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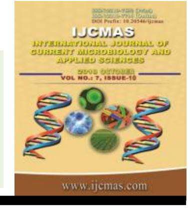

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Studies on Storability of Elite Hybrids of Sunflower

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A B S T R A C T

Sunflower (*Helianthus annuus* L.) is one of the principal oil seed crops of the world. Deterioration in seed quality is reflected in terms of loss in vigour and viability of seeds. Therefore, seed viability and vigour largely depends on the storage conditions, seed treatment and packaging materials used to store the seeds. With this background storage experiment was carried out in laboratory of Department of Seed Science and Technology in two factorial completely randomized design to assess the quality of four sunflower genotypes such as RSFH-130, RSFH-1887, KBSH- 53 and KBSH- 44 which were stored in two different packaging materials such as cloth bag and polythene bag (700 guage) for a period of 10 months and observation were taken bimonthly. In the present study the results revealed that RSFH- 1887 and stored in polythene bag maintained highest germination (80.25 %) and vigour (1559) respectively which was followed by KBSH-53 stored in polythene bag maintained germination (79.85 %) and vigour (1518) at the end of 10th month. Whereas, KBSH - 44 stored in polythene bag was intermediate storer which showed germination of (77.76 %) and vigour (1430) at the end of 10th month. While, RSFH- 130 stored in cloth bag was found to be a poor storer which showed reduced germination (57.26 %) and vigour (907) compared to other genotypes at the end of 10th month. Whereas, electrical conductivity was found to be less in RSFH-1887 stored in polythene bag (0.72 dSm^{-1}) and highest EC was found in RSFH-130 stored in cloth bag (0.85 dSm^{-1}) since it is inversely proportional to seed quality. However, the seed stored in cloth bag showed less germination and vigour compared to polythene bags irrespective of genotypes. It can be concluded that RSFH- 1887 stored in polythene bag maintained high seed quality. Thus the experiment helps in identifying best genotype among the above four genotypes and best container for better storability.

Introduction

Sunflower (*Helianthus annuus* L.) is one of the most important oil seed crops of the world. It belongs to the family *Asteraceae* bearing a basic chromosome number of 17. The native of sunflower is found to be southern parts of USA and Mexico. Sunflower ranks third, next to groundnut and soybean in total production. The crop is well adopted because of attributes such as short duration, photoperiod insensitivity, adoptability to wide range of soil and climatic conditions, drought tolerance, higher seed multiplication ratio (1:50) having high percentage of edible oil (45-50 %). In India, during 2016-17, the area under sunflower cultivation was 0.344 million ha, with a total annual production of 0.24 million tonnes and productivity of 699 kg ha-1(Anon., 2017). In Karnataka, the area under sunflower is 0.22 million ha, with total production of 0.10 million tonnes and productivity of 458 kg ha^{-1} (Anon., 2017) and occupies first position recognized as "Sunflower State" in the oilseeds scenario of the country. Seed being a biological or living entity, deterioration in its quality occurs with the advancement in ageing, which is common for all the living organisms. However, it varies with genotype to genotype as the shelf-life of seed is determined and accomplished, to a large extent, by the chemical composition. Seeds with high oil content like sunflower appear to loose their germination and vigour in short period of time despite precautions taken during harvesting and drying. High temperature and relative humidity cause rapid deterioration of viability and vigour of crop seeds, thus the existing environmental condition affect the seed quality and storability. Seeds of agricultural crops including hybrid sunflower belong to micro biotic group. Further, Ewart (1908) opined that fairly cool and dry conditions preserve seeds for longer time. Under tropical situation seed deterioration has become the most inevitable unless the seeds are dried and packed in suitable container. The relative high cost of the seed material and importance of retaining their quality for next season justify the selection of proper packaging strategy. With this background, the present study is carried out to assess the impact of different genotypes and packaging materials on storability of sunflower seeds.

