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Short Communication

Effect of seed coating with polymers and carbendazim on seed quality and storability in tomato (*Solanum lycopersicum* L.)

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Tomato is one of the most popular vegetable crop of global importance and belongs to the family of *Solanaceae.* It is the most impotent commercial sub-tropical vegetable crop of India and ranks second in both area and production. Tomato lose its viability and vigour rapidly in storage. The success of seedling establishment at the field level largely depends on the initial quality of the seed. In recent times, various quality improvement treatments are given to the seeds as a pre- sowing treatment (Manjunatha *et al.* 2008). Seed coating is a pre- sowing technique, where in an external material is applied on the seed which does not obscure its shape. Polymer is a film coating chemical normally applied over seed without significantly increasing the size or weight of seeds (Manjunatha*et al.* 2008). This type of plasticizer polymers form a flexible film that prevent dusting off and loss of fungicide during handling and are rapidly soluble in water (hydrophilic), so as not to impede with normal germination (Manjunatha *et al.* 2008 and Trivedi and Gunasekaran 2013). The application of polymers to seed serves as an extra exterior shell in order to give the desired seed characteristics viz. quick or delayed water uptake and enhanced germination that would be beneficial for better emergence and establishment in the given environment (Clayton 1988). Film coating along with colorant is an emerging pre-sowing seed management technique, recommended for high value agricultural crops (Savitri *et al.* 1994 and Manjunatha *et al.* 2008). Hence, an attempt was made to prolong the longevity of the seeds through seed management practices under ambient storage conditions.

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A Laboratory experiment was undertaken at KrishiVigyan Kendra (ICAR-VPKAS), Chinyalisaur, Uttarkashi, Uttrakhand during 2013-14, to evaluate the effect of polymers and fungicides on seed quality during storage.The freshly harvested tomato fruits were taken andseeds cleaned thoroughly. The seeds were dried to 6% moisture content and then imposed with the following seed treatments, T_1- Polymer blue@ 20ml+ bavistin @1g / kg of seed; T_2- Polymer red @ 20ml + bavistin @ 1 g / kg of seed; T_3- Polymer green 20ml + bavistin @ 1 g/kg of seeds; T_4- polymer black @ 20ml + bavistin@ 1g /kg of seed; T_5- Polymer pink @ 20ml + bavistin@ 1 g/kg of seed; T_6- Polymer clear @ 20ml + bavistin 1g/kg of seed; T_7- Polymer clear 20ml/kg of seed and T_8-control (Untreated) and stored for 12 months in polythene bag.The experiment was laid out in Completely Randomized Design (CRD) with four replications.Five hundred grams (500g) seeds of freshly harvested tomato cv. VLT-4 were taken for each treatment. Care was taken during mixing to have uniformity in coating and the seeds were air dried under shade to bring back to its original moisture content. After the seed coating, the seeds were packed in polythene bags. The tri-monthly observation on germination percentage (ISTA 1996), seedling length, vigour index (Abdul and Anderson 1973), field emergence, electrical conductivity of seed leachate (Presley 1958) and seed infection percent were calculated. The statistical analysis was done as per the procedure described by Panse and Sukhatme 1985.

Significant results were recorded due to polymer coating for all the seed quality parameters analysed in the laboratory (Table 1). The germination percentage gradually decreased from 89.97 to 75.42 % which was above minimum seed certification standards (70%)at the end of 12 months of storage (Trivedi and Gunasekaran 2013). Among the different treatment combinations, the seeds coated with polymer pink @ 20ml +bavistin@1 g

/ kg of seed (T_5) recorded significantly higher germination (77.83%)followed by 77 % in T_2 (seed coating with polymer red @20ml + bavistin@1g/ kg of seed) as compared to control (72.97) in T_8 treatment.

