International Journal of Agricultural Sciences
Volume **10** | Issue 2 | June, 2014 | 774-781
e ISSN–0976–5670 | Visit us | *www.researchjournal.co.in*

RESEARCH PAPER

Effect of containers and seed treatments on storability of sunflower (*Helianthus annuus* L.)

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Abstract : To study the effect of containers and seed treatments on storability of sunflower experiment was conducted during the year 2011-12, at Seed Research Laboratory of National Seed Project, University of Agricultural Sciences, Dharwad. The storage experiment comprised of three containers (C_1: Vacuum packing, C_2: Polythene bag and C_3: Cloth bag) and six seed treatments [T_1:Sweet flag rhizome powder(5 g/kg),T_2: Neem leaf powder(10 g/kg), T_3: Custard apple seed powder (10 g/kg), T_4: Deltamethrine @ 40 mg/kg, T_5: Vitavax (3g/kg) and T_6: Control (without any seed treatments).] in three replications with factorial concept and stored for 11 months under ambient condition. The seeds treated with vitavax (3g/kg) recorded significantly higher seed germination (84.37%), hundred seed weight (4.36g), root and shoot (17.66 and 16.25 cm, respectively) length, vigour index (2865) lower electrical conductivity (232dSm^{-1}) and seed moisture content (9.14%) at the end of eleven months of seed storage as compared to other treatments. Among the containers the seeds stored in vacuum packing recorded significantly higher germination (84.45%), hundred seed weight (4.36g), root and shoot (18.05 and 16.70 cm) length, vigour index (2935) lower electrical conductivity (225 dS m^{-1}) and seed moisture content (8.57%) which was at par with polythene bag. Whereas, lower seed quality parameters were recorded in cloth bag at the end of 11 months of storage period.

Key Words : Sunflower, Containers, Seed treatment, Seed quality parameters, Storage period

View Point Article : Udabal, Nagaraj, Hunje, Ravi and Kote, Praveen (2014). Effect of containers and seed treatments on storability of sunflower (*Helianthus annuus* L.). *Internat. J. agric. Sci.*, **10** (2): 774-781.

Article History : Received : 28.02.2014**; Revised :** 06.05.2014**; Accepted :** 18.05.2014

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is an important oilseed crop native to Mexico and South Western U.S.A and is extensively grown in USSR, it was introduced to India in 1969. India it is popularly known as "Surajmukhi". Sunflower seed contains about 48-53 per cent edible oil and being rich source of oleic and linoleic acid (64%) which is good for heart patients. Because of its drought tolerance and photoperiod insensitive it can be grown during all the three seasons under varied climatic conditions.

Worldwide sunflower is cultivated over an area of 21.00 mha with a production of 33.00 mt with a productivity of 1500 kg per ha. In India grown on an area of 1.81 mha with a production of 1.16 mt and productivity of 639 kg per hectare. In Karnataka, it is grown over an area of 1.0 mha with production of 0.41 mt and productivity is of 435 kg per hectare (Anonymous, 2009-10). Karnataka State contributes around 42.83 per cent to the country's total sunflower production.

In storage, viability and vigour of the seeds is regulated by many physico-chemical factors like moisture content of the seed, atmospheric relative humidity, temperature, initial seed quality, physical and chemical composition of seed, gaseous exchange, storage structure, storage insects, packaging materials (Doijode, 1988). Hence, storage of seed till next planting time assumes prime importance for successful seed production programme.

An era of synthetic chemicals came with the introduction of several insecticides and fungicides which successfully manage the infestation caused by insects, fungi and other

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microflora. The descriptive use of chemicals and their residual toxicity adversely affects the non-targeted animals including human being besides affecting the seed quality. Many of the synthetic chemicals look effective but they are not readily degradable physically or biologically which yield more toxic residues. Hence, safe and feasible approach is the treatment of seeds with botanicals which are safe, economical, ecofriendly, cheap, easily available locally and non harmful to seed, animals and human beings.

MATERIAL AND METHODS

The laboratory experiment was carried out to study the effect of containers and seed treatments on storability of sunflower at Seed Research Laboratory of National Seed Project, University of Agricultural Sciences, Dharwad and the average monthly maximum temperature of 35.8^{0}C was recorded in March and minimum of 13.7^{0}C in February month whereas, the highest relative humidity of 87 per cent during August and the lowest relative humidity of 43 per cent during March was recorded.

