PAT December, 2019; 15 (2):118-126 ISSN: 0794-5213

Online copy available at www.patnsukjournal.net/currentissue

Publication of Nasarawa State University, Keffi

Fruit and Seed Characteristics as Determinants of Juice Quality and Seedling Vigour in Sweet Orange and Mandarin

ABIOLA, I. O

Department of Horticulture and Landscape Technology,
Federal College of Forestry, Ibadan, Oyo State, Nigeria.

Abstract

The experiment was conducted at the Research and Teaching site of Federal College of Forestry, Ibadan to assess the effect of fruit and seed characteristics on juice quality and seedling vigour in sweet orange and mandarin. The fruit and seed characteristics of 100 fruits each of Sweet Orange (Citrus sinensis L.) and Mandarin (Cleopatra mandarin L.) were used to determine the juice quality and seedling vigour of the two species. It was discovered that the larger the fruit size of Sweet Orange, the higher the fruit weight and the vitamin C, but the number of seeds per fruit and seed size did not depend on size of the fruit. Also, the smaller the fruit size of Sweet Orange, the higher the sugar content. The larger the size of Mandarin, the higher the fruit weight, seed size and number of seeds per fruit, but the smaller the size of Mandarin, the higher the vitamin C and Sugar content. The size of seeds significantly affected the number of embryos (as shown from the number of seedlings that emerge), the seedling height, average number of leaves per seedling, number of roots, total biomass and total dry weight of Sweet Orange. However, seed size did not in any form affect the seedling vigour of Mandarin. Fruits harvested for the purposed of extracting the seeds for planting should therefore be selected on the basis of size. After the extraction of the seeds, the best seeds for planting should be the largest ones, but smaller seeds could be used if the genetic make-up is the same for all the seeds and fruits harvested for fresh juice should be selected based on the nutrition requirement of the consumer.

***Keywords**: Sweet orange, mandarin, seed characteristics, juice quality, seedling vigour.*

Introduction

In Nigeria, Sweet Orange (*Citrus sinensis* L.) and Mandarin (*Cleopatra mandarin* L.), are the most popular species for fresh consumption and from the point of view of their industrial potentials. There is need, therefore, to embark on a sound development of these species not only through breeding, selection, but also through improved methods of establishment. Until recently, Citrus growers in Nigeria were planting seedling trees since, there had been no organized system for the supply of budded plants was available (Alice *et al.,* 1987). Although these budded plants are preferred because it ensures true to type plants, uniform quality, regular bearing, etc, but propagation by seed is still in vogue in the case of certain Citrus species like Mandarins because of the higher intensity of polyembryony, also for grafting and budding purposes, root-stocks are raised by seeds only, and seed propagation is vital for developing new cultivars through hybridization (Rajput and Haribabu, 1985). Opeke (1982) pointed out that as the fruit ripens, the chlorophyll contained in the chloroplasts of the exocarp breaks down and volume of juice within the fruit increase. Citrus fruits tend to be small (undersized) when grown under dry or semi-dry conditions. Also, when Citrus fruits developed under excessive moisture, the juice tend to be watery and fruits oversized and putty. Singh[1] and Singh[2] (1991) stated that, Citrus fruits are potent source of vitamin C and minerals in readily assimilable form and most of them contain a considerable amount of sugar and starch. Their product have curing properties against many disease e.g. high blood pressure, scurvy, etc. The importance of Citrus fruits in preventing scurvy was scientifically proven in 1756 by John Lind, a Surgeon in British. Mandarin is one of the root-

