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Research Article

EFFECT OF MULTILOCATION PRODUCTION ON THE REPRODUCTIVE GROWTH, YIELD AND QUALITY OF HARUMANIS MANGO

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A B S T R A C T

Harumanis mango (*Mangifera indica* L.) is one of the most commercial and famous cultivars of mango grown in Malaysia for the past 15 years. Due to high quality and good eating preferences, the demand for this variety has increased yearly and most of the production is done in the northern region of Peninsular Malaysia specifically Perlis state. High demand of Harumanis mango caused the production acreage to be expanded to the neighboring state. However, there is insufficient information on the specific requirement of reproductive phase, yield and quality potential for production of Harumanis mango outside the Perlis state. Therefore, an evaluation was conducted at 3 different location of Harumanis mango farms which were located at same Agroclimate Zone 1 as Arau, Perlis (Control), MARDI Sintok, Kedah and Tanjung Sedili, Kota Tinggi, Johor for10 months observation. Data collection consisted of climatic data, reproductive growth, yield and quality assessment. Based on the result, the time of flowering process were initiated twice at Arau, Perlis in December 2017 and February 2018. While in MARDI Sintok and Tanjung Sedili, Johor, flowering was initiated on February 2018.Relative humidity at Tanjung Sedili, Johor was recorded as the highest and significantly different to the other locations for all 3 months observations. In terms of reproductive growth performance, data on whole flowering process, Tanjung Sedili, Johor, recorded the lowest and significant differences of the parameter measured as fruit to flower number ratio as compare to the other two locations. Grading of fruit weight (g) and percentage in MARDI Sintok, Kedah is found to be significantly higher compared to other locations for C grade (<350g). It is followed by B grade (350g-450g) where MARDI Sintok, Kedah and Tanjung Sedili, Johor recorded significantly higher number of grade B fruits compare to Arau, Perlis. However, most of the fruit in Arau, Perlis was recorded higher and significant different on A grade (450g>) of fruit weight. On the other hand, for physical fruit appearance, only a total fruit weight (g) parameter in MARDI Sintok, Kedah was observed significantly lowest amongst the locations. Quality assessment analysis showed the trend on the parameter of total titratable acidity and vitamin C for fruits in Tanjung Sedili, Johor was recorded the highest and significantly different compared to other locations.

INTRODUCTION

Mango (*Mangiferaindica L.*) is one of the most valuable fruit crops in the world. It is widely grown in subtropical and tropical regions including southeastern Asia and Central America with a fruit production of more than 33 million tons throughout the world (Mohammad A. 2008; Wei *et. al*, 2017). As recorded in 2017, there is about 6048.29 hectarage of mango cultivation in Malaysia with 16,912.59 metric tons production (DOA, 2017). Nowadays, about 300 variety of mango is cultivated in Malaysia having different growth pattern, yield and quality characteristics namely as Harumanis, Chok Anan, Sala, Masmuda, Telur, Narm Dok Mai and others (MohdAsrul S.*et al*, 2018).

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Among the varieties, Harumanisis registered by Department of Agriculture as MA128 as one of the premium varieties in Malaysia. This variety is also synonym to the Perlis state and is considered as "King of Mangoes" due to its good quality attributes as well as great taste and aroma (Khalid *et. al*, 2017, Rosidah *et al*., 2010). Furthermore, Harumanis can be sold at a high price and provide a high revenue income to the farmers for local and export market. The trend of the fruit demand for Harumanis has increased yearly in Perlis.

Mango is a seasonal plant that is influenced by specific agroclimatic conditions favorable to drought season for fruiting. Air temperature and rainfall influence vegetative and reproductive stage in mango. These are two major factors which determine the suitability of the area for mango production (Shalendra, 2016). Rajan also reported that in 2016, where mangoes grow best in climates which have low rainfall

and low relative humidity at flowering, fruit setting and harvesting, and that a warm to hot during fruiting. Therefore, Agro-climatic Zone 1 has been classified as the most suitable area for commercial mango cultivation in Malaysia. Since a decade ago, the cultivation of Harumanisin Perlis state is seen to be suitable in its Agro-climatic Zone 1. However, the rise of Harumanis mango planted in Perlis are still insufficient in supplying the local and export demand. Adequate and continuous supply of fruit production is the most critical part to achieve the market needs. This situation is also related with the exportation of Harumanis to Japan where the Japanese importers are concerned about the exporters ability to supply the mangoes in a consistent manner and adequate to their market demand (Rosidah *et. al*, 2010). importantly, Japanese importers are very concerned about the exporters' ability in supplying the mangoes in a consistent manner to fulfil the market demand. In this matter, production of fruits must be adequate to meet the market demand.

