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ASSESSMENT OF SEED POSITION IN THE FRUIT AS INDEX OF SELECTION FOR SUPERIOR SEED MORPHOMETRIC ATTRIBUTES IN FLUTED PUMPKIN (*Telfairia occidentalis*)

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ABSTRACT: Pumpkin production in Nigeria is affected by non availability of high quality seeds and information on seed positional effect on seed morphometric parameters for judicious selections of seeds for pumpkin production is necessary. Matured fruits of ten pumpkin morphotypes were selected and then cut linearly at both ends of stigmatic scar and stalk joints. Seeds from anterior, middle and posterior positions were carefully removed from the fruits, cleaned using wooden shavings and thereafter evaluated for five seed metric and five seed physiological attributes. Data obtained were then subjected to statistical analysis using analysis of variance and significant means were separated using Tukey"s HSD test at 5% probability level. From the results, seed metric and physiological parameters from the 10 morphtypes and three seed positions in the fruits and their interaction revealed existence of variability. Seeds of *Ogun*, *Isa-1* and *Abia* morphotypes were found with greater seed weight, seed length, seed width and seed thickness above other morphotypes across the seed positions. The performance of the three seed portions in the fruits brought out the significance superiority of posterior with highest seed weight, seed length, seed width and number of seeds over anterior and middle portions. The seed improvement in terms of seed weight, seed length, seed width and number of seeds from the posterior portion was about 9-11, 4-7, 5-9 and 48-52 %, respectively above seeds obtained from the middle and posterior portions. Seeds obtained from posterior portion had maximum to moderate seed width and number of seeds in *Isa-1* and *Isa-2* morphtypes. On seed physiological performance, *Isa-1* had a consistent superior seedling emergence (69%), seedling vigour index (10.71), leaf length (4.13cm), vigorous vine length (15.51cm) and number of leaves (12). Seeds from the posterior of the fruits were significantly superior in seedling emergence, seedling vigour, and number of leaves, leaf length and vine length over values obtained in seeds from anterior and middle portions. The superiority of seeds obtained from posterior portions of pumpkin fruits across genotypes was 10.7-11 % in seedling emergence, 8-13 % in seedling vigour index, 12-14 % in number of leaves,7-13 % in leaf length and 2-12 % in vine length over seeds from middle and anterior portions. Seeds from the posterior portion of pumpkin fruits had superior performance in terms of seed metric and physiological parameters and therefore recommended for use to obtain an enhanced emergence and growth performance in highly sought fluted pumpkin. Morphotypes *Isa-1* and *Isa-2* had outstanding performance in seed quality parameters and recommended for future seed improvement strategy.

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Key words: Seed quality, seed germination, seed physiological quality, seedling vigour and seedling growth

INTRODUCTION

Fluted pumpkin (*Telfiaria occidentalis* Hook F.) is an important vegetable crop which belongs to the cucurbitaceous group of vegetables. It is an important commercial crop which grow well in low land humid tropics in West Africa especially, Nigeria, Ghana and Sierria Leone, which are major producer (Nkang *et al*, 2002). In Nigeria, the crop is widely grown in the eastern part of the country, especially in Imo, Anambra, Ebonyi and Abia States. But in recent times, the crop is now gaining prominence in South-western Nigeria (Schippers, 2002).

Pumpkin vegetable is available at cheaper cost but rich in nutrients especially calcium and phosphorus (TNAU, 2008). The crops are grown mainly for the leaves which constitute an important component of the diet of many West African countries (Gill, 1988). Pumpkin possesses numerous advantageous characters but the production is less due to non availability of quality seeds materials. Crop production is affected by the availability of high quality seeds. Pumpkin seeds are extracted from the pods for further regeneration but the seed recovery potential from the fruit is very less (10-30%) (TNAU, 2008).

Seed position in the fruit is a factor which can affect the quality of seeds of pumpkin. .Ogbonna (2008) observed differences in pod portions on number of sprout per portion. The effect of seed position on vigour performance was reported by Aremu and Akinwale (2012). The authors observed significant differences in seedling vigour trait among the three seed positions (anterior, middle posterior portions) examined and found that seedlings from the anterior position had highest vigour performance. Ogunmefun (2013) and Adeyemi and Odiaka (2005) reported considerable variations in pod sizes of fluted pumkin for seed metric and physiological quality traits. The authors concluded that pod characteristics could be used as an index of selection for good seed quality in pumpkin.

Exploring seed positions in the fruits of pumpkin will provide a judicious way of selecting high quality seeds to pumpkin farmers in order to enhance better land area utilization and more leaves production and thereby improve their livelihoods. However, dearth information is available in literature on seed positional effect on seed metric and physiological quality parameters in some genotypes of pumpkin grown in Nigeria. Consequent upon this, the research work was initiated to investigate the relative effect of three seed positions in the fruits/pods of pumpkin on seed metric and physiological parameters of fluted pumpkin Morphotypes grown in South-western Nigeria.

MATERIALS AND METHODS

Seed Material and Source

Matured fruits of 10 morphotypes of fluted pumpkin were used for the study. These genetic materials were collected from the Crop Production Unit, Federal University of Technology, Akure, Ondo State, Nigeria in January, 2013. Ten large sized fruits were selected for each of the morphotypes.

Seed Preparation

The fruits were then cut linearly at both ends of stigmatic scar and stalk joints. Seeds from anterior, middle and posterior positions were carefully removed from the fruits. Seeds from each position were cleaned using wooden shavings and then allowed to dry for 24 hrs and thereafter prepared for seed quality evaluation.