stock that have been shown to be resistant to Tristeza, a deadly virus disease of Citrus. Sweet Orange can be used as rootstock. It generally produces lower yield than rough Lemon with Mandarins and Oranges, but the fruits are of very good quality, up to 90% seeds are nucellar. Soil should be well drained as Sweet Orange rootstocks are susceptible to Citrus gummosis (foot rot) *Phytophthora* species and it can also be used as rootstock top. Mandarin show some resistance to tristeza virus and are quite resistant to foot-rot and gummosis. Fruit quality is quite good. Nucellar seeds vary between 10 and 100 percent. Mandarin stocks are usually slow to develop (William and Chew, 1980).Samson (1986) stated that, as long the fruit hangs on the tree the brix continue to rise, and acid content is steadily coming down. Seed is obtained from fresh fruits which is picked from the tree rather than from the ground in order to minimize phytophthora infection and these can affect germination percentage and subsequently seedling vigour. Seed must not be allowed to dry out or germination will be sharply reduce (Rice *et al*., 1987). Opeke (1982) stated that, seeds should be selected on the basis of size- the larger the seed, the larger generally, the embryo and the food store and the more vigorous the germination and early establishment. Seeds should only be taken from ripe and well-filled fruits. Freshly extracted seeds should be sown immediately as Citrus seed rapidly lose viability on extraction. Seed size is one of the components of seed quality which affects the performance of crop (Ojo, 2000; Adebisi, 2004; Adebisi et al., 2011). Size is a wide accepted measure of seed quality (Jerlin and Vadivelu, 2004). Vigour is the condition of good health and robustness: when seed is planted, vigour permits germination to proceed rapidly under a wide range of condition (Johnson, 1980). The seedling vigour is measured by the seedling weight. Samson (1986) stated that Citrus seeds have no dormant period and are injured by drying, they should be sown fresh. The optimal temperature is about 32^{o}C. Most Citrus species and cultivars are polyembryonic; from one seed two, three or more plant may emerge. Effects of seed size on emergence and subsequent development of plant received increasing attention since, the time of Kidd and West (1918). Thus, it has been found that large seed will give seedlings which emerge earlier and of large size than those arising from small seeds. Seed-size is related to the size of the resulting seedling. Seedlings raised from small seeds start with initial disadvantage which justifies rejection of very small seeds. The smallest, however, should be adjudged with reference to most frequently occurring seed-size in an orchard. Seeds of the modal size grade tend to give highest percentage germination. The practice of using a common, arbitrarily chosen mesh for sieving out small seeds is discouraged as it may cause unnecessary loss of good seeds (Barua, 1960). Moreover, the consideration of the length of the hypocotyls and plumule and the dry weight of radical of Groundnut by Trivedi and Bhatt (1994) showed that the larger the seed, the greater the seedling growth. But Lopez and Grabe (1973), in their studies on seed weight relation to metabolism during germination, concluded that if the genetic make-up of all the seeds has been the same, small seeds could be used effectively as seedling material. Since this would help in reducing the cost of inputs to a considerable extent. However, there have been only a few published results on other seeds in relation to this (Jensen et *al.,* 1972). Literatures are still lacking on the relationship between the fruit and the seed characteristics and the effect of their association on seedling vigour. Therefore, this research was conducted to determine the relationship between fruit size and fruit weight, seed number per fruit and seed size and how the fruit size will affect juices quality. Moreover, it determines how seed size will affect the seedling vigour of Sweet-Orange selected from various locations and Mandarin collected from a single tree with the same genetic make-up.

Materials and Methods

Two Citrus species: Sweet Orange and Mandarin were used to determine the relationship between the fruit-size and weight, number of seeds per fruit and average seed size per fruit. The fruits were obtained when ripening was at the peak in the Western part of Nigeria and in this part of the Country, Sweet Orange fruits are sold based on their sizes or grades, that is, the larger the size, the higher the cost. Five market locations were randomly selected within the city and uniformly riped of all the grades of Sweet Orange were bought from each of the five locations to make up to 100 fruits of various sizes. The sizes of Mandarin are relatively uniform and seldomly categorized for sale. Therefore, 100 fruits that are uniformly riped were collected from a tree. The study involve two experiments.