The decline in germination percentage may be attributed to ageing effect, leading to depletion of food reserves and decline in synthetic activity of embryo apart from death of seed because of fungal invasion, insect damage and storage conditions. Likewise decrease in germination with increase in storage period was reported in soybean (Kurdikeri 1996) and also due to dye treatment in sorghum (Savitri 1994). The chemical acts as a protective agent against seed deterioration due to fungal invasion and physiological ageing as a result of which the seed viability was maintained for a comparatively longer period of time (Kurdikeri 1996). The film formed around seed act as a physical barrier, which has been reported to reduce leaching of inhibitors from the seed coverings and may restrict oxygen diffusion to the embryo (Duan and Burris 1997). The higher germination percentage can be seen in polymer dye coated seeds. It is due to increase in the rate of imbibition where the fine particle coating acts as a “wick” or moisture attracting materials or perhaps to improve germination.

Significantly higher seedling length (15.76 cm) was recorded in seeds coated with polymer pink@20ml +bavistin @ 1 g /kg of seed (T_5). Followed by14.73 cm in T_2 (polymer red@ 20ml + bavistin@1g/kg of seed) as compared to untreated seeds (T_8) which recorded lower seedling length (10.89 cm) at the end of 12 months of storage period. The decline in seedling length may be attributed to age induced decline in germination and damage caused by fungi and insects and due to toxic metabolic that might have hindered the seedling growth and higher seedling length in polymer coated seeds were due to higher rate of water uptake and low seed deterioration of seed during storage.

Gradual decrease in seed vigour was noticed with increase in storage period irrespective of seed treatment (Table1). Significantly higher vigour index (1227) was recorded in seeds coated with polymer pinck 20ml+bavistin@1g/kg of seed (T_5) followed by 1134 in T_2 (polymer red@ 20ml +bavistin @1g /kg of seed) as compared to untreated seeds (T_8) which recorded significantly lower seedling vigour index (795) at the end of 12 months of storage. The decrease in vigour index may be due to age induced decline in germination, decrease in dry matter accumulation in seedling and decrease in seedling length. Similar findings were reported in sorghum (Savitri 1994) and chilli (Geetharani 2006).

Significantly higher field emergence of (76.12%) was recorded in seeds coated with polymer pink 20ml +bavistin@1 g/kg of seed (T_5) followed by 65.11 % in T_2 (polymer red@ 20ml +bavistin 1 g/ kg of seed) as compared to untreated seeds (T_8) which recorded significantly lower field emergence (49.13%) at the end of 12 months of storage (Table 2). This decrease in field emergence may be due to age induced deteriorative changes in cell and cell organelles and germination capacity of seed under natural soil conditions. Higher field emergence can be seen in polymer dye coated seeds. It is due to increase in the rate of imbibition, where the fine particles in the coating acts as “ wick” or moisture attracting materials or perhaps to improve seed soil contact . Coating with hydrophilic polymer regulates the rate of water uptake, reduce imbibitiondamage and improve the emergence of soybean seeds (Hwang & Sung 1991)

Significantly lower electrical conductivity of seed leachate (1.511 dSm^{-1}) was recorded in seeds coated with polymer pink 20ml +bavistin@1g/ kg of seed (T_5) followed by 1.535 dSm^{-1} in T_2 (polymer red@ 20ml +bavistin@1g/ kg of seed) as compared to untreated

Table 1. Effect of seed coating with polymers and bavistin on germination (%), seedling length (cm) and seedling vigour index-1 in tomato seed under ambient storage conditions

Treatments	Months after storage														
	Germination (%)					Seedling length (cm)					Seedling vigour index -1				
	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12
T_1	89.90	88.19	84.89	84.49	76.28	19.30	17.57	16.40	15.17	13.91	1735	1550	1392	1282	1061
T_2	90.00	88.92	85.61	80.58	77.00	19.41	18.39	17.22	16.03	14.73	1747	1635	1474	1292	1134
T_3	89.98	88.71	85.41	80.11	76.80	19.41	18.19	17.02	15.79	14.53	1747	1614	1454	1265	1116
T_4	89.98	87.67	84.05	78.42	74.79	19.38	16.82	15.68	14.45	15.19	1744	1475	1318	1133	1136
T_5	90.01	89.75	86.45	80.85	77.83	19.40	19.32	18.15	16.99	15.76	1746	1734	1569	1274	1227
T_6	90.00	87.04	83.45	77.84	74.20	19.41	16.13	14.96	13.73	12.47	1747	1404	1248	1069	925
T_7	89.90	86.70	83.05	77.00	73.50	19.40	15.31	14.24	13.85	11.85	1744	1327	1183	1066	871
T_8	89.98	85.78	82.21	76.60	72.97	19.41	14.50	13.33	12.12	10.89	1747	1244	1096	928	795
Mean	89.97	88.25	84.39	78.86	75.42	19.39	17.03	15.88	14.67	13.42	1532	1503	1340	1157	1012
S.Em ±	0.07	0.10	0.12	0.10	0.11	0.07	0.07	0.06	0.08	0.70	12	14	16	12	13
CD at 5 %	NS	0.29	0.35	0.31	0.34	NS	0.20	0.18	0.23	0.21	NS	39	46	34	38

