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Seedling Age at Field Planting Affecting the Oil Palm Performance

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ABSTRACT

Field establishment of all seedlings was satisfactory, except for younger seedlings aged 6 and 8-month-old (A6 and A8 treatments) which resulted in high mortality due to transplanting shock and pest's infestation. At the immature stage, the vegetative growth differed significantly with the seedlings age. However, at the mature stage, the vegetative growth affected by different treatments became less apparent, especially between treatments A10 and A12. The result of soil and leaf analysis indicated that the soil and nutrients uptake were not the limiting factors for palm growth at the study site. There was no significant difference in the mean cumulative FFB yield as well as its components in A10 and A12 treatments over eight years. Oil palm planted using 10-month-old seedlings gave comparable FFB yield with 12-month-old seedlings. Therefore, seedlings of 10-month-old are suitable to be used as the minimum age of seedlings recommended for field planting. Bunch quality parameters showed satisfactory levels in most treatments. There were no significant differences in bunch quality parameters of A10 and A12 treatments. However, the effects of different seedlings ages planted over eight years showed that the 12-month-old seedlings gave better overall performance than other treatments.

ABSTRAK

Tumbesaran semua anak benih yang berlainan umur adalah memuaskan kecuali untuk anak benih muda, iaitu rawatan A6 dan A8 yang menunjukkan kematian yang tinggi disebabkan oleh tegasan semasa pemindahan ke ladang dan serangan perosak. Pada peringkat pramatang, parameter tumbesaran tampang berbeza dengan ketara yang meningkat sejajar dengan usia anak benih. Walau bagaimanapun, pada peringkat matang, perbezaan tumbesaran tampang antara rawatan telah menjadi kurang berbeza terutamanya antara rawatan A10 dan A12. Keputusan analisis tanah dan daun menunjukkan tanah dan nutrien bukanlah faktor pembatas tumbesaran sawit di tapak kajian. Selama lapan tahun, tiada perbezaan signifikan didapati dalam purata hasil dan komponennya antara rawatan A10 dan A12. Sawit yang ditanam menggunakan anak benih 10 bulan memberikan hasil yang setanding dengan penggunaan anak benih 12 bulan. Oleh itu, anak benih 10 bulan sesuai untuk dijadikan umur minimum anak benih yang disarankan untuk penanaman di ladang. Parameter kualiti tandan menunjukkan tahap memuaskan dalam kebanyakan rawatan. Tiada perbezaan ketara dalam parameter kualiti tandan antara rawatan A10 dan A12. Walau bagaimanapun, kajian umur penanaman anak benih yang berbeza selama lapan tahun menunjukkan prestasi keseluruhan anak benih berusia 12 bulan memberikan prestasi yang lebih baik berbanding rawatan lain.

Keywords: oil palm, seedling ages, FFB, vegetative measurement, bunch quality.

INTRODUCTION

High demand for oil palm seedlings throughout the country is met by up-scaling the production of germinated seeds nationally, where approximately 87.60 million of seeds were produced in 2017. The number of oil palm nursery operators registered with MPOB increased from 640 in 2009 to 884 in 2018 (MPOB, 2018). The increasing numbers of untrained nursery operators may lead to improper nursery management, which will potentially affect the quality of the seedlings.

Vigorous seedlings are an important starting point for the successful establishment of plantation with early fruiting and desired yields (Bah and Rahman, 2004; Ibrahim *et al*., 2010). The normal recommended seedlings plant in the field range from 12 to 14 months, are planted in polybags measuring 15" x 18" and arranged in a triangular pattern with a distance of 0.9 m. At this stage, the seedlings have undergone three stages of culling and are able to withstand the transplanting shock. However, in order to be more profitable, the nursery operators usually sell young seedlings of less than 12-month-old. The feedback received from the smallholders did confirm that young seedlings aged between 8

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and 10 months were cheaper and lighter as they were planted in small-sized polybags for easier handling especially during transportation.

Trial conducted by Khoo and Chew (1976) showed that the field planted with seedlings aged between 13.5 and 16.5 months old showed higher yields than that of 10-month-old seedlings using the 1960's planting materials. Hence, there is a need to review the age of seedlings recommended for field planting using current planting materials due to increasing demand for seedlings by smallholders and estates. This paper presents eight years data of fresh fruit bunch (FFB) yield and other relevant parameters, such as vegetative growth, bunch analysis, leaf nutrient content and soil fertility status of the study site. The objective of this study was to determine the optimum seedlings age in order to provide high quality seedlings for field planting to attain high yield. The results could be used to verify the minimum age of seedlings recommended for field planting.

