Effects of Planting Date and Fruit Position on Mother Plant on the Quality of Okra (Abelmoschus esculentus L. Moench) Seeds

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Abstract
A study was conducted on three popular okra species, that is, NHAe 47- 4, V35 and a local variety at Makurdi, Nigeria. The aim was to determine the effects of planting date and fruit position on mother plant on seed quality. These factors were studied using three sowing dates (i.e. 25th June, 9th July and 23rd July 2013) and three different fruit positions (i.e. Apex, Middle and Base). Bulk planting was done, and in experiment one, the three sowing dates were subjected to identical cultural operations and monitored while in experiment two, five plants of each species were randomly selected from each plot and segmented into three positions as apex, middle and base. Fruits were harvested at full maturity in their respective classes of planting date and fruit positions. Data were assessed on fruit length, diameter and weight. Number of seeds per fruit, seed weight, 100-seed weight and germination tests were also assessed. The seeds were thereafter, stored for three months under ambient conditions and further tested for viability. Results of the values generated on all the fruit and seed parameters of the third harvesting date were generally lower than those generated on the first and second planting dates. Whereas there were no significant differences in germination of seeds extracted from apex and middle positioned fruits, their germination was significantly better than that of seeds extracted from base fruits. There was a general decline in germination, when seeds were stored for three months and the rate of decline was more pronounced with seeds derived from the third planting date. It was therefore concluded that in the Benue sub-region, early planting of okra for seed is recommended and should be done before 23rd July. Furthermore, preference should be given to apex and middle positioned fruits when harvest is meant for seed extraction.
Keywords: Seed, position, maturity, storage, germination.

1. INTRODUCTION

Okra (*Albemoscus esculentus* L. Moench) is a vegetable that has gained so much prominence in Africa. Schippers (2000) stated that okra can be found in almost every market in Africa. Iremiren and Okiy (1999) reported that in Nigeria, okra is one of the foremost vegetable crops in terms of consumption and production area. It has also been reported that in Ghana, okra is the fourth most popular vegetable after tomatoes, *Capsicum* peppers and garden eggs. Not much is known about the industrial uses of okra however, okra is one of the most prevalently used local vegetable soups particularly in the West African sub-region. This is because the tender okra fruits make a good meal when they are cooked fresh, however, when immediate use cannot be made of them for more than one day after harvest, they become tough and unsuitable for direct use. They are therefore, easily processed locally by slicing into small pieces and drying in the sun to be preserved for later use either directly as dry pellets or grounded into powder. Okra also has high nutritional value. It is a good source of calcium and the amino acids found in the seeds compare favourably with those in poultry eggs and soybeans (Schippers, 2000). Due to this high prominence, okra has been a beneficiary of worldwide research over many years resulting in many varieties currently been planted in different parts of the world. Most of these studies are concerned with the development of varieties adopted to specific other needs while seed quality suffered neglect.

It is however now established that the contributions of seed to the success of every crop production venture cannot be overemphasized. Seed studies have tremendously led to improvements in germinability thus plant population per unit area of several plant species (Oladiran and Kortse, 2000; Moussavi Nik *et al.,*2012; Demir and Oztokat, 2004; Ibrahim and Oladiran, 2004; Alan and Eser, 2007, e. t. c.). In spite of these scientific advancements in seed production of other crops, most okra farmers still collect their seed from the remnants of a commercial or subsistence crop and rarely produce seed from a crop which is specifically grown for seed. Gutterman (2000) however, reported that in most plant species, the seeds vary in their degree of germinability between and within populations and between and within individuals. Some of this variation may be of genetic origin, but much of it is known to be phenotypic. That is, it is caused by the local conditions under which the seeds matured. These conditions consist of a combination of the microenvironment experienced by the seed due to its position on the parent plant and the abiotic environment of the plant (e. g. the ambient temperature, day length, water availability, sowing time etc.). Gutterman further stated that in different plant species, maternal factors, such as the position of the inflorescence on the mother plants or the position of the seeds in the inflorescence or in the fruit can markedly influence the germinability of seeds.

In the Benue sub-region of Nigeria, okra has two major production seasons (i. e. the early and late season productions). Seed sowing for the early season production begins from the onset of the first rains in April and extends to end of July. Due to this long duration of planting period therefore, this study was undertaken to determine if they would be a variation in the quality of seeds produced at different planting dates in the early season crop.

Okra is also an indeterminate plant that produces fruits along the stem as it increases in height. The study was also intended to determine if fruits produced at the base, middle and apex positions of the stem would have a variation in seed quality due to the microenvironment experienced by the seed due to its position on the parent plant as earlier reported above.

