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The Flowering Pattern and Fruit Production of Red Pitaya (*Hylocereus polyrhizus*) under Malaysian Growing Condition

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***Abstract* – Red pitaya (*Hylocereus polyrhizus*) is a popular minor fruit crop in Malaysia. It has high demand from domestic market due to its nutrition value and phytonutrient content such as betacyanins, flavonoids and phenolic acids. It started to grow in Malaysia since early of 2000's and the total planted area in year 2018 was estimated about 680 hectares. An observation was conducted to study the flowering pattern and fruit production of red pitaya under Malaysian growing condition. Total of forty-five trellises of red pitaya plants at the age of two years after fruiting from three different blocks were used to monitor the flowering batches, flower intensity, fruit production and yield for the period of two years. The recorded data indicated that red pitaya flowering minimum one batch per month to maximum three batches per month. The average flower intensity was 3.5 flowers per trellis per batch, the maximum flower numbers at peak season was 12.7 flowers per trellis and only 0.3 flowers per trellis at the low season. The average monthly flowering intensity was 6.9 flowers per trellis with the annum flowers production of 82.6 flowers per trellis. Meanwhile, the fruiting pattern of red pitaya showed to produce 4.4 fruits per trellis per month with the total annum fruit production of 52.9 fruits per trellis. The average yield of red pitaya was 20.1 tonnes per hectare per annum with the monthly yield of 1.7 tonnes per hectare. The peak production season of red pitaya was from April to September with the average monthly yield of 2.0-3.0 tonnes per hectare as compared to low season from October to January only recorded less than 1 tonnes per hectare**

***Keywords* – *Hylocereus polyrhizus*, Phytonutrients, Flowering, Fruiting, Yield.**

I. INTRODUCTION

Red pitaya (*Hylocereus polyrhizus*) which known as dragon fruit in Malaysia is an important minor fruit crop that introduced in the early of 2000's. The common name pitaya is because of the scales on the skin which means 'the scaly fruits' [1]. *Hylocereus* is characterized as a climbing plant with aerial roots that bears a large, scaly, glabrous berry and peel with large scales and a white or red pulp [2]. *Hylocereus* sp. belongs to the cacti family from the subfamily Cactoidea of the tribe Cactea [3]. Pitaya undergo Crassulacean Acid Metabolism (CAM) photosynthetic pathway, thus it use only 10% of water compare to other plants are using in the same environment [4]. The total cultivated area of pitaya in Malaysia was increased from 502 ha in year 2005 [5] to 680 ha in year 2018 with the total production of the fruit was 6407 tonnes in 2018 which contributed less than 1% of the total fruit production in Malaysia [6]. Three varieties of pitaya cultivated in Malaysia were white flesh pitaya (*Hylocereus undatus*), red flesh pitaya (*Hylocereus polyrhizus*) and yellow skin pitaya (*Selenicereus megalenthus*). Only two varieties that suitable to be planted in Malaysia which were red and white flesh varieties [7]. Pitaya flesh is firm and crisp, with a delicately sweet and lingering flavour [8]. Moreover, pitaya is highly demanded in local market due to its nutritional value and phytonutrient content such as betacyanins, flavonoids and phenolic acids [9], [10], [11] and its attractive appearance. Pitaya is a non-climacteric plant thus its best quality is displayed when the fruit is harvested at full maturity stage. The growth of red pitaya fruit usually exhibited a sigmoid pattern, where the growth of fruit weight, length, and diameter was rapid during 25 days after flower anthesis [12]. The plants are best grown under the open air in tropical areas, but must be protected from intense solar radiation and

subfreezing temperatures when cultivated under subtropical conditions [13], [14]. An artificial vertical support for pitaya to climb with 2.0-3.0 m distance between planting lines is required [15]. In Malaysia, the planting distance of 3.0 m x 2.4 m in rectangular pattern with 1,361 trellis plants/ha is the most common planting density of red pitaya cultivation [16]. Pitaya generally began to produce significant yield production two to three years after planting and reach full production after five years [17]. The flowering pattern and yield of red pitaya was inconsistent under Malaysian growing condition. Therefore, an observation was conducted to study the flowering pattern and fruit production of red pitaya under Malaysian growing condition.

