EFFECT OF POLYMER SEED COATING ON STORABILITY OF BHENDI (*Abelmoschus esculentus* L.) cv. *Arka anamika*

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ABSTRACT

An experiment was conducted to study, the effect of seed coating with polymer, polymer coupled with fungicide and insecticide on seed quality and storability of bhendi cv. *Arka anamika.* The seeds were coated with polymer alone, polymer @ 6 ml kg^{-1} + Thiram @ 2 gm kg^{-1} of seeds and polymer @ 6 ml kg^{-1} + Imidacloprid @ 1 ml kg^{-1} of seeds and stored in polythene bag for nine months. Irrespective of seed coating with polymer and polymer coupled with fungicide and insecticide, seed deteriorated and vigour declined with increased storage period of 9 months. The seeds coated with polymer @ 6 ml kg^{-1} + Imidacloprid @ 1 ml kg^{-1} of seeds maintained higher germination percentage, root length, shoot length, seedling dry weight and seedling vigour index followed by seeds treated with polymer @ 6 ml kg^{-1} + thiram @ 2 gm kg^{-1} of seeds.

Keywords: Bhendi, seed polymer coating, storage.

INTRODUCTION

Bhendi (*Abelmoschus esculentus* L.) is an important vegetable crop belongs to the family Malvaceae. It is native of South Africa and Asia. It is an annual summer vegetable crop grown in tropical and subtropical areas of the globe. The major bhendi growing countries are India, Nigeria, Pakistan, Ghana and Egypt (Badaru, 2011). It is a nutritious vegetable containing 86.1%, water, 2.2% protein, 0.2% fat, 9.7% carbohydrate and 1% fiber (Anonymous, 2007). It is rich in vitamins A, B, C, protein and minerals. It is a good source of Iodine and used to control goitre In India, bhendi is grown in an area of 5.18 lakh hectares with production of 62.5 lakh tones with productivity of 6.25 t/ha (NHB, 2011). The yield of bhendi is decreasing year by year due to availability of poor quality seeds, changed agro climatic condition, pathogenic status *etc.*

Seed is the basic input in agriculture. Quality seed is key for successful crop production and good quality seed increases the yield by 25-50% (George, 1985). The harvested seeds has to be stored, before to its usage in the next season and the seed storage become crucial to avail the benefit of bhendi (Anonymous, 2003).

Seed storage is an important aspect in crop gene bank management and is important to get adequate health and vigorous plant stand. There are several factors influencing the longevity of seeds during storage like genotype of seed, initial seed quality, seed moisture content, temperature, relative humidity, packaging material and period of storage. Aktaruzzamam *et al.* (2010), reported that storage container influenced the quality of bhendi seeds and he opined that sealed container is the best packing material than polythene and gunny bags. The packaging material had significant effect on moisture content of the seed, where the seeds stored in polythene bag and plastic container controlled the moisture content (Fabunmi, 2009). High relative humidity and temperature cause high moisture content in seeds resulting low germination at the end of storage (McCormack, 2004). Seed storage duration is another factor causing seed deterioration due to natural ageing and increased storage period, enhances the seed deterioration process. Proper storage conditions are important for retaining viability of seeds over a considerable storage periods. Seed deterioration is irreversible, inevitable and inexorable process, but deterioration process can be slowed down by various seed quality enhancement treatments like seed pelleting, seed hardening, seed colouring seed priming and seed coating.

Seed coating is a pre-sowing seed treatment, where the external material is applied to the seed without affecting the size and shape of seeds. Polymer is a film coating material applied over the seeds without increasing size and weight of the seed. This kind of plasticizer polymer form flexible film over the seeds that prevents dusting off and loss of fungicides during handling and readily water soluble and not affecting normal germination process (Sherin Susan John, 2003). The film coating provides protection from the stress imposed by accelerated ageing and fungal invasion. Therefore, the present study was undertaken to investigate the use of seed coating with polymer alone and in combination with insecticide and fungicide for improving the seed storability.

MATERIALS AND METHODS

Genetically pure and nine months of old seeds of bhendi cv. *Arka anamika* was obtained from Vegetable Research Station, Palur, Tamil Nadu was used as basic material for this study. The seeds were coated with polymer in combination with fungicide and insecticide and maintained untreated seeds (control).