2. MATERIALS AND METHODS

Okra (*Albemoscus esculentus*) was produced at three different planting dates in 2013 at the Teaching and Research Farm of the University of Agriculture Makurdi. Seeds of the first planting date were sown on the 25th June and the two others at 14 days intervals i. e. 9th and 23rd July respectively. Bulk crop was raised and okra plants were designated into base, middle and apex positions along the vine of the plant as shown in Figure 1.

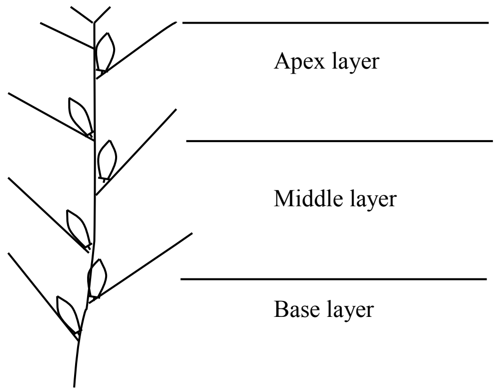

Figure 1: Designated layers for harvest of okra fruits.

Harvest of fruits at the base middle and apex layers was conducted the same day when all the fruits were fully matured and dry. Fruits of each harvest layer were bulked together and randomly divided into three replicates of five fruits each. Data were collected on the fruits in their respective replicates before breakage for seed collection. Data were collected on fruit length, diameter and weight. In addition, number of seeds per fruit, dry seed weight per fruit and 100-seed weight were also taken before seeds were tested for viability. Germination tests were conducted on freshly produced seeds. Thereafter, a second germination test was conducted after the seeds were sealed in paper envelopes and stored for three months in an ambient environment (approx. 32ºC and 40% relative humidity). Germination tests were conducted on four replicates of 50 seeds each, spread over distilled water-moistened absorbent paper in Petri dishes and incubated at 30ºC for 28 days. Counts were taken every other day.

4.0 RESULTS

4.1 First Planting Date

Table 1 shows that fruit position significantly influenced all parameters except 100-seed weight. Variety also significantly influenced all parameters except 100-seed weight while the interaction between fruit position and variety significantly influenced all other parameters except fruit diameter and number of seeds per fruit.

Table 1. Mean squares from analysis of variance in respect of okra fruits from harvest of first planting date at different fruit positions

Sources of variation	Fruit length	Fruit diameter	Fruit weight	No. of seeds/fruit	Dry seed wt/fruit	100-seed weight	Germ.% prior to storage	Germ.% after storage
Replications	1.863ns	0.285ns	1.425ns	252.7ns	2.369ns	0.44ns	11.64ns	28.03ns
Fruit Position (FP)	33.240**	4.227**	114.60**	2949.9**	28.73**	1.04ns	719.07**	1233.9**
Variety (V)	27.726**	0.921**	31.437**	1481.4*	11.89**	1.62ns	443.27**	397.98**
FP x V	20.580**	0.148ns	22.460**	278.3ns	11.84**	5.01**	117.32*	289.47**
Error	5.387	0.202	3.626	468	1.366	0.608	36.97	64.27
Total	5.960	0.237	4.918	490.09	1.810	1.384	106.17	172.81

ns, *, ** = non significant, significant at P = 0.05 and P = 0.01 respectively

4.1.1Fruit attributes

Harvests made at all fruit positions recorded significant differences among fruit attributes (length, diameter and weight) on the three varieties considered in this study. Table 2 shows that apex fruits of NHAe47-4 were significantly longer than the local and V35 varieties. Harvest of base fruits also recorded significantly longer NHAe47-4 fruits over the local variety. Whereas NHAe47-4 fruits at both apex and

Table 2 Interaction effects of variety and fruit position on fruit and seed attributes of okra harvested at the first planting date

		Fruit attributes		Seed attributes	
Frt. Posit.	**Var.**	**FL (cm)**	**FW (g)**	**DSW/F (g)**	**100-SW (g)**
Apex	Local	9.19	7.65	3.66	5.80
	NHAe	11.24	6.31	3.37	6.10
	V35	9.52	8.10	3.94	5.10
Middle	Local	10.41	10.30	4.20	6.20
	NHAe	9.61	8.10	5.92	6.00
	V35	9.30	8.29	4.21	3.20
Base	Local	10.00	9.28	3.73	5.20
	NHAe	11.74	9.49	4.43	5.30
	V35	11.00	9.92	4.12	6.80
	LSD(0.05)	**1.18**	**0.97**	**0.59**	**1.35**

basal positions were significantly longer than fruits of the other varieties, this superiority was not expressed at the middle positioned fruits. Also, even though apex fruits of the local and V35 did not differ significantly in weight, their weights were significantly higher than that of NHAe47-4. At the middle position, fruits of the local variety weighed significantly higher than both NHAe47-4 and V35. Whereas fruits of the local variety harvested both at the apex and middle positions weighed significantly higher than NHAe47-4, the same was not the case with fruits harvested at the base since no significant differences in weight were found among basal fruits in the three varieties.

