emergent
Life Sciences Research

Research Article

Correlation study between moisture loss and germination of recalcitrant seeds of jackfruit (*Artocarpus heterophyllus* Lam.) under different storage conditions

M. S. Gawankar, P. M. Haldankar, B. R. Salvi, B. M. Jamadagni

Abstract

Recalcitrant seeds loose viability on drying or their exposure to chilling temperature and are difficult to store for longer periods. An assured supply of seeds for grafting as a rootstock during the lean period can be achieved only from the seed stock held in storage. Jackfruit (Artocarpus heterophyllus Lam.) seeds are recalcitrant in nature and lose viability during storage. Hence, an investigation on seed viability of jackfruit and methods to prolong it under artificial storage conditions was conducted. The experiment was conducted with eight seed storage methods and six storage periods with two replications in factorial randomized block design. A hundred seeds per treatment per replication was the unit. It was revealed that the loss in moisture content of the seed was negatively associated with the germination percentage, days to first germination, days required for 50 per-cent germination, germination period, germination index, germination value, seed vigor, seedling vigor index and the height of the seedling from such germinated seed was seriously hampered.

Keywords moisture loss, recalcitrant seeds, seed germination, seed vigor

Received: 13 August 2019
Accepted: 18 November 2019
Online: 25 November 2019

Authors:
M. S. Gawankar
A.I.C.R.P. on Palms (Oil Palm), College of Horticulture, Mulde,Tal: Kudal Dist-Sindhudurg, Maharashtra, India

P. M. Haldankar
D. B. S. K. K.V., Dapoli, Tal-Dapoli, Dist-Ratnagiri, Maharashtra, India

B. R. Salvi
Department of Horticulture, College of Agriculture, Dapoli, Dist-Ratnagiri, Maharashtra, India

B. M. Jamadagni
Agricultural Research Station, Mulde,Tal-Kudal, Dist-Sindhudurg, Maharashtra, India

gawankarms@yahoo.co.in

Emer Life Sci Res (2019) 5(2): 28-34

E-ISSN: 2395-6658
P-ISSN: 2395-664X

DOI: https://doi.org/10.31783/elsr.2019.522834

Introduction

Jackfruit (Artocarpus heterophyllus Lam.) is an important and remunerative crop commercially cultivated in the eastern and southern parts of India and a cheap fruit available in the market. It is a native fruit of India and grows wild in the rain forest of Western Ghats [1]. The coastal warm and humid climate of the Konkan region is favorable for jackfruit cultivation. Success of a fruit nursery depends on the continuous supply of quality seeds for raising rootstock for grafting. According to Roberts [2], seeds are divided into two categories i) Orthodox ii) Recalcitrant. Recalcitrant seeds have many special features like usually the size of the seed is larger and average weight of seed is more than that of orthodox seeds [3]. The seeds of jackfruit are large-sized and slowly looses water. When the moisture content in the seeds decreases below the critical level, the seeds lose viability. The information on longevity and seed storage of this crop for plant propagation is sparsely available. An assured supply of seeds during the lean period can be achieved only from the seed stock held in storage [4]. Hence, efficient storage of seeds is indispensable to ensure continuous and cost-effective supply of rootstock seedlings, which is a prerequisite for the success of any massive nursery program. According to Chormule et al., [5] the viability and vigor of the seeds in storage not only vary from genera to

genera and variety to variety, but it is also regulated by many physicochemical factors like moisture content, atmospheric relative humidity, temperature, initial seed quality, physical and chemical composition of seed, gaseous exchange, storage structure, packaging materials, etc. Hence, research on the correlation between moisture loss in seeds and seed vigor for jackfruit was undertaken to study the correlation between the loss in seed moisture and its effect on different germination parameters during the year 2017-18.

Methodology

The experiment was conducted at the College of Horticulture, Mulde Tal. Kudal, Dist. Sindhudurg, which is a part of Konkan region of Maharashtra, India located at 17 m elevation above the mean sea level with an annual rainfall of 3000 mm. The minimum temperature ranges from 12 °C to 24 °C and the maximum temperature from 26 °C to 38 °C. The average relative humidity at this location is 80 percent. The experiment consists of eight storage methods and six storage period in factorial randomized block design with two replications. A hundred seeds per treatment per replication was the unit.

