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The quality of 'egusi' melon [(Citrullus lanatus Thunb.) Matsum and Nakai] seeds derived from fruits harvested at different growth stages and at different positions on the mother plant

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Abstract- A study of two cultivars of 'egusi' melon [Citrullus lanatus (Thunb.) Matsun and Nakai] known as bara and serewe, was undertaken at the Teaching and Research Farm of the University of Agriculture Makurdi in 2010. The aim was to study the effects of variable developmental stages and position of fruits on the mother plant on seed quality. Bulk crop was raised and fruits that developed from date tagged flowers were harvested at three days interval from 20 DAA to 47 DAA to monitor seed development and maturation. In another experiment, basal, middle and apex flowers were date tagged as they developed along the growing twine and fruits that developed were harvested at full maturity to monitor seed quality as influenced by fruit position. Mass maturity was attained between 35 and 38 DAA in the two cultivars and highest germination percentages of 85 and 87 were obtained at the last harvest (47 DAA) for both cultivars. Germination of fruits positioned at the base and middle, which showed no significant differences in themselves were significantly superior to apex fruits. It was therefore concluded that seed crop of the two cultivars should be delayed for up to 47 DAA or beyound and preference should always be given to seeds from base and middle positioned fruits against apex fruits.

Index Terms- Anthesis, fruit position, assimilates, maturation, seed quality, germination.

I. Introduction

'Egusi' melon is among the most popular African indigenous vegetable crops produced in Nigeria on a large scale. Schippers (2002) acknowledged the crop as occupying a vital role in the income generation ability of subsistence Africans. Ojo *et al.* (2002) reported a seed yield in Nigeria ranging between 131 to 1005kg /ha. Bankole and Adebanjo (2003) acknowledged that melon seeds (*Colocynthis citrullus* L.) are an important indigenous oil seed consumed by many rural communities in West Africa. Dehulled seeds contain oil, protein, amino acids, and some amounts of vitamins (John, 2002). Because of the nutritional and economic importance of 'egusi' melon, it is imparative that adequate studies should have been made to improve on its seed production practices. However, most African researchers generally pay more attention to agronomic crops while vegetable crops suffer neglect due to ignorance about their nutritive value. Bellin-Sesay (1996) reported that consumption of vegetables is far from sufficient in almost all developing countries. According to their report, two billion people, mostly women and children, are deficient in one or more micronutrients, which have been known for centuries as being responsible for diseases such as goitre, critinism, loss of sight, e.t.c. Nevertheless, vegetables still play a subordinate role in the discussion of food security in developing countries.

Farmers have always witnessed a wide variation in germination and emergence of melon seeds in the field and therefore target plant population densities are hardly met. Consequently, high seed rates are used. NIHORT (2000) recommended the sowing of four seeds per hole and that where seedling emergence is impressive, thinning to two plants per hole should be done. This practice is not only labourious but also wasteful.

Melon is a plant with an indeterminate growth, which continues to develop fruits progressively along the length of the stem. This means that melon fruits produced at the base of the stem are older, and continue to reduce in age, as they get closer to the apex of the stem. Melon farmers however, conduct harvest operations the same day and do not grade fruits according to age or fruit possition on the mother plant before seed extraction. A typical melon seed lot is therefore usually composed of seeds whoose individual ages vary widely. Seed age has however been reported, as been a major determinant of seed quality. (Demir and Samit, 2001; Oladiran and Kortse, 2002; Demir *et al*., 2004;). Since the seeds are also derived from fruits at different positions on the mother plant therefore, the food composition of individual seeds in the lot also varies. While seeds from fruits harvested at the base may be fully filled, seeds from the apex fruits may not have had enough time to be fully filled before senescence. Fruit position on the mother plant has however, also been reported as having an effect on seed quality (Alan and Eser, 2007; Ibrahim and Oladiran, 2011; K'Opondo, 2011) This study was therefore conducted to determine if seed age at harvest and fruit position on mother plant also contribute to the poor seed quality usually witnessed by melon farmers.