Seed Metric Characters Evaluation.

The following seed characteristics were evaluated according to the procedure of Kaushik *et al.*,(2007) using digital verneir caliper from 25 randomly selected pure seeds from each seed position in each morphotypes for each of the three replicates.

Seed length (mm): Distance measured between the two ends parallel to the hilum.
Seed width (mm): Distance on the seed measured perpendicular to the seed length.
Seed thickness (mm): Thickness of the seed lots was determined from the middle portion of the seed.
100-seed weight (g): Mass of 100 randomly selected seeds taken from the total seed in each seed portion in the fruit were weighed in three replicates.
Number of seeds: Number of seeds in each position in the fruits for each morphotype was counted.

Seed physiological quality evaluation

Pure seeds from each position in the fruits were evaluated for seed quality traits in the screen house of the College Of Plant Science and Crop Production, Federal University of Agriculture, Abeokuta, Ogun State, South-western Nigeria. Seeds were sown in a completely randomized design in three replicates in a factorial experiment. Each replicate consisted of 50 seeds for each seed position and morphotype-wise. There were two factors, namely morphotype (10) and seed position in the fruits (3). In all, there were 90 experimental units (i.e. 10 morphotypes) x 3 seed position x 3 replicates).
The following seed physiological attributes were assessed.

Fifty pure seeds in three replicates were sown in wooden boxes for each morphotype in each seed position. Sown seeds were sufficiently supplied water every evening and emerged seedlings were counted daily till when no seedling emerged.
Seedling emergence: At two weeks after sowing, the total number of seeds that sprouted was counted for each morphotype in each replicate. Emerged seedlings were expressed as percentage of seed sown.
Seedling vigour index (SVI): Seedling vigour was calculated by multiplying percentage seedling emergence by the average of seedling shoot length and divided by 100 (Adebisi, 2004).
Number of leaves per seedling: This was determined by counting number of leaves on 20 randomly selected seedlings for each seed position in each of the morphotype per replicate and average value recorded.
Leaf length per seedling: Lengths of 20 randomly selected leaves of 20 seedlings from each seed position in each morphotype per replicate were taken in centimeter (cm) by measuring the horizontal distance from the tip of the leaf to the edge or end of the nodes and average values recorded.
Vine length per seedling: The vine lengths of 20 randomly selected seedlings from each seed position in each morphotype per replicate were taken in centimeter (cm) by measuring the horizontal distance from the tip of the leaf to the edge or end of the nodes and average values recorded.

Data analysis

Data collected on seedling emergence percentages were transformed using arcsine transformation before analysis. Data on each parameter were subjected to analysis of variance and treatment means were separated using Tukey's HSD test at 5% probability level.

RESULTS

Data on mean values of seed metric parameters of 10 morphotypes of fluted pumpkin across three seed positions inside pods are presented in Table 1. The result reveals that *Ogun, Isa-1, Abia and Isa-2* morphotypes had significantly highest seed weight of between 57.37 and 60.18 g, though was not significantly different from value of 53.60 g obtained with *Ogbese* while other morphotypes had statistically similar values except *Igbara-2* with lowest value (42.98 g). Seed length values were statistically similar among morphotypes. Significant variation was obtained among morphotypes for seed width, with *Isa-1* recording the highest value of 36.91 cm while other morphotypes had statistically similar values which ranged from 30.07 cm for *Igbara-1* to 36.64 cm in *Abia*. Seed thickness values also varied among the morphotypes with Isa-2, *Ogbese*, *Isa-1*, *Ogun*, *Ondo and Igbara-1* with 15.81 to 16.73 mm recording the thickest values, though was not significantly superior over values of 14.82, 15.82 and 13.95 mm in *Akure, Ibule and Ogbese,* respectively while *igbara-2* had the lowest (12.75 mm). In terms of number of seeds, *Isa-1 and Igbara-2* had highest values of 39 and 38, respectively, though not different from values of 35 recorded in *Ondo* while *Igbara-1* and *Abia* had distinct lowest values of 22 and 21, respectively. The ANOVA result indicates that morphotype effect was highly significant on seed width, seed thickness and number of seeds but was significant on seed weight. The seed positional effect was significant on seed weight, seed length and seed width but had highly significant effect on and number of seeds. The interaction effect of morphotype and seed position was highly significant on seed width and number of seed only.

Data in Figure 1 show that seeds from the posterior end had hidhest seed weight while the two other positions recorded statistically similar seed weight. On seed width, posterior portion had the highest, followed by seeds from the anterior while the middle portion showed the lowest. Seed length was highest in seed from posterior end followed by seeds from the middle portion. Highest number of seeds was recorded from the posterior portion of the fruits while the two other positions had statistically values.

Data on the influence of morphootype and seed position on seed width and number of seeds are shown in Table 2. The result indicates that seeds of *Isa-1* from anterior position had distinct seed width (40.20 cm) whereas other morphotypes had almost statistically similar values. Also, seeds of *Ogun, Isa-1,Abia,Isa-2 and Ogbese* from the middle positions inside fruitss were found with greater seed width with values ranging from 33.40 to 35.81 cm while *Igbara-1* seeds from middle portion had the lowest seed width (24.47 cm). Seed width values of seeds from the posterior portion of the fruits were highest in O*gun, Isa-1,Abia, Isa-1 and Ogbese* with values of between 36.53 to 37.10 cm while other morphotypes recorded similar values of seed width. In respect to number of seeds in each portion of the fruits, highest seed numbers was recorded with *Abia* (38) and *Igbara-2* (32) in the anterior portion of the fruits, though not significantly different from the value of 29 in *Ondo* while other morphotypes gave statistically similar values. Also, middle portion of the fruits had highest number of seeds in *Isa-2, Isa-1, Igbara-2 and Akure* with values of between 23 and 27, though the values were not significantly different from values obtained in *Ogbese, Abia, Ogun and Ondo* . In the posterior end, highest number of seeds were recorded in *Ondo, Igbara-2, and Isa-2* with values of 59, 58,and 53, respectively whereas *Igbara-1* and *Abia* had the lowest number of seeds 34 and 29, respectively.