Therefore, the Harumanis cultivation is expanded to Kedah state which is located next to Perlis and situated in the same agro-climatic zone. To fulfil the demand and sustain the commercial productions for local and export market, 3 locations in different states are monitored for Harumanis production. As a result, the production has been done outside Perlis where certain area in Johor state which is identified to be suitable was selected for observation and evaluation purposes.

Nevertheless, the information about the comparison between the flowering pattern, yield and quality of Harumanis from the different location in Malaysia is still limited and questionable. Furthermore, there is a statement without scientific support and evaluation on the disability and low performances on yield and quality of Harumanis planted outside of Perlis state. Flowering of mango is ultimately influenced by environmental factors such as temperature, rainfall, relative humidity, photoperiod and water stress (Geetha *et. al*, 2016). Moreover, different climate at different locations will adversely affected the flowering time, fruiting, yield and quality of fruits. Flowering time for mango in Thailand and Malaysia is reported to be dissimilar, where Thailand will start on December while Malaysia commence on February to Mac (Ram and Rajan, 2003). Additionally, the various climate conditions may describe the fruit quality produced, where increase of drought will delay the maturity of fruit while high temperatures can induce physiological disorder like spongy tissue incidence forAlphonso mango (Sandip *et. al*, 2016). Thus, an observation was conducted with the objective to determine the precise flowering pattern, yield and quality of Harumanis mango from different location of cultivation.

MATERIALS AND METHOD

Research location

An observation was conducted by using mango trees var. *Harumanis*. This study was divided into 3 treatments representing the 3 different locations of Harumanis plots which are situated in the same Agroclimatic Zone 1. Agroclimatic Zone 1 is known as the area which has long and clear drought season. Therefore, the location which were selected in this study as Harumanis farm in Arau, Perlis as a control, Harumanis research plot in MARDI Sintok, Kedah and Harumanis farm in Tanjung Sedili, Kota Tinggi, Johor. The experiment was initiated September 2017, after scheduled pruning management until harvesting stage in June 2018. The completed growth cycle of the plant from vegetative to reproductive phase is observed. All the 3 Harumanis farm was treated with the same cultural practices recommended by MARDI including of pruning and thinning, flower induction practices, fertilization programme, pest and disease management. However, two of the studied Harumanis farm consist with the same types of soil as mineral soil for Arau, Perlis and MARDI Sintok, Kedah. Whereas Tanjung Sedili, Johor had sandy soil. The age of the selected plants from each plot ranged between 10-12 years old. The pruning programme started from August 2018 and followed by flower induction using Paclobutrazol after 2 months. Fertilization programme used compound fertilizer as Nitrophoska Blue (12:12:17:2) and was applied 3 times after pruning which is on August 2017, December 2017 and April 2018. Watchdog weather station was placed at 3 selected locations respectively started from August 2017 for climatic data collections.

Experimental Design and data Analysis

The treatments comprised of 3 different locations and were arranged in a Complete Randomized Design (CRD) with 6 replications with 5 plants per replication. The data obtained was analyzed using ANOVA in SAS software (Version 9, SAS Institute Inc. Cary, North Carolina, USA) and differences between treatments means were compared using Duncan Multiple Range Test Difference (DMRT) at $P \leq 0.05\%$. Pearson correlation coefficient (r) was determined between the variables in each species at $P \leq 0.05\%$.

Fruit Sampling and data Measurement

Fruit sampling were done at each location on different time. In Arau, Perlis state, fruit harvesting commenced in May 2018, followed by MARDI Sintok, Kedah and Tanjung Sedili, Kota Tinggi, Johor in Jun 2018. The data comprises of the reproductive until harvesting stage. At reproductive stage, inflorescence trees percentage (%), number of flower to shoot ratio and number of fruit to flower ratio were recorded and it began at week 8 after the fruit setting in a size of 1.0-1.2 cm diameter. During harvesting stage, the harvested fruits were studied for yield parameter of grading percentage (%) of fruit weight (g) and fruit weight (g) using analytical balance (AND ER 180A). Additionally, the fruit was washed using water and soaked for 10 minutes in *Benomyl* fungicide to prevent post-harvest diseases. Then, it was dried in ambient temperature and all the fruits were ripen using *Calcium Carbide* for 3 nights before transferred to the laboratory for quality assessment. 3 fruits for each plant were selected and labelled for quality assessment. The fruits size were recorded as length (cm) and width of fruit (cm) using digital caliper meter (Mitutoyo CD67), total soluble solid (TSS) using pocket refractometer (Atago PAL-1), vitamin C, pH, total titratable acidity (TTA). Climatic data such as temperature (c^o) rainfall pattern (mm) and relative humidity (%) were collected using Watchdog Weather Station (Series 2000) for all locations monthly after pruning activity. Climatic data collection was done to observe the relation between the location with the reproductive growth of Harumanis mango.

