then growth fungi and seed deterioration increased. On the other side, with prolonging the exposure period to the accelerated test conditions, seed deterioration also increased.

With respect to the effect of accelerated aging conditions on seed deterioration consequently the test results. The results, showed that seed moisture content increased as the exposure period to accelerated aging condition was increased, and this increase in seed moisture content was correlated with increasing the relative humidity and temperature degrees. Vijay and Dadlani (2003), reported that the pattern of moisture absorption the soybean and safflower seeds was similar up to 50% relative humidity.

Table (3): Effect of interaction among relative humidity, temperature degree and exposure period during aging on speed of germination of wheat, soybean and sunflower seed.

Treatments			Wheat	Soybean	Sunflower
Relative humidity (%)	Temperature degrees (C°)	Exposure periods (h.)			
Control			**48**	**42**	**42**
75%	38C°	48	34	33	32
		72	34	33	32
		96	34	33	31
	41C°	48	34	33	32
		72	32	31	31
		96	32	31	31
	44C°	48	32	30	30
		72	32	30	31
		96	30	29	32
	47C°	48	33	30	32
		72	29	27	30
		96	27	24	27
100%	38C°	48	37	30	31
		72	34	25	26
		96	31	25	26
	41C°	48	32	26	28
		72	30	23	26
		96	27	22	25
	44C°	48	30	21	24
		72	27	14	25
		96	24	13	23
	47C°	48	24	21	24
		72	14	6	26
		96	10	6	25
LSD at 0.05%			1.2	1.5	1.4

Table (4): Effect of interaction among relative humidity, temperature degree and exposure period during aging on mean germination time of wheat , soybean and sunflower seed.

Treatments			Wheat	Soybean	Sunflower
Relative humidity (%)	Temperature degrees (C°)	Exposure periods (h.)			
Control			**3.0**	**3.1**	**3.1**
75%	38C°	48	3.1	3.0	3.1
		72	3.1	3.0	3.1
		96	3.1	3.0	3.1
	41C°	48	3.0	3.0	3.0
		72	3.1	3.1	3.1
		96	3.1	3.0	3.1
	44C°	48	3.1	3.1	3.1
		72	3.0	3.0	3.0
		96	3.0	3.0	2.9
	47C°	48	3.0	3.0	3.0
		72	3.0	3.1	3.0
		96	3.1	3.2	3.1
100%	38C°	48	2.7	2.8	2.8
		72	3.0	3.2	3.2
		96	3.0	3.2	3.2
	41C°	48	2.9	3.1	3.1
		72	2.9	3.1	3.0
		96	2.9	3.1	3.0
	44C°	48	2.9	3.2	3.1
		72	3.0	3.5	3.0
		96	3.0	3.5	3.0
	47C°	48	3.0	3.0	3.4
		72	3.5	3.8	3.3
		96	3.6	3.8	3.5
LSD at 0.05%			0. 1	0.1	0. 1

But, it shot up dramatically in soybean at relative humidity 70% and above, whereas the rise remained slow and gradual in safflower. This was agree with our results while, soybean seed moisture content increased gradually comparing to wheat and sunflower seeds especially at high relative humidity and temperature degrees, this was a result of the seed chemical composition while seeds containing large quantities of proteins absorb large quantities of water (hydrophilic) meanwhile, starch rich seed have an affinity for water in seed storage tissues, but not as great as proteins on contrast, lipids strong seed have little attraction for water (hydrophobic). On the other side, Walter and Hill (1998), noted that at similar levels of relative humidity protein oil- rich seeds of soybean achieved a significantly higher moisture content comparing sunflower. From these results there are many factors affects the accelerated aging test results i.e. relative humidity, temperature degrees, exposure periods , seed size and seed chemical composition which play an important role in water sorption consequently seed moisture content which affect seed germination after aging test consequently the accuracy of the test results.

Also soybean seed was more sensitive to the accelerated aging conditions comparing to sunflower and wheat seed especially relative humidity and temperature degrees. So we can conducting the accelerated aging test for soybean seed at relative humidity 75% and temperature degrees not excesses 44C^{o} for 72hour.

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مصداقية إختبار الشيخوخة لتقييم الجودة الفسيولوجية في البذور

إبراهيم فتحي مرسال

قسم بحوث تكنولوجيا البذور, معهد بحوث المحاصيل الحقلية, مركز البحوث الزراعية.

يعتبر اختبار الشيخوخة من أهم الاختبارات الموصى بها لاختبار قوه إنبات البذور إلا أن نتائج الاختبار تتأثر بظروف إجراؤه كالرطوبة النسبية ودرجات الحرارة أثناء الإختبار ومده التعرض للاختبار ونوعيه البذور تحت الإختبار ولذلك يجب أخذ بعض الحذر عند إجراء هذا الإختبار لتقييم جوده البذور. أجريت هذه الدراسة بوحدة بحوث تكنولوجيا البذور بالمنصورة خلال ٢٠١٠ و ٢٠١١ م . لدراسة تأثير ظروف الاختبار (الرطوبة النسبية (١٠٠% و ٧٥%) – درجات الحرارة (٣٨ م٠ ,٤١ م٠ , ٤٤م٠ و ٤٧ م٠) – مده الاختبار (٤٨ , ٧٢ , ٩٦ ساعة) على مصداقيته في تقييم الجودة الفسيولوجية لبذور مختلفة في التركيب الكيمائي (نشويه (قمح)- بذور بروتينيه (فول الصويا) – بذور زيتيه (عباد الشمس)).

ويمكن تلخيص أهم النتائج كما يلي:-

أدى إجراء اختبار الشيخوخة في ظروف رطوبة نسبيه مشبعه (١٠٠%) إلى زيادة مستويات الرطوبة بالبذور المختبرة وكان مستوى الزيادة مرتفع وسريع في بذور فول الصويا مقارنه ببذور القمح وعباد الشمس مما أدى إلى التدهور السريع في الإنبات وقوه البذور عقب الاختبار وذلك مقارنه بإجراء الاختبار تحت ظروف رطوبة نسبيه (٧٥%) باستخدام محلول مشبع من كوريد الصوديوم. أدى زيادة درجات الحرارة أثناء الاختبار وزيادة مده التعريض لظروف الاختبار إلى زيادة امتصاص البذور للماء و خاصة عند إجراء الاختبار تحت ظروف رطوبة نسبيه ١٠٠% وكانت بذور فول الصويا هي الأكثر حساسية لظروف الاختبار عند إجراؤه بالطريقة التقليدية. وتوصى هذه الدراسة بإجراء اختبار الشيخوخة لبذور فول الصويا تحت ظروف رطوبة نسبيه ٧٥% ودرجه حرارة أثناء الاختبار لا تتعدى ٤٤ م لمده ٧٢ ساعة. وبذور القمح (١٠٠% رطوبة نسبيه و ٤١م٠ لمده ٧٢ ساعة) وعباد الشمس (١٠٠% رطوبة نسبيه و ٤٤م٠ لمده ٧٢ ساعة .

قام بتحكيم البحث

أ.د / أحمد نادر السيد عطية — كلية الزراعة – جامعة المنصورة

أ.د / محمود إبراهيم العميري — مركز البحوث الزراعيه