MATERIALS AND METHODS

The trial was carried out at the MPOB Research Station Lahad Datu, Sabah, located at N05° 07'50" latitude and E118° 26'34" longitude, elevated 50 m above sea level. The area experienced a dry season from May to September, followed by a wet season from October to April and the average annual rainfall from year 2000 to 2018 was 2637.72 mm.

At the nursery, the soil used was sieved through a 5 mm mesh sieve size to remove stones, large clods (>1 cm) and other debris before filling into polybags. Prior to field planting, germinated seeds were planted in polybags at different intervals in order to provide various seedling ages. Seedlings of 6, 8, 10 and 12-month-old were planted in 38.1 cm x 45.72 cm and lined in a 0.9 m triangular pattern, whereas seedlings of 14, 16 and 18 months old were planted in 45 cm x 60 cm polybags and lined in a 1.5 m triangular pattern. The seedlings were watered twice daily for about 500 ml of water per seedling. Normal estate nursery fertilisation schedule and rates were applied. Seedlings of different ages of 6, 8, 10, 12, 14, 16 and 18-month-old were then planted simultaneously in the field.

Seedlings were planted in the Bengawat soil families (*USDA*; *Typic Endoaquepts* or *FAO; Eutric Gleysols*). Soils of Bengawat families are derived from recent alluvial deposits which are poorly drained soils. The trial was laid out as a randomised complete block design (RCBD) comprising of seven treatments in three replications and each treatment consisted of 16 palms. Palm performance was evaluated based on FFB yields, vegetative growth, leaf nutrient contents and bunch analysis. Harvesting and yield recording commenced about thirty months after field planting. A total of 223 bunches were analysed in the fifth and sixth years after field planting. The fertiliser used was a compound fertiliser (10.5/5.4/16.2/2.7/0.5B). Vegetative measurements such as frond production, total green fronds (frond palm^{-1}), rachis length (cm), frond area (m^2), frond dry weight (kg), palm height (cm) and trunk diameter (m) were taken at different intervals as described by Corley and Breure (1981). Soil samples were taken from the oil palm avenue and weeded circle of the plots at three different depths *i.e.* 0 – 15 cm, 15 – 30 cm and 30 – 45 cm from soil surface. All data were subjected to analysis of variance and when significant, means were compared using Duncan Multiple Range Test (DMRT) of SAS software package.

RESULTS AND DISCUSSION

Vegetative Growth

Vegetative growth parameters obtained from all treatments are shown in *Tables 1* and *2* for the immature and mature stages, respectively. The frond area and frond dry weight were estimated according to Corley and Breure (1981). At the immature stage, most of the vegetative parameters were differed significantly corresponding to the age of seedlings. Most of the growth parameters measured were found to be slightly better in the seedlings, which remained for more than 12 months in the nursery. However, at the mature stages (*Table 2*), the vegetative growth measured differ between treatments, but had narrowed to non-significant, especially between treatments A10 and A12. There was no significant difference between the treatments of rachis length over four years. After 5 years of planting, the vegetative parameters of palms planted using older seedlings (A10 to A18) were better than palms planted using younger seedlings (A6 and A8).

In the 9th year after planting, there was no significant difference in palm growth between treatments A10 and A12. The result indicated that the nutrients uptake efficiency of 10 and 12-month-old seedlings was comparable. Despite this, younger seedlings of A6 and A8 showed better growth but had a high mortality rate of about 2% to 19% during the first year of field planting. There was no mortality of older seedlings during the same period. The field establishment of all treated seedlings was satisfactory except for A6 and A8 treatments, which their high mortality was due to transplanting shock and pest's infestation.

Thus, for seedlings from an advanced planting material, treatments A16 and A18 showed better vegetative growth throughout the ninth years of