The various seed treatments are

T_1 – Control

T_2 – Polymer @ 6 ml kg^{-1}

T_3 – Polymer @ 6 ml kg^{-1} + Thiram @ 2 g kg^{-1}

T_4 – Polymer @ 6 ml kg^{-1} + Imidocloprid 1 ml kg^{-1}

The experiment was designed in completely randomized block design with four replications. The treated seeds were packed in polythene bag (700 gauge) and seeds were stored ambient condition of Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalainagar for a period of nine months.

The seed samples drawn at biomonthly intervals and were evaluated for various seed quality tests.

Germination (%)

Germination test was conducted in four replications of 100 seeds each by adopting paper towel method as described by ISTA procedures (Anon, 1999). Seeds were incubated in growth cabinets. The temperature of 25 ± 1°C and RH of 95 per cent was maintained during the germination test. Daily germination count was performed until no further germination occurred for 14 consecutive days, then germination per cent was calculated.

$$\text{Germination \%} = \frac{\text{Number of seeds germinated}}{\text{Number of seeds kept for germination}} \times 100$$

Root length

Ten normal seedlings were selected randomly in each treatments on 14th day from germination test. The root length was measured from the tip of primary root to base of hypocotyl with the help of a scale and mean root length was measured.

Shoot length

Ten normal seedlings used for root length measurement were also used for the measurement of shoot length. The shoot length was measured from the tip of primary leaf to the base of hypocotyl and mean shoot length was expressed in centimetre.

Seedling dry weight

The normal seedlings used for root and shoot length measurements were put in butter paper cover pocket and kept in hot air oven 100°C for 2 h. The mean dry weight of the seedling was recorded and expressed in milligram.

Vigour index

Vigour index (VI) was computed from the germination percentage and the total seedling length as suggested by Abdul-Baki and Anderson (1973) and expressed in whole number

$$\text{VI} = \text{Germination (\%)} \times \text{Seedling length (cm)}$$

Electrical conductivity

Four replicates of 50 seeds were taken at random from each treatment, pre-washed with deionised water and soaked in 50 ml of deionized water for 12 hrs at room temperature. The seed steep water was decanted and measured for electrical conductivity in a digital conductivity meter. The conductivity values were expressed in dSm^{-1}.

Speed of germination

Seeds were germinated in sand medium with three replications of 100 seeds each. The number of seeds germinated was recorded daily upto the day to final count. The speed of germination was calculated by adopting the following formula (Maguire, 1962).

$$\text{Speed of germination} = \frac{X_1}{Y_1} + \frac{X_2 - X_1}{Y_2} + \frac{X_n - (Xn - 1)}{Yn}$$

X_n = Number of seeds germinated at n^{th} count

Y_n = Number of days from sowing to n^{th} count

RESULTS AND DISCUSSION

Seed deterioration is an irreversible and inexorable process. The rate of seed deterioration could not be stopped completely, but it can be slowed down by storing the seeds under controlled conditions or treating with chemicals. Seed coating with polymer is one such pre-storage treatment that can be used either singly or in combination with other fungicides and insecticides. Duan and Burris (1997) explained the possibilities of using polymers along with other chemicals to ensure the keeping quality of seeds since the controlled conditions involves huge cost, the seed coating could be the alternative method to maintain seed quality seed during storage.

The data pertaining to seed quality parameters *viz.,* germination per cent, seedling dry weight, vigour index, field emergence and moisture content is influenced by seed coating treatments. The results showed significant differences with respect to germination and vigour due to seed coating treatments. The polymer coating coupled with chemical treatment stored in polythene bag exhibited superiority in maintaining the seed quality through out the storage period. All the seed quality parameters decrease as the storage period increases in all the seed treatments.

