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EFFECT OF FRUIT AGE ON THE SEED QUALITY OF FOUR PEPPER (*Capsicum annuum* L.) GENOTYPES IN MINNA, NIGER STATE-NIGERIA

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ABSTRACT

The appropriate fruit harvest stage for optimum seed quality in four pepper genotypes usually grown in Minna, Niger State was determined. Mass transplanting of pepper seedlings was carried out on beds at 50 and 75 cm intra and inter row spacings respectively. Flowers were date-tagged as they opened for about 40 days. Fruits of different ages (24, 28, 32, 36, 40, 44, 48 and 52 DAA) were harvested at once. Data were taken on fruit colour, seed dry matter, germination percentage (GP), germination rate index (GRI) and germination index (GI). Data collected were subjected to analysis of variance (ANOVA) using Minitab 17.0 version; means were separated using Tukey's Honest Significant Different Test. Fruit colour remained green up till 28 DAA. At 32 DAA, red colouration became noticeable in a small proportion of the fruit. This continued gradually until fruits became completely red outside at 52 DAA. No significant differences were recorded among the dry matter of seeds of the four genotypes while its values increase significantly from 19.67% to 64.03% from 24 to 52 DAA respectively. Seeds of 'Shombo' genotypes (V4) is superior in both viability and longevity than all the 'Tatashe' genotypes (V 1, 2 and 3); genotype V2 of 'Tatashe' however maintain viability longer than V 1 and 3. GP increased significantly from 8.00% to 79.25% from seeds harvested at 28 to 52 DAA respectively prior to storage with slight increase to 81.50% at 52 DAA when seeds were 14 days in storage. The trends recorded in GRI and GI were similar to that of GP. The general decreases in the values of GP, GRI and GI when seeds were beyond 14 days in storage was an indication that deterioration has set in. It is concluded from this study that pepper seeds reached maximum quality at 52 DAA when fruits were completely red outside.

Keywords: Pepper; seed; germination percentage; vigour; dormancy

INTRODUCTION

Red bell pepper called "Tatashe'' (*Capsicum annuum* L.) belongs to the family Solanaceae (Kabura *et al*., 2008). The crop is said to have originated from southern tropical America and probably domesticated in Mexico around 2000BC. Pepper is a well-recognised crop in the tropics and it is the world's second most important vegetable after tomatoes (Olaniyi and Ojetayo, 2010). The crop has been grown for many years by peasant farmers in the northern part of Nigeria (Olarewaju and Showemino, 2003). It is reported to be rich in vitamins, important antioxidants, flavonoids and phytochemicals (Maria *et al*., 2010). In

Nigeria, it accounts for about 20% of the average daily vegetable consumption per person (Alegbejo, 2002). This according to Adesina *et al*. (2014) makes it an important part of the diet of millions of Nigerians, thus, its increase in popularity and demand. Peppers are used fresh in vegetable salads or used as spice in the preparation of soup and stew amongst Nigerians (Benson *et al*., 2014). Peppers are also linked with the prevention of certain types of cardiovascular diseases, atherosclerosis, cancer, haemorrhage, delaying of ageing process, preventing cholesterol build up, improving physical resistance and increasing appetite (Marin *et al*., 2004).

