Effect of polymer seed coating, chemicals and biological agent on storability of chickpea (*Cicer arietinum* L.) seeds

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Abstract: The present storage experiment was conducted at Department of Genetic and Plant Breeding, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Uttar Pradesh during 2015 - 2016 with chickpea cv. Pusa-256 obtained from Department of Genetics and Plant Breeding, SHIATS. The seeds were coated with polymer in combination with fungicide (bavistin 2 g/kg seed), insecticide (imidacloprid @ 2.5 ml/kg seed), bioagent (*Pseudomonas florosence* @ 10 g/kg seed) and maintained untreated seeds (control) where T1 is polymer coat alone, T2 is polymer + thiram, T3 is polymer + imidacloprid, T4 is polymer + thiram + imidacloprid, T5 is polymer + bavistin + imidacloprid + *Pseudomonas florosence* and T0 is control. Treated seeds were packed in cloth bag and polythene bag (700 gauge) (factor P1 and P2) at ambient conditions for assessment of seed germination, seedling length, seedling dry matter, seedling vigour indices, moisture content, insect infestation and electrical conductivity where data was subjected to factorial experiment laid out in completely randomized design. The present investigation revealed that the treatment T5 and stored in polythene bag was found to be superior in germination, seedling length, seedling dry matter, seedling vigour indices, and maintained lower moisture content, insect infestation and electrical conductivity as compared to other treatments. However moisture content, insect infestation and electrical conductivity were found in T5.

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Key words: chickpea, germination, polymer, bavistin, imidacloprid, polythene bag, cloth bag.

Introduction

Chickpea (***Cicer arietinum* L.**) is commonly known as bengalgram, gram, channa, kadle *etc.* and is the third most important pulse crop in the world after beans and peas. Anatolia in Turkey was the area where chickpea was believed to has originated (**Van Der Maesen, 1984**). Chickpea is popularly cultivated in sub tropical and semi arid to warm temperate regions under dry season. Chickpea is predominantly consumed in the form of whole grain dhal, sprouted grain, green or matured dry seeds and is used in the preparation of variety of snacks, sweets and condiments. It has highly digestible protein (21.1%), carbohydrate (61.5%), and fat (4.5%), relatively free from anti nutritional factors and is rich in phosphorous, iron, niacin and calcium compared to other pulses (**Saxena, 1990**).

As seed is an efficient media for survival and dissemination of pathogens, in order to reduce the losses due to these pathogens and preserve viability, it is advisable to treat the seeds with fungicides without significant reduction in quality. One of the major constraints in chickpea production is the non availability of quality seeds at the time of planting. The polymer coat provides protection from the stress imposed by accelerated ageing, fungal infection and pest infestation. It improves emergence of seedlings and plant stand in the field. Accurate application of chemicals reduces the wastage, polymer coat helps to make room for including all required ingredients, protectants, nutrients, plant growth promoters, hydrophobic / hydrophilic substances, oxygen suppliers etc. by encasing the seed within a thin film of biodegradable polymer, the adherence of seed treatment chemicals to the seed it ensures dust free handling and make treated seed both useful and environment friendly. Polymer coating makes sowing operation easier due to the smooth flow of seeds. Addition of colorant helps in visual monitoring of placement accuracy, enhance the appearance, marketability and consumer preference. The polymer film coat may act as a physical barrier, which has been reported to reduce the leaching of inhibitors from the seed coverings and may restrict oxygen diffusion to the embryo **(Vanangamudi *et al*., 2003)**.

The detailed information on these aspects of chickpea is lacking and thus deserves the attention of understanding the above aspects that would be of much practical significance to improve the seed production. Hence, an investigation was carried out to know effect of polymer seed coating, chemicals and biological agent on storability of chickpea Cv Pusa-256.

Materials and Methods

The chickpea cv. Pusa-256 seeds obtained from Department of Genetics and Plant Breeding, SHIATS were coated with polymer in combination with fungicide (bavistin @ 2 g/kg seed), insecticide (imidacloprid @ 2.5 ml/kg seed), bioagent (*Pseudomonas florosence* @ 10 g/kg seed) and maintained untreated seeds (control) where T1 is polymer coat alone, T2 is polymer + bavistin, T3 is polymer + imidacloprid, T4 is polymer + bavistin + imidacloprid, T5 is polymer + bavistin + imidacloprid + *Pseudomonas florosence* and T0 is control. Treated seeds were packed in cloth bag and polythene bag (700 gauge) (factor C1 and C2) for assessment of seed germination, seedling length, seedling dry matter, seedling vigour indices, moisture content, insect infestation and electrical conductivity where data was subjected to factorial experiment laid out in completely randomized design. After imposition of seed treatments, the treated seed along with untreated seeds (control) were packed in alluminium foil pouch and polythene bag (700 gauge) and stored under ambient conditions of Department of Genetics and Plant Breeding, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad, Uttar Pradesh for six months i.e. from September 2015 to march 2016. The seed samples drawn at bimonthly intervals were evaluated for various seed quality parameters like germination percentage (Anon., 2011), vigour index (Abdul-Baki and Anderson, 1973), seedling dry weight (ISTA, 1985), moisture content (ISTA rules, 1996) electrical conductivity (Dadlani and Agarwal, 1983) in order to determine the suitable treatment for better storage.

