EFFECT OF CASHEW (*ANACARDIUM OCCIDENTALE* L) NUT SIZE ON NURSERY AND FIELD PERFORMANCE

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Abstract

Cashew germination and seedling vigour as influenced by the nut size was investigated in the nursery as well as on the field, using small, medium and large sized nuts categories. The study which was carried out at the Kogi State University, Anyigba Faculty of Agriculture (Longitude: 7^0 43^1 E, Latitude 7^0 6^1 N), in the Southern Guinea Savanna ecological zone, Nigeria investigated the response of varying cashew nut size (small 5.0 – 6.9 g/nut, medium 6.0 – 7.9 g/nut and large 8.0 – 9.9 g/nut) to seedling emergence, growth and development in the nursery, while seedlings which were sown out into the field in February, 2017 after been in the nursery for 6 months were investigated for field establishment, growth parameters, days to flowering and commencement of fruiting. The results obtained showed that small-sized nuts compared favourably with large-sized nuts, while superseding medium-sized nuts both in the nursery as well as on the field for most of the studied parameters in nursery as well as on the field. These nuts (small-sized) were not at any disadvantage in respect to their ability to germinate when compared with other sizes investigated. Instead they showed the highest average percentage germination in the nursery (100%), while large-sized nuts recorded the lowest average germination percentage (84.62%), as compared to the other treatments. This outcome reveals that contrary to previous deductions on small nuts, small small-sized nut did not negatively influence nut's days to germination, total percentage germination, nor seedling establishment on the field though affected earliness. The superiority of larger nuts was however observed in the field (height, girth, earliness), regarding parameters studied. The goal of the grower should then determine the choice of nut size selected for planting, but uniformity among nuts should be maintained.

Keywords: *germination, height, stem-girth, main branches and days to flowering*

INTRODUCTION

While germination of seed of higher plant may be regarded as that consecutive number of steps which causes a quiescent seed, with low water content, to show a rise in its general metabolic activity and to initiate the formation of seedling from the embryo, seedling emergence is defined by the surfacing of the radicle above the soil surface. Seedling emergence is a product of many factors, among which are the ability of the seed to initial sprout, depth of seed placement (Oyewole and Ibikunle, 2010), seed placement (positioning) (Oyewole and Ibikunle, 2010), amount of food reserve available to embark on the journey from the point of placement and emerging above the soil surface, avaiblable oxygen below the soil for respiration, photo-tropic nature of the plant, among other factors. The process of seed germination leads to development of embryo into seedling. Mayer and Poljakoff-Mayber (1963) observed that the size and shape of seeds is extremely variable, depending on the form of ovary, the condition under which the parent plant is growing during seed formation, amount of endosperm present, to what extent other tissues participate in the seed structure and, obviously, on the species. Noting that normal seed contains materials which it utilize during the process of germination.

One of the reasons for heterogeneity in nursery stocks is the high variation in size and weight of nuts sown. Variation in the seedling size could be avoided to a great extent if nuts of uniform grade could be used in nursery sowing (Ajeesh *et al.,* 2014; Vidyasagaran *et al.,* 2014a,b; Vidyasagaran *et al.,* 2015). Grading of seeds based upon their size and weight is a common practice in majority of plant species as it has been found to regulate the germination, seedling emergence and subsequent seedling growth in such species. Nuts are vital to the propagation of the cashew plant (FAO, 2007). However, the germination of viable seed nuts is a product of many variables, but of significant importance is water imbibitions, which depends among other factors on seed size, the level of water available in the

seed; this determines the 'thirst' for water and lastly the permeability of the seed nut coat (Oyewole and Ibikunle, 2010). The major activities of growth of seedlings involve the establishment of root and shoot tissues for autotrophism. This is accomplished through stored food energy and primarily influenced by the soil environment (Nelson and Larson, 1984). In cashew nuts, the cotyledons of the seedlings have been reported to serve as repository of all classes of nutrients and minerals (Opeke, 2005). The cotyledons in conjunction with soil nutrient reserves provide sources of nutrients for germinating.

