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Effect of resultant seeds from drip irrigation and fertigation on seed storability of Bhendi

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Abstract
The present investigation was carried out to study the resultant seeds storage potential of bhendi. The resultant seeds of bhendi were stored in cloth bag and aluminium foil pouches under ambient conditions. The bhendi seeds were treated with Bavistin and Imidachloprid along with control. Bhendi resultant seeds obtained from drip fertigation with 100% RDF treated with imidachloprid 1 ml/kg and stored in aluminium foil pouches maintained lower electrical conductivity, free sugars, free amino acids and maintained higher enzyme activities like dehydrogenase, α-amylase, protease and protein content throughout the period of storage.

Keywords: Resultant seeds, storage, aluminium foil pouch, enzyme activities

Introduction

In the seed industry seed storage is very important which decides the seed quality until next sowing season. By using quality seeds yield can be increased by considerable level. Deterioration in seed starts after physiological maturity of seed crop and it affects viability and vigour potential of seeds. Initial seed quality, location of seed production, seed treatment, mechanical injury, packaging material and storage environment largely affects the viability and vigour of seeds (Verma *et al.* 1993) [41]. Seed deterioration is an irreversible change which is associated with ageing and degradation in the seed quality. Seed deterioration leads to formation and activation of hydrolytic enzymes, enzymes inactivation and degradation, affects seed metabolism, starvation of meristamatic cells, inability of ribosomes to disassociate, degradation of functional structures and accumulation of toxic compounds which results in reduced germination.

The exchange of the moisture between surrounding storage environment and seeds can be prevented by use of moisture proof containers. Seed vigour is not only decided by genetic makeup also governed by seed storage conditions and retention of viability (Deepa *et al.* 2013) [8]. Treating the seeds with chemicals during storage suppress the storage pests and fungi and maintains seed quality (Gupta *et al.*, 1989) [10]. Seed material should be packed in units of convenient size for further storage and distribution. Seed storage is inluenced by moisture content of seed, initial seed quality after harvest, storage conditions such as relative humidity, temperature (Roberts, 1973) [27]. Standardization of suitable packing material and seed treatment is very important for early emergence of crop, establishment and plant growth are required for maintaining the seed quality during storage (Wani *et al.* 2014) [43].

Materials and methods

The resultant seeds of bhendi obtained are studied for the storability after imposing seed treatment and packed in packaging material. The present investigation was carried out at Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore. The resultant seeds are treated with Bavistin 2g/kg and Imidachloprid 1 ml/kg and the packaging material include cloth bag and aluminium foil pouches. The treatments imposed are T_1 – Furrow irrigation + 125% RDF as soil application, T_2 - Furrow irrigation + 125% RDF as soil application and treated with Bavistin 2g/kg, T_3 - Furrow irrigation + 125% RDF as soil application and treated with Imidachloprid 1 ml/kg, T_4 – Drip irrigation + 125% RDF as soil application, T_5 – Drip irrigation + 125% RDF as soil application and treated with Bavistin 2g/kg, T_6 – Drip irrigation + 125% RDF as soil application and treated with Imidachloprid 1 ml/kg, T_7 – Drip fertigation with 100% RDF, T_8 – Drip fertigation with 100% RDF and treated with Bavistin 2g/kg and T_9 – Drip fertigation with 100% RDF and treated with Imidachloprid 1 ml/kg.

The study was conducted by following Factorial Completely Randomized Design with three replications. The biochemical characters are evaluated at bi monthly intervals. The biochemical analysis was carried out such as electrical conductivity, free amino acids, free sugars, dehydrogenase activity, α-amylase, protease and protein content. Electrical conductivity was determined according to Presley (1958) [24], free amino acids by Ching and Ching (1964) [6], free sugars by Somogyi (1952) [36], dehydrogenase activity by Kittock and Law (1968) [14], α-amylase by Sadasivam and Manickam (2008) [28], protease by Naithani (1987) [18] and protein content by Ali-khan and Youngs (1973) [2]. The statistical analyses of the results were done according to Panse and Sukhatme (1985) [22].

