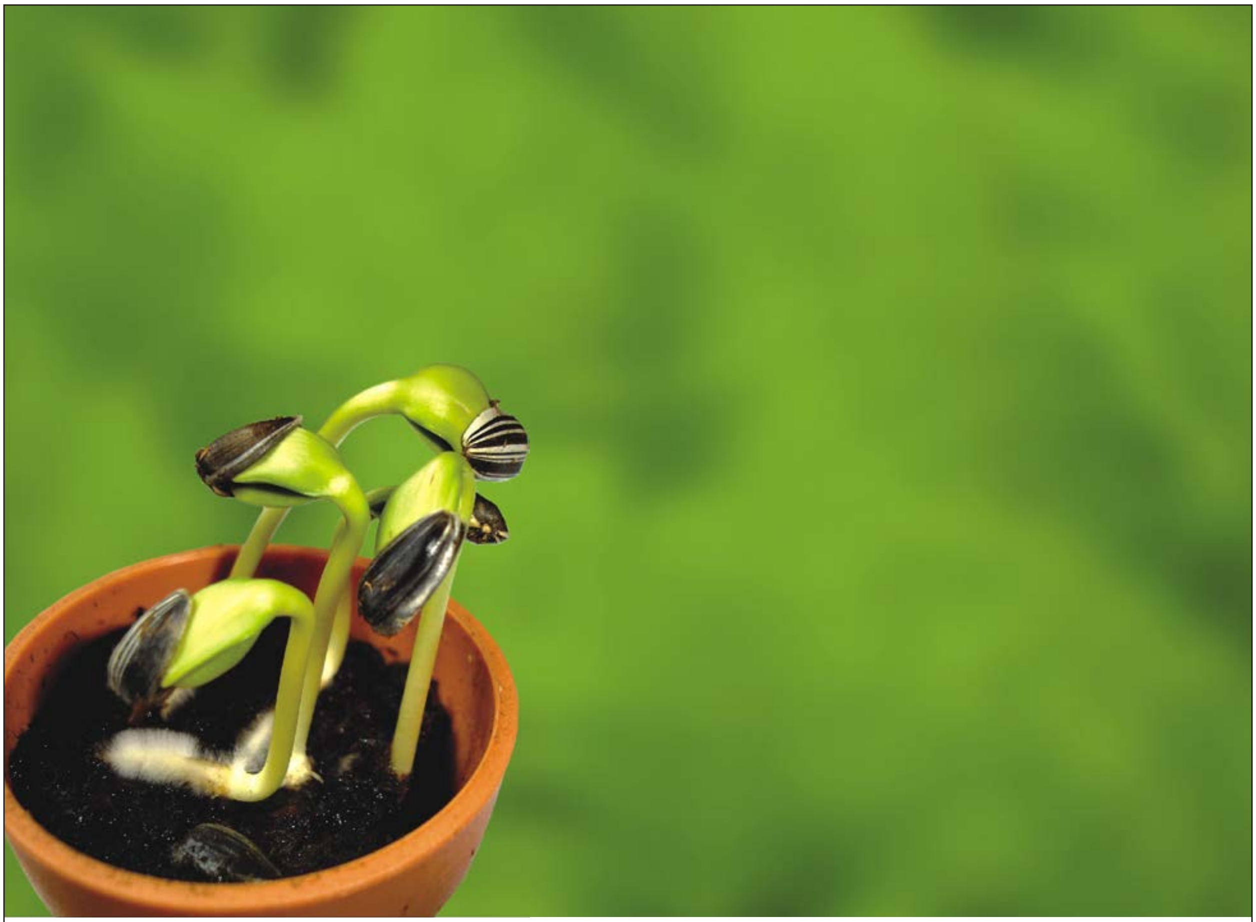

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Bunch and Nut Production of Surviving Coconut Palms in Lethal Yellowing Disease Endemic Area of Nigeria

