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**Theme: ''Horticultural Production: A Panacea for Sustainable Economic Growth and Development"**

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# Effect of harvesting stages on seed quality of beniseed (*Sesamum indicum* L)

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**Abstract**
In order to determine the appropriate harvesting time for optimum seed physiological quality (germination and vigour) in sesame, a study was conducted at the Department of Crop Production, Federal University of Technology, Minna. Seeds of two varieties (Ex-Sudan and Kenana 04) of beniseed were sourced from National Cereal Research Institute Badegi (NCRI). Mass seed production was carried out at the University's Teaching and Research Farm (latitude 90 51 1N and longitude 60 44 1E) during the 2019 cropping season. Pods were harvested at four pod colour stages (green, greenish-yellow, yellow and brown). Harvested pods were taken to the Crop Production Department laboratory for seed extraction, drying and seed quality test. Extracted seeds were stored at 40 °C and 80% relative humidity to accelerate the ageing. Germination test was carried out in four replication placing 50 seeds each on distilled water-moistened filter paper in Petri dishes at 30 °C. Germination count was taken every other day for 14 days. Germination index and germination rate index were also estimated as aspects of seed vigour. Seeds harvested when pods were yellow showed superiority in germination and other vigour parameters from 8 weeks after storage and afterward. The values recorded in seeds of yellow pod harvest were however not significantly greater than those of greenish-yellow pod harvest but significantly higher than those of green and brown pod harvests. It is, therefore, concluded that seeds harvested when pods were yellow are better in quality than those harvested at other pod colour stages.

**Keywords**: Sesame, seeds, germination, vigour, physiological maturity.

## Introduction

Sesame (*Sesamum indicum* L.) is a crop that is widely used as human food, animal feed and has great potential for the production of bio diesel (Libosa *et al*., 2016). It is reported to be the earliest known oleaginous, belonging to the *Pedaliaceae* family, with African continent as its centre of origin (Silva *et al*., 2014). Sesame is grown in several countries, especially in Africa and Asia and due to an important role it plays in human consumption, pharmaceutical and cosmetic industries through its production of seeds and oil (Anilakumar *et al*., 2010), its global production as well as land area used for it cultivation has increased over the years. A worldwide production of of 3.3 million tons in an area of 7.5 million hectare in 2011 (FAO, 2012). As at 2016, World production of sesame seeds has increased 6.2 million tons in an area of 10.8 million hectares in 2016, with an average production of 576 kg ha-1 (FAO, 2018). Nigeria is the largest producer of sesame seeds in Africa, and the third largest in the world, with about 580,000 tonnes produced in 2017. About 90% of sesame seeds produced in Nigeria are exported and it contributes 0.57% to the total export value and 36.39% of agricultural exports (Proshare intelligent investing, 2018). The global demand for this commodity is on the increase as global sesame market is expected to grow at a 4.2% compound annual growth rate (CAGR) between 2018-2024. This thereby present a golden opportunity for Nigeria as the country exports the commodity to China, Turkey, Japan, Vietnam and South Korea (Proshare intelligent investing, 2018). Therefore, the potential of this crop in boosting the Nation's economy, coupled with the fact that the crop is mostly grown by resource poor farmers who save their seeds from previously grown plant is worthy of note. However, only little information is available at the moment on low input technologies farmers could employ in order to have good quality seeds for planting. Among the factors that affect the quality of seed is fruit harvesting stages; of which fruit colour could be used as an index, as already verified for several species (Guimarães and Barbosa 2007; Silva et al., 2012; Ibrahim *et al*., 2018). Few studies that have been done on how fruit harvesting stages affect sesame seed quality (germination and vigour) were not carried out in this part of the continent and also, varieties used in those studies are not the ones grown in this part of the world. Whereas, studies have shown that seed quality of a particular crop could differ with variety and location of production. This study is hereby aimed at determining the appropriate stage at which sesame seeds, intended to be used for raising future crop should be harvested in Minna, Niger State, Nigeria.

