

Effect of Polymer Film Coating with Pesticides and Storage Containers on Longevity of Wheat Seeds

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ABSTRACT: A two years storage study was conducted for evaluation of polymer film coating along with insecticide, fungicide, storage containers and storage duration effect on storability of wheat seed. Seed treated with combination of Deltamethrin 2.8 EC @ 0.5 ml/kg seed + Vitavax power @ 2.5 g/kg seed + Polymer seed coating @ 5 ml/kg seed stored in HDPE bag for three months recorded significantly higher pooled average field emergence (90.61%), germination (92.64%), seedling vigour index I (1319) and seedling vigour index II (13.17). The seeds without any treatment stored in cloth bag for nine months recorded significantly lower seed quality parameters. Higher seed quality was maintained in HDPE bag mainly due to controlled moisture inside the bag. Seed deterioration rate was faster in the seeds stored in cloth bag. All the seed quality attributes declined gradually with the advancement of the storage period during both the years. The seed germination (87.70%) was maintained above Indian Minimum Seed Certification Standards up to 6 months of storage.

Keywords: Seed quality, Polymer coating, Fungicide, Insecticide, Container, Storage, Wheat

Wheat (*Triticum aestivum* L.) is the most important food grain of India and is the staple food of millions of Indians, particularly in the northern and north-western parts of the country. Lack of storage facilities after harvest is the main constraint in wheat production. Seed viability is a major factor in crop stand establishment and subsequent productivity of wheat. The insect infestation occurs usually from the field itself and becomes a major infestation during storage causing a significant loss in germination and other quality parameters. There is an urgent need to reduce storage insects by applying the insecticides at pre and post harvest stages. Now a days, the techniques of protecting the seeds through surface dressing with different insecticides along with polymer coating to control storage infestation for longer periods without impairing viability and vigour besides being cost effective and eco-friendly. Seeds must be properly stored in order to maintain the minimum standards of germination and other seed quality parameters until the time of planting. In view of these aspects an experiment was conducted in factorial design for determination of effect of polymer film coating along with insecticide, fungicide, storage containers and storage duration on storability of wheat seed.

MATERIALS AND METHODS

The freshly harvested seeds of the wheat variety GW 496 were treated with seven treatments comprised of different combinations of polymer film coating with insecticide and fungicide viz., T₁: Control, T₂: Deltamethrin 2.8 EC @ 0.5 ml/kg seed, T₃: Vitavax power @ 2.5 g/kg seed, T₄: Polymer seed coating @ 5 ml/kg seed, T₅: T₂+T₃, T₆: T₂+T₄, T₇: T₃+T₄ and T₈: T₂+T₃+T₄. The treated seeds were shade dried up to their original moisture content and stored in two types of storage containers viz., C₁: Cloth bag and C₂: HDPE bag for nine months at room temperature. Periodical observations on seed quality were recorded with three repeats viz., D₁: 3 months, D₂: 6 months and D₃: 9 months for evaluation of storability during 2016-17 and 2017-18. The seed quality parameters were analyzed in factorial controlled randomized design.

RESULTS AND DISCUSSION

The seed quality parameters differed significantly due to the different combinations of seed treatment of polymer film coating, fungicide, insecticide, storage containers and are presented in tables 1 to 4 and also depicted in plate 1.

Effect of Seed Treatment with Polymer Coating and Insecticide and Fungicide on Seed Quality

Among the different combinations of seed treatments with polymer coating, insecticide and fungicide, the combined seed treatment with Deltamethrin 2.8 EC @ 0.5 ml/kg seed + Vitavax power @ 2.5 g/kg seed + Polymer seed coating @ 5 ml/kg seed (T_8) recorded significantly higher field emergence (90.33%), (90.89%) and (90.61%), germination (92.28%), (93.00%) and (92.64%), seedling vigour index I (1147), (1492) and (1319) as well as higher seedling vigour index II (10.66), (15.68) and (13.17) during the year 2016-17, 2017-18 and on pooled basis, respectively. Seeds treated with Deltamethrin 2.8 EC @ 0.5 ml/kg seed (T_2) and Deltamethrin 2.8 EC @ 0.5 ml/kg seed + Polymer seed coating @ 5 ml/kg seed (T_6) were at par values for most of the seed quality parameters during both the years and in pooled analysis. Significantly lower seed quality parameters were observed in the seeds without any treatment (T_1) during the same experimental period.

