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Studies on packaging materials, storage time on seed viability and seed health in wheat (*Triticum aestivum* L.) Seeds

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Abstract
The present study elucidated that the effect of storage of wheat seeds are treated with chemical and botanical fungicide [Thiram (T_1) Castor oil (T_2) and Neem cake (T_3)] at recommended dosage and stored in types of packaging materials [Cloth bag (P_1) and Jute bag (P_2)] in ambient condition in the Post Graduate Laboratory, Department of Genetics and Plant Breeding, SHIATS, Allahabad for two, four and six months. Observations shows that the treatment of Thiram @ 3g/kg of seed stored in cloth bag for 6 months displayed significant higher percentage of seed germination, shoot length, root length, fresh weight, dry weight, seed moisture and seed viability as compared to other treated seeds were stored in jute bag. But in the case of seed health Thiram @ 3g/kg treated seed shows better result. Germination and viability decreased with the period of aging. It is also found out that vacuum cloth bag could be the best options among jute bag, jute bag for seed packing in terms of maintaining the seed quality as reflected in the varied parameters of the seed quality assessment indicators. Seeds are stored in cloth bags were affected due to storage but the effects were more pronounced in as compared to jute bags.

Keywords: wheat seed, chemical and botanical treatment, seed quality, storage container, storage period

Introduction
Wheat (*Triticum aestivum* L.), family Poaceae is the second most important food crop of India after paddy, which contributes nearly one-third of the total food grain production. India holds the second place among the wheat-growing countries of the world. Wheat is grown all over the world, with different varieties sown according to the various climates. The world's main wheat producing regions were China, India, United States, Russian Federation, France, Australia, Germany, Canada, Turkey, Pakistan, Argentina, Kazakhstan and United Kingdom (FAO, 2003).

In most cases, it has been shown that reducing the temperature of the warehouse and the moisture content of the seeds led to increasing the period of viability. Seed viability and vigor decreased with prolonging storage period. Electrical conductance of seed leachates also increased with storage under unfavorable conditions. Packaging container and storage duration significantly affected viability and seedling vigor (Rao *et. al*., (2006) [8].

Stored grains can have losses in both quantity and quality. Losses occur when the grain is attacked by microorganisms and other organisms including insects, mites, rodents and birds (Neetirajan *et al*., 2007).

Wheat (*Triticum aestivum* L.) is served as a source of staple food to the mankind since times immemorial. Seed borne diseases of wheat like Karnal bunt (*Tilletia inidica*), loose smut *(Ustilago nuda tritici)*, head blight or scab *(Fusarium spp*) and tundu or ear cockle (*Clavibacter tritici* and *Anguina tritici*) are considered as the constraints in wheat cultivation, that affect crop yield and grain quality (Mitra, 1931; Agarwal *et al.*, 2008; Kumar *et al.*, 2008).

The present research work, therefore, was undertaken with a view to determine suitable packaging material and best chemical and botanical treatment for maintaining longevity of Wheat seed quality under ambient and control conditions of Allahabad,.

Materials and Methods
The wheat seed were treated with chemical and botanical [Thiram (T_1), Castor oil (T_2) and Neem Cake (T_3)] at recommended dosage. It were packed in Cloth bag (P_1) and Jute bag (P_2).

Stored under ambient condition in the Post Graduate Laboratory, Department of Genetics and Plant Breeding, SHIATS, Allahabad for 2, 4 and 6th Months.

For seedling character, the germination test was conducted during four replications of 100 seeds from each sample in rolled towel paper as per procedure described by ISTA (1993) The following formulas were used in this experiment for determining germination %

$$\text{Germination\%} = \frac{\text{Total no. of seeds germinated}}{\text{Total number of seeds sown}} \times 100$$

Seed moisture content (ISTA 1999): In a set of 4 replicates seed sample of each treatment, the seed moisture content was determined by electric seed moisture meter method. It consists of a compression unit to compress the sample to pre - determined thickness. The thickness setting is very easily read on a vertical and circular scale. The seed material on test is taken in a test cup and is compressed. Then press the push type switch till the reading comes in the display. Here no temperature reading and correlated dial are required. The computer version of digital moisture meter automatically compensate for temperature corrections

