

Genetic Variability of Fresh Fruit Bunch Yield (FFB) Yield in Some Dura X Pisifera Breeding Populations of Oil Palm (*Elaeis guineensis* Jacq.)

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Abstract: Three Dura x Pisifera Oil Palm breeding populations were evaluated at Council for Scientific and Industrial Research(CSIR)-Oil Palm Research Institute(OPRI), Ghana to estimate the genetic variability, heritability, relative genetic gains and correlation among the fresh bunch yield traits. Population 1, 2 and 3 consisted of 7 Dura x Pisifera (DxP), 8 dura x pisifera and 8 dura x pisifera progenies, respectively. Combined analysis of variance showed significant genotypic and year differences for number of bunches (BN), average bunch weight (ABW) and fresh fruit bunch yield (FFB). There was however no significant difference between genotypes by year interaction for all the traits studied. High broad-sense heritability and genetic advance as percent of the mean were observed for all the three traits, suggesting that the trait is primarily under genetic control. In all the genotypic coefficient of variation (GCV) was less than the phenotypic coefficient of variation (PCV), but the differences were narrow suggesting resistances to environmental variation in the expression of these traits. Correlation among the traits indicates a significant positive correlation. There is wide variability based on the FFB and its components. This provides more range for selection among the three populations for FFB yield enhancement.

Key words: Oil Palm • Heritability • Fresh fruit bunch • Dura • Tenera

INTRODUCTION

Oil palm (*Elaeis guineensis* Jacq.) is one of the world's most important oil crops. In Ghana oil palm is one of the major economic crops after Cocoa. Increasing the yield of the crop will therefore enhance the economic conditions of those involved in oil palm cultivation especially the rural population since establishment of the oil palm plantation to processing employ a lot of rural population. The oil palm takes a period of 10 to 12 years to go through a cycle of selection in its breeding programme. The Oil Palm Research Institute (OPRI) of the Ghana's Council for Scientific and Industrial Research (CSIR) has gone through the first and the second cycles of selection using the modified reciprocal recurrent selection breeding strategy.

The magnitude and dimension of environmental effect may vary from genotype to genotype, thus it is important to study genotype by environment interaction in order to evaluate genotypes for selection [9]. Fresh fruit bunch yield (FFB), a product of the number of bunches (BN) and average bunch weight (ABW), is a major

determinant of oil palm productivity [2]. Selection for FFB components would rapidly advance the oil palm breeding programme; the success of this will depend on the nature and the extent of heritable variations in the populations and the trait of interest. Information on genetic variability affects the potential genetic gains through selection and will help oil palm breeders in selection of parents in breeding cycle's base on adequate variability in the breeding population. The objective of the study was to estimate the genetic variability, heritability, relative genetic gains and correlation among the fresh bunch yield traits of different breeding populations to obtain information necessary for advancing the breeding populations into the next generation.

MATERIALS AND METHODS

Three Dura x Pisifera breeding populations from the CSIR-OPRI second cycle selection were evaluated, population 1 is a comparative trial of two (2) IHRO and five (5) OPRI materials (Dura x pisifera trial) planted in 1988 with 7 treatments in 4 replicates and have 16 palms

per plot. Population 2 consist of 8 dura x pisifera progeny trial planted in 1988 in 4 replicate and 16 palms per plot and population 3 has 8 treatments in 6 replicates with 10 palms per plot planted in 1987. A standard cross from the first cycle selection was used as a control in each trial. All the trials were conducted at OPRI-Kusi (0.6.00 N, 001.45 W) and the soil belongs to Kokofu series (Ferri-Plinthic Acrisol-FAO/UNESCO). The annual rainfall ranges from 1500 to 2200 mm with a temperature of 24-34°C. Good agronomic practices were carried out from establishment to completion of the trial. Data were collected on number of bunches (BN) and average bunch weight. Fresh fruit bunch (FFB) yield was obtained as the product of BN and ABW. Nine years (1995-2003) yield data were used for the three populations. Data were subjected to analysis of variance ANOVA using Genstat 17th Edition (VSNi Product). FFB yield and its components and magnitude of variation responsiveness to selection were calculated based on Okwuagwu *et al.* [8]. Expected genetic advance of the mean for each trait was calculated according to Allard *et al.* [1]. Correlation coefficients were also computed using the same software to examine the relation between the BN, AB and the FFB.

RESULTS AND DISCUSSION

A combined analysis of variance over nine years for BN, ABW and FFB for 23 oil palm genotypes that constituted the three populations is presented in Table 1. The results showed the existence of significant genotypic and year differences among the materials used for the trial. There was however no significant difference between

genotype by year interaction, this might affect the genotypic and the heritability. Wide variations exist in the entire three bunch yield trait studied. Similar results were obtained by Rafii *et al.* [11] in 40 DxP oil palm genotypes and Okoye *et al.* [9] in DxT breeding population of oil palm. This is important for efficient selection of elite oil palm genotypes with high yield and yield component characters for the next cycle of selection.