Experiment 1:

This first experiment was performed to determine the relationship between the fruit size and other parameters such as fruit weight, vitamin C and sugar content of the juice, the number of seeds per fruit and seed size in both Sweet Orange and Mandarin. The experiment was carried out at the Horticulture and Landscape Technology, Department, Federal College of Forestry, Ibadan. Each fruit from each species was labeled serially from 1-100. The circumference of each fruit was measured with the use of string and meter rule and weighted on a balance. Each fruit was carefully and transversally cut into two in order to avoid cutting or damaging the seeds. Seeds and juice were extracted mechanically with an Orange juice extractor. The seeds collected from each were counted and weighed to determine the average number of seeds per fruit and average seed size respectively. And the relationship between the fruit size and fruit weight, number of seeds per fruit and average seed size were subjected to correlation and Regression analysis.

Sugar Content Determination

The Sugar content was determined using the Lane and Eyon method of 1923, 10ml of Orange juice was pipette into a 250ml measuring cylinder and made to mark. This was shaken vigorously to form the stock solution. The stock solution was titrated against 5ml of both Fehling solution A and B using phenol blue indicator. The solution was heated until a brick red solution was obtained.

Determination of Vitamin C (Ascorbic Acid)

0.05g of 2, 6 dichlorophenol solution was dissolved in 100ml of distilled water and filtered. To standardize this, 0.5g of pure ascorbic acid was dissolved in 60ml of 20% glacial acetic acid and the solution made up to exactly 250ml with distilled water. 10ml of this solution was pipette into a small flask and titrated against the indophenols solution until a faint pink colour was obtained. Colour persisted for 15 seconds (x ml). The concentration of the ascorbic acid in mg was express as equivalent to 1ml of dye solution.

xml of dye = 0.05g Ascorbic acid (mg)

$$1\text{ml} = \frac{0.05}{x}$$

where x = titre value

5ml of Orange juice as mixed with 100ml of distilled water, the mixture was filtered.

10ml of the filterate was taken into 100ml standard flask, 25ml of 20% glacial acetic acid added and the flask was made up to the mark. 10ml of the result solution was pipette into a conical flask and titrated with the standard Indophenol solution (y).

$$\text{10ml of sample solution} = \frac{y \times 0.05}{X}$$

100ml of sample contained "k" mg of ascorbic acid.
100ml of sample contained 20"k" mg ascorbic acid.
In 100ml of Orange juice sample = 20k mg ascorbic acid.
Formula:

$$K = Y \times \frac{0.05}{x} \times \frac{10}{1} \times \frac{100}{v} \quad \text{mg/100g}$$

Y = titre value of sample
X = titre value of standardize indophenol = 0.0488
V = volume of sample used.

Experiment II

In order to determine the effect of seed size on the seedling vigour of both Sweet Orange and Mandarin, there was a completely randomized design experiment carried out in the screen-house of the same Department. Thirty-two (32 plastic cups of 700ml capacity were filled with top soils and watered to field capacity before the seeds were planted two days after extraction in order to maintain viability. And this was done after bulking of the seeds from each species, and visually graded into four categories according to their sizes to very bold, bold, medium and small seeds. And each category was weighed and recorded. Each grade represented a treatment. Two seeds were planted per pot for each treatment and replicated four times to give sixteen pots each for Sweet Orange and Mandarin. Watering was done regularly throughout the period of the experiment. Weed infestation was controlled by hand-pulling any weed that was coming-up. There was no incidence of pest or disease attack. And seeds started to emerge twenty-one days after planting. Data collection was on parameters such as emergence, plant height, root length, number of leaves per plant, number of roots per stand and total biomass. Results were subjected to Analysis of Variance.