RESULT AND DISCUSSION

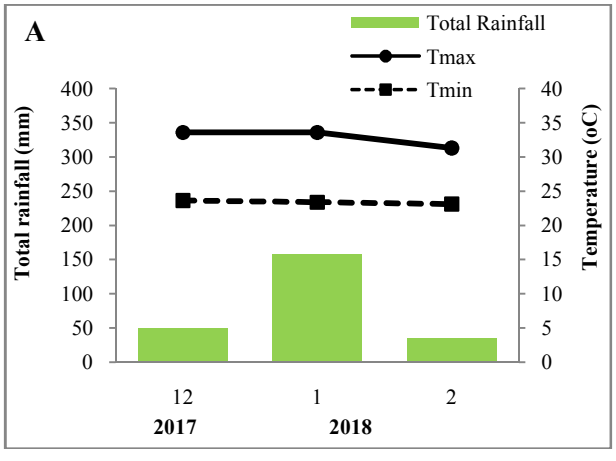
Flowering and fruiting pattern of Harumanis mango at multilocation

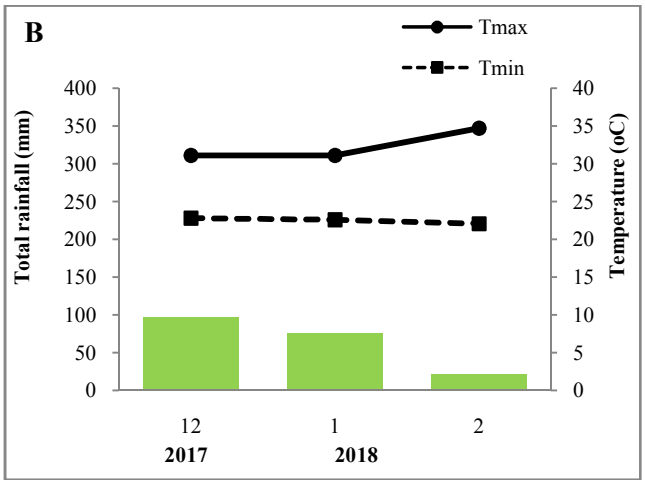
All these 3 locations were situated at different states but specifically in the same Agroclimate Zone 1 and it was classified as the most suitable zone for mango cultivation. In Arau, Perlis, the flowering of Harumanis mango occurred twice, which the first phase started in fourth week of December 2017 and second phase in third week of February 2018 (Figure 1A). First flowering phase as recorded in December 2017 showed the total rainfall was 49.7mm with maximum and minimum temperature recorded at 33.6 c^o and 23.6 c^o respectively. While second flowering phase has showed the total rainfall at 35.23mm with maximum and minimum temperature recorded at 31.3c^o and 21.3 c^o respectively. Whereas, the flowering phase in MARDI Sintok, Kedah occurred once which started at third week of February 2018 with total rainfall at 22.4 mm while maximum and minimum temperature recorded at 34.7 c^o and 22.1 c^o (Figure 1B). Furthermore, flowering phase at Tanjung Sedili, Kota Tinggi, Johor occurred also once which commenced on the third week of February 2018 with total rainfall recorded at 208.3 mm with maximum and minimum temperature at 31.3 c^o and 24.5 c^o(Figure 1C). Generally, the total rainfall (mm) was below 250mm in Arau, Perlis, MARDI Sintok, Kedah and Tanjung Sedili, Johor which by fact induced flowering effects for the trees. Moreover, the combined maximum temperature was more than 30c^o and minimum temperature as below 24.5c^o, which also triggered the trees for flowering.