II. Materials and Method

This study was carried out in FGVAS Sg. Tengi Research Station, Selangor, Malaysia. The red pitaya plants at the age of two years after fruiting were used in this study. The plants were planted in rectangular pattern with the planting distance of 3.0 m x 2.4 m which consisted of 1,361 trellises per hectare. Total of forty-five trellises which composed with four red pitaya plants in each trellis from three different blocks were used for data recording. The flowering, fruiting and yield performance of red pitaya which included the flower intensity per trellis, number of fruits produced per trellis, average fruit weight, total yield per trellis and total yield per hectare were recorded for every flowering and fruiting batches for the period of two years to monitor the flowering pattern, fruiting pattern and potential yield of red pitaya. A total of forty-eight flowering batches of red pitaya were recorded in this study for analysis.

III. Results and Discussion

A. *Flowering Patterns of Red Pitaya*

The flowering records for the period of two years were showed that red pitaya grown in Malaysia could flowers one batch to maximum three batches in a month. Flowering of pitaya is cyclic and spread out over the whole period and number of flowering depends on the species [18]. Factors affecting flowering of pitaya are including shoot age, temperature, light, and application of growth regulators [19]. For the 24 months of recording, about 7 months were recorded one batch of flower per month, 10 months were recorded two batches of flower per month and 7 months were recorded to flowers three batches per month (**Fig. 1).** The month of January to September in the first year and January to June in the second year were recorded more than one batch of flowering (**Fig. 1). Fig. 2** had showed the flowering of red pitaya for the period of two years where both showed almost similar trend of flowering pattern, the peak season of flowering was from March to September with more than 6 flowers/ trellis/ month as compared during the low flowering season from October to December which only produced less than 2 flowers/ trellis/ month. The highest flowers intensity during peak flowering season was recorded as high as 12.7 flowers and 10.0 flowers/ trellis/ batch in the first and second year of recording as compared during the low flowering season which only produced 0.3 and 0.8 flowers/ trellis/ batch, respectively in the first and second year of recording. The average flower intensity of the forty-eight flowering batches was 3.5 flowers/ trellis/ batch (**Table 1**). The flowers intensity during the peak season was about 7.5-12.4 flowers/ trellis/ month, meanwhile during the low season only produced 1.0-3.5 flowers/ trellis/ month. The annum flowers production was 82.6 flowers/trellis with the average flowers numbers of 6.9 flowers/ trellis/ month (**Table 2**). Other study had reported that annum flower production of pitaya was in the range of 9-40 flowers/ trellis [20].

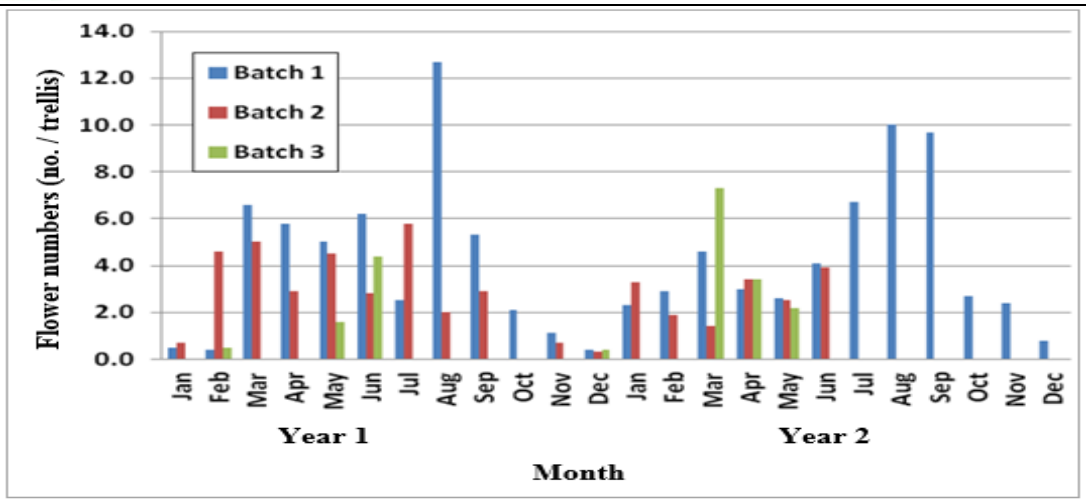

Fig. 1. Flowers intensity of red pitaya in each flowering batch for the period of two years.