Fresh seeds weighing more than 3 g from ripe soft flesh type fruits were washed to remove perianth and aril. Such seeds were treated with Carbendazim (50 % WP @ 2 g/L) for 5 minutes and further kept for surface drying under shade for three hours at room temperature (32 °C) to remove the excess moisture and were exposed to the treatments [6]. The seeds were stored in different containers by providing sufficient air space and sealed after taking the initial weight of the seeds.

After completion of the storage period of 15, 30, 60, 90, 120 and 150 days, seeds were sown in the black polythene bag of 200 gauges of size 15 X 20 cm containing soil + FYM in 3:1 proportion. Polybags were kept for raising the seedlings and watering was done immediately after sowing the seeds. Further, irrigation was given everyday till the seedling emergence. After the completion of germination, the polybags were irrigated every alternate day.

Germination was recorded at every alternate day from the first emergence until no further seeds were germinated. Observations on germination percentage, days required for germination, days required for 50 % germination and germination period were recorded. Germination percentage was calculated by dividing the total number of germinated seeds to the total number of seeds sown and multiplied by 100 as given below.

Percent loss in seed weight (moisture loss) was calculated by using the following formula

$$\text{Percent loss in seed weight (\%)} = \frac{\text{Fresh weight during storage-Final weight during sowing}}{\text{Fresh weight during storage}} \text{ X100}$$

Germination percentage

Germination percentage was calculated by dividing the total number of germinated seeds to the total number of seeds sown and multiplied by 100 as given below.

$$\text{Germination percentage (\%)} = \frac{\text{No. of seeds germinated}}{\text{Total number of seeds sown}} \text{ X 100}$$

Days required for initiation of germination

The days taken for the first germination were calculated from the date of sowing up to germination of the first seedling.

Days required for 50 percent germination

The days taken for 50 percent germination were calculated from the date of sowing up to 50 percent germination of seedlings.

Table 1: Different germination parameter influenced by moisture loss in jackfruit