The storage experiment comprised of three containers (C_1: Vacuum packing, C_2: Polythene bag and C_3: Cloth bag) and six seed treatments [T_1:Sweet flag rhizome powder (5 g/kg),T_2: Neem leaf powder (10 g/kg), T_3: Custard apple seed Powder (10 g/kg), T_4: Deltamethrine @ 40 mg/kg, T_5: Vitavax (3 g/kg) and T_6: Control (without any seed treatments).] in three replications. The seeds were treated and packed in different containers as per treatments mentioned above stored for 11 months under ambient conditions. Seed quality evaluations were made initially and subsequently at monthly interval for 11 months, the untreated seed samples were used as control. The seed quality parameters like germination percentage, seedling viguor index, electrical conductivity (dS m^{-1}) and moisture content (%) were recorded and analysed by using Completely Randomized Design (CRD) in factorial concept and replicated three times. The CD values were calculated and treatments were compared as per (Steel and Torrie, 1984) procedure of analysis.

RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under following heads :

Containers :

The germination percentage, seedling viguor index, electric conductivity and moisture content differed significantly due to the storage containers. However, significantly higher germination percentage (91.12 to 84.45%) and seedling viguor index (3373 to 2935) were recorded in C_3: (vacuum packing) which was at par with C_2: (polythene bag) and lowest in C_1: (cloth bag) (92.04 to 63.20% and 3187 to 2005, respectively) from initial to the end of 11 months of storage period (Table 1 and 3). The probable reason for retaining such high germination percentage might be due to the depletion of O_2 and increase in the concentration of CO_2 thereby inactivating the harmful organisms, either insects or moulds before they become numerous enough to cause serious damage to seeds as observed by Bailey (1965). Kopeikovskii and Turbitsyn (1968) also reported that four basic factors like temperature, seed moisture content, rate of air entry and concentration of CO_2 involved were intimately related with the maintenance of viability and germination of sunflower. Similar results were reported by Bhattacharyya *et al.* (1983) and Ankaiah *et al.* (2006) in sunflower.

The electrical conductivity was significantly lower in the seeds stored in vacuum packing which recorded 225dSm^{-1} at the end of storage period as compared to the cloth bag (297dSm^{-1}). Similarly, the moisture content was the lowest in C_3 (8.57%) followed by C_2 (9.23 %) and the highest in C_1 (10.55%) at the end of eleventh month of storage (Table 2 and 4). The results are in accordance with the reports of Shivayogi (2003) in cotton and Divya Shree (2006) in oilseed crops.

All the seed quality parameters declined at a faster rate in the seed stored in cloth bags compared to the seeds stored in vacuum packing and polythene bags due to increase in moisture content of the seed. Increase in the moisture content led to a greater metabolic activity and increased the respiration rate which in turn led to more utilization of food reserves. Similar results were also reported by Sharma *et al.* (1998) in soybean, Doijode (1988) in French bean, Dadlani and Vasisht (2006) in soybean and Lakshmi *et al.* (2006) in sunflower.

Treatments :

The germination percentage, seedling viguor index, electric conductivity and moisture content differed significantly due to the seed treatment with botanical, fungicides and insecticides. However, significantly higher germination percentage (92.54 to 84.37%) and seedling viguor index (3381 to 2865) were recorded in vitavax followed by neem leaf powder from first month to eleventh month of storage period. The lowest germination and seedling viguor index was recorded in control (91.79 to 60.36% and 3320 to 2037, respectively). The decline in germination percentage may be attributed to ageing effect leading to depletion of food reserves and decline in synthetic activity of leading to death of seed due to fungal invasion, insect damage, fluctuating temperature, relative humidity and storage container in which the seeds are stored.

The electrical conductivity was significantly lower in the seeds treated with vitavax powder which recorded 232 dSm^{-1} at the end of storage period as compared to the custard apple powder treated seeds (275 dSm^{-1}). Similarly, seed moisture content was less throughout the storage in seeds treated with vitavax (8.08% to 9.14%) followed by neem leaf powder compared to the control (8.27 to 9.84%) from initial to

Table 1 : Effect of botanical treatments on seed germination (%) during storage in cloth bag, polythene bag and vacuum packing of sunflower hybrid KBSH-53 seed

