Effect of Storage, Size of Nut and Soaking Length on Sprout Emergence in Cashew

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Abstract

Study carried out at the Kogi State University, Faculty of Agriculture, Anyigba in the Southern Guinea Savanna ecological zone, Nigeria investigated the response of sprouting in cashew nut to storage length, nut size, nut soaking and their interactions. Three storage periods (0, 2 and 4 weeks), nut size (large, medium and small) and four soaking periods (0, 12, 24 and 36 hours) were investigated. Contrary to the non significant ($p>0.05$) effect of nut storage on days to sprout emergence, nut size significantly ($p<0.05$) influenced days to sprout emergence, with the least days to nut sprouting observed in small nuts, while large nuts were the last to sprout. Sprout also responded positively to soaking length. Interaction effects revealed significant interactions between nut storage and nut size; nut storage and nut soaking; nut size and nut soaking on sprouting in cashew. Pre-soaking nuts in water for 24 or 36 hours before sowing was observed to give the best result for soaking treatment. Pre-soaking nuts for 24 to 36 hours is therefore recommended for farmers involved in raising cashew crop, as this gave the least mean day to sprout emergence.

Keywords: *Anacardium occidentale*, storage length, seed size, soaking, sprout emergence

Introduction

The cashew plant, *Anacardium occidentale*, which is now grown in many parts of the world including Nigeria, is native to Central and South America with its main centre of variation in eastern Brazil (Ohler, 1979; FAO, 2001; Udoh et al., 2005; FAO, 2007). Annual world production of cashew nut; the main commercial product of the cashew plant, is put at over 1.2 million tonnes, with India topping production, followed by Mozambique and Tanzania (FAO, 2001; Udoh et al., 2005; FAO, 2007). In addition to the nuts, cashew nut shell oil is obtained from the nut pericarp; the cashew apple is a valuable source of raw material for the manufacture of both soft and alcoholic drinks and as livestock feed ingredient after the extraction of the juice; the roots and young leaves are used as herbal remedies in the treatment of malaria, while the sap from the bark provides indelible ink and the exudates is useful as adhesive (Udoh et al., 2005).

Cashew, as a crop plant that is very tolerant of poor soils, low soil moisture content and low rainfall, has proven to be a good cash crop in area where other tree crops produced little or nothing. It is less selective and demanding in terms of soils type and fertility requirements compared with other plantation crops, thereby having wide adaptability (Udoh et al., 2005). It has great potentials as a foreign exchange earner and source of industrial raw material.

Seed nuts are vital to the propagation of the cashew plant (Udoh et al., 2005; FAO, 2007). The germination of viable seed nuts is a product of many variables, but of significant importance is water imbibition, which depends among other factors on seed size (Turner, 1956; Auckland, 1961; Ibikunle and Komolafe, 1973), the level of water available in the seed; this determines the 'thirst' for water and lastly the permeability of the seed nut coat.

Cashew nuts possess thick seed coat thus requiring considerable time for water imbibition to prompt nut germination. Slow imbibition of dry intact seed nuts is reported to be the main cause of delayed germination in cashew (Subbaiah, 1983), a problem which is greatest in the larger seeds (Turner, 1956; Auckland, 1961; Ibikunle and Komolafe, 1973). However, early germination can be induced by the following means: cracking the seed nut coat: a delicate operation which must be carried out with care to avoid damage to the embryo; treatment with dilute sulphuric acid (H_2SO_4); soaking in water for 24 to 36 hours (Turner, 1956; Auckland, 1961; Ibikunle and Komolafe, 1973). Pre-soaking for 1 or 2 days (Rao et al., 1957a, 1957b; Ibikunle and Komolafe, 1973) or the removal of the waxy layer of the pericarp by treating with chloroform or acetone (Subbaiah, 1983), which was observed to promote imbibition and reduce the time taken to germinate and increase the proportions of seed nuts germinating. Light (Rocchetti and Panerai, 1968; Rocchetti and Panerai, 1970; Adams, 1975) and gibberellins (Ayfer and Serr, 1961; Shanmugavelu, 1970; Dahab et al., 1975) are also reported to promote germination in cashew seed nuts.

