CLONAL PALM SERIES 3 (CPS3)

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The national average crude palm oil (CPO) yielding of less than 4 t ha^{-1} yr^{-1} for the last three decades has been a long-term pain point for the industry. For instance, the recorded CPO yield in 2019 of 3.47 t ha^{-1} yr^{-1} (MPOB, 2020) was four folds below the genetic potential of the oil palm of 18.2 t ha^{-1} yr^{-1} (Corley, 1998 and Chan, 2000). To date, the best seed-derived materials have shown the potential of reaching a yield of 8.6 t ha^{-1} yr^{-1} at the best experimental plot (Corley *et al*., 1976), at least 12.2 t ha^{-1} yr^{-1} at progeny level (Rajanaidu *et al*., 1990) and individual palms have even yielded 13.6 t ha^{-1} yr^{-1} (Sharma and Tan, 1999). However, due to the drawbacks of traditional seed propagation, such as a slow and poor germination process with a selection cycle of 10-12 years as well as high heterogeneity amongst the hybrid seeds, tissue culture derived plantlets provide a beneficial alternative (Weckx *et al*., 2019). The average annual yield improvement through breeding is estimated at 1.5% (Woittiez *et al*., 2017) while cloning high-yielding palms showed an increase of at least 10%-15% (Soh, 2018). MPOB has generally been focusing on clonal propagation for yield improvements (Zamzuri, 2011). However, tissue culture is also deemed as an important tool that supports modern genetic techniques such as the CRISPR/Cas 9 system (Bortesi and Fischer, 2015), which is expected to revolutionise future agriculture.

With limited land bank and pressures of meeting sustainable goals, maximising yield per unit land area is key. CPS3 is the latest addition to MPOB's Clonal Palm Series (CPS) that will help achieve this goal.

THE TECHNOLOGY

Developing improved planting materials towards enhancing productivity of CPO as well as those with special traits for the industry have been MPOB's long term goal since its inception. This commitment has led to many collaborative clonal trials forged with various agencies. CPS3 originated from amongst DxPs planted at MPOB Research Station Hulu Paka, Terengganu. The outstanding yield performance of a particular individual with fresh fruit bunches (FFB) of 198.80 kg palm^{-1} yr^{-1} and oil to bunch (O/B) of 35.22% led to the cloning of this ortet in 2001. The resultant products (ramets) were planted for field evaluation in several locations including private estates as well as MPOB research stations. The remarkable performance and unique characteristics of the initial batch of CPS3 ramets identified from cloning in 2001 were first reported by Zamzuri (2011) through MPOB-Kulim (M) Berhad collaboration at Sedenak Estate, Kota Tinggi, Johor. After seven consecutive years of field evaluation (*Tables 1* and *2*), CPS3 recorded an impressive 37.5% O/B and oil yield (OY) of 11.3 t ha^{-1} yr^{-1} (Isa *et al*., 2019) planted at a density of 136 palms ha^{-1}.

NOVELTY OF CPS3

1. Distinctive oil yield traits:
   - High OY at 11.3 t ha^{-1} yr^{-1} *vs*. 8.6 t ha^{-1} yr^{-1} of standard DxP cross.
   - High O/B of 37.5% with FFB of 221.7 kg palm^{-1} yr^{-1} *vs*. 30.8% and 206.0 kg palm^{-1} yr^{-1} for DxP standard cross respectively.

2. Distinctive FFB and bunch components:
   - Balanced bunch number (BNO) and bunch weight (BWT); 15.5 bunches and 14.3 kg *vs*. 12.1 bunches and 17.2 kg of DxP standard cross.
   - Mesocarp to fruit (M/F) was recorded at 89.7% (*Figures 1* and *2*), fruit to bunch (F/B) at 70.1% and oil to wet mesocarp was 59.7% *vs*. 86.7%, 68.9% and 51.6%, respectively, for DxP standard cross.
   - Low ratio of kernel to bunch (K/B) at 2.8% and shell to fruit (S/F) of 6.3% *vs*. 4.3% and 7.0% that of DxP standard cross specifically dictate the superiority of oil yield characteristics.

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TABLE 1. MEAN PERFORMANCE OF BUNCH YIELD, BUNCH COMPONENTS AND MORPHO-PHYSIOLOGICAL TRAITS OF CPS3 PLANTED IN SEDENAK ESTATE, JOHOR

Material	N	FFB	BNO	ABW	M/F	K/F	S/F	MC	O/WM	F/B	O/B
CPS3	34	221.7	15.5	14.3	89.7	4.1	6.3	26.2	59.7	70.1	37.5
DxP (SC)	32	206.0	12.1	17.2	86.7	6.3	7.0	35.4	51.6	68.9	30.8

