EFFECT OF FRUIT AFTER-RIPENING AND SEED SARCOTESTA ON SEED VIGOUR OF *Carica papaya*

Ibrahim, H., Oladiran, J.A., Tolorunse, K.D. and Kadiri, F.R.
Department of Crop Production, Federal University of Technology, Minna

ABSTRACT
The influence of after-ripening period and seed sarcotesta on seedling emergence and vigour were evaluated at the Crop Production Laboratory of Federal University of Technology Minna. Fruits of a pawpaw landrace (FUTM-Coe) harvested at the colour-breaking stage were divided randomly into three lots. Seeds from fruits of one lot were extracted immediately after harvest while seeds were extracted from the other two lots after fruits had after-ripened for two and four days respectively at room temperature (30 ^{o}C). Seeds from each of the three lots described above were then divided into two. The sarcotesta of seeds of one lot was removed while seeds of the other lots were left intact. Dried seeds were packaged in polythene envelope and stored at 30 ^{o}C. Freshly harvested papaya seeds exhibited dormancy which was indicated by low seedling emergence, shorter seedling height, lower leaf number and poorer seedling fresh and dry weight. Following storage, the scores for all these traits increased for some time followed by a decline at some points depending on treatments. A delay of two days before extracting seeds from opened fruits resulted in significantly higher scores of all the traits studied. The presence of sarcotesta also resulted in poorer seedling emergence.

Keywords: Seed Sarcotesta, after-ripening, seedling emergence, vigour

INTRODUCTION

Pawpaw (*Carica papaya* L.) is a fast growing, herbaceous perennial plant of the family *Caricaceaea*. The fruit may be consumed fresh or processed into drinks, jams, candies and as dried and crystallized fruit (Villegas, 1997). The green fruit, leaves and flowers has also been reported to be cooked as vegetable by (Watson, 1997). It is a good source of calcium and vitamins A and C (Nakasone and Paull, 1998). The most satisfactory means of propagation of the crop is by seed. However, the seed is faced with the challenges of slow rate of germination and in some cases even erratic and incomplete germination (Chow and Lin, 1991). Nongpanga *et al.* (2003) suggested poor post-harvest handling techniques may be result in the low, erratic and incomplete germination of *C. papaya* seeds. The seed is enclosed within a gelatinous sarcotesta, the presence of which has been reported to prevent or reduce germination and decrease the number of normal seedlings (Tokuhisa, 2007; Angeline and Ouma, 2008). The possibilities of *Carica papaya* being a cash producing crop are high for farmers in or close to urban areas. Proper handling of seeds to ensure high germination even after some storage period has become very necessary. This study was therefore conceived to examine the effect of processing protocol on seed quality and seedling traits.

MATERIALS AND METHODS

The study was conducted using fruits of a landrace (FUTM-Coe) of pawpaw (*Carica papaya* L.) harvested at the colour-breaking stage. The landrace is widely cultivated by most fruit growers in the metropolis of Minna, Niger state, Nigeria. The fruits were randomly divided into three lots. Fruits in the first lot were opened up and their seeds were extracted same day. Seeds were extracted from the remaining two lots after the fruits had after-ripened for two and four days respectively at room temperature (30 ^{o}C). Seeds from each of the three lots described above were again divided into two. The sarcotesta of seeds of one lot was washed off under running tap water, while seeds of the other lot were left with sarcotesta intact. Seeds of the different treatments were dried at room temperature (30 ^{o}C) for ten days before their moisture content was determined using the oven method at 130 ^{o}C. The six different treatments are represented thus: Seed extracted on the day of fruit harvest and with sarcotesta intact (SIO); seeds extracted on the day of fruit harvest without sarcotesta (SRO); seeds extracted after 2 days of fruit after-ripening with sarcotesta intact (SI2); seeds extracted after 2 days of fruit after-ripening without sarcotesta (SR2); seeds extracted after 4 days of fruit after-ripening with sarcotesta intact (SI4); seeds extracted after 4 days of fruit after-ripening without sarcotesta (SR4). Seeds of the different treatments were packaged in polythene envelopes and stored at 30 ^{o}C for 24 weeks. Samples were drawn for testing prior to storage and at four weeks intervals during storage. On each testing day, four replicates of 10 seeds each were sown into 5 kg soil in polythene pots. Data were collected on seedling emergence percentage, seedling height, number of leaves, fresh and dry seedling weight five weeks after seeds were sown. Data collected from all parameters were subjected to analysis of Variance (ANOVA) using Genstat statistical analysis package. All values in percentages were transformed to arcsin values before statistical analysis. Mean separation was done using the least significant difference (LSD) method in case where significant differences occur between treatments.