Results and Discussion

The results obtained on different seed quality parameters like seed germination, seedling length, seedling dry matter, seedling vigour indices, moisture content, insect infestation and electrical conductivity are presented as follows. The polymer coated seeds coupled with chemical & biological treatment stored in polythene bag (700 gauge) exhibited superiority in maintaining the seed quality throughout the storage period. Irrespective of the treatments overall the seed quality parameters decreased as the storage period advanced. Significant results were obtained due to seed treatment with polymer coating and fungicide for the seed quality parameters.

Germination percentage

A significant effect on germination percentage was observed by using different seed treatment throughout the storage periods (Table 1). The germination percentage gradually decreased (89.88%) and it was above minimum seed certification standards (85%) at the end of six months of storage. Among the seed treatment combinations, T_5 (89.88%) followed by T_4 (89.63%) recorded significantly higher germination as compared to control T_0 (79.88%) at the end of 6 months of storage period. The seeds stored in polythene bag P_1 (87.58%) was found effective for maintaining the germination over cloth bag P_2 (81.92%) at the end of six months of storage period (Table 1). The decline in seed germination percentage over the storage period may be attributed to ageing effect leading to depletion of food reserves, decline in synthetic activity of embryo, fluctuating temperature, relative humidity and seed moisture content as influenced by storage containers. Coating of seeds with polymer, insecticides and fungicides might have protected the seed from influence of above factors resulting in maintenance of seed viability for a comparatively longer period. The similar findings are in agreement with the results obtained by Verma and Verma (2014), Almeida (2014), Pawar *et al.* (2015).

Seedling length & Vigour Indices

Seedling length and vigour index I (due to seedling length) & SVI-II (due to seedling dry weight) of chickpea were significantly higher in seed coated with Polymer @ 5ml/kg + Bavistin @ 2g/kg + imidacloprid @ 2.5ml/kg + *P.florosence* @10g/kg of seed T_5 (28.85 cm, 2594.3, 21191) followed by T_4 (Polymer @ 5ml/kg + Bavistin @ 2g/kg + imidacloprid @ 2.5ml/kg of seed) (28.30 cm, 2481.9, 19887) and lowest recorded in T_1 (control) (24.09 cm, 1872, 14602). The seeds stored in polythene bag P_1 (28.41 cm, 2491.2, 20199) was found effective for maintaining the Seedling length and vigour index I & II over cloth bag P_2 (25.91 cm, 2109.2, 16071) at the end of six months of storage period respectively (Table 2, 3 and 4). The decrease in the vigour index, root length, shoot length and seedling dry weight may be due to natural ageing induced decline in germination, decrease in dry matter accumulation in seedlings and decrease in seedling length. Similar results were also reported by, Kamara *et al.* (2014), Almeida (2014) and Veraja and Rai (2015).

Seedling dry weight (mg)

Significant differences in seedling dry weight were observed in seed treatment combinations and between packaging materials. However, at the end of six months of seed storage period, T5 (235.49 mg) recorded highest seedling dry weight followed by T_4 (226.62 mg) and the lowest seedling dry weight was recorded in T_0 (185.39 mg). The seeds stored in polythene bag P_1 (230.17 mg) was found effective for maintaining the seedling dry weight over cloth bag P_2 (196.44 mg) at the end of six months of storage period (Table 5). These results are in conformity with findings of Basavaraj *et al.* (2008) in onion, Manjunatha *et al.* (2008) in chilli and Veraja and Rai (2015).