Higher seed quality parameters in polymer film coated seeds along with insecticide and fungicide might be due to combined influence of polymer along with fungicide which resulted in regulated rate of water uptake, reduced imbibitions damage [1]. Improved germination per cent and finally promoted early and healthier seedlings which resulted in improvement of seedling emergence [2]. The higher seed quality of stored seeds coated with polymer mixed with fungicide and insecticides has been reported in soybean [3] and rice [4].

Effect of Storage Containers on Seed Quality

The seeds stored in the HDPE bag (C_2) recorded significantly higher field emergence (84.24%), (84.85%) and (84.54%), germination (86.71%), (87.32%) and (87.01%), seedling vigour index I (975), (1283) and (1129) and seedling vigour index II (7.95) (12.32) and (10.14) during the year 2016-17, 2017-18 and on pooled basis, respectively. Wheat seeds stored in the moisture and vapour pervious cloth bag (C_1) showed higher seed deterioration and recorded significantly lower seed quality parameters during both the years and on pooled basis.

The higher seed quality in HDPE bag might be due to its moisture impervious property which provides controlled seed deterioration, suitable environment for storage and maintained the seed at safe storage moisture level, offer protection against contamination and also acts as a

barrier against the escape of seed treatment chemicals [5]. The reduction in germination in cloth bag might be due to more fluctuation in seed moisture as well as free exchange of surrounding moisture and temperature due to its moisture and vapour pervious nature. Higher rate of seed deterioration in cloth bag was mainly due to higher respiratory activity and other physiological activities of the stored seeds which resulted in higher percent of abnormal seedlings and dead seeds. The moisture content increased with advanced storage period but the rate was higher in the seeds stored in cloth bag in soybean [6]. The higher germination and lower prevalence of fungi in jute seeds stored in tin container followed by polythene bag and cloth bag with polythene line has been reported [7]. Similar results were reported in wheat [8, 9].

Effect of Storage Duration on Seed Quality

Irrespective of the seed treatments and storage containers the field emergence declined gradually with the advancement of the seed storage period. Significantly higher field emergence (90.90%), (91.23%) and (91.06%), germination (92.90%), (93.79%) and (93.34%), seedling vigour index I (1376), (1650) and (1513), seedling vigour index II (9.37), (14.23) and (11.80) was recorded by the seeds stored for three months (D_1) duration during 2016-17, 2017-18 and in pooled analysis, respectively. The seed deterioration during storage was mainly due to the damage in membrane integrity, enzymes, proteins and nucleic acid and such degenerative changes caused complete disorganization of membranes and cell organelles which finally resulted in death of the seed and loss of germination [10]. Higher seed quality parameters was maintained up to six months of storage (D_2), however, drastic reduction in field emergence was observed at the end of nine months of storage (D_3) which recorded lowest seed quality values during both the years and in pooled analysis. Similar findings were reported in red gram [11], green gram [12] and rice [13].

Interaction Effect of Seed Treatment and Storage Containers on Seed Quality

The combined effect of seed treatment and storage containers also influenced the seed quality of wheat and recorded significant differences in the seed quality parameters. Significantly higher field emergence (91.67%), (92.00%) and (91.83%), germination (93.22%), (93.67%) and (93.44%), seedling vigour index I (1203), (1551) and (1377), seedling vigour index II (11.58), (16.68)

Table 2. Effect of polymer film coating, fungicide, insecticide, storage containers and storage period on germination (%) of wheat