	Moisture loss (%)	Germination (%)	Days to first germination	Days to 50 % germination	Germination period (Days)	Germination index	Germination value	Seed vigour	Speed of emergence	Seedling vigour index	Height at 60 days (cm)
C1S1	0.8	84.75	11.25	19.75	15.5	26.38	20.09	96.36	13.3	24.31	43.06
C1S2	1.24	66	15	25	22	17.82	7.5	95.87	6.29	22.69	48.97
C1S3	3.86	75.5	12	17.75	18.5	28.88	17.77	96.68	10.25	18.64	45.45
C1S4	4.04	77.5	14.33	23	18	33.46	19.43	96.86	13.69	19.18	47.85
C1S5	3.7	79.5	11.25	20.25	22	32.07	15.8	93.72	6.02	27.4	42.54
C1S6	5.73	93	7.25	16	26.5	47.05	26.51	94.62	10.23	28.71	38.33
C2S1	0.74	79.5	15.5	21.25	17.25	24.32	15.45	94.08	10.14	24.68	43.41
C2S2	1.8	4.5	23	23	1	0.22	0.05	55	22.5	1.51	43
C2S3	2.67	7	21	22.5	4.5	1.18	0.18	64.58	22.92	1.32	28.92
C2S4	4.12	81.75	15.5	25.5	20.5	26.73	14.23	82.68	15.28	23.9	47.33
C2S5	4.36	10	17	21.75	9.25	1.77	0.59	49.75	16.77	2.66	32.85
C2S6	6.32	90.75	9.25	15.75	26.25	44.01	23.22	86.84	11.28	28.43	39.1
C3S1	1.31	54.75	14.75	21.25	20.25	17.52	7.01	91.58	7.34	21.11	41.9
C3S2	2.4	40.5	18	23	18	12.97	3.74	74.12	8.63	12.42	39.4
C3S3	4.72	11.5	16	26	12.5	1.77	0.22	56.35	9.13	3.32	36.8
C3S4	5.18	0	0	0	0	0	0	0	0	0	0
C3S5	5.46	0	0	0	0	0	0	0	0	0	0
C3S6	6.25	0	0	0	0	0	0	0	0	0	0
C4S1	16.31	64.25	15	23.5	23	22.64	9.61	94.42	9.6	19.61	43.66
C4S2	23.83	32.75	20.75	26	13.75	6.16	2.22	77.26	11.85	9.82	44.04
C4S3	32.85	9.75	17	21.25	8.25	1.3	0.24	55.97	15.49	2.36	33.33
C4S4	41.46	0	0	0	0	0	0	0	0	0	0
C4S5	44.57	0	0	0	0	0	0	0	0	0	0
C4S6	44.93	0	0	0	0	0	0	0	0	0	0
C5S1	4.87	79.5	13.75	19.25	18.75	25.68	16.81	97.74	7.52	27.72	48.31
C5S2	8.82	62	14.75	22.75	17.25	18.91	8.64	94.71	9.98	21.81	48.96
C5S3	3.34	74.75	11.5	18.75	17.25	32.25	18.21	94.13	9.14	21.99	41.95
C5S4	2.83	87	1	15.25	19.5	65.47	43.55	88.27	7.16	27.8	48.93
C5S5	7.3	76.25	1	13	22.25	53.61	30.47	62.27	10.51	25.56	43.83
C5S6	10.87	79	1	14.5	27.25	54.88	26.88	82.8	11.05	23.57	36.65
C6S1	1.4	37.5	16.5	23.5	20.5	10.26	3.73	85.51	3.91	14.08	46.88
C6S2	2.15	4	21	21.5	7.25	0.68	0.09	55	57.08	1.64	37.69
C6S3	6.48	4.5	17	18.5	5.5	0.77	0.06	41.67	41.67	1.26	35.75
C6S4	6.47	0	0	0	0	0	0	0	0	0	0
C6S5	8.08	0	0	0	0	0	0	0	0	0	0
C6S6	7.26	0	0	0	0	0	0	0	0	0	0
C7S1	1.25	40.25	15.75	23	22.75	12.51	3.35	78.19	2.59	13.24	43.35
C7S2	2.59	0	0	0	0	0	0	0	0	0	0
C7S3	5.87	0	0	0	0	0	0	0	0	0	0
C7S4	7	0	0	0	0	0	0	0	0	0	0
C7S5	8.82	0	0	0	0	0	0	0	0	0	0
C8S6	8.47	0	0	0	0	0	0	0	0	0	0
C8S1	18.51	53.25	18.25	24.5	18.25	14.97	6.64	89.11	13.24	17.48	43.33
C8S2	28.15	29	21.5	24.5	11.25	6.18	2	75.67	10.88	9.3	43
C8S3	36.29	9.5	6.25	9.75	7.25	3.49	0.55	68.33	13.06	2.04	30.85
C8S4	43.07	0	0	0	0	0	0	0	0	0	0
C8S5	45.36	0	0	0	0	0	0	0	0	0	0
C8S6	45.39	0	0	0	0	0	0	0	0	0	0

C_1- Screw Cap plastic bottle	C_5- Earthen pot buried in soil	S_1– 15 days	S_4 - 90 days
C_2 - Polybag -300 gauge + Screw Cap plastic bottle	C_6 - Coating with Fresh Cow dung slurry, drying and stored in Poly bag	S_2 - 30 days	S_5 - 120 days
C_3 - Polybag -300 gauge at ambient temp.	C_7 - Coating with mud slurry, drying and stored in Poly bag	S_3 - 60 days	S_6 - 150 days
C_4 - Earthen pot	C_8 - Storing at ambient temp. (Control)		

Germination period
Germination period is the period of days between the first germination to germination of the last seed.