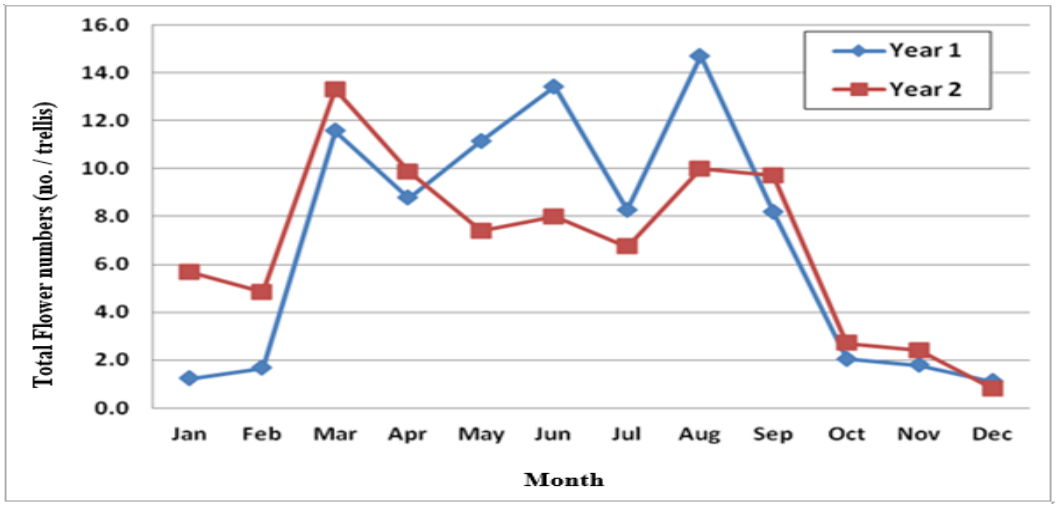

Fig. 2. The monthly flowering pattern of red pitaya for the period of two years.

Table 1. The average flowers intensity of red pitaya for the period of two years.

Flowers Intensity (no./ trellis/ batch)														
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Average**
Year 1	Batch 1	0.5	0.4	6.6	5.8	5.0	6.2	2.5	**12.7**	5.3	2.1	1.1	0.4	
	Batch 2	0.7	4.6	5.0	2.9	4.5	2.8	5.8	2.0	2.9	-	0.7	**0.3**	
	Batch 3	-	0.5	-	-	1.6	4.4	-	-	-	-	-	0.4	**3.5**
Year 2	Batch 1	2.3	2.9	4.6	3.0	2.6	4.1	6.7	**10.0**	9.7	2.7	2.4	**0.8**	
	Batch 2	3.3	1.9	1.4	3.4	2.5	3.9	-	-	-	-	-	-	
	Batch 3	-	-	7.3	3.4	2.2	-	-	-	-	-	-	-	

Table 2. The annum and monthly flowers produced of red pitaya for the period of two years.

Flower numbers (no./ trellis)														
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**	**Average**
Year 1	1.2	1.7	11.6	8.8	11.1	13.4	8.3	14.7	8.2	2.1	1.8	1.1	**83.9**	**7.0**
Year 2	5.7	4.8	13.3	9.9	7.4	8.0	6.7	10.0	9.7	2.7	2.4	0.8	**81.4**	**6.8**
Average	**3.5**	**3.3**	**12.4**	**9.3**	**9.3**	**10.7**	**7.5**	**12.4**	**8.9**	**2.4**	**2.1**	**1.0**	**82.6**	**6.9**