Figure 2 shows that the local and V35 varieties recorded no significant differences in diameter, however, their diameters were significantly higher than that of NHAe47-4. Also diameters of base and middle positioned fruits were similar but significantly bigger than those of apex fruits.

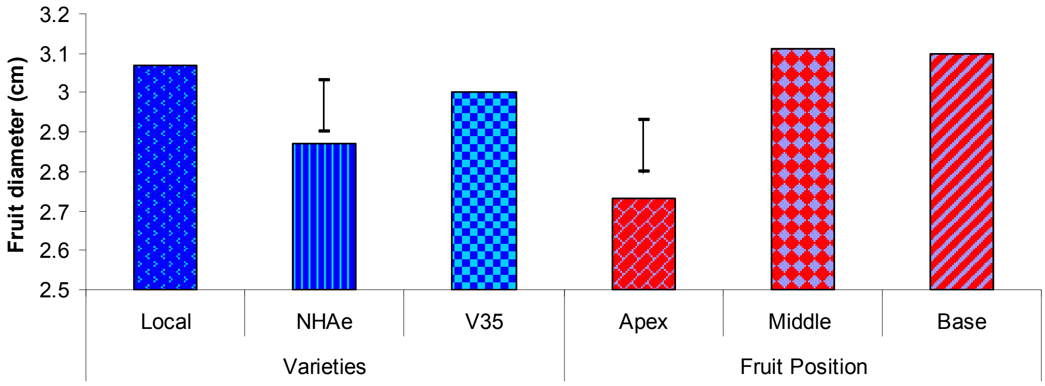

Figure 2 Variations in the average fruit diameters of three varieties of okra harvested at three fruit positions in the first planting date.
LSD at P = 0.05

4.1.2 Seed attributes

Among all the three varieties studied, middle and base seeds weighed heavier than apex seeds (Table 2). The dry seed weight per fruit of NHAe47-4 seeds harvested at both the middle and base positions were significantly heavier than those of the local variety at these positions. However, at the apex position, there were no variations in weight of seeds of the three varieties. This uniformity of apex seeds continued in 100-seed weight also. However, 100-seed weight of V35 seeds which were significantly lower than NHAe47-4 and local varieties at the middle position turned out to weigh significantly higher than both varieties at the base.

Results as indicated on Figure 3 show that number of seeds produced per fruit of NHAe 47-4 were significantly higher than those of the local and V35 varieties. The number of seeds produced by the local and V35 varieties however did not vary significantly. Middle positioned fruits of these varieties had significantly more seeds than fruits from the apex and basal positions which did not bear any significant difference in themselves.

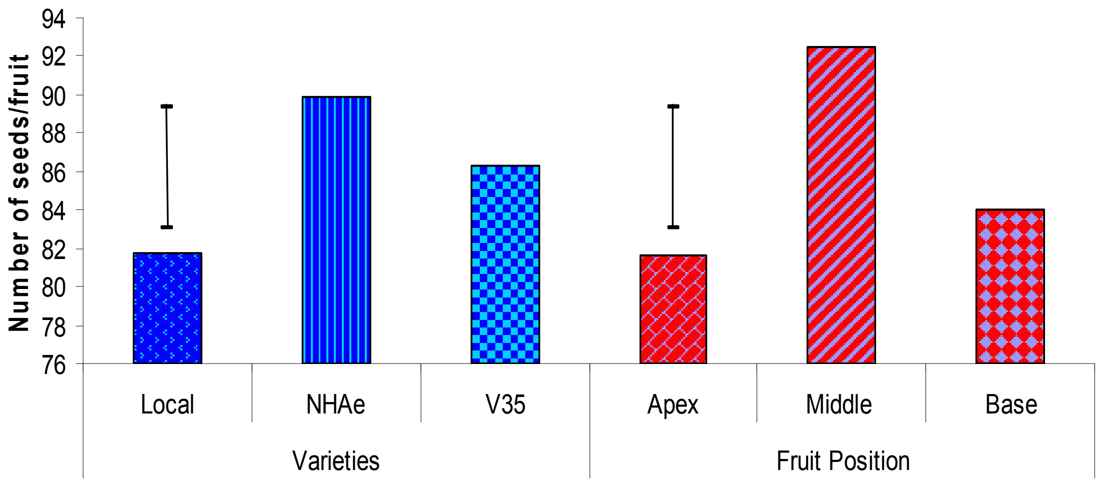

Figure 3 Variations in average number of seeds per fruit of three varieties of okra harvested at three different fruit positions in the first planting date.
LSD at P = 0.05

4.2 Second Planting Date

Table 3 shows that fruit position significantly influenced all parameters except fruit diameter and 100-seed weight. Variety also significantly influenced fruit length, number of seeds per fruit, dry seed weight per fruit and germination after three months storage. The interaction between fruit position and variety significantly influenced all other parameters except fruit diameter, 100-seed weight and germination prior to storage.