Field establishment of the crop starts from the nursery. Good performance of seedlings in the nursery translates into good and encouraging field establishment of crops (Brown, 1984). Top soil, which happens to be one of the requirements for the production of seedlings in the nursery, has become a competitive material due to high demands for construction of buildings. This had led to the use of different types of soils, especially sub soil with shallow nutrient status compared to the top soil, for raising seedlings in the nursery. This might have led to reduced performance of the seedlings in the nursery and could have corresponding effects on the plant's performance after transplanting into the field (Brown, 1984). This might have contributed to the earlier observations that cashew does not perform well after being transplanted into the field (Adenikinju *et al.,* 1996), whereas lack of understanding of the growth pattern of the crop seedlings in the nursery (Hammed, 2008) and its poor growth conditions in the nursery, might have been translated into poor field establishment of the crop after transplanting into the field. Besides, the earlier belief that cashew flourishes in soils where most other crops fail (Ohler, 1979) might have again contributed in no small measure to the problem.

In cashew, the size of nuts sown had been reported to have significant influence on the morphological growth performance of the seedlings in the nursery (Adebola, *et al.,* 1999) and they therefore recommended the use of bigger nut sizes rather than smaller nut sizes for raising cashew seedlings for plantation establishment. Besides, Hammed (2008), found that the size of cashew nuts sown, do not only influence the morphological growth performance of seedlings, it also affects dry matter yield in favour of bigger nut size.

MATERIALS AND METHODS

Experimental area

Kogi State, Nigeria in the Guinea savanna agro ecological zone has a bimodal rainfall with peak pattern occurring in July and September. The mean annual rainfall is 1,808 mm at Anyigba (Amhakhian *et al.,* 2012), which is the study area. Temperatures show some variations throughout the year; with monthly temperatures varying between 17^{o}C to 36.2^{o}C. Relative humidity is moderately high and varies from an average of 65 - 85% throughout the year (Amhakhian *et al.,* 2012), with a clear distinctive wet and dry seasons. There is usually a short dry spell in August which is referred to as "August Break", while the dry season commences in November through early March.

Nursery operations

Soil collection and poly bags filling

Top soil 5 - 9 cm depth was collected from fallow farm land around the Faculty of Agriculture, Kogi State University, Anyibga, Kogi State, Nigeria. The soil was freed of extraneous materials: plant roots, weed seeds and pebbles, then filled into polythene bags of size 22 x 15 cm to 2.5 cm from the brim to allow for watering.

Nut collection and grading

Nuts of current season were obtained from a six year old cashew plant, graded into large 8.0 – 9.9 g/nut, medium 6.0 – 7.9 g/nut and small 5.0 – 6.9 g/nut (see fig. 1a,b&c below). Each grade was aportioned thirteen marked nuts giving a total of thirty nine (39) nuts.

Nut sowing

Nuts were sown 4 - 5cm deep with concave end upward into polythene bags of size 22 x 15cm placed under pavilion shade and regularly watered.

Treatment and experimental design

The experiment consisting of three nut sizes (large, medium and small) was laid out in a Randomized Complete Block Design (RCBD) with five replications.

Data collection and analysis

Percent germination: Number of nuts that germinated over time expressed in percentage.

Plant height (m): This involves measuring the length of the plant from the ground level to the epical bud.

Number of main branches: This was determined by counting the branches on the stem.

Stem girth (m): This was determined using either a calipers or a measuring tape held just above the ground level.

Height of the first branch: This was determined by measuring from ground level to the first branch.

Days to first flowering: Obtained by counting the number of days it took for the appearance of first flower

Data collected were subjected to analysis of variance (ANOVA) and treatment found to be statistically significant at 5% probability were separated using Least Significant Difference (LSD).

