

Original Research Article

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Seed Storage Potential Assessment in Onion (*Allium cepa* L. cv. CO (On) 5) through Forced Ageing

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ABSTRACT

Keywords

Onion, Seed coating formulation, Forced ageing, Seed germination, Seedling length and Vigour index

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The laboratory experiment was conducted to study the effect of seed treatment on storage potential of onion cv. CO (On) 5 through forced ageing or accelerated ageing. The onion seeds were given with different treatments such as T₁ - Control, T₂- Seed coating formulation I @ 10 g/kg, T₃ - Seed coating formulation II @ 10 g/kg and forced aged for ten days. The forced ageing significantly influenced the germination of onion seeds and also had negative relationship. The seeds coated with formulation I and II obtained germination above IMSCS (70%) upto 7 and 8 days, respectively, whereas the untreated seeds retained only up to 5 days. The significant influence was observed in seedling length (SL), dry matter production (DMP) and vigour index (VI) due to forced ageing. It was decreased while increasing the period of forced ageing. The maximum SL, DMP and VI was recorded in T₃ (11.2 cm, 14.0 mg seedling⁻¹⁰ and 706) followed by T₂ (10.4 cm, 13.5 mg seedling⁻¹⁰ and 614) after 10 days of forced ageing. It was recorded minimum in T₁ (8.4 cm, 13.1 mg seedling⁻¹⁰ and 420). Hence, seed coating formulation I or II can be used to prolong the self-life of onion seeds.

Introduction

Many of our crops are reproduced through seeds, and throughout the world large quantities of seeds are produced, stored and transported. All seeds undergo aging process during long-term storage which leads to deterioration in seed quality. However, the rate of seed deterioration is varying among various plant species (Merritt *et al.*, 2003). Onion (*Allium cepa* L.) seeds lose vigour and viability at faster rates than seeds of most other vegetables (Choudhari and Basu, 1988).

Seed ageing during storage may cause retardation of field establishment and may eventually result in seedling abnormalities or even failure of emergence.

Seed viability is a matter of great concern and measures to maintain germination efficiency of stored seeds have significant economic implications. A range of pre-harvest, harvest and post-harvest conditions affect seed viability (Basu, 1995). Many factors contribute to seed ageing. These include genetics, mechanical damage, relative

humidity and temperature of the storage environment, seed water content, presence of micro flora, seed maturity *etc.* The rate of loss of seed viability is mainly a function of temperature and seed moisture content (McDonald, 1999, 2004). During ageing, seed viability and vigour decreases. Furthermore, the losses of viability and vigour in seeds differ with species and cultivars. Predicting the longevity of stored seeds is therefore highly relevant from an economic and social point of view.

Storage experiments have been performed to estimate the longevity of seed lots in a large number of species. But, it takes long period of time to predict the storability of seeds. So, forced ageing or accelerated ageing test used to predict the storability of seeds in a short period of time. Most often this involves storage of the seeds at an elevated moisture and temperature. When the seeds are stored at an elevated temperature and the relative humidity (RH) of the atmosphere surrounding the seeds is 100 per cent, the test is called as forced ageing or accelerated ageing. Accelerated ageing test frequently used as indicator for seed longevity under conventional storage condition.

Delouche and Baskin (1973) reported that accelerated ageing study technique could be effectively used for evaluating the seedling vigour and also for knowing relative storability of the seed. In the present study seeds were given with different treatments and subjected to forced ageing for ten days to know the storability.

Materials and Methods

The laboratory experiment was undertaken at Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India during 2017-18. Onion seeds (*Allium cepa* L. cv. CO (On)

5) were obtained from Department of Vegetable Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India. The onion seeds were given with different treatments such as T₁- Control, T₂ - Seed coating formulation I (consist of polymer-800 g, pigment-200 g, gibberellic acid-5 mg and carboxyl methyl cellulose-10 g) @ 10 g/kg and T₃ - Seed coating formulation II (consist of polymer-800g, pigment-200g, brassinosteroid -0.1 µl and carboxyl methyl cellulose – 10g) @ 10 g/kg of seeds. A 20 g seeds from each treatment was forced aged at 100 % RH and 40°C for ten days. For this, 20 g seeds were divided in to 10 parts (2 g each) and packed in small perforated butter paper covers and arranged loosely inside desiccators. To maintain 100 % RH, 40 ml of water was taken at the bottom of the desiccator and the lid was closely tightened. For maintaining 40°C temperature, the desiccator with seed packets was kept inside a B.O.D incubator set at 40°C. Daily one seed packet was drawn up to ten days and the seeds were evaluated for the seed quality parameters.

