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VARIABILITY OF BUNCH YIELD AMONG THE D X T INTER-POPULATION PROGENIES OF THE NIFOR SECOND CYCLE OIL PALM (*Elaeis guineensis Jacq.*) BREEDING PROGRAMME

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ABSTRACT

The performance of 51 D x T inter-population progenies derived from the second cycle modified reciprocal recurrent selection (RRS) breeding programme of Nigerian Institute for Oil Palm Research (NIFOR) was evaluated to estimate variability among the progenies and to identify the best performing progenies for introduction into the locality where the experiment was conducted. The trials were laid out in a randomized complete block design. Data was collected on number of harvested bunches (BN), single bunch weight (SBW), and fresh fruit bunch (FFB) yield. Analysis of variance (ANOVA) showed significant difference in all the traits analyzed among the progenies. Each trait was also analyzed using F-LSD. The results showed that De10, Dut6, Du15, Du12 (BN); Det6, Det1, and Du16 (SBW) and Det5 and Du10 (FFB) were quite outstanding and thus, recommended for the production of genetically superior progenies as new commercial planting materials.

Keywords: Oil palm, variability, bunch yield, fresh fruit, breeding, NIFOR.

INTRODUCTION

The African oil palm (*Elaeis guineensis* Jacq.) is endemic to the tropical low lands of West Africa and indigenous to the south eastern region of Nigeria. It is a major oil producing plant of the world, with an oil yield per hectare above any other crop and ranking second in the world market as a producer of vegetable fats and oils (Rajanaidu *et al.,* 2000: Fold, 2003). In Nigeria, oil palm accounts for about 72% of the vegetable oil produced in the country with a total of 900,000 metric tonnes of oil annually. Considering the genetic and economic potentials of the crop, mean fresh fruit bunch (FFB) yield is low when compared to the countries of South East Asia with non-seasonal climate (Okwuagwu, 1994). The oil palm bunch yield depends on several factors such as planting materials, agronomic inputs, photosynthetic activities and seasonal climatic conditions. The plant breeder's aim is to reduce the palm to palm variation in production and eliminate those factors causing low yield. Although the variation is not entirely due to genetic factors, there is still a very large variation in oil palm bunch yield even when the environmental factors which reduce yield have been considered. The modified reciprocal recurrent selection (RRS) scheme was adopted by the Nigerian Institute for Oil Palm Research (NIFOR) with the aim of developing genetically superior varieties by improving fresh fruit bunch (FFB) yield on the basis of performance of the yield components; number of harvested bunches (BN) and single bunch weight (SBW). The essence is to narrow the gap between commercial yield and potential yield of the crop. To sustain genetic progress in the NIFOR oil palm varietal development programme, great emphasis has been placed in the conservation, evaluation and exploitation of the very diverse genetic variation which abound in the natural and semi-natural groves for which the country is exceptionally endowed. Maizura *et al*., (2001) evaluated different oil palm germplasm collections using RFLP and concluded that Nigeria is most likely the centre of highest genetic diversity for oil palm germplasm. Ataga *et al*., (2003) studied 80 accessions of oil palm in relation to vegetative, bunch and fruit traits; and observed positive significant relationship with yield. Okoye *et al.*, (2007) analyzed genotype by trait relations of oil yield in the oil palm and found significant differences among genotypes. Johnson *et al*., (1955) reported that it is very important in any breeding programme to select and evaluate varieties for quantitative and yield ability before such varieties can be introduced to a given local environment. The present study was undertaken to evaluate 51 oil palm progenies to estimate their variability and to identify the best performing progenies, under the climatic condition of NIFOR.

MATERIALS AND METHODS

Three distinct breeding trials derived from the NIFOR second cycle modified reciprocal recurrent selection (RRS) breeding programme planted on the NIFOR Main Station, near Benin City, Nigeria, were evaluated in this study. All the populations were progeny trials laid out in a randomized complete block design (RCBD) with a recommended planting space of 9 x 9 metre triangular under the same management practices. Trial I consists of 15 Deli x *Tenera* progenies planted in 1987 with 6 replicates of 16 palms per plot. Trial II comprised 17 *Dura* x *Tenera* progenies planted in 1987 in 4 replicates of 16 palms per plot. Trial III comprised 22 Deli/*dura* x *Tenera* progenies planted in 1993 in 3 replicates of 16 palms per plot. Extension work seeds (EWS) were used as control in each trial. The detailed pedigrees of each progeny in the different trials are given in Tables 1a, 1b, and 1c, respectively.