RESULT

Nursery operation

Generally, germination responded significantly ($p \leq 0.05$) to nut size investigated (Table 1). However, germination commenced for all nut sizes 12 days after sowing, with large and small sized nuts at par recording 15.38 percent germination while medium sized nuts recorded 7.69 percent germination (Table 1). This latter treatment continues to lag behind until 20 days after sowing when it overtook large sized nuts, but not small sized nuts. At the end of data taking (21 days), small sized nuts recorded 100 percent germination, while medium nuts recorded 92 percent to follow closely, with large nuts recording 77 percents. The results obtained showed that small sized nuts compared favourably with large nuts, while superseding medium size nuts throughout the experimental period, an indication that these nuts were not at any disadvantage in respect to ability to germinate when compared with other sizes investigated.

The germination of viable nuts is a product of many variables, of significant importance is water imbibitions, which depends among other factors on seed size (Oyewole and Koffa, 2010), the level of water available in the seed (this determines the thirst' for water), the permeability of the seed nut coat, which varies with seed coat thickness, integument composition, water availability in the environment as well as seed physiological condition in storage. Any of these numerous factors may have played out in the observed outcome leading to better performance in small sized nuts (100 percent germination), followed by medium sized nuts (92.00 percent), while large sized nut yielded 84.62 percent at the close of data collection. The result however contradicts previous reports by Ibikunle and Komolafe (1973); Faluyi, (1986) and Adebola *et al*. (1999) that large cashew nuts had superior germination compared with small nuts.

Nut size did not significantly ($p \geq 0.05$) influence height of plants in the nursery within the period of data collection, nor did it influence significantly number of branches produced, stem girth and number of leaves produced (Tables 2, 3, 4 and 5). The implication of this outcome could imply that effect of nut size on growth may not show out at the early stages of cashew growth – observing that previous reports opined that nut size of cashew is a direct reflection of the size of cotyledons contained and that

there is superior performance in quantitative plant vigour of cashew seedlings raised from larger nut-size (Adebola *et al*., 1999; Offiong, 2008; Simmone *et al*., 2009). Noting that large nuts possess higher nutrient reserves which it use for superior plant growth vigour.

Field operation

Nut size did not influence seedling establishment on the field, as 100 percent establishment was observed for all nut size. From the result obtained nut-size significantly influenced some growth characters such as plant height (Table 7) and stem girth (Table 8), but not the number of main branches (Table 9) and height of base branch (Table 10). Months / Days to first flowering (Table 11) was also not influenced by nut size. In all the parameters investigated, small-sized nut out performed medium-sized nuts, often favourably comparing with large-sized nuts in outcomes.

Table 1. Germination percentage as affected by nuts size

Nut size	**Day / Percentage germination**									
	12	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
Large	15.38	30.77	46.15	69.23	76.92	84.62	84.62	84.62	84.62	84.62
Medium	7.69	15.38	23.08	30.77	38.46	61.54	69.23	84.62	92.00	92.00
Small	15.38	30.77	46.15	61.54	69.23	84.62	100.00	100.00	100.00	100.00
LSD	2.1	2.3	3.4	2.6	5.2	3.3	4.1	4.1	3.7	2.8
Significance	**	**	**	**	**	**	**	**	**	**

Table 2. Mean plant height (cm) weeks after sowing (WAS)

Nut size	**Week / Plant height (cm)**						
	4	**6**	**8**	**10**	**12**	**14**	**16**
Large size	15.28	17.25	19.27	22.60	26.87	30.51	33.44
Medium size	14.99	19.08	20.50	22.53	26.66	30.11	33.00
Small size	17.18	20.18	21.40	20.25	26.34	29.97	32.34
Significance	NS	NS	NS	NS	NS	NS	NS

Table 3. Mean number of branches weeks after sowing (WAS)

Nut size	**Number of Branches**						
	4	**6**	**8**	**10**	**12**	**14**	**16**
Large size	0.00	0.00	0.46	0.62	0.62	0.69	0.85
Medium size	0.00	0.00	0.23	0.69	0.77	0.77	0.77
Small size	0.00	0.00	0.54	0.77	0.85	1.15	1.15
LSD	NS	NS	NS	NS	NS	NS	NS