Viability Test (TZ test): The tetrazolium test was performed according to the procedure devised by International Seed Testing Association.200 seeds from each seed lot were used for this test in four replications of 50 seeds each. The seeds were soaked in distilled water for 24 hours before staining to allow complete hydration of all the tissues. This process permits the activation of germination and makes the seed tissues less fragile. The seeds were then bisected longitudinally to expose the embryo and stained with 1% solution by weight of triphenyl tetrazolium chloride made by dissolving the 2, 3, 5 TTC in double distilled water.. This test based on the reaction of 2,3,5-triphenyl tetrazolium chloride (bromide) salt with dehydrogenase enzyme, active during respiration in living tissues of the seed and the hydrogen ions so released, reduce tetrazolium chloride to a red stable substance, resulting in the coloring of the tissues. Thus, it makes possible to distinguish the red colored living tissues of the seed from the colorless dead ones

Health test of stored Wheat seeds (Blotter method): One hundred seeds will be tested for each variety maintaining four replications. Twenty-five seeds were placed on three layers of moist blotting paper (Whatman No.1) in each glass Petridishes. The Petridishes will be incubated at 25±1°C under 12/12 hrs light and darkness cycle for 7 days. Each seed will be observed under stereomicroscope in order to record the presence of fungal colony and bacterial ooze 7 days after incubation based on growth habit. In doubtful cases temporary slides will be prepared from the fungal colony temporary slides were prepared from the fungal colony.

Results and Discussion

The germination percentage of wheat seeds declined progressively with the enhanced storage period. On an average the germination percentage recorded at the beginning and at the end of storage period was 84.22 and 78.94 percent, respectively.

Significant differences in germination percentage due to seed treatments were observed throughout storage period except initial month. The Treatment in combination with fungicide or alone recorded significantly higher germination percentage compared to untreated seeds. Significantly higher germination was recorded with seeds treated with Thiram @ 3g per kg of seed along with Neem cake @ 10g per kg of seed and along with Castor oil 5ml per kg at the end of storage period T_1 (82.38%), followed by T_3 (80.25%), followed by T_2 (78.88%). Significantly lower seed germination was recorded throughout the storage period with untreated control (T_0) which recorded a germination percentage of (74.25%) at the end of 6th month of storage.

The germination percentage seeds stored in Cloth bag recorded significantly higher germination percentage over Jute bag throughout the storage period. The germination percentage recorded with Cloth bag, Jute bag at the end of 6th month of storage was (80.25%), (77.62%) percent, respectively.

Interaction effects due to packaging materials and seed treatments were significant throughout the storage period except at initial month of storage. Significantly higher germination percentage was recorded in P_1T_1 (88.25%) and lower germination percentage was noticed in P_2T_2 (78.00%) percent at the end of 6th month of storage period. Sinha and Sharma (2004) [9] observed maximum changes in wheat quality when stored in cloth bags compared to jute bags.

The results of the study showed that seeds treated with Thiram maintained germination above (>80%) after six months of storage, while other chemicals could not retain germination above. The better seed quality parameters observed with chemical and botanicals treatment may be because of lower insect infestation noticed with these treatment. The insects not only eats the storage food in the seed, but also eats the germ, leading to death of the seed and hence result in poor seed germination and lower vigour (Deshpande *et al.*, 2004) [4].

The seeds stored in cloth bag containers maintained viability to longer period mainly because of lesser fluctuation of moisture content compared to those seeds stored in cloth bag. The results are in conformity with Kumarsen (1981) and Malabasari (2003).

The shoot length of wheat seeds declined progressively with the enhanced storage period. On an average the shoot length recorded at the beginning and at the end of storage period was 10.18 cm and 8.64 cm percent, respectively.