Table 3. Mean squares from analysis of variance in respect of okra fruits from harvest of second planting date at different fruit positions

Sources of variation	Fruit length	Fruit diameter	Fruit weight	No. of seeds/fruit	Dry seed wt/fruit	100-seed weight	Germ.% prior to storage	Germ.% after storage
Replications	0.657ns	0.429ns	12.312ns	314.4ns	27.252ns	1.2233ns	6.93ns	93.82ns
Fruit Position (FP)	129.2**	0.405ns	93.685**	1240.9*	9.349**	1.440ns	153.58**	220.09**
Variety (V)	113.3**	0.133ns	2.454ns	1378.2*	7.596*	1.170ns	25.81ns	125.69*
FP x V	18.51**	0.478ns	30.385**	2866.6*	21.192**	0.600ns	25.03ns	121.54*
Error	4.823	0.2036	4.235	385.6	1.609	0.4633	15.80	34.93
Total	6.726	0.2103	0.0312	435.665	2.193	0.6723	24.541	65.639

ns, *, ** = non significant, significant at P = 0.05 and P = 0.01 respectively

4.2.1 Fruit attributes

Although the pattern of development with respect to fruit attributes (i. e. fruit length, diameter and weight) as recorded in the first planting date was not consistent, there were some common observations which occurred in both planting dates. Fruits of NHAe 47-4 were significantly longer than those of the local and V35 varieties at the apex and basal positions (Table 4). Unlike in the first planting date where the basal fruits of NHAe 47-4 were significantly longer than only fruits of the local variety, they were now significantly longer than both the local and V35 varieties. The middle positioned fruits of all the varieties again produced fruits which had no significant differences in length. There was no significant interaction between fruit position and variety on diameter in the first planting date. However, whereas there were no significant variations in the diameters of fruits harvested at the apex and middle positions of all the varieties at the second planting date, diameters of fruits of V35 variety harvested at the base were significantly wider than those of the local variety. Whereas it was the weights of apex fruits of V35 and the local varieties that were significantly higher than NHAe 47-4 in the first planting date, it was now NHAe 47-4 and the local variety that were similar but significantly higher than V35 variety. Weights of NHAe 47-4 again maintained significant superiority over both local and V35 varieties for fruits harvested at the middle position but at the base, the local and V35 varieties all weighed significantly higher than NHAe 47-4 variety.

Table 4 Interaction effects of variety and fruit position on fruit and seed attributes of okra harvested at the second planting date

		Fruit attributes			Seed attributes	
Frt. Posit.	**Var.**	**FL (cm)**	**FD (cm)**	**FW (g)**	**NS/F**	**DSW/F (g)**
Apex	Local	8.20	2.87	8.50	84	4.16
	NHAe	11.10	2.87	9.31	91	4.68
	V35	8.98	2.67	8.25	72	3.22
Middle	Local	10.46	2.92	10.47	87	4.51
	NHAe	10.73	2.85	11.73	97	4.33
	V35	9.93	3.04	9.95	80	4.13
Base	Local	10.62	2.86	10.47	86	4.91
	NHAe	13.64	2.77	8.85	71	3.29
	V35	11.16	3.00	10.65	86	4.61
	LSD(0.05)	**1.12**	**0.23**	**1.05**	**9.98**	**0.65**

4.2.2 Seed attributes

There was no significant interaction between fruit position and variety on number of seeds per fruit in the first planting date. However, table 4 shows that the number of seeds obtained from NHAe 47-4 fruits harvested at the apex and middle positions at the second planting date were not significantly different from seeds obtained from fruits of the local variety harvested at that position but were significantly higher than seeds obtained from V35 fruits. At the middle position however, seeds obtained from NHAe 47-4 fruits were significantly more in number than those obtained from local and V35 fruits, while at the basal position, it was the local and V35 varieties which exercised significant superiority of NHAe 47-4. The dry seed weight per fruit of the local and NHAe 47-4 varieties which were not significantly different from themselves were significantly higher than V35 variety in the apex position. At the basal position, it was the local and V35 varieties that produced seeds which did not show any significance variation in weight however, they were both significantly higher than NHAe 47-4. At the middle position however, all the varieties produced seeds of identical weight.

