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Effects of polymer seed coating and fungicide seed treatment on seedling characteristics of tomato (*Lycopersicon esculentum*) during storage

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Abstract
The present storage experiment was conducted at Department of Genetic and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, Uttar Pradesh during 2016 - 2017 with tomato seeds (Cv. Arka saurabh). The seeds were coated with polymer in combination with fungicide (thiram) and maintained untreated seeds (control) where T_0 is control, T_1 is fungicide(thiram) alone 3g/kg of seeds, T_2 is polymer @ 3ml/kg of seeds, T_3 is polymer @ 5ml/kg of seeds, T_4 is polymer @ 7ml/kg of seeds, T_5 is polymer @ 3ml + thiram @2g/kg, T_6 is polymer @ 5ml/kg + thiram @ 2g/kg and T_7 is Polymer @ 7ml + thiram @ 2g/kg of seeds. Treated seeds were packed in polythene bag (700 gauge) and aluminium foil pouch (factor P_1 and P_2) for the assessment of seed germination, seedling length, seedling dry weight, seedling vigour indices, moisture content and seed infection where data was subjected to factorial experiment laid out in completely randomized design. Germination percentage, seedling length, seedling dry weight, seedling vigour indices were high in seed treatment T_7P_2 as compared to all other seed treatments. However, seed infection and moisture content were lowest in T_7P_2.

Keywords: Tomato, thiram, polymer, polythene bag, aluminium foil pouch

Introduction
Tomato (*Lycopersicon esculentum*) belongs to the genus *Lycopersicon* under Solanaceae family. Tomato is herbaceous sprawling plant growing to 1-3 m in height with weak woody stem. The flowers are yellow in colour and the fruits of cultivated varieties vary in size from cherry tomatoes, about 1–2 cm in size to beefsteak tomatoes, about 10 cm or more in diameter. Most cultivars produce red fruits when ripe. Tomato ranks next to the potato crop and ranks first among the processing crops in the world acreage. Tomato is a native to Peruvian and Mexican region. Though there are no definite records of when and how it came to India, the Portuguese perhaps introduced it to India.

Tomato also has high medicinal value; the pulp and juice is digestible, promoter of gastric secretion and blood purifier. Tomato is commonly consumed in our daily life and it is a good source of antioxidants. Tomato contains 95.3% of water, 0.07% calcium and niacin, all of which have great importance in metabolic activities of humans. With high nutritional value, it provides a balance source of Vitamin A, C and E needed to maintain good human health.

The polymer coat provides protection from stress imposed by accelerated ageing, which include fungal invasion. The coat is thin (84u), simple to apply, diffuses rapidly and non-toxic to the seed during germination. It improves plant stand and emergence of seeds, accurate application reduces chemical wastage, helps to make room for including all required ingredients protect the nutrients, plant growth promoters, hydrophobic/hydrophilic substances, oxygen suppliers and protect seed from attach of ants. By encasing the seed with thin film of biodegradable polymer, the adherence of seed treatment to the seed is improved, ensures dust free handling, making treated seed both useful and environment friendly. Polymer coating makes sowing operation easier due to the smooth flow of seeds.

Packaging materials play a major role in prolonging the shelf life of a seed during storage as they separate seeds from the surrounding environment. Some packaging materials are moisture pervious and some are impervious. Suitability of various packaging materials for safe storage of seeds for longer periods needs to be studied under various crop seeds.

Materials and Methods
After imposition of seed treatments, the treated seed along with untreated seeds (control) were packed in aluminium foil pouch and polythene bag (700 gauge) and stored under ambient conditions of Department of Genetics and Plant Breeding, Sam Higginbottom University of

Agriculture, Technology and Sciences, Allahabad, Uttar Pradesh for six months. The seed samples drawn at bimonthly intervals were evaluated for various seed quality parameters in order to determine the suitable treatment for better storage.