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ABSTRACT

Until recently, bunch and nut yield has dominated the previous coconut breeding programmes in Nigeria. With the outbreak of Awka wilt Lethal Yellowing Disease (LYD), research focus in coconut breeding has been drastically changed due to decline in yield and the high susceptibility of the local land race, the West African Tall (WAT). Hence, the evaluation of the comparative performance of different coconut varieties surviving under natural field conditions in an LYD endemic area of Nigeria. Five coconut varieties (Malayan Green Dwarf (MGD), Malayan Yellow Dwarf (MYD), Malayan Orange Dwarf (MOD), WAT and Hybrid (HY) varieties) derived from the Nigerian Institute for Oil Palm Research (NIFOR) Tall and Exotic Malayan Dwarf parents were evaluated for bunch and nut production for a period of seven years. Data was subjected to simple measures of variability while the pattern of variation was deduced using Spearman's rank correlation coefficient. The results indicate that the surviving palms in the respective varieties are vigorous with the dwarf varieties showing more resistance to LYD when compared with WAT. However, WAT recorded the highest yield (8.1 and 63.7) for bunch and nut production, respectively. Very high variation ranging from 13.5-16.8% was observed for nut yield. Evidence of biennial rhythm was revealed among the palms across the years. The number of nuts/palm/year and bunch production/palm/year was highest in year 2007 with a range of 42.2-83.8 and 7.2-8.6, respectively. The distribution of the measured traits was very discrete in the WAT variety when compared to the other dwarf varieties. The rank correlation coefficient revealed very high significant positive coefficients for bunch and nut yield. Despite the relatively poor performance of the varieties, the high yielding palms would be used in crossing programme for the production of Breeders' Test Materials (BTM) for further testing whilst serving as a germplasm base for resistance breeding.

Key words: Resistance breeding, breeders' test material, germplasm, Spearman's correlation coefficient, frequency polygon

INTRODUCTION

Bunch production and the number of mature nuts produced per tree or per hectare are important agro-economic index in the evaluation of coconut (*Cocos nucifera* L.) yield or productivity. Notwithstanding the economic implications, most financial exchange in the coconut is paid for per nut (Ahmed *et al*., 2004). After initial bearing, economic nut production continues for over a period of 50 years. The production of nuts on coconut palms takes place in the bunch and bunch production is dependent on leaf formation. A vigorous coconut palm produces one mature bunch of coconut every month (Mathes and Marikkar, 2004). A palm producing more than 80 nuts per year is considered to be a high yielding palm (Nair *et al.*, 2003). Hence, the use of number of nuts produced per tree as an important standard or criteria for the selection of mother palms. Considering the economic potential of the coconut palm (Nair *et al.*, 2003; Geethalakshmi *et al.*, 2005), the growing domestic demand for the crop in Nigeria and elsewhere could not be met by the prevailing production levels characterized by diminishing trends. The declining productivity has been attributed to poor management practices, unselected planting materials, poor soil fertility and diseases (Nair *et al.*, 2003; Baloch *et al.*, 2004).

Surveys conducted in Nigeria have established that Awka wilt Lethal Yellowing Disease (LYD) is a major cause of decline in the growth of coconut industry in Nigeria (Eziashi and Omamor, 2010; Nair *et al.*, 2003; Omamor *et al.*, 2011). According to Osagie and Asemota (1997), the symptoms of this disease comprises premature shedding of immature nuts which begins with the youngest and terminates with the oldest, blackening of the upper half of the spikelets; yellowing, browning and shedding of leaves which starts with the older leaves and progress to the new ones; and the decapitation of the palm within a year of infection. Consequently, the primary research thrust of coconut breeding is the production of high yielding and disease resistant planting materials to coconut growers. The introduction of the Malayan Green Dwarf (MGD) in the NIFOR programme has been found to be resistant while the West African Tall (WAT) cultivars are susceptible to the LYD of coconut. The major constraint in the production of resistant hybrids has been the inability to identify tolerant or resistant tall cultivars (Okwuagwu, 2003). The present paper focuses on the evaluation of comparative performance of different coconut cultivars surviving for over twenty years under natural field conditions in an LYD endemic area. This will enhance the selection of high yielding parent palms for resistance breeding in NIFOR coconut improvement programme.

