Some Aspects on Growth, Yield, Phenology and Grape Quality of 'Isabella' Grapevine (*Vitis* × *labruscana*) Planted in Sandakan, Sabah as Ornamental Plant

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ABSTRACT In wet tropical areas, a successful planting of grapevines will depend on several factors including the use of greenhouse and the effort to carry out intensive pruning. These requirements are expensive especially for using these plants for home decoration. Thus, in the present study, growth and development of 'Isabella' grapevine (*Vitis* × *labruscana*) grown in pot system without the use of greenhouse to beautify a semi-shaded home sidewalk were studied to assess its potential to serve as ornamental and fruit-bearing plants. The seedlings from the woodcuts of 'Isabella' grapevine were planted on organic soil in 55 L plant pots. The pots were placed in 19 L water basins and positioned at 84 cm interval on a walkway (0.9–1.2 m width) of a house (310 cm tall wall; 76 cm long roof extension). Tap water was supplied as 2–4 L/grapevine following a 1-1-0-0-1-0-0 cycle per week (1 = watered; 0 = not watered). Initial fertiliser was added as 20 g NPK 15:15:15 and maintenance fertiliser was supplied monthly as 8 g NPKMg+TE 12: 12: 17: 2 per grapevine. After 3 months, pruning was carried out once a week. Data were recorded for vine vigour, berry, cluster and yield attributes, phenology, grape quality, fruit predators, pests and diseases. It was found that the grapevines have no issues in terms of vigour, cluster production, grape ripening and grape quality. The average physical size of the grapevines was 1.25 m (tall) × 0.75 m (width). Trunk diameter was 18 mm/grapevine. Cordon, cane and shoot number per grapevine was 14, 49 and 53, respectively. Fruitful shoot diameter was 3.8 mm/shoot/grapevine. The grapes achieved veraison at day 78 and berry ripe at day 124 after bud burst. The average yield was 37 grape clusters/grapevine, 16 g/cluster or 3 g/berry. Hens and chicks berry problem was 64% vs. 36% per cluster. The average sugar content (ºBrix) was 18.5; the berries were sweet-sour. The titratable acidity was 1.55 g/100 mL of juice. The pH was 3.3. There was, however, a marked grape loss due to a predation by yellow-vented bulbul and bats. 'Isabella' grapevine grown in pot system has a potential to serve as ornamental and fruit-bearing plants without the use of greenhouse.

KEYWORDS: Tropical grape; 'Isabella' grapevine; Ornamental grape; Grape phenology; Grape quality.
I Received 2 May 2019 **II Revised** 24 June 2019 **II Accepted** 6 August 2019 **II Online** 28 August 2019 **II © Transactions on Science and Technology I**
Full Article

INTRODUCTION

Grapevine is a group of plants that has probably caught the interest of many people around the world. These plants are commonly associated with temperate climate, but over the past decades a few varieties have been developed or found to grow well in tropical climate (Possingham *et al*., 1990; Camargo *et al*., 2012). In Malaysia, grapes for commercial use are produced mainly in Perlis, Perak and Pahang (DOA, 2016 & 2017). The production is low and inconsistent if not declining in recent years. In 2012, the area planted with grapevines was estimated to be 3.7 ha, this increased to 6.6 ha in 2013, but decreased to only 0.4 ha in 2017. The quantity of grapes produced was 204.2 MT in 2012, 228.5 MT in 2013, but only 0.34 MT in 2017 (DOA, 2016 & 2017). Hence, grapes were imported to meet the local demand. The cost was estimated to be RM334 million a year (FAMA, 2016). A small portion of the local grapes, however, was exported, with the export value was estimated to be RM11 million a year (FAMA, 2016). The statistics indicate the merit to establish a local grape industry in Malaysia.