Figure 4 shows that 100-seed weight of the three varieties showed no significant variation. However, 100-seed weight of seeds obtained from middle fruits were significantly heavier than those obtained from the

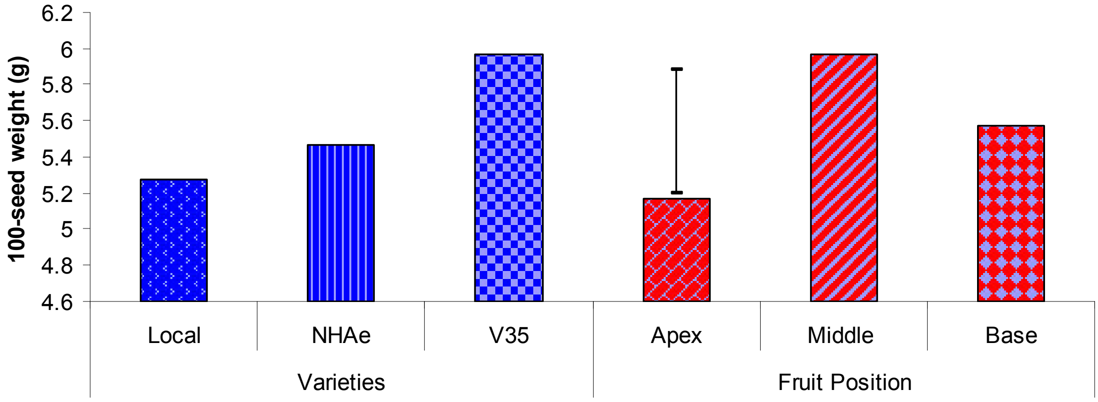

Figure 4 Variations in 100-seed weight (g) of three varieties of okra harvested at three different fruit positions in the second planting date.
LSD at P = 0.05

apex fruits. No other significant differences were observed from seed weights on the varieties and fruit positions.

4.3 Third Planting Date

Table 5 shows that fruit position significantly influenced all the parameters except 100-seed weight. Variety also influenced fruit length, fruit weight, number of seeds per fruit and germination percentages conducted prior to and after storage respectively. The interaction between fruit position and variety significantly influenced only fruit

Table 5. Mean squares from analysis of variance in respect of okra fruits from harvest of second planting date at different fruit positions in the third planting date

Sources of variation	Fruit length	Fruit diameter	Fruit weight	No. of seeds/fruit	Dry seed wt/fruit	100-seed weight	Germ.% prior to storage	Germ.% after storage
Replications	11.057ns	1.3558ns	47.834ns	4234.4ns	22.1125ns	0.0478ns	28.66ns	48.37ns
Fruit Position (FP)	107.099**	0.8575*	136.063**	5861.9**	28.1029**	0.5633ns	165.74**	290.13**
Variety (V)	52.933**	0.3806ns	60.079**	1531.0*	1.5360ns	1.3233ns	282.05**	315.11**
FP x V	23.527**	0.2059ns	7.573ns	1299.7*	1.3792ns	1.7733*	24.54ns	202.10**
Error	4.080	0.2160	4.344	442.1	0.8224	0.4778	29.66	45.39
Total	5.5498	0.2302	6.1089	531.394	1.1970	0.7156	50.7565	92.9548

ns, *, ** = non significant, significant at P = 0.05 and P = 0.01 respectively

length, number of seeds per fruit, 100-seed weight and germination percentage conducted after storage.

4.3.1 Fruit attributes

Among the fruit attributes (i.e. length, diameter and weight) considered in this study, it was only fruit length that was significantly influenced by the interaction between fruit position and variety. Whereas NHAe 47-4 variety was significantly longer than the other varieties in the apex position in both first and second planting dates, the reverse was the case in the third planting date as all the varieties in the study did not show any significant variation in fruit length at the apex and middle positions (Table 6). At the base position however, NHAe 47-4 fruits were significantly longer than both the local and V35 varieties.

Table 6 Interaction effects of variety and fruit position on fruit and seed attributes of okra harvested at the third planting date

		Fruit attribute	Seed attributes	
Frt. Posit.	**Var.**	**FL (cm)**	**NS/F**	**100-SW (g)**
Apex	Local	7.99	64.20	4.60
	NHAe	8.51	54.70	5.30
	V35	8.09	47.80	4.50
Middle	Local	9.33	69.10	4.80
	NHAe	9.86	74.80	4.70
	V35	9.87	64.50	4.90
Base	Local	8.89	63.30	3.40
	NHAe	12.33	76.40	4.00
	V35	9.78	69.10	5.70
	LSD(0.05)	**1.03**	**10.69**	**1.20**

Fruit diameters of varieties in the third planting date did not show any significant variation (Figure 5). Diameters at the different fruit positions however showed that, fruits harvested at the base and middle positions which in themselves had no significant differences were significantly wider than apex fruits.