Treatments	Duration of storage period (months)											
	0	1	2	3	4	5	6	7	8	9	10	11
Containers (C)												
C_1	92.04	92.04	90.42	89.42	88.12	87.00	84.16	82.95	77.91	72.03	69.20	63.20
	(73.72)*	(73.72)	(72.06)	(71.11)	(69.94)	(68.96)	(66.77)	(65.91)	(62.37)	(58.45)	(56.66)	(52.92)
C_2	92.00	92.00	90.75	90.22	89.71	89.00	88.00	87.33	86.91	83.04	80.49	77.87
	(73.68)	(73.68)	(72.39)	(71.88)	(71.39)	(70.74)	(69.83)	(69.25)	(68.91)	(65.99)	(64.18)	(62.30)
C_3	91.12	91.12	91.58	91.17	90.58	90.29	89.46	88.58	87.75	86.91	86.12	84.45
	(72.92)	(72.92)	(73.24)	(72.82)	(72.24)	(71.95)	(71.15)	(70.36)	(69.63)	(68.89)	(68.22)	(66.91)
Mean	91.72	91.72	90.92	90.27	89.47	88.76	87.21	86.29	84.19	80.66	78.60	75.17
	(73.44)	(73.44)	(72.57)	(71.94)	(71.19)	(70.55)	(69.25)	(68.51)	(66.97)	(64.44)	(63.02)	(60.71)
S.E. ±	0.44	0.44	0.44	0.43	0.43	0.43	0.42	0.41	0.41	0.39	0.38	0.37
C.D. (P=0.01)	N.S.	N.S.	N.S.	N.S.	1.66	1.64	1.62	1.60	1.56	1.50	1.47	1.41
Botanical (T)												
T_1	92.38	92.38	91.21	90.87	89.87	89.29	88.04	87.04	8604	84.29	83.37	80.04
	(74.09)	(74.09)	(72.85)	(72.52)	(71.54)	(71.00)	(69.87)	(68.99)	(68.21)	(66.89)	(66.16)	(63.82)
T_2	92.21	92.21	91.29	90.79	90.29	89.71	88.54	88.29	87.12	85.04	84.04	80.87
	(73.90)	(73.90)	(72.94)	(72.43)	(71.95)	(71.40)	(70.35)	(70.11)	(69.10)	(67.49)	(66.67)	(64.38)
T_3	89.71	89.71	90.29	89.29	88.37	87.46	86.62	85.87	80.79	75.37	72.70	68.70
	(71.58)	(71.58)	(71.94)	(70.99)	(70.15)	(69.35)	(68.64)	(68.02)	(64.30)	(60.63)	(58.87)	(5635)
T_4	91.71	91.71	91.04	90.37	89.37	88.87	87.79	87.21	85.37	82.37	80.20	76.70
	(73.37)	(73.37)	(72.68)	(72.02)	(71.09)	(70.63)	(69.65)	(69.13)	(67.73)	(65.40)	(63.79)	(61.40)
T_5	92.54	92.54	91.62	91.24	90.96	90.46	89.54	88.96	88.80	86.71	85.29	84.37
	(74.27)	(74.27)	(73.29)	(72.89)	(72.61)	(72.12)	(71.24)	(70.70)	(70.55)	(68.77)	(67.65)	(66.92)
T_6	91.79	91.79	90.04	89.04	87.96	86.79	82.70	80.37	77.03	70.20	66.03	60.36
	(73.46)	(73.46)	(71.70)	(70.75)	(69.80)	(68.81)	(65.76)	(64.09)	(61.93)	(57.49)	(54.98)	(51.40)
Mean	91.72	91.72	90.92	90.27	89.47	88.76	87.21	86.29	84.19	80.66	78.60	75.17
	(73.44)	(73.44)	(72.57)	(71.94)	(71.19)	(70.55)	(69.25)	(68.51)	(66.97)	(64.44)	(63.02)	(60.71)
S.E. ±	0.62	0.62	0.62	0.61	0.61	0.60	0.59	0.59	0.57	0.55	0.54	0.52
C.D. (P=0.01)	N.S.	N.S.	N.S.	N.S.	N.S.	2.32	2.29	2.26	2.21	2.13	2.08	2.00

N.S. = Non-significant
* Figures in the parenthesis are arcsine transformed values
Containers (C) C_1: Cloth bag C_2: Polythene bag C_3: Vacuum packing
Botanicals (T) T_1: Sweet flag powder (5 g/kg) T_2: Neem leaf powder (10 g/kg) T_3: Custard apple seed powder (10 g/kg)
T_4: Deltamethrine @ 0.4 ml/kg. T_5: Vitavax (3g/kg). T_6: Control (without any seed treatments)

Table 1a : Interaction effect of botanical treatments on seed germination (%) during storage in cloth bag, polythene bag and vacuum packing of sunflower hybrid KBSH-53 seed