## Materials and Methods

This research was carried out at the Department of Crop Production, Federal University of Technology, Minna. Seeds of two varieties (Ex-Sudan and Kenana

04) of beniseed were sourced from National Cereal Research Institute Badegi (NCRI). Mass seed production was carried out at the University's Teaching and Research Farm (9° 40'N and 6° 30'E) during the 2019 cropping season. Seeds were harvested at four pod colour stages (green, greenish-yellow, yellow and brown). Harvesting was done by cutting the stem at the base, after which the pods were detached. Harvested pods were taken to the laboratory of the Department of Crop Production for seed extraction, drying and seed quality test. Extracted seeds were stored at 40 °C and 80% relative humidity for twelve weeks to accelerate the ageing and germination test was done prior to storage and every two weeks until the twelfth week after storage. Germination test was carried out in four replication placing 50 seeds each on distilled water-moistened filter paper in Petri dishes at 30 °C seeds of each variety on distilled water-moistened filter paper in Petri dishes at 30 °C. Germination count was taken every other day for 14 days. Germination rate index and Germination index were also estimated as aspects of seed vigour. Germination rate index (GRI), an estimation of the percentage of seed germination per day and germination index (GI). also determined using the expressions under:

GRI (% $day^{-1}$) = $\sum (Ni/i)$; (Esechie, 1994)

Where N is the percentage of seeds germinated on day i.

The higher the GRI value, the higher and faster the germination (Kader, 2005).

GI was calculated using a modification of the formula developed by (Bench Arnold, 1991):

GI = (14 x n1) + (12 x n2) + ...........+ (2 x n14)

Where n1, n2......., n14 are the number of seeds that germinated on the first, second and subsequent days until the 14th day, respectively; 14, 12, ..........., and 2 are the weight given to the number of seeds that germinated on the first, second and subsequent days respectively.

GI is assessed by Kader (2005) to be a comprehensive measuring parameter since it combines both germination percentage and speed (spread, duration and high and low events). Data was analysed Minitab (version 17) and means were ranked using Tukey test.

## Results

The germination percentage (GP) of seeds of Ex-Sudan and Kenana 04 varieties of sesame are shown in Table 1. There was no significant difference among the GP of seeds of the two varieties throughout the period of the study. Harvesting stages showed no significant difference until eight weeks after storage (8 WAS) when seeds harvested from yellow pods had a significantly higher GP (93%). This value was statistically similar to the GP recorded from seeds of greenish yellow pods but significantly higher than those of green- and brown pod harvest. The GP of seeds of the later-mentioned harvesting stages were however not significantly lower than that of greenish-yellow stage. Similar trends were observed at 10 and 12 WAS with that of 8 WAS but seeds at both yellow and greenish-yellow pod stages were significantly higher than those of other harvesting stages. The variety-harvesting stage interaction was significant at 8 WAS when seeds of Ex-Sudan harvested at yellow pod stage had 94.50% germination. This value was significantly higher than that of the seeds of Kenan 04 variety at brown pod stage (82.0%), but was statistically similar to other interaction values; all of which were not significantly different from that of brown pod harvest of Kenan variety (Figure 1).

Seeds of the two sesame varieties were not significantly different for germination index (GI) throughout the period of the study as shown in Table 3. The GI value (644.50) recorded in seeds harvested from yellow pods was statistically similar to the 616.75 recorded in seeds of greenish-yellow pod harvest, but the former was significantly greater than those of other harvesting stages at 8 WAS. Similar trend was recorded at 1 WAS but at 12 WAS, seeds harvested at both yellow and greenish-yellow pod stages were significantly higher in GI than those of other harvesting stages. Significant interaction was recorded at 8 WAS as the 650.00 recorded when seeds of Ex-sudan harvested at yellow pod stage was significantly greater than the 585.50 and 567.00 recorded in seeds of green and brown pod stages respectively of Kenana 04 variety. The value recorded in seeds of Ex-sudan harvested at yellow pod stage was however statistically similar to that those of other interaction values. The interaction at 10 WAS was of similar trend to that of 8 WAS (Table 4).