MATERIALS AND METHOD

Location of experiment: The experiment was conducted on a 10 hectare coconut hybrid seed garden planted in 1987 on the NIFOR Main Station Benin City Edo State (6°30'N and 5°40'E, 149.4 m above sea level), Nigeria. The soil, climate and vegetative features of the area have been extensively described by Ogeh and Ogwurike (2006) and Ubom (2010). The field has been under natural condition with more than 20 years of cyclic Lethal Yellowing Diseases (LYD) infection.

Planting materials and experimental design: Five coconut varieties derived from the NIFOR's tall and exotic Malayan dwarf parents were planted in an unreplicated progeny row. These coconut varieties include: Malayan Green Dwarf (MGD), Malayan Yellow Dwarf (MYD), Malayan Orange Dwarf (MOD), West African Tall (WAT) and Hybrid varieties (HY). The dwarf and tall seedlings were interplanted in the proportion of two rows of dwarf palms to one row of tall palms. With the emasculation of the dwarf palms, production of dwarf×tall hybrids by natural cross pollination would be achieved.

Data collection and analysis: Considering the high mortality rate of the palms due to the devastating attack of LYD, data on bunch production and nut yield were recorded on the surviving palms for each variety for a period of seven years (2000-2003 and 2006-2008). Data were analyzed using simple measures of variability (frequency distribution, arithmetic mean, range, standard deviation and coefficient of variation) according to Obi (2002). The arithmetic mean (X), Standard

Deviation (SD) and range were employed to examine the performance of the varieties in relation to the measured traits. In addition, the visual display of the frequency distribution (frequency polygon) was adopted to deduce the dispersion of the individual palms in the coconut populations. Due to the unequal number of individual palms in the respective varieties studied, Coefficient of Variability (CV) was used to estimate with precision the variability of the traits within the varieties. The pattern of variation in yield between palms across the years was evaluated using Spearman's rank correlation. All the statistical analysis was facilitated using the GenStat software 14th edition VSN International (2011).

RESULTS

The maximum number of bunches per palm per year for WAT was 9.6 while, the other dwarf varieties has 7.4. Mean bunch production for all the cultivars were generally low except for WAT which produced 8.1 bunches per palm per year. This is followed by MGD with 6.9 bunches^{-1} palm^{-1} year^{-1}. The lowest bunch production was observed among the dwarf cultivars (MGD, MOD and MYD). The same trend was recorded for number of nuts per bunch in all the cultivars (Table 1). Maximum number of nuts per palm ranged between 42.2 in MOD to 83.8 in WAT. Very low production was observed although a few palms among the West African Tall showed reasonable performance. In comparing the variation between different cultivars, reliance is placed on the coefficient of variability because standard deviation may vary with the size of the mean. Generally, there was greater variation in number of nuts than in bunch production (Table 1). MOD and WAT recorded the highest variation in bunch production and nut yield.

A comparative assessment of the coconut cultivars across the years revealed an alternating yield increase from year to year (Table 2). Number of nuts per palm per year and bunch production was

Table 1: Bunch and nut production of coconut cultivars under natural condition in an LYD endemic area

		Bunch yield				Nut yield			
Variety	No. of palms	Mean	Range	SD	CV (%)	Mean	Range	SD	CV (%)
MGD	63	6.9	5.8-7.5	0.57	8.2	48.2	39.5-56.3	6.53	13.5
MYD	41	6.8	6.0-7.5	0.58	8.9	34.5	30.0-42.2	4.90	14.2
MOD	10	6.6	5.1-7.4	0.79	11.9	43.2	33.3-49.9	6.10	14.1
WAT	5	8.1	7.0-9.6	1.10	12.9	63.7	53.8-83.8	10.70	16.8
HY	29	7.2	6.4-8.0	0.50	7.5	49.5	42.1-63.2	7.20	14.6