II. MATERIALS AND METHODS

'Egusi' melon [*Citrullus lanatus* (Thunb.) Matsum and Nakai] of cultivars bara and serewe were produced at the Crop Production Research farm of the University of Agriculture Makurdi in 2010. Planting was done on the flat at a spacing of 2m x 2m on 7th October 2010. Bulk crop was raised and each female flower was date tagged at anthesis to monitor fruit age. Fruits that developed from the tagged flowers were harvested at three days interval starting from 20 to 47 days, i.e. 20, 23, 26, 29, 32, 35, 38, 41, 44 and 47 days after anthesis (DAA). At each harvest, the seeds were extracted, washed, and dried. Dry seed weight per fruit, 100-seed weight and germination percentages were then determined.

In another study, the first five fruits of each plant were tagged as base fruits, the second five as medium, while the rest were left as apex fruits. Harvesting was done for all the fruit positions on the same day at maturity. Post harvest handling of fruits and determination of data was done on the same parameters as in the first study. This study was conducted to ascertain if there are variations in the quality of seeds derived from the three fruit positions.

Seeds samples from both experiments were tested for viability. Germination tests were conducted on four replicates of 50 seeds each, spread over distilled water-moistened absorbent paper in Petri dishes and incubated at 30^{o} C for 28 days. Counts were taken every other day.

III. RESULTS

Fruit age

Although the two cultivars recorded progressive inreases in fruit length with age, significant increases between each succeeding harvests were were only recorded at 23 and 47 DAA respectively in bara and 41 DAA in serewe (Figure 1).

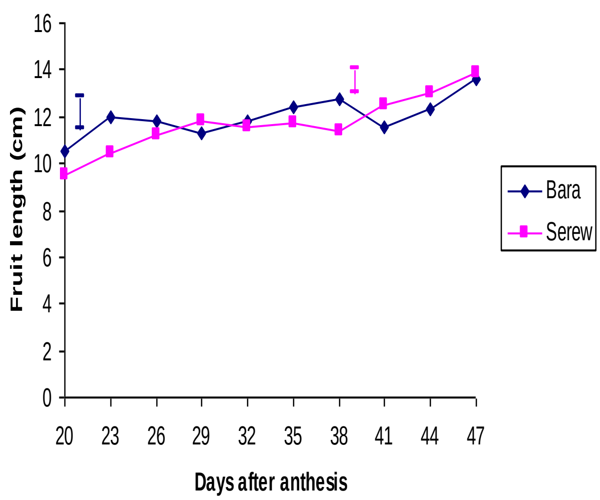

Fig. 1 Variations in average fruit length of bara and serewe harvested at different days after anthesis.
LSD at P = 0.05

Figure 2 shows that though there were progressive increases in diameter of fruits of the two cultivars with age, significant differences in bara were only recorded at the second harvest (23 DAA) and harvest at 41 and 44 DAA which were not significantly different in themselves. Serewe however, recorded significant increases at the second harvest (23 DAA) and harvest at 29 DAA. Thereafter, no other significant differences were observed until the last harvest (44 DAA).

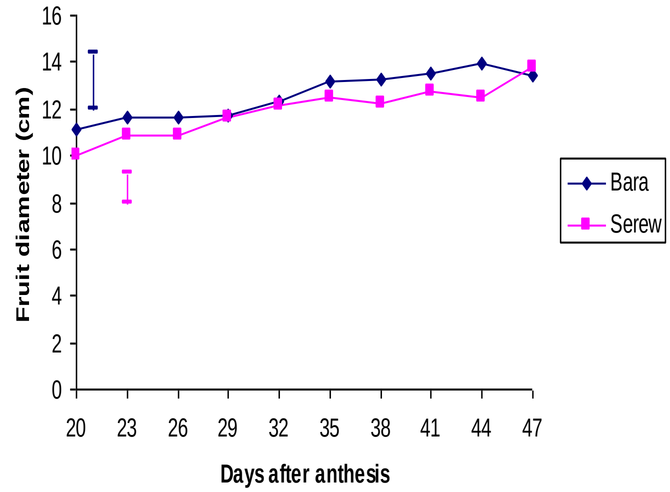

Fig. 2 Variations in average fruit diameter of bara and serewe harvested at different days after anthesis.
LSD at P = 0.05