In Table 3, seedling emergence values among morphotypes were variable across seed positions in fruits with *Isa-1* (89 %) and *Isa-2* (67 %) recording the highest values, closely followed by seeds of *Ogun* with 60 % emergence. Highest seedling vigour values were recorded in *Isa-1* (10.71), followed by O*gbese* (8.16) and *Ogun* (8.59) while *Igbara-2* had the lowest (2.42). Number of leaves varied among some morphotypes with *Isa-1* having the highest value of 12, followed by *Ondo, Ogun and Ogbese* with value of 10. Similarly, leaf length values differed among some genotypes with *Isa-1* recording the highest value of 4.13 cm, followed by *Abia, Ogun and Ibule* with values of 3.56, 3.84 and 3.36 cm, respectively while other morphotypes had statistically similar values except *Igbara-2* with the least value (1.71 cm). Vine length values were variable among some morphotypes with O*gbese, Isa-1 and Ogun* having highest values of 16.53, 15.51 and 15.98 cm, respectively, followed by *Ibule* (13.74) and *Abia* (13.40cm) while *Igbara-2* had the lowest value of 5.40 cm. The ANOVA result reveals that morphotypes effect were highly significant on the five seed physiological attributes examined whereas the seed position effect was highly significant on seedling emergence, seedling vigour index, number of leaves and vine length but had significant effect on leaf length. The interaction effect of morphotypes x seed position was highly significant\ on all the five seed physiological attributes examined.

Mean values of seed physiological attributes as affected by three seed positions inside the pods of fluted pumpkin across morphotypes are displayed in Figure 2. The data reveal that seeds obtained from the posterior portion of the fruits had the highest seedling emergence (56%) while other two positions had statistically similar values. In terms of seedling vigour index trait, seeds derived from posterior and anterior positions gave greater vigour level of 6.79 and 6.11, respectively while seeds from middle portion recorded lower vigour level. Number of seeds was highest in posterior portion of the fruits with value of 9.47 while the two other positions had statistically similar values. Seeds obtained from the posterior portion of the fruits had highest leaf length of 3.04 cm, though not significantly different from the value of 2.48cm from seeds obtained from the anterior positions. Also, seeds from the posterior end of the fruits had the highest vine length (12.37 cm) which was not significantly different from value of 12.45cm obtained in the middle portion of fruits while seeds from anterior end had lowest value

Data presented in Table 4 reveal that seedling emergence and seedling vigour values were significantly different among some morphotypes under each of the three seed positions in the fruits. A perusal of data on seedling emergence shows that seed from the anterior part of the fruits had highest emergence in *Isa-1* (69%) and *Isa-2* (67%) which were not statistically different from value of 58 % obtained in *Igbara-1 and Akure* while other morphotypes had similar values except *Igbara-2* and *Abia* which had the lowest value 33 and 27 %, respectively. Seedling emergence of seeds from the middle portion of the fruits showed that highest values of 67 and 69 % were obtained in *Isa-1 and Isa-2*, respectively which was not statistically different from value of 58 % in *Ogun* while *Ibule* recorded the lowest of 27 %, respectively. Seeds obtained from the posterior end of the fruit had the highest seedling emergence of 71 % which was not statistically different from values of between 58 and 65 % realized from *Isa-2, Ondo, Igbara-2 and Ibule* while *Akure and Abia* gave lowest value of 47 and 40 %, respectively. A close perusal of data on seedling vigour index reveals that four morphotypes (*Ibule, Ogun, Isa-1 and Isa-2*) were statistically found with greatest vigour level which ranged from 7.07 to 10.17, followed by *Ogbese* (6.90) while *Igbara-2* (1.83) and Abia (2.43) had lowest values. Seeds from the middle portion of fruits had highest seedling vigour in *Isa-1* (11.17) and *Ogbese* (9.83) while most of the other morphotypes recorded statistically similar vigour values except *Igbara-2* which had the lowest value (1.80). Also, seeds from the posterior end had highest seedling vigour level in *Ogun* (11.07) and *Isa-1* (10.80) and closely followed by values of 7.97, 7.20 and 7.70 observed in *Ibule, Isa-2 and Ogbese*, respectively whereas other morphotypes recorded statistically lowest seedling vigour values.

