Comparison of Bunch Yield of Five Hybrids and Two Commercial Tenera Oil Palms in the Young Mature Phase

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ABSTRACT

The young mature phase is a pivotal period for small oil palm plantations, as bunch harvesting takes about 2-3 years. Our study aimed to evaluate the bunch yields of five hybrids (H1–H5) and two commercial Tenera oil palms during this crucial phase. The assessment, conducted over four consecutive years from 2012 to 2015 at the Hong Sila Agriculture and Industry Company Limited, Krabi, Thailand, revealed some intriguing findings using a randomized complete block design with four replicates spaced 9 meters in a triangular pattern. H3 emerged as the best Tenera, delivering the highest fresh fruit bunch (FFB, 243.90 kg/palm/year) over other hybrids and two commercial varieties. H4 demonstrated the highest bunch number (BNO, 26.04 bunches/palm/year) and the lowest average bunch weight (ABW, 8.17 kg/bunch) in the young mature phase. The H3 and H5 were high FFB over checks varieties followed by year. This information was essential in selecting oil palm parents, which had high potential for crossing to produce new hybrids and recognize to choose for their genetics to improve oil palm variety. These findings highlighted the potential benefits of understanding the impact of genetics on the parents of oil palm to produce Tenera.

Keywords: fresh fruit bunch; bunch number; average bunch weight

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INTRODUCTION

In 2023, the Office of Agricultural Economics reported that the southern region of Thailand had the highest ranked first in terms of oil palm plantation and fresh fruit bunch (FFB) production, with about 0.89 million hectares and 19.22 tons per hectare. The Central, Northeastern, and Northern regions followed, with about 0.09, 0.04 and 0.01 million hectares and FFB about 14.66, 9.46 and 7.89 tons per hectare, respectively (Office of Agricultural Economics, 2024). The production distribution information across regions is crucial for target development strategies for each area, such as high yield, high oil yield, dwarf palm, and resistance to disease. The oil palm industry has the potential for significant development and is well-positioned to meet the growing demand for its products. The expansion of oil palm planting is located in Southeast Asian countries, especially Malaysia, Indonesia, and Thailand (Bessou et al., 2017). Additionally, Lawson et al. (2014) recorded that the growth of the oil palm area has been a factor in deforestation and land use change (LUC), and between 2000 and 2012, 60% of tropical deforestation was due to commercial agriculture. Promoting high FFB production by increasing potential variety to high yield per area will ensure a sustainable supply chain, increase farmers' income, and reduce forest encroachment. The industry should focus on breeding the best Tenera variety by estimating the potential germplasm and selecting superior parents and progeny for commercial seed production, paving the way for a promising future.

The Thailand government has laid out an action plan for the palm oil and oil palm sector, demonstrating its commitment. It also supports the breeding and registering of oil palm varieties to achieve the plan. The action plan, entitled "Plan to reform the oil palm and palm oil sector (2017-2036)," aims to increase planting area and fresh fruit bunch yield production by a minimum of 10% per annum from 2016 (15 tons per hectare) to 21.88 tons per hectare per year in 2036. This increase corresponds to an increase in the extraction rate of palm oil from 17% to 23%, which was implemented on January 1, 2020, through the utilization of biodiesel B7, B10, and B20 to completely substitute for petroleum diesel (Department of Internal Trade, 2017; Sowcharoensuk, 2020).

The government actively supports the transition from rubber to oil palm plantations, a project led by the Rubber Authority of Thailand (RAOT). The plan is to replant about one hundred thousand rai annually, starting in 2015 (Rubber Authority of Thailand, 2024). This support underscores the government's commitment to the sector and its smallholders. Nowadays, both the Thai government and private units develop high-quality and high-quantity oil palm varieties to support Thai oil palm plantations without using imported oil palm varieties.