Materials and Methods

Source of Seed

The seeds of sunflower hybrid RSFH-1887 and RSFH-130 were procured from sunflower scheme Main Agricultural Research Station, University of agricultural sciences, Raichur. The seeds of sunflower hybrid KBSH-44 and KBSH-53 were procured from Seed unit, University of agricultural sciences, Raichur and University of agricultural sciences Bangalore, respectively.

Design and layout

The experiment was laid out in FCRD (Factorial completely randomised design) two factors with three replications and eight treatment combinations.

Treatment details

Factor-I- Genotypes (G)

G_1: RSFH-130
G_2: RSFH-1887
G_3: KBSH-53
G_4: KBSH-44

Factor-II-Containers (C)

C_1 – Cloth bag
C_2 – Polythene bag (700 guage).

Treatment combinations

G_1C_1: RSFH- 130 stored in cloth bag
G_1C_2: RSFH- 130 stored in polythene bag
G_2C_1: RSFH- 1887 stored in cloth bag
G_2C_2: RSFH- 1887 stored in polythene bag
G_3C_1: KBSH- 53 stored in cloth bag
G_3C_2: KBSH- 53 stored in polythene bag
G_4C_1: KBSH -44 stored in cloth bag
G_4C_2: KBSH – 44 stored in polythene bag.

Observations to be recorded bimonthly

Germination (%)

The germination test was conducted in the laboratory using between paper methods as per ISTA (1999). One hundred seeds of four replicates were placed equidistantly between moist paper towels. The rolled towels were placed in the germination chamber, where 25 ± 1^o C and 90 per cent RH were maintained. The seedlings were evaluated on eighth day of incubation and the cumulative percentage of germination was expressed based on normal seedlings. (ISTA, 1999).

$$\text{Seed Germination}(\%) = \frac{\text{Number of normal seedings}}{\text{Total number of seeds}} \times 100$$

Seedling vigour index I

The seedling vigour index was computed by adopting the formula given by Abdul-Baki and Anderson (1973) and expressed in whole number.

Seedling vigour index I = Germination (%) x Mean seedling length (cm)

Electrical conductivity (dSm^{-1})

Three replicates of 5 grams of seeds each were taken at random from each sample and washed with distilled water three to four times to. Then they were soaked in 25 ml of distilled water at 25 ± 1^o C for 24 hours. The leachate was decanted and the EC was measured with Digital conductivity meter. The electrical conductivity of the seed leachate was measured in the digital conductivity bridge (ELICO) with a cell constant 1.0 and the mean values were expressed in deci simons per meter (dSm-1) (Milosevic *et al.*, 2010).

Statistical analysis

The mean data of the laboratory experiments were statistically analyzed by adopting appropriate statistical methods as outlined by Panse and Sukhatme (1967). The critical differences were calculated at one per cent level of probability wherever 'F' test was found significant for various seed quality parameters under study. The percentage data were transformed into arcsine root transformation wherever it was applicable prior to the statistical analysis.

Results and Discussion

Seed germination (%)

The data recorded on seed germination as influenced by different hybrids, packaging materials and their interaction are presented in Table 1. mean germination declined significantly with seed aging irrespective of the treatments from initial (95.69 %) to (73.77 %) at the end of 10 months.

Genotypes (G)

Seed germination differed significantly between the genotypes during storage. In the 2nd month of storage, significantly higher germination (96.13 %) was seen in RSFH-1887 (G_2) which was followed by KBSH-53 (96.07 %).Whereas, RSFH-130 showed lesser germination of 95.26 per cent. The similar trend was followed throughout the storage experiment. At the end of 10 months highest germination was seen in G_2 (78.20 %) which was followed by G_3 (77.60 %) and G_4 (75.50 %), the lowest seed germination was observed in G_1 (63.67 %). The genotypes in polythene bag showed significantly higher germination compared to seeds stored in cloth bag. Sunflower hybrids recorded lower germination percentage which might be attributed to variation among genotypes in withstanding environmental condition and the result is in consonance with findings of Shelar *et al.*, (2008) that decline of germination is much more acute under tropical conditions. The observed reduction in percentage seed germination over time could also be linked to the reduction in enzyme activity within the seed and with the reduction in germination percentage there is reduction in all the seed quality parameters, Iqbal *et al.,* (2002), Ruzrokh *et al.,* (2003), and Demirkaya *et al.,* (2010).

