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RESPONSE OF OIL PALM PROGENIES TO DIFFERENT FERTILIZER RATES

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Ninety-nine dura *x* pisifera *progenies (genotypes) from six seed producers (populations) in Malaysia were subjected to three fertilizer treatments after field planting in 1983. The fertilizer treatments were half, normal and twice the standard estate rate. Yield recordings and bunch analyses were taken between 1987 and 1998. Analyses of variance (ANOVA) for fresh fruit bunch (FFB), bunch number (BNO) and average bunch weight (ABW) showed significant differences for fertilizers, populations and genotypes. In addition, FFB differed significantly for genotype x fertilizer (GxF) interaction. Generally, FFB would increase at twice the estate fertilizer rate, but reducing the normal rate to half did not reduce the yield significantly. Despite improvements in ABW, reduction in FFB was due to lowering of BNO. Conversely, an increase over the standard fertilizer rate did not affect BNO. Populations 4 and 2 were high in FFB due to higher BNO and higher ABW, respectively. Progenies 4062, 4056 and 6094 shared the highest yields at half, standard and twice the standard estate rate, respectively.*

ANOVA for bunch quality components was carried out and significance was detected for the populations and genotypes. Variation between fertilizers was significant for mean fruit weight, oil to bunch and kernel yield (KPY). High values for these characters along with FFB were advantages in certain populations and genotypes for higher total economic product (TEP). Highest TEP within the normal fertilizer level was recorded in Population 3, and at the altered levels was Population 4. Progeny 4051 was outstanding for TEP at half the fertilizer rate, Progeny 4056 at normal level and Progeny 5073 at twice the estate standard rate. Populations 4 and 2 offered prospects for higher oil yields at half the fertilizer cost, while Population 5 might be advantageous in lauric oil production.

Keywords:

oil palm, DxP, genotype x fertilizer interaction, performance, yield.

INTRODUCTION

The oil palm, *Elaeis guineensis* Jacq. is native to West and Central Africa. Four seedlings introduced in 1848 to the Bogor Botanical Garden, Java gave rise to the Deli *dura* population (Jagoe, 1952; Hardon and Thomas, 1968; Hartley, 1988). The first commercial oil palm plantations in Malaysia in 1917 and the subsequent plantings up to the 1960s were established using the Deli *dura* material. With the discovery of the single gene inheritance for shell thickness (Beirnaert and Vanderweyen, 1941), oil palm plantations gradually switched to the hybrid *dura* x *pisifera* (DxP) or *tenera* planting material, thereby realizing a 30% increase in oil yield.

Besides genetic improvement, yields were further enhanced by proper agronomic practices, principally through fertilizer applications. Earlier fertilizer experiments determined the importance of the primary and other elements for maximizing responses for higher yields. The experiments provided rates of application sufficient to discover the optimum level of application for any fertilizer combination used (Hartley, 1988). A series of experiments on Rengam and Pamol Series soils gave results that may be taken as a first guide to the fertilizer requirements of inland soils in Malaysia (Rosenquist, 1962).

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Current fertilizer trials emphasized improvements of the recommended rates in a given environment for better yield profiles (Foster *et al.*, 1985). Meanwhile, the effects of fertilizer on oil palm genotypes had not been seriously looked into. Kushairi *et al.* (1998) first reported on a GxF interaction in oil palm, which influenced bunch yield, oil and kernel production in oil palm genotypes when subjected to three fertilizer rates. This paper is an update of the responses of these oil palm progenies to three fertilizer rates.

MATERIALS AND METHOD

A total of 99 DxP progenies (genotypes) described by Kushairi (1992) and Kushairi *et al.* (1994; 1998) were evaluated for response to three fertilizer rates at the Palm Oil Research Institute of Malaysia (PORIM), now Malaysian Palm Oil Board (MPOB) Research Station in Hulu Paka, Terengganu. Oil palm seedlings were obtained from six major seed producers (populations) in Malaysia, namely, Federal Land Development Authority or FELDA (26 progenies), Golden Hope (six progenies), Guthrie Research Chemara (10 progenies), Highlands Research Unit (25 progenies), Socfin (18 progenies) and United Plantations Berhad (14 progenies). To avoid projecting the commercial interest of these agencies, the populations were randomly coded 1, 2, 3, 4, 5, 6 and their progenies were prefixed accordingly. For example, Progeny 1007 is the progeny number 007 in Population 1, and Progeny 2028 is the progeny number 028 in Population 2.

A total of 3564 seedlings were planted in trial 0.189 on inland soil (Bungor Series) at 8.8 m triangular spacing (148 palms ha^{-1}). The trial was laid down in September 1983 in a completely randomized design (CRD) with six palms per progeny in each of the three fertilizer treatments with two replications. The estate's fertilizer recommendations and subsequent revisions were based on soil and foliar analyses of MPOB Agronomy Group. The recommended rate was the estate's standard fertilizer rate, or treatment T2 for this experiment (*Table 1*). Treatments T1 and T3 were half and double the standard fertilizer rate, respectively. Fertilizers for these treatments were individually weighed using a salter balance, separately packed in plastic bags and applied to individual palms since field planting. Yield recordings and bunch analyses on an individual palm basis were taken for 12 years from January 1987 to December 1998.

Unlike yield of total oil (TOIL) that was derived from the extraction rates, *viz.*, oil per

TABLE 1. FERTILIZER TREATMENTS FOR INDIVIDUAL PALM IN TRIAL 0.189

Period (yr)	Fertilizers	Fertilizer treatments* (kg palm^{-1} yr^{-1})		
		T1	T2	T3
1983-1992	Sulphate of ammonia (split applications)	1.5	3.0	6.0
	Christmas Island rock phosphate	1.5	3.0	6.0
	Muriate of potash (split applications)	1.5	3.0	6.0
	Kieserite	0.25	0.5	1.0
1993-1994	Sulphate of ammonia (split applications)	1.5	3.0	6.0
	Jordanian rock phosphate	1.7	3.4	6.8
	Muriate of potash (split applications)	1.7	3.4	6.8
	Kieserite	0.75	1.5	3.0
1995-1998	Sulphate of ammonia (split applications)	1.75	3.5	7.0
	Rock phosphate	1.75	3.5	7.0
	Muriate of potash (split applications)	1.75	3.5	7.0
	Kieserite	0.75	1.5	3.0
	Borate	0.5	1.0	2.0

Notes: * T1 = half the estate fertilizer rate, T2 = estate fertilizer rate, T3 = double the estate fertilizer rate.

palm per year (OPY) plus 50% kernel per palm per year (KPY), *i.e.* OPY + 50% KPY, the total economic product (TEP) was based on the prices of palm oil and kernel, hence the term *economic*. Over the last 20 years, the price of kernel was about 60%-70% that of the palm oil. Taking the conservative lower estimate, the TEP was formulated as OPY + 60% KPY.