Results and Discussion

Significant results were obtained due to seed treatment with polymer coating and fungicide for the seed quality parameters. Among the seed treatments, T_7 followed by T_6 recorded significantly higher germination at the end of 6 months of storage period. Treatment T_7P_2 was effective for maintaining the germination over T_0P_1 (control). The decline in germination is attributed to ageing leading to depletion of food reserves and decline in synthetic activity of embryo apart from the death of seed because of fungal invasion, insect damage and storage conditions. Thiram acted as protective agent against fungal invasion and physiological ageing. The film formed around the seed act as a physical barrier, which has been reported to reduce leaching of inhibitors from the seed covering and may restrict oxygen diffusion to the embryo. The higher germination percentage can be seen in polymer coated seeds, it is mainly due to increase in the rate of imbibition where the fine particles in the coating acts as a "wick" or moisture attracting material or perhaps to improve germination.

Germination %, Seedling length and vigour index I and II of tomato were significantly higher in seeds coated with polymer @ 7ml/kg of seed along with thiram @ 2g/kg of seed T_7 followed by T_6 (polymer @ 5ml/kg and thiram @2g/kg of seed) stored in aluminium foil pouch compared to all other treatments and the lowest germination %, Seedling length and vigour index I and II recorded in T_0 (control) at the end of 6 months storage (Table). Similar results were also reported by Geetharani *et al*, 2006 [7], Kamara *et al.* (2014) [3].

At the end of six months of storage period, the lowest moisture content and seed infection was recorded in the seeds coated with polymer @ 7ml/kg of seed along with thiram @2g/kg of seeds T_7 followed by T_6 (polymer @ 5ml/kg of seeds and thiram @ 2g/kg of seed) stored in aluminium foil pouch and the highest moisture content and seed infection was recorded in T_0 (control).

Treated seed stored in aluminium foil pouch had lesser fungal infection as compared to untreated seed stored in polythene bag. The incidence of fungi depends on the moisture content of seed, temperature and relative humidity. These results are in conformity with the results of in maize. The seeds coated with polymer combined with fungicide had minimal fungal infection (Geetharani *et al.*, 2006) [7] in chilli.

Table 1: Effect of seed treatments and packaging materials of germination %

Treatments	2 Months		4 Months		6 Months	
	P1	P2	P1	P2	P1	P2
T0	85.75	86	84.75	85.5	82.25	83.5
T1	87.5	87.75	85.75	86.5	83	84.75
T2	88.25	88.5	86	86.5	83.25	85
T3	88.25	88.5	86.5	87	83.5	85
T4	88.75	89	86.75	87.25	84.5	85.25
T5	89.25	89.5	87	87.5	84.75	85.75
T6	89.25	89.5	87	87.75	85	86
T7	89.5	90	87.25	88.25	85.25	86.5
mean	88.31	88.59	86.38	87.03	83.94	85.22
	T	P	T	P	T	P
SEm±	0.487	0.244	0.44	0.22	0.44	0.22
CD at 5%	1.39	NS	1.25	0.6252	1.25	0.6252

Table 2: Effect of seed treatments and packaging materials of seedling length (cm)

Treatments	2 Months		4 Months		6 Months	
	P1	P2	P1	P2	P1	P2
T0	15.13	15.22	13.78	14.02	10.86	12.21
T1	16.07	16.14	14.77	15.18	12.12	13.42
T2	16.11	16.22	15.15	15.41	12.51	13.84
T3	16.46	16.60	15.72	16.02	12.87	14.42
T4	17.24	17.31	15.95	16.35	12.97	15.02
T5	17.82	17.91	16.21	16.57	13.28	15.56
T6	17.92	17.99	16.45	16.93	13.59	16.14
T7	18.25	18.29	16.70	17.39	14.18	16.29
Mean	16.87	16.96	15.59	15.98	12.80	14.61
	T	P	T	P	T	P
SEm±	0.139	0.069	0.151	0.075	0.153	0.076
CD at 5 %	0.39	NS	0.429	0.214	0.434	0.217