Data on number of bunches (BN) produced and fresh fruit bunch (FFB) yield (kg/palm/year) were recorded each year. The single bunch weight (SBW) in Kg

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was obtained as the ratio of FFB to BN. Six years (1999-2004) juvenile yield data for trial III and seven years (1999-2005) mature yield data for trials I and II were used.

The values obtained were subjected to Analysis of variance (ANOVA) and means were compared using Fisher's least significant Difference Test (F-LSD) at 0.05 level of probability when the F-values were significant (Obi, 2002).

Table-1a: Pedigrees of Deli x Tenera progenies.

S. No.	PARENTAGE	PROGENY
1	(NIFOR ex Serdang x IRHO) x (Ogba ex Calabar)	Det1
2	(NIFOR ex Serdang) x (Umuabi)	Det2
3	(Ufuma x Aba) x (NIFOR ex Serdang x IRHO)	Det3
4	(Sabah ex Banting) x (Serdang x Aba)	Det4
5	(NIFOR ex Serdang) x (Aba x Calabar)	Det5
6	(NIFOR ex Serdang x IRHO) x (Aba x Calabar	Det6
7	(Sabah ex Banting) x (Ufuma)	Det7
8	(NIFOR ex Serdang x IRHO) x (Umuabi)	Det8
9	(Aba x Calabar) x (Sabah ex Bantig)	Det9
10	(NIFOR ex Serdang) x (Calabar)	De10
11	(Igala) x (NIFOR ex Serdang)	De11
12	(Igala) x (Sabah ex Bantig)	Det12
13	(Ulu Remis x Aba) x (NIFOR ex Serdang x IRHO)	De13
14	(Ulu Remis x Aba) x (NIFOR ex Serdang x IRHO)	De14
15	EWS	De15

Table-1b: Pedigrees of Dura x Tenera progenies.

S. No.	PARENTAGE	PROGENY
1	Ufuma x Calabar	Dut1
2	Equador x Umuabi	Dut2
3	Ufuma x Umuabi	Dut3
4	Ufuma x (NIFOR ex Serdang x Aba)	Dut4
5	Ufuma x Ufuma	Dut5
6	Calabar x Umuabi	Dut6
7	(NIFOR ex Serdang x Aba) x Calabar	Dut7
8	Calabar x (Aba x Calabar)	Dut8
9	(Ufuma x Ufuma) x Deli ex Equador	Dut9
10	(Aba x Calabar) x Deli ex Equador	Du10
11	Deli ex Equador x Ogba ex Calabar	Du11
12	Ogba ex Calabar x Umuabi	Du12
13	Ogba ex Calabar x Igala	Du13
14	(Ulu Remis Deli x Aba) x Ogba ex Calabar	Du14
15	Aba x Umuabi	Du15
16	Aba x (Aba x Calabar)	Du16
17	EWS	Du17

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Table-1c: Pedigrees of Deli/Dura x Tenera progenies.

S. No.	PARENTAGE	PROGENY
1	(Ogba ex Calabar x Aba) x (Ulu Remis x Aba)	Dde1
2	(Ogba EWS ex Calabar) x(Aba x Ogba Calabar))	Dde2
3	Calabar x Aba	Dde3
4	Aba x (Ulu Remis x Aba)	Dde4
5	Deli ex Equado x (Ulu Remis xAba)	Dde5
6	(Ufuma x Aba) x Deli ex Equador	Dde6
7	Igala x NIFOR ex Up Malaya	Dde7
8	(Deli ex Equado x Aba) x Aba	Dde8
9	New Deli introduction ex Equador x Ogba ex Calabar	Dde9
10	(Ulu Remis x Aba) x (Ogba EWS ex Calabar x Aba)	Dd10
11	Aba x NIFOR ex Serdang	Dd11
12	(Ufuma x Aba) x Ufuma pollen mixture new introdution	Dd12
13	(Ufuma x Ufuma pollen mixture new introduction) x New Deli introduction ex Equador	Dd13
14	New dura introduction Igala x NIFOR ex Serdang	Dd14
15	New dura introduction Opobo x Ufuma	Dd15
16	(Aba x Calabar) x New Deli introduction ex Equador	Dd16
17	(Ulu Remis x Aba) x Ogba ex Calabar	Dd17
18	Calabar x Aba	Dd18
19	(Ufuma x Ufuma pollen mixture new introduction) x NIFOR ex Serdang	Dd19
20	New Deli introduction x Aba	Dd20
21	(Aba x Calabar) x NIFOR ex Serdang	Dd21
22	EWS	Dd22