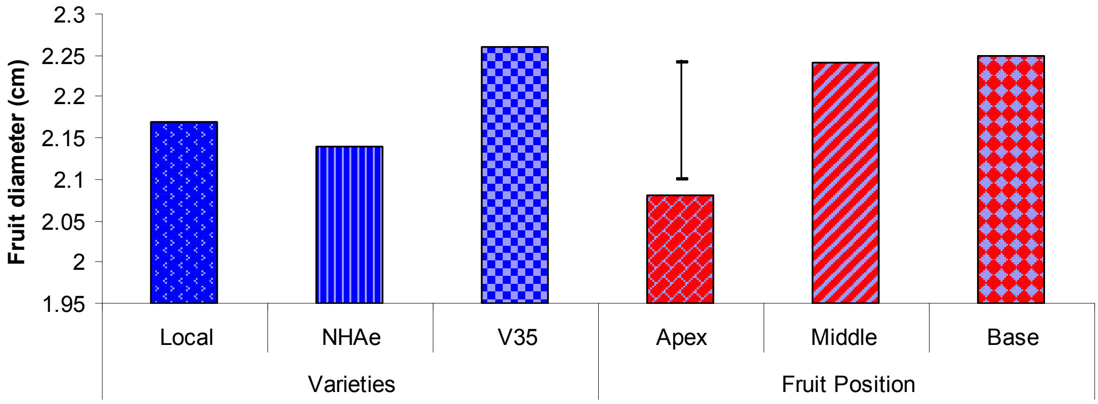

Figure 5 Variations in average fruit diameters (cm) of three varieties of okra planted at the third planting date and harvested at three different fruit positions

I LSD at P = 0.05

Fruit weights of the local and NHAe 47-4 varieties which were not significantly different in themselves were significantly higher than the V35 variety at the third planting date (Figure 6). In terms of fruit position however, the base and middle positioned fruits which did not differ significantly were significantly higher than the apex fruits.

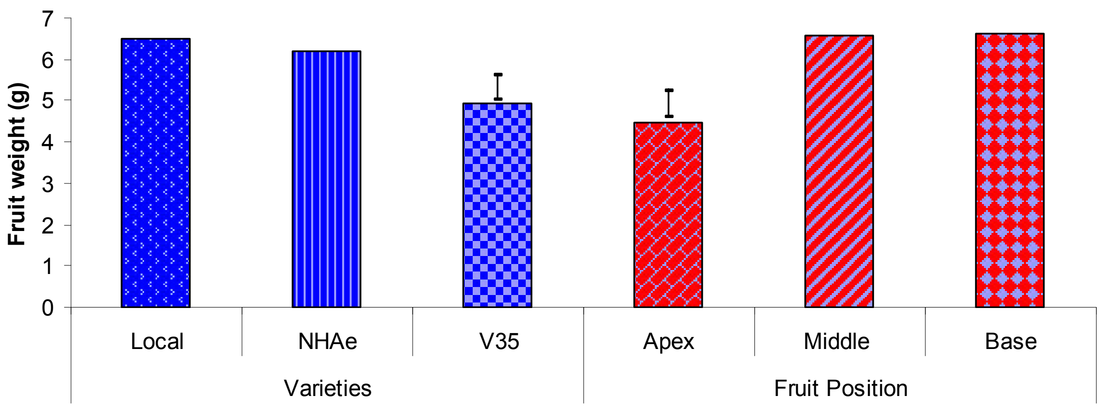

Figure 6 Variations in average fruit weight of three okra varieties planted on the third planting date and harvested at three different fruit positions

I LSD at P =0.05

4.3.2 Seed attributes

Apex fruits of the local and NHAe 47-4 varieties produced seeds which did not vary significantly in number but were significantly more than the seeds produced by V35 variety (Table 6). At the base position, it was fruits harvested from NHAe 47-4 and V35 varieties that produced seeds which did not vary in number but were significantly higher than seeds from fruits of local variety. At the middle position, seeds from all varieties did not vary significantly.

As shown on Figure 7, the dry seed weight per fruit of the three varieties did not show any significant variation however, the same trend in which fruit parameters of the base and middle positions were expressing