MGD: Malayan green dwarf, MYD: Malayan yellow dwarf, MOD: Malayan orange dwarf, WAT: West African tall, HY: Hybrid

Table 2: Yield assessment of coconut cultivars across the years

	Average bunch yield							Average nut yield						
Variety	2000	2001	2002	2003	2006	2007	2008	2000	2001	2002	2003	2006	2007	2008
MGD	7.3	7.0	7.10	6.6	5.8	7.2	7.5	56.3	44.8	47.5	42.5	39.5	56.2	50.6
MOD	6.0	6.0	6.20	6.5	6.6	7.5	7.2	34.6	30.0	31.7	32.3	30.4	42.2	40.5
MYD	6.4	6.3	7.00	7.1	5.1	7.4	7.2	38.1	40.8	46.1	45.1	33.3	49.9	49.2
WAT	9.6	7.4	7.60	7.0	7.6	9.6	8.2	70.6	54.4	57.0	53.8	63.0	83.8	63.0
HY	7.4	6.9	7.20	6.8	6.4	8.0	7.6	53.7	44.5	47.7	44.5	42.1	63.2	50.7
Mean	7.3	6.7	7.02	6.8	6.3	7.9	7.5	50.7	42.9	46.0	43.6	41.7	59.1	50.8
CV (%)	19.0	8.4	7.30	3.8	14.8	12.3	5.4	28.8	20.5	19.8	17.7	30.7	26.9	15.7
t-statistics	11.8	26.7	30.70	59.6	15.1	18.2	41.1	7.7	10.9	11.3	12.7	7.3	8.3	14.2

MGD: Malayan green dwarf, MYD: Malayan yellow dwarf, MOD: Malayan orange dwarf, WAT: West African tall, HY: Hybrid highest in year 2007 and ranged between 42.2 to 83.8 for nut yield and 7.2 to 8.6 for bunch production. A critical examination of year 2006 yield showed that the data were lower than those of other years except for WAT which produced 63 nuts and 7.6 bunches in same year.

Figure 1 shows the frequency polygon for nuts/palm. The five polygons indicate that the group 32-37 nuts/palm in the distribution is the modal group for MGD, MYD and HY. This trend is however in contrast with the frequency polygon for bunches/palm with MYD and MOD having the same modal group of 6.2-6.7 bunches (Fig. 2). Generally, the modal groups were within the grand mean for the respective traits.