Despite the numerous benefits and uses of this crop, availability of quality seeds to farmers in Nigeria particularly in Minna Niger State is a major problem limiting its production. Seed is a primary and essential starting point for a wide range of horticultural and arable crops, including many annual and biennial ornamentals (Demir and Balkaya, 2005). Most resource poor farmers obtain seeds from fruits that have been left to weather on the field which are most likely to be of poor quality. Such seeds are known to germinate and store poorly when used (Ibrahim *et al*., 2017). The production and distribution of seeds by seed companies and enterprises in Nigeria is more in the area of cereal and grain legumes. This explains why vegetable farmers source their seeds locally and this has great negative effects on seed quality. However, some low input technologies such as good cultural practices are known to result in high quality seed yield from mother-plants on farmers' fields. Among several cultural practices, harvesting of the fruit at the right stage of maturity is of great importance for obtaining high quality seeds (Ali and Singh, 2015). Though several works have been done on when fruits of pepper should be harvested in order to obtain seeds of high quality, results revealed that variations exist even among cultivars or genotypes within same species. The work done by Oladiran and Kortse (2002) revealed that fruits of pepper harvested at 44 days after anthesis (DAA) yielded seeds of highest quality while Vidigal *et al*. (2011) reported 75 DAA as the optimum harvest time for seeds of high quality in '*Amarela comprida*' cultivar of sweet pepper. Lady's Finger pepper is reported to be physiologically mature when the fruits are intense red in colour at about 45 DAA and a 10-day after-ripening of fruits improves the physiological potential of the seeds (Periera *et al*., 2014). Furthermore, seeds of pepper have been considered to have poor longevity (Basak *et al*., 2006). "Tatashe" seed in particular is reported to be an excellent poor storer (Oladiran and Kortse, 2002). The aim of this study was to determine the appropriate fruit harvest time for the production of high-quality seeds in the four pepper genotypes usually grown in Minna, Niger State.

MATERIALS AND METHODS

Study Area

The experiment was carried out at the Teaching and Research Farm of Federal University of Technology, Minna (9^{o} 40/ N and 6^{0} 30/ E) in the Southern Guinea Savanna region of Nigeria. The site experiences two seasons, Rainy beginning from April to October and Dry starting from November and stops in March. The vegetation cover is mostly grasses and shrubs with scattered trees. The soil is sandy loam in composition.

Sample Collection and Field Trial

Fresh red ripe fruits of four genotypes ('Tatashe' Dan Kano (V 1), 'Tatashe' Dan Kaduna (V2), 'Tatashe' Dan Zaria (V 3) and 'Shombo' (V 4) of *Capsicum annuum* L. were

obtained from Kure Market, Minna. The fruits were carefully sliced with the aid of sharp knife and seeds were extracted from them. The extracted seeds were air dried at room temperature (*ca* 30 ºC) for 2 weeks. In the nursery, the seeds were sown by drilling in 5 kg topsoil in plastic buckets with perforated bottom to enhance proper drainage and watering was done as found necessary. Seedlings that emerged were nursed for five weeks. Matured seedlings were mass-transplanted in three rows on each bed with inter and intra-row spacings of 70 cm and 50 cm respectively. Water was applied at interval of five days till the end of harvesting. The plots were manually weeded using hoe as found necessary. NPK 15:15:15 at the rate of 300 kg ha^{-1} was applied to the plants four weeks after transplanting to supply 45 kg each of N, P_2O_5 and K_2O ha^{-1}at first application. A second application of N at 50% flowering (using urea 46% as source) to the plants at the rate of 76 kg ha^{-1} was done to supply the balance of 35 kg N. The total application resulted to 80 kg N, 45 kg P_2O_5 and 45 kg K_2O ha^{-1}.

Data Collection

Flowers were date-tagged as they opened for about 40 days and fruits of the different ages (24, 28, 32, 36, 40, 44, 48 and 52 DAA) were harvested at once. Soon after each harvest, fruits were cut open with a sharp knife to extract the seeds. The moisture content of the seeds of each of the treatments was determined using the high temperature oven drying method at 130 ºC for one hour as described by (International Seed Testing Association, 2005). Thereafter, seed dry matter was determined by subtracting the percentage moisture content from 100. The rest of the seeds were air-dried at ambient condition (*ca* 30 ºC) for 14 days and then packaged in screw-cap plastic bottles.

For longevity studies, seeds from fruits of all the different ages were stored at 37 ºC and 75% relative humidity in open plastic plates; to accelerate ageing of the seeds (Ibrahim *et al*., 2013). Germination tests were carried out on all the seed lots prior to storage and at two-week intervals afterwards for six weeks (i.e. 0, 2, 4, and 6 (WAS). This was done by placing four replicates of 50 seeds each of the different harvesting stages on distilled water-moistened-filter paper in plastic Petri-dishes. Germination counts were taken every-other-day and the results were expressed in percentage.