RESULTS AND DISCUSSIONS

The analysis of variance table (Tables 2a, 2b, and 2c) showed that there are significant differences in all the traits studied among the progenies and years. This is an indication that genetic variability existed for all the traits analyzed. This variability could be exploited for future improvement of these traits because the basis of any crop improvement is the availability of genetic variability within a population (Henry, 2004). Progeny x year interaction term was significant for BN and FFB yield in some of the trials (Tables 2a and 2b) meaning that the progenies performed differently in the environment of study. This is in line with earlier reports of Raffi *et al.*, (2001) on the differential performance of oil palm progenies in relation to bunch yield in different environments. The significant environmental effects imply that the differential performance of the progenies could be explained by the fluctuation in the weather variables from year to year. However, progeny x year interaction term was not significant for SBW in all the trials (Tables 2a, 2b, and 2c). The variations were more pronounced on BN and FFB yield than SBW. This validates earlier reports (Broekmans, 1957; Sparnaaij, 1960; and Hartley, 1988) that SBW is generally less affected by environmental factors than BN. Some degree of selection for broad adaptation in the yield traits is therefore possible in the genetic materials grown at NIFOR. The consistency of the experimental plots measured by the coefficient of variability (C.V. %) was within the acceptable levels of reasonable statistical comparison for the three bunch yield traits in Deli x *Tenera* (Table-2a) and *Dura* x *Tenera* (Table 2b) trials. The coefficient of variation for the bunch yield traits among the Deli x *Tenera* progenies was lower than the *Dura* x *Tenera* progenies. Although coefficients of combined years tend to be lower, Hartley (1988) observed that variability of bunch yield within the Deli progenies was lower than in the Nigerian *dura* progenies. For the Deli/*Dura* x *Tenera* trials (Table-2c) however, the coefficients of variability for the 3 bunch yield traits were too high, 22%-38%, allowing only statements on the trends of observations. The high levels of missing stands and plots, as reflected in the error degrees of freedom, also account for this high level of intra plot variability in this trial. However, the progenies were different from one another in terms of BN, SBW and FFB yield in the different trials.

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Table-2a: Combined analyses of variance for BN, SBW and FFB yield in the Deli x Tenera trial (trial I).

Sources of variation	d.f.	Mean BN	Squares SBW	FFB
Replicate	5	2.632***	25.290***	548.819***
Progeny	14	8.645***	81.843***	871.042***
Prog. x Rep.	70	1.126***	7.128***	140.234***
Year	6	80.284***	71.667***	9082.392***
Rep. x Year	30	3.223***	4.845ns	467.933***
Prog. x Year	84	1.150***	4.686ns	165.894***
Rep. x Prog. x Year	420	0.593	3.714	78.139
C.V. (%)		24.3	16.1	24.4

*** Significant at P = 0.1%; ns = not significant; d.f. = degrees of freedom

Table-2b: combined analyses of variance for BN, SBW and FFB yield in the Dura x Tenera trial (trial II).

Sources of variation	d.f.	Mean BN	Squares SBW	FFB
Replicate	3	9.123***	50.563***	1611.042***
Progeny	16	3.812***	46.098***	497.930***
Prog. x Rep.	48	1.969***	17.869***	311.129***
Year	6	65.303***	93.522***	5702.985***
Rep. x Year	18	3.262***	7.830ns	485.109***
Prog. x Year	96	1.261*	8.658**	131.043ns
Rep. x Prog. x Year	288	0.937	5.967	123.116
C.V. (%)		29.4	19.1	28.1

*,**,*** Significant at P = 5%, 1%, and 0.1%, respectively; ns = not significant; d.f. = degrees of freedom

Table-2c: Combined analyses of variance for BN, SBW and FFB yield in the Deli/Dura x Tenera trial (trial III).