Design of the experiment

The laboratory experiment was conducted in the completely randomized block design with two factorial concepts and replicated four times.

Observations

Seed germination (%) (ISTA, 2013)

The germination test was carried out as per the procedure prescribed by ISTA with four replicates of 100 seeds in paper medium. The test conditions were 25 ± 2°C and 95 ± 5 % RH maintained in a germination room illuminated with fluorescent light. After twelve days, the seedlings were evaluated and

the normal seedlings with “knee bent” were counted and expressed as germination percentage.

Root length (cm)

Ten normal seedlings from the standard germination test were randomly selected and the root length was measured from the collar region to the tip of the primary root and the average expressed in centimeter.

Shoot length (cm)

Ten normal seedlings were randomly selected from the standard germination test and the length from the collar region to the tip of the shoot was measured and the average expressed in centimeter.

Dry matter production (mg seedlings⁻¹⁰) (ISTA, 2013)

The seedlings used for growth measurement were placed in a paper cover and dried in shade for 24 h and then kept in an oven maintained at $85 \pm 2^{\circ}\text{C}$ for 24 h. The dried seedlings were removed from the hot air oven and cooled in the desiccators over silica gel. Dry weight was recorded and the mean values were expressed in mg seedlings⁻¹⁰.

Vigour index (Abdul-Baki and Anderson, 1973)

Vigour index values were computed using the following formula and the mean values were expressed in whole number.

Vigour index = Germination (%) x Total seedling length (cm)

Statistical analysis

The data collected from the experiment was analyzed statistically adopting the procedure

described by Panse and Sukhatme (1985). Wherever necessary, the per cent values were transformed to angular (Arc-sine) values before analysis. The critical differences (CD) were calculated at 5 per cent ($P= 0.05$) probability level. If the F test is non-significant it was indicated by the letters NS.

Results and Discussion

The forced ageing technique is commonly used, through which changes in the seed at the cellular level during long term storage can be stimulated within a comparatively short period of time by exposing seeds to increased temperature ($40 - 45^{\circ}\text{C}$) and a high relative humidity (100%).

The forced ageing significantly influenced the germination of onion seeds and also had negative relationship. The seeds coated with seed coating formulation I (SCF-I) and seed coating formulation II (SCF-II) obtained germination above IMSCS (70%) upto 7 and 8 days, respectively, whereas the untreated seeds retained only up to 5 days. The maximum germinability of 63 per cent was maintained by SCF-II which was higher than SCF-I (59) and control (50) at 10 days after forced ageing (Table 1) (Figure 1 & 2). Failure of aged seeds to germinate may be attributed to lipid peroxidation, mitochondrial disfunction and less ATP production (Basra *et al.*, 1994). Accelerated ageing adversely affects the seed viability and vigour in pea seeds (Khan *et al.*, 2003). Seed germinability maintenance effect of SCF- I and II may be due to the hormones present in that. SCF-II contains brassinosteroid (BR) and SCF- I contains gibberellic acid (GA_3), it may enhance and maintains the seed germination during forced ageing. Brassinosteroid application has been reported to enhance germination in several crops (Takeuchi *et al.*, 1995 in parasitic angiosperms; Steber and McCourt, 2001 in Arabidopsis; Leubner-

Metzger, 2001 in tobacco). Pretreatment with brassinolide has been found to stimulate the germination and seedling emergence of aged rice seeds (Yamaguchi *et al.*, 1987).

Table.1 Effect of seed treatment and forced ageing on seed germination

Days after forced ageing	Germination (%)			
	T ₁	T ₂	T ₃	Mean
Fresh seed	90 (71.57)	92 (73.57)	94 (75.82)	92 (73.57)
1	87 (68.87)	90 (71.57)	91 (72.54)	89 (70.63)
2	84 (66.42)	86 (68.02)	88 (69.73)	86 (68.02)
3	80 (63.44)	83 (65.65)	85 (67.22)	83 (65.65)
4	77 (61.74)	81 (64.16)	83 (65.65)	80 (63.44)
5	72 (58.05)	78 (62.03)	80 (63.44)	77 (61.34)
6	68 (55.55)	75 (60.00)	78 (62.02)	74 (59.34)
7	64 (53.13)	72 (58.05)	75 (60.00)	70 (56.79)
8	59 (50.19)	68 (55.55)	72 (58.05)	66 (54.33)
9	54 (47.30)	63 (52.54)	67 (54.94)	61 (51.36)
10	50 (45.00)	59 (50.19)	63 (52.54)	57 (49.03)
Mean	71 (57.42)	77 (61.34)	80 (63.44)	76 (60.67)
	FA	T	FA X T	
SEd	2.692	1.406	4.662	
CD(0.05)	5.374	2.806	NS	