Data Analysis

Germination rate index (Kader, 2005) and germination index (GI) were calculated and used to estimate the vigour of the seeds. Data in percentages were transformed to arcsine values before statistical analysis and data were analysed using analysis of variance (ANOVA). Where significant differences exist between treatments, the Tukey's Honesty Significant Difference test was used to separate the means. All the analysis was carried out using Minitab 17.0 version

RESULTS

Physical observations of the test fruits for the duration of the experiment shows that fruit colour remained green up till 28 DAA and at 32 DAA, red colouration became noticeable in a small proportion of the fruit flesh. The displacement of green colouration by

the red continued gradually until fruits became completely red outside at 52 DAA (Plates 1 and 2).

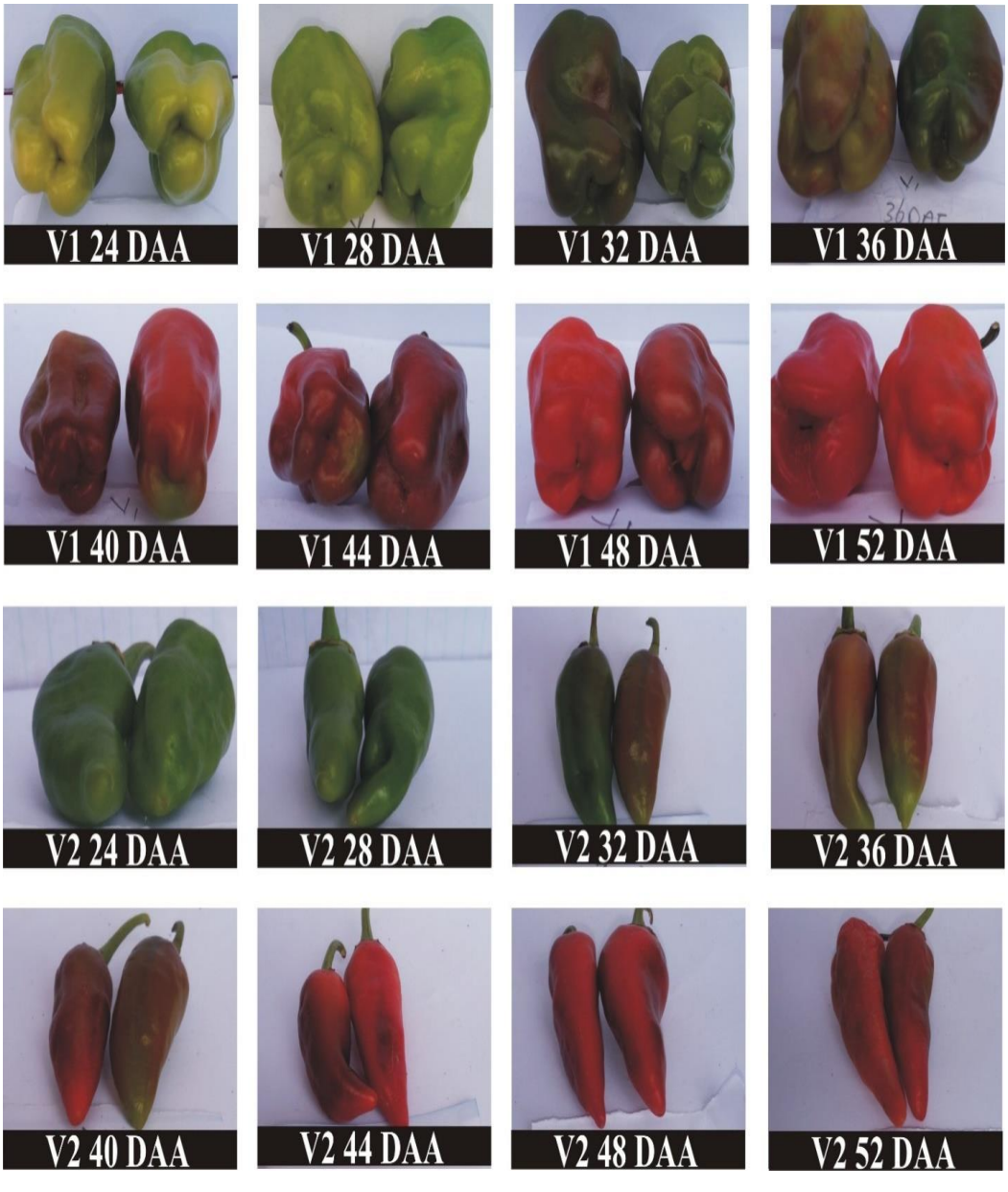

Plate 1: Changes in fruit colour with age in V1 and V2 accessions of pepper

Plate 2: Changes in fruit colour with age in V3 and V4 accessions of pepper

Seeds germination of genotype V4 was significantly higher than those of other genotypes throughout the storage. Germination in seeds of V 1, 2 and 3 were statistically similar prior to storage and up till 14 days of storage after which V2 germinated significantly higher than those of V 1 and 3 (Table 1).

Table 1: Effect of variety and fruit age on seed germination percentage at different storage periods

	Storage periods (days)			
Variety (V)	0	14	28	42
1	38.38b	41.25b	12.44d	8.81c
2	40.50b	45.75b	20.94b	11.37b
3	37.75b	39.98b	14.44c	5.31d