Therefore, this study is a crucial breeding project that will significantly support and drive the palm supply chain of the action plan. It is essential to have oil palm seedlings with high quality and potential for yielding at a young mature phase at 4-7 years after planting in the field or steep ascent yield phase by yield increase; it would give support to the next phase which is the mature phase (7-18 years after plantation) or yield peak. Within the oil palm production cycle, revenue generation for cultivators commences during the immature phase, approximately 2 to 3 years after field planting (Woittiez et al., 2017). Moreover, by selecting different oil palm materials, one can tap into the high potential for bunch yield, thereby boosting income for oil palm smallholders. This result should be considered when planting oil palm seedlings to ensure early high yields in FFB, BNO, or ABW, thereby influencing year-round harvesting.

This study compares the performance of a Tenera oil palm with two commercially available oil palms regarding their fresh fruit bunch yield potential during the young mature phase. This allows oil palm planters to earn income earlier after waiting until 3 years to start bunch harvesting.

MATERIALS AND METHOD

Tenera oil palm materials

This experiment involved planting five improved Tenera oil palm varieties (H1-H5) and two commercial Tenera (C1-C2) from Univanich Oil Palm Company Limited and the Department of Agriculture, respectively. They were planted in November 2009 at Hong Sila Agriculture and Industry Company Limited in Krabi Province. The H1-H5 were improved Tenera from Goldentenera Company Limited. The experiment followed a randomized complete block design with four replications, each replication had 15 palms spaced at triangular distance of 9×9×9 meters. Oil palm management for fertilizer and weeding control followed the method of Corley and Tinker (2016). The plantation was located at latitude 8°17'41.5''N and longitude 99°05'03.7''E on sandy, loam-textured soil with a pH value of 6.49 and an organic matter content of 1.42%. From 2012 to 2015, the region experienced an average annual rainfall of 2,395.55 mm (Thai Meteorological Department, 2021).

Phenotype recording and data analysis

The data on oil palm yield, which included the fresh fruit bunch produced per palm annually in kilograms, the number of bunches per palm annually, and the average bunch weight (ABW) from January 2012 to December 2015 (4-7 years after planting; YAP was a young mature phase), had been meticulously gathered. Data collection was continued after the young mature phase for 8-12 years. The collection of oil palm bunches for weighing and counting was done every 15 to 20 days, strictly following the standardized guidelines of the National Bureau of Agricultural Commodity and Food Standards (2009). The ABW was then computed using the formula of Arolu et al. (2017):

$$\mathrm{ABW} = \frac{\mathbf{FFB}}{\mathbf{BNO}}$$

Where ABW = average bunch weight (kg/bunch), FFB = fresh fruit bunch (kg/palm/year), and BNO = bunch number (bunches/palm/year)

Finally, the data were analysed using Bartlett's test, analysis of variance and the means of each factor were compared using the DMRT method using the R program (R Core Team, 2021). Nevertheless, the year factor was calculated using the Bartlett's test, then to make a mean of each trait when the variance test of each year was not significantly different or the variance was the same. The two-way analysis was focused on year and oil palm varieties without the interaction of year.

RESULTS AND DISCUSSION

The analysis of variance (ANOVA) conducted on fresh fruit bunch, bunch number, and average bunch weight is shown in Table 1. It was found that the year, oil palm varieties, and interaction between year and varieties significantly differed in FFB, BNO, and ABW, except for the year and varieties in FFB. The results indicate that the coefficient of variation was relatively low for FFB, BNO, and ABW, suggesting a more precise estimation in these cases. The average of FFB, BNO, and ABW of all varieties was 220.17 kg/palm/year, 23.34 bunches/palm/year, and 10.30 kg/bunch, respectively. The effect of the young mature phase in this experiment was a criterion from Woittiez et al. (2017), who stated that the young mature phase was the year after planting (YAP) in the oil palm field in 4-7 YAP when yield increased. During this period, oil palm smallholders experienced increased yield and income from utilizing the oil palm variety, which demonstrated significant potential and became evident after three years of cultivation. This observation suggests that the data should be substantiated by carefully selecting an appropriate oil palm variety and procuring seedlings for subsequent plantations.