Note: Figures in parenthesis indicate arcsine values

Fresh seed indicates seeds before forced ageing; FA- Forced ageing; T- Treatment; FA X T- Interaction between forced ageing and treatment; NS- Non-significant at 5 per cent (P= 0.05) probability level

Table.2 Effect of seed treatment and forced ageing on seedling shoot length and root length

Days after forced ageing	Shoot length (cm)				Root length (cm)			
	T ₁	T ₂	T ₃	Mean	T ₁	T ₂	T ₃	Mean
Fresh seed	9.1	9.4	9.8	9.4	5.9	6.7	7.1	6.6
1	8.5	8.9	9.3	8.9	5.6	6.4	6.9	6.3
2	8.1	8.8	9.2	8.7	5.2	6.0	6.7	6.0
3	7.6	8.6	9.0	8.4	4.9	5.8	6.5	5.7
4	7.4	8.5	8.8	8.2	4.7	5.5	6.2	5.5
5	7.1	8.2	8.5	7.9	4.3	5.1	5.9	5.1
6	6.7	8.0	8.3	7.7	4.0	4.8	5.5	4.8
7	6.4	7.7	8.0	7.4	3.8	4.6	5.2	4.5
8	6.0	7.3	7.7	7.0	3.6	4.4	4.9	4.3
9	5.7	7.0	7.3	6.7	3.3	4.1	4.6	4.0
10	5.3	6.6	6.9	6.3	3.1	3.8	4.3	3.7
Mean	7.1	8.1	8.4	7.9	4.4	5.2	5.8	5.1
	FA	T	FA X T			FA	T	FA X T
SEd	0.112	0.058	0.194		SEd	0.069	0.036	0.119
CD(0.05)	0.223	0.117	0.386		CD(0.05)	0.138	0.072	NS

Table.3 Effect of seed treatment and forced ageing on seedling dry matter production and vigour index

Days after forced ageing	Dry matter production (mg seedling ⁻¹⁰)				Vigour index			
	T ₁	T ₂	T ₃	Mean	T ₁	T ₂	T ₃	Mean
Fresh seed	16.1	16.4	16.6	16.4	1350	1481	1589	1473
1	15.8	16.0	16.3	16.0	1227	1377	1474	1359
2	15.4	15.6	16.0	15.7	1117	1273	1399	1263
3	15.0	15.2	15.8	15.3	1000	1195	1318	1171
4	14.7	15.0	15.5	15.1	932	1134	1245	1104
5	14.3	14.7	15.2	14.7	821	1037	1152	1003
6	14.0	14.4	14.9	14.4	728	960	1076	921
7	13.8	14.2	14.7	14.2	653	886	990	843
8	13.6	14.0	14.5	14.0	566	796	907	756
9	13.4	13.8	14.2	13.8	486	699	797	661
10	13.1	13.5	14.0	13.5	420	614	706	580
Mean	14.5	14.8	15.2	14.8	845	1041	1150	1012
	FA	T	FA X T			FA	T	FA X T
SEd	0.145	0.076	0.251		SEd	13.54	7.072	23.456
CD(0.05)	0.289	0.151	NS		CD(0.05)	27.04	14.12	NS

Fig.1 Effect of seed treatment on seed germination and seedling growth before forced ageing



Fig.2 Effect of seed treatment and forced ageing on seed germination and seedling growth at 5th day of forced ageing



Rice and Ornamental plant (*Cyclamen* species) treated with foliar application of GA₃ improved the germination percentage of resultant seeds (Wang *et al.*, 2019; Cornea-Cipcigan *et al.*, 2020). Seed treatment with GA₃ has been resulted in the highest germination percentage in tomato (Balaguera-Lopez, 2009).