Pitaya is a long day plant [19] which requires longer sunshine for flowering and fruit production. The longer sunshine hour during the dry weather was the major factor to trigger the flowers of red pitaya [21]. Moderate temperature about 32°C during dry season is major influence that able to induce heavy flowering of red pitaya as compared to extreme high and low temperature [22]. **Fig. 3** showed the relationship between the monthly flowers intensity of red pitaya with the monthly rainfall. It was clearly demonstrated in the first year of recording where during the dry weather from March to July with the monthly rainfall less than 100 mm, the flowers intensity of red pitaya was as high as 8-14 flowers/ trellis. However, during the wet weather from October to December with the monthly rainfall of 200-500 mm, the plants only produced about 2 flowers/ trellis. The beginning of flowering generally occurs after the rainy season. Furthermore, excessive water systematically results in the abscission of flowers and young fruits [15]. This is supported by a finding that this crop required yearly rainfall of 600-1300 mm with alternating wet and dry seasons [23]. However, a report has been conducted that suggested 120 mm/ year of water supply is enough for pitaya requirement [24].

B. *Fruits Production of Red Pitaya*

The fruiting of red pitaya was also showed the similar production trend in the first and second year of recording, where the peak fruiting season was from April to September and the low season was from October to January **(Fig. 4).** The average fruit numbers of red pitaya that produced during the peak season was about 4.9-8.6 fruits per trellis, meanwhile during the low fruiting season only produced 1.2-2.2 fruits per trellis. The annum fruits production of red pitaya was 46.9 and 59.0 fruits per trellis for the first and second year of recording and the average annum fruits production of red pitaya was 52.9 fruits per trellis **(Table 3).** The result is comparable with a report that showed annual harvest for a middle-age pitaya plant was ranged from 45 to 98 fruits per plant [25]. Meanwhile, the average fruit weight of red pitaya was ranged 211-297 g and 251-334 g respectively for the first and second year of recording and the average fruit weight over the 2 years was 271 g **(Table 4**). Findings in other literatures shown that the average fruit yield of red pitaya is around 200-400 g/fruit respectively [26], [27]. Other studies had reported that the average fruit weight ranged from 300-393 g/fruit [28], [29].