Table 1 Mean squares, mean, and coefficient of variation percentage of fresh fruit bunch yield including fresh fruit bunch, bunch number, and average bunch weight in Tenera oil palm for four years (2017-2020) in Krabi province

Source of variation	Df	Fresh fruit bunch (FFB)		Bunch number (BNO)		Average bunch weight (ABW)	
Year	3	11,229	**	1,024.5	**	430.8	**
Replication/Year	12	2515		9.90		1.10	
Variety	6	3,547	**	102.1	**	33.9	**
Year:Variety	18	629		6.35	*	3.26	**
Pooled error	72	459		3.22		0.28	
CV (%)		9.73		7.68		5.13	
Mean		220.17		23.34		10.30	

Df, degrees of freedom; *, significant for p<0.05; **, significant for p<0.01

The response by year to mean FFB increased each year while the BNO decreased and ABW increased, as shown in the reliable data in Table 2 and Figure 1-3. The best yearly performance on FFB and ABW was observed in Y7, while BNO was in Y4. This result supported the steep ascent fresh fruit bunch yield phase, as mentioned 4-7 YAP, and under favorable conditions, bunch production peaked 6-7 YAP (Ng, 1983; Donough et al., 2009) shown in Table 2. The best oil palm performance in FFB was H3 (243.90 kg/palm/year) and H5 (236.81 kg/palm/year), giving the FFB higher than the two commercial oil palms, C1 (209.31 kg/palm/year) and C2 (216.62 kg/palm/year). Additionally, H3 showed the lowest BNO value of 23.42 bunches/palm/year, while H4 showed the highest BNO at 26.04 bunches/palm/year, contrasting to the lowest FFB of 202.91 kg/palm/year shown in Figures 1 and 2. In this study, 5 tenera oil palms had higher FFB and BNO than the mean of 34 progenies (24 Deli Dura × 10 Nigerian Pisifera palms) studied by Arolu et al. (2017) which was FFB 192.93 kg/palm/year and BNO 16.94 bunches/palm/year. The large bunch or high ABW found H2 in 12.68 kg/bunch, which was higher than the average of 9.87 kg/bunch from C1 (10.01 kg/bunch) and C2 (9.73 kg/bunch) displayed in Table 2 and illustrated the ABW of different hybrids (Figure 3).

The FFB of 7 oil palm varieties trialed in this study showed that the average FFB was over the standard of SIRIM from Malaysia, which is 170 kg/palm/year (Department of Standards Malaysia, 2005). The number of fronds, a key factor in oil palm production, is significantly influenced by genetic control. As Fairhurst and Härdter (2003) observed, oil palm age 4-6 YAP produced approximately 18-24 fronds per year, a difference from the 2-3 YAP with over 40 fronds production. This result, with a BNO 18.18-26.04 bunches/palm/year and an annual average of 7 oil palm varieties found 16.13-30.12 bunches/palm/year, supported the data from Fairhurst and Härdter (2003) who stated that the number of fronds from the immature phase was 40 fronds/palm, with Y4 giving the highest average BNO of 30.12 bunches/palm/year. Some varieties produced over 24 fronds because of a trait controlled by genetics and influenced by the environment's effect on inflorescence by females or males, depending on the previous 2 years' drought or water deficiency conditions. These results supported the preliminary basis for choosing oil palm varieties, in which H3 showed the highest FFB, H4 for BNO, and H2, H3 for ABW, more than commercial varieties in the Krabi area. This information was essential to support the designation of oil palm planters in select parent palms for developing superior new varieties and enhancing breeding programs. The difference in oil palm varieties displayed the response to fresh fruit bunch yield with the potential trend to give the income shown in Figure 4, which showed a trend from 4 to 7 YAP (the result in this study) and continuous from 8 to 12 YAP, which was recorded after this study period.