Significant influence was observed in root length due to forced ageing. The length of the root was decreased while increasing the period of forced ageing. The longest root of 7.1 cm was recorded in seeds treated with SCF-II on initiation of force ageing; it was reduced to 6.7 cm at 3rd day of ageing. Eventually it reached 4.3 cm on 10th day of forced ageing. Shortest root (3.1 cm) was recorded in control on 10th day of forced ageing. The same trend was observed in case of shoot length as that of root length. The values ranged between 9.8 cm and 6.9 cm for the seeds coated with SCF-II at initial and 10 days of forced ageing. It was recorded minimum (5.3 cm) for control at 10th day of forced ageing. SCF- I also recorded somewhat higher root and shoot length (3.8 cm and 6.6 cm) than the control at the end of forced ageing (Table 2) (Figure 1 & 2). With increase of forced ageing, there was decrease in seedling shoot and root length. It is line with finding of Hussein, 2011 in sunflower.

This result clearly indicates that GA₃ and BR present in the SCF I and II helps in seedling growth even after ageing. Seed treatment with GA₃ has been resulted in the highest root length in tomato (Balaguera-Lopez, 2009) and it also has been stimulated the shoot extension growth in eucalypt seedlings (Bachelard, 1968). *Brassica juncea* seeds pre-soaked with 24-epibrassinolide has been increased the shoot length and root length of seedlings when compared with control (Sharma and Bhardwaj, 2007). BR seed treatment has been enhanced the seedling length in radish (Raghu

et al., 2014). Exogenous Application of Brassinolide has been increased the shoot length and root length in wheat seedlings (El-Feky and Abo-Hamad, 2014).

As, that of germination, root length and shoot length, the dry matter production also significantly influenced by the forced ageing period and negative relationship with each other. The dry matter production was more in seed treated with SCF- II, 16.6 mg seedling⁻¹⁰ and 14.0 mg seedling⁻¹⁰ at initial and 10th day of forced ageing respectively. SCF-I followed by SCF-II recorded higher DMP than the control at the end of forced ageing (Table 3). It insists that higher seedling length in SCF-I and II leads to higher dry matter production in SCF-I and II. Seed treatment with GA₃ has been resulted in the highest dry matter production in tomato (Balaguera-Lopez, 2009). A seed treatment with brassinosteroid has been increased the seedling dry weight in radish and *Brassica juncea* (Raghu *et al.*, 2014; Sharma and Bhardwaj, 2007). El-Feky and Abo-Hamad, 2014 found that exogenous application of brassinolide enhanced the seedling dry weight in wheat.

The difference due to forced ageing period was significant with respect to vigour index. As all the physiological parameters, the vigour index also decreased while increasing days of forced ageing. The control seeds recorded vigour index of 1350 at initial day of forced ageing, it reduced drastically and reached minimum of 420 on 10th day of forced ageing. Seeds treated with SCF I and II recorded more vigour index (1481 and 1589) at initial day of forced ageing; it reduced to 614 and 706 on 10th day of forced ageing (Table 1).

From the above result, gibberellic acid and brassinosteroid present in the SCF-I and SCF-II may involve in seed vigour maintenance during ageing. It indicates that SCF I and II

delays or reduces the rate of seed deterioration during storage. Seed treatment with gibberellic acid can dramatically increase seedling vigor in rice (Dunand, 1993). Rice and Ornamental plant (*Cyclamen* species) treated with foliar application of GA₃ has been improved the seedling vigor index of resultant seeds (Wang *et al.*, 2019; Cornea-Cipcigan *et al.*, 2020). The film formed around the seed in seeds coated with SCF I and II, it act as a physical barrier, which has been reported to restrict oxygen diffusion to the embryo (Dheeraj *et al.*, 2018) and may reduce the catabolic activity or food reserve degradation. Hence, it may be the reason for seed viability and vigour maintenance in onion by SCF I and II during forced ageing. Leelavathi, (2018) who studied the effect of seed coating formulation (contains brassinosteroid) in different crops like maize, black gram and cotton on their storage potential and confirmed that all the seed quality parameters *viz.*, germination, seedling length, dry matter production and vigour index were found to be maximum for the treated seeds than the untreated control.

In conclusion the seeds coated with seed coating formulation I and II maintained the seeds with high seed germination, seedling length, dry matter production and vigour index than the control seeds under forced ageing condition. Seed coating formulation I or II can be used to treat the onion seeds for seed quality enhancement and prolong the self-life.

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