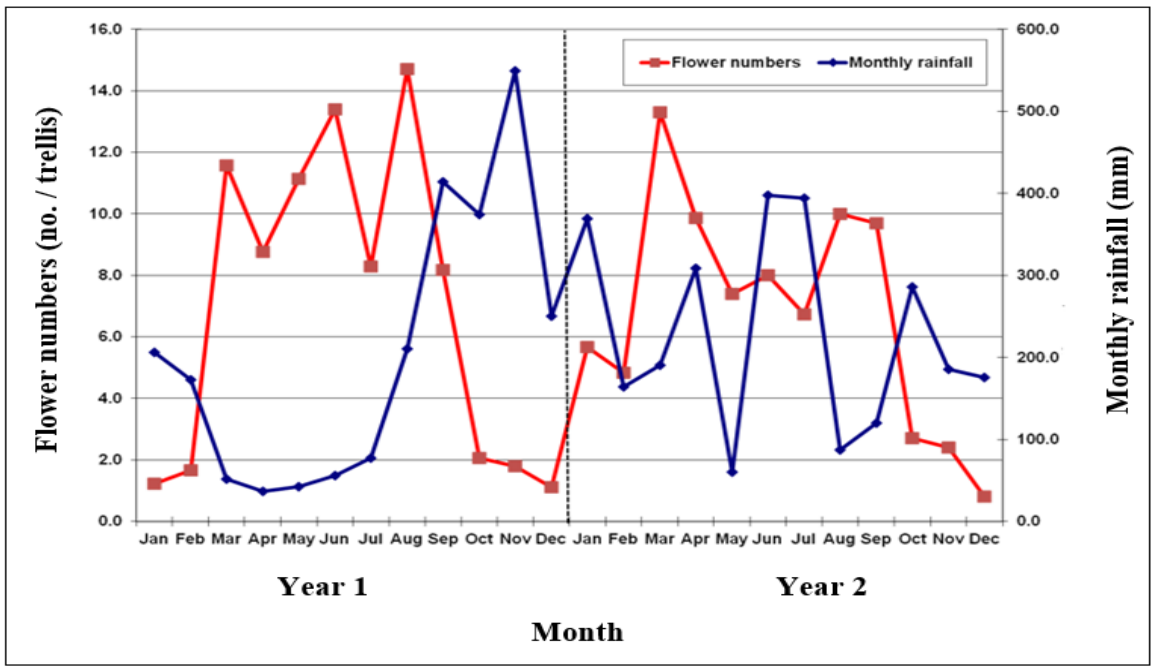

Fig. 3. The relation of flowering intensity of red pitaya to monthly rainfall.

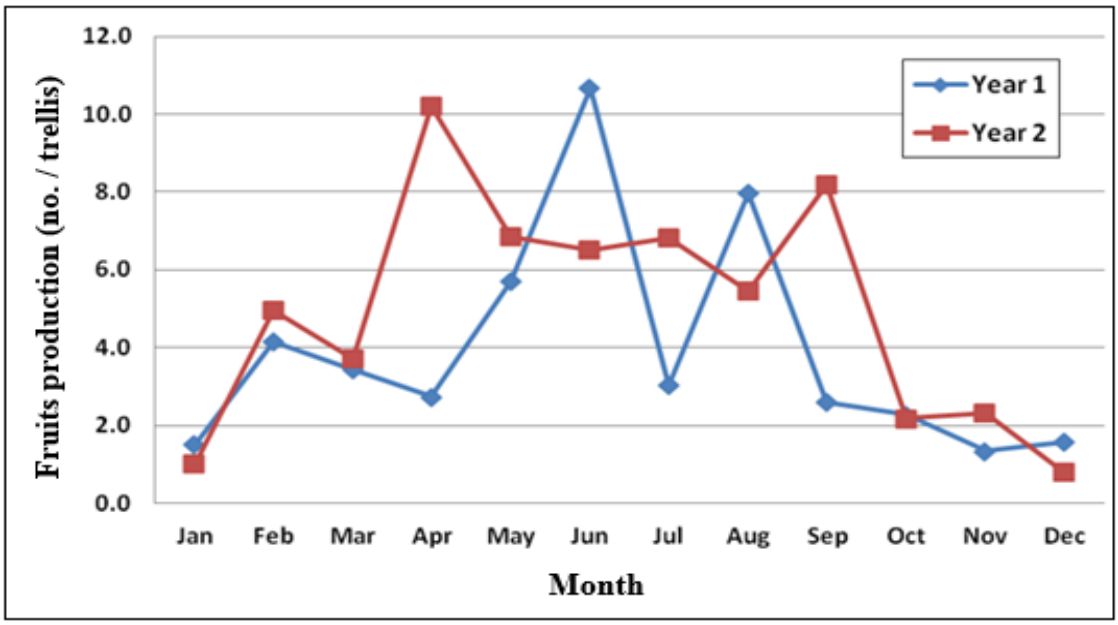

Fig. 4. The monthly fruits production pattern of red pitaya for the period of two years.

Table 3. The fruits production of red pitaya for the period of two years.

Fruit numbers (no. /trellis)													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**	**Average**
Year 1	1.5	4.1	3.4	2.7	5.7	10.7	3.0	8.0	2.6	2.3	1.3	1.6	**46.9**	**3.9**
Year 2	1.0	5.0	3.7	10.2	6.9	6.5	6.8	5.5	8.2	2.2	2.3	0.8	**59.0**	**4.9**
Average	**1.3**	**4.5**	**3.6**	**6.5**	**6.3**	**8.6**	**4.9**	**6.7**	**5.4**	**2.2**	**1.8**	**1.2**	**52.9**	**4.4**

Table 4. The average fruit weight of red pitaya for the period of two years.

