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QUALITY OF PEPPER SEEDS (*Capsicum annuum* L.) OBTAINED FROM SUN AND AIR-DRIED FRUITS OF DIFFERENT CUTTING TREATMENTS

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ABSTRACT

The effect of cultivar ('Tatashe' and 'Shombo'), fruits cutting techniques (fruits cut at the tip, fruits cut into halves and uncut fruits) and drying methods (air and sun) on seed quality was tested during 60 days of storage period at 37 °C and 90% relative humidity in the Laboratory of Crop Production Department, Federal University of Technology, Minna, Nigeria. Data were collected on moisture content, germination percentage, germination rate, germination rate index and germination index. Data collected were subjected to analysis of variance using Minitab 17.0 version and means were separated using Duncan Multiple Range Test (DMRT). High significant ($P \leq 0.05$) performances in respect of all the parameters were recorded in 'Shombo' cultivar than in 'Tatashe'. Seed quality level declined as from 40/60 days after storage. The quality of seeds were also enhanced with air-drying method in intact fruits compared to those that were sun-dried and other cutting treatments particularly in aged seeds.

Key words: Pepper, cutting treatment, germination rate, 'tatashe'

INTRODUCTION

Pepper plays a major role in pharmaceutical and cosmetics industries, in the production of mild drugs; it is also used in storing grains. Bosland and Votava (2000) stated uses of pepper to include addition of flavour and taste to food in the daily diet of over 1.2 million Nigerians irrespective of their socio-economic status. Pepper is an excellent source of vitamin C (ascorbic acid), vitamin B6, phytochemicals such as lycopene and beta-carotene (a precursor of vitamin A), potassium and fiber. Nadeem *et al.* (2011) also stated that besides vitamins A and C, the fruits contain mixtures of antioxidants notably carotenoids, ascorbic acid, flavonoids and polyphenols. In some parts of southern Nigeria, pepper is served with kola nut for entertaining guests.

Nascimento (2005) listed drying, processing and storage among items that affect the production of quality vegetable seeds. Sliva *et al.* (2011) stated that improper drying can cause damage to the seeds which may result in reduced storage potential. Simply drying of pepper seeds in intact fruits is less laborious and cheaper for poor-resource farmers than when seeds are extracted from fresh fruits and then dried using sophisticated equipment. Most farmers therefore extract seeds from dry fruits for the purpose of raising a crop. Studies have shown that pepper seeds extracted from sun dried fruits are of low quality. High temperature and moisture content to which seeds in intact fruits are exposed during sun-drying may have an adverse effect on seed quality. Studies have also shown that seeds in intact fruits dry slowly in the shade and may therefore be attacked by micro-organisms which will result in low quality. Roopa (2006) reported that seeds dried in an oven at 40°C temperature recorded lower moisture content with significantly higher speed of germination, seedling length, seedling dry weight and vigour index. However, though high temperatures result in reduced drying time and an increase in the effective moisture diffusivity, they may result in low quality seeds (Di Scala and Crapiste, 2008). K'Opondo (2011) warned that when a seed has a high moisture content (MC), it may be damaged by too rapid drying, causing

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bursting or "case-hardening", in which the surface of the seed dries out rapidly, sealing moisture within the seed.

