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Improvement in germination characteristics in artificially aged seeds of okra (*Abelmoschus esculentus*) by osmoconditioning

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ABSTRACT

Okra [*Abelmoschus esculentus* (L.) Moench.] seeds of three cultivars, viz. Arka Anamika, Hisar Unnat and Varsha Uphar were subjected to accelerated ageing (exposed to approximately 100% RH at 40±1°C for 72 hr) and were hydro and osmoprimed to find out the ability of priming treatment in the repair of deterioration sustained during ageing. Seed quality parameters like germination percent, seedling length, seedling dry weight, vigour index-I and vigour index-II measured in fresh and accelerated aged seed, whereas germination percent was measured in primed seeds. Overall, accelerated ageing reduced germination, seedling length, seedling dry weight, vigour index-I and vigour index-II in all the varieties. However, priming reduced the deleterious effects of ageing and improved germination in all the varieties. Hydration with GA_3 (50 ppm for 6 hr), ascorbic acid (100 ppm for 6 hr), polyethylene glycol (PEG) in combination with hydration (6 hr) with water, thiram (0.25%), GA_3 (50 ppm for 6 hr) and ascorbic acid (100 ppm for 6 hr) were proved beneficial for enhancing standard germination significantly. Among all these priming treatments the combination of PEG with GA_3 and ascorbic acid were proved better/superior for increasing germination in all the three varieties of okra.

Key words: Ascorbic acid, Osmopriming, Polyethylene glycol, Thiram, Vigour index

Okra [*Abelmoschus esculentus* (L.) Moench.] is an important vegetable crop of the region. The most important single factor affecting crop production is the quality of seed. Seed deteriorate during the period of prolonged storage. As far as the vegetable seed is concerned, it is very susceptible to have loss in quality in terms of seed viability and vigour during seed storage. Ageing of seeds starts right from physiological maturity. It is one of the most intriguing and challenging scientific problems of universal concern (Moment 1978).

As the seeds aged, they come to germinate more slowly than fresh seeds, respire slower and become more susceptible to diseases, chromosomal abnormalities and increased proportion of abnormal seedlings are produced. Rapid deterioration of stored seed is a serious problem in the tropical and subtropical countries like India where high temperature and high relative humidity greatly accelerate the seed ageing phenomena. Retention of seed viability during storage has always been of utmost concern to seedsman. Thus it will be highly relevant to develop an insight into the basic phenomena of seed ageing and longevity. One of the approaches adopted in this direction is to identify the physiological and biochemical changes accompanying seed deterioration during seed storage.

Seed deteriorates during the period of prolonged storage. Higher the moisture content of the seeds and higher the temperature at which they are stored, sooner the viability is lost (Abba and Lovato 1999). Accelerated ageing of seeds over several days of exposure to high temperature and high relative humidity is a good predictor of seed storability (Sung and Jeng 1994). Seeds that deteriorate rapidly under accelerated ageing, will perform poorly in long term storage (Delouche and Baskin 1973).

Although seed viability is not only a function of seed storage but a variety of factors to which the parent plant is exposed during seed formation, can also profoundly affect subsequent viability of seeds. Okra seeds are moderate storer under ambient conditions (Doijode 1999). Nagarajan *et al.* (2004) studied that longevity of okra seeds is affected by seed moisture content. Seed deterioration in terms of loss of viability and vigour was faster in seed lots of higher initial moisture compared to seed lots of low initial moisture.

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Controlled deterioration treatments (accelerated ageing) involve exposing seeds to adverse storage conditions namely, increased temperature and relative humidity for specific period of time. It is assumed that the process of deterioration which occurs under these artificial ageing conditions to be similar to those which occur during natural ageing (Delouche and Baskin 1973). The main difference between artificial ageing and actual deterioration in poor storage conditions being the speed at which the changes occur in case of accelerated ageing. This can be used to investigate the factors responsible for seed deterioration in storage and the efficacy of various pre-sowing treatments that can improve the performance of a given seed lot. This paper reports the improvement of seed quality obtained in artificially aged okra cultivars by osmo and hydropriming treatments.

MATERIALS AND METHODS

Three cultivars of okra, viz. Arka Anamika, Hisar Unnat and Varsha Uphar having germination above minimum seed certification standards (76.00-89.69%). The seed material was collected from the Department of Vegetable Science, CCS Haryana Agricultural University, Hisar and was stored under ambient conditions. The research work was conducted in the Department of Seed Science and Technology, CCS Haryana Agricultural University, Hisar.