TABLE 1. VEGETATIVE GROWTH PERFORMANCE OF IMMATURE PALM PLANTED USING SEEDLINGS OF DIFFERENT AGES

Treatment	Frond production				Total fronds				Rachis length (cm)			
	6 MAP	12 MAP	18 MAP	24 MAP	6 MAP	12 MAP	18 MAP	24 MAP	6 MAP	12 MAP	18 MAP	24 MAP
A6	n.a	12.33a	14.33a	14.67c	13.50c	19.67d	33.67b	32.67b	48.50d	111.93d	186.67b	207.03b
A8	n.a	11.67a	18.67a	15.33bc	16.00b	22.67c	41.00a	37.67ab	81.30c	131.57c	203.23b	225.28b
A10	n.a	12.00a	12.67a	15.67bc	16.00b	26.00b	38.33ab	38.33ab	100.60b	152.43ab	227.57a	258.97a
A12	n.a	12.00a	13.67a	16.67b	19.00a	26.33b	39.67ab	39.33ab	99.40b	144.07bc	230.60a	247.80a
A14	n.a	11.33a	14.33a	16.67b	18.67a	28.00ab	42.00a	39.67ab	102.27b	164.27a	235.83a	259.70a
A16	n.a	10.67a	16.67a	15.67bc	19.33a	26.00b	42.33a	40.00ab	104.77b	157.83ab	229.20a	259.27a
TA18	n.a	11.33a	14.67a	18.67a	19.00a	29.33a	44.00a	42.67a	128.00a	165.93a	249.67a	260.47a
LSD $_{(0.05)}$	-	1.534	7.183	1.436	1.1374	2.394	6.232	6.800	9.46	16.20	22.64	20.63
CV (%)	-	7.433	26.969	5.036	4.217	5.302	8.743	10.000	5.235	6.213	5.712	4.773

Treatment	Frond area (m^2)				Frond dry wt. (kg)			
	6 MAP	12 MAP	18 MAP	24 MAP	6 MAP	12 MAP	18 MAP	24 MAP
A6	0.18c	0.61d	1.63c	3.23c	0.29d	0.46d	0.89a	0.97c
A8	0.31c	0.81c	1.84bc	3.88b	0.39c	0.54cd	0.96a	0.98c
A10	0.55b	1.14ab	2.27ab	4.79a	0.45b	0.68b	1.10a	1.19ab
A12	0.47b	0.96bc	2.15abc	4.26ab	0.44bc	0.59bc	1.01a	1.10abc
A14	0.56b	1.31a	2.47a	4.71a	0.44bc	0.65bc	1.05a	1.09bc
A16	0.62b	0.91c	2.32ab	4.55a	0.48ab	0.63bc	1.01a	1.26a
A18	0.83a	1.19a	2.37ab	4.33ab	0.54a	0.81a	1.21a	1.20ab
LSD $_{(0.05)}$	0.141	0.198	0.524	0.607	0.001	0.104	0.304	0.157
CV (%)	14.693	11.231	13.720	8.109	7.207	9.354	16.560	7.997

Note: Mean with different alphabets in the same column are significantly different at 5% level with DMRT; measurement taken at 6, 12, 18 and 24 month after planting (MAP).

recording (*Table 2*). However, handling them during transporting to the field was difficult owing to their size and weight due to the transplantation stress. This problem would affect the initial growth of these seedlings and subsequently reduce the yield of early FFB. The A6 and A8 seedlings which were planted at younger age would be less susceptible to transplanting shocks, but would be more vulnerable to attack by pests and animals such as wild boars, porcupines, rats, beetles, *etc*.

Soil and Leaf Nutrient Levels

The results of soil chemical properties at palm weeded circle and avenue are shown in *Tables 3* and *4*, respectively. Generally, most of the soil chemical analyses conducted in 2004 and 2006 were found to be in the range of moderate to very high compared to the nutrients required by the palms (Goh and Rolf, 2003). However, the available phosphorus (P) at the avenue was less than 15 mg kg^{-1} soil. The exchangeable calcium (Ca) and magnesium (Mg) in the Bengawat family soils were generally higher than in other soils, especially for exchangeable Ca. The soil chemical contents in the weeded circle were higher than those in the palm avenue, which could be due to the unevenly broadcasted fertiliser application. On the other hand, the palm avenue has lower nutrient content, which could be taken up by oil palm tertiary roots. In general, most of the soil nutrients decrease with increasing soil depth, especially for mobile nutrients such as nitrogen and potassium. The available P in the topsoil was much higher as P was relatively immobile and the exchangeable Ca and Mg did not vary with depth. The results showed that the soil nutrients at this study site were not the limiting factors for palm growth.