ANOVA on pooled data were computed according to the nested design. Missing values or palms and the unequal number of progenies between populations were weighted using the harmonic mean (Steel and Torrie, 1981). Comparisons of means by Duncan's Multiple Range Test (DMRT) and least significant difference (LSD) were generated using the Statistical Analysis System (SAS).

RESULTS AND DISCUSSION

The 12-year mean FFB yield for trial 0.189 was 127.14 kg palm^{-1} yr^{-1} or 18.8 t ha^{-1} yr^{-1}, BNO was 8.12 bunches palm^{-1} yr^{-1} and ABW was 15.92 kg palm^{-1} yr^{-1} (*Tables 2* and *3*). Yields of this trial were somewhat low compared with 30-40 t ha^{-1} yr^{-1} reported by the individual agency (Anon., 1984; Lee and Toh, 1991; Yong and Chan, 1991; Chin, 1991; Sharma and Tan, 1999). Low yield in Hulu Paka was possibly due to the poor inland soil, hilly terrain and the extremely high rainfall (Kushairi, 1992). The annual precipitations of up to 4000 mm yr^{-1} were unevenly distributed (300-2000 mm mth^{-1}) with more rain occurring during the three monsoon months. The excessive moisture had resulted in many rotten bunches being observed following the very wet months.

ANOVA for bunch yield showed significant effects of fertilizers, populations and genotypes (*Table 4a*). In addition, GxF interaction was significant for FFB. The significance of the interaction suggests that variable fertilizer rates would have the advantage of increasing yields in certain progenies, but not others. Significant populations and genotypic differences for FFB and its components implied that the variation between sources of planting materials were attributed to both BNO and ABW.

At the lower fertilizer level (T1), FFB yield was not significantly different from that of the estate's standard rate (T2) despite a significant increase in ABW (*Table 2*), suggesting that the yield difference if any, could be largely due to the differences in BNO. Doubling the fertilizer level (T3) significantly increased the FFB yield which was attributed to improvements ABW yet without any significant change in BNO when compared to treatment T2.

Comparing the six populations, Population 4 had the highest FFB yield, while Population 2 was ranked a close second in T1 and in the *overall mean* (*Table 3*). Populations 2, 4 and 5 in T2, and all other populations in T3, except Population 3, were high yielding and did not differ significantly for FFB yields. Across the fertilizer treatments, Populations 2 and 6 attained lower FFB and ABW at the standard fertilizer rate (T2) as compared to the reduced (T1) and increased (T3) levels. The remaining populations, 1, 3, 4, 5, generally increased in FFB yield as the fertilizer level increased. BNO was reduced when the standard fertilizer rate was altered in all six populations, except Populations 3 and 6, where higher BNO was observed at the higher fertilizer rate. In treatment T3, Population 3 produced the highest BNO but this was not significantly different from those of Populations 2, 5 and 6. On the other hand, Population 3 was consistently hav-

TABLE 2. OVERALL PERFORMANCE (1987-1998) FOR BUNCH YIELDS BASED ON FERTILIZER TREATMENTS IN TRIAL 0.189

Fertilizer treatment*	FFB (kg palm^{-1} yr^{-1})	BNO (No. palm^{-1} yr^{-1})	ABW (kg palm^{-1} yr^{-1})
T1	124.79b	7.98b	15.91b
T2	125.32b	8.21a	15.48c
T3	131.32a	8.17ab	16.36a
Mean	127.14	8.12	15.92

Notes: T1 = half the estate fertilizer rate, T2 = estate fertilizer rate, T3 = double the estate fertilizer rate. Means with the same letter in the same column are not significantly different by DMRT.

TABLE 3. PERFORMANCE (1987-1998) FOR BUNCH YIELD BASED ON POPULATIONS AND FERTILIZER TREATMENTS IN TRIAL 0.189

Pop.	T1			T2			T3			Mean		
	FFB (kg palm^{-1} yr^{-1})	BNO (No. palm^{-1} yr^{-1})	ABW (kg palm^{-1} yr^{-1})	FFB (kg palm^{-1} yr^{-1})	BNO (No. palm^{-1} yr^{-1})	ABW (kg palm^{-1} yr^{-1})	FFB (kg palm^{-1} yr^{-1})	BNO (No. palm^{-1} yr^{-1})	ABW (kg palm^{-1} yr^{-1})	FFB (kg palm^{-1} yr^{-1})	BNO (No. palm^{-1} yr^{-1})	ABW (kg palm^{-1} yr^{-1})
1	122.97b	7.55c	16.73b	125.99b	7.77b	16.41b	128.56ab	7.73b	16.95b	125.85b	7.69e	16.70b
2	136.65a	8.89a	15.66c	131.62ab	8.92a	15.07c	137.77a	8.66a	16.37b	135.33a	8.82a	15.70c
3	110.09c	8.30b	13.31d	110.63c	8.67a	12.89d	123.15b	8.78a	14.18c	114.59c	8.58ba	13.46d
4	137.76a	7.84bc	17.81a	138.23a	8.02b	17.39a	138.26a	7.72b	18.09a	138.08a	7.86de	17.77a
5	125.49b	8.04bc	15.73c	131.63ab	8.72a	15.41c	132.67ab	8.34ab	16.17b	129.92b	8.36bc	15.77c
6	126.98b	8.04bc	16.02bc	124.16b	8.06b	15.45c	134.19ab	8.24ab	16.45b	128.40b	8.11dc	15.97c
Mean	124.79	7.98	15.91	125.32	8.21	15.48	131.32	8.17	16.36	127.14	8.12	15.92

Notes: T1 = half the estate fertilizer rate, T2 = estate fertilizer rate, T3 = double the estate fertilizer rate.
Means with the same letter in the same column are not significantly different by DMRT.

ing the lowest ABW in all three fertilizer levels. It seemed that Population 3 needs a higher fertilizer input, perhaps higher than T3 to produce bigger bunches to pair with the high BNO in order to perform well for FFB yield.

Populations 2 and 4, with the highest ABW, resulted in high FFB yields in all fertilizer levels, hence in the overall mean. The FFB yields of these two populations did not differ significantly (*Table 3*). High yield of Population 4 was largely due to high ABW, and that of Population 2 was attributed to BNO. Differences in BNO and ABW between these populations were about one bunch and 2 kg palm^{-1} yr^{-1}, respectively. It could be seen that a reasonably high BNO is important for a high FFB yield, but the vital component for an even higher yield in this trial was perhaps ABW. The possible reason for ABW to have played a major role in determining FFB yield was probably due to previous selection pressure for high BNO, resulting in consistently high BNO of variable ABW in modern planting materials. Hence, any significant change in higher ABW would perhaps affect the outcome of higher FFB yield. For example, low ABW of Population 3 differed significantly from the rest of the populations as tested by DMRT (*Table 3*). As a result, its FFB yield was significantly the lowest despite a high BNO. On the contrary, high yield of Population 4 was largely attributed to high ABW although the BNO was low. Likewise, Population 1 had the lowest BNO but maintained a high ABW to be statistically similar in FFB to the third and fourth ranked Populations 5 and 6.