This experiment therefore, addressed the following objectives: (1) Evaluation of length of nut storage on nut viability, (2) Evaluation of nut size on sprouting and seedling vigour, (3) Evaluation of length of nut soaking on nut sprouting.

Materials and Methods

Experimental Area

The study was carried out between February and June, 2009 at the Faculty of Agriculture, Kogi State University Green House (Longitude 7° 06′ N: 6° 43′ E), Anyigba in the Southern Guinea Savanna ecological zone of Nigeria.

Collection of Nuts

Nuts of current season with no sign of damage, insect pest attack or disease symptoms collected from a single mother tree in the Faculty of Agriculture, Kogi State University, Anyigba, Kogi State, Nigeria were used in the trial.

Soil Collection and Poly Bags Filling

Top soil 5-9 cm depth was collected from fallow farm land around Faculty of Agriculture, Kogi State University, Anyigba, Kogi State, Nigeria for the trial. Soils were freed of extraneous materials: plant roots, weed seeds, and pebbles. The soil was then filled into poly bags of size 25x15 cm to 2.5 cm from the brim to allow for watering and placed under pavilion shade.

Nut Sowing

A nut was sown at 4-5 cm depth with concave end upward into poly bag of size 25x15 cm placed under pavilion shade and observed daily for emergence of sprout. A total of 108 nuts were sown, divided evenly among the various sizes investigated (36 nuts each).

Treatment

Treatments investigated were storage length, nut size and soaking period and their interactions.

Storage length: Three storage lengths were investigated (0, 2, and 4 weeks after nut gathering). The nuts, packed into jute bags, were stored at ambient temperature, after adequate sun drying, for the stipulated time periods.

Nut Size: Cashew nuts were visually graded according to size into large, medium and small, with nuts size ranging between 8-11.9 g nut^{-1} for large nuts, while medium nuts ranged between 4.0-7.9 g and small nuts between 2.0-3.9 g nut^{-1}.

Nut Soaking: Four soaking periods were investigated: soaking in one liter of borehole water for 12, 24 and 36 hours, in addition to the control. Borehole was the main water source, thus its usage.

Experimental Design

The trial a split-split plot design with three replications had storage as main plot factor, while seed size was a sub plot factor and soaking the sub-subplot factor. All treatments were replicated three times.

Data Collection/Days to Germination

Data were collected on days to sprout emergence, sprouting percentage; as a ratio of number of nuts sown relative to nuts that sprouted,

data was also collected on seedling vigour as a measure of height gained over a given time, plant gilt, number of leaves at the time of the termination of the trial, leave area and number of formed branches. However, the only reported parameter is on days to sprout emergence.

Data Analysis

Data generated were subjected to analysis of variance using SAS statistical package (SAS Institute, 1996) as described for split-split plot design. Treatments means found to be statistically significant ($p<0.05$) were compared using appropriate comparative tools (Least Significance Difference for main treatment means, or Standard Error of Means for the means of interaction effects).

Results and Discussion

Effect of Nut Storage on Days to Sprout Emergence

The least mean-day to sprout emergence was observed when nuts were stored for 2 weeks (26±9.7), the control treatment (no storage), gave a mean-day to nut sprouting of 27±8.2, while storing nuts for 4 weeks recorded 27±3.8 days to sprout emergence. However, the least standard deviation (±3.8) was recorded when nuts were stored for 4 weeks, thus implying that the treatment gave better convergence of sprout emergence. No significant statistical differences were, however, observed between the storage lengths investigated as they affect mean-day to sprout emergence in cashew plant (Table 1). This observation reported is within the limit of the length of storage (0-4 weeks) investigated. It may not be unlikely to observe a different outcome with longer nut storage, as some authors have observed different outcome with longer storage lengths.

Effect of Nut Size on Days to Sprout Emergence

Contrary to the non significant effect of nut storage, on mean-day to sprout emergence, within the limit of the storage length investigated (0-4 weeks), nut size significantly ($p<0.05$) influenced days to sprout emergence, with the least, days to sprout emergence being observed in small nuts (26±6.7), while the large nuts were the last to sprout (28±8.1 days). There were however, no significant differences between small and medium sized nuts (with a mean day to sprout emergence of 27 days) in respect of days to sprout emergence, or between medium nuts and large nuts in respect of this parameter (Table 1).

