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Study on viability and germination of papaya seeds stored at various temperature and seed moisture content

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Abstract
Papaya (*Carica papaya* L.) is the most popular tropical fruit crop which is valued for its wholesome and delicious fruit. Universally it is propagated sexually by seeds. However storage behavior of papaya seeds is still contradictory to recalcitrant or orthodox. Therefore to know the storage behavior of papaya seeds the experiment was conducted at Junagadh Agricultural University. Fifteen treatment combinations *viz*., T_1 (-4 ℃ with 6% MC), T_2 (0℃ with 6% MC), T_3 (4 ℃ with 6% MC), T_4 (8 ℃ with 6% MC), T_5 (Room temperature with 6% MC), T_6 (-4 ℃ with 8% MC), T_7 (0 ℃ with 8% MC), T_8 (4 ℃ with 8% MC), T_9 (8 ℃ with 8% MC), T_{10} (Room temperature with 8% MC), T_{11} (-4℃ with 10% MC), T_{12} (0 ℃ with 10% MC), T_{13} (4 ℃ with 10% MC), T_{14} (8 ℃ with 10% MC) and T_{15} (Room temperature with 10% MC) were assessed with factorial concept in completely randomized design with three replications. The results concluded that T5 (Room temperature with 6% MC) showed highest germination percentage (62.00), seed vigor index length and mass (337.90 and 20.56), shoot length (82.5), root length (26.08), seedling length (40.00), number of leaves (8.85), fresh weight (2.52) and dry weight (1.26) over all other treatments after the storage period of 1 month. T1 (-4 ℃ with 6% MC) exhibits highest seed viability percentage (80.33) over all other treatments after the storage period of 1 month. The seed and seedling growth parameters decrease as the storage period increases. The result clearly indicates that papaya seeds are desiccation tolerant but freezing sensitive which confirms its intermediate storage behavior.

Keywords: Papaya, storage temperature, seed moisture content, viability, germination, desiccation

Introduction
Papaya (*Carica papaya* L.) is generally consumed as desert fruit. It can also be processed into jams, juices and ice cream. Unripe fruits and leaves are consumed as a vegetable and the seeds are also used as an ingredient in salad dressings. Papaya, originated from Central America and successfully introduced to all the tropical areas of the world, is now being cultivated as a commercial fruit in almost all the tropical countries of the world. It is popularly known as paw paw or papaw (British), mamao (Brazil), and lechosa (Venezuela). It was introduced in India by Dutch traders during the 16th century. Papaya is now grown widely in India, Sri Lanka, Australia, Philippines and South Africa. In India, it is grown luxuriantly in the southern peninsular region of Tamil Nadu, Karnataka, Kerala and Andhra Pradesh. Papaya is also successfully cultivated in the states of Maharashtra, Gujarat, Madhya Pradesh, Uttar Pradesh, Bihar and Assam and West Bengal in subtropical region. It is one of the richest sources of vitamin A (2020 IU) after mango.

Propagation of papaya is universally done through seed which is the only viable option. Being a dicot, papaya tree lacks cambium which is a major drawback in carrying out the vegetative propagation and so far there is no commercially feasible vegetative propagation technique is recommended. So, the only way for commercial propagation is through seeds. However, poor seed handling and storage are known to affect germination, seedling emergence, poor or low seedling vigour and even total or complete failure of seedlings with attendant low yield and quality. Papaya seeds deteriorate rapidly at higher storage temperatures and relative humidity. Seed moisture content is very crucial in papaya seed storage. Higher seed moisture content injures the seed life and rapidly reduces seed viability during the storage. Papaya seeds have been grouped as recalcitrant seed by Chin *et al*. (1984) [3] and Hofmann and Steiner (1989) [8] but more recently it was grouped as the intermediate seed (Ellis *et al*., 1990) [5]. Papaya seeds are susceptible to chilling temperatures and are killed when stored at zero or subzero temperatures. Therefore, the seeds are considered intermediate between recalcitrant and orthodox attribute.