RESULTS

Experiment I

Fruit size for both Sweet Orange and Mandarin was shown in (Table 1) and it could be observed that Sweet Orange has larger circumference than Mandarin. The size of Sweet Orange fruit ranges from 18.20cm to 28.30cm per circumference. The fruit size was positively and significantly correlated with the fruit weight. There is no correlation between the size of the fruit of Sweet Orange and the average size of seeds and there was no significant correlation between the fruit size and number of seeds per fruit of Sweet Orange. There was positive and significant correlation between the fruit size of Sweet Orange and vitamin C, but there is negative and significant correlation between fruit size and sugar content of Sweet Orange as shown in Table 2. The fruit size of Mandarin ranges between 13.30cm and 19.00cm in circumference, and there was positive associations between the fruit size and fruit weight seed size and seed number per fruit

respectively, as shown in Table 3. However, there was no significant correlation between the fruit size of Mandarin and sugar content and vitamin C. Table 4 show that, the larger the size of Sweet Orange, the higher the vitamin C content and lower the Sugar content.

Table 1: **Fruit sizes of Both Sweet Orange and Mandarin**

Categories	**Sweet Orange (Cm)**	**Cleopatra Mandarin (Cm)**
Extra Large	25.01 above	17.50 above
Large	22.01 – 24.99	15.10 -17.49
Medium	20.01 – 22.00	14.00 – 15.09
Small	20.00 below	13.99 below

Table 2: Sweet Orange

Correlation Coefficient (r)	Regression equations	t Calculated	t 0.05 (98) tabulated
Fruit size x Seed size r = -0.26	y = 18.86 – 11.88x	+1.67	+1.98
Fruit size x Seed number r = -0.10	y = 21.93 – 0.04x	+0.94	+1.98
Fruit size x Fruit weight r = +0.99	y = 14.57 + 0.04x	+65.86	+1.98
Fruit size x Sugar content r = +0.96	y = 12.45 + 147.14x	+32.16	+1.98
Fruit size x vitamin C r = +0.94	y = 19.49 + 0.66x	+25.86	+1.98

Table 3: Cleopatra Mandarin

Correlation Coefficient (r)	Regression equations	t Calculated	t 0.05 (99) tabulated
Fruit size x Seed size r = +0.32	y = 12.35 + 26.07x	+3.17	+1.98
Fruit size x Seed number r = +0.25	y = 14.75 + 0.09x	+2.42	+1.98
Fruit size x Fruit weight r = +0.95	y = 9.76 + 0.13x	+28.56	+1.98
Fruit size x Sugar content r = -0.66	y = 15.79 – 4.34x	-8.25	+1.98
Fruit size x vitamin C r = -0.59	y = 15.79 - 0.16x	+6.86	+1.98

Table 4: **Effect of Fruit sizes on vitamin C and Sugar content of Sweet Orange juice**

Fruit size (Cm)	Vitamin C mg/100g	Sugar Content (%)
20.00 and below	67.01	1.02
22.01 – 24.99	62.87	1.02
20.01 – 22.00	67.01	1.28
25.01 and above	77.32	1.01

Table 5: **Effect of Fruit sizes on vitamin C and Sugar content of Sweet Content of Mandarin**

Fruit size (cm)	Vitamin C mg/100g	Sugar Content (%)
13.99 and below	67.01	2.50
15.10 – 17.49	25.78	1.27
14.00 – 15.09	51.55	2.60
17.50 and above	36.09	1.28

Experiment II

Table 6, showed the average weight (sizes) of sixteen seeds from each categories of both Sweet Orange and Mandarin seeds. An average of between 2.00 and 4.354 grammes was recorded per 16 seeds of Sweet Orange while that of Mandarin was between 1.32 and 2.58 grammes per 16 seeds. From Table 7, it was observed that the highest number of Sweet Orange seedlings that emerge was recorded from the seeds belonging to "very bold" category, while the least was found to be from the small seed category. It was also observed that the seedling height, average number of roots per seedling, the total biomass and the total dry weight were higher in very bold than in small categories. However, seed size did not affect the root-length of Sweet Orange seedling. From Table 8, it was observed that seed size did not significantly affect the emergence, seedling number of root per seedling, the total biomass and total dry weight of Mandarin.