Germination index (GI)
Germination index was calculated as described in the Association of Official Seed Analysts (AOSA, 1983) [7] using the following formula

Germination index (GI) =

$$\frac{\text{No. of germinated seed}}{\text{Days of first count}} + \frac{\text{No. of germinated seed}}{\text{Days of second count}} + \ldots\ldots\ldots + \frac{\text{No. of germinated seed}}{\text{Days of final or last count}}$$

Germination value (GV)
Germination value was calculated by the following formula

$$\text{Germination value (GV)} = (\sum \text{DGs}/\text{N}) \text{ X } \text{GP}/10$$

- Where
- Σ DGs = is the total germination obtained by adding every DGs value obtained from the daily counts.
- DG = is the daily germination speed obtained by dividing the cumulative germination percentage by the number of days since sowing.
- N = is the total number of daily counts starting from the first germination and 10 is constant.
- GP = is the germination percentage at the end of the experiment.

Speed of emergence (RE)
The speed of emergence was calculated according to Islam et al., [8] using following formula

$$\text{Speed of emergence} = \frac{\text{No.of seedling emerge at 14 days after sowing}}{\text{No.of seedlings emerge at 41 days after sowing}} \text{ X } 100$$

Seed vigor
The seed vigor index was calculated as described in the Association of Official Seed Analysts (AOSA, 1983) [7] using the following formula

$$\text{Seed vigor} = \frac{\text{Total no. of healthy seedlings}}{\text{Number of total seedlings}} \text{ X } 100$$

Seedling vigor index (SVI)
Seedling vigor index was calculated according to Islam et al., [8] using the following formula

$$\text{Seedling vigor index (SVI)} = \frac{\text{Seedling length (Height cm)at 30 days}}{100} \text{X Germination \%}$$

For statistical analysis, the data of percentage was transformed to arcsine √ (100/ X) and the actual percentage is shown. Experimental data were analyzed by a statistical package SAS (2008) [9], version 9.01.

Table 2: Correlation studies on moisture loss observed against different germination parameters in jackfruit

Parameters	Per cent moisture loss	Germ. percentage	Days to first germ.	Days to 50 % germ.	Germ. period	Germ. index	Germ. value	Seed vigour	Speed of emergence	Seedling vigour index	Height at 60 days
Per cent moisture loss	1.000										
Germination percentage	-0.396	1.000									
Days to first germination	-0.311	0.335	1.000								
Days to 50 % germination	-0.391	0.614	0.924	1.000							
Germination period	-0.396	0.919	0.493	0.756	1.000						
Germination index	-0.336	0.909	0.078	0.409	0.821	1.000					
Germination value	-0.329	0.880	0.025	0.348	0.741	0.984	1.000				
Seed vigour	-0.401	0.862	0.720	0.898	0.912	0.691	0.638	1.000			
Speed of emergence	-0.246	0.133	0.656	0.575	0.224	0.091	0.083	0.412	1.000		
Seedling vigour index	-0.400	0.990	0.335	0.614	0.926	0.897	0.862	0.857	0.116	1.000	
Height at 60 days (cm)	-0.415	0.781	0.795	0.948	0.864	0.627	0.579	0.968	0.524	0.781	1.000

Regression Statistics			
Multiple R	0.48806539	Standard Error	14.24903002
R Square	0.238207825	Adjusted R Square	0.032318048

Results and Discussion

The parameters related to germination have relevance with the moisture content of seeds. Usually during the course of storage, there is a loss in moisture content which can execute influence on parameters related to the germination. The data on germination presented in Table 1 were subjected to the correlation analysis. The coefficients of correlation of all such parameters under investigation are given in Table 2.

It is revealed that the loss in the moisture content of the seed was negatively associated with germination percentage, days to first germination, days required for 50 percent germination, germination period, germination index, germination value, seed vigor and seedling vigor index. It means that the moisture loss diminishes the value of all such parameters. This was reflected by affecting the seed vigor and seedling vigor index. Ultimately, the height of the seedling from such germinated seed was seriously hampered.