Thus the main objective of this experiment is to get the ideal storage conditions for papaya seeds to reduce its deterioration and maintain its germinability.

Materials and Methods

The experiment was carried out at College of Horticulture, Junagadh Agriculture University in Junagadh district of Gujarat during May to November 2019. The seeds of the Papaya cv. GJP 1 were collected from Fruit Research Station, Madhadibaugh, JAU, during May. Seeds were collected from the mature fruits and are dried to desirable moisture content. Then they were sealed in polythene and kept at five different range of temperature for six month. The seeds were evaluated at monthly interval for seed and seedling parameters.

Seed moisture content determination

The desired moisture content was obtained by shade drying the seeds for specific period of time. The moisture content was measured by the oven dry method as per the procedures of ISTA (Anon., 1996). Fresh seeds were weighed in a sensitive electronic balance and were taken in moisture cans that were weighed before filling the sample. Then the moisture cans were kept in hot air oven, maintained at a temperature of 103 ± 2℃ for 17 hours. Later the weight of can with sample and the moisture percentage is estimated by the loss of weight in the sample using the following formula:

$$MC\ (\%) = \frac{(M2 - M3)}{(M2 - M1)} \times 100$$

Where

M1 = Container weight,
M2 = Container weight + Fresh seed weight,
M3 = Dry seed weight

Germination (%)

Seeds were sown in portrays and were considered as germinated when the seedlings emerge from soil surface.

$$\text{Germination percentage} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds sown}} \times 100$$

Seed vigor index length (cm)

A combination of standard germination test with seedling length provides evaluation of seedling vigor index. Vigor index was calculated as per following formula given by Abdual-Baki and Anderson (1973) [1].

Vigor index length = Germination percentage x Seedling length (cm).

Seed vigor index mass (g)

Vigor index is determined by multiplication of germination percentage with seedling dry weight.

Vigor index mass = Germination percentage x Seedling dry weight (g)

Seed viability percentage

Seeds were retrieved every month to determine the viability using tetrazolium test. The seeds were longitudinally cut and completely immersed in 0.1% tetrazolium solution. After 4-5 hours, the seeds were observed for the appearance of red color which indicates the respiratory activity of the seed. The seeds that show the respiratory activity via color change indicated as viable seed.

Shoot length (cm)

After 45 days of sowing, five normal seedlings were uprooted and cleaned with water to remove the adhered soil. Then the shoot length was recorded from collar region to tip of the seedling.

Root length (cm)

Root length of the respective five seedlings was recorded from the base of the root to the tip at 45 days of sowing.

Seedling length (cm)

The combined value of shoot length and root length was recorded as seedling length.

Number of leaves

Numbers of leaves were counted in the tagged plants and the mean is expressed as number of leaves.

Fresh weight of seedling (g)

Immediately after uprooting, the seedlings were washed and dried for ten minutes under shade. Then the fresh weight is checked in weighing balance and the average is recorded as fresh weight in grams.

Dry weight of seedling (g)

Previously uprooted plants were oven dried at 65°C in hot air oven until a constant weight was obtained. After complete drying, the weight of seedling is checked using electronic balance and the mean is expressed as dry weight in grams.

Statistical Analysis

The data was analysed for 'F' test of significance accorded to the methods described by Panse and Sukhatme, 1985. Wherever necessary, the per cent values were transformed to angular (Arc-sine) values before analysis. The critical differences (CD) were calculated at 5 per cent probability level. The data were tested for statistical significance (*). If F test is non-significant, it was indicated as NS.

Results and Discussions

Seed Parameters

The results of the experiment revealed that T_5 (Room temperature with 6% MC) exhibited the highest germination percentage (62.00), seed vigor index length and mass (2481.47 and 77.80) on 1 MAS. Whereas T_{11} (- 4℃ with 10% MC) showed lowest germination percentage (27.00), seed vigor index length and mass (337.90 and 20.56) on 1 MAS (Table 1 and 2). The viability of seeds was found highest (80.33) in T_1 (-4℃ with 6%MC) and lowest (68.00) in T_{15} (Room temperature with 8% MC).