Table 3: Effect of seed treatments and packaging materials of vigour index I

Treatments	2 Months		4 Months		6 Months	
	P1	P2	P1	P2	P1	P2
T0	1297	1309	1168	1199	893	1019
T1	1406	1416	1267	1313	1006	1137
T2	1422	1436	1303	1333	1042	1176
T3	1452	1468	1359	1393	1075	1226
T4	1530	1541	1383	1427	1096	1280
T5	1590	1603	1410	1450	1126	1334
T6	1599	1610	1430	1485	1155	1388
T7	1633	1646	1457	1534	1209	1409
Mean	1491	1503	1347	1392	1075	1246
	T	P	T	P	T	P
SEm±	14.109	7.054	13.15	6.575	12.729	6.364
CD at 5%	40.12	NS	37.392	18.696	36.194	18.097

Table 4: Effect of seed treatments and packaging materials on seed moisture content (%)

Treatments	2 Months		4 Months		6 Months	
	P1	P2	P1	P2	P1	P2
T0	6.43	6.42	7.20	6.58	7.42	6.87
T1	6.42	6.40	7.03	6.56	7.19	6.84
T2	6.39	6.37	6.96	6.55	7.01	6.83
T3	6.37	6.37	6.80	6.53	6.95	6.83
T4	6.36	6.34	6.74	6.52	6.92	6.81
T5	6.33	6.30	6.63	6.50	6.92	6.8
T6	6.32	6.30	6.58	6.49	6.9	6.77
T7	6.3	6.29	6.37	6.48	6.84	6.69
Mean	6.37	6.35	6.79	6.52	7.02	6.80
	T	P	T	P	T	P
SEm±	0.015	0.007	0.067	0.034	0.05	0.025
CD at 5 %	0.04	NS	0.191	0.096	0.141	0.071

Table 5: Effect of seed treatments and packaging materials on seed infection (%)

Treatments	2 Months		4 Months		6 Months	
	P1	P2	P1	P2	P1	P2
T0	4.76	4.70	5.12	4.85	5.75	5.50
T1	3.15	3.12	3.47	3.24	4.79	4.76
T2	4.47	4.42	4.45	4.38	5.14	5.08
T3	4.23	4.35	4.25	4.21	5.08	5.06
T4	4.19	4.17	4.02	4.01	5.02	4.96
T5	3.50	3.43	3.59	3.58	4.90	4.81
T6	3.25	3.19	3.44	3.38	4.83	4.77
T7	3.14	3.10	3.34	3.21	4.72	4.69
Mean	3.83	3.81	3.96	3.85	5.03	4.95
	T	P	T	P	T	P
SEm±	0.024	0.012	0.029	0.015	0.025	0.012
CD at 5 %	0.07	NS	0.083	0.042	0.071	0.035

NS: Non significant

T_0- Control (uncoated)
T_1- Only Fungicide (thiram @ 3g/kg of seed)
T_2- Polymer @ 3ml/kg of seed
T_3- Polymer @ 3ml/kg of seed
T_4- Polymer @ 5ml/kg of seed
T_5- Polymer @ 5ml + thiram @ 2g/kg of seed
T_6- Polymer @ 7ml + thiram @ 2g/kg of seed
T_7- Polymer @ 7ml + thiram @ 2g/kg of seed
P_1 – Polythene bag 700 gauge
P_2 – Aluminium foil pouch

Conclusion

It is concluded that tomato seeds treated with the combined treatment of polymer and fungicide T7 followed by T6 recorded significantly higher seed quality parameters. These two seed treatments were found effective in improving the shelf life of seed and productivity and it is more beneficial to the farmers. Tomato seeds packed in aluminium foil pouch were found very effective for extending the seed longevity and maintaining the storability by safe guarding seed deteriorating from mycoflora.

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