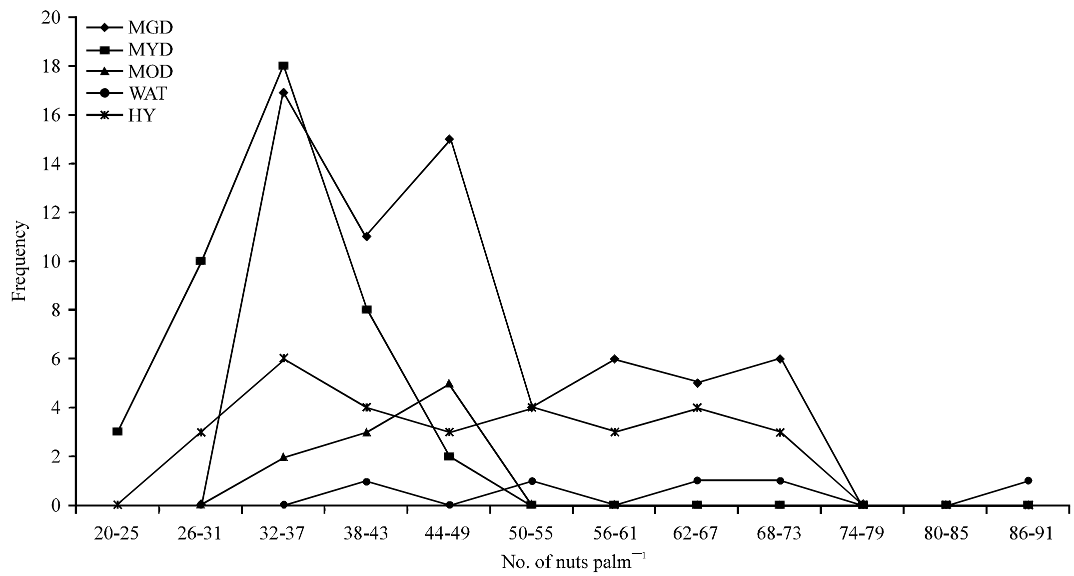

Fig. 1: Frequency polygon of different palms' nut yield

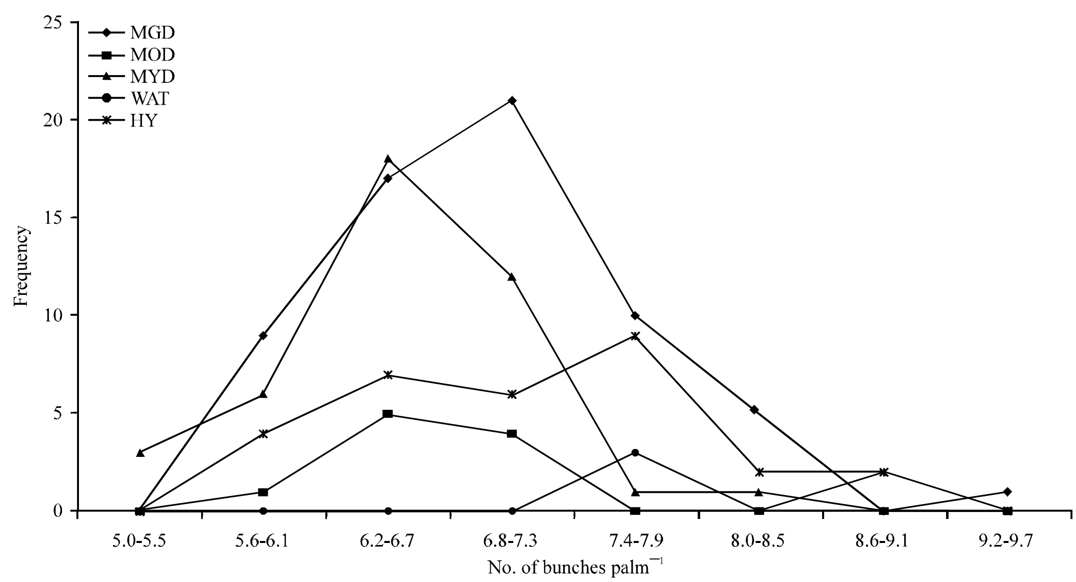

Fig. 2: Frequency polygon of different palms' bunch yield

Table 3: Rank correlations for yield of nuts and bunch production

	Rank correlation coefficient	
	Nut yield	Bunch production
19th year vs. 4 years average	+0.99**	+0.90*
20th year vs. 4 years average	+0.99**	+0.90*
21st year vs. 4 years average	+0.99**	+0.82*

*,**Correlation is significant at 0.01 and 0.05 level, respectively

The mean number of nuts and bunches were higher than the frequency groups for MGD and HY and MYD and WAT, respectively. Interestingly, the number of palms was the same in both traits for MYD. Although high number of nuts was produced by WAT, the distribution was not consistent unlike in MGD for the traits evaluated.

The rank correlation coefficient (Spearman's) for bunch production and nut yield is given in Table 3. The results show very high positive correlation coefficients for nut yield and bunch production. The correlation coefficients for nut yield was highly significant compared to the bunch production which was significant.