Thus, the moisture content of seed during the storage has a great bearing not only in terms of the germination of seed, but also on seedling vigor and seedling growth. In simple words, if water loss is less, better is the expression of germination and associated parameters and vice-versa. The germination percentage was positively correlated with the days for first and 50 percent germination, germination period, germination index, germination value, and seed vigor, but it had no correlation with the speed of emergence. It is important to note that the germination percentage had very high correlation with the seedling vigor.

The days for first and 50 percent germination showed a positive association with the germination period, seed vigor, speed of germination and seedling vigor index. Ultimately, it is reflected in establishing the strong correlation with seedling vigor index and seedling height of 60 days.

The period between the appearance of the first seed germination and the completion of germination is the germination period. This attribute showed positive correlation with germination index, germination value, seed vigor, seedling vigor and the height after 60 days. This implied that wider the period more was the success of germination.

The germination index had no relation with the speed of germination, but its association with germination value and seedling vigor index was positive and highly significant. The germination value in turn also had a strong positive association with seed vigor and seedling vigor, but had no relevance with the speed of emergence. The seed vigor has a practical significance on early establishment of crop. This has a positive relation with the speed of emergence, seedling vigor index and the height at 60 days. The speed of emergence had non-significant association with seedling vigor index, but was positively correlated with the height of seedling at 60 days. The seedling vigor index had a very strong positive correlation with the height at 60 days.

In conclusion, almost all the parameters of germination were mutually associated with each other, but the moisture content of the seed had a paramount bearing on the expression of all such parameters. Similar results were reported by Muthanna et al., [10] in jamun and Meena et al., [11] in papaya. Abbas et al., [12] noticed the association of increased electrolyte leakage with loss of seed viability and seed vigor in jamun.

Conclusion

The germination percentage in jackfruit seeds was positively correlated with the days for first germination, 50 percent germination, germination period, germination index, germination value, seed vigor and seedling vigor, but it had no association with the speed of emergence.

References

[1] A. P. De Condolle **(1885)**. Origin of cultivated plants. (Vol. 48). D. Appleton.
[2] E. H. Roberts **(1973)**. Predicting the storage life of seeds. Seed Sci. and Technol., **1:** 499-514.
[3] H. F. Chin, and H. W. Pritchard **(1988)**. Recalcitrant seeds: a Status Report, including a bibliography 1979-87. International Board for Plant Genetic Resources.

[4] R. Umarani, A. Kanthaiya and M. M. Faisal **(2015)**. Understanding poor storage potential of recalcitrant seeds. Curr. Sci., **108:** 2023-2031.
[5] S. R. Chormule, N. M. Changade and J. B. Patel **(2018)**. Effect of seed treatments on storability of vegetable seeds: a review. Plant Archives, **18:** 28-32.
[6] S. D. Doijode **(2012)**. Seed storage of horticultural crops. CRC Press.
[7] AOSA. **(1983)**. Seed vigour testing handbook. Contribution No. 32 to Handbook on seed testing. Association of Official Seed Analysts.
[8] A. K. M. A. Islam, N. Anuar and Z. Yaakob **(2009)**. Effect of genotypes and pre-sowing treatment on seed germination behavior of Jatropa. Asian J. Plant Sci., **8:** 433-439.
[9] SAS. **(2008)**. SAS/STAT User Installation Guide for SAS® 9.1.3 Foundation for Microsoft® Windo®. SAS Institute Inc., Cary, North Caroline, USA.
[10] K. T. Muthanna, Y. S. Praneeth, G. M. Vinay and M. Mahadevamma **(2016)**. Seed storage methods, germination and growth studies in karonda (*Carissa carandas* L.). Res. Environ. Life Sci., **9:** 651-654.
[11] A. K. Meena **(2015)**. Effect of different growing media on seed germination and seedling growth of papaya (*Carica papaya* L.) Cv. Pusa Delicious. (Doctoral dissertation, SKNAU).
[12] M. Abbas, M. M. Khan, M. J. Iqbal and B. Fatima **(2003)**. Studies on Jamun (*Syzygium cuminii* L. Skeels) seed storage behavior. Pak. J. Agri. Sci., **40:** 164-169.