Table 6: Seed Categories of Sweet Orange and Mandarin

Categories	Weight g/sixteen seeds	
	Sweet Orange	Mandarin
Very bold	4.34	2.58
Bold	3.27	2.33
Medium	2.27	1.91
Small	2.00	1.32

Sweet Orange		Cleopatra Mandarin	
Very bold	0.29 – 0.26	Very bold	0.18 – 0.16
Bold	0.25 – 0.19	Bold	0.15 – 0.13
Medium	0.18 -0.14	Medium	0.12 – 0.09
Small	0.13 – 0.10	Small	0.08 – 0.06

Table 7: Effect of seed size on emergence, height, number of leaves, root length, number of roots, total biomass and total dry weight of Sweet Orange seedling (2 months after emergence).

Seed size	Average seedling emergence (2 months after planting)	Average seedling height (cm)	Average number of leaves per seedling	Average number of leaves per seedling	Average number of roots per seedling	Total biomass (g)	Total dry weight (g)
Extra Large	3.75a	5.07ab	10a	6.57	16.75a	1.40a	0.35a
Large	2.25bc	3.81bc	5.75b	5.95	6.5b	0.93b	0.23b
Medium	3.25ab	5.58a	10.25a	7.37	12.25ab	1.10ab	0.21b
Small	1.50c	2.80c	3.5b	5.56	7.5b	0.40c	0.10c
LSD (0.05)	1.19	1.52	3.17	NS	7.18	0.41	0.08

Table 8: Effect of seed size on emergence, height, number of leaves, root length, number of roots, total biomass and total dry weight of Cleopatra Mandarin seedling (2 months after emergence).

Seed size	Average seedling emergence (2 months after planting)	Average seedling height (cm)	Average number of leaves per seedling	Average root length (cm)	Average number of roots per seedling	Total biomass (g)	Total dry weight (g)
Extra Large	2.5	3.40	7.25	6.17	11.75	0.56	0.17
Large	3.75	3.06	6.50	6.29	8.50	0.64	0.17
Medium	1.75	2.86	3.25	3.36	5.0	0.35	0.11
Small	2.0	3.50	5.25	5.25	9.75	0.38	0.09
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS

Discussion

The wide range in size of Sweet Orange (18.20 to 28.30cm in circumference) was probably due to the fact that the fruits' were obtained from different trees of wide genetic composition and possibly due to the fact that the fruits were from various locations that were under varied environmental influences. This was done, so as to have variation in the sizes of the fruits. But lesser range was obtained in Mandarin due to the fact that Mandarin normally produce fruits of smaller sizes and since all the fruits were harvested from the same tree, difference in sizes was bound to be minimal. This was because the fruit were bound to have the same genetic make-up and were all almost subjected to the same environmental influences. The fruit sizes of both species of Citrus were found to be positively correlated with their weights. This might be due to the fact that other components of the fruit such as the water content, seeds (both size and number), thickness of rind,

etc. must have either in part of whole, increase with the increase in size of the fruits. The lack of correlation between the fruits size and both the number of seeds per fruit and size of seed per fruit must have possibly resulted from the fact that the same factors do not control the size of fruit and number and size of seeds in Sweet Orange especially when they are not all gotten from the same tree. This is contrary to the pattern exhibited by Mandarin whose fruit sizes were positively correlated with the seed number and sizes. Moreover, seeds may be many or few in Sweet Orange irrespective of the fruit size while seeds are generally many in Mandarin (Rajput and Haribabu, 1985). The fruit size of Sweet Orange significantly influenced the sugar content and vitamin C because it has been found out that Citrus fruits developed under excessive moisture, the juice tend to be "watery" and fruit oversized and putty. Fruit size of Mandarin has no influence on sugar content and vitamin C. this could be attributed to little variation in size of Mandarin and since the fruits are from the same tree, there might be little variation in water content. In the screen-house, the highest number of seedlings that emerge from the Sweet Orange seeds belonging to "very bold" category show that, the seeds were mostly poly-embryonic than those belonging to the 'small" category. The larger the embryo and the food stored, the more vigorous the germination and early establishment (Opeke, 1982). Moreover, the genetic make-up in Mandarin is likely to be the same, since the fruits were plucked from the same tree. Hence, the seed size did not significantly affect the seedling emergence and vigour. Moreover, large seeds may have many embryos each of which may not be as big as those that has lesser number of embryos. Therefore, resulting to non-differences in their vigour.