At the progeny level (*Table 4b*), Progeny 4062 in treatment T1 yielded the highest FFB (170.48 kg palm^{-1} yr^{-1}) and Progeny 3050 the lowest (66.69 kg palm^{-1}yr^{-1}). In treatment T2, highest and lowest FFB were recorded in Progenies 4056 (166.11 kg palm^{-1} yr^{-1}) and 3037 (88.96 kg palm^{-1} yr^{-1}), respectively. In treatment T3, Progeny 6094 (161.44 kg palm^{-1} yr^{-1}) was highest and, again Progeny 3037 (104.29 kg palm^{-1} yr^{-1}) was lowest. The range in BNO for T1 was 4.68 (Progeny 1001) to 9.82 bunches palm^{-1} yr^{-1} (Progeny 1025), T2 was 5.79 (Progeny 4055) to 10.36 bunches palm^{-1} yr^{-1} (Progeny 4052) and T3 was 6.20 (Progeny 6083) to 11.25 bunches palm^{-1} yr^{-1} (Progeny 5072). In comparison for ABW, Progeny 1004 in T1 (21.14 kg palm^{-1} yr^{-1}) and T3 (21.54 kg palm^{-1} yr^{-1}), and Progeny 1001 (20.63 kg palm^{-1} yr^{-1}) in T2 produced the heaviest bunches. On the contrary, the lowest ABW

TABLE 4a. MEAN SQUARES FOR BUNCH YIELD IN TRIAL 0.189

Source	df	FFB	BNO	ABW
Fertilizers (F)	2	14 602.99**	18.94*	212.65**
Populations (P)	5	33 636.51**	87.50**	1 141.09**
Genotypes within Populations (G)	93	4 048.27**	23.23**	65.53**
P x F	10	1 701.63 ns	4.23 ns	6.44 ns
G x F	186	1 557.42**	5.70 ns	9.08 ns
Palms	3 018	1 554.95	5.79	9.72

Notes: ** P < 0.01, * P < 0.05, ns P > 0.05.

in T1, T2 and T3 were recorded in Progenies 3050 (11.18 kg palm^{-1} yr^{-1}), 3037 (10.60 kg palm^{-1} yr^{-1}) and 3038 (12.49 kg palm^{-1} yr^{-1}), respectively. These three progenies, all from Population 3, were also low for FFB yields. This suggests that some progenies are better adapted to low or high fertilizer regimes.

The overall mean for bunch quality components of this trial (*Table 5*) were comparable to results presented by other workers elsewhere. The mean oil to bunch (O/B) of trial 0.189 was 25.40%. Population 4 attained the highest mesocarp to fruit (M/F), O/B and TEP across all fertilizer treatments. Population 5 recorded the best kernel to bunch (K/B) in every treatment, hence in the overall mean.

Variance analysis indicated significant populations and genotypes differences for all bunch quality components. Mean fruit weight (MFW), oil to wet mesocarp (O/WM), O/B and KPY differed significantly for the fertilizers item (*Table 6*). Both the interaction items, namely, population x fertilizer (PxF) and GxF were significant for M/F, kernel to fruit (K/F), shell to fruit (S/F) and K/B. The GxF effects were also significant for OPY and KPY. Significant interaction suggests that under varying fertilizer levels certain populations and progenies might have avail themselves the advantage for improvements in bunch quality components, oil and kernel yields.

Responses of the progenies on bunch quality components towards the different fertilizer treatments were marginal for most traits, otherwise no significant changes were noted (*Table 5*). The M/F, K/F, S/F, F/B and K/B were not significantly affected by altering the fertilizer levels. Although there were changes in values of MFW, O/DM, O/WM and O/B in T1 as compared to T2, these were however, not significantly different. On the contrary, significant reductions in the values of the traits as tested by DMRT (*Table 5*) were observed when the level of fertilizer was double the normal. Increases in OPY, KPY and TEP with increased fertilizer as compared to the standard rate were most likely attributed to the improvements in FFB yield. Generally, the effect on bunch quality components between fertilizer treatments T1 and T2 was not significantly different. Although significant increase in values of some bunch quality attributes were noted in T3, the changes however, might not justify an elevated fertilizer input under normal estate practice as the profit margin would be marginal.

The progeny means for O/B, K/B and TEP based on fertilizer treatments in *Table 7* showed that pooled mean O/B ranged from 19.84% (Progeny 6081) to 28.29% (Progeny 2027). The values for K/B in T3 and the overall mean were highest in Progenies 1019 and 1007. TEP production for Progeny 2029 was best in treatment T3, largely attributed to high O/B (28.69%) and high FFB yield. Kernel content in bunches of Progeny 5065 (8.88%) was lower compared with that of PORIM Series 3 (PS3) that produces 10.53% to 13.26% K/B (Rajanaidu *et al.*, 1996).

All the six populations of trial 0.189 had high KPY under the increased fertilizer rate (T3). Under this fertilizer rate, Populations 5 and 2 had high KPY, with 12.36 kg palm^{-1} yr^{-1} and 10.89 kg palm^{-1} yr^{-1}, respectively. Outstanding genotypes for KPY from these populations might be exploited for lauric oil production. Maximum OPY and TEP for Populations 1, 3, 5 and 6 were accounted for in T3 (*Table 5*), implying the need for higher fertilizer input for better yields. Generally, OPY and TEP improved with increasing fertilizer rates, except Populations 2 and 4. Population 2 in T1 produced the highest TEP, which was the best production among the three fertilizer treatments and the six populations.