Pepper is an important vegetable crop consumed by virtually everybody and therefore in high demand all year round. A good crop can only be raised from high quality seeds. If the quality of seed is low, there will be low germination and poor seedling emergence and development (Changyeun, *et al.*, 2014). This means that the vigour of the seeds which determines the performance capability of the crop will be low. Use of poor quality seeds will lead to poor yield and poor income to farmers. Use of high quality seeds is a major prerequisite for high and stable yield of crops. The traditional and most common methods of determining high quality seeds are based on certain physical characteristics such as weight, germination, biochemical, and physical tests (ISTA, 2008). Seed vigour is measured to provide an indication of future performance of a seed and most times, performance relates to the ability of seeds to germinate and produce seedlings that will grow into a vigorous plant. Changyeun, *et al.* (2014) stated that the use of defective pepper seeds can cause losses during the production process, including sowing, growing, and harvesting. Seed vigour affects seed viability, speed of germination, seedling growth, seedling sensitivity to external factors and seed lot storability (Corbineau, 2012). According to Mathews *et al.* (2012), seed vigour tests are based on different concepts, such as the resistance to stress, speed of germination, membrane integrity and seedling development. Some of the indices that have been used to evaluate seed quality are germination percentage, germination rate, germination rate index and germination index (Kader, 2005). Maintaining the quality of seeds during the storage period is a factor that must be considered in the production process of any crop, because crop performance significantly depends on the use of high quality seeds (Freitas *et al.*, 2004). Seed moisture content/relative humidity, packaging and seed coat characteristics are known to influence viability during storage (Caldwell *et al.*, 2005; Toledo *et al.*, 2009). The type of storage component in the seed also influences the equilibration of seed moisture content. Because of the differences in anatomical structure and storage components of seeds, the equilibrium moisture content differs between similar species.

The accelerated ageing test is also indicated to define seeds' vigour (Marcos- Filho, 2005) and it is used to evaluate the physiological potential of seeds after certain storage period (Panobianco *et al.*, 2007). Oyekale *et al.* (2012) reported that seed deterioration during storage was due to damage to cell membrane. Such damages result in complete disorganization of membranes and cell organelles and ultimately cause death of seed and complete loss of viability. The most common and consistent ultra-structural changes in all the cell organelles were the loss in integrity of membranes which invariably leads to increased seed deterioration especially during storage. Adriana *et al.* (2012) stated that seeds stored in ambient conditions lose their viability and vigour. Ghahfarokhi *et al.* (2014) also reported that seeds deteriorated and lost germinability during prolonged storage periods. Much of the pepper fruits in markets are produced by poor-resource farmers. It is therefore necessary to develop low-input processing technology that will ensure production of high quality seeds.

The aim of this study was to determine the effect of different fruit cutting treatments and drying methods on seed quality in 'Tatashe' and 'Shombo' cultivars of pepper.

MATERIALS AND METHODS

The experiment was carried out in the Laboratory of Crop Production Department, Federal University of Technology, Minna, Nigeria. Red- ripe fruits of two pepper cultivars 'Tatashe' (T) and 'Shombo' (S) were each divided into six lots and processed using six different procedures as detailed below:

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Lot 1- Fruits were cut at the tip and then air-dried (i e. dried in the laboratory under ambient condition) for 16 days; Lot 2 - Fruits were cut at the tip and then sun-dried for 16 days; Lot 3 – Fruits were cut into halves and then air-dried as in Lot 1; Lot 4 – Fruits were cut into halves and then sun-dried as in Lot 2; Lot 5 – Fruits were left intact (uncut) and air-dried as in Lot 1; Lot 6 – Fruits were left intact (uncut) and sun-dried as in lot 2. Fruits of the two (2) different cultivars were therefore subjected to three (3) cutting treatments (tip, half and intact) and two (2) drying methods (air and sun). The study was therefore a 2 x 3 x 2 factorial experiment (12 treatment combinations) fitted into a completely randomized design (CRD). Prior to fruits drying, seeds were extracted from randomly selected fruits of the two cultivars for moisture content determination using the hot oven method. Also at 4, 8 and 16 days after drying, seeds of the 12 treatment combinations were tested for moisture content levels. For this purpose, seeds of known weight from each treatment combinations was placed in aluminum foil boats which were then placed in oven that had been pre-heated to a constant temperature of 130 °C for one hour (ISTA, 2005). The samples were transferred immediately after drying to a desiccator for 30 minutes for gradual cooling. Weight of the dried seeds was taken and moisture content was calculated on wet weight basis as follows:

$$MC(\%) = \frac{\text{Weight of water lost by seeds}}{\text{weight of wet seeds}} \times 100$$