Table 4. Mean stem girth (cm) weeks after sowing (WAS)

Nut size	Stem girth (cm)						
	4	6	8	10	12	14	16
Large size	0.27	1.08	1.09	1.15	1.17	1.17	1.19
Medium size	0.23	1.43	1.47	1.47	1.47	1.48	1.49
Small size	0.26	1.52	1.55	1.57	1.58	1.60	1.64
LSD	NS	NS	NS	NS	NS	NS	NS

Table 5. Mean number of leaves weeks after sowing (WAS)

Nut size	Number of leaves WAS						
	4	**6**	**8**	**10**	**12**	**14**	**16**
Large size	0.69	4.38	6.85	10.15	10.54	11.92	12.77
Medium size	0.46	5.15	7.46	11.38	13.15	16.25	17.54
Small size	0.69	5.46	10.46	14.69	15.62	18.15	19.54
LSD	NS	NS	NS	NS	NS	NS	NS

Table 6. Effect of nut-size on plant height (m) in the field

Nut size	Plant height (m)				
	Sept. 2018	**Oct. 2018**	**Nov. 2018**	**Dec. 2018**	**Jun. 2019**
Large size	3.88	3.92	4.04	4.16	4.80
Medium size	3.62	3.74	3.81	3.93	4.07
Small size	3.75	3.80	3.96	4.06	4.70
LSD	0.082	0.061	0.056	0.247	0.502
Significance	**	**	**	**	**

Table 7. Effect of nut-size on stem girth (m)

Nut size	Stem girth (m)				
	Sept. 2018	**Oct. 2018**	**Nov. 2018**	**Dec. 2018**	**Jun. 2019**
Large size	0.27	0.30	0.32	0.34	0.38
Medium size	0.20	0.23	0.27	0.30	0.30
Small size	0.25	0.27	0.30	0.31	0.33
LSD	0.014	0.018	0.019	0.016	0.013
Significance	**	**	**	**	**

Table 8. Effect of nut-size on number of main branches

Nut size	Number of main branches				
	Sept. 2018	**Oct. 2018**	**Nov. 2018**	**Dec. 2018**	**Jun. 2019**
Large size	2.00	3.20	4.40	4.68	4.68
Medium size	1.30	1.90	2.23	3.31	3.31
Small size	1.60	2.40	3.10	3.50	3.50
Significance	NS	NS	NS	NS	NS

Table 9. Effect of nut-size on height of first branch

Nut size	height of first branch (m)				
	Sept. 2018	**Oct. 2018**	**Nov. 2018**	**Dec. 2018**	**Jun. 2019**
Large size	0.35	0.35	0.35	0.35	0.35
Medium size	0.20	0.20	0.20	0.20	0.20
Small size	0.26	0.26	0.26	0.26	0.26
LSD	0.08	0.08	0.08	0.08	0.08
Significance	NS	NS	NS	NS	NS

Table 10. Effect of nut-size on flowering

Nut size	Number of months / days to first flowering
Large size	31.20
Medium size	32.00
Small size	32.05
LSD	NS

That large-sized nuts recorded significantly the tallest average height on the field may not be unconnected with availability of more food reserves for early growth. This observation is similar to the one made by Offiong (2008), who reported that seeds with large dimensions are likely to have large embryo which enhances good growth and development. Oni and Bada (2010) also reported that seed from large nuts showed better germination and growth than seed from small nuts. They further reported that seed nut – size can be used as a parameter for predicting germination and seedling growth rate both in the nursery and a brief period following establishment. On a similar note, Simmone *et al*. (2009) reported that size of nut seed has a strong influence on germination as well as growth biomass increment of a plant.

CONCLUSION

The results obtained showed that small sized nuts compared favourably with large nuts, while superseding medium-sized nuts both in the nursery as well as on the field for most of the studied parameters. These nuts were also not at any disadvantage in respect to their ability to germinate when

compared with other sizes investigated. The observations contradict previous reports that size of nut seed has a strong influence on germination as well as growth biomass increment of a plant.

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