TABLE 4b. PROGENY MEAN (1987-1998) FOR BUNCH YIELD BASED ON FERTILIZER TREATMENTS IN TRIAL 0.189

Progeny	T1			T2			T3		
	FFB (kg palm^{-1} yr^{-1})	BNO (No. palm^{-1} yr^{-1})	ABW (kg palm^{-1} yr^{-1})	FFB (kg palm^{-1} yr^{-1})	BNO (No. palm^{-1} yr^{-1})	ABW (kg palm^{-1} yr^{-1})	FFB (kg palm^{-1} yr^{-1})	BNO (No. palm^{-1} yr^{-1})	ABW (kg palm^{-1} yr^{-1})
1001	87.67	**4.68**	18.68	140.15	6.84	**20.63**	122.71	6.22	19.71
1002	134.18	8.76	15.38	128.76	8.08	15.81	138.39	8.70	15.68
1003	145.74	9.05	16.39	144.15	9.28	15.48	118.35	7.52	15.79
1004	153.96	7.31	**21.14**	147.95	8.02	19.01	149.56	6.91	**21.54**
1005	142.00	8.58	16.36	109.37	6.15	17.18	109.65	7.05	15.01
1006	138.37	7.25	19.36	126.59	7.25	17.82	144.76	8.18	17.69
1007	94.55	6.73	15.56	121.74	8.33	15.01	139.45	8.53	17.06
1008	120.03	7.05	17.17	146.07	8.21	17.86	125.68	7.26	18.33
1009	137.33	8.58	16.15	122.35	8.30	14.81	131.23	8.65	15.80
1010	138.89	8.75	16.72	145.78	9.59	15.23	136.42	8.25	16.71
1011	116.04	7.60	15.36	122.48	8.13	15.04	116.54	7.38	16.09
1012	111.25	7.77	13.80	113.66	7.93	14.09	141.23	9.27	15.44
1013	126.35	8.00	15.59	124.48	8.62	14.22	145.77	9.46	14.98
1014	137.54	7.25	19.70	128.56	7.19	18.12	143.93	7.75	19.49
1015	118.04	5.69	20.91	132.28	6.93	19.25	143.16	8.03	18.59
1016	114.14	8.25	13.47	109.17	7.56	14.68	118.60	8.29	14.13
1017	103.43	7.54	14.36	110.12	8.58	13.06	131.48	9.26	14.49
1018	128.10	8.16	16.08	130.33	7.91	16.61	115.61	6.85	16.61
1019	126.11	7.84	16.45	132.62	8.09	16.56	123.72	7.89	15.92
1020	124.70	9.53	13.62	109.84	8.24	13.72	118.74	8.20	15.03
1021	123.25	6.95	17.92	136.41	7.32	18.75	117.57	6.45	18.82
1022	116.12	6.19	19.07	133.59	6.85	19.28	140.58	6.98	21.11
1023	106.30	5.90	18.66	127.91	6.82	18.92	119.03	6.65	17.43
1024	100.92	6.54	15.99	105.22	6.38	16.53	116.56	7.38	15.78
1025	140.65	**9.82**	14.26	126.61	8.72	14.02	124.81	8.20	15.22
1026	96.93	5.79	16.81	107.81	6.77	15.94	112.28	6.39	17.52
2027	134.18	9.19	15.16	112.32	8.15	14.38	119.70	7.41	16.90
2028	136.49	9.36	15.11	156.67	9.64	16.46	115.67	6.44	18.30
2029	128.40	9.00	14.54	131.66	9.84	13.67	153.82	10.53	14.71
2030	136.67	8.04	17.09	126.64	8.84	14.66	137.78	7.92	17.78
2031	139.50	8.87	16.02	139.96	8.94	15.76	147.34	9.73	15.30
2032	143.08	9.01	15.69	121.71	8.14	15.39	151.45	9.81	15.30
3033	108.68	8.21	13.04	119.02	10.17	12.31	114.55	8.88	13.61
3034	118.87	8.90	13.36	104.02	8.11	12.58	119.68	8.73	13.55
3035	102.81	7.54	13.77	105.68	8.44	13.06	125.24	8.76	14.49
3036	100.17	7.81	13.25	105.73	8.17	13.12	105.88	7.62	14.28
3037	108.35	9.08	12.22	**88.96**	7.82	**10.60**	**104.29**	8.33	12.71
3038	103.47	8.22	11.92	120.36	9.33	13.17	108.85	8.81	**12.49**
3039	116.74	8.20	12.77	113.31	8.90	13.01	116.88	116.88	14.34
3040	119.31	7.77	15.12	94.64	6.93	13.21	120.48	7.79	15.39
3041	98.61	8.52	11.53	122.24	10.09	11.82	135.69	9.25	14.78
3042	125.63	8.71	14.29	125.09	9.27	13.89	124.78	9.74	12.91
3043	124.83	9.05	14.11	124.22	9.21	13.70	135.11	9.52	13.96
3044	98.79	7.45	13.62	100.18	8.92	11.69	121.57	7.90	15.71
3045	105.70	8.98	11.68	103.03	7.64	13.47	137.20	10.05	13.56
3046	95.65	7.98	12.04	120.83	9.76	12.54	115.03	8.43	13.71
3047	123.50	8.34	15.06	115.94	7.61	15.29	141.39	9.00	15.80
3048	99.16	8.15	12.36	111.10	9.80	11.39	130.50	9.04	14.73
3049	158.83	9.05	17.74	102.64	7.64	13.59	128.28	8.57	15.01
3050	**66.69**	6.20	**11.18**	118.83	8.72	13.70	127.95	9.23	14.14