High temperature, rainfall and humidity may influence a mango tree to grow continuously as vegetative measurement (Sandip *et. al*, 2016). However, there is a contradicting finding for flowering process requirement where low rainfall and humidity is required by the mango trees (Sandip *et. al*, 2016). Areas with seasonal rainfall of 100mm or above are favoured for growing mango because vegetative growth is inhibited during the dry season (Shalendra, 2012). Shalendra also reported that (2012), with high rainfall incidence may force a mango tree to grow constantly that finally resulted non-flowering effect to the trees. Due to the drought incidence or reduction of rainfall pattern in this study, water stress situation is investigated further. This phenomenon is related with the age of last flush as the key factor in mango flowering which coincide with the duration of water stress (Ramirez and Davenport, 2010). Ramirez and Davenport also claimed that (2010), water stress prevents shoot initiation and maintains trees at rest until age accumulation in leaves takes place and trees flower due to the age-dependant reduction of vegetative promoter. Mango flowering only occurs in tropical warm temperatures in initiating shoots of stem that reached a sufficient maturity from previous vegetative flush in four to five months depending upon cultivar (Davenport, 2003). This situation can also be positively modified by cool temperature. Floral induction of mango trees is undeniably affected by cool temperatures (Normand *et. al*, 2015). This condition is also similar with the finding where flowering of mango has occurred for 'Haden' mango after 12 days of being exposed with the maximum and minimum temperatures at 31c^o/ 25c^o (Shu, 1999). Similar finding was obtained using 3 cultivars of mangoes namely as Kesar, Alphonso and Rajapuri where better performance of flowering at cool temperatures recorded above 12c^o (Patel *et. al*, 2015). On the other hand, the effect of temperature is more evident under subtropical conditions where flower formation occurs after or during exposure to floral inductive cool temperatures (Davenport, 2009). However, evidence has showed that, cool temperature condition may also contribute to a reduction of hermaphrodite flowers, while warm temperature may increase the percentage of hermaphrodite flower in mangoes (Singh *et. al*, 1966; Singh and Sharma, 1972; and Shu, 1999). Based on Figure 2, there is a trend of relative humidity from December 2017 till February 2018 where Tanjung Sedili, Johor showed the highest and significantly different relative humidity compared to other locations at 88.75% (December 2017), 91.67% (January 2018) and 82.62% (February 2018).

Due to the flowering process beginning February 2018 for all the locations, it shows the range of relative humidity required for Harumanis mango flowering in Agroclimate Zone 1 is below 82.62% and this situation indicates that, relative humidity had no influence on Harumanis mango flowering. Similar finding with previous study as marian plum as not influenced by the relative humidity (Mavuso and Yapwattanaphun, 2017). As for high relative humidity in Tanjung Sedili, Johore; flowering of mango was still enabled to commence. This also related directly to the findings where high relative humidity can also promoted flower development and retention in *Tamarindus indica* (Fandohan *et al*., 2015). However, the floral indication of mango is also related with other factors as mentioned above for temperature and rainfall pattern.

Based on Table 2, there is no significantly difference in terms of percentage (%) of inflorescence trees and number of flower to shoot ratio among the locations observed. However, the situation was different for Tanjung Sedili location, where the number of fruit to flower ratio where recorded a significantly low compare to the other locations. During flowering phase in third week of February 2018, high rainfall distribution was recorded at 208.3mm (Figure 1C) and significant value were recorded by relative humidity at 82.62% (Figure 2). Unfavorable moisten condition may affected the flowering process at floral initiation and blooming. In addition, a prerequisite for successful mango production in the absence of rain during the flowering period. Moist and humid atmosphere washes pollen, disturbs the pollinators activity and encourages insect pests and diseases. High precipitation, heavy dew or foggy weather during the flower blooming season can stimulate tree growth but interfere with flower production and encourage diseases of the inflorescence (Shalendra, 2012).