The interest in grapevines in Malaysia is not limited to grapes for consumption. There are a few sites in this country including in Sabah offering visitors the opportunity to see grapevines and grapes planted and produced locally. Grapevines are markedly beautiful during veraison (period when grapes start to ripe) to berry ripe. During this period, the berries will change colour gradually from plain green to mild pink, red, yellowish or orangish and then to dark red, burgundy or dark purple at berry ripe, depending on the varieties. At this period, the grapes are "the flowers" of the grapevines. This phase is the best time for visitors to view the plants. To date, the largest agritourism grape farm in Sabah is Jongrapevines and Figs Garden (Figure 1), located at Tamparuli. Many visitors of these agritourism grape farms are surprised to discover that many varieties of grapevines can be grown and become fruitful in hot and humid climate. It is a reality that a large number of them are interested in growing grapevines as ornamental plants at home. In wet tropical areas, however, a successful planting of grapevines will depend on several factors including the use of greenhouse (to protect the vines from rain and fungus outbreak) and the effort to carry out intensive pruning (to control the canopy). These requirements are known to be costly, a drawback for many people to have and maintain a grapevine garden, even a backyard one. To date, only strongly interested individuals are committed enough to start and build their own grapevine garden despite the high costs.

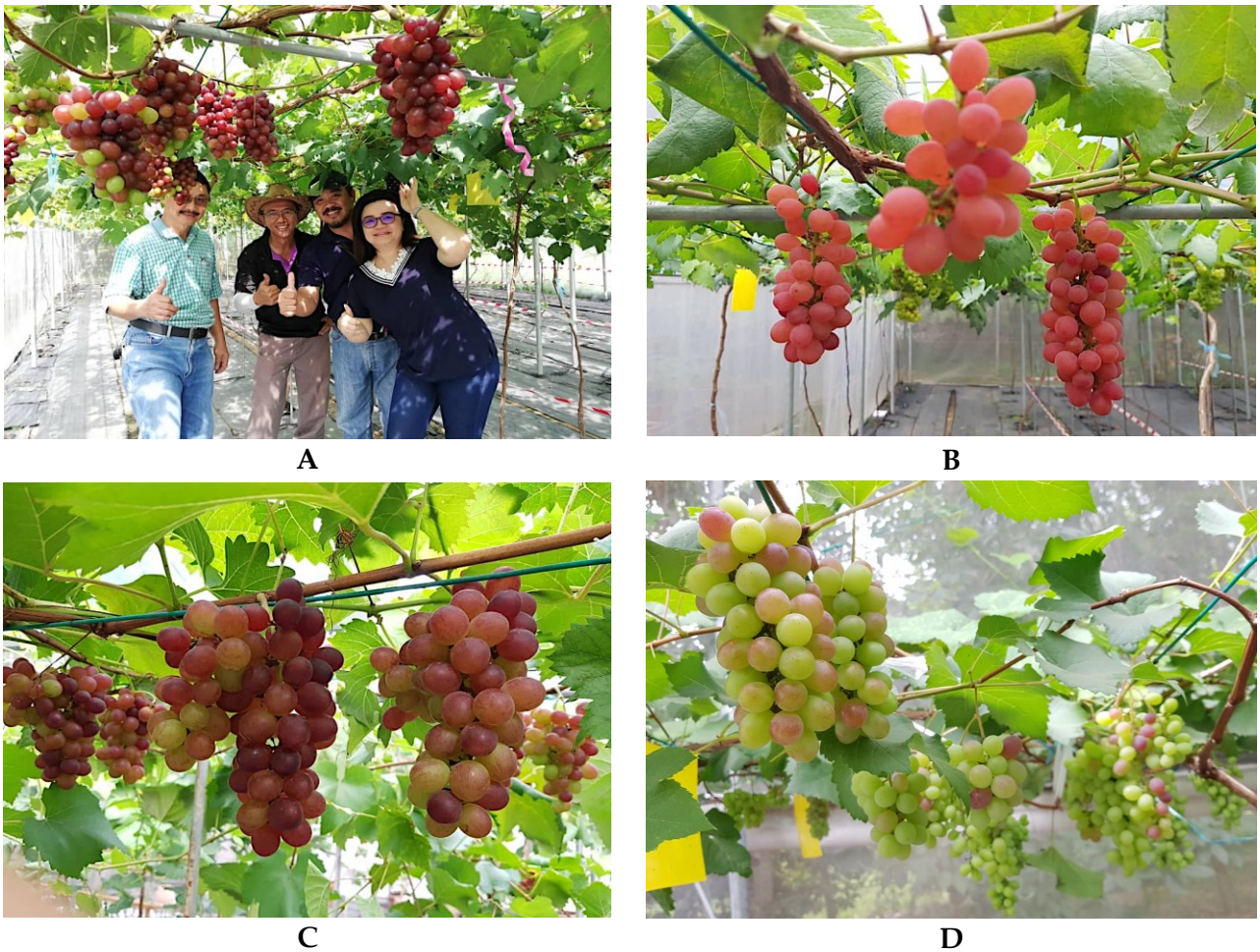

Figure 1. **A**: Visitors at Jongrapevines and Figs Garden (JGFG), Tamparuli. **B–D**: Some grapevines at JGFG (**B**: Vanessa; **C**: Glasha; and **D**: Jupiter).

Grapevines have long been used as decorative plants (Dangl *et al*., 2010), but little is reported in the tropics about grapevines as ornamental plants. Decades ago, Hedrick (1908) in his work on The Grapes of New York stated that "While it is of small commercial importance, 'Isabella' is still worthy a place in the garden and as an ornamental". In fact, of the many grapevines planted in the tropics, 'Isabella' (syn. Bangalore Blue) is one of the robust varieties (Possingham *et al*., 1990). It can withstand open planting in the tropical hot and humid weather much better than other varieties. 