4	59.06a	64.69a	32.00a	16.38a
DAA				
24	0.00e	0.00e	0.00f	0.00f
28	8.00d	4.75d	1.13f	0.00f
32	31.88c	30.50c	9.88e	3.75e
36	51.50b	59.38b	20.63d	9.75d
40	58.75b	65.25b	26.13cd	11.88cd
44	59.50b	66.25b	28.88bc	15.75bc
48	62.50b	75.70a	35.00ab	19.75ab
52	79.25a	81.50a	38.00a	22.88a
V*DAA	*	*	*	*

Means followed by the same letter (s) for the same factor in a column are not significantly different at 5% level of probability by Tukey test. V1 = Tatashe Dan Kano, V2 = Tatashe Dan Kaduna, V3 = Tatashe Dan Zaria, V4 = Shombo, DAA= Days after anthesis

Germination did not occur in any of the seeds harvested before 28 DAA. Poor germination (8.00%) was recorded prior to storage when seeds were harvested at 28 DAA (Table 1). Germination increased with increase in the fruit age reaching a maximum of 79.25% at 52 DAA and this value was significantly greater than those of lower ages. Similarly, the maximum germination percentage of 81.50% was attained in seeds harvested at 52 DAA when seeds were 14 days in storage. However, the value is not significantly higher than the 75.70% recorded in seeds from fruits harvested at 48 DAA. Maximum seed dry matter of 64.03% was also recorded at 52 DAA (Figure 1), coinciding with the fruit age at which maximum seed viability and longevity was expressed. Seeds of V2 however stood out among the other 'Tatashe' genotypes in terms of longevity.

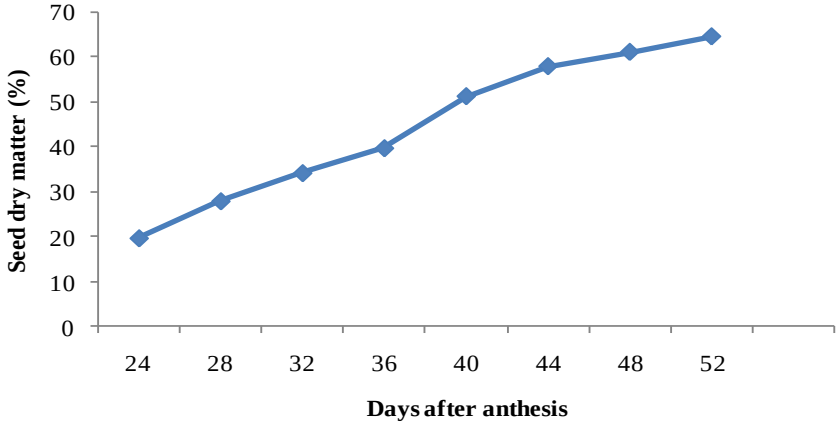

Figure 1: Seed dry matter at different fruit ages

Table 2: Interaction effect of variety and fruit age on germination percentage at different storage periods

