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Evaluating the Variability of Germination Pattern of Coconut Types

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ABSTRACT

Background: This study is meant to evaluate the variability in the germination pattern of the coconut types and the effect of climatic factors on their germination.

Methods: Matured seed nuts from 124 genotypes of the Green Dwarf (GD), Orange Dwarf (OD), Yellow Dwarf (YD) and Tall (T) ecotypes were sown in the nursery over a period of two years.

Results: Among the coconut types evaluated, YD had fastest emergence in 54.5 days while OD had the shortest duration of 32.5 days between the commencement and completion of emergence. Days to emergence was affected by the viability of the embryo and the climatic factors except rainfall. Humidity was the most important climatic factor required for the growth, and emergence of coconut embryo. It positively affected Days to Emergence (DE), Emergence Interval (EI), Twenty-five percent emergence (TFE) and Fifty percent emergence (FE) with high positive significant correlation unlike sunshine hours and temperature which had negative disposition to coconut emergence. With high sunshine hours, EI, TFE and FE increased which indicated that at high sunshine dominated periods, number of days to emergence increased as a result of high evapo-transpiration. Temperature had negative disposition on DE, EI, TFE and FE. At high temperature, emergence and germination depreciated and this translated to prolonged number of days to achieve TFE and consequently FE.

Conclusion: The YD and OD could be utilized to produce early germinating hybrid varieties. The seed nuts meant for sowing should be allowed to mature before harvesting. Seed nuts should preferably be under shade to maintain humid environment and irrigation should be provided to maintain humidity during off rain periods of planting.

INTRODUCTION

Coconut is a recalcitrant seeded crop whose embryo is peg-like or cylindrical and is embedded beneath the germ pore (the 'soft eye') of the shell and it never really stops growing (Ibrahim *et al*., 2022). This effectively makes the coconut viviparous (live-bearing). The embryo loses its viability if dried for storage (as in copra), it is therefore classified as a recalcitrant seed (Harris, 2012). The ripe fruit bunch, after harvesting does not germinate immediately. It has to undergo the process of curing which prepares the embryo for germination. It however loses viability if dried which is in contrast with the bunches of fruit retained in the crown of the palm that may in certain circumstances germinate to produce seedlings while still on the mother palm (Harries, 2012). Matured fruit can be harvested from the palm at 11th - 13th month after pollination and fertilization or when the skin of the husk begins to change colour (Odufale *et al*., 2021). The pericarp or outer most part of the seed nut covering the husk is glossy which do no not permit express entry of water into the fruit until certain level of biodegradation. Therefore, to increase the rate of moisture absorption into the planted seed nuts, it is preferable to remove a thin slice of the husk or create cavity in the husk to receive moisture (Ugba and Akpan, 2003).

The embryo and emerging organs rely completely on the liquid and solid endosperm for moisture, food and energy prior to shoot emergence and formation of leaves (Fernanda *et al*., 2022). Henderson 2006 identified three types of germination and emergence pattern in palms which are: remote tubular, remote ligular and adjacent ligular. Coconut embryos have an adjacent ligular-type of germination, whereby the plumule emerges from the germ pore and continues to grow until it emerges from the mesocarp while the haustorium continues to grow and fill the endocarp cavity before the radicle eventually protrudes from the mesocarp. Although emergence in coconut has been defined biologically to have taken place when the embryo is stimulated and begins to grow to form haustorium. However, coconut growers defined germination as the emergence of the integument of the petiole (crow beak) from the husk (Fernanda *et al*., 2022). Germination in coconut is affected by the fruit and nut traits. Fruit weight, fruit length, volume of coconut water and polyphenol contents in the husk have positive correlation with germination rate whereas, the total soluble solvent (TSS) of nut water, husk thickness, husk weight and shell thickness were negatively correlated with germination (Harris 1981).

Germination and emergence of seed cannot take place devoid of the climatic factors. Crops, being active and important member of the ecosystem are faced with the effect of climate change just like every other members of the ecosystem. Countries especially in the sub-Saharan Africa and the Caribbean are mostly detrimentally affected by the reduction of crops suitable for cultivation as well as drop in yield. To minimize the impacts of these climate and other environmental changes, it will be crucial to breed new varieties for improved resistance to abiotic and biotic stresses Lane and Jarvis 2007.