Conclusion

From the experiments, it could be observed that when fruits are to be selected for consumption, the consumer should take into consideration of his preference for either vitamin C or sugar is gotten from fruits of smaller sizes than vitamin C, when considering Sweet Orange fruits from various trees. When fruits are harvested for the purpose of extracting he seeds for planting, he fruits should be selected on the basis of size because apart from the fact that it may help in transferring other genetically advantageous characters like juice quantity and quality, it may also affect the seeds. Large seeds when planted will lead to high number of seedlings and also improves the seedling vigour, especially when the seedlings are to be budded. However, small seeds could be used as seedling materials if the genetic-make-up of all the seeds are the same.

References

Adebisi, M.A., (2004): Variation, stability and correlation studies in seed quality and yield componenents of sesame (Sesamum *indicum* L.). Ph.D. Thesis, University of Agriculture, Abeokuta, Nigeria.

Adebisi, M.A., Kehinde, T.O., Ajala, M.O., Olowu, E.F., and Rasaki, S. (2011): Assessment of seed quality and potential longevity in elite tropical soybean (*Glycine max* L.) Merrill grown in Southwestern Nigeria. Niger. Agric. J., 42: 94-103.

Alice, P. C., Dede and Varma, A., (1987): Citrus scab diseases in Nigeria. The J. of Hort. Sci. Volume 62: 111-116.

Barua, D. N., (1960): The significance of seed-size in cultivated Tea (*Camellia sinensis L.*). The Empire J. of Exp. Agric. 29: 143.

Jensen, E. H., Frelich, J. R., and Gifford, R. O., (1972): Emergence of force of forage seedlings. Agro. J. 64: 635-639.

Jerlin, R., and Vadivelu, K.K., (2004): Effect of fertilizer application in nursery for elite seedling

production of pungam (*Pongamia pinnata* L. Picrre). J. Trop. Agric. Res. Extension, 7: 69-71.

Johnson, E. D., (1980): successful seed program: A planning and Management Guide. West view Press, Inc. USA. Pp.302.

Ojo, D.K., (2000): Studies on soybean seed quality and longevity improvement in the humid tropics. Ph.D Thesis, University of Agriculture, Abeokuta, Nigeria.

Opeke, L.K., (1982): Tropical Tree Crops. John Wiley and Sons Ltd. New York. Pp.312.

Rajput C.B.S., and Haribabu, R.S., (1985): Citriculture. Kalyani Publishers, New Delhi, India. Pp.368.

Rice, R. P., Rice, L. W., and Tindall, H.D., (1987): Fruit and Vegetable Production in Africa. Macmillian Press Ltd. London. Pp.371.

Samson, J. A., (1986): Tropical fruits. 2nd edition. Tropical Agricultural series. Longman Singapore Publishers Ltd. Pp.336.

Singh[1], A. R., and Singh[2] B., (1991): performance of Lemon (*Citrus limon Burm*) Cultivars in the Gangetic Plains of Northern India. Scientific Horticulture 1. Scientific Publishers, India. Pp. 23-27.

Trivedi, M. L., and Bhatt, P. H., (1994): The Physioclogy of seed germination in groundnut (*Arachis hypogeal*). Cultivar. GG-2.1. effect of seed size. J. of Agro. and Crop Sci. 172 (4):265-268.

William, C. N., and Chew, W. Y., (1980): Tree and Field Crops of the Wetter Regions of the Tropic. Longman Group Ltd. Pp.265.