TABLE 4b. Continued

Progeny	T1			T2			T3		
	FFB (kg palm^{-1} yr^{-1})	BNO (No. palm^{-1} yr^{-1})	ABW (kg palm^{-1} yr^{-1})	FFB (kg palm^{-1} yr^{-1})	BNO (No. palm^{-1} yr^{-1})	ABW (kg palm^{-1} yr^{-1})	FFB (kg palm^{-1} yr^{-1})	BNO (No. palm^{-1} yr^{-1})	ABW (kg palm^{-1} yr^{-1})
4051	151.66	8.56	17.83	141.78	9.29	15.58	132.35	7.77	16.67
4052	154.35	9.72	16.06	163.38	**10.36**	16.07	137.16	8.58	16.62
4053	144.29	8.19	18.27	141.19	8.50	16.21	125.78	7.15	18.25
4054	134.18	8.04	16.90	100.86	6.76	15.80	127.09	7.81	16.54
4055	100.22	5.94	17.06	110.80	**5.79**	18.90	133.37	7.08	18.76
4056	135.72	9.03	15.11	**166.11**	9.51	17.60	133.93	8.22	16.35
4057	124.60	7.18	17.50	127.25	8.38	15.59	105.28	6.55	16.24
4058	120.92	6.10	20.09	129.16	6.45	20.28	151.70	7.16	21.30
4059	149.39	8.38	18.11	119.99	6.92	17.21	141.97	7.39	19.34
4060	136.11	7.50	18.20	140.23	8.08	17.49	149.28	7.90	18.93
4061	134.59	8.17	16.06	154.04	9.46	16.34	160.65	8.77	18.69
4062	**170.48**	8.58	20.22	146.73	7.59	18.46	149.58	7.92	18.89
4063	137.41	7.36	19.04	151.85	7.98	18.98	152.34	8.21	18.82
4064	134.64	7.08	18.72	144.52	7.75	18.42	134.49	7.74	17.48
5065	135.42	9.02	15.08	141.35	9.96	14.56	128.39	8.48	14.87
5066	125.39	7.81	16.12	146.04	9.71	15.31	135.97	8.46	16.71
5067	133.36	7.26	18.67	122.93	7.12	17.23	121.59	6.52	18.48
5068	122.37	7.99	15.11	116.80	6.94	17.17	110.46	7.19	16.56
5069	141.31	8.65	16.42	121.93	7.83	15.57	134.50	8.54	15.42
5070	91.10	5.50	15.92	129.78	9.04	14.50	121.46	7.55	16.07
5071	136.51	8.85	15.35	143.30	9.78	14.83	138.51	9.19	15.18
5072	125.86	9.63	12.79	145.71	10.33	14.61	155.45	**11.25**	13.99
5073	115.59	7.01	16.86	117.31	7.45	15.64	121.45	6.61	17.69
5074	128.64	8.54	15.23	129.31	8.84	14.76	157.88	9.59	16.70
6075	140.65	8.53	16.86	149.52	9.87	14.95	153.66	9.68	16.16
6076	109.08	6.38	16.91	130.55	8.12	15.93	119.98	7.36	16.21
6077	129.76	8.45	15.66	130.10	8.13	16.08	126.57	8.33	15.27
6078	144.00	8.43	17.18	145.25	9.13	16.40	156.72	8.61	18.35
6079	121.82	7.29	16.45	118.73	7.10	16.73	134.63	7.43	18.49
6080	117.63	7.36	15.96	131.54	8.54	15.55	133.85	7.04	19.57
6081	133.72	8.81	15.36	121.81	7.56	16.04	129.83	8.51	15.82
6082	103.63	6.15	17.13	102.71	7.04	15.18	136.89	8.41	15.92
6083	104.61	6.68	16.11	109.62	5.94	18.50	116.03	**6.20**	18.97
6084	123.38	6.79	19.00	104.49	6.85	15.65	109.90	6.21	17.56
6085	114.45	8.47	13.40	116.93	8.10	14.20	126.68	7.84	15.91
6086	121.79	7.88	15.73	127.11	7.83	16.42	132.32	7.57	17.44
6087	137.02	9.03	15.40	112.40	8.41	12.97	136.97	9.13	14.57
6088	99.37	7.86	12.89	124.60	9.07	13.00	118.62	8.83	13.07
6089	144.91	8.70	16.98	121.34	8.33	14.68	131.78	8.16	16.25
6090	120.67	8.30	14.70	117.62	7.75	15.63	116.13	7.52	16.18
6091	141.57	8.82	16.36	131.09	7.73	16.94	155.76	9.81	15.96
6092	100.74	6.69	15.65	115.27	8.05	14.41	119.34	7.15	16.92
6093	151.21	9.64	16.75	139.96	9.13	15.19	155.33	8.93	17.44
6094	135.53	8.97	14.94	129.53	8.97	13.83	**161.44**	10.34	15.63
6095	127.51	7.33	17.25	118.11	6.58	18.27	148.14	7.78	19.22
6096	159.21	9.73	16.51	146.23	8.66	16.30	139.11	8.54	15.76
6097	123.87	8.21	15.88	130.98	9.03	14.78	142.39	8.31	17.61
6098	138.91	9.13	15.20	123.04	8.09	15.37	136.10	9.90	13.51
6099	108.03	6.62	16.51	103.16	7.42	13.40	110.87	7.25	15.17

Notes: T1 = half the estate fertilizer rate, T2 = estate fertilizer rate, T3 = double the estate fertilizer rate.
Figures in bold within each column are minimum and maximum values.

TABLE 5. MEAN PERFORMANCE OF OIL PALM POPULATIONS FOR BUNCH QUALITY COMPONENTS BASED ON FERTILIZER IN TRIAL 0.189

Population	MFW (g)				M/F (%)				K/F(%)				S/F (%)			
	T1	T2	T3	Mean	T1	T2	T3	Mean	T1	T2	T3	Mean	T1	T2	T3	Mean
1	9.44	9.43	9.11	9.32	77.59	77.55	77.01	77.38	9.16	9.39	9.65	9.40	13.25	13.06	13.34	13.22
2	9.63	9.67	9.64	9.65	77.63	77.13	75.70	76.79	10.45	10.38	10.63	10.49	11.92	12.50	13.68	12.72
3	8.47	9.07	8.40	8.64	76.46	77.68	77.75	77.30	9.95	9.47	9.43	9.60	13.63	12.84	12.82	13.10
4	10.15	9.62	10.02	9.93	79.14	78.90	78.13	78.75	8.57	8.99	9.00	8.85	12.29	12.12	12.87	12.41
5	8.19	8.16	7.81	8.07	72.35	73.16	72.92	72.81	11.74	11.77	11.83	11.77	15.91	15.07	15.25	15.42
6	9.95	10.65	10.01	10.20	77.40	78.12	77.81	77.77	9.24	8.97	9.23	9.15	13.36	12.92	12.96	13.08
Mean	9.38ab	9.58a	9.25b	9.40	77.03a	77.41a	77.05a	77.17	9.58a	9.56a	9.67a	9.60	13.39a	13.03a	13.27a	13.23
$LSD_{0.05}$	0.25	0.27	0.24	0.26	0.54	0.53	0.57	0.55	0.25	0.25	0.26	0.25	0.37	0.38	0.40	0.38

Population	O/DM (%)				O/WM (%)				F/B(%)				O/B (%)			
	T1	T2	T3	Mean	T1	T2	T3	Mean	T1	T2	T3	Mean	T1	T2	T3	Mean
1	79.27	79.25	78.77	79.10	49.85	49.38	48.58	49.27	67.75	67.62	67.90	67.76	26.26	25.83	25.43	25.84
2	78.94	78.85	78.25	78.67	49.78	48.38	47.57	48.55	68.42	68.29	68.51	68.41	26.39	25.44	24.71	25.49
3	78.56	79.28	78.95	78.93	50.07	50.98	49.76	50.27	86.01	65.70	65.62	65.78	25.26	26.05	25.39	25.56
4	79.44	79.51	79.57	79.50	51.45	50.39	50.42	50.77	65.43	65.02	65.75	65.38	26.62	25.90	25.93	26.16
5	77.34	77.57	76.66	77.23	46.50	47.30	46.05	46.66	66.19	66.79	67.53	66.80	22.48	23.22	22.74	22.82
6	78.88	79.13	78.74	78.92	49.35	49.30	48.36	49.01	66.77	67.00	66.05	66.61	25.53	25.82	24.89	25.42
Mean	78.85ab	79.05a	78.68b	78.86	49.65a	49.51a	48.70b	49.29	66.73a	66.68a	66.70a	66.71	25.57a	25.57a	25.06b	25.40
$LSD_{0.05}$	0.35	0.29	0.30	0.31	0.54	0.53	0.55	0.31	0.44	0.50	0.45	0.46	0.38	0.39	0.39	0.39