Results and discussion

In the present investigation, the EC values (Table 1), free amino acids (Table 3) and free sugars (Table 4) of the seed leachates of the stored seeds showed positive association with the period of storage irrespective of treatments and containers. The increase in EC values, free amino acids and free sugars was more pronounced in the seeds of surface irrigation with 125% RDF as soil application and the increase in EC values was minimum for the seeds from drip fertigation with 100% RDF and treated with imidachloprid 1 ml/kg. Between the containers, the seeds stored in cloth bag showed increased seed leachate values irrespective of treatments. However, the treated seeds showed lesser rate of increase compared to untreated ones. Such increase in seed leachate values have already been reported by Saxena and Singh (1987) [31], Santhaceline (1991) [30], Vijayakumar (1996) [42], Umesha *et al.* (2017) [39], Autade and Ghuge (2018) [4] and Saisanthosh and Patil (2018) [29].

The relationship of the EC of the seed leachate to the membrane integrity has been discussed in detail by Ching and Schoolcraft (1968) [7], Koostra and Harrington (1969) [15] and Berjak and Villiers (1972) [5]. The leachate exudates from the seed in terms of EC have been known to be associated with loss of vigour and viability (Mathews and Bradnock, 1968 [16] and Perry, 1969) [23]. Decrease in electrical conductivity, free amino acids and free sugars was found in seeds stored in aluminium foil pouch which may be due to reduced release of free radical and lipid peroxidation by maintaining higher membrane integrity due to lesser moisture fluctuation as compared to seeds stored in cloth bags (Shelar *et al.* 2008) [33]. Seed deterioration leads to higher permeability of membrane integrity, increase in free fatty acids, production of free radical due to lipid peroxidation which leads to increased leakage of electrolytes, free amino acids, sugars, etc. Significantly higher negative correlation occurs between electrical conductivity of seed leachate and seed viability. Use of proper packaging material leads to proper disintegration of membrane integrity and lesser solute leakage which causes loss of seed vigour and viability. Similar results were reported by Singh and Malavika Dadlani (2003) [34].

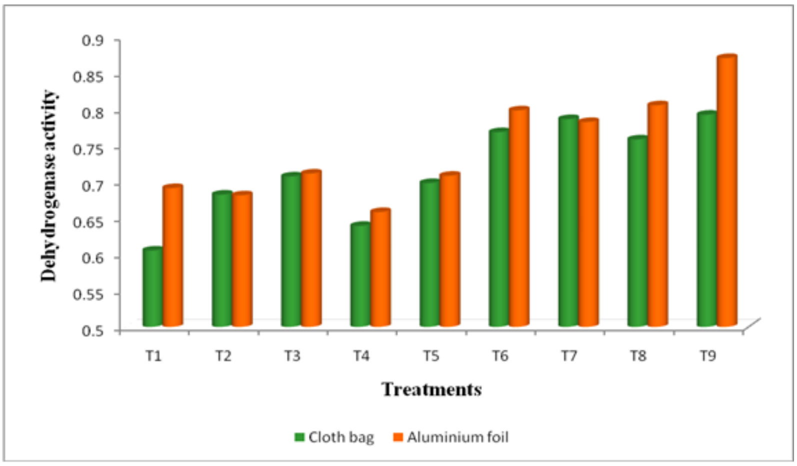

Fig 1: Effect of drip irrigation and drip fertigation treatments on dehydrogenase activity in different storage container in six months after storage in Bhendi cv. Arka anamika