Treatments	Duration of storage period (months)											
	0	1	2	3	4	5	6	7	8	9	10	11
Interaction (C × T)												
C_1T_1	92.04	92.04	90.79	90.04	88.79	87.79	86.04	85.04	82.04	78.04	77.03	70.03
	(73.72)	(73.72)	(72.42)	(71.69)	(70.51)	(69.61)	(68.12)	(67.30)	(64.97)	(62.09)	(61.40)	(56.84)
C_1T_2	92.29	92.29	90.79	90.04	89.04	88.04	86.04	86.04	84.04	79.04	78.04	72.03
	(73.99)	(73.99)	(72.42)	(71.69)	(70.74)	(69.84)	(68.12)	(68.12)	(66.50)	(62.79)	(62.090	(58.11)
C_1T_3	92.04	92.04	89.79	88.29	87.29	86.04	84.54	84.04	72.28	64.03	62.03	56.03
	(73.72)	(73.72)	(71.45)	(70.06)	(69.18)	(68.12)	(66.90)	(66.50)	(58.27)	(53.18)	(51.99)	(48.49)
C_1T_4	91.79	91.79	90.54	89.54	8754	8704	85.79	85.54	80.04	7603	74.03	68.03
	(73.45)	(73.45)	(72.18)	(71.21)	(69.40)	(68.96)	(67.91)	(67.71)	(63.50)	(60.73)	(59.40)	(55.60)
C_1T_5	92.54	92.54	91.29	90.54	90.04	89.04	88.04	87.04	87.06	83.04	80.04	79.04
	(74.27)	(74.27)	(72.93)	(72.18)	(71.69)	(70.74)	(69.84)	(68.96)	(68.98)	(65.73)	(63.50)	(62.79)
C_1T_6	91.54	91.54	89.29	88.04	86.04	84.04	74.53	70.03	62.03	52.02	44.02	34.02
	(73.19)	(73.19)	(70.97)	(69.84)	(68.12)	(6650)	(59.73)	(56.84)	(51.99)	(46.18)	(41.59)	(35.70)
C_2T_1	92.29	92.29	91.04	90.79	90.04	89.54	88.54	87.79	88.04	87.04	86.04	84.04
	(73.99)	(73.99)	(72.68)	(72.42)	(71.69)	(71.21)	(70.28)	(69.61)	(69.84)	(68.96)	(68.12)	(66.50)
C_2T_2	92.04	92.04	91.04	90.79	90.54	90.04	89.04	88.79	88.29	88.04	86.54	84.04
	(73.72)	(73.72)	(72.68)	(72.42)	(72.18)	(71.69)	(70.74)	(70.51)	(70.06)	(69.84)	(68.54)	(66.50)
C_2T_3	92.04	92.04	90.04	89.04	88.54	87.29	86.79	85.54	84.04	77.03	72.03	68.03
	(73.72)	(73.72)	(71.69)	(70.74)	(70.28)	(69.18)	(68.75)	(67.71)	(66.50)	(61.40)	(58.11)	(55.60)
C_2T_4	91.29	91.29	91.04	90.54	89.79	89.04	88.29	87.54	88.04	84.04	80.54	78.04
	(72.93)	(72.93)	(72.68)	(72.18)	(71.45)	(70.74)	(70.06)	(69.40)	(69.84)	(66.50)	(63.87)	(62.09)
C_2T_5	92.54	92.54	91.29	91.14	91.04	90.79	89.79	89.29	89.04	88.04	87.79	86.04
	(74.27)	(74.27)	(72.93)	(72.78)	(72.68)	(72.42)	(71.45)	(70.97)	(70.74)	(69.84)	(69.61)	(68.12)
C_2T_6	91.79	91.79	90.04	89.04	88.29	87.29	85.54	85.04	84.04	74.03	70.03	67.03
	(73.45)	(73.45)	(71.69)	(70.74)	(70.06)	(69.18)	(67.71)	(67.30)	(66.50)	(59.40)	(56.84)	(54.99)
C_3T_1	92.79	92.79	91.79	91.79	90.79	90.54	89.54	88.29	88.04	87.79	87.04	86.04
	(74.55)	(74.55)	(73.45)	(73.45)	(72.42)	(72.18)	(71.21)	(70.06)	(69.84)	(69.61)	(68.96)	(68.12)
C_3T_2	92.29	92.29	92.04	91.54	91.29	91.04	90.54	90.04	89.04	88.04	87.54	86.54
	(73.99)	(73.99)	(73.72)	(73.19)	(72.93)	(72.68)	(72.18)	(71.69)	(70.74)	(69.84)	(69.40)	(68.54)
C_3T_3	85.04	85.04	91.04	90.54	89.29	89.04	88.54	88.04	86.04	85.04	84.04	82.04
	(6730)	(6730)	(72.68)	(72.18)	(70.97)	(70.74)	(70.28)	(69.84)	(68.12)	(67.30)	(66.50)	(64.97)
C_3T_4	92.04	92.04	91.54	91.04	90.79	90.54	89.29	88.54	88.04	87.04	86.04	84.04
	(73.72)	(73.72)	(73.19)	(72.68)	(72.42)	(72.18)	(70.97)	(70.28)	(69.84)	(68.96)	(68.12)	(66.50)
C_3T_5	92.54	92.54	92.29	92.04	91.79	91.54	90.79	90.54	90.29	89.04	88.04	88.04
	(74.27)	(74.27)	(73.99)	(73.72)	(73.45)	(73.19)	(72.42)	(72.18)	(71.93)	(70.74)	(69.84)	(69.84)
C_3T_6	92.04	92.04	90.79	90.04	89.54	89.04	88.04	86.04	85.04	84.54	84.04	80.04
	(73.72)	(73.72)	(72.42)	(71.69)	(71.21)	(70.74)	(69.84)	(68.12)	(67.30)	(66.90)	(66.50)	(63.50)
Mean	91.72	91.72	90.92	90.27	89.47	88.76	8721	86.29	84.19	80.66	78.60	75.17
	(73.44)	(73.44)	(72.57)	(71.94)	(71.19)	(70.55)	(69.25)	(68.51)	(66.97)	(64.44)	(63.02)	(60.71)
S.E. ±	1.08	1.08	1.07	1.06	1.05	1.04	1.03	1.02	0.99	0.95	0.93	0.90
C.D. (P=0.01)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	3.96	3.92	3.83	3.68	3.60	3.46