Container	2016-17															2017-18															Pooled																																																																																																																																																					
	Treatment					Treatment					Treatment					Treatment					Treatment					Treatment																																																																																																																																																										
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	CXD	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	CXD	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	CXD	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	CXD																																																																																																																																																
D ₁	87.67	95.33	89.00	89.33	92.67	96.00	92.33	96.33	90.67	96.33	90.33	89.33	89.33	94.00	97.00	93.00	93.00	97.00	93.46	89.17	95.83	89.67	89.33	93.33	96.50	92.67	96.67	92.90	87.67	95.33	89.00	89.33	92.67	96.00	92.33	96.33	90.67	96.33	90.33	89.33	89.33	94.00	97.00	93.00	93.00	97.00	93.46	89.17	95.83	89.67	89.33	93.33	96.50	92.67	96.67	92.90																																																																																																																												
C ₁	66.00	90.33	84.00	85.00	86.67	91.00	86.33	92.33	85.21	76.33	89.33	85.00	85.00	88.00	90.67	87.00	87.00	93.33	86.83	71.17	89.83	84.50	85.00	87.33	90.83	86.67	92.83	86.02	66.00	90.33	84.00	85.00	86.67	91.00	86.33	92.33	85.21	76.33	89.33	85.00	85.00	88.00	90.67	87.00	87.00	93.33	86.83	71.17	89.83	84.50	85.00	87.33	90.83	86.67	92.83	86.02																																																																																																																												
D ₃	27.67	83.67	65.33	76.00	75.33	84.67	78.00	85.33	72.00	31.67	84.00	68.67	76.00	76.00	85.67	80.00	86.67	73.58	29.67	83.83	67.00	76.00	76.00	75.67	85.17	79.00	86.00	72.79	27.67	83.67	65.33	76.00	75.33	84.67	78.00	85.33	72.00	31.67	84.00	68.67	76.00	76.00	85.67	80.00	86.67	73.58	29.67	83.83	67.00	76.00	76.00	75.67	85.17	79.00	86.00	72.79																																																																																																																												
D ₁	88.67	96.67	89.00	90.33	94.33	97.00	93.33	98.33	93.46	89.67	98.00	89.00	92.00	95.00	97.33	93.33	98.67	94.13	89.17	97.33	89.00	91.17	94.67	97.17	93.33	98.50	93.79	88.67	96.67	89.00	90.33	94.33	97.00	93.33	98.33	93.46	89.67	98.00	89.00	92.00	95.00	97.33	93.33	98.67	94.13	89.17	97.33	89.00	91.17	94.67	97.17	93.33	98.50	93.79																																																																																																																														
D ₂	86.67	92.33	84.67	85.67	89.33	92.67	88.00	94.33	89.21	86.67	91.67	84.67	87.33	89.67	93.00	88.33	95.00	89.54	86.67	92.00	84.67	86.50	89.50	92.83	88.17	94.67	89.38	86.67	92.33	84.67	85.67	89.33	92.67	88.00	94.33	89.21	86.67	91.67	84.67	87.33	89.67	93.00	88.33	95.00	89.54	86.67	92.00	84.67	86.50	89.50	92.83	88.17	94.67	97.17	93.33	98.50	93.79																																																																																																																											
D ₃	56.33	85.67	66.00	77.00	81.67	86.00	80.00	87.00	77.46	57.33	86.33	66.33	78.00	83.33	87.00	80.67	87.33	78.29	56.83	86.00	66.17	77.50	82.50	86.50	80.33	87.17	77.88	56.33	85.67	66.00	77.00	81.67	86.00	80.00	87.00	77.46	57.33	86.33	66.33	78.00	83.33	87.00	80.67	87.33	78.29	56.83	86.00	66.17	77.50	82.50	86.50	80.33	87.17	93.33	98.50	93.79																																																																																																																												
Treatment	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	C	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	C	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	C	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	C	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	C	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	C																																																																																																																																
C ₁	60.44	89.78	79.44	83.44	84.89	90.56	85.56	91.33	83.18	66.22	89.89	81.33	83.44	86.00	91.11	86.67	92.33	84.63	63.33	89.83	80.39	83.44	85.44	90.83	86.11	91.83	83.90	60.44	89.78	79.44	83.44	84.89	90.56	85.56	91.33	83.18	66.22	89.89	81.33	83.44	86.00	91.11	86.67	92.33	84.63	63.33	89.83	80.39	83.44	85.44	90.83	86.11	91.83	83.90																																																																																																																														
C ₂	77.22	91.56	79.89	84.33	88.44	91.89	87.11	93.22	86.71	77.89	92.00	80.00	85.78	89.33	92.44	87.44	93.67	87.32	77.56	91.78	79.94	85.06	88.89	92.17	87.28	93.44	87.01	77.22	91.56	79.89	84.33	88.44	91.89	87.11	93.22	86.71	77.89	92.00	80.00	85.78	89.33	92.44	87.44	93.67	87.32	77.56	91.78	79.94	85.06	88.89	92.17	87.28	93.44	87.01																																																																																																																														