Result in Table 5 presents the effect of seed position in the fruits on leaf and vine length of ten morphotypes of fluted pumpkin. The result shows that significant differences leaf and vine lengths were recorded under each of the three seed positions among some morphotypes. Seeds derived from anterior portion of the fruits had a distinct highest leaf length in *Isa-1* (4.47) which was not statistically different from values obtained in the other morphotypes except *Igbara-2* which gave lowest value (1.33). Furthermore, seeds obtained from the middle portion of the fruits had the maximum leaf length in *Ogun* and *Isa-1* with 4.03 and 4.00 cm, respectively, though the values were not statistically different from other genotypes except *Igbara-2* (1.68) and *Isa-2* (1.93) with lowest values. Similarly, seeds from posterior portion of the fruits had maximum leaf length in *Isa-1* (4.63) *Ogun* (4.53) which were not significantly different from other genotypes except *Igbara-1* which had the lowest value (2.00). A cursory look on data on vine length show that the values statistically differed among some morphotypes under each of the three seed positions investigated. Highest vine length values of 15.77 cm was recorded in *Ogun* and *Isa-2*, closely followed by *Isa-1* (14.50 cm) while *Akure* had the lowest (7.20 cm). Similarly, seeds of Ogbese obtained from the middle portion of the fruits had the highest vine length (19.80cm) followed by *Abia* with value of 18.60 cm whereas *Ibule*, *Ogun*, *Isa-1* had vine length above 10 cm but *Igbara-2* recorded the least value of 4.77 cm. Also, seeds obtained from the posterior end of the fruits had the highest vine length of 16.50 and 16.23 cm in *Ogun* and *Ogbese*, respectively, closely followed by value of 15.40 cm in *Isa-1* while *Igbara-2* recorded the lowest value of 6.27 cm.

Data in Table 6 show the influence of seed position in the fruit on number of leaves in ten morphotypes of fluted pumpkin. The result reveals that number of leaves varied among the morphotypes under each of the three seed positions in the fruits. A cursory evaluation of the data show that seeds derived from the anterior end of the fruitss had the highest number of leaves in *Isa-1* (13) and distinctively followed by *Ogbese* and *Ondo* with values of 10 while *Abia* recorded the lowest (5). Similarly, seeds obtained from the middle portion of the fruits showed highest number of leaves in *Isa-1* (11), though was not significantly different from values of 10 and 9 recorded in *Ogun* and *Igbara-1*, respectively while *Igbara-2* had a distinct lowest value (4). Furthermore, seeds from the posterior end of the fruits recorded the highest number of leaves in *Isa-1* (13) and *Ogbese* (12), though was not significantly different from value of 11 obtained in *Ogun* and *Ondo* whereas *Abia* and *Igbara-1* had the lowest value of 6.

DISCUSSION

Seed Metric Attributes

Seeds are extracted from the fluted pumpkin fruits for further regeneration but with low recovery potential from the fruits (TNAU, 2008). The search for criteria for judicious selection of seeds for cultivation is imperative. The result of the study revealed considerable differences among pumpkin morphotypes for seed weight, seed width, seed thickness and number of seeds per seed position in the fruits. Significant differences were observed among the three seed position inside the fruits for all the seed metric characters evaluated except seed thickness. This suggests that selection is possible among the 10 pumpkin morphotypes for superior seed metric characters. The variation in these seed metric characters among these fluted pumpkin morphotypes may be due to variation in genetic make-up of the morphotypes examined.

Ogunmefun (2013) had earlier observed significant differences in some mophotypes of fluted pumpkin in respect to seed metric characters across pod sizes and suggested that variation could be due to differences in the genetic constitutions. Greater differences observed among the three seed positions in the fruits for the seed metric characters revealed ample opportunity to select seed with superior seed characters. The results also showed that seeds of *Ogun, Isa-1, Abia* and *Isa-2* were found with higher seed weight, seed length, seed width and seed thickness above other morphotypes whereas *Igara-2* and *Isa-2* had greater number of seeds (38-39) in the fruits over other morphotypes.

The performance of the three seed positions in the fruits brought out the significant superiority of posterior end with distinct highest seed weight, seed length, seed width and number of seeds per fruits, followed by seeds from the middle position of the pods in terms of seed length and width. The increment in seed weight, seed length, seed width and number of seeds in the fruits obtained from the posterior portion was 9-11 , 4-7 , 5-9 and 48-52 %, respectively over seeds characters obtained from middle and anterior portions of pumpkin fruits.

The study also identified variability among morphotypes under each of the three seed positions examined. A cursory analysis of the data revealed that seeds obtained from the anterior position of pumpkin fruits had distinct highest seed width in *Isa-1* (40.20 cm) whereas seeds derived from the middle portion were found with the highest seed width of above 35.00 cm in *Ogun, Abia, Isa-2* and *Ogbese*. Similarly, seeds obtained from the posterior position had highest seed width in five morphotypes (*Ogun, Isa-1, Abia, Isa-2* and *Ogbese*) with values ranging from 36.53 to 37.36 cm. Number of seeds varied in the three seed positions among some pumpkin morphotypes. Furthermore, seeds scooped from the anterior end of the pods had distinct highest number of seed in *Isa-2* (38) and *Igara-2* (32). Likewise, seeds from the middle portion of the pods had maximum number of seeds in *Isa-1* (24), *Isa-2* (27), *Igara-2* (24), *Akure* (23) whereas other genotypes had intermediate values of numbers of seeds per portion in the fruits. Also, seeds from the posterior portion were found with highest numbers of seeds in *Ondo* (59), *Igara-2* (58) and *Isa-2* (53). In most cases, *Igara-1* had the least values of seed width and number of seeds under each of the three seed positions in the pumpkin fruits.

Seed Physiological Attributes

Successful crop production depends on availability of quality seed. Judicious selection criteria for making high quality seeds available to pumpkin growers are desirable. The present study revealed significant differences among the 10 morphotypes for seedling emergence, seedling vigour, leaf length and vine length, thereby providing opportunity to select for morphotypes with good seed seedling emergence and early seedling growth characters and that selection for seeds from different positions in the fruits that will guarantee superior seed quality is possible. Aremu *et al.*, (2013) observed significant differences in seedling characters among three seed positions in pumpkin pods. Also, significant interaction effect of genotypes x seed positions indicated that genotype exerted great influence on the variation observed among the three seed positions for all the five seed physiological parameters examined. Considerable variation in seed quality parameters of different fraction of seeds and pods have been documented by Adebisi *et al* (2013) and Ogunmefun (2013) in pepper species and pumpkin morphotypes, respectively.