Significant differences in shoot length due to seed treatments were observed throughout storage period except initial month. The Treatment in combination with fungicide or alone recorded significantly higher shoot length compared to untreated seeds. Significantly higher shoot length was recorded with seeds treated with Thiram @ 3g per kg of seed along with Neem cake @ 10g per kg of seed and along with Castor oil 5ml per kg at the end of storage period T_1 (8.92 cm), followed by T_3 (8.58 cm), followed by T_2 (8.53 cm). Significantly lower shoot length was recorded throughout the storage period with untreated control (T_0) which recorded a shoot length of (8.33 cm) at the end of 6th month of storage.

The shoot length seeds stored in Cloth bag recorded significantly higher shoot length over Jute bag throughout the storage period. The shoot length recorded with Cloth bag, Jute bag at the end of 6th month of storage was (8.51 cm), (8.76 cm) percent, respectively.

Interaction effects due to packaging materials and seed treatments were significant throughout the storage period except at initial month of storage. Significantly higher shoot length was recorded in P_1T_1 (10.67 cm) and lower shoot length was noticed in P_2T_2 (8.49 cm) percent at the end of 6th

month of storage period. The root length of wheat seeds declined progressively with the enhanced storage period. On an average the root length recorded at the beginning and at the end of storage period was 8.83 cm and 7.33 cm percent, respectively.

Significant differences in root length due to seed treatments were observed throughout storage period except initial month. The Treatment in combination with fungicide or alone recorded significantly higher root length compared to untreated seeds. Significantly higher root length was recorded with seeds treated with Thiram @ 3g per kg of seed along with Neem cake @ 10g per kg of seed and along with Castor oil 5ml per kg at the end of storage period T_1 (7.72 cm), followed by T_3 (7.59 cm), followed by T_2 (7.58 cm). Significantly lower root length was recorded throughout the storage period with untreated control (T_0) which recorded a root length of (6.88 cm) at the end of 6th month of storage.

The root length seeds stored in Cloth bag recorded significantly higher root length over Jute bag throughout the storage period. The root length recorded with Cloth bag, Jute bag at the end of 6th month of storage was (7.66 cm), (7.22 cm) percent, respectively.

Interaction effects due to packaging materials and seed treatments were significant throughout the storage period except at initial month of storage. Significantly higher root length was recorded in P_1T_1 (8.11 cm) and lower root length was noticed in P_2T_2 (7.33 cm) percent at the end of 6th month of storage period.

The fresh weight of wheat seeds declined progressively with the enhanced storage period. On an average the fresh weight recorded at the beginning and at the end of storage period was 7.33 (g) and 5.80 (g), respectively.

Significant differences in fresh weight due to seed treatments were observed throughout storage period except initial month. The Treatment in combination with fungicide or alone recorded significantly higher fresh weight compared to untreated seeds. Significantly higher fresh weight was recorded with seeds treated with Thiram @ 3g per kg of seed along with Neem cake @ 10g per kg of seed and along with Castor oil 5ml per kg at the end of storage period T_1 (6.02g), followed by T_3 (6.00g), followed by T_2 (5.67g). Significantly lower fresh weight was recorded throughout the storage period with untreated control (T_0) which recorded a fresh weight of (5.52g) at the end of 6th month of storage.

The fresh weight seeds stored in Cloth bag recorded significantly higher fresh weight over Jute bag throughout the storage period. The fresh weight recorded with Cloth bag, Jute bag at the end of 6th month of storage was (5.92g), (5.69g), respectively.

Interaction effects due to packaging materials and seed treatments were significant throughout the storage period except at initial month of storage. Significantly higher fresh weight was recorded in P_1T_1 (6.31g) and lower germination percentage was noticed in P_2T_2 (5.62g) percent at the end of 6th month of storage period.

The dry weight of wheat seeds declined progressively with the enhanced storage period. On an average the dry weight recorded at the beginning and at the end of storage period was (2.38g) and (2.71g), respectively.