Usually, slow imbibition of dry intact seeds is the main cause of delayed germination in cashew (Lemaistre, 1959; Nimadzhanova et al., 1977; Subbaiah, 1983), with the nut covering structures and epicarp presenting a formidable barrier to embryo growth and germination (Joley, 1960), and the endocarp reducing the rate of imbibition (Crane and Forde, 1974), a problem, which was reported to be greatest in the larger seeds (Turner, 1956; Auckland, 1961; Ibikunle and Komolafe, 1973; Maggs, 1973; Crane and Forde, 1974; Casini and Conticini, 1979). These factors may have been responsible for the observed delayed in sprout emergence with increase in nut size from small to large nuts.

Table 1 Effect of length of nut storage, nut size and length of soaking on mean days to sprout emergence.

Treatment	Days to sprout emergence[1/]	SD
Nut storage		
0 week	27	8.2
2 weeks	26	9.7
4 weeks	27	3.8
SD (4 d.f.)	1.1	
Nut size		
Small Nut	26b	6.7
Medium Nut	27ab	11.7
Large Nut	28a	8.1
SD (12 d.f.)	1.3	
Nut soaking		
0	28	8.6
12 h	28	8.0
24 h	25	5.8
36 h	25	12.6
SD (54 d.f.)	1.8	
CV %	24.8	

[1/] Treatment means followed by different letters are statistically significant at 5% probability level.

The implication of this outcome is that large seed nuts which are more desirable to farmers than small seed nuts because they are usually more vigorous when sown are likely to sprout last due to the presence of thicker seed nut coat (Maggs, 1973; Crane and Forde, 1974; Casini and Conticini, 1979). However, early sprouting can be induced by thinning down or cracking the seed coat (Turner, 1956; Auckland, 1961; Ibikunle and Komolafe, 1973) or to remove the waxy layer of the pericarp by treatment with chloroform or acetone (Subbaiah, 1983), which will further promote imbibition and reduce the time taken to germinate and increase the proportions of seeds germinating. In this way farmers will ensure early sprouting while enjoying the benefits of sowing large seed nuts.

Effect of Nut Soaking on Days to Sprout Emergence

Soaking nuts in water significantly ($p<0.05$) reduced days to sprout emergence as compared with the control (Table 1). The least days (25 days) to sprout emergence was recorded when nuts were pre-soaked in water for 24 or 36 hours before sowing, while pre-soaking nuts for 12 hours was not significantly different from the control treatment, with a record of approximately 28 days to sprout emergence.

In previous research, Amoah (2005), while researching into the germination and early growth of cashew, observed that Cashew seeds soaked in water for 24 hour and sown at 4cm depth gave better germination and growth than cracked seeds or those sown at 8 or 12 cm. Pre-soaking nuts for 24-48 hours (Turner, 1956; Auckland, 1961; Kravchenko, 1961; Hartmann, 1967; Joley and Opitz, 1971; Ibikunle and Komolafe, 1973; Crane and Forde, 1974) was reported to promote imbibition and reduce the time taken for seeds to germinate and increase the proportions of seeds germinating. The out come of this research is therefore in line with previous findings as reported above.

Interaction Effects on Days to Nut Sprout in Cashew

Analyzed data revealed significant interactions ($p<0.05$) between nut storage and nut size (Table 2); nut storage and nut soaking (Table 3); nut size and nut soaking (Table 4) on sprout emergence in cashew plant. The three way interaction (storage x nut size x nut soaking) was however, not significant (Table 5).

While nut storage tends to improve early sprout emergence in large nuts compared with the control, no such improvement was observed in medium or small nuts with storage (Table 2). Non storage of nut before sowing gave mean days to sprout emergence of 28 days for large nuts while medium and small nuts recorded 26 days to sprout emergence. When nuts were stored for two weeks before sowing large nuts still recoded the longest time to sprout emergence, however, storing large nuts for four weeks, days to sprout emergence compared with small nuts stored for the same length of time, which recorded the least mean days to sprout emergence. Pre-soaking non stored nuts for 36 hours gave the best response to sprout. The same treatment gave the best response when nuts were stored for four weeks, while 24 hours pre-soaking treatment gave the best response when nuts were stored for two weeks, however not significantly different from 36 hours treatment (Table 3).