In terms of seed physiological quality performance among the morphotypes across the seed position inside fruits, *Isa-1* had consistent superior seedling emergence, seedling vigour, number of leaves , leaf length and vigorous vine length whereas *Ogun* and *Ogbese* had greater values of vine length, respectively. On the performance of seed physiological quality under three seed positions in the fruits across morphotypes, seeds from the posterior portion of the fruits were significantly superior in seedling emergence, seedling vigour, number of leaves, leaf length and vine length over the two other seed positions. The superiority of seeds from posterior portion of the fruit was 10.7 to 11 % in seedling emergence, 8 to 13 % in seedling vigour, 12 to 14 % in number of leaves, 7 to 13 % in leaf length and 2 to 12 % in vine length over seeds from middle and anterior portions of pumpkin fruits.

The study also reveals that differential responses were observed among some morphotypes under each of the three seed positions investigated in respect of five seedling emergence and seedling growth parameters. Seeds of *Isa-1* and *Isa*-2 obtained from either anterior, middle or posterior portion of the fruits had superior seedling emergence over other morphotypes.

Conclusion

Variability was observed among morphotypes and the three seed positions within fruits evaluated in fluted pumpkin. The performance of the three seed portions in the fruit brought out the significance superiority of seeds from posterior portion with highest seed weight, seed length, width and number of seed over other two seed positions (anterior and middle portions of fruits). Four pumpkin morphotypes (*Ogun*, *Isa-1*, *Abia* and *Isa-2*) were identified with greater seed weight, length, width and thickness over other morphotypes whereas *Igbara* 2 and *Isa-2* had more seeds in the fruits than other morphotypes.

Seeds scoped from posterior end in *Isa-1* and *Isa-2* had maximum to moderate seed weight and number of seeds. Seeds of *Isa-1* showed a consistent highest seed physiological quality (emergence and seedling vigour traits) across three seed positions in the fruits. Seeds obtained from posterior portion of the fruits were found with significant superior seed physiological quality parameters. Seeds of *Isa-1* from the posterior portion of the fruits were significantly superior in seedling emergence, seedling vigour, leaf length, vine length and number of leaves.

Seeds from the posterior end gave outstanding performance in terms of seed metric and physiological quality parameters. Morphotype *Isa-1* and *Isa-2*, therefore, are desirable for use with superior performance in seed metric and physiological quality parameters across seed positions and these two morphotypes are recommended for future seed improvement programme.

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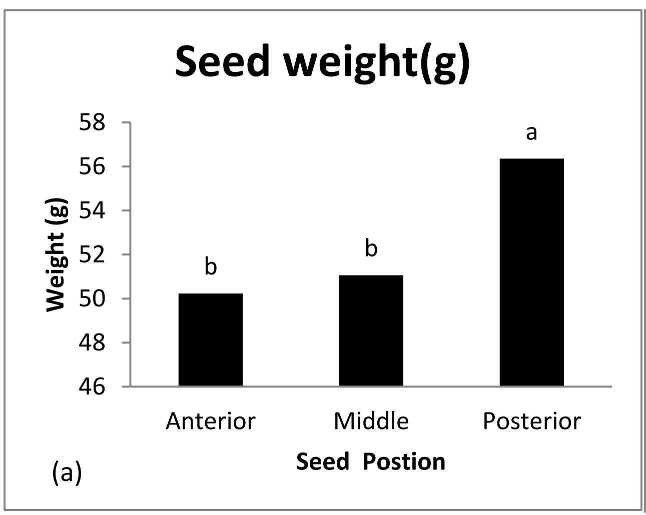
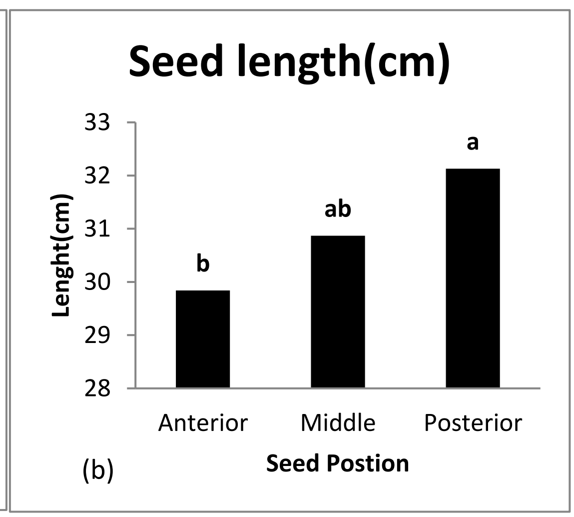
Table 1: Mean values of seed metric parameters of 10 morphotypes of fluted pumpkin across three seed positions inside the fruits.