Significantly minimum percentage of germination was recorded when the seeds stored at -4℃ might be due to the fact that chilling temperature causes decrease in the activity of enzymes such as α and β amylase which are essential in the breakdown of starch during respiration. On the other hand seeds stored at room Discussion temperature probably favored the increase of those enzymes which positively affect the germination (Dadjo *et al*. 2019). Papaya seeds are chilling sensitive and may enter into dormancy upon chilling. Low

temperature can cause the formation of intracellular ice crystals which further contributes to gradual seed deterioration (Shuib *et al.* 2018) [12]. Genes and Agnes (2018) [7] reported that increase in storage period resulted in the decline of ability of seeds to germinate. The seed quality parameters decrease as the storage period increases for upto 6 months.

The vigor index length of seed is directly proportional to germination percentage and seedling length. The vigor index mass is directly related to germination percentage and seedling dry weight. Higher the germination percentage, higher will be the vigor index and visa versa.

The results are in conformity with the findings of Ellis *et al.* (1990) [5] in papaya, Sharma *et al.* (2011) [11] in bael, Dadjo *et al.* (2019) [4] in Garcinia kola, Tchokponhoue *et al.* (2019) [13] in miracle berry. However these results are in contradictory to the findings of Zulhisyam *et al.* (2013) [13] in papaya who reported that seeds stored at 0 ℃ showed highest germination percentage.

Significantly highest percentage of germination was observed in the seeds which were dried to 6% moisture. This may be due to the fact that partial drying can reduce seed metabolism and fungal growth on seeds, and deterioration and damage to seeds are reduced in consequence which further leads to higher percentage of germination (Wen 2009). These results are in conformity with the findings reported by Zulhisyam *et al.* (2013) [13] in papaya, Kim (2018) in Populus species and Yang *et al.* (2007) in Zelkova serrata. These findings are in contrast to Ellis *et al.* (1991) [6] who explained that seeds of papaya stored for 12 months with 7.9-9.4% moisture content maintained their original germination.

Seedling Parameters

The data represented in Table-3 and Table-4, depicted that T_5 (Room temperature with 6% MC) showed the highest shoot length (82.5), root length (26.08), seedling length (40.00), number of leaves (8.85), fresh weight (2.52) and dry weight (1.26) on 1 MAS. Whereas T_{11} (- 4℃ with 8% MC) showed lowest shoot length (29.40), root length (7.60), seedling length (12.50), number of leaves (6.05), fresh weight (1.53) and dry weight (0.76) on 1 MAS. Low temperature causes injury to the seeds by restricting the metabolic activity which further affects the seedling growth (Corbineau1989). Significantly minimum number of leaves, fresh weight and dry weight of seedling was recorded in the seeds stored at -4 ℃ might be due to the fact that low temperature restricts the enzymatic action which hinders the breakdown of starch to sugar. Due to the lack of food supply, seedling growth and initiation of leaves get affected which further affects the seedling fresh and dry weight.

At low moisture level, the availability of free water become low or almost negligible which prevent the growth of microbes and further deterioration and ultimately leads to the healthy seedling growth. At higher seed moisture level, physiological potential of seeds was very high which favors the growth of microorganisms and fungal attack which adversely affect the radical and plumule emergence and ultimate seedling growth. Partial drying can reduce seed metabolism and fungal growth on seeds, and deterioration and damage to seeds are reduced in consequence which further leads to higher percentage of germination and healthy seedling growth inturn increases the number of leaves and weight of seedling.