MATERIALS AND METHODS

This study was conducted at the coconut nursery of the Nigerian Institute for oil palm research (NIFOR) Benin-City. NIFOR, is a tropical environment located on longitude 05^0 37' E, latitude 06^0 33' N and altitude of 149m above sea level. One hundred and twenty-four genotypes of the Orange Dwarf (OD), Green Dwarf (GD), Yellow Dwarf (YD) and Tall (T) varieties were involved. The study was conducted for two years. The seed nuts were harvested from each of the genotypes when few of the nuts in the bunches turn brown on the tree indicating maturity of the entire fruit bunch (Odufale *et al.,* 2021) and were thereafter stored in the seed store and allowed to cure (Ugba and Akpan 2003) before being transported to the nursery for sowing. Before sowing, there was partial removal of the face (husk) close to the point of attachment to the palm in order to increase the absorption of water and nutrient for the embryo's use (Fernando, 1993). The seed nuts were sown in regular rows on ground seed bed devoid of shade using sandy soil as substrate. The study was conducted with rain-fed irrigation as the primary source of water for the sown seeds. However, whenever there is no rainfall for consecutive eight days, the sown seeds were provided with water using hose-fed irrigation. The date of germination was noted and recoded as when the crow beak was noticed for each of the sown seed nut and this is regarded as the emergence date. Climatic data for the duration of the study was retrieved from the Institute's weather station.

Parameters Evaluated

Days to Emergence (DE): This was the number of days it took for the first crow beak to emerge in each set of the sown seed nuts.

Emergence Interval (EI): was the number of days between the first emergence and the last seed nut emergence in each of the sets of the sown seed nuts.

Days to Twenty-Five Percent Emergence (DTFE): is the number of days it took for twenty five percent of the sown seed nuts to emerge in each set of the sown seed nuts and

Days to Fifty Percent Emergence (DFE): is the number of days it took for fifty percent of the sown seed nuts to emerge in each set of the sown seed nuts.

Percentage Emergence (PE): The number of seed nuts that emerged in each of the sown set of seed nuts were expressed in terms of the total number of seed nuts sown per set and is regarded as the percentage germination (PG).

$$PE = \frac{\text{Number of emerged seed nut in the same set}}{\text{Total number of seed nuts sown per set}} \times 100$$

Statistical Analysis

The data was subjected to Descriptive Statistics and correlation analysis using SPSS Statistical software.

RESULTS AND DISCUSSION

Data evaluated for the descriptive statistics of the four coconut ecotypes (Green Dwarf (GD), Orange Dwarf (OD), Yellow Dwarf (YD) and NIFOR Tall (T)) indicated that YD had faster speed of emergence than the other ecotypes considered in this study accomplishing emergence at 54.5 days after sowing (Table 1). The GD, OD and T germinated at 70.0, 65.5 and 80.8 days after sowing respectively. On the other hand, the OD had the least number of days to complete and round up emergence after sowing. It took the OD 32.5 days to complete emergence after the first seed nut had germinated while GD, YD and T had complete emergence after 54.3, 41.3 and 34.7 days respectively from the emergence of the first seed nut.

Results from this study indicated that the dwarfs irrespective of the ecotype, emerged much quicker than the tall which can be attributed to the thinner husk and shell of the dwarf relative to the tall types. This result corroborates the findings of Harris (2012) and Shareefa *et al.,* (2014) who stated in different studies that thinner husked coconut emerged earlier than thicker husked types. However, the tall type, even though did not commence emergence quick enough compared with the dwarfs, had the highest emergence percentage (82.7%) among all the ecotypes (GD – 70.3, OD – 48, YD – 63.3) considered in this study (Table 1). This as well agrees with Fernando 1993 that tall coconut have higher germination percentage than the dwarf types and this can be partially attributed to higher water content of the tall coconut. In the Tall, desiccation of the nut and dehydration of the embryo is less likely to be observed because of the larger content of the liquid endosperm (coconut water) which nourishes and hydrates the embryo thus elongating its period of viability.

Rainfall and adjoining climatic factors are important factors to be considered when raising seedlings from coconut seed nuts. The embryo need moisture to grow and complete physiological maturity which was provided by the liquid endosperm. This was evident by the fact that rainfall does not have significant correlation with the number of days to germination (DE; $r = 0.01$, $p=_{NS}$) but affects the germination interval (EI; $= 0.32$, $p<0.01$) (Table 2) i.e. the number of days it takes for the set of sown seed nuts to complete germination, DTFE and DFE which were events that occur much longer after the liquid and solid endosperm might have been used up were affected by rainfall and are significantly positively correlated to rainfall ($r=0.27$, $p<0.05$) and ($r=0.40$, $p<0.01$) respectively. However, humidity seems to be the most important climatic factor required for the growth, development and germination of coconut seed nut embryo. Its effect was immense on the DE ($r=0.33$, $p<0.01$), EI ($r=0.44$, $p<0.01$), DTFE ($r=0.63$, $p<0.01$) and DFE (0.70, $p<0.01$) with high positively significant correlation unlike rainfall whose effect was only felt on DTFE and DFE (Table 2). At high humidity there would have been reduced stress on the developing embryo which enhanced rapid growth and development of the haustorium but low humidity caused the embryo to shrivel, dry up, or get deformed which resulted in the die back of supposed shoot (crow beak). This finding corroborates the results of Foale and Nair, (1993) who observed that humidity had high positive significant correlation with germination. He further stated that in as much as the humidity is 40%, and the embryo is viable, coconut seed nut will germinate.