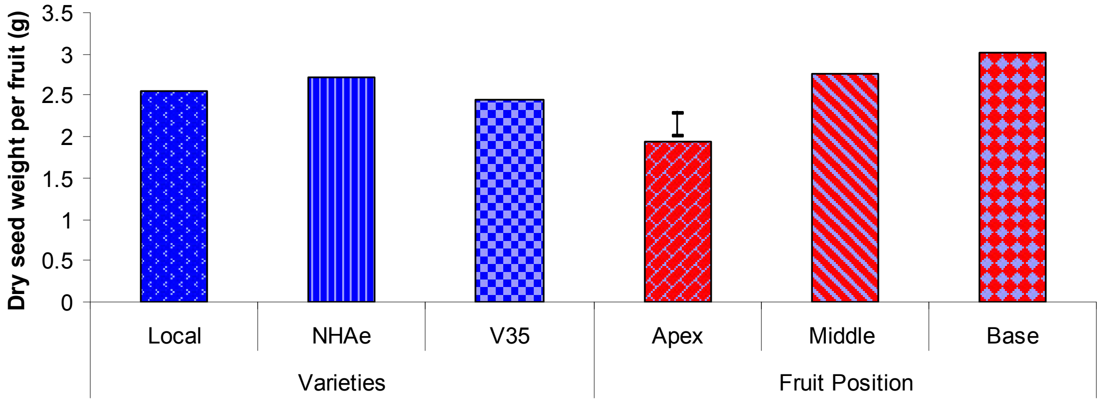

Figure 7 Variations in average dry seed weight per fruit (g) of three okra varieties planted on the third planting date and harvested at three different fruit positions

I LSD at P =0.05

superiority over apex fruits also continued with the dry seed weight per fruit parameter.

Table 6 also shows that 100-seed weight of all the varieties did not produce any significant differences at the apex and middle positions except at the base where the V35 variety was significantly heavier than both NHAe 47-4 and the local varieties.

4.4 Germination

Germinations were better from seeds obtained from the first and second planting dates at all the fruit positions (Table 7). Apex fruits produced best germination among the three fruit positions, followed by the middle position while the lowest germination was obtained from basal fruits. Germinations produced by the local variety were most outstanding followed by NHAe 47-4 while the least came from V35. Germinations generally declined with storage at all the planting dates irrespective of whatever fruit position the seeds were harvested.

Table 7 Interaction effects of variety and fruit position on percentage germination of freshly harvested and stored okra seeds harvested at three fruit positions and planted at three different dates.

		Percentage germinations					
		Prior to storage			After three months storage		
	Planting dates	1st	2nd	3rd	1st	2nd	3rd
Frt. Posit.	**Var.**						
Apex	Local	60.17	55.97	36.17	46.10	47.10	32.90
	NHAe 47-4	50.51	52.91	27.04	42.00	39.30	17.70
	V35	50.81	60.01	29.52	37.70	45.90	16.60
Middle	Local	48.18	56.49	44.42	34.90	52.30	39.10
	NHAe	55.85	51.74	30.97	43.80	47.70	22.70
	V35	39.76	54.42	34.00	34.40	34.90	31.40
Base	Local	46.15	49.05	32.88	7.90	39.20	21.90
	NHAe	40.17	50.20	28.91	36.00	32.70	28.60
	V35	29.13	48.74	26.43	24.00	41.50	17.80
	LSD (0.05)	**8.48**	**5.59**	**7.81**	**11.26**	**9.34**	**9.81**

*The percentage germination values presented are arcsine transformed values

Table 8 Meteorological data of Makurdi for the year 2013, where the study was undertaken

Month	Rainfall (mm)	Min.Temp. (oC)	Max. Temp. (oC)	R/H (%)
January	00	17.9	35.3	48
February	00	20.9	36.7	57
March	44.2	23.3	37.7	66
April	122.9	21.5	34.4	75
May	183.4	20.4	32.2	81
June	141.8	20.5	31.0	82
July	243.6	22.6	30.0	85
August	131.0	22.7	29.5	85
September	285.5	22.4	30.3	84
October	125.5	23.0	31.9	85
November	00	23.0	34.3	75
December	10.1	19.5	34.6	58

Source: Tactical Air Command, NAF Base Makurdi.

5.0 DISCUSSION

It has been reported that seeds within even the same fruit do not grow at the same rate. This view agrees with that of Nielsen (1996) who reported that seeds on the same fruit may not normally be of the same age. So also seed position in different organs on the mother plant can have different effects on colour, size, morphology and germination in many plant species (Gutterman, 1990a, b, 1994a). It is therefore not surprising that the morphology size and weight of okra fruits harvested at the three fruit positions differed. Basal and apex fruits of NHAe 47-4 in the first and second planting dates were significantly longer than other varieties but this superiority could only be maintained at the base position on the third planting date as no significant differences in lengths were recorded at the apex and middle positions on the third planting date. This kind of inconsistencies were also observed with the other fruit parameters harvested at the three planting dates from different fruit positions. K'Opondo (2011) also reported this kind of inconsistency among four morphotypes of spiderplant and suggested that factors related to their genotypes as well as their production environment may have been responsible. Munier-Jolain *et al.* (1998) also supported that variations among seed sizes often occur and stated that as soon as accumulation of storage compounds has begun in seeds at a given morphological position, the mean final seed weight depends on the duration of seed filling. This depends on the different source-sink ratios; hence variations in seed weight among different environmental situations are mainly due to variations in seed growth rate, even if the duration of filling varies.