Significant differences in dry weight due to seed treatments were observed throughout storage period except initial month. The Treatment in combination with fungicide or alone recorded significantly higher fresh weight compared to untreated seeds. Significantly higher dry weight was recorded with seeds treated with Thiram @ 3g per kg of seed along with Neem cake @ 10g per kg of seed and along with Castor oil 5ml per kg at the end of storage period T_1 (2.46g), followed by T_3 (2.42g), followed by T_2 (2.42g). Significantly lower dry weight was recorded throughout the storage period with untreated control (T_0) which recorded a dry weight of (2.26g) at the end of 6th month of storage.

The dry weight seeds stored in Cloth bag recorded significantly higher dry weight over Jute bag throughout the storage period. The dry weight recorded with Cloth bag, Jute bag at the end of 6th month of storage was (2.39g), (2.36g), respectively.

Interaction effects due to packaging materials and seed treatments were significant throughout the storage period except at initial month of storage. Significantly higher dry weight was recorded in P_1T_1 (2.43g) and lower germination percentage was noticed in P_2T_2 (2.36g) percent at the end of 6th month of storage period.

The seed viability percentage of wheat seeds declined progressively with the enhanced storage period. On an average the seed viability percentage recorded at the beginning and at the end of storage period was (85.19%) and (79.84%) percent, respectively.

Significant differences in seed viability percentage due to seed treatments were observed throughout storage period except initial month. The Treatment in combination with fungicide or alone recorded significantly higher seed viability percentage compared to untreated seeds. Significantly higher seed viability was recorded with seeds treated with Thiram @ 3g per kg of seed along with Neem cake @ 10g per kg of seed and along with Castor oil 5ml per kg at the end of storage period T_1 (83.25%), followed by T_3 (76.68%), followed by T_2 (79.00%). Significantly lower seed viability was recorded throughout the storage period with untreated control (T_0) which recorded a seed viability percentage of (77.75%) at the end of 6th month of storage.

The seed viability percentage seeds stored in Cloth bag recorded significantly higher seed viability percentage over Jute bag throughout the storage period. The seed viability percentage recorded with Cloth bag, Jute bag at the end of 6th month of storage was (80.50%), (80.19%) percent, respectively.

Interaction effects due to packaging materials and seed treatments were significant throughout the storage period except at initial month of storage. Significantly higher seed viability percentage was recorded in P_1T_1 (83.50%) and lower seed viability percentage was noticed in P_2T_2 (79.75%) percent at the end of 6th month of storage period.

The moisture percentage of wheat seeds increase progressively with the enhanced storage period. On an average the moisture content recorded at the beginning and at the end of storage period was (10.19%) and (10.75%), respectively.

Significant differences in moisture content of seeds due to seed treatments were observed throughout storage period except initial month. The Treatment in combination with fungicide or alone recorded significantly lower moisture content of seeds compared to untreated seeds. Significantly higher moisture content of seeds was recorded with seeds treated with Neem Cake @ 10g per kg of seed along with Thiram @ 3g per kg of seed and along with Castor Oil @ 5 ml per kg of seed at the end of storage period (T_3) 10.73%, followed by (T_1) 10.70% followed by (T_3) 10.64% Significantly maximum moisture content was recorded throughout the storage period with untreated control (T_0) which recorded a moisture content of 10.93% at the end of 6th month of storage.

The moisture content of seeds stored in Cloth bag recorded significantly lower moisture content over Jute bag and throughout the storage period. The moisture content recorded with Cloth bag and Jute bag at the end of 6th month of storage was 10.76 % and 10.74%, respectively.

Interaction effects due to packaging materials and seed treatments were significant throughout the storage period except at initial month of storage. Significantly minimum moisture content was recorded in (P_2T_2) 10.57% and maximum moisture content was noticed in (P_1T_3) 10.76% at the end of 6th month of storage period.

The seed infection per cent increased progressively with the enhanced storage period. On an average, the seed infection per cent recorded at the beginning and at the end of storage period was Karnal bunt 11.97 and 13.19, Loose smut 11.28 and 12.59, Tandu 10.66 and 12.12 per cent, respectively. Significant differences in seed infection per cent due to seed treatments was observed after the 6th month of storage periods onwards.