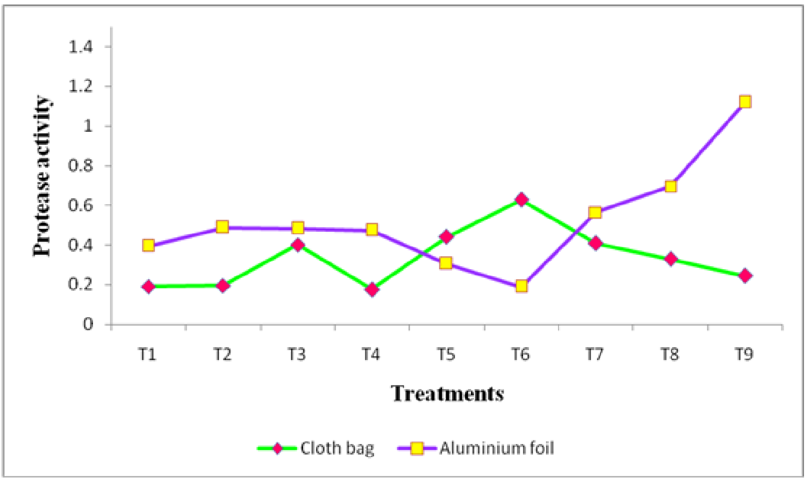

Fig 2: Effect of drip irrigation and drip fertigation treatments on protease activity in different storage container in six months after storage in Bhendi cv. Arka anamika

Table 1: Effect of drip irrigation and drip fertigation treatments, storage container and period of storage on electrical conductivity in Bhendi cv. Arka anamika

Storage periods	P0		P1		P2		P3		Mean	
Containers / Treatments	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
T1	0.312	0.310	0.344	0.338	0.375	0.364	0.425	0.416	0.364	0.357
T2	0.292	0.308	0.323	0.318	0.354	0.346	0.368	0.353	0.334	0.331
T3	0.294	0.310	0.334	0.321	0.363	0.353	0.357	0.358	0.337	0.335
T4	0.296	0.312	0.328	0.317	0.358	0.375	0.388	0.375	0.342	0.344
T5	0.304	0.301	0.312	0.305	0.326	0.325	0.359	0.344	0.325	0.318
T6	0.300	0.298	0.318	0.301	0.337	0.321	0.346	0.338	0.325	0.314
T7	0.308	0.295	0.340	0.306	0.378	0.323	0.425	0.336	0.362	0.315
T8	0.305	0.287	0.316	0.300	0.335	0.318	0.348	0.331	0.326	0.309
T9	0.303	0.284	0.322	0.296	0.342	0.308	0.354	0.328	0.330	0.304
Mean	0.301	0.300	0.326	0.311	0.352	0.337	0.374	0.353	0.338	0.325

	P	C	T	P x C	C x T	P x T	P x C x T
SEd	0.002	0.001	0.003	0.002	0.004	0.006	0.008
CD (P=0.05)	0.004	0.002	0.006	0.005	0.008	0.012	0.017

In this present study, enzymes like dehydrogenase (Fig 1), α-amylase (Table 2), protease (Fig 2) and protein content (Table 5) decrease with increase in the storage period. Drip fertigation with 100% RDF and treated with imidachloprid 1 ml/kg maintained higher enzyme activity, protease and α-amylase content and protein content throughout the storage period. According to Abdul-Baki and Anderson (1972), [1] the dehydrogenase enzyme exhibit decreasing trend in deteriorating seeds. The dehydrogenase, enzyme activity, α-amylase enzyme protease activity and protein synthesis decrease with advancement of storage period. Decline in the activity of dehydrogenase with increased storage period was observed. Similar results were reported by Sitoula (1985) [35] in tomato. Subbarao (1984) [37] observed decrease in the activity of dehydrogenase as well as amylase enzyme during ageing in brinjal and Palanisamy (1990) [21] in tomato.

α-amylase, lipase, proteases, phytases and phosphatises are some of the hydrolytic enzymes whose activity is associated with degradation of nucleoproteins, organelles membranes, etc. In the present study lesser decrease in enzymatic activity such as dehydrogenase, α-amylase, protease and protein content was observed in aluminium foil pouch which was also reported by Selvaraj (1988) [32] in brinjal; Padma and Reddy (2000) [20] in onion; Venkatasalam (2001) [40] in tomato and Ashok *et al* (2019) [3] in onion.