Table 1: Effect of storage temperature and moisture content on germination percentage and seed viability percentage

Treatments	Germination % (Months After Storage)						Seed viability % (Months After Storage)					
	1	2	3	4	5	6	1	2	3	4	5	6
T_1	31.50 (34.13)	16.50 (23.92)	2.07 (8.14)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	80.33	76.67	70.33	62.00	58.33	53.17
T_2	38.50 (38.34)	19.00 (25.78)	3.07 (9.98)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	78.50	74.00	68.00	62.00	56.00	51.00
T_3	43.50 (41.26)	22.00 (27.96)	5.02 (12.89)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	76.00	72.00	66.00	60.00	54.33	49.00
T_4	47.50 (43.57)	41.00 (39.80)	36.50 (37.16)	30.50 (33.52)	27.00 (31.29)	21.50 (27.60)	74.00	70.00	64.00	57.00	52.00	47.00
T_5	62.00 (51.96)	53.00 (46.73)	48.50 (44.14)	42.00 (40.40)	37.00 (37.45)	33.00 (35.04)	72.00	68.00	62.67	56.00	50.00	45.00
T_6	29.00 (32.58)	13.00 (21.11)	1.50 (6.78)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	78.00	74.67	68.00	62.00	56.00	51.00
T_7	33.50 (35.36)	16.50 (23.87)	2.55 (9.07)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	76.00	72.00	66.00	60.50	54.00	49.00
T_8	39.50 (38.94)	19.00 (25.73)	4.55 (12.21)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	74.00	70.00	65.33	58.00	51.00	47.33
T_9	43.50 (41.26)	39.00 (38.64)	31.00 (33.83)	27.00 (31.30)	23.50 (28.98)	19.00 (25.75)	72.00	68.83	62.00	56.00	50.17	45.00
T_{10}	59.00 (50.19)	48.00 (43.85)	43.50 (41.26)	38.50 (38.35)	34.00 (35.64)	30.00 (33.19)	70.33	66.00	60.00	54.00	48.83	42.83
T_{11}	27.00 (31.29)	10.50 (18.90)	0.92 (5.11)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	76.00	72.00	66.33	60.00	54.00	49.00
T_{12}	30.50 (33.51)	14.00 (21.91)	2.07 (8.07)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	75.00	71.67	64.67	58.00	52.17	47.17
T_{13}	37.00 (37.43)	16.00 (23.55)	4.57 (12.28)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	72.00	68.00	62.00	55.67	50.00	45.00
T_{14}	42.00 (40.39)	36.00 (36.85)	30.00 (33.15)	24.00 (29.33)	19.50 (26.18)	16.50 (23.84)	70.00	66.00	60.50	54.00	48.00	43.67
T_{15}	54.00 (47.31)	49.00 (44.43)	40.00 (39.22)	35.00 (36.26)	31.00 (33.80)	27.20 (31.42)	68.00	64.00	58.00	51.33	46.33	41.00
Temperature(T) S.Em.±	0.411	0.431	0.401	0.160	0.271	0.319	10.06	0.960	0.941	1.056	0.949	0.798

	C.D.@5%	1.164	1.218	1.133	0.451	0.767	0.901	2.998	2.715	2.661	2.988	2.684	2.257
Moisture(M)	S.Em.±	0.319	0.334	0.310	0.124	0.210	0.247	0.821	0.743	0.729	0.818	0.735	0.618
	C.D.@5%	0.902	0.944	0.878	0.350	0.594	0.698	2.323	2.103	2.061	2.315	2.079	1.748
T×M	S.Em.±	0.713	0.746	0.694	0.276	0.470	0.552	1.836	1.662	1.629	1.830	1.643	1.382
	C.D.@5%	NS	NS	NS	0.782	1.329	1.561	NS	NS	NS	NS	NS	NS

* Figures in parentheses are Arc sine transformed values

Table 2: Effect of storage temperature and moisture content on seed vigor index length and seed vigor index mass