It can thus be suggested that rather than wetting once in the day in the coconut nursery especially when indoor or covered nursery is not practiced, wetting or irrigation of the seed nuts should be done more than once in a day in order to maintain high humidity and thus indoor or covered nursery will be preferable to open air or outdoor coconut nursery especially during the off rain period. The percentage of seed nut that germinated was not affected by any of the climatic factors evaluated. It was rather influenced by other internal factors of the seed nut, probably the viability of the embryo at the time of planting which is in line with the findings of Ranasinghe *et. al.* (2010) who stated that meiosis is sensitive to high temperature and could affect the growth and development of the embryo. Also, Harris (1983) stated that coconut embryo continues to develop even after harvesting and as such, seed nuts should be allowed time to cure before sowing. Hence it is important to always allow seed nuts meant for propagation to mature properly before harvesting to reduce wastage of seed nut. However, the significant negative correlation coefficient between the PE and both of DTFE ($r = -0.32$, $p<0.01$) and DFE ($r = -0.41$, 0.01) indicated that the percentage of seed nut germination affected the number of days to achieve twenty-five percent and fifty percent seed nut germination. i.e. if the embryo in the seed nuts are allowed to mature properly, it will increase the PE and as well shorten the number of days to achieve DTFE and DFE which will reduce cost of irrigation during the off rain period and also improve the chances of embryo survival and number of seedling that can be raised.

On the other hand, unlike humidity that promoted and supported emergence and germination in coconut, sunshine hours and temperature had negative disposition to coconut germination. Sunshine hours had positive significant correlation with the DE ($r = 0.41$, p<o.01), DTFE ($r = 0.52$, $p<0.01$) and the DFE ($r = 0.53$, $p<0.01$). With high sunshine hours, DE, DTFE and DFE increases which indicated that at high sunshine dominated periods, number of days to achieve germination increases as a result of high evapo-transpiration and reduced available moisture affects number of days to germination spread among the sown seed nuts per lot which reflects in the DTFE and DFE. Similarly, temperature had negative disposition on DE (r = -0.26, p<0.05), GI (0.29, p<0.05), TFP (-0.27, p<0.05) and FP (-0.26, p<0.05). At high temperature, days to emergence increased and this translated to prolonged number of days to achieve DTFE and consequently DFE (Table 2).

Table 1: Mean and Standard Error of Germination Parameters of the Ecotypes

Type	DE	EI	DTFE	DFE	PE
GD	70.0±3.9	54.3±4.9	80.1±2.9	99.5±2.9	70.3±3.4
OD	65.5±7.5	32.5±9.5	72.5±14.5	106±10	48.0±4.0
YD	54.5±5.9	41.3±8.1	77.0±4.04	91.3±4.0	63.3±10.5
T	80.8±7.9	34.7±5.2	88.7±5.4	102.2±5.2	82.7±4.9

GD = Green Dwarf, OD = Orange Dwarf, YD = Yellow Dwarf, T = Tall, DE = Days to Emergence, EI = Emergence interval, DTFE = Days to twenty- five Percent Emergence, DFE = Days to fifty percent emergence, PE = Percentage emergence

Table 2: Correlation Analysis of the Germination Parameters and Climatic factors

	DE	EI	DTFE	DFE	PE	Rain	Sun	Hum	Tmp
DE	1								
EI	-0.50**	1							
DTFE	0.77**	-0.09	1						
DFE	0.60**	0.01	0.87**	1					
PE	-0.04	0.01	-0.32**	-0.41**	1				
Rain	0.01	0.32**	0.27*	0.40**	-0.08	1			
Sun	0.41**	0.19	0.52**	0.53**	0.04	-0.05	1		
Hum	0.33**	0.44**	0.63**	0.70**	-0.02	0.66**	0.58**	1	
Tmp	-0.26*	0.29*	-0.27*	-0.26*	0.19	-0.14	-0.07	0.06	1

*, **: Significant at 0.05 and 0.01 level of probability respectively
DE = Days to Emergence, EI = Emergence interval, DTFE = Days to twenty- five Percent Emergence, DFE = Days to fifty percent emergence, PE = Percentage emergence, Rain = Rainfall, Sun = Sunshine Hours, Hum = Humidity, Tmp = Temperature

CONCLUSION

The YD which showed prospect of early germination can be suggested to be included in early germination population improvement collections. Also, it should be adopted as base material in producing early germinating and early fruiting hybrid varieties. The fruit bunch meant for sowing should be allowed to mature before harvesting. Seed nuts when sown, should be sown preferably under shade to maintain humid environment and wetting in the off rain period should be done in the morning and noon to maintain humidity which is required for effective emergence and subsequently germination of seedlings.

Conflict of Interest

There is no conflict of interest in procedure or process during the period of this study

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