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

Period of seed storage									
Treatment	2 months		Mean	4 months		Mean	6 months		Mean
	P1	P2		P1	P2		P1	P2	
T_0	90.25	90.00	90.13	87.25	85.50	86.38	83.25	76.50	79.88
T_1	91.75	91.00	91.38	89.25	87.75	88.50	85.25	79.00	82.13
T_2	94.00	92.50	93.25	91.50	90.50	91.00	88.50	82.25	85.38
T_3	93.50	91.75	92.63	90.00	88.25	89.13	87.25	80.00	83.63
T_4	95.25	93.25	94.25	92.75	91.25	92.00	89.50	85.75	87.63
T_5	96.75	94.75	95.75	94.25	92.50	93.38	91.75	88.00	89.88
Mean	93.58	92.21	**92.90**	90.83	89.29	**90.06**	87.58	81.92	**84.75**
	T	**P**	**T x P**	**T**	**P**	**T x P**	**T**	**P**	**T x P**
SEm±	0.57	0.33	0.80	0.37	0.21	0.52	0.41	0.23	0.57
CD at 5%	1.63	0.94	NS	1.06	0.61	NS	1.16	0.67	1.65

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

Period of seed storage									
Treatment	2 months		Mean	4 months		Mean	6 months		Mean
	P1	P2		P1	P2		P1	P2	
T_0	31.25	28.17	29.71	28.93	26.93	27.93	26.17	22.00	24.09
T_1	31.71	29.39	30.55	29.41	27.55	28.48	27.82	25.69	26.76
T_2	32.11	29.88	31.00	30.55	28.40	29.48	28.86	26.63	27.75
T_3	31.88	29.76	30.82	30.06	28.04	29.05	28.31	26.13	27.22
T_4	32.35	30.02	31.19	31.34	28.80	30.07	29.44	27.16	28.30
T_5	32.80	30.19	31.50	31.62	29.36	30.49	29.84	27.85	28.85
Mean	32.02	29.57	**30.79**	30.32	28.18	**29.25**	28.41	25.91	**27.16**
	T	**P**	**T x P**	**T**	**P**	**T x P**	**T**	**P**	**T x P**
SEm±	0.30	0.17	0.42	0.28	0.16	0.40	0.16	0.09	0.22
CD at 5%	0.89	0.49	NS	0.81	0.47	NS	0.45	0.26	0.64

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

Period of seed storage									
Treatment	2 months		Mean	4 months		Mean	6 months		Mean
	P1	P2		P1	P2		P1	P2	
T_0	2820.3	2457.0	2638.7	2524.1	2302.5	2413.3	2178.7	1565.3	1872.0
T_1	2909.4	2674.5	2791.9	2624.8	2417.5	2521.2	2371.7	2029.5	2200.6
T_2	3018.3	2763.9	2891.1	2795.3	2570.2	2682.8	2554.1	2190.3	2372.2
T_3	2980.8	2730.5	2855.6	2705.4	2474.5	2590.0	2470.1	2090.4	2280.2
T_4	3081.3	2799.4	2940.4	2906.8	2628.0	2767.4	2634.9	2329.0	2481.9
T_5	3173.4	2860.5	3017.0	2980.2	2715.8	2848.0	2737.8	2450.8	2594.3
Mean	2997.3	2714.3	**2855.8**	2756.1	2518.1	**2637.1**	2491.2	2109.2	**2300.2**
	T	**P**	**T x P**	**T**	**P**	**T x P**	**T**	**P**	**T x P**
SEm±	18.74	10.82	26.51	19.39	11.20	27.42	14.77	8.52	20.88
CD at 5%	53.76	31.04	NS	55.62	32.11	NS	42.35	24.45	59.89

Table 4: Effect of seed treatments and packaging materials of seedling vigour index-II

Period of seed storage									
Treatment	2 months		Mean	4 months		Mean	6 months		Mean
	P1	P2		P1	P2		P1	P2	
T_0	23670	20996	22333	20013	16744	18379	17047	12095	14602
T_1	24143	21301	22722	21216	18147	19681	18822	14512	16667
T_2	25553	22552	24053	23223	20017	21620	20729	16594	18662
T_3	24987	21948	23468	22165	18957	20561	20013	15587	17800
T_4	26072	23230	24651	23971	20888	22430	21701	18074	19887
T_5	26819	23822	25321	24896	22007	23451	22881	19501	21191
Mean	25207	22308	**23758**	22581	19460	**21020**	20199	16071	**18135**
	T	**P**	**T x P**	**T**	**P**	**T x P**	**T**	**P**	**T x P**
SEm±	230.68	133.19	326.24	204.75	118.21	289.56	177.92	102.72	251.61
CD at 5%	661.64	382.00	NS	587.25	339.05	NS	510.29	294.62	721.66

Seed moisture content (%)

The moisture content differed significantly due to packaging materials and seed treatment combinations during storage period. At the end of six months of storage period, the lowest (9.65%) moisture content was recorded in T_5 followed by T_4

(10.49%) stored in polythene bag and the highest (11.78%) moisture content was recorded in T_0 (control). Among the packaging materials, significantly lowest (10.20%) seed moisture content was noticed in polythene bag P_1 compared to cloth bag (11.69%) at the end of the storage period, respectively (Table 6). The results of the present study revealed that the moisture content of the seeds increased with increase in period of storage Increase in seed moisture might be due to metabolic release of water during respiration and the hygroscopic nature of seed. Similar results were recorded by Malimath and Merwade (2007), Chattha *et al.* (2012) Monira *et al.* (2012) and Veraja and Rai (2015).