RESULTS

Table 1 shows the seedling emergence and vigour as influenced by after-ripening and seed sarcotesta. Prior to storage, emergence was generally low in seeds extracted immediately on the day of harvest (control) and those from fruits after-ripened for four days with values ranging between 25 and 45% irrespective with or without sarcotesta. However, emergence of 78% was recorded in seeds extracted from fruits that were after-ripened for two days and with sarcotesta removed (SR2). Following storage, seedling emergence generally improved in all the treatments. The peak points however, varied with treatments. For example, seeds extracted immediately on the day of fruit harvest attained a peak at four weeks after storage (4 WAS) with values of 40 and 53% for lots with and without sarcotesta respectively. Seedling emergence from fruits after-ripened for four days peaked (with 53% and 63%) at 16 WAS with or without sarcotesta respectively. Removal of sarcotesta from seeds extracted from fruits that were after-ripened for two days

Table 1. Effect of fruit after-ripening and sarcotesta removal from seeds on seedling emergence before and during storage.

Treatments	Storage period (weeks)						
	0	4	8	12	16	20	24
SI 0	25	40	33	28	25	15	0.0
SR 0	45	53.	48	50	40	40	.33
SI 2	40	58	60	60	55	45	43
SR2	78	83	95	98	95	98	93
SI4	25	38	35	48	53	23	25
SR4	33	40	40	50	63	38	35
LSD	9.26	9.79	7.62	10.86	9.13	8.81	9.36

SIO= Sarcotesta intact and not after-ripened; SI2 and SI4= Sarcotesta intact and after-ripened for 2 and 4 days respectively; SRO= Sarcotesta removed and not after-ripened; SR2 and SR4= Sarcotesta removed and after-ripene for 2 and 4 days respectively

Table 2. Effect of fruit after-ripening and sarcotesta removal from seeds on seedling height before and during storage.

Treatment	Storage period (weeks)						
	0	4	8	12	16	20	24
SI 0	5.1	5.2	4.6	4.9	4.4	3.9	0.0
SR 0	5.7	6.1	6.5	6.3	6.2	5.7	5.5
SI 2	5.7	6.0	4.9	5.6	5.6	4.9	4.8
SR 2	8.6	14.6	14.4	15.4	15.6	15.6	15.6
SI 4	5.0	5.3	4.5	4.9	3.9	4.0	3.8
SR 4	5.0	5.2	4.3	4.2	3.8	3.5	3.7
LSD	0.54	0.59	0.61	0.43	0.36	0.53	0.57

SIO= Sarcotesta intact and not after-ripened; SI2 and SI4= Sarcotesta intact and after-ripened for 2 and 4 days respectively; SRO= Sarcotesta removed and not after-ripened; SR2 and SR4= Sarcotesta removed and after-ripene for 2 and 4 days respectively

Table 3. Effect of fruit after-ripening and sarcotesta removal from seeds on number of leaves before and during storage.

Treatment	Storage period (weeks)						
	0	4	8	12	16	20	24
SI 0	5.0	5.0	4.0	3.0	3.0	3.0	0.0
SR 0	7.0	6.0	6.0	6.0	5.0	4.0	4.0
SI 2	6.0	6.0	4.0	6.0	5.0	3.0	3.0
SR 2	8.0	8.0	8.0	8.0	9.0	9.0	8.0
SI 4	5.0	5.0	4.0	5.0	4.0	3.0	2.0
SR 4	6.0	5.0	4.0	4.0	3.0	3.0	2.0
LSD	0.79	0.85	0.63	0.72	0.63	0.50	0.61

SIO= Sarcotesta intact and not after-ripened; SI2 and SI4= Sarcotesta intact and after-ripened for 2 and 4 days respectiv
SRO= Sarcotesta removed and not after-ripened; SR2 and SR4= Sarcotesta removed and after-ripened for 2 and 4 days respectively

Table 4. Effect of fruit after-ripening and sarcotesta removal from seeds on fresh seedling weight before and during storage.

	Storage period (weeks)						
Treatment	0	4	8	12	16	20	24
SI 0	1.3	1.3	1.2	1.3	1.3	1.2	0.0
SR 0	1.2	1.5	1.4	1.4	1.5	1.3	1.1
SI 2	1.4	1.5	1.2	1.3	1.3	1.2	1.0
SR 2	2.1	2.4	2.5	2.4	2.4	2.4	2.4
SI 4	1.2	1.3	1.1	1.2	1.2	1.2	0.1
SR 4	1.3	1.4	1.1	1.1	1.1d	1.1c	1.0
LSD	0.26	0.16	0.12	0.15	0.16	0.14	0.15

SIO= Sarcotesta intact and not after-ripened; SI2 and SI4= Sarcotesta intact and after-ripened for 2 and 4 days respectively; SRO= Sarcotesta removed and not after-ripened; SR2 and SR4= Sarcotesta removed and after-ripened for 2 and 4 days respectively

Table 5. Effect of fruit after-ripening and sarcotesta removal from seeds on dry seedling weight before and during storage.