	Days after anthesis							
Variety	24	28	32	36	40	44	48	52
				Zero storage				
1	0.00i	1.00hi	13.50g	50.50c-f	51.50c-f	52.00c-f	65.00a-e	73.50a-d
2	0.00i	7.00g-i	7.5g-i	43.00ef	56.00b-e	59.50a-e	69.00a-e	82.00a
3	0.00i	10.50gh	28.00fg	43.50ef	46.00d-f	44.5c-f	53.00c-f	76.50a-c
4	0.00i	13.50g	78.50a	69.00a-e	81.50a	82ab	63.00a-e	85.00a
				14 DAS				
1	0.00l	0.00l	13.00jk	56.50gh	58.00gh	61.00f-g	65.50c-g	76.00a-g
2	0.00l	4.00kl	7.50kl	58.00gh	65.00d-g	67.00c-g	82.50a-e	82.00a-f
3	0.00l	9.50jk	28.00ij	37.00hi	53.50g-i	53.00g-i	63.30e-g	75.50b-g
4	0.00l	5.5kl	73.5c-g	86.00a-d	84.5a-e	84.00a-c	91.50a	92.50ab
				28 DAS				
1	0.00l	0.00l	0.00l	11.00g-j	13.50f-l	19.00f-h	26.50d-g	29.50a-f
2	0.00l	0.00l	4.00i-l	18.00f-h	27.50b-g	30.00a-f	41.50a-d	46.50ab
3	0.00l	1.50kl	5.50h-k	14.50f-i	19.50e-g	22.50d-g	25.00c-g	27.00b-g
4	0.00l	3.00jkl	30.00a-f	39.00a-e	44.00a-c	44.00a-c	47.00ab	49.00a
				42 DAS				
1	0.00j	0.00j	1.50ij	7.50e-h	8.50e-h	14.00b-f	18.00a-e	21.00b-d
2	0.00j	0.00j	3.50h-j	10.50d-g	12.50c-f	17.50b-e	23.00a-c	24.00a-c
3	0.00j	0.00j	0.00j	3.50g-i	5.00f-i	8.50e-h	11.00d-g	14.50b-e
4	0.00j	0.00j	10.00d-h	17.50b-e	21.50a-d	23.00a-c	27.00ab	32.00a

Means followed by the same letter (s) for the same factor in a column and a row are not significantly different at 5% level of probability by Tukey test. V1 = Tatashe Dan Kano, V2 = Tatashe Dan Kaduna, V3 = Tatashe Dan Zaria, V4 = Shombo, DAS= Days after storage.

Seed vigour as measured by germination rate index and germination index followed a similar trend with the values obtained in germination percentages. The values were highest in seeds of V 4 followed by those of V 2 (Tables 3 and 5).

Table 3: Effect of variety and fruit age on germination rate index (%day^{-1}) at different storage periods

	Storage periods (days)			
Variety (V)	0	14	28	42
1	2.66b	3.10b	0.79c	0.43c
2	3.26b	2.87b	1.43b	0.62b
3	2.73b	2.49b	1.02c	0.30d
4	5.36a	5.89a	2.32a	0.90a
SE±	0.51	0.18	0.1	0.04
DAA				
24	0.00c	0.00e	0.00f	0.00d
28	0.54c	0.29e	0.08f	0.00d
32	2.27bc	2.12d	0.77e	0.17c
36	3.79ab	4.01c	1.38de	0.50c
40	4.60ab	5.09bc	1.74cd	0.63bc
44	6.43a	5.09bc	2.02bc	0.82b
48	4.34ab	5.62ab	2.43ab	1.12a
52	6.03a	6.67a	2.69a	1.28a
SE±	0.72	0.26	0.14	0.05
V*DAA	*	*	*	*

Means followed by the same letter (s) for the same factor in a column are not significantly different at 5% level of probability by Tukey test. V1 = Tatashe Dan Kano, V2 = Tatashe Dan Kaduna, V3 = Tatashe Dan Zaria, V4 = Shombo, DAA= Days after anthesis