Treatments		SVI Length in cm (Months After Storage) SVI Mass in gm (Months After Storage)						SVI Length in cm (Months After Storage) SVI Mass in gm (Months After Storage)					
		1	2	3	4	5	6	1	2	3	4	5	6
T_1		453.07	138.10	0.00	0.00	0.00	0.00	25.51	12.55	0.00	0.00	0.00	0.00
T_2		819.58	179.27	0.00	0.00	0.00	0.00	34.07	15.96	0.00	0.00	0.00	0.00
T_3		947.05	227.00	0.00	0.00	0.00	0.00	43.94	20.58	0.00	0.00	0.00	0.00
T_4		1386.75	462.50	366.72	294.32	249.50	188.50	52.76	51.47	35.66	28.31	22.29	16.77
T_5		2481.47	687.83	528.95	459.90	379.50	327.00	77.80	62.85	54.78	43.45	34.54	29.39
T_6		389.00	104.30	0.00	0.00	0.00	0.00	22.79	9.05	0.00	0.00	0.00	0.00
T_7		688.40	148.22	0.00	0.00	0.00	0.00	28.80	13.16	0.00	0.00	0.00	0.00
T_8		824.22	189.30	0.00	0.00	0.00	0.00	38.93	16.83	0.00	0.00	0.00	0.00
T_9		1230.48	425.17	294.73	250.00	205.93	158.90	47.25	47.65	29.60	24.19	19.05	14.32
T_{10}		2311.08	602.90	460.42	404.57	331.45	279.40	72.35	55.28	48.10	38.88	30.65	25.54
T_{11}		337.90	80.50	0.00	0.00	0.00	0.00	20.56	7.10	0.00	0.00	0.00	0.00
T_{12}		605.87	120.63	0.00	0.00	0.00	0.00	25.50	11.04	0.00	0.00	0.00	0.00
T_{13}		743.62	151.62	0.00	0.00	0.00	0.00	35.30	14.16	0.00	0.00	0.00	0.00
T_{14}		1152.27	376.15	274.15	211.27	162.73	130.65	44.56	43.12	27.68	21.23	14.78	11.87
T_{15}		2071.40	593.00	410.00	353.37	290.20	235.08	64.66	54.81	43.40	34.50	27.43	21.72
Temperature(T)	S.Em.±	20.339	5.453	3.178	2.286	2.031	1.585	0.809	0.499	0.302	0.199	0.167	0.135
	C.D.@5%	57.536	15.426	8.989	6.467	5.746	4.483	2.288	1.411	0.855	0.563	0.473	0.382
Moisture(M)	S.Em.±	15.754	4.224	2.461	1.771	1.573	1.228	0.626	0.386	0.234	0.154	0.130	0.105
	C.D.@5%	44.567	11.949	6.963	5.009	4.451	3.472	1.772	1.093	0.662	0.436	0.367	0.296
T×M	S.Em.±	35.228	9.445	5.504	3.960	3.518	2.745	1.401	0.864	0.524	0.345	0.290	0.234
	C.D.@5%	99.655	NS	15.569	11.201	9.952	7.765	NS	NS	1.481	0.976	0.820	0.662

Table 3: Effect of storage temperature and moisture content on shoot length, root length and seedling length