Sources of variation	d.f.	MEAN BN	SQUARES SBW	FFB
Replicate	2	36.384**	3.558ns	808.801**
Progeny	21	8.008**	12.472**	392.999***
Prog. x Rep.	42	7.919**	8.330ns	257.030**
Year	5	201.004***	395.392***	3762.096***
Rep. x Year	10	18.518***	5.576ns	204.400ns
Prog. x Year	105	3.901ns	4.227ns	141.550ns
Rep. x Prog. x Year	175	4.619	6.105	139.493
C.V. (%)		35.9	21.8	37.8

*,**,*** Significant at P = 5%, 1%, and 0.1%, respectively; ns = not significant; d.f. = degrees of freedom

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In view of the highly significant differences observed among the progenies for the three bunch yield traits, the mean performance of each of the progenies in all the trials were evaluated (Tables 3a, 3b, and 3c). The performance of the EWS control did not differ between trials I and II. The EWS values were generally around the trial means even in trial III. About half of the trial populations performed better than the EWS control. Direct progeny comparisons across the trials I and II are valid.

Table-3a: Mean values of Deli x Tenera progenies for BN, SBW and FFB yield.

Progeny	Mean BN	Mean SBW	Mean FFB
Det1	2.2110 G	13.6257 B	28.542 H
Det2	3.6298 AB	10.1033 H	36.634 CDEF
Det3	3.3436 BC	12.5114 CD	40.652 AB
Det4	2.9486 DE	10.9624 EFG	30.370 GH
Det5	3.2693 CD	13.1986 BC	43.428 A
Det6	2.7186 EF	14.5771 A	37.503 BCDE
Det7	2.8945 E	13.1836 BC	36.240 DEF
Det8	3.5400 BC	10.6333 FGH	36.089 EF
Det9	3.2521 CD	12.6807 C	39.978 ABCD
De10	3.9017 A	10.0126 H	38.576 BCDE
De11	3.5305 BC	11.7200 DE	37.498 BCDE
Det12	3.3364 BC	12.6169 C	40.155 ABC
De13	2.4510 FG	11.2502 EF	27.371 H
De14	3.2917 C	10.3176 GH	33.283 FG
De15	3.2862 C	11.6017 E	36.416 CDEF
MEAN	3.174	11.930	36.182
RANGE	3.90-2.21	14.577-10.013	43.428-27.371
LSD	0.3303	0.8267	3.7916

Table-3b: Mean values of Dura x Tenera progenies for BN, SBW and FFB yield.

Progeny	Mean BN	Mean SBW	Mean FFB
Dut1	2.4643 F	13.7614 BC	31.944 F
Dut2	3.5668 AB	11.1329 EF	36.180 DEF
Dut3	3.3461 ABCD	13.5243 BCD	38.724 CDE
Dut4	3.1654 BCDE	12.8214 CD	40.462 BCDE
Dut5	2.9164 CDEF	14.3411 AB	41.563 BCD
Dut6	3.7582 A	11.2675 EF	36.546 DEF
Dut7	3.3439 ABCD	12.9264 CD	40.165 BCDE
Dut8	3.4218 ABC	13.4889 BCD	44.262 ABC
Dut9	3.4950 AB	13.2579 BCD	44.046 ABC
Du10	3.4354 AB	13.7904 BC	48.563 A
Du11	3.2750 ABCD	12.3736 DE	38.624 CDE
Du12	3.6875 A	11.2843 EF	39.528 BCDE
Du13	3.6096 AB	12.8461 CD	44.652 AB
Du14	3.1182 BCDE	11.4404 EF	34.995 EF

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Du15	3.6904 A	10.8696 F	37.168 DEF
Du16	2.6957 EF	15.5629 A	39.318 BCDE
Du17	2.8957 DEF	12.9368 CD	34.716 EF
MEAN	3.287	12.801	39.497
RANGE	3.758-2.464	15.563-10.870	48.563-31.944
LSD	0.5091	1.2849	5.8367

Table-3c: Mean values of Deli/Dura x Tenera progenies for BN, SBW and FFB yield.