As shown on Figure 3, no significant increase in fruit weight was observed in bara from 20 to 29 DAA. However, fruits harvested at 32 DAA were significantly heavier than those harvested at 20 DAA. Fruits harvested from 38 to 47 DAA, which showed no significant differences in themselves, also weighed significantly heavier than the later. Serewe fruits harvested at 29 DAA weighed significantly heavier than harvest at 20 DAA. Thereafter, further succeeding harvests, whoose weight increased progressively in succession did not record any significance until the last harvest at 47 DAA.

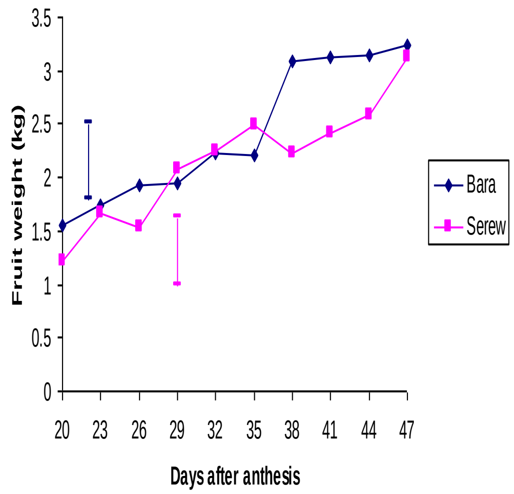

Fig. 3 Variations in average fruit weight (kg) of bara and serewe harvested at different days after anthesis.
I LSD at P = 0.05

Number of seeds per fruit of the two cultivars also increased progressively from inception of harvest without significant differences until harvest at 35 DAA, which recorded a significant difference to the first harvest (20 DAA). Thereafter, further succeeding harvests increased progressively to the last harvest without significant differences (Figure 4). The total number of seeds produced by serewe was greater than those produced by bara.

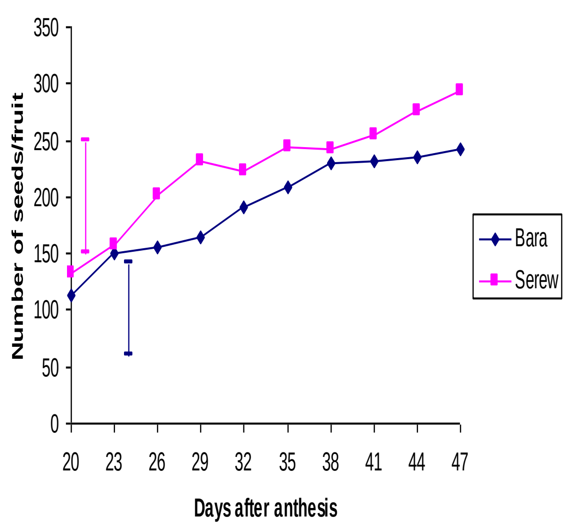

Fig. 4 Variations in average number of seeds per fruit of bara and serewe harvested at different days after anthesis.
I LSD at P = 0.05

Following the same trend as observed in number of seeds per fruit, the dry seed weight per fruit of Bara cultivar also recorded progressive insignificant increases from inception of harvest until 35 DAA when a significant difference was recorded with the first harvest (20 DAA). Further succeding harvest recorded no significant differences among themselves. Figure 5, however shows that in serewe a slight variation from the foregoing trend was recorded as it was seeds of harvest at 32 DAA that weighed significantly higher than the first harvest (20 DAA). In contrast to the greater seed number produced by serewe, bara produced a greater seed weight per fruit.