At the end of the 16-day drying period seeds were extracted and cleaned. Samples of the seeds of the different lots were tested for germination before storage while some other samples were stored in open aluminum foil containers at a temperature of 37 °C and relative humidity of 90% in order to accelerate seeds ageing. Germination tests were conducted at 0, 10, 20, 40, and 60 days in storage. Four replicates of 50 seeds each were placed on distilled water-moistened filter paper in plastic Petri-dishes and arranged in a germination chamber running at 30 °C for 20 days and germination count was taken daily. Data were collected on percentage moisture content, seed germination percentage, mean germination time (MGT); germination index GI = (16 x n1) + (14 x n2) + ...+ (2 x n16) and germination rate index GRI (% day^{-1}) = $\sum$ (Ni/i)

(Kader, 2005). Data on all parameters were subjected to analysis of variance (ANOVA) using Minitab 17.0 version. All values in percentages were transformed to arcsin values before statistical analysis. Means were separated by the Duncan Multiple Range Test (DMRT, 1955) where significant differences occurred.

RESULTS

Moisture content

There was a significant difference in the moisture content (MC) between the two cultivars when seeds were freshly extracted from fruits. Values of 48.7 and 43.3% were recorded for 'Tatashe' and 'Shombo' seeds respectively. Table 1 shows that MC values were generally significantly influenced by cultivars (C), cutting (F), drying (D) methods and all the interactions were significant except in CxF at 16 days after drying (DAD). At 4 DAD, MC of the two cultivars were similar at about 36 and 35 %. Seeds dried further to 14.4 and 8.8% at 8 DAD and to 3.8 and 4.4% at 16 DAD for 'Tatashe' and 'Shombo' respectively; the differences between cultivars were significant. Seeds dried faster when fruits were cut into two halves compared to when fruits were left uncut and when cut at the tip. At 16 days after drying, moisture levels were 5.1, 2.7 and 6.5% for tip cutting, half cutting and intact fruits respectively. Furthermore, seeds dried faster in the sun than in the shade and the 4.0 and 3.4% MC recorded for air and sun-drying at 16 days after drying were significantly different. Table 2 reveals that at 8 DAD, seed MC was similar in both sun and air-dried fruits of 'Tatashe' that were cut into halves whereas seeds from fruits that were either cut at the tip or left intact recorded significantly lower MC in sun-drying than in air-drying treatment. The MC of 'Shombo' seeds extracted from fruits cut at the tip or into halves were not significantly affected by drying method whereas MC of seeds extracted from intact fruits were significantly lower when sun-dried than when air-dried. At 16 DAD, drying method did not significantly affect 'Tatashe' seed MC in each of the three fruits cutting treatments. This was also recorded with 'Shombo' when fruits were either cut into halves or at the tip whereas seeds extracted from sun-dried intact fruits were significantly lower than those from air-dried fruits.

Germination percentage

Germination percentage was significantly higher in 'Shombo' seeds than in 'Tatashe'seeds at all storage periods (Table 3). Cutting treatment also significantly affected this parameter at 10, 40 and 60 days after storage (DAS). Values were generally lowest in the seeds extracted from fruits cut into halves. However, there were no significant differences among cutting treatments at 0 and 20 DAS. Seeds extracted from fruits cut into two halves and those from intact fruits had similar germination percentages (58 and 62% respectively) which were significantly different from 67% recorded for seeds from fruit-tip cutting. Cutting of fruits into halves resulted in significantly poorer seed germination percentage (56%) than in other treatments at 40 DAS (about 61%). At 60 DAS, germination percentage was significantly higher in intact fruits (45%) than in fruits cut into halves. The performance in the latter was at par with that of seeds from fruit-tip cutting (42%) which in turn is similar with that of seeds from fruits cut into halves (38%). Furthermore, significantly higher germination percentages were recorded in air-dried than in sun-dried fruits.