The seeds were subjected to controlled deterioration (ageing) by equilibrating the seeds in about 100% RH at 40±1°C for 72 hr they were dried at room temperature to reach their original moisture content. The artificially aged seeds of these cultivars were osmotically primed on one layer of filter paper wetted with distilled water (hydration for 6 hr), hydration for 6 hr then treat dry seeds with 0.25% thiram, hydration with GA_3 (50 ppm for 6 hr), ascorbic acid (100 ppm for 6 hr), polyethylene glycol (PEG) of –1 MPa PEG-6000 (Michel and Kaufmann 1973), PEG with combination with 0.25% thiram, GA_3 (50 ppm for 6 hr), ascorbic acid (100 ppm for 6 hr). Seeds were kept in a single layer in petridishes (9 cm dia.) and replicated 3 times for each cultivar. All these seeds then dried in shade at room temperature for overnight on filter paper for one day. After priming, these seeds were subjected to germination testing, which was estimated following ISTA procedure (ISTA 2001) in paper towels soaked in water with 100 seeds in each replicated three times. After 10 days, 5 seedlings from each replication were randomly removed and the seedling length measured. The dry weight of 5 seedlings together was also obtained. The seed vigour index-I was calculated as the product of seedling length and germination whereas the seed vigour index-II was calculated as the product of seedling dry weight (Abdul-Baki and Anderson 1973). The factorial experiment in completely randomized block design (CRD) has been conducted. The angular transformation was applied to the percent data. The data was subjected to analysis of variance to get the treatment and cultivar effect and their interactions (Table 1).

RESULTS AND DISCUSSION

Accelerated ageing

The analysis of variance (ANOVA) after accelerated ageing in okra for different seed quality parameters, i e standard germination (%), seedling length (cm), dry weight (mg), vigour index-I and vigour index-II showed significant mean sum of square due to variety and seed quality parameters, which revealed presence of sufficient level of variability in the material studied for the characters studied (Table 1).

Ageing treatment of okra seeds showed deleterious effect on germination and other quality traits. Overall reduction in germination, seedling length, seedling dry weight, vigour index-I and vigour index-II was recorded (Table 2). In the present study, all the three varieties of okra showed a considerable variability in respect to viability. The germination of all the varieties decreased after accelerated ageing at 40±1°C for 72 hr. Maximum germination was recorded in Varsha Uphar (56.67%) and minimum in Arka Anamika (40.67%) (Table 2). Similar results were reported in okra (Narwal 1995). The effect of accelerated ageing on seedling length and dry weight were also recorded which showed decreasing trend in both the parameters. Varsha Uphar observed longest seedling (34.20 cm) and maximum accumulation of dry matter (26.40 cm) after accelerated ageing among all the three varieties. The decreased seedling length and dry weight after accelerated ageing were recorded by Nagarajan *et al.* (2004) and Doijode (1999) in okra. Moreover, the germination test fails to account the progressive nature of seed deterioration.

The seeds are merely classified as either germinable or non-germinable with no distinction between strong or weak seedlings after accelerated ageing. These weakness have encouraged the interest in vigour testing to provide information about the quality and longevity of seeds. In the present study, the variability in the seeds of all the three varieties of okra were evaluated for seed vigour based on seedling length and seedling dry weight after accelerated ageing. Seed vigour also decreased after accelerated ageing

Table 1 Analysis of variance for different seed quality parameters after accelerated ageing in okra (*Abelmoschus esculentus*)

Parameters	Variety (A)	Error	SE (m)
Degree of freedom	2	6	
Standard germination (%)	203.11**	19.56	2.553
Seedling length (cm)	71.60*	13.21	2.091
Dry weight (mg)	43.71*	7.69	1.602
Vigour index-I	794 493.94**	74 925.10	158.035
Vigour index-II	399 879.70**	35 076.12	108.103

**P = 0.01, *P = 0.05

Table 2 Physiological and biochemical basis for loss in viability and vigour during accelerated ageing (72 hr, 40±1°C)

Varieties	SG	SL	DW	VI-I	VI-II
Arka Anamika	40.67	29.50	18.77	1 200.80	770.00
	(76.00)	(35.15)	(25.73)	(2 671.60)	(1 955.50)
Hisar Unnat	52.00	33.33	22.50	1 731.47	1 167.47
	(88.00)	(35.67)	(29.53)	(3 139.83)	(2 578.93)
Varsha Uphar	56.67	34.20	26.40	1 938.11	1 499.20
	(89.67)	(37.37)	(31.87)	(3 359.68)	(2 864.47)
CD (P = 0.05)	9.01	7.40	5.65	557.50	381.45
CV	8.88	10.69	12.30	15.91	16.35