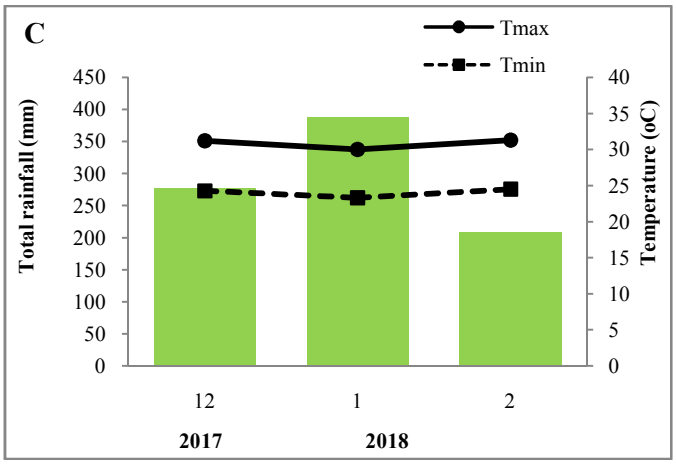


Figure 1A, 1B and 1C. Total rainfall (mm) and temperature (c°) for multilocation of Harumanis mango production (A: Arau, Perlis, B: MARDI Sintok, Kedah, C: Tanjung Sedili, Johor) for 3 months

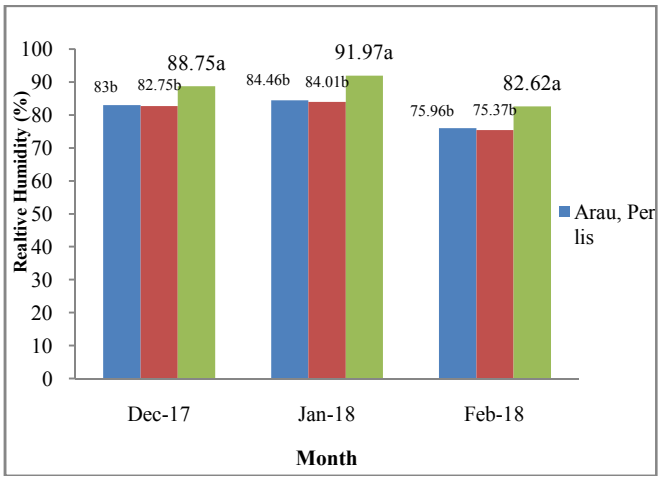


Figure 2. Relative humidity (%) from different cultivation location of Harumanis mango for 3 months

Means with the different number in the same fruit weight range percentage is significantly difference at p≤0.05 according to DMRT

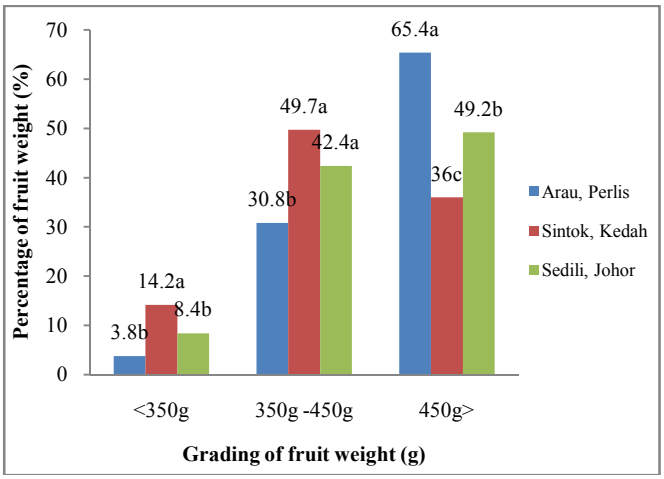


Figure 3 Effect of different multilocation Harumanis mango production to the fruit weight grading percentage (%)

Means with the different number in the same fruit weight range percentage is significantly difference at p≤0.05 according to DMRT

Table 1 Effect of different multilocation Harumanis production to the fruiting pattern as percentage (%) of inflorescence trees, average number of flower to shoot ratio and average number of fruit to flower ratio

Location	Percentage (%) of inflorescence trees	Average number of flower to shoot ratio	Average number of fruit to flower ratio
Arau, Perlis	93.33a	0.86a	0.47a
Sintok, Kedah	90a	0.79a	0.39a
Tanjung Sedili, Johor	90a	0.81a	0.25b

Means with the different number in the same column is significantly difference at p≤0.05 according to DMRT

Table 2. Effect of different multilocation Harumanis production to the physical fruit appearance as fruit weight (g), fruit length (mm) and fruit width (mm)

Location	Fruit Weight (g)	Fruit Length (mm)	Fruit Width (mm)
Arau, Perlis	497.12a	134.91a	83.05a
Sintok, Kedah	376.38b	123.8a	80.42a
Tanjung Sedili, Johor	496.11a	132.6a	86.99a

Means with the different number in the same column is significantly difference at p≤0.05 according to DMRT