Germination rate

Germination was faster in cultivar 'Shombo' than in 'Tatashe' at all storage periods except at 40 DAS when no significant difference was recorded (Table 4). Seeds extracted from intact fruits generally germinated significantly faster than those from fruits that were cut into two halves or cut at the tip. There were no significant differences in the germination rates of seeds extracted from fruits which tips were cut and those cut into halves. Furthermore, seeds from air-dried fruits also resulted in faster germination than those from sun-dried fruits.

Table 5 shows that seeds of 'Tatashe' germinated significantly faster irrespective of cutting method when fruits were air-dried than when sun-dried especially at 10, 20 and 60 DAS whereas fruit cutting and drying methods did not generally affect GR in 'Shombo'. Sun-drying of cut 'Tatashe' fruits generally resulted in slower seed germination compared with values recorded for seeds from intact fruits.

Germination Rate Index (GRI)

Table 6 shows that there were significant differences in the GRI values of 'Tatashe' and 'Shombo' cultivars throughout the storage periods with values being significantly higher in the latter than in the former. GRI values generally declined from 40 DAS. Fruits cutting treatments significantly affected the GRI at only 10 and 60 DAS. At 10 DAS, germination was significantly higher and faster in seeds extracted from fruits in which tip was cut than in the other fruit cutting methods which were poor. At 60 DAS, germination was significantly higher and faster in seeds from intact fruits than in those from fruits cut into halves. However, there was no significant difference in the values obtained in fruit-tip cutting and half fruit cutting and between fruit-tip cutting and intact fruit. Air-drying of fruits resulted in significantly higher and faster seed germination than sun-drying throughout the storage period.

Table 7 shows that when fruits of each cutting methods were air-dried, there were generally no significant differences between the GRI values of the two cultivars at 10 DAS. On the contrary 'Shombo' seeds had significantly higher GRI than 'Tatashe' seeds when fruits of the different cutting treatments were sun-dried. At 60 DAS, 'Tatashe' seeds from air-dried intact fruits recorded significantly higher GRI (19% day-1) than seeds of the other treatments combinations, whereas no significant differences were recorded among different treatment combinations in 'Shombo'. It was further observed that the injurious impact of sun-drying was greater in 'Tatashe' than in 'Shombo'.

Germination index (GI)

Table 8 shows that there were significant differences in the germination index (GI) of the two cultivars at 0, 20, 40 and 60 DAS with significantly higher values recorded in 'Shombo' than in 'Tatashe'. Fruit cutting method significantly affected GI at 10 and 60 DAS. At 10 DAS the GI of seeds obtained from fruits cut at the tip was significantly higher than that from intact fruits which in turn was significantly higher than the value recorded for seeds extracted from fruits cut into halves. At 60 DAS GI was significantly higher in intact fruits than in fruits cut into halves; there were significant differences in GI values of seeds from the former and those from fruits cut at the tip as well as between those from fruits cut at the tip and those cut into halves. Furthermore, seeds from air-dried fruits recorded significantly higher GI than those from sun-dried fruits.

DISCUSSION

Seed moisture content recorded in the current study for 'Tatashe' and 'Shombo' cultivars were 43-48% respectively. This result is contrary to the report of Ravi *et al.* (2006) which revealed that seed moisture content of chilli seeds is normally 30-40% at physiological maturity. The differences in moisture content of seeds in the current study and the above author may be due to differences in the cultivars used. Seed quality (using germination percentage, germination rate, germination rate index and germination index as parameters) was generally significantly greater in 'Shombo' than in 'Tatashe'.this agrees with report of Probert *et al.* (2009) and Nagel and Barner (2010) which indicated that seed quality varied among seed lots of the same species. The situation in this study in which seeds from fruit cut into two halves germinated poorer than those from intact fruits may be due to what obtains in seed weathering. Pepper seeds from cut fruits in this study will normally dry rapidly during the day and absorb water from the placenta at night (since they were still attached to the placenta). The cycle of drying (during the day) and wetting (at night) might have resulted in reduced quality of such seeds (Garud *et al.*, 2014).