Treatments		Shoot Length in cm (MAS)						Root Length in cm (MAS)						Seedling Length in cm (MAS)					
		1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
T_1		34.50	50.10	0.00	0.00	0.00	0.00	8.60	9.70	0.00	0.00	0.00	0.00	14.35	18.05	0.00	0.00	0.00	0.00
T_2		46.20	56.40	0.00	0.00	0.00	0.00	13.55	11.88	0.00	0.00	0.00	0.00	21.25	21.28	0.00	0.00	0.00	0.00
T_3		58.20	61.80	0.00	0.00	0.00	0.00	12.05	13.75	0.00	0.00	0.00	0.00	21.75	24.05	0.00	0.00	0.00	0.00
T_4		70.20	67.50	10.05	9.65	9.25	8.75	17.45	17.95	17.75	17.25	16.75	16.25	29.15	29.20	27.80	21.90	26.00	25.00
T_5		82.50	78.00	10.90	10.60	10.25	9.75	26.08	20.60	19.95	19.75	18.75	17.25	40.00	33.60	30.85	25.70	29.00	27.00
T_6		32.10	48.00	0.00	0.00	0.00	0.00	8.05	9.35	0.00	0.00	0.00	0.00	13.40	17.35	0.00	0.00	0.00	0.00
T_7		43.80	53.70	0.00	0.00	0.00	0.00	13.22	11.00	0.00	0.00	0.00	0.00	20.52	19.95	0.00	0.00	0.00	0.00
T_8		55.80	59.70	0.00	0.00	0.00	0.00	11.55	13.25	0.00	0.00	0.00	0.00	20.85	23.20	0.00	0.00	0.00	0.00
T_9		68.10	65.40	9.50	9.25	8.75	8.35	16.90	17.50	17.35	16.80	16.25	15.80	28.25	28.40	26.85	21.05	25.00	24.15
T_{10}		80.10	75.30	10.55	10.50	9.75	9.30	25.80	20.15	19.55	19.30	18.35	16.80	39.15	32.70	30.10	24.80	28.10	26.10
T_{11}		29.40	45.90	0.00	0.00	0.00	0.00	7.60	8.95	0.00	0.00	0.00	0.00	12.50	16.60	0.00	0.00	0.00	0.00
T_{12}		42.30	51.30	0.00	0.00	0.00	0.00	12.78	10.50	0.00	0.00	0.00	0.00	19.83	19.05	0.00	0.00	0.00	0.00
T_{13}		53.40	56.70	0.00	0.00	0.00	0.00	11.15	12.75	0.00	0.00	0.00	0.00	20.05	22.20	0.00	0.00	0.00	0.00
T_{14}		65.70	62.70	8.82	8.80	8.35	7.90	16.45	17.05	16.87	16.40	15.75	15.40	27.40	27.50	25.68	20.15	24.10	23.30
T_{15}		77.40	72.60	10.25	10.10	9.35	8.85	25.40	19.70	19.00	18.90	17.90	16.63	38.30	31.80	29.25	24.05	27.25	25.48
Temperature(T)	S.Em.±	0.045	0.112	0.069	0.036	0.036	0.045	0.225	0.231	0.055	0.053	0.030	0.125	0.142	0.134	0.086	0.075	0.055	0.143
	C.D.@5%	0.128	0.317	0.195	0.101	0.101	0.128	0.638	0.653	0.156	0.151	0.084	0.353	0.402	0.379	0.243	0.211	0.154	0.405
Moisture(M)	S.Em.±	0.035	0.087	0.053	0.028	0.028	0.035	0.175	0.179	0.043	0.041	0.023	0.097	0.110	0.104	0.067	0.058	0.042	0.111
	C.D.@5%	0.099	0.245	0.151	0.078	0.078	0.099	0.494	0.506	0.121	0.117	0.060	0.273	0.311	0.293	0.188	0.164	0.120	0.314
T×M	S.Em.±	0.079	0.194	0.120	0.062	0.062	0.079	0.390	0.400	0.095	0.092	0.052	0.216	0.246	0.232	0.149	0.129	0.095	0.248
	C.D.@5%	NS	NS	0.338	0.175	0.175	0.222	NS	NS	0.269	0.261	0.146	NS	NS	NS	0.421	0.366	0.268	0.701

Table 4: Effect of storage temperature and moisture content on number of leaves, fresh weight and dry weight of seedling