Treatment	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	D	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	D	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	D	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	D	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	D	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	D																																																																																																																																
D ₁	88.17	96.00	89.00	89.83	93.50	96.50	92.83	97.33	92.90	90.17	97.17	89.67	90.67	94.50	97.17	93.17	97.83	93.79	89.17	96.58	89.33	90.25	94.00	96.83	93.00	97.58	93.34	88.17	96.00	89.00	89.83	93.50	96.50	92.83	97.33	92.90	90.17	97.17	89.67	90.67	94.50	97.17	93.17	97.83	93.79	89.17	96.58	89.33	90.25	94.00	96.83	93.00	97.58	93.34																																																																																																																														
D ₂	76.33	91.33	84.33	85.33	88.00	91.83	87.17	93.33	87.21	81.50	90.50	84.83	86.17	88.83	91.83	87.67	94.17	88.19	78.92	90.92	84.58	85.75	88.42	91.83	87.42	93.75	87.70	76.33	91.33	84.33	85.33	88.00	91.83	87.17	93.33	87.21	81.50	90.50	84.83	86.17	88.83	91.83	87.67	94.17	88.19	78.92	90.92	84.58	85.75	88.42	91.83	87.42	93.75	87.70																																																																																																																														
D ₃	42.00	84.67	65.67	76.50	78.50	85.33	79.00	86.17	74.73	44.50	85.17	67.50	77.00	79.67	86.33	80.33	87.00	75.94	43.25	84.92	66.58	76.75	79.08	85.83	79.67	86.58	75.33	42.00	84.67	65.67	76.50	78.50	85.33	79.00	86.17	74.73	44.50	85.17	67.50	77.00	79.67	86.33	80.33	87.00	75.94	43.25	84.92	66.58	76.75	79.08	85.83	79.67	86.58	75.33																																																																																																																														
Treatment mean	68.83	90.67	79.67	83.89	86.67	91.22	86.33	92.28	72.06	90.94	80.67	84.61	87.67	91.78	87.06	93.00	70.44	90.81	80.17	84.25	87.17	91.50	86.69	92.64	85.46	68.83	90.67	79.67	83.89	86.67	91.22	86.33	92.28	72.06	90.94	80.67	84.61	87.67	91.78	87.06	93.00	70.44	90.81	80.17	84.25	87.17	91.50	86.69	92.64	85.46																																																																																																																																		
Overall mean	84.94																																																																																																																																																																																			
Comparing means	SEM (±)	85.97																																											SEM (±)	85.97																																											SEM (±)	85.46																																													SEM (±)	85.46																																												
Treatment	CD (p=0.05)	1.68																																											CD (p=0.05)	1.98																																											CD (p=0.05)	1.28																																													CD (p=0.05)	1.28																																												
Container	SEM (±)	0.60																																											SEM (±)	0.70																																											SEM (±)	0.46																																													SEM (±)	0.46																																												
Storage period	SEM (±)	0.30																																											SEM (±)	0.35																																											SEM (±)	0.23																																													SEM (±)	0.23																																												
T X C	SEM (±)	0.37																																											SEM (±)	0.43																																											SEM (±)	0.28																																													SEM (±)	0.28																																												
T X D	SEM (±)	0.85																																											SEM (±)	1.00																																											SEM (±)	0.65																																													SEM (±)	0.65																																												
C X D	SEM (±)	1.04																																											SEM (±)	1.22																																											SEM (±)	0.80																																													SEM (±)	0.80																																												
T X C X D	SEM (±)	0.52																																											SEM (±)	0.61																																											SEM (±)	0.40																																													SEM (±)	0.40																																												
CV %	SEM (±)	1.47																																											SEM (±)	1.73																																											SEM (±)	1.13																																													SEM (±)	1.13																																												
	CV %	2.99																																											CV %	3.47																																											CV %	3.24																																													CV %	3.24																																												