N.S. = Non-significant

Table 2 : Effect of botanical treatments on seed moisture content (%) during storage in cloth bag, polythene bag and vacuum packing of sunflower hybrid KBSH-53 seed

Treatments	Duration of storage period (months)											
	0	1	2	3	4	5	6	7	8	9	10	11
Containers (C)												
C_1	8.21	8.21	9.55	10.16	10.39	10.63	10.81	10.67	10.53	10.34	10.44	10.55
C_2	8.17	8.10	8.33	8.48	8.76	8.98	9.27	9.09	8.78	8.78	9.07	9.23
C_3	8.13	8.08	8.19	8.28	8.42	8.56	8.66	8.60	8.53	8.35	8.45	8.57
Mean	8.17	8.13	8.69	8.97	9.19	9.39	9.58	9.45	9.28	9.16	9.32	9.45
S.E. ±	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.04	0.04	0.04	0.05
C.D. (P=0.01)	N.S.	N.S.	0.16	0.17	0.17	0.17	0.18	0.18	0.17	0.17	0.17	0.18
Botanical (T)												
T_1	8.17	8.08	8.60	8.87	9.10	9.28	9.50	9.38	9.21	9.07	9.24	9.36
T_2	8.12	8.07	8.58	8.87	9.04	9.17	9.32	9.22	9.04	8.93	9.12	9.23
T_3	8.22	8.22	8.85	9.14	9.35	9.61	9.81	9.65	9.48	9.34	9.50	9.65
T_4	8.16	8.15	8.70	8.98	9.20	9.42	9.62	9.48	9.34	9.20	9.35	9.47
T_5	8.08	8.00	8.52	8.81	8.95	9.07	9.23	9.16	8.95	8.88	9.04	9.14
T_6	8.27	8.23	8.87	9.16	9.47	9.77	10.00	9.82	9.65	9.51	9.66	9.84
Mean	8.17	8.13	8.69	8.97	9.19	9.39	9.58	9.45	9.28	9.16	9.32	9.45
S.E. ±	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.06	0.06	0.06	0.06	0.06
C.D. (P=0.01)	N.S.	N.S.	0.23	0.24	0.24	0.25	0.25	0.25	0.24	0.24	0.25	0.25

N.S. = Non-significant * Figures in the parenthesis are arcsine transformed values

Containers (C) C_1: Cloth bag C_2: Polythene bag C_3: Vacuum packing

Botanicals (T) T_1: Sweet flag powder (5 g/kg) T_2: Neem leaf powder (10 g/kg) T_3: Custard apple seed powder (10 g/kg)
T_4: Deltamethrine @ 0.4 ml/kg. T_5: Vitavax (3g/kg). T_6: Control (without any seed treatments)

Table 2a : Interaction effect of botanical treatments on seed moisture content (%) during storage in cloth bag, polythene bag and vacuum packing of sunflower hybrid KBSH-53 seed