Table 4: Interaction effect of variety and fruit age on germination rate index (%day^{-1}) at different storage periods

	Days after anthesis							
Variety	24	28	32	36	40	44	48	52
				0 Storage				
1	0.00b	0.04b	1.04b	4.05b	2.75b	3.45b	4.57b	5.35b
2	0.00b	0.36b	0.41b	2.68b	5.50b	4.74b	5.90b	6.46b
3	0.00b	0.84b	2.16b	3.58b	3.27b	2.76b	2.76b	6.46b
4	0.00b	0.94b	5.44b	4.84b	6.89ab	14.79a	4.13b	5.88b
SE±				1.45				
				14 DAS				
1	0.00i	0.00i	0.73i	4.09c-f	4.72c-f	4.00c-g	5.34b-e	5.91b-d
2	0.00i	0.20i	0.32i	3.76c-g	3.62c-g	5.51b-e	5.04b-f	4.51c-f
3	0.00i	0.64i	1.19g-i	2.34f-i	2.81e-i	3.22d-h	4.47c-f	5.22b-e
4	0.00i	0.33i	6.24bc	5.83b-d	9.21a	7.63ab	7.61ab	10.24a
SE±				0.51				
				28 DAS				
1	0.00f	0.00f	0.00f	0.63d-f	0.71d-f	1.28c-f	1.74b-e	1.97b-d
2	0.00f	0.00f	0.21ef	1.14c-f	1.96b-d	2.11a-d	2.92ab	3.12ab
3	0.00f	0.08f	0.29ef	0.90d-f	1.19c-f	1.65b-e	1.91b-d	2.12a-d
4	0.00f	0.22ef	2.58a-c	2.86ab	3.12ab	3.03ab	3.16ab	3.56a
SE±				0.28				
				42 DAS				
1	0.00j	0.00j	0.06j	0.39g-j	0.41g-j	0.66e-i	0.88c-g	1.07b-f
2	0.00j	0.00j	0.14ij	0.52f-j	0.71d-i	0.93c-g	1.28a-d	1.40a-c
3	0.00j	0.00j	0.00j	0.15h-j	0.22h-i	0.44g-j	0.72d-h	0.84c-g
4	0.00j	0.00j	0.48g-j	0.93c-g	1.17b-e	1.23b-e	1.59ab	1.80a
SE±				0.1				

Means followed by the same letter (s) for the same factor in a column are not significantly different at 5% level of probability by Tukey test. V1 = Tatashe Dan Kano, V2 = Tatashe Dan Kaduna, V3 = Tatashe Dan Zaria, V4 = Shombo, DAS= Days after storage

Table 5: Effect of variety and fruit age on seed germination index at different storage periods

	Storage periods (days)			
Variety (V)	0	14	28	42
1	213.75b	236.75b	67.81c	38.31c
2	255.88b	237.81b	116.15b	56.25b
3	211.81b	193.75b	85.25c	25.88d
4	342.38a	376.13a	186.25a	81.38a
SE±	13.1	12	7.4	3.34
DAA				
24	0.00d	0.00e	0.00f	0.00d
28	34.13d	21.50e	6.25f	0.00d
32	184.75c	160.75d	62.25e	15.00d
36	306.13b	319.38c	115.50d	44.63c
40	356.13b	371.25bc	144.63cd	56.50bc
44	323.00b	339.25c	164.38bc	72.50b
48	354.25b	427.88ab	197.25ab	101.13a
52	489.25a	448.88a	220.63a	113.88a
SE±	18.5	16.9	10	4.73
V*DAA	*	*	*	*

Means followed by the same letter (s) for the same factor in a column are not significantly different at 5% level of probability by Tukey test. V1 = Tatashe Dan Kano, V2 = Tatashe Dan Kaduna, V3 = Tatashe Dan Zaria, V4 = Shombo, DAS= Days after storage

Table 6: Interaction effect of variety and fruit age on germination index at different storage periods