The coefficient of variation (CV) for populations 1, 2 and 3 with respect to BN (19.70, 23.8 and 21.80%) and ABW (21.40, 27.20 and 24.50%), were in the acceptable levels for valid statistical comparison of bunch yield traits. However, CV higher than 20% is considered to be high; however, for a perennial tree crop like oil palm, CV values of 20-30% for bunch yield traits have been reported as tolerable [3]. Nonetheless, the CV values obtained in the present study for FFB for all three populations were too high (39.50, 47.60 and 44.0 %), this might be because of the inherent variability in juvenile fresh fruit bunch yield of oil palm [7].

Estimation of genetic parameters of FFB and its components are presented in Table 2. Mean BN for population 1 and 2 are the same (6.12 and 6.12, respectively). Also ABW for population 1 and 3 were similar (82.50 and 81.06, respectively). In all the genotypic coefficient of variation (GCV) was less than the phenotypic coefficient of variation (PCV) but the differences were narrow suggesting resistances to environmental variation in the expression of these traits. This agrees with those reported by Kushairi *et al.* [5] and Musa *et al.* [6]. GCV values varied from population to population. High estimates of GCV for traits in population

Table 1: Combined analysis of variance for number of bunches (BN), average bunch weight (ABW) and fresh fruit bunch yield (FFB) for the second cycle Dura x Pisifera oil palm breeding population

		Mean square		
Sources of variation	df	BN	ABW	FFB
Population 1				
Progeny	7	83.86***	1660.60***	856812***
Year	8	75.69***	8924.70***	1412894***
Progeny x year	56	1.33ns	329.70ns	50771ns
CV (%)		19.70	21.40	39.50
Population 2				
Progeny	6	46.33***	764.10*	226931***
Year	8	52.07***	9483***	1412894***
Progeny x year	48	1.39ns	202.30ns	50771ns
CV (%)		25.80	27.20	47.60
Population 3				
Progeny	7	105.81***	9627.60***	1592617***
Year	8	197.75***	24748.90***	4287527***
Progeny x Year	56	1.50ns	394.30ns	6651ns
CV (%)		21.30	24.50	44.40

Populations 1,2 and 3 are 7 dura x pisifera progenies, 8 dura x pisifera progenies and 8 dura x pisifera progenies; df=degrees of freedom; *, ***Significant at p=5% and 0.1% respectively; ns=not significant; CV=coefficient of variation

Table 2: Genetic variability parameters for bunch yield components for the second cycle Dura x Pisifera oil palm breeding population

Traits	Population	Mean±SE	Range	GCV (%)	PCV (%)	H _{bs} (%)	GAs
BN	1	6.12±0.85	4.08-9.18	24.64	25.16	96.62	49.87
	2	6.12±1.12	5.04-7.86	18.30	18.95	93.28	36.42
	3	5.72±0.70	3.93-7.94	24.30	24.65	96.98	49.25
ABW (kg palm ⁻¹ year ⁻¹)	1	82.5±12.48	73.9-92.7	7.37	8.97	67.50	12.47
	2	64.8±12.47	58.9-71.4	6.10	7.98	58.38	9.60
	3	81.06±11.48	52.81-95.88	16.14	16.80	92.12	31.89
FFB (kg palm ⁻¹ year ⁻¹)	1	540±150.8	343-831	27.71	28.86	92.21	54.81
	2	429±47.6	323-531	17.51	19.63	79.52	32.16
	3	530±135.8	240-777	31.72	36.13	77.06	57.36

Populations 1,2 and 3 are 7 dura x pisifera progenies, 8 dura x pisifera progenies and 8 dura x pisifera progenies GCV=genotypic coefficient of variation; PCV=phenotypic coefficients of variation, A=genetic advance as % of mean; h²b = broad sense heritability

Table 3: Correlations among bunch yield traits for the second cycle Dura x Pisifera oil palm breeding population

Traits	BN	ABW
FFB	0.87**a	0.86***a
	0.90**b	0.86***b
	0.94**c	0.92***c
BN		0.58***a
		0.62***b
		0.83***c

, * Correlation is significant at p=1% and 0.1%; a, b, c are correlation coefficients for population 1, 2 and 3 respectively

3 suggest progress in selection within the population. Low GCV for ABW in population 1 and 2 suggest reduced genetic variability. Therefore there is the need to refresh the gene pools of these populations by introgression of new genes from oil palm germplasm. Broad-sense heritability of BN, ABW and FFB yield were high > 50% in all the populations. Similar results were obtained by Musa *et al.* [6], Okwuagwu and Okoye [7] and Okoye *et al.* [9]. It was suggested by Okwuagwu *et al.* [8], that high heritability in broad sense does not always lead to better response to selection because it consist of non-additive genetic variance. Genetic advance as a percentage of the mean is more of a useful response to selection combined with high heritability estimates. High genetic advance as a percentage of the mean was recorded for all the traits in all the population with exception of ABW in population 1 and 2 (12.47 and 9.60). Correlation among the traits indicates a significant positive correlation. These results suggested that any increase in BN and ABW will lead to an increase in FFB.

Conclusion can be drawn from the study that, there is wide variability based on the FFB and its component. This provides more range for selection among the three populations for FFB yield enhancement.

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