Treatments		Number of leaves (MAS)						Fresh weight in gm (MAS)						Dry weight in gm (MAS)					
		1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
T_1		6.75	6.25	0.00	0.00	0.00	0.00	1.63	1.45	0.00	0.00	0.00	0.00	0.81	0.76	0.00	0.00	0.00	0.00
T_2		7.40	6.85	0.00	0.00	0.00	0.00	1.78	1.69	0.00	0.00	0.00	0.00	0.89	0.84	0.00	0.00	0.00	0.00
T_3		7.85	7.40	0.00	0.00	0.00	0.00	2.02	1.88	0.00	0.00	0.00	0.00	1.01	0.94	0.00	0.00	0.00	0.00
T_4		8.40	7.85	7.35	6.80	6.25	5.75	2.23	2.00	0.97	1.88	1.68	1.58	1.11	1.04	0.99	0.94	0.84	0.79
T_5		8.85	8.40	7.85	7.40	6.85	6.40	2.52	2.37	1.28	2.08	1.88	1.78	1.26	1.19	1.14	1.04	0.94	0.89
T_6		6.40	5.95	0.00	0.00	0.00	0.00	1.58	1.40	0.00	0.00	0.00	0.00	0.79	0.70	0.00	0.00	0.00	0.00
T_7		7.05	6.55	0.00	0.00	0.00	0.00	1.73	1.63	0.00	0.00	0.00	0.00	0.86	0.82	0.00	0.00	0.00	0.00
T_8		7.60	7.05	0.00	0.00	0.00	0.00	1.98	1.83	0.00	0.00	0.00	0.00	0.99	0.91	0.00	0.00	0.00	0.00
T_9		8.15	7.60	7.05	6.30	5.85	5.50	2.18	1.95	0.93	1.83	1.63	1.53	1.09	1.01	0.96	0.91	0.81	0.76
T_{10}		8.60	8.15	7.55	7.10	6.45	6.15	2.45	2.32	1.23	2.03	1.83	1.73	1.23	1.16	1.11	1.04	0.91	0.86
T_{11}		6.05	5.50	0.00	0.00	0.00	0.00	1.53	1.35	0.00	0.00	0.00	0.00	0.76	0.68	0.00	0.00	0.00	0.00
T_{12}		6.80	6.05	0.00	0.00	0.00	0.00	1.68	1.58	0.00	0.00	0.00	0.00	0.84	0.79	0.00	0.00	0.00	0.00
T_{13}		7.25	6.80	0.00	0.00	0.00	0.00	1.93	1.78	0.00	0.00	0.00	0.00	0.96	0.89	0.00	0.00	0.00	0.00
T_{14}		7.88	7.25	6.72	5.90	5.45	5.20	2.13	1.90	0.89	1.78	1.52	1.48	1.06	0.99	0.94	0.89	0.79	0.74
T_{15}		8.30	7.80	7.20	6.80	6.00	5.80	2.40	2.26	1.19	1.98	1.78	1.68	1.20	1.13	1.09	0.99	0.89	0.84
Temperature(T)	S.Em.±	0.047	0.047	0.058	0.053	0.043	0.042	0.035	0.025	0.009	0.013	0.014	0.012	0.012	0.018	0.005	0.008	0.003	0.003
	C.D.@5%	0.132	0.133	0.165	0.149	0.122	0.119	0.099	0.070	0.024	0.037	0.041	0.034	0.033	0.050	0.013	0.021	0.007	0.008
Moisture(M)	S.Em.±	0.036	0.037	0.045	0.041	0.033	0.032	0.027	0.019	0.007	0.010	0.011	0.009	0.009	0.014	0.004	0.006	0.002	0.002
	C.D.@5%	0.103	0.103	0.128	0.115	0.094	0.092	0.077	0.054	0.019	0.028	0.032	0.027	0.026	0.039	0.010	0.016	0.006	0.007
T×M	S.Em.±	0.081	0.082	0.101	0.091	0.075	0.073	0.061	0.043	0.019	0.023	0.025	0.021	0.020	0.031	0.008	0.013	0.005	0.005
	C.D.@5%	NS	NS	0.286	0.257	0.211	0.206	NS	NS	NS	NS	NS	NS	NS	NS	0.023	NS	0.013	0.015

Conclusion

The present investigation concluded that papaya seeds are desiccation tolerant but sensitive to freezing. It can be stored well at ambient temperature with 6% MC over a period of time. Hence it can be classified under intermediate category of seeds.

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