TABLE 5. Continued

Population	K/B (%)				OPY (kg palm^{-1} yr^{-1})				KPY (kg palm^{-1} yr^{-1})				TEP (kg palm^{-1} yr^{-1})			
	T1	T2	T3	Mean	T1	T2	T3	Mean	T1	T2	T3	Mean	T1	T2	T3	Mean
1	6.21	6.38	6.55	6.38	33.62	33.71	34.05	33.80	7.92	8.31	8.69	8.30	38.37	38.70	39.27	38.78
2	7.15	7.10	7.30	7.19	36.83	34.78	33.97	35.17	9.99	9.75	10.36	10.04	42.83	40.64	40.19	41.19
3	6.59	6.24	6.21	6.35	28.85	30.19	32.68	30.59	7.53	7.20	8.00	7.58	33.37	34.51	37.48	35.14
4	5.65	5.87	5.95	5.82	37.87	37.36	37.59	37.61	8.00	8.26	8.61	8.28	42.67	42.31	42.75	42.57
5	7.74	7.85	7.98	7.85	29.55	31.40	32.93	31.20	10.16	10.59	11.70	10.76	35.65	37.75	39.95	37.66
6	6.18	6.00	6.12	6.10	33.06	33.35	34.95	33.78	7.99	7.79	8.67	8.15	37.85	38.03	40.16	38.67
Mean	6.40a	6.39a	6.47a	6.42	33.01b	33.31b	34.38a	33.56	8.24b	8.30b	8.92a	8.48	37.95b	38.29b	39.74a	38.65
$LSD_{0.05}$	0.17	0.17	0.18	0.18	0.94	0.97	1.07	0.99	0.30	0.31	0.36	0.32	1.03	1.07	1.18	1.09

Notes: T1 = half the normal estate rate, T2 = normal estate rate, T3 = double the normal estate rate. Bunch analysis 1987-1998.
Means within a trait with the same letter are not significantly different by DMRT.

TABLE 6. MEAN SQUARES FOR BUNCH QUALITY COMPONENTS IN TRIAL 0.189

Source	df	MFW	M/F	K/F	S/F	O/DM	O/WM
Fertilizers (F)	2	73.67**	37.60 ns	16.91 ns	4.92 ns	33.38 ns	203.45**
Populations (P)	5	163.29**	696.66**	200.09**	172.02**	88.40**	328.24**
Genotypes within Populations (G)	93	15.45**	127.47**	18.08**	80.77**	15.20*	53.84**
P x F	10	7.88 ns	53.35*	12.87*	25.78*	9.35 ns	16.96 ns
G x F	186	7.07 ns	35.11**	8.13**	15.59**	9.49 ns	26.14 ns
Palms	2 142	7.28	28.66	6.60	13.46	11.47	33.09
Source	**df**	**F/B**	**O/B**	**K/B**	**OPY**	**KPY**	**TEP**
Fertilizers (F)	2	66.06 ns	104.93**	5.82 ns	88.52 ns	57.80**	128.62 ns
Populations (P)	5	228.03**	219.00**	97.22**	1418.23**	179.42**	1362.56**
Genotypes within Populations (G)	93	41.15**	38.56**	8.66**	211.74**	19.60**	235.31**
P x F	10	30.64 ns	17.39 ns	6.71*	95.83 ns	8.49 ns	103.73 ns
G x F	186	21.49 ns	13.87 ns	3.65**	110.02**	11.77**	132.19 ns
Palms	2142	24.48	16.02	3.22	108.89	11.23	133.48

Notes: $^{**}P< 0.01$, $^{*}p<0.05$, ns $P>0.05$

Population 4 had highest TEP in treatments T2, T3 and the overall mean when compared with other populations. However, the best TEP of Population 4 was recorded in T1. Thus, Populations 4 and 2 might be potentially viable in reducing cost of fertilizers and increasing productivity concurrently.

At half the normal fertilizer level (T1), Progeny 4051 produced the best TEP (*Table 7*). On the contrary, TEP of this progeny was low at twice the standard fertilizer rate (T3), indicating GxF interaction causing contrasting yields. Despite producing the best FFB in T3, the TEP of Progeny 6094 was only slightly above that of the treatment mean. Contrasting performances between the progenies were likely due to the lower O/B in Progeny 6094 despite the high K/B, suggesting that the increase in kernel content was insufficient to compensate for the low O/B for increasing TEP.

The TEP in T3 differed significantly from T1 and T2 by DMRT (*Table 5*), and the variations between populations and genotypes were distinguishable by ANOVA (*Table 6*). While Progeny 5073 in T3 and Progeny 4051 in T1 were highly productive for TEP, Progeny 4056 in T2 produced the highest TEP among all progenies and fertilizer rates. Progeny 4056 seemed to have responded for a higher TEP under the normal fertilizer application. Outstanding TEP of this progeny was ascribed to the high O/B, moderate K/B and high FFB. The high FFB yield resulted from high and balanced BNO and ABW.

In spite of the significant differences in the bunch quality components, differences in TEP were largely due to the variation in the bunch yields rather than the bunch quality components. Genotypes and populations that were similar in oil and kernel production but higher in bunch yields had significant advantage for a better TEP as compared to those producing lower FFB.

CONCLUSION

Altering the standard estate's fertilizer rate had significantly affected the performance of some oil palm genotypes and populations. Generally, doubling the fertilizer rate improved the TEP production, largely attributed to the increase in KPY and FFB yields. Yield improvements at double the fertilizer input and hence twice the cost may not be economically attractive unless the profit margin due to increase TEP was large. While Progeny 4051 yielded the best TEP at half the normal fertilizer rate, Progeny 4056 was outstanding at the normal estate rate and Progeny 5073 at double the rate. Mass production of cost effective populations and progenies in environments similar to Hulu Paka, *i.e.* exploiting specific combining ability, might be feasible for higher productivity in the oil palm.