Significant results were obtained due to polymer coating for all the seed quality parameters evaluated in the laboratory. Germination percentage declined in all the treatments gradually from 72.0 per cent to 49.0 per cent with the advancement of storage period, but it was above the seed certification standards (65.0%) at the end of 3 months of storage (Table 1). Among the different treatments, seed coated with polymer @ 6 ml kg^{-1} + Imidacloprid @ 1 ml kg^{-1} (T_4) recorded significantly higher germination (65%) followed by 61% in T_3 (seed coating with polymer @ 6 ml kg^{-1} + Thiram @ 2 gm kg^{-1}) as compared to control (T_1) (57%) at the end of 7 months of storage period. At the end of 9 months of storage period T_4 maintained higher germination per cent, while the control recorded the least germination per cent. The seeds treated with polymer coupled with imidacloprid or thiram recorded higher germination per cent against the lowest recorded in control. The polymer with fungicide and insecticide reduce the impact of ageing enzymes by acting as protective agent against seed deterioration due to fungal invasion, insect attack and physiological ageing as a result of which seed viability could be maintained for longer period of time. These results are in conformity in maize (Vanangamudi *et al.*, 2003) and in chilli (Manjunatha *et al.*, 2008). Polymer and seed treatment chemicals cover the pores in the seed coat and prevent the entry of water and fungal mycelia and provide protection from physical damage. Similar results was recorded by Rathinavel and Raja (2007). The decline in germination percentage may be attributed to ageing leading to depletion of food reserves and decline in synthetic activity of embryo due to fungal invasion and insect damage.

Significantly higher root length (5.93 cm) and shot length (11.36 cm) were recorded for seed coated with polymer @ 6.0 ml per kg of seed + Imidacloprid @ 1 ml per kg of seed (T_4) followed by seed coated with polymer @ 6 ml kg^{-1} + Thiram @ 2 gm kg^{-1} of seed (T_3) as compared to untreated seeds (T_1) which recorded the lowest root length (4.67 cm) and shoot length (9.23 cm) at the end of 9 months of storage period (Table 2 & 3). The decline in seedling length may be attributed to age induced decline in germination and damage caused by fungi and insects and higher root length and shoot length in (polymer + imidacloprid) T_4 and (polymer + thiram) T_3 coated seeds was due to higher germination percentage and better initial growth of seedlings. Similar results were reported in rice (Dadlani *et al.*, 1992) and in soybean (Polimero *et al.*, 2007).

Significantly higher field emergence (56.56%) was recorded in seeds coated with polymer @ 6 ml kg^{-1} + Imidacloprid @ 1 ml kg^{-1} (T_4) followed by (53.34%) in T_3 (polymer @ 6 ml kg^{-1} + thiram @ 2 gm kg^{-1} of seed) as compared to untreated seeds (T_1), which recorded lower field emergence (45.08%) at the end of 9 months of storage period (Table 4). This decrease in field emergence may be due to age induced deteriorative changes in cell and cell organelles and high field emergence in polymer coated seed is due to increase in the rate of water imbibition. Similar finding was reported in soybean (Hwang and Sung, 1991).

Significantly higher seedling dry weight (0.16 g) was recorded for seed coated with polymer @ 6 ml kg^{-1} + Imidacloprid @ 1 ml kg^{-1} (T_4) followed by (0.110 gm) in T_3 (polymer @ 6 ml kg^{-1} + Thiram @ 2 gm kg^{-1} of seeds) as compared to control (T_1) which recorded the lower seedling dry weight (0.040 g) at the end of 9 months of storage period (Table 5). The dry matter seed production of seedling is the ultimate manifestation of physiological vigour. This is essentially a physiological phenomenon influenced by the reserve metabolites, enzyme activities and growth regulators. Similar results was recorded in rice (Dadlani *et al.*, 1992).

Gradual decline in seedling vigour index was recorded with advancement of storage period irrespective of seed treatments. Significantly higher vigour index (1054) was recorded for T_4 seed treatment followed by (946) T_3 seed treatment as compared to control (T_1) which recorded the lower seedling vigour index (681) at the end of 9 months of storage period (Table 6). The decline 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 finding was reported in clusterbean (Renugadevi *et al.*, 2008).