Significantly lower seed infection was recorded in (T_1) at the end of storage period Karnal bunt (12.12%), Loose smut (11.75%), Tandu (11.38%). Significantly higher seed infection was recorded throughout storage with untreated seeds (T_0) which recorded Karnal bunt (14.25%), Loose smut (13.38%), Tandu (13.38%) infection at the end of 6th month of storage.

Significant variations were recorded containers throughout the storage. Significantly lower seed infection was observed in cloth bag Karnal bunt (12.81%), Loose smut (12.38%), Tandu (12.00%) compared to jute bag Karnal bunt (13.56%), Loose smut (12.81%), Tandu (12.25%) at the end of 6th month of storage period. Dhaliwal and Arora, (2001). It has also been reported that about 9.3 to 42% of attainable wheat production is lost as a result of attack of various pests, pathogens and poor crop management. The superiority of deltamethrin and castor oil and neem oil might be due to the fact that, these treatments keep the seeds intact as it acts as binding material and covers the minor cracks and aberrations on the seed coat at initial stage thus blocking the fungal invasion. Apart from this, the insecticidal property present in the botanicals also helps in making the seeds incompatible for insects during storage (Prakash and Jagadishwari, 1992; Maraddi, 2002).

Table 1: Effect of packaging materials and seed treatment on the germination % of wheat during storage

Treatments	Month			
	Initial	2nd month	4th month	6th month
Packaging materials (P)				
Cloth bag (P_1)	86.19	83.75	82.69	80.25
Jute bag (P_2)	82.25	79.12	78.75	77.62
SEm	0.44	0.46	0.22	0.26
CD (5%)	1.28	1.34	0.65	0.77
Seed treatment (T)				
Control (T_0)	83.25	76.88	76.12	74.25
Thiram (T_1)	87.62	84.50	83.62	82.38
Castor oil (T_2)	82.75	81.75	81.12	78.88
Neem (T_3)	83.25	82.62	82.00	80.25
SEm	0.62	0.65	0.32	0.37
CD (5%)	1.81	1.89	0.92	1.08
Treatment combination (P×T)				
P_1T_0	85.50	79.00	77.75	74.75
P_1T_1	88.25	87.00	86.00	84.75
P_1T_2	85.50	84.00	83.00	79.75
P_1T_3	85.50	85.00	84.00	81.75
P_2T_0	81.00	74.75	74.50	73.75
P_2T_1	87.00	82.00	81.25	80.00
P_2T_2	80.00	79.50	79.25	78.00
P_2T_3	81.00	80.25	80.00	78.75
SEm	0.88	0.92	0.45	0.53
CD (5%)	2.56	2.67	1.31	1.53
Grand mean	84.22	81.44	80.72	78.94
CV (%)	2.10	2.20	1.10	1.30

Table 2: Effect of packaging materials and seed treatment on the seed viability % of wheat during storage

Treatments	Month			
	Initial	2nd month	4th month	6th month
Packaging materials (P)				
Cloth bag (P_1)	85.44	84.25	81.81	80.50
Jute bag (P_2)	84.94	83.19	81.50	80.19
SEm	0.33	0.46	0.25	0.26
CD (5%)	0.97	1.36	0.73	0.76
Seed treatment (T)				
Control (T_0)	82.75	81.12	79.50	77.75
Thiram (T_1)	88.38	87.00	85.38	83.25
Castor oil (T_2)	84.25	83.12	80.75	79.00
Neem (T_3)	85.38	83.62	81.00	79.38
SEm	0.47	0.66	0.36	0.37
CD (5%)	1.37	1.92	1.04	1.08
Treatment combination (P×T)				
P_1T_0	82.00	80.75	79.75	77.50
P_1T_1	89.50	88.25	86.50	83.50
P_1T_2	84.75	83.50	80.50	78.25
P_1T_3	85.50	84.50	80.50	78.75
P_2T_0	83.50	81.50	79.25	78.00
P_2T_1	87.25	85.75	84.25	83.00
P_2T_2	83.75	82.75	81.00	79.75
P_2T_3	85.25	82.75	81.50	80.00
SEm	0.66	0.93	0.50	0.52
CD (5%)	1.93	2.71	1.47	1.53
Grand mean	85.19	83.72	81.66	79.84
CV (%)	1.60	2.20	1.20	1.30