Morphotypes	Seed weight(g)	Seed length(g)	Seed width(cm)	Seed thickness(mm)	Number of seeds
Igbara1	47.21 bc	29.00 a	30.07 b	16.76 a	22 d
Akure	48.08 bc	29.51 a	30.94 ab	14.82 ab	30 bc
Ondo	47.41 bc	30.22 a	32.83 ab	15.67 a	35 ab
Igbara2	42.78 b	31.15 a	32.70 ab	12.75 b	38 a
Ibule	49.98 b	30.70 a	32.16 ab	15.44 ab	23 c
Ogun	57.37 a	32.17 a	35.03 ab	15.81 a	26 bcd
Isa-1	58.09 a	31.68 a	36.91 a	15.84 a	29 bc
Abia	57.44 a	33.20 a	36.64 ab	16.23 a	21 d
Isa-2	60.18 a	30.41 a	36.01 ab	16.63 a	39 a
Ogbese	53.60 ab	31.44 a	36.06 ab	13.95 ab	27 c
SE	3.98	1.18	1.42	0.61	3.23
Summary of ANOVA					
Morphtype (M)	*	ns	**	**	**
Seed positions(S)	*	*	*	ns	**
MxS	ns	ns	**	ns	**

Means followed by the same alphabet along the column are not different from one another according to Tukey's HSD test at 5% probability level.
** Significant at 1% probability level, * Significant at 5% probability level, SE Standard error, ns Not significant





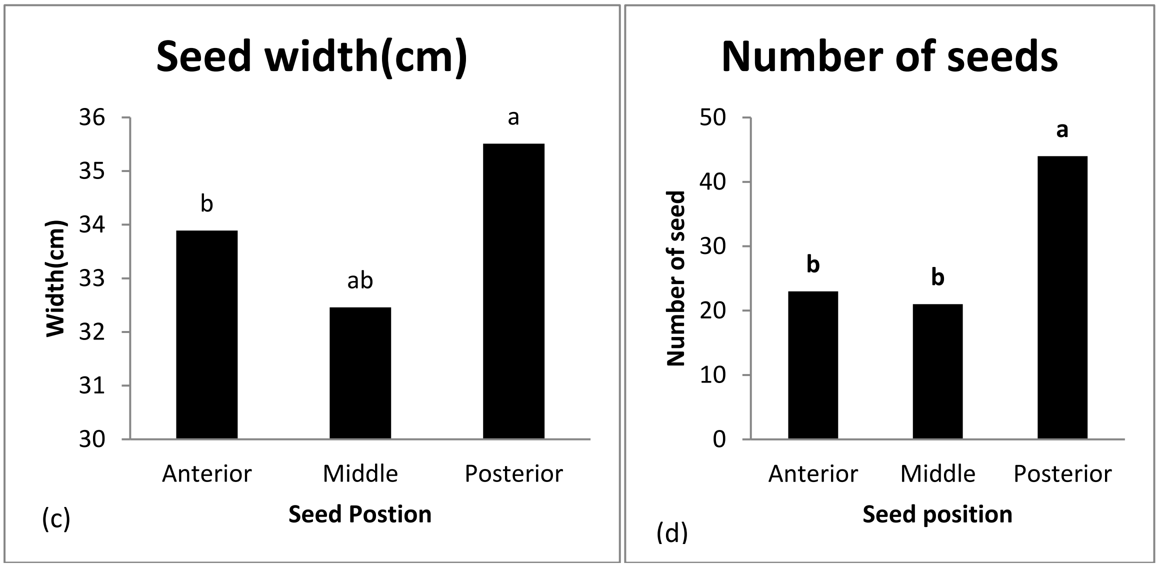
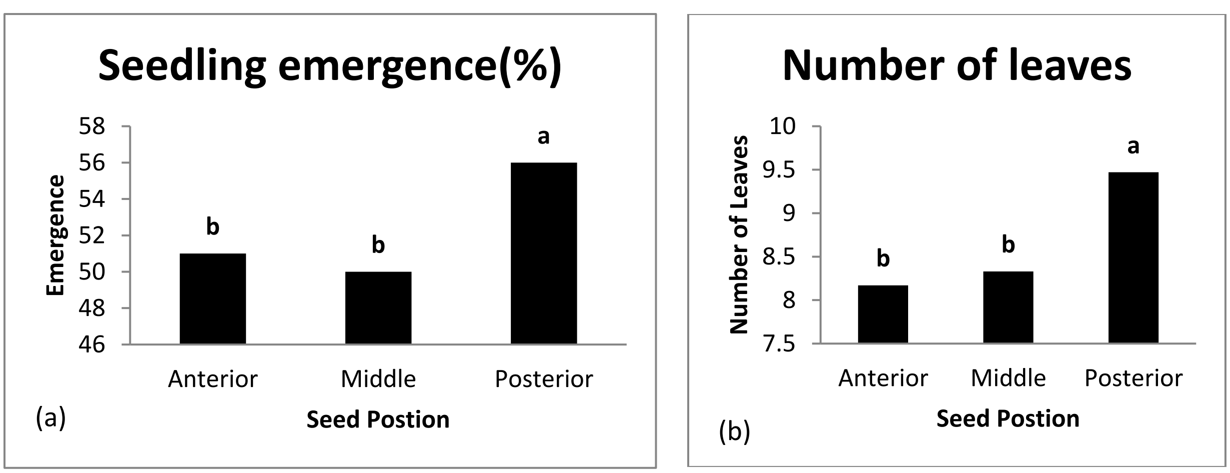


Figure 1: Influence of seed position in the fruits on seed metric characters in fluted pumpkin across morphotypes. Bars with same alphabet are not different from one another.

Table 2: Influence of morphotype and seed position in fruits on seed width and number of seeds in fluted pumpkin.