Average Fruit Weight (g/ fruit)													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Average**
Year 1	269	297	288	230	286	270	277	242	240	241	228	211	**257**
Year 2	265	289	251	318	277	228	301	323	328	250	334	254	**285**
Average	**267**	**293**	**270**	**274**	**282**	**249**	**289**	**283**	**284**	**246**	**281**	**232**	**271**

C. *Yield Performance*

The yielding pattern of red pitaya was showed the peak from April to September in the first year and May to June and August in the second year of recording. The harvested yield was more than 1500 kg/ha/month during the peak season. Meanwhile, during the low yield season from October to Jan, the yield was less than 500 kg/ ha/ month for both harvesting year **(Fig. 5).** The total yield of red pitaya was recorded about 16.8 tonnes/ ha/ year and 23.5 t/ ha/ year in the first and second year of recording. The average yield of red pitaya over the two years was 20.1 t/ ha/ year **(Table 5).** This finding is supported by other study reported that the average yield of red pitaya is between 5 to 30 tonnes/ ha/ year, varying according to the cultivation density and practices, type of pollination and others [30].

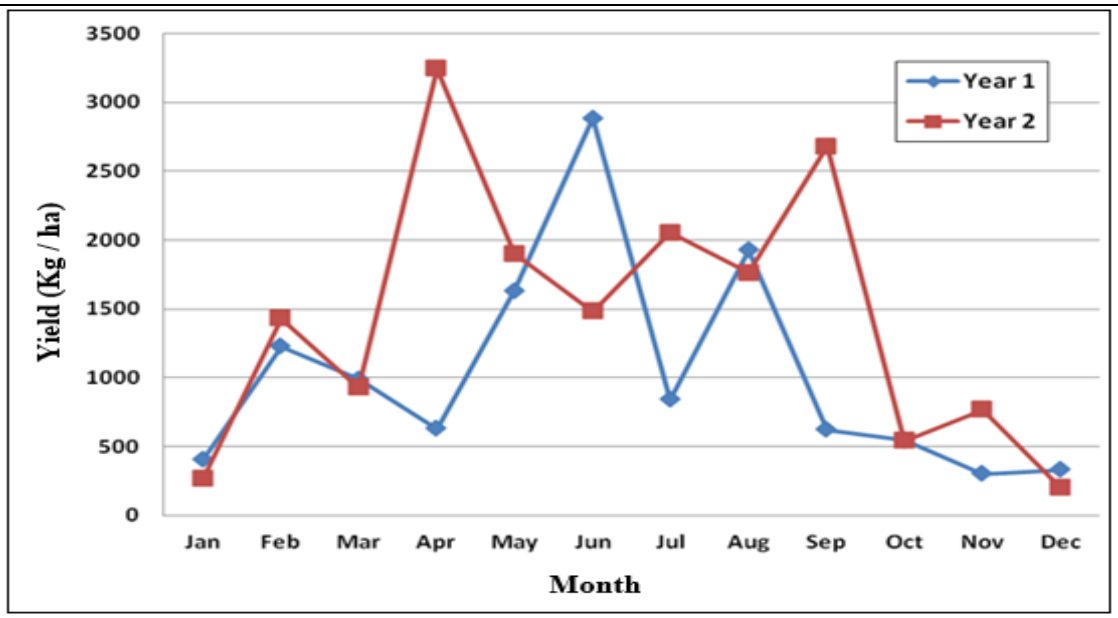

Fig. 5. The yield of red pitaya for the period of two years.

Table 5. The yield of Red Pitaya for the period of two years.

Yield of Red Pitaya (kg/ha)													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Year 1	549	1669	1347	857	2221	3924	1143	2622	848	744	413	449	**16788**
Year 2	361	1947	1266	4414	2586	2017	2796	2400	3650	740	1047	277	**23500**
Average	**455**	**1808**	**1307**	**2636**	**2403**	**2970**	**1970**	**2511**	**2249**	**742**	**730**	**363**	**20144**

IV. Conclusion

Red pitaya grown under Malaysian weather condition seem to have better flowering, fruiting and yield during the dry weather from April to September, where else during the wet weather from October to December the yield was low. The plants were able to flowers up to 83 flowers/ trellis/ year with the production of 53 fruits/ trellis/ year. The average yield of red pitaya was 20.1 t/ha.

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