Pertanika Proceedings 1 (7): 147 - 150 (2025)

PERTANIKA JOURNALS

PERTANIKA PROCEEDINGS

Journal homepage: http://www.pertanika.upm.edu.my/

Evaluation of *Pisifera* Male Parents for Producing High-yielding and Sustainable Oil Palm Planting Material

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ABSTRACT

During 2023-2024, oil palm (*Elaeis guineensis* Jacq.) accounted for more than 36% of global vegetable oil supply. The commercial cultivation of oil palm is based on crosses between *dura* (D) and *pisifera* (P) types, which require selection of superior parental lines. This study aimed to identify elite *pisifera* male parents for developing high-yielding D×P planting materials. Eleven *pisifera* male parents were evaluated based on their 38 D×P progenies established at one of the MPOB research stations located in Hulu Paka, Terengganu, Malaysia. Analysis of variance was used to analyse data on bunch quality components (year 2011–2018), bunch yield (year 2014–2017), and vegetative measurements (year 2015), where mean comparison was carried out thereafter. Most of the traits exhibited highly significant differences ($p<0.01$), indicating wide genetic variability among the AVROS, MPOB-Nigeria, and MPOB-Nigeria × United Plantations (UP) *pisifera* male parents. Among them, P6 (*pisifera* 0.337/552) recorded the highest fresh fruit bunch yield (FFB = 206.29 kg palm^{-1} year^{-1}) and oil yield (OY = 63.54 kg palm^{-1} year^{-1}), surpassing the D×P standard cross by 15% and 25%. Its progenies also exhibited a trunk height (HT) of 2.09 m, which was 26% lower than the standard cross. Molecular analysis confirmed P6 as homozygous *virescens*, ensuring a clear fruit colour change at ripening that enhances harvesting efficiency. In conclusion, P6 is a promising male parent for developing new commercial D×P planting materials, maximising productivity and harvesting efficiency.

Keywords: oil yield, *pisifera* male parent, pollen source, *virescens*

ARTICLE INFO

Article history:
Received: 27 October 2025
Published: 10 December 2025

DOI: https://doi.org/10.47836/pp.1.7.026

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INTRODUCTION

Among global oilseed crops, oil palm or *Elaeis guineensis* Jacq., ranks as the highest-yielding oil crop, consistently exceeding yields from soybean, rapeseed,

sunflower, cottonseed, and peanut (United States Department of Agriculture, 2024). It was estimated that global palm oil output would surpass 79.3 million metric tons in 2023-2024, accounting for over 36% of total vegetable oil production (OFI, 2023). Oil palm commercial seed production relies on the use of *dura* × *pisifera* (D×P) hybrids, with breeding programmes focus on development and improvement of both populations. Most oil palm breeding programmes employ Deli *dura* as the female parent (Rajanaidu et al., 2000). Meanwhile, Kushairi et al. (2011) reported that AVROS *pisifera* has been widely utilised for its strong combining ability with Deli *dura*.

Problem Statement

In Malaysia, oil palm populations exhibit limited genetic diversity due to the extensive use of Deli *dura* and AVROS *pisifera*, both of which originated from a few ancestral palms (Fadila et al., 2024). The limited genetic diversity within these populations has become the limiting factor in achieving further gains in yield potential. This study evaluated 11 *pisifera* male parents from three genetic backgrounds (AVROS, MPOB-Nigeria, and MPOB-Nigeria × UP), based on their 38 D×P progenies, in accordance with the selection criteria outline in the Malaysian Standard (MS 157:2017), titled Oil Palm Seeds for Commercial Planting (Fourth revision), to identify promising *pisifera* male parents as pollen sources for future commercial planting materials.

Research Questions

Table 1 shows the *pisifera* male parents' performance. MPOB-Nigeria *pisifera* P6 (0.337/552) recorded the highest FFB, primarily attributed to its significantly greater bunch number (BNO) compared to other *pisifera* male parents. Meanwhile, MPOB-Nigeria *pisifera* P4 (0.337/147) showed notable performance by recording the highest value for mesocarp to fruit ratio (M/F), as well as oil components such as oil to bunch (O/B) and oil to dry mesocarp (O/DM) ratios. While P6 recorded the highest total economic product (TEP) and oil yield (OY), it did not differ significantly from P4 for these two traits. Based on the Malaysian Standard MS 157: 2017, the *tenera* palms in the progeny test must produce at least 170 kg palm^{-1} year^{-1} of FFB, with O/B and kernel to bunch (K/B) ratios of 25% and 3%, respectively, and OY of 42.5 kg palm^{-1} year^{-1}. Both P4 and P6 meet these minimum requirements, with the exception of K/B. Molecular verification of P6 using the *SureSawit*™ *VIR* kit was conducted in 2024. The results confirmed that P6 is homozygous *virescens*, which ensure a clear fruit colour change at ripening, an important trait for harvesting accuracy and oil yield.