No significant difference was recorded in germination rate index (GRI) of seeds of the two sesame varieties all through the period of the experiment while seeds harvested at yellow pod stage had a GRI value of 45.19%$day^{-1}$; which was significantly higher than the GRI of seeds harvested at other maturity stages. At 10 WAS, seeds harvested at yellow pod stage were statistically similar in GRI to those of greenish-yellow stage, but significantly higher than those of other harvesting stages (Table 5). At 8 WAS, the interaction value (45.63%$day^{-1}$) recorded in Ex-sudan seeds harvested at yellow pod stage was significantly higher than those of green pod harvests of the same variety (40.38%$day^{-1}$), green (40.13%$day^{-1}$) and yellow (39.75%$day^{-1}$)pod harvest of Kenan variety. Other interaction values were statistically similar to the 45.63%$day^{-1}$ recorded in Ex-sudan seeds harvested at yellow pod stage. The interaction at 8 and 10 WAS were of similar trend.

## Discussion

In this study, the two variety of sesame seeds (Ex-Sudan and Kenana 04) presented no significant variation in the viability and vigour parameters evaluated; which is an indication that both varieties are similar with respect to these indices. The superiority of seeds harvested from yellow pod, as evident from 8 WAS suggests this pod harvesting stage as the point of seed physiological maturity. This is a point where germination and vigour are maxima (Neto *et al.*, 2015). An important aspect in the production of high quality seeds is the determination of physiological maturity and ideal period to harvest seeds (Martins *et al.*, 2012). Similar to what was obtained in this study, earlier report by Silva *et al.* (2017) has also recommended harvesting seeds when BRS Seda cultivar of sesame fruit turns yellow or yellowish-green in Brazil. Ferreria *et al.* (2017) also reported that the physiological maturity of the sesame seeds, was reached between 52 and 54 days after anthesis.. The loss of viability and vigour after physiological maturity was attained as evident in the reduced germination percentage and vigour indices (GI and GRI) is a natural phenomenon in seeds. Similar result was obtained by Ferreria *et al.* (2017) on sesame where seeds harvested after 52-54 days after anthesis (DAA) presented reduction in viability and vigour. The phenomenon has been previously reported by Delouche (1975) who stated that, After physiological maturation, the period in which the seeds remain in the field is decisive for deterioration or loss of vigor. This fact was further attested to by Welbuam (1999) who reported that just a matter of five day delay in harvest after physiological maturity is attained in seed resulted in significant reduction in muskmelon seed quality. The condition has been attributed mainly to the relative air humidity and the temperature to which seeds are exposed to after physiological maturity is reached (Garcia *et al.*, 2004). The general decline in seed quality (germination and vigour) with increase in storage is an indication of deterioration. This is a natural process in seeds involving changes that could be cytological, physiological, biochemical and physical which in turn result in reduced viability and death of the seed. This has also been reported in *Capsicum annum* (Patil and Nagaraja, 2000), onions (Amjad and Anjum, 2002), cucumber (Ahmed *et al.*, 2002), eggplant (Ibrahim *et al.*, 2017) maize (Ibrahim *et al.*, 2019)

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**Table 1: Effect of Harvesting Stages on The Seed Germination Percentage of Sesame Varieties**

| Treatment | Storage Periods (week) | | | | | | |
|---|---|---|---|---|---|---|---|
| | ZERO | 2WAS | 4WAS | 6WAS | 8WAS | 10WAS | 12WAS |
| Variety | | | | | | | |
| Ex-Sudan | 93.63a | 92.25a | 92.00a | 90.38a | 88.94a | 87.63a | 86.25a |
| Kenana 04 | 91.5a | 90.50a | 90.50a | 88.25a | 86.63a | 86.31a | 85.63a |
| SE± | 1.35 | 1.3 | 1.42 | 1.42 | 1.16 | 1.09 | 1.11 |
| Harvesting Stage | | | | | | | |
| Green | 91.00a | 89.50a | 90.50a | 86.00a | 85.88b | 83.38b | 81.75b |
| Greenish-Yellow | 93.50a | 92.00a | 92.00a | 90.50a | 88.00ab | 88.88ab | 89.50a |
| Yellow | 95.25a | 94.50a | 94.00a | 93.25a | 93.00a | 91.00a | 90.50a |
| Brown | 90.50a | 89.50a | 88.50a | 87.50a | 84.25b | 84.63b | 82.00b |
| SE± | 1.9 | 1.84 | 2.01 | 2.01 | 1.63 | 1.54 | 1.56 |
| VAR*HS | NS | NS | NS | NS | * | NS | NS |