There were no significant differences in the leaf macro as well as micronutrient contents except for leaf P and Mg (*Table 5*). The nutrient contents for 9 years after planting showed satisfactory nutrient levels in all tested treatments and were in agreement with the findings of Goh and Rolf (2003). The results showed that there was no significant difference in

TABLE 2. VEGETATIVE GROWTH PERFORMANCE OF MATURE PALM PLANTED USING SEEDLINGS OF DIFFERENT AGES

Treatment	Frond production				Total fronds				Rachis length (m)			
	6 YAP	7 YAP	8 YAP	9 YAP	6 YAP	7 YAP	8 YAP	9 YAP	6 YAP	7 YAP	8 YAP	9 YAP
A6	15.43ab	27.33b	26.70a	27.54a	41.50ab	44.33a	41.90a	44.54a	5.09a	5.42a	5.75a	6.18a
A8	15.73ab	26.00ab	25.80a	26.66a	42.30ab	41.33a	42.20a	44.44a	5.15a	5.54a	6.08a	6.16a
A10	15.50ab	26.33ab	25.30a	25.50a	41.77ab	42.67a	40.93a	41.06a	5.27a	5.64a	5.99a	6.31a
A12	14.33b	24.67b	26.60a	26.17a	40.67b	41.67a	43.30a	46.33a	5.19a	5.58a	6.20a	6.52a
A14	16.10a	26.00ab	21.90a	27.36a	44.10ab	43.67a	44.03a	41.93a	5.25a	5.52a	6.02a	6.23a
A16	15.00ab	24.00b	19.90a	25.89a	44.07ab	42.00a	41.43a	43.83a	5.26a	5.66a	6.06a	6.38a
A18	15.60ab	27.33a	25.97a	26.53a	45.03a	44.67a	45.40a	47.73a	5.28a	5.53a	5.80a	6.23a
LSD $_{(0.05)}$	1.345	2.361	7.031	2.301	3.625	4.457	4.437	6.392	0.255	0.365	0.4231	0.3991
CV (%)	4.915	5.115	16.07	4.88	4.763	5.840	5.83	8.11	2.750	3.694	3.97	3.56

Treatment	Frond dry wt. (kg)				Height (m)				Diameter (m)			
	6 YAP	7 YAP	8 YAP	9 YAP	6 YAP	7 YAP	8 YAP	9 YAP	6 YAP	7 YAP	8 YAP	9 YAP
A6	2.41b	2.73c	3.14b	3.30b	1.46b	2.24b	2.88b	3.77b	0.57b	0.57a	0.61a	0.54c
A8	2.62ab	2.94bc	3.52ab	3.45ab	1.79ab	2.68ab	3.26ab	4.29ab	0.63a	0.61a	0.64a	0.56bc
A10	2.83a	3.48a	3.59ab	3.51ab	1.84a	2.59ab	3.24ab	4.26ab	0.61ab	0.58a	0.64a	0.57bc
A12	2.46ab	2.83c	3.77ab	3.80ab	1.85a	2.50ab	3.15ab	4.13ab	0.59ab	0.56a	0.61a	0.54c
A14	2.85a	3.23abc	3.49ab	3.77ab	1.86a	2.84a	3.53a	4.22ab	0.62ab	0.61a	0.61a	0.59ab
A16	2.75ab	3.17abc	3.58ab	3.71ab	1.99a	2.67ab	3.35a	3.88ab	0.60ab	0.58a	0.62a	0.57bc
A18	2.73ab	3.42ab	3.84a	3.94a	2.03a	2.72ab	3.38a	4.34a	0.63a	0.62a	0.66a	0.63a
LSD $_{(0.05)}$	0.382	0.485	0.5888	0.5618	0.356	0.511	0.4095	0.5005	0.051	0.059	0.0554	0.0444
CV (%)	8.056	8.740	9.29	8.68	10.926	11.011	7.07	6.82	4.741	5.648	4.97	4.38

Note: Mean with different alphabets in the same column are significantly different at 5% level with DMRT; measurement taken at 6, 7, 8 and 9 year after planting (YAP).

TABLE 3. SOIL CHEMICAL PROPERTIES OF THE WEEDED CIRCLE AREA

Soil parameter	Soil depth (cm)					
	0 - 15		15 - 30		30 - 45	
	2004	2006	2004	2006	2004	2006
Total Nitrogen (%)	0.23 ± 0.07	0.20 ± 0.04	0.14 ± 0.04	0.14 ± 0.02	0.15 ± 0.06	0.11 ± 0.03
Available P (mg kg^{-1})	38.85 ± 31.98	41.55 ± 41.36	15.73 ± 13.34	19.74 ± 21.22	6.14 ± 3.14	8.45 ± 9.12
Exchangeable cations (cmol kg^{-1})						
Potassium	0.45 ± 0.33	0.85 ± 0.39	0.24 ± 0.16	0.44 ± 0.22	0.26 ± 0.15	0.29 ± 0.18
Calcium	12.82 ± 2.85	12.45 ± 3.11	12.06 ± 3.27	13.15 ± 3.03	12.33 ± 3.67	12.57 ± 3.05
Magnesium	4.83 ± 0.55	5.27 ± 0.87	5.11 ± 0.54	5.61 ± 0.73	5.28 ± 0.62	5.68 ± 0.71
Soil pH (H_2O)	5.26 ± 0.49	4.53 ± 0.30	4.93± 0.51	4.64± 0.45	4.77 ± 0.39	4.52 ± 0.20

Note: Figures are mean from three replicates ± standard deviations, where n = 21.