The smaller values recorded for dry seed weight per fruit of the three varieties harvested at the apex position as compared to middle and basal positions on the first planting date is an indication that the first planting date provided favourable environmental conditions for growth. As a result, a higher number of fruits were set thus creating a higher competition for assimilates, and since the basal and middle fruits came first in the competition therefore, they had an edge over the apex fruits. This is in agreement with the argument by Medrano (2000) that, the low fruit and seed production by late flowers of inflorescences of *P. maritimum* under natural conditions cannot be attributed to insufficient pollen receipt or to architectural constraints. The principal proximate cause of the decreasing pattern of female reproductive success within inflorescences appears to be competition for resources among the flowers of each inflorescence, with early flowers sequestering more resources than "late" flowers. This argument was corroborated by Fenner (2005) in a statement that timing is a crucial factor influencing the level of resources available to the ovules and consequently, determining their survivorship adding that fruits produced late in the season sometimes show a reduced size or a reduced level of seed set. Fenner explained that the availability of resources such as nutrients and water may decline as the season progresses. By the end of the flowering period, the early fruits will be considerably larger than the later fruits and probably will form stronger sinks that divert nutrients towards themselves. The late arrivals are often disadvantaged further by being at more distal positions on the inflorescence resulting in the decline of individual seed weight that occurs through the season in many species.

In all the three planting dates, 100-seed weight of seeds harvested in the apex position of the three varieties showed no significant differences among varieties however, the weight of middle and base positioned seeds were significantly heavier than the apex seeds. This superiority in 100-seed weight of seeds from middle and basal fruits did not translate into better germination as suggested by Ibrahim and Oladiran (2011) who reported that okra seeds from fruits that developed at higher positions may be of poor quality. Conversely it was apex seeds whose seeds recorded the lowest weight among the three varieties that germinated better. This result however, agrees with the reports by Baskin and Baskin (1998) who found that germination responses in seeds depend on the species investigated. Susko and Lovett-Dousts (2000) further named some species whose smaller seeds gave better germination responses and attributed the earlier germination of small seeds to their greater access to water as a result of their higher surface to volume ratios. Hence small seeds imbibed water faster and broke dormancy sooner.

The better germination recorded by the local variety at the apex and basal positions on the first planting date in comparison to the two other exotic varieties could be because the local variety was more adapted to the production environment. The situation in which seeds obtained from harvest of the first and second planting date germinated better than those obtained from the third planting date could also be attributed to environmental factors. The higher precipitation recorded in July (Month of the third planting date) as revealed in Table 8 must have been responsible for the poorer seed quality of seeds produced at that stage of planting. Ezeakunne (2004), observed an improvement in the performance of okra with the relative humidity range of 70 to 80%. Similar results were earlier reported by Yamaguchi (1983). In this study, the average germination of seeds from the apex and middle positioned fruits at all planting dates were significantly better than the basal positioned fruits. Although this result is at variance with some other authors like Malik *et al.* (2000) and Munich *et al.* (2004) who both found seeds obtained from bottom positioned pods to germinate higher, it however, cannot be exclusively so for all cultivars because Mohammadi *et al.* (2011) reported that in okra, seed germination is influenced not only by the position of the fruit on the plant but also the cultivar as well. Gutterman (2000) however reported that even within a single capsule, terminal seeds of *Mesembryanthemum nodiflorum* L. (*Aizoaceae*) germinated better and more readily than those lower in the fruit. Gutterman (2000) further reported that the same trend occurs with regards to capsule or fruit position and gave the example of another South African shrub, *Glottiphyllum linguiforme (Aizoaceae)* which produces central and peripheral capsules that are different in size, number of loculi valves and number of seeds, stating that seeds from peripheral capsules proved to be of a better quality than those from the central position. The reason advanced for this germination behavior is that the peripheral capsules are easily separated from the mother plant and it is possible that they act as a dispersal unit which could be dispersed by wind or floods. The central capsules remain below the canopy in the central part of the shrub covered by a hillock that forms below the shrub. These capsules the report says may provide the long living seeds of the local seed bank, supplying seedlings to replace the dead mother plant.

The decline in germination recorded when seeds obtained from all the planting dates and harvested at all fruit positions were stored in an ambient environment for three months, is indicative of seed deterioration which is linked to the hygroscopic nature of seeds. Khaldun and Ehsanul (2009) warned that the conventional practices of seed storage by farmers in gunny bags are not suitable because there is a chance for moisture gain and insect and disease attack which may enhance the viability loss as seed is highly hygroscopic in nature. It was therefore concluded that early planting of okra should be encouraged and planting of the early crop should not be delayed beyond 9th July. Furthermore, preference should be given to apex and middle positioned pods when harvest is meant for seed extraction.

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