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Material	OER	K/B	KER	TER	OY	CPO	KY	KO	TOT	RL	HTI
CPS3	28.1	2.8	1.1	29.2	11.3	8.5	0.9	0.3	8.8	6.1	0.42
DxP (SC)	23.1	4.3	1.6	24.7	8.6	6.5	1.2	0.5	6.9	6.0	0.43

Note: FFB = fresh fruit bunch (kg palm^{-1} yr^{-1}), BNO = bunch number (no. palm^{-1} yr^{-1}), ABW = average bunch weight (kg), M/F = mesocarp to fruit (%), K/F = kernel to fruit (%), S/F = shell to fruit (%), M/C = moisture content (%), O/WM = oil to wet mesocarp (%), F/B = fruit to bunch (%), O/B = oil to bunch (%), OER (oil extraction rate) = O/B x 0.75, K/B = kernel to bunch (%), KER (kernel extraction rate) (%) = K/B x 0.5 x 0.75, TER (total extraction rate) (%) = OER + KER, OY = oil yield (t ha^{-1} yr^{-1}), CPO (crude palm oil) = FFB x OER x planting density @ 136 palms ha^{-1}, KY = kernel yield (t ha^{-1} yr^{-1}), KO (kernel oil) (t ha^{-1} yr^{-1}) = FFB X KER x planting density @136 palms ha^{-1}, TOT = total oil (t ha^{-1} yr^{-1}) = CPO + KO, RL = rachis length (m), HTI = height increment (m yr^{-1}), SC = standard cross.
Data FFB: 7 years (2011-2017).

TABLE 2. COEFFICIENT OF VARIATION (CV) FOR BUNCH YIELD, BUNCH COMPONENTS AND MORPHO-PHYSIOLOGICAL TRAITS OF CPS3 PLANTED IN SEDENAK ESTATE, JOHOR

Material	N	FFB	BNO	ABW	M/F	K/F	S/F	MC	O/WM	F/B	O/B
CPS3	34	14.6	15.4	7.7	1.0	11.3	8.5	3.1	1.2	2.4	3.0
DxP (SC)	32	13.8	15.8	8.9	2.7	18.9	17.9	6.5	4.6	3.4	6.3

Continue…

Material	OER	K/B	KER	TER	OY	CPO	KY	KO	TOT	RL	HTI
CPS3	3.0	11.5	11.5	2.9	15.3	15.3	19.3	19.3	15.3	4.0	9.8
DxP (SC)	6.3	19.3	19.3	5.6	15.0	15.0	24.5	24.5	14.8	4.0	12.0

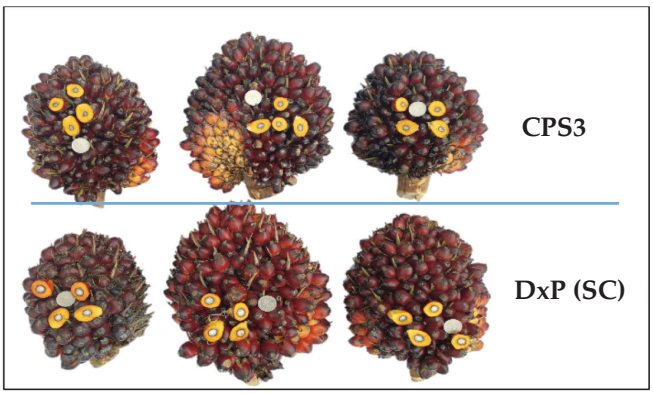

Figure 1. Fresh fruit bunch (FFB) of four years old CPS3 and DxP (SC) planted at Sedenak Estate, Kulim (M) Berhad, Johor.

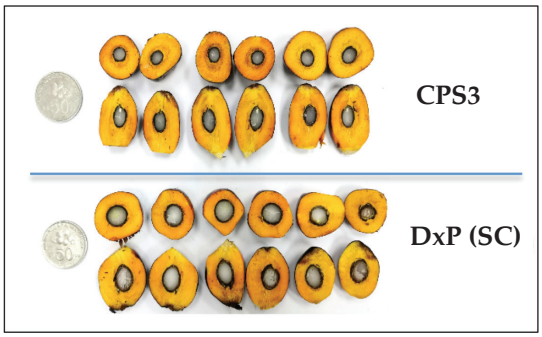

Figure 2. Cross and longitudinal sections of CPS3 and DxP (SC) fruitlets.

BENEFITS AND ADVANTAGES

- Achieving 37.5% of O/B, CPS3 is the planting material of choice for planters and millers;
- With achievable mill oil extraction rate (OER) of 28.1% and estimated CPO of 8.5 t ha^{-1} yr^{-1} CPS3 is superior to DxP by 21.7% and 30.7% respectively.

COMMERCIALISATION POTENTIAL

Premium clonal materials are made available for stakeholders to propagate at their own tissue culture laboratories. Quick lab-to-market process.

CONCLUSION

CPS3 is the planting material of choice in meeting national aspiration towards higher CPO productivity and sustainable agriculture.

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