For vegetative traits, P6 also recorded the highest frond production (FP), significantly outperforming other *pisifera* male parents. None of the *pisifera* male parents fulfilled the compactness criteria (rachis length, RL < 5 m and HT < 1.80 m) for high-density planting

Table 1
Means of dura × pisifera *progenies based on* pisifera *male parents*

***Pisifera* male parent code**	**FFB (kg palm^{-1} year^{-1})**	**BNO (no. palm^{-1} year^{-1})**	**Average Bunch Weight (kg)**	**M/F (%)**	**Shell to Fruit (%)**	**O/DM (%)**	**Fruit to Bunch (%)**
P1 (0.292/1218)	199.66^{ab}	13.49^{c}	15.07^{c}	76.86^{f}	15.72^{a}	78.00^{f}	61.72^{e}
P2 (0.292/1250)	172.04^{ef}	13.09^{c}	13.39^{e}	80.28^{d}	13.48^{c}	79.93^{ab}	65.58^{bc}
P3 (0.292/353)	184.63^{cd}	13.04^{c}	14.50^{cd}	78.75^{e}	14.69^{b}	79.14^{cd}	62.15^{e}
P4 (0.337/147)	201.12^{ab}	14.65^{b}	13.93^{de}	86.43^{a}	8.55^{e}	80.41^{a}	65.70^{ab}
P5 (0.337/535)	165.39^{f}	10.44^{f}	16.23^{b}	81.69^{c}	11.67^{d}	75.02^{h}	64.03^{d}
P6 (0.337/552)	206.29^{a}	16.71^{a}	12.67^{f}	83.57^{b}	11.88^{d}	79.32^{bc}	65.93^{ab}
P7 (0.337/94)	189.51^{cd}	11.58^{de}	16.73^{b}	78.67^{e}	13.66^{c}	77.26^{g}	61.25^{e}
P8 (0.394/222)	191.61^{bc}	11.85^{d}	16.46^{b}	77.91^{ef}	13.32^{c}	78.56^{def}	65.19^{bcd}
P9 (0.394/234)	183.12^{cd}	10.23^{fg}	18.35^{a}	81.01^{cd}	11.42^{d}	79.82^{ab}	65.52^{bc}
P10 (0.394/24)	181.26^{de}	11.17^{e}	16.67^{b}	78.36^{e}	12.95^{c}	78.84^{cde}	66.95^{a}
P11 (0.394/456)	167.72^{f}	9.63^{g}	17.95^{a}	77.59^{ef}	13.13^{c}	78.40^{ef}	64.33^{cd}
D×P SC	179.23	9.12	20.01	77.03	13.08	80.68	69.48
Mean	188.78	12.69	15.44	80.20	12.77	78.76	64.56
Standard Error	1.09	0.09	0.09	0.18	0.12	0.08	0.16

***Pisifera* male parent code**	**O/B (%)**	**OY (kg palm^{-1} year^{-1})**	**TEP (kg palm^{-1} year^{-1})**	**FP (no. palm^{-1} year^{-1})**	**RL (m)**	**HT (m)**	**Leaf Area (m^{2})**
P1 (0.292/1218)	23.75^{f}	48.73^{cd}	54.06^{bc}	24.51^{de}	5.30^{e}	2.14^{d}	9.00^{bcd}
P2 (0.292/1250)	28.03^{c}	52.84^{b}	57.26^{b}	24.07^{ef}	5.62^{ab}	2.14^{d}	9.33^{ab}
P3 (0.292/353)	25.51^{e}	51.37^{bc}	56.05^{b}	25.64^{b}	5.47^{cd}	1.90^{e}	8.88^{cd}
P4 (0.337/147)	30.42^{a}	60.87^{a}	64.54^{a}	25.03^{cd}	5.61^{ab}	2.28^{c}	9.11^{bc}
P5 (0.337/535)	22.71^{g}	38.28^{f}	42.24^{e}	21.76^{g}	5.57^{bc}	1.98^{e}	9.67^{a}
P6 (0.337/552)	29.42^{b}	63.54^{a}	67.15^{a}	27.62^{a}	5.55^{bc}	2.09^{d}	8.23^{f}
P7 (0.337/94)	23.99^{f}	45.65^{de}	50.73^{cd}	23.62^{f}	5.68^{a}	2.33^{bc}	9.57^{a}
P8 (0.394/222)	25.34^{e}	50.99^{bc}	57.17^{b}	24.75^{d}	5.25^{e}	2.25^{c}	8.85^{cd}
P9 (0.394/234)	26.76^{d}	51.83^{bc}	57.20^{b}	23.84^{f}	5.47^{cd}	2.47^{a}	8.74^{de}
P10 (0.394/24)	26.67^{d}	49.62^{bc}	55.48^{b}	24.65^{d}	5.44^{d}	2.41^{ab}	9.34^{ab}
P11 (0.394/456)	24.98^{e}	43.46^{e}	49.00^{d}	25.51^{bc}	5.34^{e}	2.40^{ab}	8.39^{ef}
D×P SC	28.35	50.67	57.33	26.32	5.68	2.81	9.71
Mean	26.41	52.03	56.95	24.79	5.46	2.21	8.98
Standard Error	0.13	0.44	0.44	0.07	0.01	0.01	0.04

P1-P3: MPOB-Nigeria × United Plantations, P4-P7: MPOB-Nigeria, P8-P11: AVROS. Mean values sharing the same letter do not differ significantly at $p \leq 0.05$, as determined by Fisher's Least Significant Difference test

(Norziha et al., 2020). Nevertheless, all *pisifera* male parents exhibited lower HT than the D×P standard cross, which favourable for ease of harvesting.

CONCLUSION

Pisifera P6 has shown potential as a male parent for developing new commercial D×P planting materials due to its superior yield, low trunk height, and *virescens* fruit colour, traits that contribute to maximising oil yield per unit land area and efficient harvesting, thereby supporting the goals of sustainable oil palm production.

ACKNOWLEDGEMENT

The authors would like to express their sincere appreciation to the Director-General of the MPOB for granting permission to publish this paper.

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