Table 3. Effect of polymer film coating, fungicide, insecticide, storage containers and storage period on seedling vigour index I of wheat

Container	2016-17															2017-18															Pooled														
	Treatment					Treatment					Treatment					Treatment					Treatment					Treatment																			
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	CXD	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	CXD	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	CXD																		
D ₁	1078	1461	1199	1226	1350	1498	1327	1533	1334	1333	1792	1416	1441	1637	1829	1585	1861	1612	1205	1627	1308	1334	1494	1664	1456	1697	1473																		
D ₂	457	940	699	779	845	977	815	1004	815	892	1357	1078	1158	1284	1390	1289	1456	1238	674	1148	889	968	1064	1184	1052	1230	1026																		
D ₃	158	682	423	513	559	701	568	735	542	275	982	625	724	776	958	795	981	765	217	832	524	619	667	829	682	858	654																		
D ₁	1087	1565	1213	1277	1423	1671	1375	1732	1418	1373	1910	1418	1531	1715	1918	1660	1981	1688	1230	1738	1316	1404	1569	1794	1517	1856	1553																		
D ₂	628	999	762	799	911	1017	895	1064	884	1050	1446	1127	1212	1348	1508	1307	1595	1324	839	1222	945	1005	1130	1262	1101	1329	1104																		
D ₃	355	761	443	553	652	786	611	813	622	507	991	614	761	898	1013	841	1077	838	431	876	529	657	775	899	726	945	730																		
Treatment	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	C	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	C	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	C																		
	TXC															TXC															TXC														
C ₁	564	1028	774	839	918	1059	904	1091	897	833	1377	1040	1108	1232	1393	1223	1433	1205	699	1202	907	973	1075	1226	1063	1262	1051																		
C ₂	690	1108	806	876	995	1158	960	1203	975	977	1449	1053	1168	1321	1479	1269	1551	1283	833	1279	930	1022	1158	1319	1115	1377	1129																		
Treatment	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	D	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	D	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	D																		
	TXD															TXD															TXD														
D ₁	1082	1513	1206	1252	1386	1585	1351	1632	1376	1353	1851	1417	1486	1676	1873	1622	1921	1650	1218	1882	1312	1369	1531	1729	1487	1777	1513																		
D ₂	542	969	731	789	878	997	855	1034	849	971	1402	1103	1185	1316	1449	1298	1526	1281	757	1185	917	987	1097	1223	1077	1280	1065																		
D ₃	257	722	433	533	605	743	590	774	582	391	987	620	743	837	986	818	1029	801	324	854	526	638	721	864	704	902	692																		
Treatment mean	627	1068	790	858	957	1108	932	1147		905	1413	1047	1138	1276	1436	1246	1492		766	1241	918	998	1117	1272	1089	1319																			
Overall mean	936															1244															1090														
Comparing means	SEm (±)	SEm (±)	SEm (±)	SEm (±)	SEm (±)	SEm (±)	SEm (±)	SEm (±)	SEm (±)	SEm (±)	SEm (±)	SEm (±)	SEm (±)	SEm (±)	SEm (±)	SEm (±)	SEm (±)	SEm (±)	SEm (±)	SEm (±)	SEm (±)	SEm (±)	SEm (±)	SEm (±)	SEm (±)	SEm (±)	SEm (±)																		
Treatment	5.51	2.76	3.38	7.80	9.55	4.78	13.51	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60																		
Container	5.51	2.76	3.38	7.80	9.55	4.78	13.51	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60																		
Storage period	5.51	2.76	3.38	7.80	9.55	4.78	13.51	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60																		
T X C	5.51	2.76	3.38	7.80	9.55	4.78	13.51	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60																		
T X D	5.51	2.76	3.38	7.80	9.55	4.78	13.51	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60																		
C X D	5.51	2.76	3.38	7.80	9.55	4.78	13.51	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60																		
T X C X D	5.51	2.76	3.38	7.80	9.55	4.78	13.51	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60																		
CV %	2.60															3.33															3.09														
	CD (p=0.05)															CD (p=0.05)															CD (p=0.05)														
Treatment	16.52	2.80	15.18	7.92	9.70	4.85	18.13	55.24	7.76	45.77	21.96	26.89	NS	55.00	16.52	2.80	15.18	7.92	9.70	4.85	18.13	55.24	7.76	45.77	21.96	26.89																			