Containers (C)

There was a significant variation among the storage containers for seed germination throughout the storage period irrespective of containers. At second month of storage, maximum germination percentage was recorded by C_2 (96.46%) and minimum germination was recorded in C_1 (94.92), the same trend was followed till 10 months of storage. At the end of 10 months the seeds stored in polythene bag (C_2) recorded highest germination of 76.98 per cent and seeds stored in cloth bag (C_1) showed minimum germination of 70.57 per cent. The germination and seedling vigour were significantly higher in sunflower seed stored in moisture impervious containers when compared to moisture pervious containers throughout the storage period. Decline in germination percentage with advance in storage period, may be attributed to aging effect, leading to depletion of food reserves and decline in synthetic activity of embryo apart from loss of viability and storage condition and might be development of storage fungi which resulted in poor performance in seed stored in cloth bag (Tekrony *et al.,* 1993). Superiority of Polythene over cloth bag in prolonging the storage life was reported by Bhattacharya *et al.,* 1983 and Ankaiah *et al.,* 2006 in sunflower and Mote *et al.,* 1995 in Sorghum.

Interaction between genotypes and containers: (G×C)

Interaction between Genotypes and Containers differed significantly in all the months of storage except for 2^{nd} month. In the second month, G_2C_2 depicted highest germination of 96.92 per cent followed by G_3C_2 (96.69 %) and G_4C_2 (96.07 %). G_1C_1 (94.46 %) showed minimum germination compared to other treatments. Similar trends were followed till 10 months of storage. At the end of storage period RSFH-130 in cloth bag (G_1C_1) showed least germination (57.26 %) and RSFH-1887 stored in polythene bag (G_2C_2) maintained maximum germination of 80.25 per cent. The differences in germination percentage among the genotypes may be due to varietal differences in the seed chemical composition and its ability to withstand the differences in the environmental conditions and same as reported by Natraj, 2008 in sunflower, Simic *et al.,* 2006 in maize, soybean and sunflower and Reuzeau and Cavalie (1995) in sunflower seeds.

Seedling vigour index

The effect of genotypes packaging materials and their interaction effects on seedling vigour index I are discussed in Table 2. Generally the mean seedling vigour index declined from 2532 to 1308 at the end of 10 months.

Genotypes (G)

Seedling vigour index I differed significantly among all the months irrespective of the genotypes. Initially highest seedling vigour index I was seen in G_2 (2620) which was followed by G_3 (2600) and G_4 (2489) and lowest in G_1 (2418).

The same order was followed upto 10 months of storage where, G_2 maintained highest vigour of 1443 which was followed by G_3 (1408) and least vigour index I was found in G_1 (1042). The differences in seedling vigour among the genotypes may be due to mechanical threshing method where the seeds may get damaged. This result is in good accordance with Muhammad *et al.,* (2008), Sharma *et al.,* (2006)

Table.1 Effect of genotypes, containers and their interaction on germination percentage of sunflower hybrids during storage