DISCUSSION

The yielding ability of the palms for the respective varieties is dependent on the measured traits (yield of nuts and bunch production). It is often concluded that a vigorous palm should have more bunches and nuts per bunch. The low bunch and nut yield or the low yield obtained in this study could be linked to the incidence of LYD (Odewale *et al*., 2006). However, poor soil conditions and high water deficit during the dry season could be implicated (Peiris and Thattil, 1997; Peiris, 2006) and it has been reported that under favourable growing conditions, dwarf palms give excellent yields (Bourdeix *et al*., 2005). Baloch *et al*. (2004) reported significant increase in nut yield of coconut due to the application of NPK fertilizers in association with farmyard manure. Balasundram *et al*. (2006) recommended management zoning for optimum returns in his work on spatial variability of soil fertility variables affecting yield in the oil palm.

Year to year yield variations among the cultivars was very conspicuous. The comparatively higher yield of the previous year could be explained by the phenomenon of alternate yielding tendency characteristic of some dwarf coconut palms (Akpan, 1985, 1989, 1994). Although, the intensity of biennial fluctuation is low and of little economic significance, most tree crops are to some extent biennial in growth and cropping. Those that exhibit a biennial rhythm carry heavy crop in one year and less in the following year. Nevertheless, the relatively low mean value for the different cultivars is an indication of a wide variation between the high and low yielders. Despite the incidence of LYD, year 2007 seem to be the best year for bunch and nut production for all the cultivars. This could be linked to the differential response of the genotypes/varieties to fluctuation in climatic parameters and other detrimental external factors like disease and water deficit. The differential response of genotypes to seasonal variations has been well documented in cereals, legumes and tree crops in Nigeria and elsewhere (Okoye *et al*., 2008, 2011; Akinwale *et al*., 2011; Sreedhar *et al*., 2011; Udensi *et al*., 2012). However, there is paucity of information on this subject with respect to the coconut palm in Nigeria therefore a detailed assessment of this observation will be reported in a subsequent publication. Irrespective of the general poor performance of the cultivars, there is high palm to palm variation for the yield traits. The continuous distribution of

MGD could be due to the high tolerance of LYD unlike the other varieties especially WAT (Omamor *et al*., 2011). According to the yield grouping of Nampoothiri *et al.* (1975), the frequency distribution fell within the medium yield group.

Considering the incidence of LYD and wide seasonal variation in this study, repeatability value of the data would obviously be low. But the high rank correlations for the yield traits suggest that the yield pattern between different palms among the cultivars has been consistent over the years notwithstanding seasonal fluctuations and LYD prevalence. Consequently, selection of high yielding LYD resistant green dwarf and WAT hybrid planting materials for the farmers in areas where the disease is prevalent can be achieved. Also a fair estimate of the reliability of the data as described by the rank correlation coefficient connotes that four year data analysis would not show a significant difference from result obtained from data of a single year.

Further works will explore the *in vitro* selection methods for disease resistance breeding as was highlighted by Chandra *et al.* (2010) for perennial fruit crops. The use of molecular markers will also provide opportunities for precise and efficient characterization of resistant varieties/cultivars for the establishment of coconut LYD resistance breeding programme (Kumar *et al*., 2011). This will not only complement the conventional breeding method but save, time, cost, labour, etc.

CONCLUSION

In the light of the rather disappointing performance of the coconut varieties evaluated, coupled with the LYD prevalence; the few surviving trees per variety would serve as a germplasm base for resistance breeding. However, the few surviving trees will be used in a crossing programme to produce Breeders' Test Materials (BTM) for further testing. The high yielding trees will be used for mother palm and seedling selection. The relatively high nut yield of the dwarf varieties compared to the highly susceptible WAT will be used in the production of high yielding disease tolerant dwarf x tall hybrids as better planting materials than either parent.

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