The superiority in the quality of air-dried seeds over sun-dried ones as obtained in this study is in agreement with those of (Chakradharpatra *et al.*, 2016). Kaleemulla and Kaiapan (2005); Vega *et al.* (2007); Di Scala and Crapiste, (2008) stated that high temperatures resulted in reduced drying time and an increase in the effective moisture diffusivity but led to the production of low quality of seeds.

The loss of quality as seeds aged in this study supports the findings of other researchers. Ghahfarokhi *et al.* (2014) also reported that seeds of sesame deteriorated and lost germinability during periods of prolonged storage. Oyekale *et al.* (2012) reported that seed deterioration during storage was due to the damage to cell membrane; which may be due to changes that resulted in the complete disorganization of membranes and cell organelles and ultimately causing death of the seeds and loss of viability.

CONCLUSION

It is concluded from this study that seeds of 'Tatashe' were poorer in quality than those of 'Shombo' cultivar. Also seeds extracted from intact (uncut) fruits were generally of significantly higher quality than those from cut fruits. Furthermore, air-drying of fruits of 'Tatashe' resulted in seeds that were of higher quality compared to those from sun-dried fruits. Seeds quality of cultivar 'Shombo' was generally unaffected by fruit drying method. Seeds of the two cultivars declined in quality as they aged. Based on the result of this study, it is recommended that intact fruits of both 'Shombo' and 'Tatashe' be air-dried in order to ensure high, fast and uniform germination.

Table 1 Percentage moisture content of 'Tatashe' and 'Shombo' seeds after 4, 8 and 16 days of drying (DAD)

Treatments	Drying periods (days)		
	4	8	16
Cultivar (C)			
'Tatashe	36.5[a]	14.4[a]	3.8[b]
'Shombo'	33.4[b]	8.8[b]	4.4[a]
Fruit cutting (F)			
Tip	42.4[a]	28.2[b]	5.1[a]
Half	43.3[a]	4.6[c]	2.7[b]
Intact	35.6[b]	35.6[a]	6.5[a]
Drying (D)			
Air	17.7[a]	17.7[a]	4.0[a]
Sun	5.5[b]	4.6[b]	3.4[b]
Interaction			
C XF	*	*	NS
C X D	*	*	*
F X D	*	*	*
C X F X D	*	*	*

Means sharing the same alphabet along the column within the same factor are not significantly different from one another at 5% probability level, ns= Not significant

Table 2 Interaction of cultivar, fruit cutting and drying methods on percentage moisture content at 8 and 16 DAD

C x F x D interaction	Drying periods (days)	
	8	16
C1 x F1 x D1	28.2[ab]	5.4[b]
C1 x F1 x D2	6.0[d]	3.9[bcd]
C1 x F2 x D1	4.6[d]	2.6[d]
C1 x F2 x D2	4.5[d]	2.5[d]
C1 x F3 x D1	35.6[a]	4.4[bcd]
C1 x F3 x D2	7.7[cd]	4.1[bcd]
C2 x F1 x D1	11.0[c]	4.9[bc]
C2 x F1 x D2	5.9[cd]	4.1[bcd]
C2 x F2 x D1	4.5[d]	2.8[cd]
C2 x F2 x D2	4.5[d]	3.7[bcd]
C2 x F3 x D1	22.3[b]	8.5[a]
C2 x F3 x D2	4.8[d]	2.5[d]

Means that do not share the same letter under the same column are significantly different ($P \leq 0.05$)

Table 3 Germination percentage of 'Tatashe' and 'Shombo' seeds with fruit cutting treatments and drying methods at 0, 10, 20, 40 and 60 (DAS)