TABLE 7. PROGENY MEAN FOR O/B, K/B AND TEP BASED ON FERTILIZER TREATMENTS IN TRIAL 0.189

Prog.	O/B (%)				K/B (%)				TEP (kg palm^{-1} yr^{-1})			
	TI	T2	T3	Mean	TI	T2	T3	Mean	TI	T2	T3	Mean
1001	24.23	23.99	23.55	23.87	7.13	8.14	8.19	7.90	26.91	40.39	35.36	34.85
1002	27.85	24.01	26.50	26.25	4.92	7.29	5.36	5.78	40.86	36.05	45.29	40.89
1003	28.24	28.14	27.74	28.08	6.24	6.37	6.76	6.42	46.94	45.04	45.36	45.89
1004	25.06	28.30	24.17	25.99	6.74	5.61	6.47	6.29	46.79	45.09	49.28	**46.74**
1005	26.34	26.31	23.54	25.48	6.77	6.44	6.98	6.73	47.36	34.93	38.53	40.89
1006	26.41	23.41	23.67	24.56	6.67	5.82	5.03	5.80	40.57	33.50	40.68	38.77
1007	21.90	21.19	21.25	21.43	5.47	6.89	5.11	5.78	24.68	32.79	34.14	30.76
1008	23.15	22.58	20.92	22.32	6.00	7.37	6.83	6.73	33.68	39.48	33.27	35.65
1009	26.25	22.63	26.32	25.07	4.85	5.89	5.66	5.43	40.88	34.70	40.99	38.85
1010	25.33	26.39	25.98	25.92	6.76	6.89	6.29	6.64	42.01	46.23	39.12	42.47
1011	26.41	27.86	24.73	26.38	5.80	6.03	6.90	6.28	34.62	40.05	35.97	37.24
1012	24.80	25.84	24.35	25.06	6.79	6.80	7.27	6.94	33.59	35.97	45.44	38.15
1013	28.67	26.67	26.45	27.12	6.37	5.62	7.47	6.43	43.41	39.01	42.36	41.27
1014	26.73	23.82	27.18	26.33	6.62	7.03	6.34	6.59	44.34	43.42	47.38	45.37
1015	27.75	26.12	25.39	26.28	5.33	5.45	6.73	5.93	40.86	40.21	44.39	42.06
1016	25.92	23.62	24.41	24.66	6.11	6.76	7.09	6.63	35.37	30.35	36.72	34.04
1017	24.38	25.23	24.30	24.63	6.95	7.28	6.44	6.87	31.61	32.87	36.95	33.91
1018	26.22	26.79	27.27	26.74	5.84	5.56	5.44	5.62	37.72	38.43	35.86	37.31
1019	25.91	25.73	27.38	26.38	6.60	6.28	6.47	6.45	39.34	37.30	38.49	38.38
1020	27.06	25.98	27.48	26.81	6.23	5.18	6.64	5.99	40.98	34.85	36.92	37.61
1021	26.49	28.53	25.63	26.71	5.41	5.15	5.95	5.55	36.68	47.69	35.05	39.02
1022	26.12	28.02	27.81	27.31	6.00	6.04	4.95	5.74	31.13	41.37	41.75	37.93
1023	26.38	28.84	26.47	27.13	6.18	5.70	5.75	5.90	34.88	44.61	39.19	39.16
1024	25.82	26.93	26.77	26.52	7.19	6.83	7.19	7.08	31.35	34.37	37.17	34.40
1025	25.90	24.00	23.69	24.57	6.04	5.84	7.36	6.40	41.52	36.18	33.78	37.29
1026	**30.77**	27.74	26.20	**28.29**	6.30	7.69	8.36	7.42	36.18	40.84	36.17	37.38
2027	25.61	23.81	23.85	24.45	6.25	7.68	7.83	7.24	39.76	34.69	37.48	37.40
2028	28.25	23.67	24.09	25.18	5.95	5.86	6.03	5.95	46.17	44.10	**29.67**	39.37
2029	28.92	27.85	27.85	28.14	5.84	6.74	7.06	6.60	41.75	42.70	50.11	45.00
2030	25.70	24.65	21.76	24.09	7.46	7.57	7.38	7.47	40.23	37.61	34.43	37.52
2031	26.04	26.79	25.27	26.03	8.81	7.54	8.02	8.10	43.83	43.72	44.17	43.91
2032	24.93	24.89	25.25	25.03	7.82	7.12	7.32	7.45	45.55	39.74	44.08	43.46
3033	26.78	27.58	27.54	27.33	5.59	5.83	5.66	5.70	32.73	38.15	35.14	35.43
3034	22.65	24.88	22.86	23.41	9.71	8.14	7.91	8.60	35.85	33.95	36.52	35.50
3035	24.87	26.52	26.71	26.01	7.51	6.52	5.58	6.57	29.78	32.29	40.59	34.00
3036	28.75	27.61	26.01	27.52	6.18	5.48	5.61	5.75	34.32	33.02	36.89	34.54
3037	24.73	24.19	23.37	24.10	6.63	8.12	6.49	7.08	31.77	**27.79**	30.22	**29.92**
3038	26.40	28.51	27.61	27.54	6.05	5.58	5.44	5.68	30.79	39.56	37.96	36.24
3039	25.37	25.33	24.75	25.16	6.60	6.29	7.06	6.65	34.44	33.97	33.48	33.98
3040	25.58	27.77	26.27	26.52	7.28	5.79	5.36	6.08	38.83	32.83	36.94	36.26
3041	23.53	25.62	27.22	25.67	6.19	6.08	6.23	6.17	32.44	40.13	44.75	39.82
3042	25.92	26.15	23.32	25.16	5.29	5.66	5.81	5.59	34.34	37.17	33.96	35.23
3043	26.60	25.16	23.98	25.42	6.31	6.10	6.10	6.18	40.22	36.40	43.31	39.52
3044	24.14	24.53	23.71	24.13	6.43	7.77	6.67	6.92	30.22	30.69	36.21	32.21
3045	23.95	26.56	25.48	25.33	5.78	5.94	6.27	5.99	31.75	31.19	40.33	34.43
3046	23.83	23.28	23.87	23.66	8.45	**8.40**	7.14	8.01	27.53	35.47	32.45	31.69
3047	24.54	28.42	26.19	26.23	5.20	3.97	5.67	5.04	35.64	37.47	41.72	38.45
3048	24.47	23.71	24.72	24.31	7.34	6.84	7.55	7.25	29.00	32.11	39.76	33.82
3049	26.66	26.11	26.37	26.39	5.61	**3.76**	5.04	4.85	48.05	32.30	38.05	39.66
3050	26.54	27.73	26.39	26.89	5.84	5.67	6.00	5.84	**21.65**	37.68	37.55	33.21