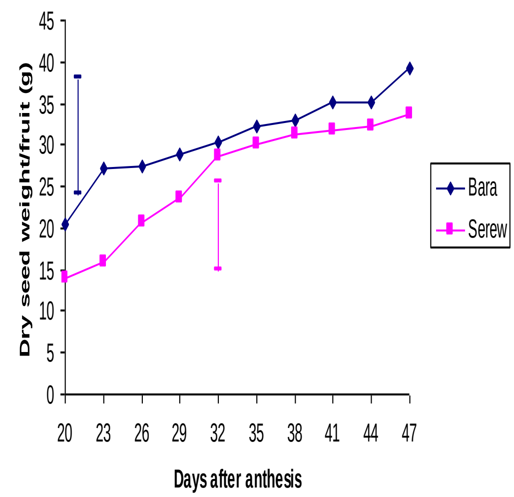

Fig. 5 Variations in average dry seed weight (g) per fruit of bara and serewe harvested at different days after anthesis.
I LSD at P = 0.05

Progressive increases in 100-seed weight of bara were observed which were not significant until at 38 DAA. Further seed weight recorded thereafter until the end of harvest were insignificant. Following the same trend, serewe also produced insignificant progressive increases until 35 DAA.Thereafter, there were no significant differences until the end of harvest. The 100-seed weight of bara cultivar were also greater than those of serewe even though as earlier observed, serewe produced more seeds per fruit.

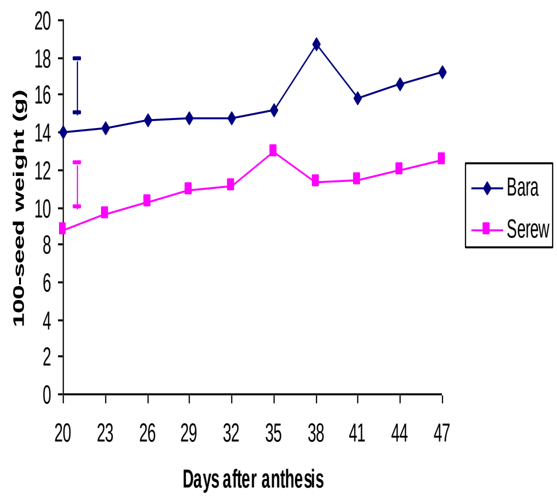

Fig. 6 Variations in 100-seed weight (g) per fruit of bara and serewe harvested at different days after anthesis.

LSD at P = 0.05

A general progressive improvement in germination was observed in bara throughout seed development period. Significant increase in germination was recorded between 20 and 26 DAA and further between 26 and 32 DAA. Thereafter, no significant increase was observed to the end of production period (Figure 8). Serewe also recorded significant increase in germination between 20 and 26 DAA and further between 23 and 35 DAA. No other significant increase was observed thereafter until the last harvest at 47 DAA in which the improvement in germination was significantly better than all other harvests.

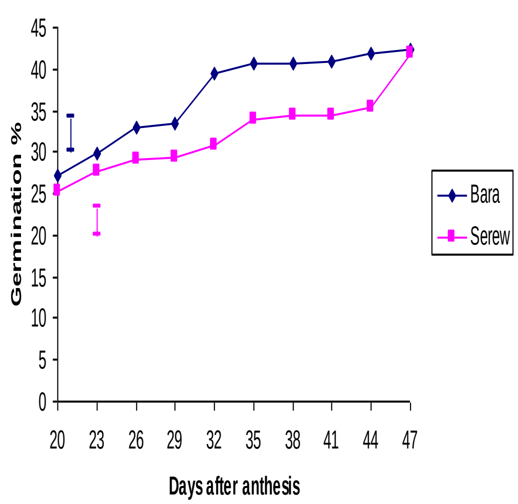

Fig. 7 Variations in 100-seed weight (g) per fruit of bara and serewe harvested at different days after anthesis.