Treatments	Storage periods (days)				
	0	10	20	40	60
Cultivars (C)					
'Tatashe'	52.6^{b}	59.4^{b}	58.7^{b}	54.3^{b}	27.7^{b}
'Shombo'	71.8^{a}	65.4^{a}	64.3^{a}	64.4^{a}	55.6^{a}
Fruit cutting(F)					
Tip	62.5^{a}	67.2^{a}	64.2^{a}	61.2^{a}	41.9^{ab}
Half	60.8^{a}	57.8^{b}	58.6^{a}	56.0^{b}	38.2^{b}
Intact	63.4^{a}	62.3^{b}	61.5^{a}	60.9^{a}	44.7^{a}
Drying (D)					
Air	70.2^{a}	68.7^{a}	67.8^{a}	66.8^{a}	48.0^{a}
Sun	54.2^{b}	56.2^{b}	55.1^{b}	51.1^{b}	35.2^{b}
Interactions					
C x F	*	*	nS	nS	*
C x D	*	nS	nS	*	*
F x D	*	*	*	nS	*
C x F x D	nS	nS	nS	nS	nS

Means sharing the same alphabet along the column within the same factor are not significantly different from one another at 5% probability level, ns= Not significant, DAS= Days after storage

Table 4 Germination rate of 'Tatashe' and 'Shombo' cultivars at 0, 10, 20, 40 and 60 DAS

Treatments	Storage periods (days)				
	0	10	20	40	60
Cultivar (C)					
'Tatashe'	6.3^{a}	7.6^{a}	5.4^{a}	6.8^{a}	10.9^{a}
'Shombo'	5.1^{b}	5.7^{b}	4.8^{b}	6.8^{a}	6.8^{b}
Fruit cutting					
Tip	6.0^{a}	6.7^{ab}	5.3^{a}	7.2^{a}	8.7^{a}
Half	6.4^{a}	7.1^{a}	5.0^{a}	6.9^{ab}	9.6^{a}
Intact	4.7^{b}	6.0^{b}	5.0^{a}	6.4^{b}	8.4^{b}
Drying (D)					
Air	4.5^{b}	4.0^{b}	4.1^{b}	5.7^{b}	6.9^{b}
Sun	6.8^{a}	8.4^{a}	6.1^{a}	7.9^{a}	10.9^{a}
Interaction					
C x F	*	*	NS	*	*
C x D	*	*	*	*	*
F x D	*	*	*	*	NS
C x F x D	*	*	NS	*	NS

Means sharing the same alphabet along the column within the same factor are not significantly different from one another at 5% probability level, nS= Not significant

Table 5 Interaction effect of cultivar, fruit cutting and drying methods on germination rate at 0, 10, 20, 40 and 60 DAS.

C x F x D Interaction	Storage periods (days) 0	10	20	40	60
C1 x F1 x D1	6.1^{bcd}	5.5^{def}	4.0^{de}	5.1^{e}	8.7^{b}
C1 x F1 x D2	7.8^{b}	10.4^{ab}	7.6^{a}	9.4^{a}	13.1^{a}
C1 x F2 x D1	4.2^{e}	4.7^{ef}	3.7^{e}	6.1^{cde}	9.2^{b}
C1 x F2 x D2	11.6^{a}	12.2^{a}	6.6^{ab}	8.4^{ab}	15.6^{a}
C1 x F3 x D1	4.1^{e}	4.5^{ef}	3.6^{e}	5.1^{e}	6.3^{bc}
C1 x F3 x D2	4.1^{e}	8.0^{bc}	6.6^{ab}	6.9^{b-e}	12.7^{a}
C2 x F1 x D1	4.3^{de}	3.8^{f}	3.9^{de}	6.1^{cde}	5.4^{c}
C2 x F1 x D2	5.8^{cde}	7.1^{cd}	5.8^{bc}	8.1^{abc}	7.4^{bc}
C2 x F2 x D1	4.2^{de}	4.9^{def}	5.0^{b-e}	5.7^{de}	5.6^{c}
C2 x F2 x D2	5.6^{cde}	6.4^{cde}	4.7^{cde}	7.3^{a-d}	8.2^{bc}
C2 x F3 x D1	4.3^{de}	5.4^{def}	4.2^{cde}	6.3^{cde}	6.4^{bc}
C2 x F3 x D2	6.2^{bc}	6.3^{cde}	5.5^{bcd}	7.4^{a-d}	8.1^{bc}