Table 3. Effect of different multilocation Harumanis production to the chemical assessment as pH, total soluble solid, total titratable acidity, and vitamin C

Location	pH	Total Soluble Solid	Total Titratable Acidity	Vitamin C
Arau, Perlis	5.46a	16.93a	1.32a	1.21b
Sintok, Kedah	5.44a	17.19a	1.02a	0.11c
Tanjung Sedili, Johor	5.64a	16.85a	0.15b	4.54a

Means with the different number in the same column is significantly difference at p≤0.05 according to DMRT

Yield and quality of Harumanis mango at multilocation

Based on Figure 3, the fruit weight grading percentage (%) indicated MARDI Sintok, Kedah had the highest and significantly differentfruit weight grading percentage of 14.2% for C grade (<350g) compare to other locations. Furthermore, B grade of fruit weight (350g – 450g), MARDI Sintok, Kedah

and Tanjung Sedili, Johor recorded at 49.7% and 42.4% with no significant difference. Nevertheless these 2 locations are significantly different compared to Arau, Perlis at 30.8%. In addition, grade A fruit weight (450g>) indicated that, Arau, Perlis has the highest and significantly difference compare to other locations at 65.4%. However, MARDI Sintok, Kedah recorded a 49.2% of grade A fruit weight which is significantly different compared to Tanjung Sedili, Johor at 36%.In terms of physical fruit appearance as stated in Table 1, for average fruit weight (g) recorded in MARDI Sintok, Kedah, the lowest and significantly different average fruit weight was of 376.38g compare to other locations. Based on fruit size perspective as fruit length (mm) and fruit width (mm), there is no significantly difference amongst the locations recorded. In the aspect of chemical assessment of fruit between the locations on Table 2, there is no significantly difference on pH and total soluble solid parameter. While, for total titratable acidity of fruit in Tanjung Sedili, Johor the lowest was recorded at 0.15 and significantly different compared to the other locations. However, for Vitamin C assessment, fruit in Tanjung Sedili, Johor has showed the highest and significantly difference of 4.54 compare to other locations.

This result reflects with the usage of different types of soil which Arau, Perlis and MARDI Sintok are categorized as mineral soil while Tanjung Sedili, Johor is presented with sandy soil. Proportion of soil types may influence ultimately the nutrient content which influenced the fruit yield and quality. Similar finding from Hofman *et. al* (1997), where eating quality and dry matter content were affected as the study on different soil proportion as use river gravel soil, without gravel soil and gleyed podsolic soil. This is also in line with the finding made by Mohd Asrul S. *et. al* (2018), as a sample of Harumanis fruit from different tree architecture types from different locality gives no significant effect on the fruit width parameters. All of the variable result is also projected to the variable climatic condition and different specified agronomic practices applied. An increase in precipitation during fruit and development may affect the quality of fruit in terms of delayed fruit maturity and fruit physio-chemical content (Sandip *et. al*, 2016). On the other hand, in terms of fruit growth and development process, it is ultimately influenced by genes, proteins as well as agronomic practices, climate and other mechanical processes that specify or affect the fruit formation and development (Mohd Asrul S. *et. al*, 2018). There is also finding where even if a variety of mango is grown in the same or different region may affected the quality caused by different environmental conditions (Khan *et. al* 2015). Similar with other finding which stated that, fruit quality of different geographical locations was different, which could be due to the difference in environmental factors as temperature, humidity, rainfall and sunlight round the year or an interaction of environmental factors and production practices (Fiaz *et. al*, 2016).

CONCLUSION

Production of Harumanis mango can be adapted from multilocation in Malaysia in the same Agroclimate zone 1 which is proven by the same timing of months in terms of flowering and harvesting process. Floral initiation and flowering process will be regulated and influenced by the specified range of day and night (cool) temperatures and also coincide with the drought period or low rainfall pattern in one month to all locations. Climatic environment affected the rates of fruiting performance and yield potential of Harumanis mango. Furthermore, several of parameters in the aspect of yield and quality assessment resulted the differences due to the microclimate, soil types proportion and agronomic practices. However, the eating quality of Harumanis at everylocationstill represented the good tastes and categorized in the par with the actual attributes of yield and quality of Harumanis as referred to the pH and total soluble solid content measurement. Harumanis mango as evaluated at different locations met the standard parameters for high quality of fruits and can be recommended for their performances and sustainable yield in such type of environments for productions.