Insect infestation

At the end of six months of storage period period, the lowest insect infestation was recorded in the seeds treated with Polymer.

@ 5ml/kg + Bavistin @ 2g/kg + imidacloprid @ 2.5ml/kg + *P.florosence* @10g/kg of seeds T_5 (3.78%) followed by T_4 (Polymer @ 5ml/kg + Bavistin @ 2g/kg + imidacloprid @ 2.5ml/kg of seed) (4.06%) lowest recorded in T_0 (control) (5.12%). The seeds stored in polythene bag P_1 (4.24%) had lesser insect infestation as compared to cloth bag P_2 (4.66%) (Table 7). Imidacloprid in combination in T_5 and T_4 was found very effective in controlling in insect pest due to phytotoxic effect and reduced the insect infestation. Similar findings were reported by Suresh Vegulla, (2008) in maize and Shushma, *et al.* (2014).

***Electrical conductivity* (dSm^{-1})**

The electrical conductivity of seed leachate indicate the membrane integrity and quality of seed and it is negatively correlated with seed quality. The electrical conductivity increases as the storage period advances. At the end of six months period of seed storage, the seed treatment combinations, T_5 recorded lesser (0.495 dSm^{-1}) electrical conductivity, followed by T_4 (0.520 dSm^{-1}) and it was significantly higher in T_0 (0.699 dSm^{-1}). At the end of six months of storage period, seeds stored in polythene bag P_1 (0.572dSm^{-1}) was effective as it is having lesser electrical conductivity over P_2 (0.610 dSm^{-1}) (Table 8). Polymer film may acts as physical barrier, which has been reported to reduced leaching of inhibitors from the seed coverings and may restrict oxygen diffusion to embryo. So the viability maintained for a comparatively longer period of time. Similar results were observed by Avelar *et al*. (2012), Wilson and Geneva (2004) in maize.

Interaction effect due to different seed treatment combinations and packaging materials were observed the seeds quality parameters were higher with T_5P_1 followed by T_4P_1 and lower with T_0P_2 at the end of storage period in most of the cases.

Table 5: Effect of seed treatments and packaging materials of Seedling dry weight (mg)

Period of seed storage									
Treatment	**2 months**		**Mean**	**4 months**		**Mean**	**6 months**		**Mean**
	P1	**P2**		**P1**	**P2**		**P1**	**P2**	
T_0	262.27	243.29	252.78	229.38	195.84	212.61	204.77	166.00	185.39
T_1	263.14	243.56	253.35	237.71	206.80	222.26	220.79	183.69	202.24
T_2	271.84	253.81	262.83	253.80	221.18	237.49	234.23	201.75	217.99
T_3	267.24	249.22	258.23	246.28	214.81	230.55	229.38	194.84	212.11
T_4	273.72	259.12	266.42	258.45	228.91	243.68	242.47	210.77	226.62
T_5	277.20	261.42	269.31	264.15	237.91	251.03	249.38	221.60	235.49
Mean	269.24	251.74	**260.49**	248.30	217.57	**232.93**	230.17	196.44	**213.31**
	T	**P**	**T x P**	**T**	**P**	**T x P**	**T**	**P**	**T x P**
SEm±	2.52	1.46	3.57	2.76	1.59	3.90	1.06	0.61	1.50
CD at 5%	7.24	4.18	NS	7.91	4.57	NS	3.04	1.75	4.30

Table 6: Effect of seed treatments and packaging materials on seed moisture content (%)