TABLE 4. SOIL CHEMICAL PROPERTIES OF THE AVENUE AREA

Soil parameter	Soil depth (cm)					
	0 - 15		15 - 30		30 - 45	
	2004	2006	2004	2006	2004	2006
Total Nitrogen (%)	0.20 ± 0.06	0.17 ± 0.04	0.16 ± 0.06	0.15 ± 0.04	0.15 ± 0.06	0.11 ± 0.02
Available P (mg kg^{-1})	12.22 ± 8.08	7.66 ± 10.42	8.87 ± 11.88	4.91 ± 5.59	5.04 ± 3.54	3.34 ± 4.16
Exchangeable cations (cmol kg^{-1})						
Potassium	0.29 ± 0.13	0.30 ± 0.24	0.19 ± 0.09	0.21 ± 0.11	0.33 ± 0.24	0.16 ± 0.07
Calcium	13.69 ± 3.73	13.96 ± 3.53	11.74 ± 3.09	13.20 ± 3.15	12.72 ± 3.81	12.86 ± 3.39
Magnesium	4.98 ± 0.62	5.54 ± 0.76	5.35 ± 0.61	5.67 ± 0.67	5.37 ± 0.56	5.07 ± 0.59
Soil pH (H_2O)	5.50 ± 0.77	5.46 ± 0.35	5.41± 0.52	5.19 ± 0.29	5.07± 0.32	5.07 ± 0.32

Note: Figures are mean from three replicates ± standard deviations, where n = 21.

TABLE 5. EFFECTS OF TREATMENTS ON LEAF NUTRIENT CONTENT ANALYSED AT 9 YEARS AFTER PLANTING

Treatment	Macro nutrient content (%)					Micro nutrient content (ppm)				
	N	P	K	Ca	Mg	Cu	Zn	Mn	Fe	B
A6	2.70a	0.17ab	0.70a	0.60a	0.39a	7.67a	14.50a	326.33a	58.00a	14.52a
A8	2.59a	0.17ab	0.70a	0.58a	0.29b	8.50a	14.83a	345.00a	62.33a	13.77a
A10	2.51a	0.17ab	0.70a	0.69a	0.37ab	8.33a	15.83a	334.33a	65.33a	12.12a
A12	2.60a	0.17ab	0.70a	0.62a	0.34ab	8.00a	16.00a	337.67a	64.00a	12.76a
A14	2.55a	0.17a	0.70a	0.64a	0.32ab	8.00a	15.67a	346.67a	57.17a	13.77a
A16	2.50a	0.17ab	0.70a	0.68a	0.36ab	8.50a	14.83a	314.67a	57.83a	14.82a
A18	2.51a	0.15b	0.67a	0.68a	0.41a	8.33a	16.17a	328.00a	66.67a	12.53a
MSE	0.0128	0.00007	0.0005	0.004	0.0039	0.9524	1.6161	586.679	54.6964	2.8567
CV (%)	4.55	4.87	3.14	8.13	13.51	9.4	6.46	9.78	12.16	11.52

Note: Means with different alphabets in the same column are significantly different at 5% level with DMRT (Duncan Multiple Range Test). Figures are mean from three replicates.

the nutrient uptake efficiency of palms grown with 10 month and 12-month-old seedlings.

Oil Palm Yield and Bunch Quality

The most important parameters for evaluating oil palm performance are the FFB yield and bunch quality, which could determine the optimum seedling age for field planting to sustain high yield. The effects of 8-year treatment on FFB yield and its components are presented in *Tables 6*, *7* and *8*. Generally, FFB yield over eight years showed an increasing trend with palm age except for the oldest seedlings (A18), indicating the drawbacks of planting older oil palm seedlings. Although the 18-month-old seedlings possessed the most vigorous palms with the highest trunk height and diameter, these trunk reserves were not able to maintain high FFB production for long periods of time. The 12-month-old seedling gave the highest FFB record. In Bengawat soils, the eight-year cumulative FFB yields of A12 and A10 treatments were 203.01 and 195.87 t ha^{-1}, respectively, with insignificant difference of 3.5%. The initial FFB yield of the 10-month-old seedlings was slightly lower than that of the 12-month-old seedlings, but it improved consistently for eight years after harvest.