Treatment	Germination percentage				
	Storage period in months				
	2	4	6	8	10
Genotypes (G)					
G_1	95.26(77.48)	87.06(69.05)	81.65(64.69)	74.49(59.83)	63.67(53.00)
G_2	96.13(78.70)	90.89(72.47)	84.92(67.20)	82.71(65.49)	78.20(62.19)
G_3	96.07(76.64)	89.17(70.85)	84.57(66.86)	81.57(64.60)	77.60(61.82)
G_4	95.31(77.54)	88.19(69.9)	85.53(67.70)	81.05(64.21)	75.50(60.40)
Mean	**95.69**	**88.83**	**84.17**	**79.95**	**73.77**
S.Em±	**0.11**	**0.02**	**0.01**	**0.10**	**0.04**
CD at 1%	**0.44**	**0.07**	**0.04**	**0.42**	**0.17**
Containers (C)					
C_1	94.92(77.00)	86.80(68.75)	82.38(65.21)	76.91(61.39)	70.57(57.3)
C_2	96.46(79.18)	90.86(72.42)	85.97(68.02)	83(65.67)	76.98(61.4)
Mean	**95.69**	**88.83**	**84.17**	**62.26**	**73.77**
S.Em±	**0.08**	**0.01**	**0.01**	**0.07**	**0.03**
CD at 1%	**0.33**	**0.03**	**0.04**	**0.27**	**0.12**
Interaction (G×C)					
G_1C_1	94.46(76.40)	84.04(66.46)	79.32(62.95)	68.26(55.71)	57.26(49.18)
G_1C_2	96.07(78.57)	90.08(71.46)	84.01(66.43)	80.73(63.96)	70.08(56.84)
G_2C_1	95.52(77.70)	89.65(71.24)	83.66(66.16)	80.16(63.55)	76.15(60.77)
G_2C_2	96.92(79.90)	92.13(73.71)	87.90(69.67)	85.26(67.43)	80.25(63.62)
G_3C_1	95.22(77.37)	87.26(69.08)	83.44(65.98)	79.82(63.3)	75.49(60.32)
G_3C_2	96.69(79.60)	91.08(72.62)	86.27(68.25)	83.32(65.89)	79.85(63.32)
G_4C_1	94.54(76.50)	86.24(68.23)	83.12(65.74)	79.41(63.01)	73.38(58.93)
G_4C_2	96.07(78.58)	90.15(71.70)	85.66(67.75)	82.69(65.41)	77.76(61.80)
Mean	**95.69**	**88.83**	**84.17**	**79.95**	**73.77**
S.Em±	**0.16**	**0.03**	**0.02**	**0.14**	**0.05**
CD at 1%	**NS**	**0.12**	**0.09**	**0.56**	**0.22**

Genotypes: G_1- RSFH-130; G_2- RSFH-1887; G_3- KBSH-53; G_4- KBSH-44
Containers: C_1- Cloth bag; C_2- Polythene bag
*The figures in the parenthesis are arc sine transformed
NS – Non – Significant

Table.2 Effect of genotypes, containers and their interaction on seedling vigour index I of sunflower hybrids during storage

Treatment	Seeding vigour index I				
	Storage period in months				
	2	4	6	8	10
Genotypes (G)					
G_1	2418	1967	1822	1616	1042
G_2	2620	2263	2056	1920	1443
G_3	2600	2107	1927	1839	1408
G_4	2489	2064	1920	1804	1341
Mean	**2532**	**2100**	**1931**	**1795**	**1308**
S.Em±	**11.30**	**4.01**	**3.34**	**5.82**	**4.16**
CD at 1%	**44.2**	**16.00**	**13.20**	**21.40**	**16.40**
Containers (C)					
C_1	2404	1968	1812	1653	1196
C_2	2659	2233	2051	1936	1421
Mean	**2532**	**2100**	**1931**	**1795**	**1308**
S.Em±	**8.00**	**2.84**	**2.36**	**4.11**	**2.94**
CD at 1%	**32.00**	**11.00**	**9.22**	**15.61**	**10.70**
Interaction (G×C)					
G_1C_1	2301	1857	1690	1386	907
G_1C_2	2534	2077	1955	1847	1177
G_2C_1	2492	2130	1945	1808	1328
G_2C_2	2747	2396	2168	2032	1559
G_3C_1	2480	1960	1819	1724	1298
G_3C_2	2721	2256	2037	1955	1518
G_4C_1	2342	1926	1795	1697	1253
G_4C_2	2636	2203	2045	1913	1430
Mean	**2532**	**2100**	**1931**	**1795**	**1308**
S.Em±	**16.09**	**5.70**	**5.03**	**6.67**	**5.96**
CD at 1%	**NS**	**18.80**	**19.56**	**24.40**	**22.60**