LSD at P = 0.05

Fruit position on mother plant

Though bara fruits harvested at the base position were longer and decreased retrogressively upwards towards the apex, analysis revealed that significant difference only existed between the base and apex fruits while middle fruits bore no significance with both the base and the apex fruits. In serewe however, base fruits were significantly longer than both middle and apex fruits (Figure 10).

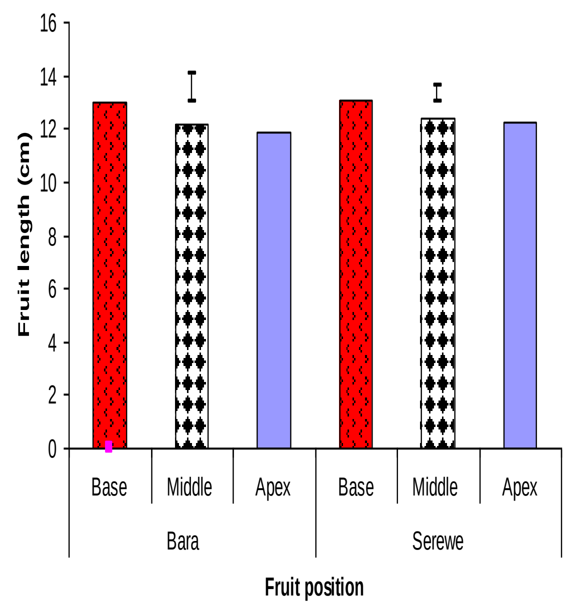

Fig. 10 Variations in the average fruit length (cm) of bara and serewe fruits harvested at different positions on mother plant.

LSD at P = 0.05

Base fruits of bara significantly recorded greater diameters than middle and apex fruits (Figure 11). However, the differences in diameters of serewe fruits at the different fruit positions were insignificant.

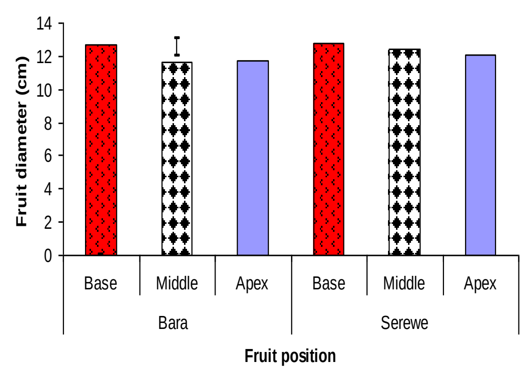

Fig. 11 Variations in the average fruit diameter (cm) of bara and serewe fruits harvested at different positions on mother plant.

LSD at P = 0.05

Although the weights of of both cultivars (bara and serewe) fruits harvested at the base obtained a higher value and progressively retrogressed towards the apex, analysis revealed that there were no significant differences between them (Figure 12).

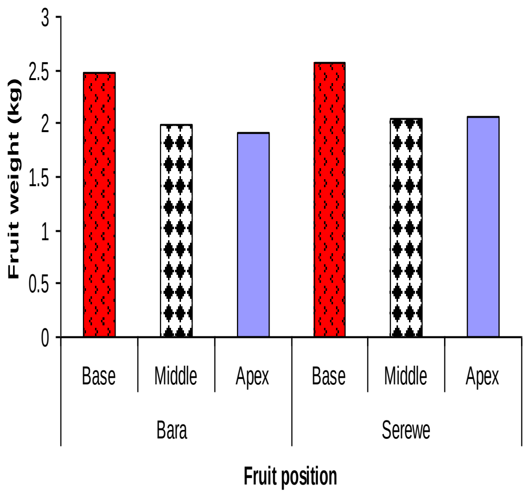

Fig. 12 Variations in the average fruit weight (kg) of bara and serewe fruits harvested at different positions on mother plant.