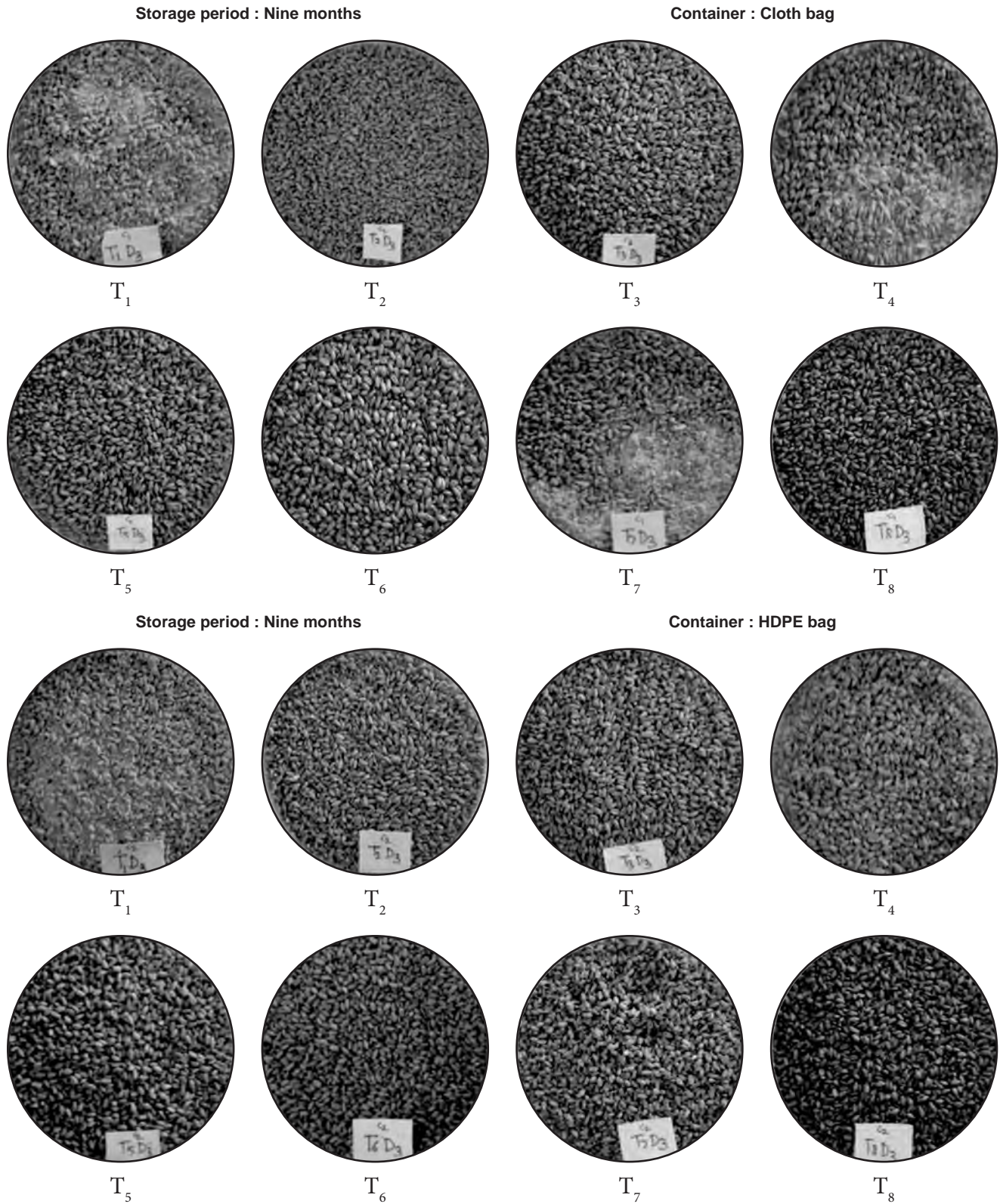


Plate 1. Effect of seed treatment with polymer coating, insecticide, fungicide and storage containers on seed quality after nine months storage

T₁: Control, T₂: Deltamethrin 2.8 EC @ 0.5 ml/kg seed, T₃: Vitavax power @ 2.5 g/kg seed, T₄: Polymer seed coating @ 5 ml/ kg seed,
 T₅: T₂ + T₃, T₆: T₂ + T₄, T₇: T₃ + T₄, T₈: T₂ + T₃ + T₄

and (14.13) was recorded by the seeds stored in HDPE bag and treated with Deltamethrin 2.8 EC @ 0.5 ml/kg seed + Vitavax power @ 2.5 g/kg seed + Polymer seed coating @ 5 ml/kg seed (T_8C_2). The values for most of the observed seed quality parameters were at par by the seeds stored in HDPE bag and treated with Deltamethrin 2.8 EC @ 0.5 ml/kg seed (T_2C_2) and Deltamethrin 2.8 EC @ 0.5 ml/kg seed + Polymer seed coating @ 5 ml/kg seed (T_6C_2).