	Days after anthesis							
Variety	24	28	32	36	40	44	48	52
				0 Storage				
1	0.00m	4.00m	76.50h-m	311.00b-g	233.00e-k	276.50c-h	374.00a-f	435.00a-e
2	0.00m	28.00lm	37.50k-m	242.50d-j	407.00a-f	365.00a-g	444.00a-d	523.00a
3	0.00m	47.00j-m	167.00g-m	270.00c-h	252.50d-i	226.00f-l	243.50d-j	488ab
4	0.00m	57.50i-m	458.00a-c	401.00a-f	532.00a	424.50a-f	355.50a-g	510.50ab
SE±				37.1				
				14 DAS				
1	0.00j	0.00j	62.50ij	319.50d-g	373.50b-f	311.50d-g	393.50b-f	433.50a-e
2	0.00j	18.50j	30.00j	312.50d-g	331.00c-g	386.00b-f	438.00a-e	386.50b-f
3	0.00j	46.50j	99.00h-j	181.50g-j	241.00f-i	252.00e-h	363.50b-g	366.50b-g
4	0.00j	21.00j	451.50a-d	464.00a-d	539.50ab	407.50b-f	516.50a-c	609.00a
SE±				33.9				
				28 DAS				
1	0.00h	0.00h	0.00h	56.50f-h	67.00e-h	106.50d-h	144.50b-f	168.00a-f
2	0.00h	0.00h	19.50gh	92.50d-h	157.50b-f	168.50a-f	236.00a-c	255.00ab
3	0.00h	8.00h	24.50gh	81.00e-h	104.00d-h	133.00c-g	153.00b-f	178.50a-e
4	0.00h	17.00h	205.00a-d	232.00a-c	250.00ab	249.50ab	255.50ab	281.00a
SE±				20.9				
				42 DAS				
1	0.00j	0.00j	5.00j	34.50g-j	34.00g-j	60.50e-i	79.00c-g	93.50b-f
2	0.00j	0.00j	12.00ij	46.00f-j	63.50e-i	84.00c-g	118.00a-d	126.50a-c
3	0.00j	0.00j	0.00j	13.00ij	21.00h-j	37.50g-j	62.50e-i	73.00d-h
4	0.00j	0.00j	43.00f-j	85.00c-g	107.50b-e	108.00b-e	145.00ab	162.50a
SE±				9.45				

Means followed by the same letter (s) are not significantly different at 5% level of probability by Tukey test.
V1 = Tatashe Dan Kano, V2 = Tatashe Dan Kaduna, V3 = Tatashe Dan Zaria, V4 = Shombo, DAS= Days after storage

DISCUSSION

The changes in colour through various hues until red colour was maintained may not be unconnected with the process of fruit maturation. Similar changes had been observed in previous studies. Ibrahim *et al*. (2017) observed colour changes from green through several hues up till when brown colouration was attained and they attributed such changes to progressive fruit maturation in *Solanum macrocarpon*. Changes in colour of catingueira (*Caesalpinia pyramidalis* Tul.) was also attributed to evolution of maturation of fruit internal tissue and the attained red colouration in the opinion of the authors could be associated to chlorophyll degradation and synthesis of pre-existing pigments specific to species (Lima *et al*., 2012). Barroso *et al*. (2017) also observed decreases in chlorophyll content with progress in fruit maturation which resulted in changes in colour from yellowish-green through to light-yellowish brown and crumbly appearance in *Physalis ixocarpa*.

The significantly higher germination percentages recorded in seeds of V4 over those of V 1, 2 and 3 in this study may be due to genetic superiority. This is similar to what was reported by Aloui *et al.* (2014) on three cultivars of pepper which showed that Anaheim Chili germinated better than Beldi and Baklouti cultivars. The work of Seyed and Naser (2012) has also shown significant differences among 10 cultivars of *Solanum lycopersicum* in all parameters including germination percentage.

In this study, longevity of seeds was poor in V1, V2 and V3. This trend suggests the inherent differences known in varieties. This has previously been reported by Dharwad (2007) who stated that pepper varieties may vary greatly in their potential for retaining germinability and vigour of seed under storage conditions and that this is tied to inherent differences in varieties. Oladiran and Kortse (2002) also reported that pepper seeds of 'Rodo' cultivar-maintained viability better than 'Tatashe' cultivar. Ahmed *et al*. (2002) also recorded variation in the rate of deterioration among species of cucumber seeds.