Table 2 Length of nut storage and nut size interaction effect on meandays to sprout emergence.

Treatment	Days to sprout emergence[1/]		
	Large nut	Medium nut	Small nut
Storage x Nut size			
0 Week	28ab	26ab	26ab
2 Weeks	29a	26ab	24b
4 Weeks	26ab	28ab	26ab
SD (16 d.f.)		2.1	

[1/] Treatment means followed by different letters are statistically significant at 5% probability level.

Table 3 Storage and nut soaking interaction effects on mean days to sprout emergence.

Treatment	Days to sprout emergence[1/] (h)			
	0	12	24	36
Storage x Nut soaking				
0 Week	29ab	30a	25ab	23b
2 Weeks	26ab	26ab	25ab	27ab
4 Weeks	28ab	27ab	27ab	25ab
SD (16 d.f.)		2.1		

[1/] Treatment means followed by different letters are statistically significant at 5% probability level.

Table 4 Nut size and nut soaking interaction effects on mean days to sprout emergence.

Treatment	Days to sprout emergence[1/] (h)			
	0	12	24	36
Nut size x Nut soaking				
Large Nut	32a	27abc	24abc	28abc
Medium Nut	26abc	30ab	28abc	22c
Small Nut	26abc	26abc	25bc	25bc
SD (66 d.f.)		3.0		

[1/] Treatment means followed by different letters are statistically significant at 5% probability level.

Table 5 Storage, nut size and nut soaking interaction effects on mean-days to sprout emergence.

Treatment		Days to sprout emergence[1/] (h)			
Storage x nut size x nut soaking	Nut size	0	12	24	36
0 Week	Large	35	31	23	23
2 Weeks	Medium	25	31	26	21
4 Weeks	Small	27	29	26	24
0 Week	Large	31	25	24	36
2 Weeks	Medium	24	29	27	22
4 Weeks	Small	24	24	24	24
0 Week	Large	29	26	25	24
2 Weeks	Medium	29	31	30	24
4 Weeks	Small	27	26	24	28
SD (68.58 d.f.)				5.1	

[1/] Treatment means followed by different letters are statistically significant at 5% probability level.

The problem of slow imbibition of dry intact seeds (Lemaistre, 1959; Nimadzhanova et al., 1977) is said to be more pronounced in larger seeds (Maggs, 1973; Crane and Forde, 1974; Casini and Conticini, 1979) thus stressing the correlation between nut size and water inbibition. The thick shells in larger nuts pose greater obstacle to water uptake than in medium or small nuts. This factor must have been responsible for the significant interactions.

Conclusions

Trial conducted at the Faculty of Agriculture, Kogi State University, Anyigba, Kogi State, Nigeria in the Southern Guinea Savanna ecological zone investigated sprouting in cashew as affected by storage length, nut size and nut soaking in water. No significant differences were observed between the storage lengths and the control (within the limit of the length of nut storage) as it affects days to sprout emergence. It is however, not unlikely to observe a different out come with longer period of nut storage. Contrary to the non significant effect of nut storage, on days to sprout emergence, nut size significantly ($p<0.05$) influenced days to sprout emergence with small nuts being the first to emerge, while the large nuts where usually the last to sprout. In addition, soaking nuts in water significantly influenced ($p<0.05$) days to nut sprouting. Pre-soaking nuts in water for 24 or 36 hours gave the best result. Interaction effects revealed significant interactions between nut storage and nut size; nut storage and nut soaking; nut size and nut soaking as it affect sprouting in cashew.

In conclusion, pre-soaking nuts in water for 24-36 hours which was observed to reduce days to sprout emergence is recommended for farmers raising cashew seedlings from seed nuts. To achieve early nut sprout, sowing small nuts is recommended as this gave the least mean days to sprout emergence - there is however the problem of seedling vigour.

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