Figures in parenthesis are control value

SG, Standard germination; SL, seedling length; DW, dry weight per seedling; VI, vigour index; EC, electrical conductivity

but Varsha Uphar recorded maximum vigour which showed that this variety is more resistant to stress conditions among all the three varieties whereas Arka Anamika recorded minimum vigour, indicating its susceptibility to ageing. The reduction in seed vigour after accelerated ageing were also reported earlier by Basra *et al.* (2003) in cotton and Khan *et al.* (2005) in turnip.

Seed priming of accelerated aged seeds

The seed germination process is initiated when seeds begin to imbibe water and it is common practice in many laboratories to submerge seeds under water for one to several hours before planting to hasten the germination (Kay *et al.* 1977). The present investigation revealed that various priming treatments enhanced the standard germination in accelerated aged seed lots in all the varieties of okra. The analysis of variance (ANOVA) for accelerated ageing test presented in Table 3 showed significant mean sum of square due to variety and priming treatments which revealed presence of sufficient level of variability in the material studied.

But the interaction among varieties × treatment was found to be non-significant. The increased seed germination by hydration-dehydration can be due to quenching effect on the propagation of free radicals (Basu 1976). The beneficial effect of priming is known to occur due to higher mitochondrial activity, formation of more high energy compounds and vital bio-molecules (Henckel 1961). All the priming treatments were found effective for improving the

Table 3 Analysis of variance for the seed priming of accelerated aged seeds of okra

Source	Degree of freedom	Accelerated ageing	SE (m)
Variety (A)	2	384.64**	1.05
Priming treatment (B)	8	413.53**	1.83
A × B	16	15.59	3.16
Error	54	30.02	

**P = 0.01, *P = 0.05

Table 4 Effect of priming on seed germination of artificial aged seed in okra (*Abelmoschus esculentus*)

Varieties	Treatments									
	T_0	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	Mean
Arka Anamika	40.67	47.33	51.33	61.33	60.00	56.67	57.33	70.00	62.67	56.37
	(39.59)	(43.44)	(45.75)	(51.55)	(50.76)	(48.83)	(49.22)	(56.80)	(52.35)	(48.70)
Hisar Unnat	52.00	54.67	56.00	61.33	62.00	61.33	65.33	72.00	67.33	61.33
	(46.13)	(47.67)	(48.44)	(51.57)	(51.94)	(51.61)	(53.96)	(58.07)	(58.13)	(51.61)
Varsha Uphar	56.67	57.33	57.33	66.00	62.67	63.33	66.67	73.33	73.33	63.79
	(48.82)	(49.21)	(50.40)	(54.33)	(52.35)	(52.74)	(54.75)	(58.99)	(56.09)	(53.70)
Mean	49.78	53.11	55.56	62.89	61.56	60.44	63.11	71.78	66.22	
	(44.85)	(46.77)	(48.19)	(52.48)	(51.68)	(51.06)	(52.65)	(57.95)	(54.52)	
CD for factor A (Var.)			2.99							
Factor B (Treatment)			5.18							
A × B			NS							

Figures in parenthesis are arcsine value

T_o-Untreated control, T_1-hydration (6 hr), T_2-hydration for 6 hr then treat dry seeds with 0.25% thiram, T_3-hydration with GA_3 (50 ppm for 6 hr), T_4-ascorbic acid (100 ppm for 6 hr), T_5- T_1 + PEG (polyethylene glycol), T_6- T_2 + PEG, T_7- T_3 + PEG, T_8- T_4 + PEG germination but hydration with GA_3 in combination with PEG (71.78) and ascorbic acid in combination with PEG treatments (66.22) recorded maximum germination (Table 4). In both these treatments the variety Varsha Uphar recorded maximum germination 73.33% and 68.67%, respectively which indicated that this cultivar is able to recover after stress conditions by priming. Similar results were reported by Pallavi *et al.* (2003) in sunflower, Pandita and Nagarajan (2004) in bitter gourd, Tajbakhsh *et al.* (2004) reported that GA_3 alone was able to improve the seed germination in onion. Similar results were observed by Khan *et al.* (2003) in sunflower.

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