	Storage period (weeks)						
Treatment	0	4	8	12	16	20	24
SI 0	0.06	0.08	0.08	0.08	0.09	0.09	0.00
SR 0	0.07	0.07	0.08	0.08	0.08	0.09	0.10
SI 2	0.08	0.07	0.09	0.08	0.08	0.08	0.10
SR 2	0.10	0.14	0.17	0.18	0.18	0.19	0.20
SI 4	0.05	0.07	0.07	0.07	0.07	0.08	0.08
SR 4	0.02	0.08	0.08	0.09	0.08	0.08	0.09
LSD	0.02	0.02	0.02	0.02	0.02	0.01	0.03

SIO= Sarcotesta intact and not after-ripened; SI2 and SI4= Sarcotesta intact and after-ripened for 2 and 4 days respectively; SRO= Sarcotesta removed and not after-ripened; SR2 and SR4= Sarcotesta removed and after-ripened for 2 and 4 days respectively

resulted in significantly higher seedling emergence before and during storage with scores ranging from 78 - 98%. After the attainment of maximum seedling emergence for all the treatments, a decline generally set in. As reported above after-ripening of fruit for two days combined with the removal of sarcotesta resulted in the production of significantly taller seedlings compared with other treatments (Table 2). In non-after-ripened fruits and those after-ripened for two days, seedlings from seeds without sarcotesta was significantly taller than those with sarcotesta all through the study period. Slight increases in seedling height was recorded within the four weeks of storage in other treatments and the increases were followed by a decline as from about eight weeks of storage.

Table 3 shows that removal of sarcotesta from seeds led to the production of greater numbe of leaves from seedlings especially when seeds were extracted from freshly harvested fruits or when fruits were afte ened for two

days before seeds were extracted. After-ripening of fruits for two days in combination with removal of sarcotesta significantly enhanced leaf production. Unlike the trend reported for the other two traits above, the number of leaves per seedling did not increase with storage time except in SR2. Rather a decline set in from around 8 to 16 weeks of storage.

Removal of sarcotesta from the seeds extracted from non-after-ripened fruits and those after-ripened for two days gave best results (Table 4). Seedlings were significantly heavier when fruits were after-ripened for two days before seeds were extracted and washed free of sarcotesta. After-ripening of fruits for four days reversed whatever seed quality improvement that might have been achieved following two days of after-ripening.

Removal of seed sarcotesta following the after-ripening of fruits resulted in the production of significantly higher seedling weight. After-ripening per se did not lead to increased dry weight.

DISCUSSION

The increase in seedling emergence, fresh and dry seedling weight with storage time in this study could be attributed to loss of dormancy which is common in freshly harvested seeds of many crop species. This confirms the reports by Kader (2000), Copeland *et al.* (2001) and OECD (2005) whose works showed that freshly harvested papaya seeds improved in germination and seedling emergence following storage. Ibrahim *et al.* (2011) also reported the same trend in some pawpaw landraces very recently. The decline in the values of all the parameters after attainment of maximum point in this study suggests that deterioration sets in with seed age which is evident by reduction in the capabilities of the plants (reduced vigour). This agrees with Ellis (1991), Priestly (1986), Begum *et al.*(1987) and Roberts (1989) who reported that seeds often undergo gradual changes as they age which decreases their vigour and germinability. Ashmore and Drew (2006) have also reported loss of viability during storage of seed of papaya. The superiority in seed quality following after-ripening of fruits for two days in this study agrees with what has been reported for tick seeds species by Jeffery and James (2007). Such improvement is said to be due to more accumulation of materials in the seed during the after-ripening process (Mack *et al.*, 2007). The negative effect of sarcotesta on seed quality as obtained in the current study confirms recent reports (Ibrahim *et al.*, 2011). After-ripening of fruits for four days resulted in poor performances of all the parameters in this study. Delayed harvest and seed processing are known to result in reduced quality following maximum dry matter accumulation in seeds (Gherardi and Valina, 1976; Gregory, 1999). Gregory (1999) reported that microbial degeneration of papaya seed sarcotesta resulted in reduced viability.

CONCLUSION

It is concluded from this study that quality papaya seeds were obtained when ripe fruits were after-ripened for two days and the sarcotesta was removed.

RECOMMENDATION

Based on the result of this study, it is recommended that to obtain high seedling emergence with optimum vigour pawpaw fruits harvested at colour-breaking point should be after-ripened for two days before seeds are extracted. In addition, the sarcotesta that surrounds the seed should be washed off and the seed dried before packaging.

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