Table 2: Effect of drip irrigation and drip fertigation treatments, storage container and period of storage on α-amylase content in Bhendi cv. Arka anamika

Storage periods	P0		P1		P2		P3		Mean	
Containers / Treatments	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
T1	4.86	6.02	4.94	6.26	4.76	6.16	4.54	6.02	4.77	6.11
T2	6.02	5.52	6.10	5.72	5.78	5.52	5.50	5.38	5.85	5.53
T3	7.12	6.90	7.22	7.06	7.08	7.00	6.86	6.96	7.07	6.98
T4	5.34	5.30	5.42	5.42	5.30	5.30	5.02	5.22	5.27	5.31
T5	7.30	6.34	7.38	6.50	7.14	6.36	6.84	6.22	7.16	6.35
T6	9.12	7.74	9.24	7.90	9.16	7.78	8.42	7.56	8.98	7.74
T7	6.86	7.52	6.98	7.70	6.74	7.58	6.56	7.30	6.78	7.52
T8	8.18	7.08	8.36	7.22	8.02	7.10	7.74	6.96	8.07	7.09
T9	7.56	9.66	8.02	9.96	7.96	9.74	7.62	9.56	7.79	9.73
Mean	6.92	6.89	7.07	7.08	6.88	6.94	6.56	6.79	6.86	6.93

	P	C	T	P x C	C x T	P x T	P x C x T
SEd	0.044	0.031	0.066	0.062	0.094	0.133	0.188
CD (P=0.05)	0.088	0.062	0.132	0.124	0.186	NS	NS

Table 3: Effect of drip irrigation and drip fertigation treatments, storage container and period of storage on free amino acid content in Bhendi cv. Arka anamika

Storage periods	P0		P1		P2		P3		Mean	
Containers / Treatments	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
T1	6.85	6.58	9.85	7.58	12.85	9.58	15.85	12.58	12.55	11.15
T2	5.89	6.43	8.89	7.43	11.89	9.43	14.89	12.43	12.35	10.85
T3	6.56	6.21	9.56	7.21	12.56	9.21	15.56	12.21	12.15	10.55
T4	5.78	5.84	8.78	6.84	11.78	8.84	14.78	11.84	11.95	10.25
T5	5.64	5.58	8.64	6.58	11.64	8.58	14.64	11.58	11.75	9.95
T6	5.46	5.54	8.46	6.54	11.46	8.54	14.46	11.54	11.55	9.65
T7	5.46	5.24	8.46	6.24	11.46	8.24	14.46	11.24	11.35	9.35
T8	5.34	5.18	8.34	6.18	11.34	8.18	14.34	11.18	11.15	9.05
T9	5.23	5.12	8.23	6.12	11.23	8.12	14.23	11.12	10.95	8.75
Mean	7.00	6.70	10.00	8.70	13.00	10.70	17.00	13.70	11.75	9.95

	P	C	T	P x C	C x T	P x T	P x C x T
SEd	0.071	0.050	0.107	0.101	0.152	0.214	0.304
CD (P=0.05)	0.142	0.100	0.213	0.201	0.301	NS	NS

Table 4: Effect of drip irrigation and drip fertigation treatments, storage container and period of storage on free sugars in Bhendi cv. Arka anamika

Storage periods	**P0**		**P1**		**P2**		**P3**		**Mean**	
Containers / Treatments	**C1**	**C2**	**C1**	**C2**	**C1**	**C2**	**C1**	**C2**	**C1**	**C2**
T1	6.85	6.58	9.85	7.58	12.85	9.58	15.85	12.58	11.35	9.08
T2	5.89	6.43	8.89	7.43	11.89	9.43	14.89	12.43	10.39	8.93
T3	6.56	6.21	9.56	7.21	12.56	9.21	15.56	12.21	11.06	8.71
T4	5.78	5.84	8.78	6.84	11.78	8.84	14.78	11.84	10.28	8.34
T5	5.64	5.58	8.64	6.58	11.64	8.58	14.64	11.58	10.14	8.08
T6	5.46	5.54	8.46	6.54	11.46	8.54	14.46	11.54	9.96	8.04
T7	5.46	5.24	8.46	6.24	11.46	8.24	14.46	11.24	9.96	7.74
T8	5.34	5.18	8.34	6.18	11.34	8.18	14.34	11.18	9.84	7.68
T9	5.23	5.12	8.23	6.12	11.23	8.12	14.23	11.12	9.73	7.62
Mean	5.80	5.74	8.80	6.74	11.80	8.74	14.80	11.74	10.30	8.24