The highest yields of A10 and A12 treatments were 31.29 and 31.51 t ha^{-1} yr^{-1}, respectively, which were recorded in the fourth and eighth years of harvest. The cumulative average bunch weight showed an increasing trend, although the average bunch number decreased with the seedling age. The higher bunch number resulted in higher FFB yields for A12 and A10 treatments. However, for older seedlings of A14, A16 and A18, the bunch weight contributed to FFB yield rather than the bunch number.

TABLE 6. EFFECTS OF TREATMENTS ON FFB YIELD OVER EIGHT YEARS OF HARVESTING

Treatment	FFB yield (t ha^{-1} yr^{-1}) over 8 years of harvest								Total (t ha^{-1})	*FFB Yield ranking
	1	2	3	4	5	6	7	8		
A6	8.46d	19.28b	18.06b	24.85c	21.76bc	22.34a	24.34ab	31.86a	170.96c	7
A8	10.18cd	20.30b	22.45ab	27.93bc	26.45ab	26.13a	27.56a	31.94a	192.93ab	3
A10	11.44bc	21.79ab	23.16ab	31.29a	26.73a	25.33a	26.74a	29.40ab	195.87ab	2
A12	13.01ab	23.11ab	25.72a	28.45ab	27.43a	27.97a	25.80a	31.51a	203.01a	1
A14	13.15ab	25.78a	23.45ab	26.60bc	25.76abc	22.18a	26.67a	28.91ab	192.50ab	4
A16	11.21bc	22.06ab	23.49ab	26.14bc	24.59abc	23.16a	25.08ab	28.42ab	184.14abc	5
A18	14.47a	20.18b	24.64a	26.20bc	21.31c	22.98a	21.62b	24.75b	176.35bc	6
MSE	*10.357*	*12.5406*	*15.1369*	*10.7099*	*13.4237*	*11,1287*	*10.81956*	*16.7759*	*316.6978*	
CV (%)	*10.78*	*11.25*	*12.47*	*5.99*	*10.13*	*16,94*	*7.74*	*10.96*	*5.50*	

Note: Means with different alphabets in the same column are significantly different at 5% level with DMRT (Duncan Multiple Range Test). *FFB yield ranking over 8 years of harvest.

TABLE 7. EFFECTS OF TREATMENTS ON AVERAGE BUNCH WEIGHT OVER 8 YEARS OF HARVESTING

Treatment	Average bunch weight (kg bunch^{-1}) over 8 years of harvest								Total ABWT (kg bunch^{-1})	* ABWT ranking
	1	2	3	4	5	6	7	8		
A6	3.86c	6.98a	8.00b	9.86c	11.11b	14.32bc	17.07a	17.76a	88.97b	7
A8	3.76c	7.20a	8.49ab	10.62bc	11.39ab	13.97c	16.48a	17.71a	89.62b	6
A10	4.45b	7.80a	9.91a	12.01ab	12.04ab	14.94abc	17.23a	18.85ab	97.22ab	5
A12	4.53b	7.56a	9.39ab	11.84ab	13.21ab	16.04abc	18.47a	20.03ab	101.07ab	4
A14	4.81ab	8.44a	9.46ab	12.63a	13.72a	16.54ab	19.13a	19.96ab	104.70a	2
A16	4.80ab	8.39a	9.74a	11.91ab	13.24ab	15.36abc	18.34a	19.63ab	101.41ab	3
A18	5.12a	8.16a	10.10a	12.38ab	13.00ab	17.37a	19.80a	20.51a	105.73a	1
MSE	0.6026	0.7544	1.3552	2.2907	2.3435	3.8245	2.50025	3.0686	106.6353	
CV (%)	4.56	10.46	9.1458	8.05	9.96	8.33	10.43	7.67	7.14	

Note: Means with different alphabets in the same column are significantly different at 5% level with DMRT (Duncan Multiple Range Test). *ABWT ranking over 8 years of harvest.