Table 3: Effect of packaging materials and seed treatment on the seed moisture % of wheat during storage

Treatments	Month			
	Initial	2nd month	4th month	6th month
Packaging materials (P)				
Cloth bag (P_1)	10.21	10.43	10.64	10.76
Jute bag (P_2)	10.16	10.43	10.67	10.74
SEm	0.06	0.04	0.05	0.04
CD (5%)	0.17	0.11	0.13	0.13
Seed treatment (T)				
Control (T_0)	10.30	10.56	10.83	10.93
Thiram (T_1)	10.14	10.38	10.60	10.70
Castor oil (T_2)	10.19	10.43	10.64	10.64
Neem (T_3)	10.13	10.35	10.54	10.73
SEm	0.08	0.05	0.06	0.06
CD (5%)	0.23	0.15	0.19	0.18
Treatment combination (P×T)				
P_1T_0	10.34	10.60	10.88	10.88
P_1T_1	10.06	10.34	10.58	10.68
P_1T_2	10.23	10.37	10.63	10.71
P_1T_3	10.23	10.41	10.47	10.76
P_2T_0	10.26	10.52	10.79	10.97
P_2T_1	10.21	10.42	10.62	10.71
P_2T_2	10.15	10.48	10.66	10.57
P_2T_3	10.03	10.30	10.60	10.70
SEm	0.11	0.07	0.09	0.09
CD (5%)	0.33	0.21	0.26	0.26
Grand mean	10.19	10.43	10.65	10.75
CV (%)	2.20	1.40	1.70	1.70

Table 4: Effect of packaging materials and seed treatment on the Seed health testing of wheat during storage

Treatment	Karnal bunt		Loose smut		Tandu	
	Initial	6th Month	Initial	6th Month	Initial	6th Month
Packaging material (P)						
Cloth bag (P_1)	11.62	12.81	11.06	12.38	10.94	12.00
Jute bag (P_2)	12.31	13.56	11.50	12.81	10.38	12.25
SEm	0.186	0.222	0.212	0.232	0.209	0.201
CD (5%)	0.542	0.649	0.619	0.678	0.610	0.586
Seed treatment (T)						
Control (T_0)	13.12	14.25	12.12	13.38	11.25	13.38
Thiram (T_1)	11.75	13.00	11.12	12.50	10.75	12.00
Castor oil (T_2)	10.88	12.12	10.38	11.75	9.88	11.38
Neem (T_3)	12.12	13.38	11.50	12.75	10.75	11.75
SEm	0.263	0.315	0.300	0.329	0.295	0.284
CD (5%)	0.767	0.918	0.875	0.960	0.862	0.829
Treatment combination (P×T)						
P_1T_0	13.00	14.00	11.75	13.00	11.75	13.75
P_1T_1	11.50	12.75	11.00	12.50	11.25	12.25
P_1T_2	10.25	11.50	10.00	11.50	9.75	11.25
P_1T_3	11.75	13.00	11.50	12.50	11.00	11.75
P_2T_0	13.25	14.50	12.50	13.75	10.75	13.00
P_2T_1	12.00	13.25	11.25	12.50	10.25	11.75
P_2T_2	11.50	12.75	10.75	12.00	10.00	11.50
P_2T_3	12.50	13.75	11.50	13.00	10.50	11.75
Grand mean	11.97	13.19	11.28	12.59	10.66	12.12
SEm	0.372	0.445	0.424	0.465	0.418	0.402
CD (5%)	1.084	1.299	1.237	1.357	1.219	1.173

Conclusion

It is concluded from the present study that seed were treated with thiram and stored in cloth bag shown significant results for seedling characters followed by germination%, shoot length, root length, fresh weight, dry weight, viability even after 6th months of storage period. But in the case of seed moisture and seed health castor oil is best for control of storage fungi.

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