Period of seed storage									
Treatment	**2 months**		**Mean**	**4 months**		**Mean**	**6 months**		**Mean**
	P1	**P2**		**P1**	**P2**		**P1**	**P2**	
T_0	9.02	9.21	9.12	10.70	11.21	10.96	10.89	12.66	11.78
T_1	8.90	9.18	9.04	10.26	10.98	10.62	10.56	12.33	11.45
T_2	8.88	9.09	8.99	9.35	10.46	9.91	10.60	11.66	11.13
T_3	8.81	9.14	8.98	9.49	10.63	10.06	10.47	11.87	11.17
T_4	8.78	9.05	8.92	9.22	10.23	9.73	9.81	11.17	10.49
T_5	8.65	9.00	8.83	8.68	9.98	9.33	8.84	10.45	9.65
Mean	8.84	9.11	**8.98**	9.62	10.58	**10.10**	10.20	11.69	**10.94**
	T	**P**	**T x P**	**T**	**P**	**T x P**	**T**	**P**	**T x P**
SEm±	0.09	0.05	0.12	0.10	0.06	0.14	0.11	0.06	0.15
CD at 5%	NS	0.14	NS	0.28	0.16	NS	0.31	0.18	NS

Table 7: Effect of seed treatments and packaging materials on insect infestation (%)

Period of seed storage									
Treatment	**2 months**		**Mean**	**4 months**		**Mean**	**6 months**		**Mean**
	P1	**P2**		**P1**	**P2**		**P1**	**P2**	
T_0	2.19	2.25	2.22	3.25	4.07	3.66	4.86	5.38	5.12
T_1	2.18	2.23	2.21	3.14	3.98	3.56	4.65	4.93	4.79
T_2	2.16	2.21	2.19	3.05	3.85	3.45	4.33	4.79	4.56
T_3	2.17	2.21	2.19	2.97	3.76	3.37	4.11	4.68	4.40
T_4	2.16	2.19	2.18	2.91	3.69	3.30	3.85	4.26	4.06
T_5	2.14	2.18	2.16	2.86	3.63	3.25	3.63	3.93	3.78
Mean	2.17	2.21	**2.19**	3.03	3.83	**3.43**	4.24	4.66	**4.45**
	T	**P**	**T x P**	**T**	**P**	**T x P**	**T**	**P**	**T x P**
SEm±	0.02	0.01	0.03	0.03	0.02	0.05	0.04	0.03	0.06
CD at 5%	NS	0.04	NS	0.10	0.06	NS	0.12	0.07	NS

Table 8: Effect of seed treatments and packaging materials on electrical conductivity (%)

Period of seed storage									
Treatment	**2 months**		**Mean**	**4 months**		**Mean**	**6 months**		**Mean**
	P1	**P2**		**P1**	**P2**		**P1**	**P2**	
T_0	0.330	0.332	0.331	0.498	0.554	0.526	0.652	0.746	0.699
T_1	0.328	0.331	0.330	0.489	0.532	0.511	0.621	0.659	0.640
T_2	0.323	0.327	0.325	0.455	0.493	0.474	0.609	0.643	0.626
T_3	0.324	0.327	0.326	0.463	0.509	0.486	0.551	0.583	0.567
T_4	0.319	0.324	0.322	0.438	0.478	0.458	0.509	0.531	0.520
T_5	0.315	0.321	0.318	0.425	0.449	0.437	0.491	0.498	0.495
Mean	0.323	0.327	**0.325**	0.461	0.503	**0.482**	0.572	0.610	**0.591**
	T	**P**	**T x P**	**T**	**P**	**T x P**	**T**	**P**	**T x P**
SEm±	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01
CD at 5%	NS	NS	NS	0.01	0.01	NS	0.02	0.01	0.02

T_0 - Control (Untreated) P_1 – Polythene bag 700gauge
T_1 - Polymer coating alone @ 5ml kg^{-1} of seeds P_2 – Cloth bag
T_2 - T_1 + Bavistin @ 2g kg^{-1} of seeds
T_3 - T_1 + imidacloprid @ 2.5ml kg^{-1} of seeds S: Significant
T_4 - T_1 + Bavistin @ 2g kg-1 + imidacloprid @ 2.5ml kg^{-1} of seeds NS: Non significant
T_5 - T_4 + *P.florosence* @ 10g kg^{-1} of seeds

Conclusion

From the present investigation it is concluded that the seeds treated with combination of polymer @ 5 ml kg^{-1} + bavistin @2g kg^{-1} + imidacloprid @2.5ml kg^{-1} + *P.florosence* @10g kg^{-1} of seeds (T_5) and polymer @ 5ml kg^{-1} + bavistin @ 2g kg^{-1} + imidacloprid @ 2.5ml kg^{-1} of seeds (T_4) were found to be the best treatment combination for maintenance of chickpea seed quality under ambient conditions for six months period of storage. Chickpea seeds packed in vapour proof packaging material i.e. polythene bag (700 gauge) was very effective for extending the seed longevity and maintaining the storability by safe guarding seed.

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