	P	C	T	P x C	C x T	P x T	P x C x T
SEd	0.061	0.043	0.092	0.087	0.130	0.184	0.261
CD (P=0.05)	0.122	0.086	0.183	0.172	0.259	NS	NS

Protein content gradually decreased with increase in storage period period. This was in conformity with results of Menaka (2000) [17] in amaranthus and Venkatasalam (2001) [40] in tomato. The decline in protein content with advancement in storage period might be due to increased proteolytic activity which resulted in increased content of free aminoacid and peptides. Similiar results were obtained by Jones *et al* (1942) [13]. During seed deterioration, degradation of protein leads to rearrangement, fragmentation, condensation and polymerization (Tatipata, 2009) [38]. The decrease in protein content presumably, resulted from protein degradation of protease enzymes (Ching and Schoolcraft 1968) [7]. Bhendi seeds stored in aluminium foil pouch maintained higher protein content which is in conformity with Narayana Murthy *et al.* (2003) [19], Tatipata (2009) [38], Radha *et al.* (2013) [25], Saisanthosh and Patil (2018) [29].

Table 5: Effect of drip irrigation and drip fertigation treatments, storage container and period of storage on protein content (%) in Bhendi cv. Arka anamika

Storage periods	**P0**		**P1**		**P2**		**P3**		**Mean**	
Containers / Treatments	**C1**	**C2**	**C1**	**C2**	**C1**	**C2**	**C1**	**C2**	**C1**	**C2**
T1	15.11	24.35	23.73	30.39	18.93	29.03	16.03	24.66	18.45	27.11
T2	25.34	30.76	25.09	25.03	23.61	26.26	20.78	25.03	23.70	26.77
T3	22.69	22.44	25.27	26.26	21.52	25.03	19.42	26.26	22.22	25.00
T4	19.24	22.26	26.57	27.06	21.45	20.90	15.54	18.74	20.70	22.24
T5	22.69	18.25	17.33	33.90	24.04	28.17	19.42	25.58	20.87	26.47
T6	21.76	20.47	27.06	29.59	23.12	26.26	18.00	24.97	22.49	25.32
T7	33.96	19.54	28.48	28.35	24.41	21.02	16.16	16.77	25.75	21.42
T8	18.87	25.64	27.00	29.83	24.29	30.39	20.72	28.48	22.72	28.58
T9	28.48	21.33	29.34	29.71	21.95	31.86	18.93	29.83	24.67	28.18
Mean	23.12	22.78	25.54	28.90	22.59	26.55	18.33	24.48	22.40	25.68

	P	C	T	P x C	C x T	P x T	P x C x T
SEd	0.153	0.108	0.229	0.216	0.324	0.459	0.649
CD (P=0.05)	0.303	0.214	0.455	0.429	0.644	0.911	1.288

The use of sealed containers in the maintenance of seed viability and vigour has been well established (Roberts and Abdalla, 1968) [26]. Seed storability being determined to a large extent by the choice of the container assumes paramount importance (Harrington and Douglas, 1970) [11]. In the present study seeds stored in aluminium foil pouch maintained the biochemical characteristics throughout the period of storage. Similar findings were reported by Doijode (1997) [9] in okra. The efficacy of the sealed containers like aluminium foil pouches was confirmed as the best storer for bhendi (Jayaraj *et al*., 1988) [12].

The impervious nature of aluminium foil pouches leads to lesser fluctuation of moisture into seeds prevents seed deterioration thereby maintained higher biochemical parameters and increased the storage life of seed.

Conclusion

In the present study it can be concluded that higher biochemical parameters of dehydrogenase activity, α-amylase, protease and protein content and lower electrical conductivity, free sugars, free amino acids was maintained by resultant bhendi seeds of drip fertigation with 100% RDF and treated with imidachloprid 1 ml/kg stored in aluminium foil pouches throughout the storage period.

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