Number of seeds per fruit of both cultivars (bara and serewe) also did not show any significant differences among the respective fruit positions even though the base fruits maintained a greater number as shown in Figure 13. The total number of seeds produced by serewe cultivar was greater than those produced by bara.

Fig. 13 Variations in the average number of seeds per fruit of bara and serewe harvested at different positions on mother plant.

There were no significant differences in the dry seed weight per fruit of bara harvested at different positions on the mother plant. However, whereas harvest of serewe fruits from base and middle positions yielded no significant differences in dry seed weight, harvest at the apex position resulted in significantly lower dry seed weight to the later two positions (Figure 14). In contrast to the greater seed number produced by serewe, a higher seed weight was obtained from bara cultivar.

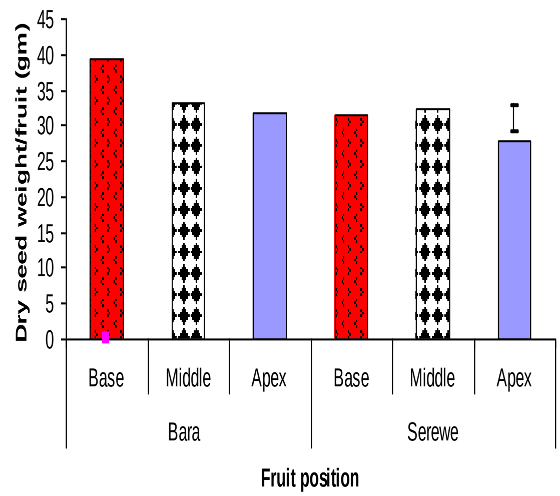

Fig. 14 Variations in the average dry seed weight (gm) per fruit of bara and serewe harvested at different positions on mother plant.

I LSD at P = 0.05

No significant differences were obtained in 100-seed weight of both cultivars (bara and serewe). However, Figure 15 reveals that in contrast to the number of seeds produced by serewe, bara produced a greater 100-seed weight.

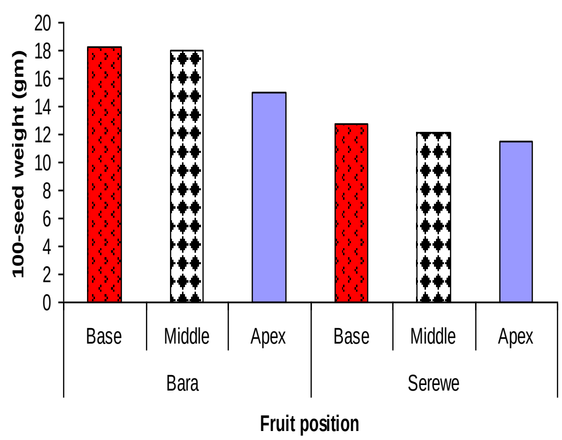

Fig. 15 Variations in the 100-seed weight (gm) of bara and serewe harvested at different positions on mother plant.

There was no significant difference in the germination levels of seeds obtained from fruits of both bara and serewe cultivars harvested at the base and middle positions. However, germination was significantly enhanced by these positions in comparism to the apex position as shown in Figure 16.

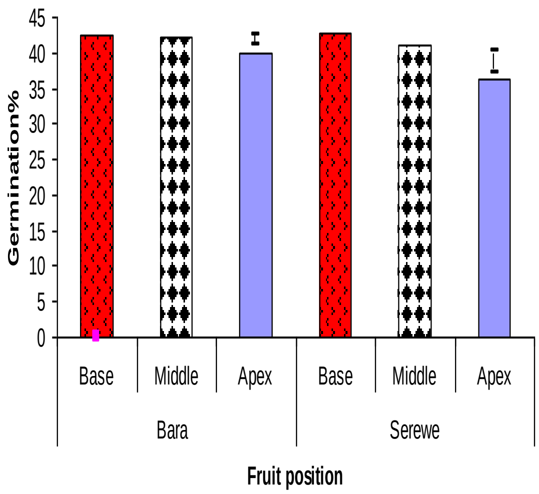

Fig. 16 Variations in percentage germination of bara and serewe harvested at different positions on mother plant.
LSD at P = 0.05