Morphotypes	Seed width(cm)			Number of seeds		
	Anterior	Middle	Posterior	Anterior	Middle	Posterior
Igbara1	33.33^{bc}	24.47^{c}	32.40^{b}	20^{bc}	14^{b}	34^{c}
Akure	30.27^{bc}	31.05^{b}	31.50^{b}	17^{c}	23^{a}	49^{b}
Ondo	33.87^{bc}	29.80^{b}	34.83^{b}	29^{ab}	18^{ab}	59^{a}
Igbara2	31.73^{bc}	31.80^{b}	34.57^{b}	32^{a}	24^{a}	58^{a}
Ibule	30.12^{c}	31.58^{b}	34.77^{b}	19^{c}	15^{b}	36^{b}
Ogun	32.78^{bc}	35.20^{a}	37.10^{a}	18^{c}	21^{ab}	37^{b}
Isa-1	40.20^{a}	33.40^{ab}	37.13^{a}	24^{bc}	24^{a}	38^{b}
Abia	34.77^{b}	35.80^{a}	37.36^{a}	16^{c}	19^{ab}	29^{c}
Isa-2	36.38^{ab}	35.70^{a}	36.53^{ab}	38^{a}	27^{a}	53^{a}
Ogbese	35.45^{b}	35.81^{a}	36.90^{ab}	16^{c}	22^{ab}	42^{b}
SE	2.46	2.46	2.46	5.59	5.59	5.59

Means followed by the same alphabet along the column are not different from one another according to Tukey's HSD test at 5% probability level. SE= Standard Error



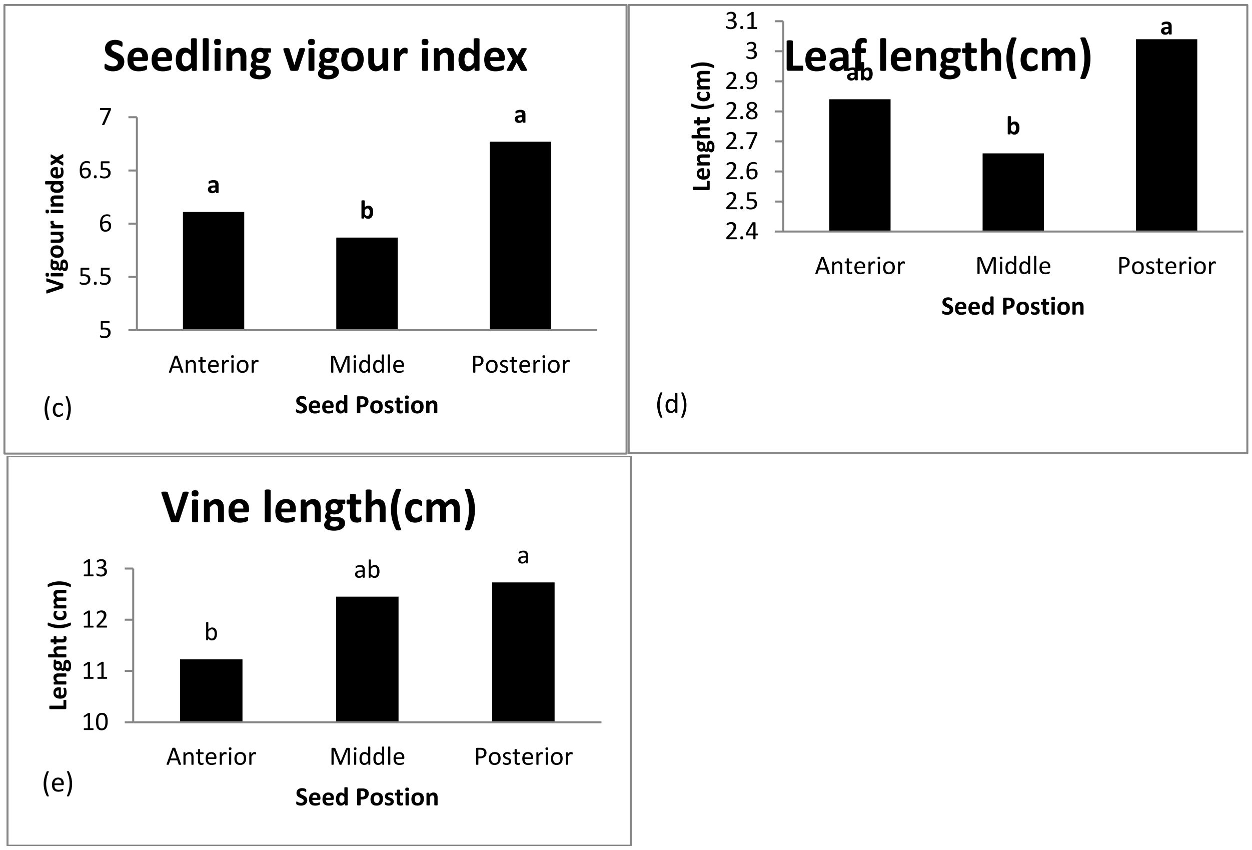


Figure 2: Influence of seed position in the fruits on seed physiological characters in fluted pumpkin across morphotypes. Bars with same alphabet are not different from one another.

Table 3: Mean values of seed physiological parameters in 10 morphotypes of fluted pumpkin across seed positions in the fruits.