TABLE 8. EFFECTS OF TREATMENTS ON AVERAGE BUNCH NUMBER OVER 8 YEARS OF HARVESTING

Treatment	Average bunch number over 8 years of harvest								Total ABNO	* ABNO ranking
	1	2	3	4	5	6	7	8		
A6	15.87c	20.27a	16.27c	18.37ab	14.27ab	11.50a	10.34ab	13.05a	119.87abc	4
A8	19.63ab	20.53a	19.17ab	19.07a	16.93a	13.53a	12.22a	13.07a	134.07a	1
A10	18.60abc	20.43a	16.80c	18.93a	16.17a	12.33a	11.31ab	11.51ab	126.07abc	3
A12	20.80a	22.13a	19.90a	17.43abc	15.10ab	12.73a	10.13ab	11.41ab	129.57ab	2
A14	19.80ab	22.17a	17.97abc	15.30c	13.67ab	9.73a	10.21ab	10.48ab	119.23abc	5
A16	16.87bc	19.10a	17.53bc	16.03bc	13.57ab	11.17a	10.14ab	10.55ab	114.93bc	6
A18	20.47a	18.13a	17.70abc	15.40c	11.97b	9.53a	7.92b	8.75b	110.17c	7
MSE	9.2637	6.4888	4.5344	6.1925	6.4917	5.4595	3.65727	5.5756	174.5042	
CV (%)	9.43	14.26	6.43	7.53	13.1	19.63	14.84	14.09	6.88	

Note: Means with different alphabets in the same column are significantly different at 5% level with DMRT (Duncan Multiple Range Test). *ABNO ranking over 8 years of harvest.

The mean cumulative FFB yield and its components over eight years are presented in *Figures 1* and *2*. The mean cumulative FFB yield and components between A8 and A16 treatments were not significantly different. However, besides A10, A12 or the standard age of seedlings for field planting gave the highest FFB yield. Even though the FFB yield of A8 treatment was not significantly different from the rest (except for A6), their mortality rate was higher, about 2% to 19% in the first year of field planting. Moreover, younger seedlings do not undergo complete stages of culling and they usually suffer from transplanting shock.

The 10-month-old seedlings planted in the field produced comparable FFB yield with the 12-month-old seedlings. Therefore, the findings of this study could be used as a guideline for selecting the suitable minimum seedling age recommended for field planting or for sale by the nursery operators. Furthermore, for 10-month-old seedlings, the nursery operators will benefit from a two-month maintenance cost-saving of RM0.50 to RM0.80/ seedlings. Nursery operators could also increase the number of seedlings per area, from about 12 000 (at 0.9 m spacing) to 20 050 (at 0.75 m spacing) seedlings per hectare.

The effects of the different planting ages on the bunch quality taken at 5 and 6 years after harvest are summarised in *Table 9*. For over two years, the total bunch number taken for bunch analysis was approximately 223 bunches, with an average of 31 bunches per treatment. The parameters analysed showed satisfactory levels of bunch quality in most of the treatments. There were no significant differences in bunch quality parameters between A10 and A12 treatments. The results showed that the oldest (A18) and the youngest (A6) seedlings used for field planting could result in low bunch quality, as indicated by the ratio of mesocarp to fruit and oil to wet mesocarp. Bunch analysis showed that the 10-month-old seedlings could be suitable for field planting rather than 12-month-old seedlings (normal practice), leading to reduced nursery expenditure.

CONCLUSION AND RECOMMENDATION

The performance of planted seedlings of different ages could be evaluated by their growth performance, nutrients uptake efficiency, FFB yield as well as their components and their bunch quality. The effects of different planting ages over eight years had showed that the overall performance of the 12-month-old seedlings gave better performance than other treatments. However, there was no significant difference in the growth, nutrients uptake, FFB yield as well as the components and bunch quality of the 10-month-old seedlings compared to the 12-month-old seedlings. In conclusion, the 10-month-old seedlings are suitable and recommended for field planting as their performance are comparable to that of 12-month-old seedlings. The findings of this study should be conveyed to the industry for better future of oil palm in Malaysia. In addition, this allows the nursery operator to save two months of maintenance costs, so the profits gained are apparently higher.