Means that do not share the same letter under the same column are significantly different ($P \leq 0.05$)
DAS= Days after storage

Table 6 Germination rate index (% day-1) at different storage periods as affected by cultivar (C), fruit cutting (F) and drying methods (D)

Treatments	Storage periods (days) 0	10	20	40	60
Cultivar (C)					
'Tatashe'	20.1^{b}	21.8^{b}	24.3^{b}	19.4^{b}	9.2^{b}
'Shombo'	27.0^{a}	24.6^{a}	26.8^{a}	22.1^{a}	19.8^{a}
Fruit cutting					
Tip	23.3^{a}	24.8^{a}	26.1^{a}	20.8^{a}	14.6^{ab}
Half	23.8^{a}	21.8^{b}	24.5^{a}	19.8^{a}	13.3^{b}
Intact	23.6^{a}	22.9^{a}	26.0^{a}	21.7^{a}	15.6^{a}
Drying (D)					
Air	28.3^{a}	28.1^{a}	29.7^{a}	24.1^{a}	17.7^{a}
Sun	18.8^{b}	18.2^{b}	21.3^{b}	17.5^{b}	11.3^{b}
Interaction					
C x F	nS	*	nS	*	*
C x D	*	*	*	*	*
F x D	*	*	*	nS	nS
C x F x D	*	*	nS	nS	*

Means sharing the same alphabet along the column within the same factor are not significantly different from one another at 5% probability level, nS= Not significant

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Table 7 Interaction effect of cultivar, fruit cutting and drying methods on germination rate index at 10 and 60 DAS

C x F x D	Storage periods (days)	
interaction	10	60
C1 x F1 x D1	28.5^{ab}	13.3^{b}
C1 x F1 x D2	15.8^{e}	4.6^{c}
C1 x F2 x D1	27.0^{b}	10.2^{b}
C1 x F2 x D2	14.7^{e}	3.0^{c}
C1 x F3 x D1	29.1^{ab}	19.0^{a}
C1 x F3 x D2	15.4^{e}	5.2^{c}
C2 x F1 x D1	32.9^{a}	21.7^{a}
C2 x F1 x D2	22.1^{cd}	19.0^{a}
C2 x F2 x D1	24.8^{bcd}	21.6^{a}
C2 x F2 x D2	20.6^{d}	18.3^{a}
C2 x F3 x D1	26.4^{c}	20.2^{a}
C2 x F3 x D2	20.6^{d}	17.9^{a}

Means that do not share the same letter within the same column are significantly different ($P \leq 0.05$)

Table 8 Germination index of 'Tatashe' and 'Shombo' cultivars at 0, 10, 20, 40 and 60 DAS

Treatments	0	Storage periods (days) 10	20	40	60
Cultivar (C)					
'Tatashe'	476.0^{b}	547.1^{a}	568.0^{b}	464.8^{b}	155.3^{b}
'Shombo'	762.9^{a}	651.3^{a}	647.2^{a}	578.1^{a}	477.2^{a}
Cutting (F)					
Tip	619.5^{a}	659.8^{a}	636.3^{a}	526.4^{a}	318.0^{ab}
Half	603.3^{a}	534.0^{c}	573.8^{a}	493.9^{a}	279.4^{b}
Intact	635.5^{a}	603.8^{b}	612.7^{a}	544.0^{a}	351.3^{a}
Drying (D)					
Air	765.1^{a}	728.7^{a}	717.8^{a}	640.1^{a}	396.2^{a}
Sun	473.8^{b}	469.8^{b}	497.3^{b}	402.8^{b}	236.3^{b}
Interaction					
C x F	*	*	*	*	*
C x D	*	*	*	*	*
F x D	*	*	nS	nS	*
C x F x D	nS	nS	nS	nS	nS

Means sharing the same alphabet along the column within the same factor are not significantly different from one another at 5% probability level, nS= Not significant

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