The moisture content of seed due to various seed treatments varied significantly throughout the storage period (Table 7). Significantly lowest moisture content (10.37%) was recorded in T_4 (seed coated with polymer @ 6 ml kg^{-1} + Imidacloprid @ 1 ml kg^{-1} of seeds) followed by T_3 (10.52%) where as control (T_1) recorded highest moisture content (11.1%) at the end of nine months of storage period. In storage conditions, where the relative humidity fluctuates, seed moisture content varies in equilibrium with atmospheric water vapour and to obtain equilibrium seed grains and looser the moisture. In the present study, seed moisture content increased throughout the storage.

Electrical conductivity of seed leachate increased as the storage period advanced. Significantly lower electrical conductivity of seed leachates (220.6 dSm^{-1}) was recorded in (T_4) seeds treated with polymer @ 6 ml kg^{-1} + Imidacloprid @ 1 ml kg^{-1} of seeds followed by (T_3) seeds treated with polymer @ 6 ml kg^{-1} + Thiram

@ 2 gm kg^{-1} of seeds, whereas control (T_1) recorded higher electrical conductivity of seed leachate (274.7 dSm^{-1}) at the end of 9 months of storage period (Table 8). The difference in electrical conductivity of seed leachate indicate that there is increased membrane permeability and decrease in integrity of cellular membrane. Similar results was reported in pearlmillet (Patil *et al.*, 2004). The polymer film formed around the seed acted as physical barrier, which reduce leaching of electrolytes from seed covering (Duan and Burris, 1997).

The present study showed that higher germination percentage, root length, shoot length, field emergence, seedling dry weight and seedling vigour index and lower electrical conductivity of seed leachates was recorded in seed coated with polymer @ 6 ml kg^{-1} + Imidacloprid @ 1 ml kg^{-1} of seeds followed by seeds treated with polymer 6 ml kg^{-1} + Thiram @ 2 gm kg^{-1} of seeds stored in polythene bag for nine months of storage period.

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Table 1. Effect of polymer seed coating, container and period of storage on germination (%) of stored seeds of bhendi cv. *Arka anamika*

Polymer coating treatments	Period of storage					
	M1	**M3**	**M5**	**M7**	**M9**	**Mean**
T1	70 (56.29)	66 (53.73)	61 (51.35)	57 (48.44)	49 (43.85)	60 (50.18)
T2	71 (57.42)	68 (54.94)	62 (50.86)	59 (50.13)	52 (45.57)	62.4 (51.71)
T3	72 (58.05)	70 (56.29)	65 (53.13)	61 (51.35)	57 (48.44)	63.8 (51.85)
T4	72 (58.05)	71 (57.42)	68 (54.94)	65 (53.13)	61 (51.35)	65.4 (53.21)
Mean	66.5 (53.79)	65.2 (53.19)	63.5 (51.89)	61 (51.35)	58.2 (49.67)	62.8 (51.74)

M – Month; T – Treatment

Table 2. Effect of polymer seed coating, container and period of storage on root length (cm) of stored seeds of bhendi cv. *Arka anamika*

Polymer coating treatments	Period of storage					
	M1	M3	M5	M7	M9	Mean
T1	5.66	5.43	5.23	4.93	4.67	5.18
T2	6.58	6.26	5.91	5.67	5.32	5.94
T3	6.96	6.53	6.26	5.83	5.41	6.19
T4	7.31	6.84	6.60	6.23	5.93	6.58
Mean	6.62	6.26	6.0	5.66	5.33	5.97
S.Ed.	0.008	0.023	0.082	0.006	0.002	-
CD at 5%	0.018	0.55	0.018	0.015	0.011	-

Table 3. Effect of polymer seed coating, container and period of storage on shoot length (cm) of stored seeds of bhendi cv. *Arka anamika*

Polymer coating treatments	Period of storage					
	M1	M3	M5	M7	M9	Mean
T1	10.46	10.15	9.73	9.40	9.23	9.79
T2	11.50	11.10	10.83	10.42	10.21	10.81
T3	11.80	11.56	11.40	11.03	11.20	11.39
T4	12.33	11.96	11.60	11.40	11.36	11.73
Mean	11.52	11.19	10.89	10.56	10.5	10.93
S.Ed.	0.072	0.090	0.080	0.050	0.070	-
CD at 5%	0.018	0.021	0.019	0.023	0.016	-