TABLE 7. Continued

Prog.	O/B (%)				K/B (%)				TEP (kg palm^{-1} yr^{-1})			
	TI	T2	T3	Mean	TI	T2	T3	Mean	TI	T2	T3	Mean
4051	26.77	25.26	21.71	24.39	5.79	6.33	6.44	6.21	**50.63**	40.89	34.72	41.49
4052	28.14	27.38	23.54	26.58	4.52	5.01	5.34	4.92	43.87	48.46	35.16	43.08
4053	27.85	28.25	28.35	28.12	4.76	4.33	**4.18**	4.46	46.18	48.49	42.54	46.23
4054	23.91	24.29	24.23	24.14	7.42	9.32	8.62	8.45	38.55	29.98	40.68	36.24
4055	26.94	25.29	26.09	26.14	5.76	6.15	6.83	6.21	31.31	33.11	44.68	35.87
4056	27.33	25.53	25.44	26.13	5.15	6.74	6.42	6.06	42.65	**51.41**	42.34	45.08
4057	26.53	26.81	28.50	27.23	8.21	6.42	6.22	7.04	38.76	44.39	36.50	39.81
4058	27.04	23.43	26.96	25.43	5.92	5.16	5.60	5.48	42.28	34.84	44.36	39.67
4059	26.69	28.48	27.38	27.49	6.10	7.07	6.86	6.65	44.97	42.46	47.66	44.94
4060	24.86	25.97	25.23	25.36	5.37	5.75	5.28	5.48	39.65	40.57	47.82	42.50
4061	28.46	27.67	26.13	27.48	5.03	4.82	5.20	5.00	45.16	47.79	47.52	46.87
4062	25.22	24.67	26.34	25.24	5.04	4.81	6.62	5.29	48.57	44.54	48.01	46.86
4063	26.40	23.54	27.49	25.99	**4.16**	5.31	4.32	4.54	43.85	42.86	47.72	44.97
4064	26.90	25.37	26.48	26.31	5.64	5.39	5.08	5.36	42.04	42.15	40.71	41.60
5065	20.19	22.51	19.80	20.92	8.57	8.31	**10.19**	**8.88**	35.09	38.39	35.73	36.43
5066	25.91	23.92	21.77	24.19	8.28	8.56	7.84	8.29	41.86	43.46	43.06	42.75
5067	25.72	26.98	25.72	26.22	6.71	6.61	7.35	6.82	40.08	39.56	34.95	38.64
5068	23.33	23.15	21.03	22.36	6.37	7.43	8.01	7.38	36.72	32.43	30.02	32.61
5069	23.31	24.41	24.49	24.11	7.01	7.11	7.18	7.10	38.62	36.47	38.77	37.88
5070	**18.07**	21.29	21.83	20.39	**8.96**	8.11	8.17	8.40	26.17	33.53	42.27	33.35
5071	19.24	**20.79**	**19.43**	**19.84**	7.59	7.26	8.02	7.59	33.90	36.70	34.48	35.06
5072	21.67	20.90	22.87	21.74	7.00	8.43	7.60	7.68	34.55	38.78	44.75	39.01
5073	24.30	24.71	26.79	25.17	8.64	9.57	8.23	8.83	33.40	37.73	**50.58**	39.85
5074	24.33	24.88	24.23	24.47	7.83	7.32	7.65	7.61	36.49	41.03	46.36	41.30
6075	28.00	25.11	22.70	25.29	5.50	6.82	8.02	6.78	43.80	43.27	42.39	43.14
6076	25.28	23.85	27.79	25.48	6.27	6.75	5.56	6.24	33.85	39.29	36.92	36.67
6077	25.01	27.23	26.02	26.00	6.87	5.84	5.33	5.98	37.98	38.69	37.69	38.05
6078	26.62	27.06	25.09	26.27	5.73	5.77	5.33	5.61	43.10	44.76	45.90	44.54
6079	27.52	25.66	**28.81**	27.59	4.65	5.65	4.84	4.96	35.42	37.18	44.70	39.39
6080	23.33	25.38	22.77	23.90	6.54	4.59	5.46	5.37	35.26	37.22	34.24	35.62
6081	26.79	27.08	25.15	26.28	5.45	6.00	5.11	5.49	39.91	37.35	36.68	37.96
6082	24.83	24.89	24.33	24.71	6.78	6.58	7.92	7.03	32.09	29.79	44.17	34.67
6083	23.68	24.38	23.12	23.82	6.76	6.03	7.42	6.63	30.03	33.60	32.06	31.95
6084	23.39	26.48	23.67	24.43	7.42	6.31	8.23	7.33	34.82	34.96	34.04	34.62
6085	25.54	26.17	24.83	25.54	6.36	6.09	5.84	6.10	33.65	35.86	40.70	36.60
6086	27.35	27.54	26.53	27.12	4.58	4.96	5.38	4.96	36.50	40.26	39.86	38.71
6087	24.97	**28.99**	25.22	26.42	5.87	5.17	6.17	5.71	38.78	38.50	44.11	40.18
6088	25.50	24.34	21.62	23.89	6.92	6.31	6.76	6.66	29.65	38.53	32.22	33.51
6089	26.56	26.53	24.64	26.00	4.95	5.24	4.99	5.06	42.89	34.50	38.68	38.69
6090	25.01	23.98	23.92	24.24	6.52	6.61	5.81	6.25	36.69	34.74	32.06	34.17
6091	24.07	26.62	25.50	25.44	6.78	5.90	5.57	6.07	39.99	40.81	45.60	42.09
6092	25.92	24.80	25.18	25.18	6.69	6.87	7.04	6.89	34.12	35.34	37.47	35.89
6093	24.26	24.99	23.20	24.18	5.47	5.44	5.47	5.46	44.38	39.86	43.62	42.47
6094	25.45	25.81	26.68	25.96	6.96	6.21	5.67	6.30	40.62	41.95	46.72	43.02
6095	26.07	27.46	25.37	26.25	5.84	5.55	5.88	5.77	36.83	36.14	44.29	39.04
6096	25.72	26.29	25.93	25.98	7.51	6.10	6.34	6.65	47.92	45.65	45.60	46.39
6097	25.32	25.24	23.31	24.79	5.50	5.80	7.69	6.15	35.94	39.49	45.77	39.64
6098	23.62	23.39	24.98	23.95	6.59	6.95	6.40	6.67	40.56	37.08	43.68	40.18
6099	25.70	26.33	24.76	25.62	7.33	6.55	7.35	7.05	35.04	32.94	35.77	34.50
Mean	25.57	25.57	25.06	25.40	6.40	6.39	6.47	6.42	37.95	38.29	39.74	38.65

Note: figures in bold within each column are minimum and maximum values.

The ranking for overall TEP production was Populations 4, 2, 6, 1, 5 and 3. Additionally, Populations 4 and 2 offered prospects for higher oil yields at half the cost, while Population 5 might be advantageous in lauric oil production. Thus, the current oil palm DxP planting materials produced in Malaysia had provided alternatives to the industry for the production of either oil, kernel or total economic product.

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