Interaction Effect of Seed Treatment and Storage Period on Field Emergence (%)

Significantly higher field emergence (95.50%), (95.67%) and (95.58%), germination (97.33%), (97.83%) and (97.58%), seedling vigour index I (1632), (1921) and (1777), seedling vigour index II (14.21), (18.01) and (11.80) was recorded after three months of storage in seeds treated with Deltamethrin 2.8 EC @ 0.5 ml/kg seed + Vitavax power @ 2.5 g/kg seed + Polymer seed coating @ 5 ml/kg seed (T_8D_1). At par values for most of the observed seed quality parameters were recorded by the three months stored seeds treated with Deltamethrin 2.8 EC @ 0.5 ml/kg seed (T_2D_1) and Deltamethrin 2.8 EC @ 0.5 ml/kg seed + Polymer seed coating @ 5 ml/kg seed (T_6D_1).

Interaction Effect of Storage Container and Period on Field Emergence (%)

Significantly higher field emergence (91.50%), (91.54%) and (91.52%), germination (93.46%), (94.13%) and (93.79%), was recorded by the seeds stored in HDPE bag after three month storage (C_2D_1) during 2016-17, 2017-18 and in pooled analysis, respectively and was at par with seeds stored in cloth bag for three months (C_2D_1). However, the differences in seedling vigour index I was not found significant during experimental duration and significantly higher seedling vigour index II (10.12) during 2016-17.

Interaction Effect of Seed Treatment of Polymer Film Coating, Fungicide, Insecticide, Storage Container and Storage Period on Field Emergence (%)

It was observed that the field emergence was significantly influenced due to combined effect of seed treatment with polymer film coating, fungicide, insecticide, storage container and storage period and the differences were also found significant during both the years. Significantly

higher field emergence (96.67%), (97.00%) and (96.83%), germination (98.33%) and (98.67%) and (98.50%), seedling vigour index I (1732), (1981) and (1856) and significantly higher seedling vigour index II (16.06) and (19.08) was recorded by seeds treated with Deltamethrin 2.8 EC @ 0.5 ml/kg seed + Vitavax power @ 2.5 g/kg seed + Polymer seed coating @ 5 ml/kg and stored in HDPE bag for three months ($T_8C_2D_1$) during 2016-17, 2017-18 and pooled analysis, respectively. However the differences in seedling vigour index II was not found significant in pooled analysis. Field emergence was at par by the same treatment combination of seed treatment and storage duration and stored in cloth bag ($T_8C_1D_1$) as well as seeds treatment of Deltamethrin 2.8 EC @ 0.5 ml/kg seed + Polymer seed coating (@ 5 ml/kg and stored in HDPE and cloth bag for three months *i.e.* ($T_6C_1D_1$), ($T_6C_2D_1$), respectively.

Higher values for seed quality parameters were recorded by the combined seed treatment with polymer film coating along with fungicide and insecticide might be due to pathogen and pest suppressive nature of chemicals. Seed treatment with Vitavax reduced seed deterioration due to fungal invasion and physiological ageing [14, 15]. Deltamethrin is a pyrethroid and was very effective in controlling the insect pest during storage and found the most effective protectant against *Rhizopertha dominica* due to its phytotoxic effect in wheat [16]. Seeds coated with liquid polymer creates smooth surface on seed coat so there is no choice to lay eggs on seed coat. Higher seed quality of polymer coated maize seeds during storage has been reported [17]. Polymer film acts as physical barrier and reduces the leaching of inhibitors from the seed coverings and may restrict oxygen diffusion to embryo which resulted in reduced respiration of embryo [18]. The polymer coated to the seeds keeps the seed intact, as it acts as binding material, covers the minor cracks and aberrations on the seed coat and blocked the fungal invasion [19]. Reduced leaching of inhibitors from the seed coverings restricts oxygen diffusion to the embryo, which maintained the seed viability for comparatively longer period of time [20]. The experimental findings are in agreement with the previous studies in rice [21], sunflower [22] and wheat [23].

Freshly harvested wheat seeds treated with Deltamethrin 2.8 EC @ 0.5 ml/kg seed + Vitavax power @ 2.5 g/kg seed + Polymer seed coating @ 5 ml/kg and stored in HDPE bag could maintain the seed quality for nine months and

the HDPE bag maintained the wheat seed germination above the Indian Minimum Certification Standards at the end of nine months storage and was found to be more useful in maintaining the desired seed quality for longer period.

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