Table 2. Effect of seed coating with polymers and bavistin on field emergence (%), electrical conductivity of seed leachate (dSm^{-1}), seed infection (%) in tomato seed under ambient storage conditions

Treatments	Months after storage														
	Field emergence (%)					Electrical conductivity of seed leachate (dSm^{-1})					Seed Infection (%)				
	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12
T_1	88.10	77.80	70.40	66.00	55.92	0.333	0.419	0.740	1.325	1.579	2.90	3.83	4.51	5.40	6.70
T_2	88.13	82.50	76.52	73.55	65.11	0.332	0.374	0.698	1.290	1.535	3.00	3.48	4.17	5.06	6.36
T_3	88.11	81.80	75.52	72.55	64.55	0.333	0.392	0.713	1.299	1.554	2.90	3.65	4.34	5.23	6.53
T_4	88.12	75.40	68.20	64.40	55.70	0.332	0.441	0.765	1.350	1.584	3.00	3.99	4.68	5.57	6.87
T_5	88.11	87.50	83.81	83.31	76.12	0.334	0.353	0.675	1.268	1.511	2.80	3.05	3.68	5.00	5.30
T_6	88.12	73.40	65.21	61.10	52.70	0.332	0.463	0.788	1.379	1.610	3.00	4.16	4.85	5.74	7.04
T_7	88.11	72.00	64.20	59.80	51.10	0.332	0.485	0.810	1.405	1.639	3.00	4.46	5.20	6.16	7.65
T_8	88.11	70.11	62.22	57.78	49.13	0.333	0.505	0.835	1.435	1.660	3.00	4.70	5.70	6.60	8.23
Mean	88.11	77.56	70.76	67.31	58.79	0.333	0.429	0.753	1.344	1.584	2.95	3.92	4.64	5.47	6.84
S.Em ±	0.08	0.37	0.37	0.34	0.34	0.007	0.007	0.008	0.007	0.008	0.10	0.14	0.15	0.36	0.36
CD at 5 %	NS	1.10	1.09	1.00	1.01	NS	0.020	0.022	0.20	0.023	NS	0.41	0.43	1.00	1.01

seeds (T_8) which recorded significantly higher electrical conductivity of seed leachate (1.660 dSm^{-1}) at the end of 12 months of storage (Table 2). This variation in electrical conductivity of seed leachate indicating increased membrane permeability and decreased compactness of seed coat and cellular membrane deterioration. Similar findings were reported by Patel et.al. (2004)and the polymer film formed around seed acts 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 (Duan and Burris 1997).

In the present study, the fungal infection had significant influence from one month of storage up to 12 months. Significantly lower seed infection (5.30%) was recorded in seeds coated with polymer pink 20ml +bavistin@1g/kg of seed (T_4) followed by 6.36 % in T_2(polymer red@ 20ml+bavistin @1g /kg of seed) as compared to untreated seeds (T_8) which recorded higher seed infection (8.63%) at the end of 12 months of storage (Table 2). However, non – significant results were recorded in T_2, T1, T3, T4, T6 treatment which were at par with each other. The infection by the fungal pathogen was comparatively low in above treatments compared to control (8.23%) due to the preventive mechanism in seeds coated with fungicide and similar findings were also reported in various crops (Kumarand Agrawal 1998, Manjunatha 2008 and Bhanuprakash 2008).

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