Treatments	Duration of storage period (months)											
	0	1	2	3	4	5	6	7	8	9	10	11
Interaction (C×T)												
C_1T_1	8.21	8.11	9.36	9.97	10.22	10.47	10.70	10.55	10.40	10.18	10.29	10.40
C_1T_2	8.15	8.12	9.37	9.98	10.10	10.22	10.30	10.15	10.05	9.89	9.97	10.08
C_1T_3	8.24	8.34	9.84	10.45	10.67	10.92	11.16	11.00	10.85	10.63	10.74	10.85
C_1T_4	8.18	8.28	9.60	10.21	10.46	10.71	10.95	10.80	10.65	10.43	10.54	10.65
C_1T_5	8.16	8.06	9.31	9.92	10.01	10.12	10.17	10.07	9.97	9.87	9.92	10.03
C_1T_6	8.31	8.30	9.80	10.41	10.84	11.30	11.60	11.43	11.26	11.03	11.15	11.26
C_2T_1	8.19	8.08	8.29	8.41	8.71	8.85	9.19	9.04	8.72	8.72	9.03	9.16
C_2T_2	8.12	8.05	8.25	8.40	8.66	8.80	9.08	8.99	8.61	8.61	9.00	9.13
C_2T_3	8.23	8.18	8.43	8.61	8.89	9.26	9.52	9.26	8.96	8.96	9.21	9.37
C_2T_4	8.14	8.09	8.33	8.45	8.72	8.99	9.24	9.05	8.81	8.81	9.07	9.21
C_2T_5	8.08	795	8.18	8.33	8.53	8.65	8.97	8.90	8.53	8.53	8.85	9.02
C_2T_6	8.26	8.20	8.46	8.64	9.01	9.30	9.60	9.28	9.00	9.00	9.23	9.46
C_3T_1	8.11	8.05	8.14	8.23	8.37	8.51	8.61	8.55	8.50	8.30	8.40	8.50
C_3T_2	8.09	8.03	8.12	8.21	8.35	8.49	8.58	8.52	8.45	8.27	8.37	8.47
C_3T_3	8.19	8.13	8.26	8.35	8.49	8.63	8.74	8.68	8.63	8.43	8.53	8.71
C_3T_4	8.14	8.08	8.17	8.26	8.40	8.54	8.65	8.59	8.54	8.34	8.44	8.55
C_3T_5	798	798	8.07	8.16	8.30	8.44	8.55	8.49	8.35	8.24	8.34	8.36
C_3T_6	8.24	8.18	8.33	8.42	8.56	8.70	8.81	8.75	8.70	8.50	8.60	8.80
Mean	8.17	8.13	8.69	8.97	9.19	9.39	9.58	9.45	9.28	9.16	9.32	9.45
S.E. ±	0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
C.D. (P=0.01)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	0.44	0.43	0.42	0.42	0.42	N.S.

N.S. = Non-significant

Table 3 : Effect of botanical treatments on seedling vigour index during storage in cloth bag, polythene bag and vacuum packing of sunflower KBSH-53

Treatments	Duration of storage period (months)											
	0	1	2	3	4	5	6	7	8	9	10	11
Containers (C)												
C_1	3187	3169	3075	3026	2964	2907	2804	2738	2558	2347	2231	2005
C_2	3370	3363	3283	3248	3211	3164	3114	3068	3032	2874	2762	2648
C_3	3373	3366	3358	3327	3291	3264	3225	3172	3126	3074	3019	2935
Mean	3310	3299	3239	3200	3155	3112	3048	2993	2905	2765	2671	2529
S.E.±	15	15	15	15	15	14	14	14	13	13	12	12
C.D. (P=0.01)	59	59	58	57	56	55	54	53	52	50	48	46
Botanical (T)												
T_1	3303	3289	3219	3194	3144	3109	3054	2997	2947	2863	2803	2666
T_2	3344	3338	3271	3239	3204	3162	3115	3083	3028	2938	2881	2741
T_3	3197	3183	3187	3140	3092	3042	3004	2953	2764	2557	2439	2295
T_4	3314	3304	3247	3208	3157	3121	3076	3024	2943	2818	2713	2570
T_5	3381	3380	3301	3264	3238	3202	3159	3122	3099	3008	2938	2865
T_6	3320	3302	3209	3156	3097	3035	2877	2776	2650	2406	2251	2037
Mean	3310	3299	3239	3200	3155	3112	3048	2993	2905	2765	2671	2529
S.E.±	22	22	21	21	21	20	20	20	19	18	18	17
C.D. (P=0.01)	83	83	82	81	79	78	77	75	73	70	68	65

N.S. = Non-significant * Figures in the parenthesis are arcsine transformed values

Containers (C) C_1: Cloth bag C_2: Polythene bag C_3: Vacuum packing

Botanicals (T) T_1: Sweet flag powder (5 g/kg) T_2: Neem leaf powder (10 g/kg) T_3: Custard apple seed powder (10 g/kg)
T_4: Deltamethrine @ 0.4 ml/kg. T_5: Vitavax (3g/kg). T_6: Control (without any seed treatments)