IV. DISCUSSION

Yadav (1983) and Dhanelappagol *et al.* (1994) named amino acid, phosphorus active substances, dry matter, sugar, water soluble proteins, acids and necotonic acid levels as some of the assimilates usually transported from other plant parts for accumulation into the fruits/seeds as the plant develops progressively until physiological maturity is attained. The progressive increases obtained in fruit/seed attributes (length, diameter and weight) with age in this study is therefore an indication of progressive increase in the accumulation of assimilates during fruit/seed maturation. This finding agrees with that of Bino *et al.* (1996) who categorised cell expansion and accumulation of reserve materials by the embryo and endosperm as a second in the three phases of seed development. Demir and Ellis (1992) reported a similar trend in tomato but stated that maximum seed quality is attained in tomato some time after the end of the seed-filling period. Natrajan and Srimathi (2008) also reported that increase in Petunia pod weight with increase in DAA was supported by increse in pod length and width due to the development from zygote to matured seeds. Furthermore, Kortse *et al.* (2012) reported increases in the values for fruit and seed traits of *Citrullus lanatus* as time progressed up to 26 and 38 DAA in the two seasons of production. The decrease in fruit/seed traits retrogressively from basal through medium to the apex suggests that as an indeterminate plant develops more and more flowers, there is competition for assimilates. The basal fruits, which have an age in the competition because they started first, therefore get a higher share while the later fruits suffer shortages. This finding agrees with the report by Demir and Ellis (1993) that the duration of seed filling in marrow was two days longer within the earlier-formed basal fruits than within the later-formed apical fruits, while the rate of seed-filling was also greater in the former. Consequently, mature seeds from basal fruits were 17% heavier than those from apical fruits. Passam *et al.* (2010) also found that during fruit growth and maturation in eggplant, there was competition between fruits on the plant for essential nutrients and storage reserves, which led to a reduction in flower induction and flower size and adversely affect seed yield.

The number of filled seeds per fruit, which increased with corresponding increase in DAA, is an indication that different seeds within a fruit do not mature 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. This is expected since pollen grain may not germinate at the same rate and also pollen tube growth, zygote formation and seed development and maturation may not proceed at the same rate (Silvertown, 1984; Delph *et al.*, 1998).

The greater seed number produced by serewe relative to that produced by bara in both experiments which conversely generated values of lower seed weight also supports the competition for assimilates already explained above. This competitive theory suggest that the quantity of assimilates alocated to an individual seed in a fruit would be determined by the total number of seeds the fruit contains. The more seeds a fruit contains the higher the competition and the fewer nutrients individual seeds would get and thus the low seed weight. This finding contradicts the report by Marcelis and Hofman-Eijer (1997) on *Cucurbita pepo* in which they reported that fruits that contained more seeds competed better for available assimilates and therefore achieved greater size.

The result of this study in which values of 100-seed weight recorded significant increases at 38 and 35 DAA respectively in bara and serewe suggests that maximum dry matter accumulation was attained between 35 and 38 DAA in these two cultivars. Germinability however improved until the last harvest. This is in agreement with the report by Demir and Ellis (1992) which found maximum seed quality of tomato to be attained some time after the end of the seed filling period. This finding is also in agreement with those of Nerson (2002) and Demir *et al.* (2004) who both found fully matured melon seed lots (35 – 49 DAA and 40 – 45 DAA respectively) to have better germination and longevity than the less matured ones. The insignificant differrences obtained in the germination of seeds from base and middle positions of both cultivars show that there were no marked changes in provision of assimilates at this stage of development however, the seeds from the apex positions were lacking in supply.

It is therefore recommended that harvest of melon fruits for seed can be delayed for up to 47 DAA and even beyound. For better germination still, basal and middle positioned fruits should be preffered.

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