Means followed by the same letter (s) in the same column are not significantly different at $p<0.05$ according to Tukey test

WAS= Weeks after storage, NS = Not significant, * = Significant

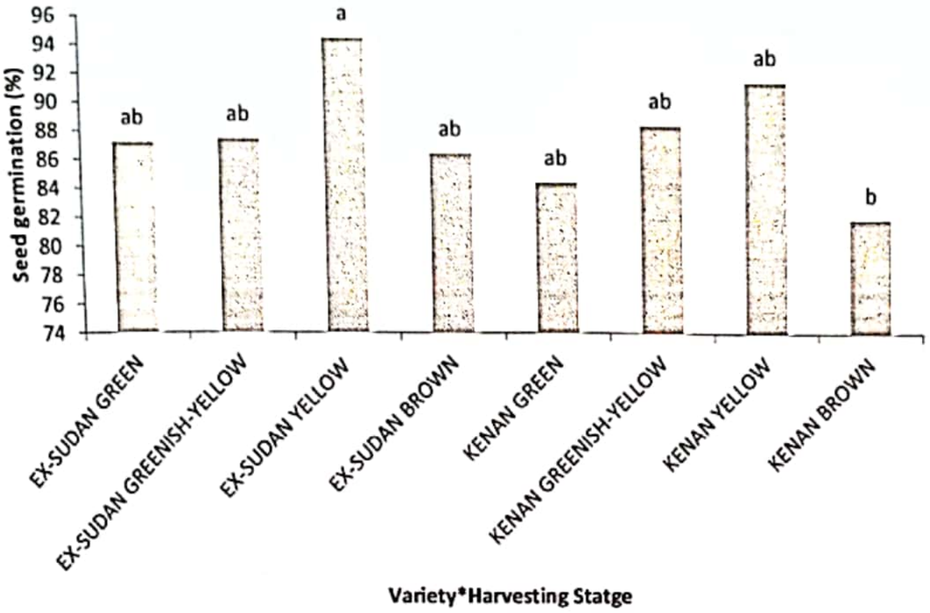


Figure 1: Interaction effect of variety and harvesting stages on seed germination percentage

**Table 2: Effect of Harvesting Stages on the Seed Germination Index of Sesame Varieties**

| Treatment | Storage periods (Week) | | | | | | |
|---|---|---|---|---|---|---|---|
| | ZERO | 2WAS | 4WAS | 6WAS | 8WAS | 10WAS | 12WAS |
| VARIETY | | | | | | | |
| EX-SUDA | 522.13a | 628.25a | 638.88a | 626.38a | 614.75a | 613.00a | 601.86a |
| KENAN | 489.63a | 607.00a | 634.25a | 613.00a | 601.25a | 601.75a | 599.38a |
| **SE±** | 18 | 7.81 | 14.3 | 9.61 | 6.38 | 7.22 | 7.75 |
| HARVESTING STAGE | | | | | | | |
| GREEN | 542.25a | 617.00a | 607.25a | 597.75a | 588.50b | 579.00c | 572.25b |
| GRE-YEL | 505.75a | 614.00a | 656.75a | 627.00a | 616.75ab | 624.25ab | 622.75a |
| YELLOW | 483.00a | 604.25a | 639.00a | 642.00a | 644.50a | 639.00a | 633.50a |
| BROWN | 492.50a | 635.25a | 643.25a | 612.00a | 582.25b | 586.75bc | 574.00b |
| **SE±** | 25.5 | 15.6 | 20.3 | 19.2 | 9.02 | 10.2 | 10 |
| VAR*HS | NS | NS | NS | NS | * | * | * |