Table 3a : Interaction effect of botanical treatments on seedling vigour index during storage in cloth bag, polythene bag and vacuum packing of sunflower KBSH-53

Treatments	Duration of storage period (months)											
	0	1	2	3	4	5	6	7	8	9	10	11
Interaction (C×T)												
C_1T_1	3186	3170	3089	3051	2993	2945	2873	2819	2706	2555	2492	2240
C_1T_2	3211	3204	3107	3066	3018	2958	2895	2862	2784	2598	2546	2321
C_1T_3	3134	3113	3001	2939	2890	2833	2771	2733	2337	2051	1961	1751
C_1T_4	3166	3146	3058	3012	2929	2894	2844	2805	2610	2461	2367	2152
C_1T_5	3250	3242	3170	3130	3098	3037	2989	2930	2907	2749	2634	2538
C_1T_6	3174	3139	3024	2955	2855	2777	2451	2282	2001	1665	1389	1031
C_2T_1	3322	3307	3238	3215	3174	3136	3089	3046	3035	2970	2902	2804
C_2T_2	3377	3369	3303	3279	3251	3212	3163	3138	3101	3074	2999	2867
C_2T_3	3344	3332	3247	3199	3161	3099	3076	3001	2923	2650	2450	2307
C_2T_4	3367	3363	3322	3284	3237	3189	3160	3093	3076	2909	2762	2657
C_2T_5	3442	3449	3329	3296	3273	3248	3202	3170	3146	3093	3064	2971
C_2T_6	3367	3358	3262	3213	3171	3099	2991	2958	2910	2549	2396	2280
C_3T_1	3400	3389	3329	3315	3266	3245	3200	3126	3099	3064	3016	2955
C_3T_2	3445	3439	3402	3371	3344	3314	3286	3250	3198	3144	3097	3035
C_3T_3	3413	3404	3312	3282	3225	3194	3166	3125	3031	2969	2906	2828
C_3T_4	3408	3402	3360	3328	3304	3281	3226	3176	3143	3084	3009	2902
C_3T_5	3452	3450	3404	3367	3343	3322	3287	3266	3245	3180	3117	3087
C_3T_6	3417	3408	3342	3299	3265	3227	3188	3088	3040	3003	2970	2799
Mean	3310	3299	3239	3200	3155	3112	3048	2993	2905	2765	2671	2529
S.E. ±	37	37	37	36	36	35	34	34	33	32	31	29
C.D. (P=0.01)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	133	131	127	122	118	112

N.S. = Non-significant

Table 4 : Effect of botanical treatments on electrical conductivity (dSm^{-1}) during storage in cloth bag, polythene bag and vacuum packing of sunflower KBSH-53

Treatments	Duration of storage period (months)											
	0	1	2	3	4	5	6	7	8	9	10	11
Containers (C)												
C_1	115	120	125	132	141	152	166	194	225	259	284	297
C_2	115	119	124	130	136	143	149	169	186	212	229	241
C_3	114	117	122	127	132	139	146	164	180	198	212	225
Mean	115	119	123	130	136	145	154	176	197	223	242	254
S.E.±	0.8	0.02	0.02	0.03	0.05	0.06	0.09	0.11	0.15	0.20	0.23	0.23
C.D. (P=0.01)	N.S.	0.06	0.09	0.13	0.19	0.23	0.34	0.42	0.56	0.77	0.90	0.90
Botanical (T)												
T_1	115	119	125	131	137	146	157	181	199	229	251	261
T_2	115	117	120	125	129	135	139	163	186	204	221	239
T_3	115	122	128	135	144	152	165	186	204	242	262	275
T_4	114	119	124	131	138	148	157	177	197	225	242	257
T_5	115	116	119	123	128	136	146	164	195	207	219	232
T_6	115	120	125	134	143	150	158	183	201	231	253	263
Mean	115	119	123	130	136	145	154	176	197	223	242	254
S.E.±	0.01	0.02	0.03	0.05	0.07	0.08	0.12	0.15	0.21	0.28	0.33	0.33
C.D. (P=0.01)	N.S.	0.09	0.13	0.18	0.27	0.33	0.47	0.59	0.80	1.08	1.28	1.27

N.S. = Non-significant * Figures in the parenthesis are arcsine transformed values

Containers (C) C_1: Cloth bag C_2: Polythene bag C_3: Vacuum packing

Botanicals (T) T_1: Sweet flag powder (5 g/kg) T_2: Neem leaf powder (10 g/kg) T_3: Custard apple seed powder (10 g/kg)
T_4: Deltamethrine @ 0.4 ml/kg. T_5: Vitavax (3g/kg). T_6: Control (without any seed treatments)