Table 4. Effect of polymer seed coating, containers and period of storage on field emergence of stored seeds of bhendi cv. *Arka anamika*

Polymer coating treatments	Period of storage					
	M1	**M3**	**M5**	**M7**	**M9**	**Mean**
T1	70.81 (56.66)	55.01 (47.29)	48.31 (43.45)	46.73 (42.54)	45.08 (41.59)	47.18 (42.80)
T2	73.55 (58.39)	57.50 (48.73)	54.76 (47.15)	51.76 (45.43)	48.74 (43.70)	57.26 (48.59)
T3	76.85 (60.56)	61.58 (51.10)	59.62 (49.95)	56.70 (48.26)	53.34 (46.33)	61.61 (51.12)
T4	79.52 (62.38)	66.93 (54.28)	63.68 (52.34)	60.81 (50.65)	56.56 (48.18)	65.42 (53.37)
Mean	75.18 (59.45)	60.25 (50.32)	56.59 (48.20)	54.00 (46.72)	50.93 (44.95)	57.86 (48.93)
S.Ed.	1.16	1.12	0.95	0.99	0.76	-
CD at 5%	2.47	2.41	2.05	2.14	1.64	-

Table 5. Effect of polymer seed coating, container and period of storage on seedling dry weight (g) of stored seeds of bhendi cv. *Arka anamika*

Polymer coating treatments	Period of storage					
	M1	**M3**	**M5**	**M7**	**M9**	**Mean**
T1	0.17	0.14	0.10	0.06	0.04	0.10
T2	0.25	0.21	0.16	0.11	0.09	0.16
T3	0.27	0.23	0.19	0.13	0.11	0.18
T4	0.30	0.25	0.22	0.19	0.16	0.22
Mean	0.24	0.20	0.16	0.12	0.1	0.16
S.Ed.	0.009	0.008	0.005	0.004	0.007	-
CD at 5%	0.019	0.017	0.014	0.09	0.015	-

Table 6. Effect of polymer seed coating, container and period of storage on vigour index of stored seeds of bhendi cv. *Arka anamika*

Polymer coating treatments	Period of storage					
	M1	M3	M5	M7	M9	Mean
T1	1128.4	1028.2	912.5	816.8	681.1	913.4
T2	1283.6	1180.4	1037.8	949.3	807.5	1051.7
T3	1350.7	1266.3	1147.9	1028.4	946.7	1148
T4	1414	1334.8	1237.6	1145.9	1054.6	1237.3
Mean	1294.1	1202.4	1083.9	985.1	872.4	1087.5
S.Ed.	18.36	23.68	21.02	21.06	19.01	-
CD at 5%	31.54	41.20	43.12	43.23	38.72	-

Table 7. Effect of polymer seed coating, container and period of storage on moisture content of stored seeds of bhendi cv. *Arka anamika*

Polymer coating treatments	Period of storage					
	M1	**M3**	**M5**	**M7**	**M9**	**Mean**
T1	10.85	10.88	10.90	10.93	11.1	10.93
T2	10.16	10.37	10.40	10.62	10.64	10.43
T3	10.04	10.26	10.33	10.45	10.52	10.32
T4	9.94	10.08	10.16	10.23	10.37	10.15
Mean	10.24	10.39	10.44	10.55	10.65	10.45
S.Ed.	0.073	0.164	0.183	0.17	0.16	-
CD at 5%	0.150	0.336	0.067	0.038	0.35	-

Table 8. Effect of polymer seed coating, container and period of storage on electrical conductivity (dsm^{-1}) of stored seeds of bhendi cv. *Arka anamika*

Polymer coating treatments	Period of storage					
	M1	**M3**	**M5**	**M7**	**M9**	**Mean**
T1	196.8	214.3	235.7	255.2	274.7	235.34
T2	182	205.3	219.1	242.7	262.7	222.36
T3	165.8	185.1	197.5	225.7	243.8	203.58
T4	149.5	166.8	178.9	199.2	220.6	183.00
Mean	173.52	192.87	207.8	230.7	250.45	211.07
S.Ed.	0.955	0.872	0.799	1.149	2.13	-
CD at 5%	1.951	1.781	0.163	3.40	5.87	-