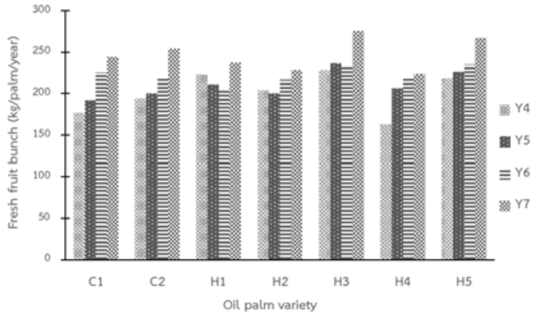

Figure 1 Seven oil palm varieties response to different four years in the young mature phase period (4-7 years after planting, 2012-2015) on fresh fruit bunch

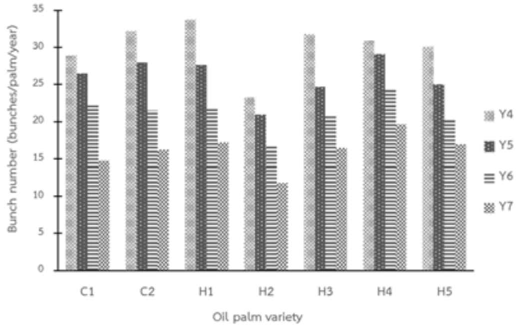

Figure 2 Seven oil palm varieties response to different four years in the young mature phase period (4-7 years after planting, 2012-2015) on bunch number

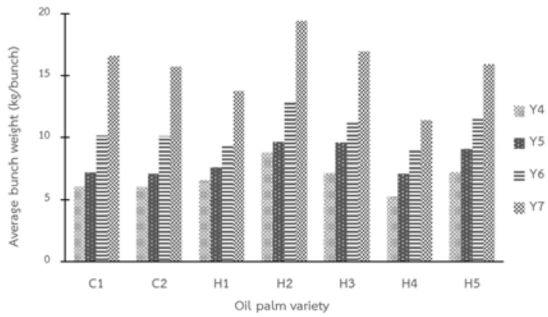

Figure 3 Seven oil palm varieties response to different four years in the young mature phase period (4-7 years after planting, 2012-2015) on average bunch weight

Table 2 Means of each year and bunch yield (FFB, BNO, and ABW) of seven Tenera varieties in the young mature phase in Krabi province

Year	FFB (kg/palm/year)	BNO (bunches/palm/year)	ABW (kg/bunch)
Y4	201.00 c	30.12 a	6.73 d
Y5	210.23 bc	25.97 b	8.18 c
Y6	222.19 b	21.13 c	10.62 b
Y7	247.24 a	16.13 b	15.67 a
Variety			
C1	209.31 b	23.09 c	10.01 c
C2	216.62 b	24.46 bc	9.73 c
H1	219.25 b	25.08 ab	9.35 c
H2	212.36 b	18.18 d	12.68 a
H3	243.90 a	23.42 c	11.22 b
H4	202.91 b	26.04 a	8.17 d
H5	236.81 a	23.11 c	10.92 b

Means with different lowercase letters in the same column denote significant differences between oil palm varieties based on DMRT

CONCLUSION

The young mature phase (4-7 years after planting) is the critical period of fresh fruit bunch yield, and the sharp yield curve showed that H3 exhibited the highest yield of FFB, 243.90 kg/palm/year, while H4 exhibited the BNO 26.04 bunches/palm/year and ABW 8.17 kg/bunch. The trend of FFB and ABW increases with age, while BNO exhibits a different pattern. After Y7 was the expected period to know with nearly the highest fresh fruit bunch yield for expect extension continue to get fresh fruit bunch yield in the future, which the mature phase or the stable of yield refers to farmers' income. Therefore, selecting superior Tenera is a choice that supports career stability for farmers and government policy to expand plantations and replants for other farmers in the nearby environment.