Table 4a : Interaction effect of botanical treatments on electrical conductivity (dSm^{-1}) during storage in cloth bag, polythene bag and vacuum packing of sunflower KBSH-53

Treatments	Duration of storage period (months)											
	0	1	2	3	4	5	6	7	8	9	10	11
Interaction (C×T)												
C_1T_1	114	121	127	134	140	152	163	196	231	271	304	310
C_1T_2	115	117	121	129	137	144	150	187	194	231	249	257
C_1T_3	117	123	128	136	145	157	169	198	234	273	309	326
C_1T_4	112	119	125	134	143	153	163	188	220	247	267	285
C_1T_5	115	116	119	125	132	151	172	193	234	255	262	278
C_1T_6	115	122	129	137	148	157	178	201	239	279	312	328
C_2T_1	116	120	124	134	144	149	154	178	187	222	236	243
C_2T_2	115	117	119	125	130	132	134	154	185	195	214	223
C_2T_3	115	121	127	134	141	150	159	178	188	224	235	248
C_2T_4	115	118	123	128	132	144	155	173	188	213	231	248
C_2T_5	115	117	119	123	127	130	133	151	179	188	205	226
C_2T_6	116	122	129	135	144	151	160	180	189	231	250	257
C_3T_1	114	115	120	125	128	136	150	167	179	193	215	223
C_3T_2	114	116	119	123	122	130	133	149	178	188	200	217
C_3T_3	114	121	127	132	141	149	157	178	185	215	224	239
C_3T_4	115	117	122	131	141	146	150	172	183	198	214	221
C_3T_5	114	115	118	121	125	128	132	147	170	178	191	213
C_3T_6	114	118	125	130	139	147	154	170	182	216	228	239
Mean	115	119	123	130	136	145	154	176	197	223	242	254
S.E. ±	1.35	0.04	0.06	0.08	0.12	0.15	0.21	0.26	0.36	0.49	0.57	0.57
C.D. (P=0.01)	N.S.	0.16	0.23	0.31	0.46	0.57	0.82	1.02	1.38	1.88	2.21	2.21

N.S. = Non-significant

the end of storage period (Table 2 and 4).

Generally, electrical conductivity of seed leachates is negatively correlated with the seed viability and vigour. As the seed ages the cell and cell organelles membrane become leaky on account of decrease in the phospholipids content due to either non enzymic lipid auto oxidation or enzymically or due to fungi and insect activity (Ching and Schoolcraft, 1968; Kostra and Harrington, 1969) .The differential EC values recorded among the seed treatments indicated that the nature and extent of membrane protection offered may not be same for all the treatments, thus resulting in difference in EC values (Kurdikeri, 1991) in maize.

The Seed moisture content is a function of relative humidity and it fluctuated concomitantly with the changes in atmospheric relative humidity and temperature due to hygroscopic nature of seed and at higher seed moisture content seed deterioration occurred more rapidly owing to more invasion of fungi, increased activity of storage pest, higher metabolic and enzymic activity.

Interaction :

Among the interactions between seed treatments and packaging materials (T × C) seeds treated with vitavax and stored in vacuum packing C_3T_5 recorded significantly higher (82.80%) germination percentage, seedling vigour index (3087) and with lower EC (213dSm^{-1}) and moisture content (8.36%) at the end of 11 months of storage period and was followed by polythene bags and lowest values were recorded with untreated seeds stored in the cloth bags C_1T_6 (69.0%,1031, 328 dSm^{-1} and 11.26% , respectively) at the end of 11 months of storage period (Table 1a,2a, 3a and 4a). This may be due to prevention of fungal invasion by vitavax and also due to phytotoxic effect of vitavax against detrimental changes associated with the deterioration and the moisture fluctuation in impervious containers would be rather very negligible on account of which higher seed quality parameters have been observed with these combined treatments.

In general, declining trend for all seed quality parameters was observed as the storage period advanced. Further, it may be due to natural ageing resulting in different changes that are reported to take place at different levels during seed deterioration including important shifts in metabolic activity which included changes like membrane permeability as evidenced by leakage of electrolytes from naturally aged seeds (Pandey, 1989).

Conclusion :

Sunflower seeds treated with vitavax 3g kg^{-1} of seed in vacuum packing have retained better seed quality parameters up to eleven months of storage. Sweet flag rhizome and neem leaf powder usage in storage was found quite promising which can substitute deltamethrine, this is significant particularly in storage.

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