Means followed by the same letter (s) in the same column are not significantly different at $p<0.05$ according to Tukey test
WAS= Weeks after storage, NS = Not significant, * = Significant

**Table 3: Interaction effect of Harvesting Stages on the Seed Germination Index of Sesame Varieties**

| Treatments | | Storage periods (Week) | | |
|---|---|---|---|---|
| VARIETY*HARVESTIG STAGE | | 8WAS | 10WAS | 12WAS |
| EX-SUDAN | GREEN | 591.50abc | 570.50bc | 570.50bc |
| | GREEN-YELLOW | 620.00abc | 630.00abc | 622.50a |
| | YELLOW | 650.00a | 644.00a | 633.50a |
| | BROWN | 597.50abc | 607.50abc | 581.00b |
| KENAN | GREEN | 585.50bc | 587.50abc | 574.00bc |
| | GREEN-TELLOW | 613.50abc | 618.50abc | 623.00a |
| | YELLOW | 639.00ab | 635.00ab | 633.50a |
| | BROWN | 567.00c | 566.00c | 567.00c |
| | SE± | 12.8 | 14.4 | 15.5 |

Means followed by the same letter (s) in the same column are not significantly different at $p<0.05$ according to Tukey test
WAS= Weeks after storage

**Table 5: Effect of Harvesting Stages on the Seed Germination Rate Index of Sesame**

| TREATMENT | STORAGE PERIODS (WEEKS) | | | | | | |
|---|---|---|---|---|---|---|---|
| VARIETY | ZERO | 2WAS | 4WAS | 6WAS | 8WAS | 10WAS | 12WAS |
| EX-SUDAN | 26.83a | 42.97a | 44.93a | 43.47a | 42.28a | 42.92a | 42.63a |
| KENANA 04 | 26.83a | 41.00b | 42.83b | 42.94a | 42.69a | 42.03a | 42.31a |
| SE± | 0.64 | 0.59 | 0.68 | 0.68 | 0.47 | 0.55 | 0.58 |
| HARVESTING STAGE | | | | | | | |
| GREEN | 28.88a | 42.75a | 41.83b | 41.31a | 40.25b | 40.96b | 41.13a |
| GRE-YEL | 24.56b | 40.48a | 44.19ab | 43.63a | 42.31b | 43.19ab | 43.38a |
| YELLOW | 25.89ab | 43.17a | 45.96a | 44.25a | 45.19a | 44.63a | 44.30a |
| BROWN | 27.95ab | 41.56a | 43.56ab | 43.63a | 40.19b | 41.13b | 41.13a |
| SE± | 0.91 | 0.84 | 0.96 | 0.98 | 0.66 | 0.77 | 0.82 |
| VAR*HS | NS | NS | NS | NS | * | * | * |

Means followed by the same letter (s) in the same column are not significantly different at $p<0.05$ according to Tukey test
WAS= Weeks after storage, NS = Not significant, * = Significant

**Table 6: Interaction Effect of Harvesting Stages on the Seed Germination Rate Index of Sesame.**

| Variety*Harvesting Stages | | STORAGE PERIODS (WEEKS) | | |
|---|---|---|---|---|
| | | 8WAS | 10WAS | 12WAS |
| EX-SUDAN | GREEN | 40.38c | 40.04b | 41.00b |
| | GREEN-YELLOW | 42.50abc | 44.25ab | 43.00ab |
| | YELLOW | 45.63a | 45.50a | 44.75a |
| | BROWN | 40.63bc | 41.88ab | 41.75b |
| KENANA 04 | GREEN | 40.13c | 41.88ab | 41.25b |
| | GREEN-TELLOW | 42.13abc | 42.13ab | 43.75ab |
| | YELLOW | 44.75ab | 43.75ab | 43.75ab |
| | BROWN | 39.75c | 40.38b | 40.50ab |
| | SE± | 0.93 | 1.09 | 1.16 |

Means followed by the same letter (s) in the same column are not significantly different at $p<0.05$ according to Tukey test
WAS= Weeks after storage