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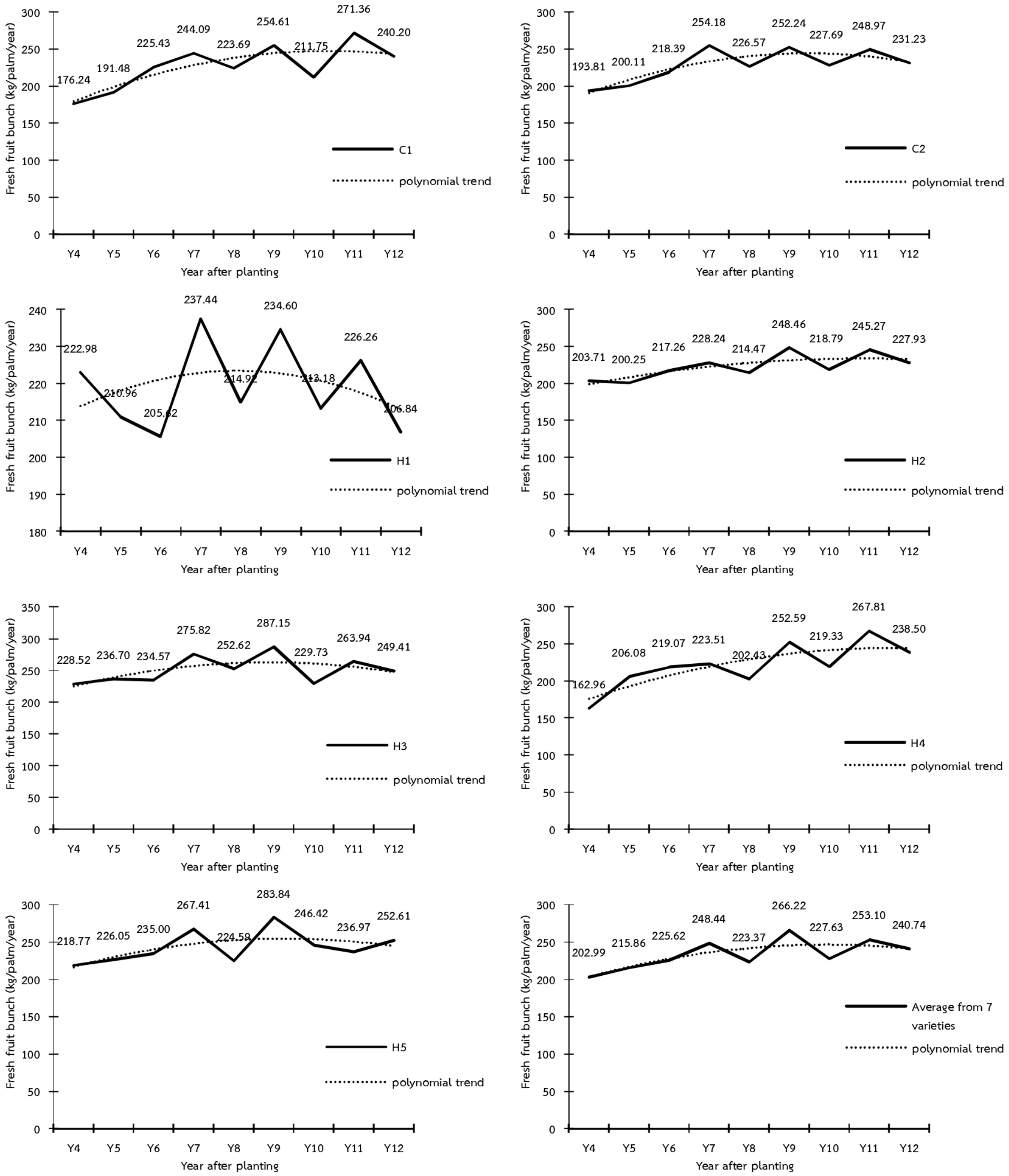

Figure 4 Seven oil palms fresh fruit bunch yield response in 4-12 years after planting of oil palm at Krabi province

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