Progeny	Mean BN	Mean SBW	Mean FFB
Dde1	4.6	6.2	23.9
Dde2	3.7	6.8	20.7
Dde3	5.2	6.1	27.3
Dde4	5.0	5.9	27.6
Dde5	4.2	8.3	32.3
Dde6	4.4	6.1	24.7
Dde7	3.6	7.3	18.9
Dde8	3.8	7.5	19.3
Dde9	4.5	6.0	25.0
Dd10	5.3	6.6	29.9
Dd11	5.5	6.6	31.3
Dd12	3.9	6.1	21.3
Dd13	3.7	7.9	25.4
Dd14	3.4	7.6	22.2
Dd15	4.4	6.3	23.5
Dd16	3.9	8.0	23.7
Dd17	3.1	6.0	15.7
Dd18	3.4	6.0	21.5
Dd19	5.9	6.3	33.2
Dd20	4.2	7.9	28.8
Dd21	4.1	5.7	20.0
Dd22	4.6	6.8	22.3
MEAN	4.3	6.7	24.6
RANGE	5.9-3.1	8.0-5.7	33.2-15.7
LSD	NS	NS	NS

Bunch number (BN)

The mean bunch number (BN) performance of the Deli x Tenera trial (Table 3a) was very similar to that of the Dura x Tenera trial (Table-3b), with grand means of 3.174 and 3.287 bunches annually respectively. The highest number of harvested bunches was recorded in De10, Dut6, and Dd19 (3.902, 3.758, and 5.9) while lowest for Det1, Dut1, and Dd17 (2.211, 2.464, and 3.1) respectively (Tables 3a, 3b, and 3c). The data for this parameter ranged from 2.2 to 3.9 (Table-3a), 2.4 to 3.7 (Table-3b), and 3.1 to 5.9 (Table-3c). The observed differences among the progenies could be explained by the different genetic make up of the planting materials. These results are in agreement with that of Kushairi *et al*., (1999) who also reported significant variability among *dura* x *pisifera* oil palm progenies.

Single bunch weight (SBW)

The single bunch weight (SBW) performance of the *dura* x *tenera* trial was unexpectedly higher than the

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Deli x tenera trial (12.801kg and 11.93kg) respectively (Tables 3a and 3b). Det6, Du16, and Dd16 showed maximum SBW (14.577kg, 15.563kg, and 8.0kg) in the respective trials while De10, Du15, and Dd21 showed minimum SBW (10.013kg, 10.870kg, and 5.7kg) respectively (Tables 3a, 3b, and 3c).values regarding the parameter ranged from10.013kg to 14.577kg (Table-3a), 10.870kg to 15.563kg (Table 3b), and 5.7kg to 8.0kg (Table-3c). Critical assessment of the data showed that the best performing progenies for BN turned out to be the worst with respect to SBW in most cases. This is expected, as BN is determined earlier than SBW during ontogeny. This observation strengthens the strong negative association often reported between the two yield traits (Okwuagwu and Tai 1995; Okoye *et al*., 2007). The negative correlation may be developmental rather than genetic *per se*.

Fresh fruit bunch (FFB) yield

Analysis regarding FFB yield (Table-3a) revealed that Det5, Det3, and De12 produced the highest FFB yield (43.428 kg/p/yr, 40.652 kg/p/yr, and 40.155 kg/p/yr) respectively while the lowest FFB yield (27.371 kg/p/yr) was recorded by De13. Maximum FFB yield was observed in Du10, Du13, Dut8, and Dut9 while minimum FFB yield was produced by Dut1 (Table-3b). The FFB yield was however very low in the Deli/dura x tenera trial (Table-3c) when compared to the other trials (Tables 3a and 3b). This could be attributed to the inherent variability in juvenile FFB yield in the oil palm. It is interesting to note that all the progenies that produced minimum number of bunch equally produced minimum FFB in all the trials. This is a strong indication that the productivity of a progeny is primarily determined by the number of bunches it bears. The highest yielding FFB progenies were either as a result of high BN or high SBW, suggesting component complementation of the yield traits. This trend tends to clarify the effectiveness of selecting parents whose yield components will complement each other in their offspring to produce higher FFB yield (Okwuagwu and Okoye; 2006). Sparnaaij (1960 and 1969) and Van der Vossen (1974) who analyzed the juvenile bunch yield of NIFOR breeding population advocated the exploitation of the complementation of BN and SBW in the determination of high FFB yield. However, West (1976) did not consider the role of component complementation as being important in the oil palm yield improvement programme.

CONCLUSIONS AND RECOMMENDATIONS

This experiment was conducted to evaluate the progeny performance of the second cycle D x T inter-population progenies. Very high significant differences were observed among the progenies for the three bunch yield traits in all the three trials. High FFB yield recorded for some of the progenies was sustained by the ability of the two parents to confer either high BN or high SBW to the offspring. These progenies may be used for the production of genetically superior progenies as new commercial planting materials.

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