Genotypes: G_1- RSFH-130; G_2- RSFH-1887; G_3- KBSH-53; G_4- KBSH-44
Containers: C_1- Cloth bag; C_2- Polythene bag
NS – Non - Significant

Table.3 Effect of genotypes, containers and their interaction on electrical conductivity (dSm^{-1}) of sunflower hybrids during storage

Treatment	Electrical conductivity (dSm^{-1})				
	Storage period in months				
	2	4	6	8	10
Genotypes (G)					
G_1	0.51	0.55	0.60	0.69	0.83
G_2	0.45	0.49	0.53	0.66	0.75
G_3	0.45	0.51	0.56	0.68	0.77
G_4	0.48	0.55	0.58	0.68	0.81
Mean	**0.47**	**0.52**	**0.57**	**0.68**	**0.78**
S.Em±	**0.008**	**0.002**	**0.004**	**0.001**	**0.001**
CD at 1%	**0.03**	**0.008**	**0.01**	**0.003**	**0.003**
Containers (C)					
C_1	0.51	0.54	0.59	0.69	0.80
C_2	0.43	0.50	0.55	0.66	0.76
Mean	**0.47**	**0.52**	**0.57**	**0.68**	**0.78**
S.Em±	**0.006**	**0.001**	**0.003**	**0.001**	**0.0009**
CD at 1%	**0.02**	**0.004**	**0.01**	**0.002**	**0.003**
Interaction (G×C)					
G_1C_1	0.54	0.57	0.63	0.71	0.85
G_1C_2	0.48	0.53	0.58	0.68	0.81
G_2C_1	0.48	0.51	0.55	0.67	0.78
G_2C_2	0.41	0.47	0.52	0.65	0.72
G_3C_1	0.50	0.54	0.58	0.70	0.79
G_3C_2	0.42	0.48	0.55	0.66	0.74
G_4C_1	0.52	0.56	0.62	0.70	0.81
G_4C_2	0.43	0.53	0.55	0.67	0.80
Mean	**0.47**	**0.52**	**0.57**	**0.68**	**0.78**
S.Em±	**0.01**	**0.002**	**0.005**	**0.001**	**0.002**
CD at 1%	**NS**	**0.007**	**0.023**	**0.004**	**0.008**

Genotypes: G_1- RSFH-130; G_2- RSFH-1887; G_3- KBSH-53; G_4- KBSH-44
Containers: C_1- Cloth bag; C_2- Polythene bag
NS – Non - Significant

Containers (C)

Seedling vigour index I differed significantly among all the containers for all the storage months. In the second month of storage, highest seedling vigour index I was seen in C_2 (2659) and minimum seedling vigour was seen in C_1 (2404). The decreasing trend of seedling vigour was seen as the storage period prolonged. At the end of 10 months, highest Seedling vigour I was seen in Polythene bag (700 gauge) (1421) and minimum was seen in Cloth bag (C_1) 1196. Reduction of seedling vigour index was always greater in seeds stored in cloth bag, which is mainly due to increased seed deterioration and decreased seedling vigour index due to loss of viability has been observed in barley (Abdul Baki and

Anderson, 1973). Lowest vigour was obtained from cloth bag for all storage periods, which might be due to high moisture and fungi infestation (Singh and Dadlani, 2003).

Interaction between genotypes and containers (G×C)

The seedling vigor index I decreased significantly with increase in storage period except for first two months. Initially, highest seedling vigour index I was seen in G_2C_2 (2747) which was followed by G_3C_2 (2721) and minimum seedling vigour index I was seen in G_1C_1 (2301).

At the end of 10 months G_2C_2 recorded highest seedling vigour index I (1559) which was followed by G_3C_2 (1518) and lowest was seen in G_1C_1 (907) RSFH- 130 stored in cloth bag showed lowest seedling vigour and RSFH-1887 stored in polythene bag showed highest seedling vigour index I.