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References

Davenport T.L. 2003. Management of flowering in three tropical and subtropical fruit tree species. Horticulture Science 38: 1331-1335

Davenport T.L. 2007. Reproductive physiology of mango, *Brazil Journal Plant Physiology*, 19(4): 363-376

Department of Agriculture (DOA), 2017. Fruit Crop Statistic 2017 (Malaysia), 11-40

Fandohan A.B., Salako V.K., Assogbadjo A.E., Diallo B.O., Van Damme P., and Sinsin B. 2015. Effect of climatic conditions on flowering and fruiting of *Tamarindus indica* (Fabaceae). *Journal Horticulture Forestry*, 7: 186-192

Fiaz M., Malik A.U., Amin M., Khan A.S., Rehman A., Alam M.W., Hofman P.J. and Johnson P. 2016. Production locality influences postharvest disease development and quality in mangoes. Acta Horticulturae 1111: 369-376

Geetha G.A., Shivashankara K.S., and Reddy Y.T.N.,(2016). Varietal variations in temperature response for hermaphrodite flower production and fruit set in mango (Mangifera indica L). *South African Journal of Botany* 106: 196-203

Hofman J., Smith P.G., Meiburg L.F., Giles G.E.1997. Production locality affects mango fruit quality. *Australian Journal of Experimental Agriculture* - AUST J EXP AGR. 37. 10.1071/EA97058

Khalid N.S., Abdullah A.H., Shukor S.A.A., FathinulSyahir A.S., Chau S.C., Nor Dalila N.D., and Mansor H. 2017. Image processing techniques for Harumanis disease severity and weighting estimation for automatic grading system application. *Journal of telecommunication, electronic and computer engineering* 10:1-15

Khan A.S., Ali S., and Khan I.A. 2015. Morphological and molecular characterization and evaluation of mango germplasm: An overview, Scientific Horticulture (Amsterdam), 194: 353–366

Mavuso V.L. and Yapwatthanaphun C. 2017. Effect of environmental conditions on flower induction of marian

plum (*Bouea burmanica* Griff). Agriculture and Natural resources, 51(4): 243-246

Mohammad A. (2008) Food and Agriculture Organization (FAO) FAOSTAT Data

MohdAsrul S., Hartinee A., Mahmad N.J., and Mohamad Bahagia A.G. 2018. Morphological Characterisation of Harumanis Mango (Mangiferaindica Linn.) in Malaysia. *International Journal of Environmental and Agriculture Research* 4:36-42

Normand F., Lauri P.E., and Legave J.M. 2015. Climate change and its probable effects on mango production and cultivation, Acta Horticulturae 1075: 21-32

Patel G.D., Patel B. N. and Chauhan D. A. 2015. Influence of Temperature on Pollen Viability and Fruit Setting In Mango. *Journal of Environmental Research and Development* 10(1): 47-53

Rajan S. 2012. Phenological Responses to Temperature and Rainfall: A Case Study of Mango, Tropical Fruit Tree Species and Climate Change, 71-96

Ram S., and Rajan S. 2003. Status report on genetic resources of mango in Asia-Pacific region, International Plant Genetic Resource Institute, New Delhi pp. 196

Ramirez F. and Davenport T.L. 2010. Mango (*Mangifera indica L.*) flowering physiology. Scientia Horticulturae, 126: 65-72

Rosidah M., Faridah H., Jamaliah M.Y., and Norzaidi M.D. 2010. Examining market accessibility of Malaysia's Harumanis mango in Japan: challenges and potentials. Business Strategy Series, Vol. 11 Issue: 1, pp. 3-12

Sandip M., Pritam B., Lokesh Y., and Yadav B.K., 2016. Impact of climate change on phenology of Mango – The case study, Ecology, Environment and Conservation Paper 22: 119-124

Shu Z.H., 1999. Effect of temperature on the flowering biology and fertilization of mangoes *(Mangifera indica* L.), *Journal Applied Horticulture*, 1(2): 79-83

Singh R.N., Majumder P.K., and Sharma D.K. 1966. Sex-expression in mango (*Mangifera indica L.*) with reference to prevailing temperature. Proceedings American Society Horticulture Science, 89:228-229

Singh R.N., and Sharma D.K., 1972. Some pollination problems in mango. Acta Horticulturae, 24:134-138.

Wei J., Liu G., Liu D., Chen Y. 2017. Influence of irrigation during the growth stage on yield and quality in mango (Mangifera indica L). PLoS ONE 12(4): 1-14

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