The 0% germination recorded in seeds of all the genotypes harvested before 28 DAA suggests that the seeds were immature and showed that the capacity to germinate had not been developed prior to this point. This was similar to what was reported by Barroso *et al*. (2017) in *Physalis ixocarpa* where seeds harvested prior to 25 DAA recorded no germination. Yisa *et al*. (2013) reported that the stage of fruit development at harvest has a profound influence on the ability of pepper seeds to germinate and that seeds from fully ripe fruits resulted in the highest germination. When seeds of pepper were harvested earlier than 36 days after anthesis, germination did not occur.

In this study, maximum seed dry matter was attained at 52 DAA, when maximum seed germination and storability were achieved. This fruit maturity stage is called the physiological maturity stage. This therefore means that both mass and physiological maturity were attained at 52 DAA in this study. This is similar to the observations by Vidigal *et al*. (2011) in pepper and Dias *etal*. (2006) in tomato who reported that both the maximum germination and dry matter were obtained at 75 DAA. This confirms the earlier hypothesis of Harrington (1972) that mass and physiological maturity occur at the same time in crop species. However, this is contrary to report by Demir *et al*. (2002) that maximum quality occurred between 8 and 24 days after maximum dry weight in aubergine (*Solanum melongena*) seeds. Kortse and Oladiran (2002) also recorded the highest germination percentage at 10-25 days after seed-filling phase in 'Egusi-Ito' melon (*Cucumeropsis mannii* Naudin.). This suggests that mass and physiological maturity time may be crop dependent.

Increases in germination in seeds extracted from fruits harvested from 36 to 52 DAA when seeds were 14 days in storage in this study is an indication of the presence of dormancy. Dormancy was reported in stored seeds of habenero pepper which was broken after four months of storage (Caxeita *et al*., 2013). Ibrahim *et al*. (2017) also recorded improvement in germination after 7 and 14 days of storage in *Solanum macrocarpon*. Seed dormancy has been reported to be a problem in *Solanum macrocarpon* and it could take up to 12 months for it to be naturally lost (Yogeesha *et al*., 2008).

Result of this study showed higher vigour in seeds of V4 than those of V 1, 2 and 3. The reason for this observation may be genetic which is known to occur amongst crop species. This was similar to what had been reported in other studies. Mustapha *et al*. (2017) reported that seeds of FUTMSm-1 cultivar of *Solanum macrocarpon* exhibited superior vigour using GRI and GI as indices. This agrees with the work of Seyed and Naser (2012) which showed significant variations in seed germination rate among selected cultivars of *Solanum lycopersicum.* Moghanibashi *et al*. (2012) also reported that Urfloar cultivar of sunflower recorded higher germination index and germination rate index than Blazar cultivar.

Seed vigour indices were also higher in more mature seeds in this study and this is also in agreement with previously documented works. Demir *et al*. (2002) recorded lower values of normal germination, germination after cold test, emergence and seedling dry weight and these increased as maturity progressed in *S. melongena*. Similar results were obtained by Sowmya *et al*. (2012) who also recorded higher germination percentages, germination at first and final count, mean seedling length and dry weight as well as other vigour indices in seeds extracted from yellow fruits (60 DAA) and lowest in those from green fruits (45 DAA), attributing this to physiological maturity of the seeds at yellow fruit stage.

The general decline in germination percentage, germination rate index and germination index as storage period progressed might be due to deterioration.

CONCLUSION

It is concluded from this study that both mass and physiological maturity of seeds was attained in the four genotypes of pepper at 52 DAA. Seeds of 'Shombo' (V4) germinated and stored better than all the 'Tatashe' genotypes (V1, V2 and V3); however, genotype 2 of 'Tatashe' maintain viability longer than varieties 1 and 2. It is therefore recommended that fruits of these pepper genotypes be harvested at 52 DAA to obtain seeds of high quality.

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