Morphotypes	Seedling emergence (%)	Seedling vigour index	Number of leaves	Leaf length(cm)	Vine length(cm)
Igbara1	55[c]	4.50 [e]	8 [c]	2.34 [c]	8.10 [c]
Akure	52 [c]	4.65 [e]	8 [c]	2.36 [c]	9.28 [c]
Ondo	53 [c]	4.59 [e]	10 [b]	2.90 [c]	8.24 [c]
Igbara2	43 [d]	2.42 [f]	5 [e]	1.71 [d]	5.40 [d]
Ibule	46 [d]	6.18 [d]	8 [c]	3.56 [b]	13.74 [b]
Ogun	60 [bc]	8.59 [b]	10 [b]	3.84 [b]	15.98 [a]
Isa-1	69 [a]	10.71 [a]	12 [a]	4.13 [a]	15.51 [a]
Abia	36 [e]	4.74 [e]	7 [d]	3.56 [b]	13.40 [b]
Isa-2	67 [ab]	7.98 [c]	8 [c]	2.39 [c]	11.66 [c]
Ogbese	50 [c]	8.16 [b]	10 [b]	2.72 [c]	16.53 [a]
SE	4.85	0.92	0.46	0.36	1.35
Summary of	ANOVA				
Morphotype(M)	**	**	**	**	**
Seed position(S)	**	**	**	*	**
MxS	**	**	**	**	**

Means followed by the same letter along the column are not different from one another according to Tukey's HSD test at 5% probability level.. SE= Standard Error.
** Significant at 1% probability level, * Significant at 5% probability level,

Table 4: Influence of seed position in the fruits on seedling emergence and seedling vigour index of 10 morphotypes of fluted pumpkin.

Morphotypes	Seedling emergence (%)			Seedling vigour index		
	Anterior	Middle	Posterior	Anterior	Middle	Posterior
Igbara1	58^{ab}	54^{b}	53^{bc}	4.90^{c}	4.67^{cd}	3.80^{c}
Akure	58^{ab}	51^{bc}	47^{cd}	4.27^{c}	4.83^{cd}	4.57^{c}
Ondo	47^{b}	49^{bc}	62^{ab}	4.57^{c}	3.53^{d}	5.67^{c}
Igbara2	33^{c}	38^{cd}	58^{ab}	1.83^{d}	1.80^{e}	3.63^{c}
Ibule	53^{b}	27^{d}	58^{ab}	7.07^{a}	3.47^{d}	7.97^{b}
Ogun	55^{b}	58^{ab}	67^{ab}	8.93^{a}	5.77^{bc}	11.07^{a}
Isa-1	69^{a}	67^{a}	71^{a}	10.17^{a}	11.17^{a}	10.80^{a}
Abia	27^{c}	40^{c}	40^{cd}	2.43^{d}	6.93^{bc}	4.87^{c}
Isa-2	67^{a}	69^{a}	65^{ab}	10.00^{a}	6.70^{bc}	7.20^{b}
Ogbese	51^{b}	51^{bc}	49^{bc}	6.90^{b}	9.83^{a}	7.70^{b}
SE		8.42			1.60	

Means followed by the same alphabet along the column are not different from one another according to Turkey's HSD test at 5% probability level. SE= Standard Error

Table 5: Infloence of seed position in fruits on seedling leaf and vine length of 10 morphotypes of fluted pumpkin.

Morphotypes	Leaf Length			Vine Length		
	Anterior	Middle	Posterior	Anterior	Middle	Posterior
Igbara1	2.53^{ab}	2.50^{ab}	2.00^{b}	8.20^{e}	8.73^{h}	7.37^{g}
Akure	2.30^{ab}	2.23^{ab}	2.27^{ab}	7.20^{f}	9.87^{g}	10.77^{e}
Ondo	3.10^{ab}	2.93^{ab}	2.67^{ab}	9.23^{d}	6.77^{i}	8.53^{f}
Igbara2	1.33^{b}	1.68^{b}	2.13^{ab}	5.17^{g}	4.77^{j}	6.27^{h}
Ibule	3.13^{ab}	3.37^{ab}	3.27^{ab}	13.50^{c}	13.93^{e}	13.80^{c}
Ogun	3.87^{ab}	4.03^{a}	4.53^{a}	15.77^{a}	15.67^{d}	16.50^{a}
Isa-1	4.47^{a}	4.07^{a}	4.63^{a}	14.50^{b}	16.63^{c}	15.40^{b}
Abia	3.23^{ab}	3.70^{ab}	3.73^{ab}	9.43^{d}	18.60^{b}	12.17^{d}
Isa-2	2.97^{ab}	1.93^{b}	2.37^{ab}	15.77^{a}	9.50^{f}	10.30^{e}
Ogbese	2.47^{ab}	2.33^{ab}	3.37^{ab}	13.57^{c}	19.80^{a}	16.23^{a}
SE		1.34			0.45	

Means followed by the same letter along the column are not different from one another according to Tukey's HSD test at 5% probability level. SE- Standard Error

Table 6: Influence of seed position in the fruits on number of leaves in 10 morphotypes of fluted pumpkin.

Morphotypes	Seed position in fruits		
	Anterior	Middle	Posterior
Igbara1	8^{bc}	9^{ab}	7^{cd}
Akure	7^{cd}	8^{b}	10^{bc}
Ondo	10^{b}	8^{b}	11^{ab}
Igbara2	6^{d}	4^{c}	6^{d}
Ibule	9^{bc}	8^{b}	8^{cd}
Ogun	9^{bc}	10^{ab}	11^{ab}
Isa-1	13^{a}	11^{a}	13^{a}
Abia	5^{d}	8^{b}	7^{cd}
Isa-2	9^{bc}	6^{bc}	9^{b}
Ogbese	10^{b}	8^{b}	12^{a}
SE		1.54	

Means followed by the same letter along the column are not different from one another according to Tukey's HSD test at 5% probability level. SE: Standard Error

9/21/2022