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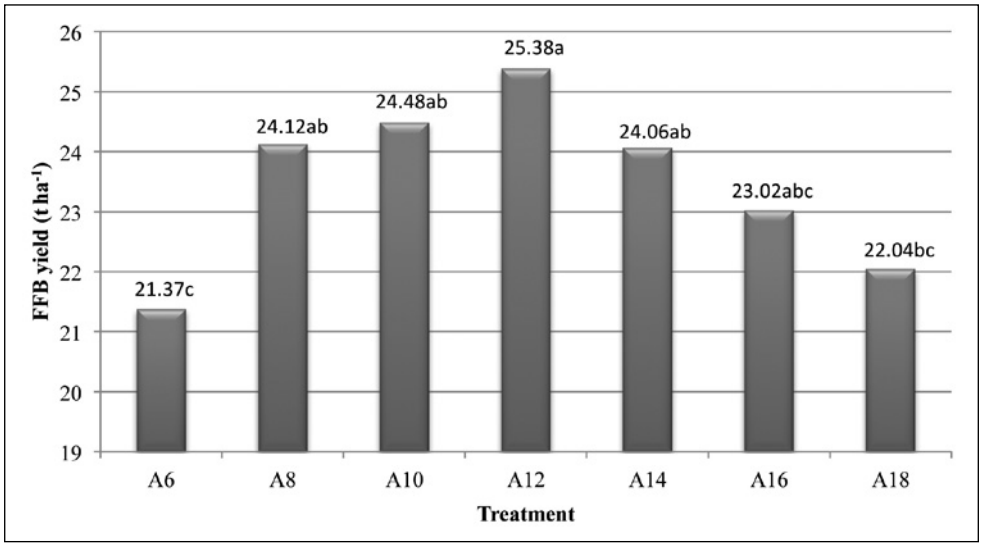
TABLE 9. EFFECT OF TREATMENTS ON BUNCH QUALITY

Treatment	No. of bunch analysed	Mean bunch wt (kg)	Mesocarp to fruit (%)	Fruit to bunch (%)	Oil to wet mesocarp (%)	Oil to bunch (%)
A6	26	10.87a	83.62bc	66.34a	48.48c	26.91a
A8	34	10.43a	86.10ab	62.87ab	50.05abc	27.07a
A10	32	11.24a	85.14abc	61.81ab	50.71ab	26.68a
A12	36	10.90a	86.85a	59.50b	51.74a	26.73a
A14	32	13.00a	85.30abc	64.49b	49.95abc	27.45a
A16	32	11.48a	84.66abc	60.92ab	48.72bc	25.13a
A18	31	12.80a	83.12c	63.87ab	50.88a	26.98a
$LSD_{(0.05)}$		2.595	2.354	5.339	1.968	2.757
CV (%)		12.65	1.56	4.78	2.21	5.80

Note: Mean with different alphabets in the same column are significantly different at 5% level with DMRT; Figures are means of bunch analysis results taken at 5 to 6 year after planting.



Note: Means with different alphabets between bars are significantly different at 5% level with DMRT (Duncan Multiple Range Test).

Figure 1. Mean cumulative of FFB yields over eight years yielding.

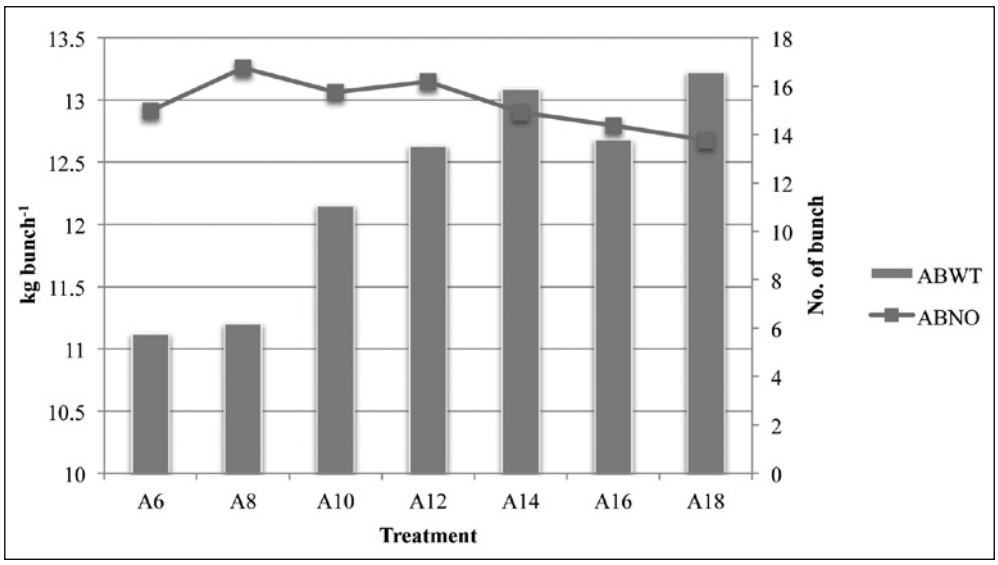


Figure 2. Mean cumulative of average bunch weight (ABWT) and average bunch number (ABNO) over eight years yielding.

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