This effect can be attributed to the reason that with the passing of storage period, vigour of seed decline due to catabolic activity going in the seed and thus the seed though viable yet fails to emerge. Similar observations are made by Gujar *et al.,* (2001) in China aster seeds, Yogeesha *et al.,* (2004) and Arulnandhy and Senanayake (1991) in soybean.

Electrical conductivity (dSm^{-1})

The results on Electrical conductivity of seed leachate during the storage period as influenced by different genotypes and packaging materials are depicted in Table 3.

The Electrical conductivity of seed leachate increased progressively with advancement of storage period irrespective of the genotypes, storage containers and their interactions. The mean value of the seed lechate increased from 0.47 to 0.78 dSm^{-1} at the end of 10 months.

Genotypes (G)

Significant results were seen during all the 10 months of storage irrespective of genotypes. The minimum EC value was observed in G_2 (0.45dSm^{-1}) which was on par with G_3 (0.45) and maximum EC value was seen in G_1 (0.51 dSm^{-1}). Whereas, G_4 showed EC of 0.48. This trend was followed till 10 months where G_2 maintained minimum EC value of (0.75 dSm^{-1}) and G_1 showed maximum EC value of 0.83 dSm^{-1}. This may be due to the Physical injury to the seeds, seed size adversely affect the electrical conductivity test results (Loeffeler *et al.,* 1988). The difference in the electrical conductivity among the genotypes may be because RSFH-130 may be susceptible to field weathering causing reduction in seed membrane integrity at warmer sites and probably due to inherent qualities of varieties such as seed size and may be weaker seed coat properties, Chirchir (2015).

Containers (C)

Electrical conductivity of seed leachate differed significantly among the storage containers at all the months of storage. Initially, C_2 showed minimum Electrical conductivity (0.43 dSm^{-1}) and C_1 showed maximum EC (0.51 dSm^{-1}). At the end of 10^{th} month, G_2 showed EC value of 0.76 dSm^{-1} which found to be lesser then C_1 (0.80). The negative relationship between EC and seed germination indicated that more cells leachate escaped from low quality seed and lowered the germination capacity of sunflower seed, which is in agreement with the findings of Halim *et al.,* (2012) in onion seeds. High EC of seed is assumed due to membrane deterioration during the imbibition period of lower quality seeds. The vigour of cloth bag's seed was decreased over time of storage due to greater moisture absorption (Abdul-Baki and Anderson, 1973). The variation noticed in two containers like cloth and polythene bag may be due to structural differences, permeability of membrane and cellular membrane deterioration.

Interaction between genotypes and containers (G×C)

Interaction between Genotypes and containers differed significantly on Electrical conductivity of seed leachate in all months of storage except 2nd month of storage.

The seeds of RSFH-1887, stored in polythene bag of 700 guage (G_2C_2) showed significantly lesser EC of 0.41 dSm^{-1}, which was followed by G_3 (0.42 dSm^{-1}) and maximum was seen in RSFH-130 seeds stored in cloth bag (0.54 dSm^{-1}). Similar order was seen till the end of 10th month, where G_2C_2 maintained minimum EC value of, 0.72 dSm^{-1} and maximum EC value was seen in G_1C_1 (0.85 dSm^{-1}).

This indicates that, progressive increase in EC in G_1C_1 may be due to the genotypic variations and its susceptibility to the membrane damage as influenced by packaging materials (Natraj, 2008).

Results from the present study suggest that the sunflower genotype differences affect germinability and storability here each genotype behaved differently during storage. The sunflower seeds generally deteriorated with storage and deterioration of the seeds was particularly strong for seeds stored in cloth bag. High temperature, high relative humidity, and moisture in the storage environment are the principal factors involved in deterioration of sunflower seed quality during storage.

The seeds of RSFH-1887 can be stored for long duration which was followed by KBSH-53 and RSFH-130 was found to be the poor storer compared to other hybrids. It can also be concluded that the seed stored in polythene bag (700 guage) shows highest germination and vigour compared to cloth bag irrespective of genotypes.

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