'Isabella' grape berries are largely resistant to fungus due to the volatile substances released by the berries (Kulakiotu *et al*., 2004). The drawback of this cultivar, as said by many people including in Malaysia, is the inconsistency of the taste of the grapes, with the usual one being sour with a little bit of sweet. European wine connoisseurs consider 'Isabella' wines to be inferior, and in most European countries, 'Isabella' grapevine and the production of wine from its grapes are officially banned. This cultivar, however, has been planted for commercial use in other countries. In Brazil, there were 600 ha of 'Isabel' grape (*Vitis labrusca* L.) in São Vicente Férrer-PE municipality, meaning this cultivar is well adapted to this region of Brazil (Silva *et al*. (2012) as cited by Santos *et al*., 2017) and indirectly indicating the possibility to farm 'Isabella' in other countries of similar weather to São Vicente Férrer-PE. 'Isabel' grape has a potential to produce high quantity of grapes and sugar (Sato *et al*. (2009) as cited by Santos *et al*., 2017). Cangi *et al*. (2006) reported that 'Isabella' type or native foxy group of grapes in Northern Turkey are consumed as table grapes, marmalade, pickled grapes or grape juice. The 'Isabel', or 'Isabella', grapes from Sao Francisco River Valley is a good source of antioxidant and is the commonly used grape in Brazil for juice production (Cazarin *et al*., 2013).

In Malaysia, 'Isabella' is probably the most planted grape cultivar for hobby because of its resilience, but in many instances, it has been planted in greenhouses and on infertile soil at the side of houses or buildings which leads it to a poor state and become unattractive. The sour to sour-sweet taste of the grapes makes 'Isabella' grapevine an unprofitable choice to be planted in greenhouse, and its poor growth and development at the side of houses or buildings due to improper maintenance mislead people to depreciate this cultivar. Therefore, in the present paper, we assessed the growth and development of 'Isabella' grapevine (*Vitis* × *labruscana*) grown in pot system to beautify a semi-shaded home sidewalk to assess the potential of this cultivar to serve as ornamental and fruit-bearing plants without use of greenhouse. The information can be used in the future as a basis to establish a good-quality home 'Isabella' (or probably other varieties) garden.

METHODOLOGY

The study was carried out at Mile 8, Sandakan, Sabah. The daytime temperature at the study area based on the records from the nearest weather station is estimated to be 29°C to 33°C (Sandakan Airport weather average: https://weatherspark.com). The average total rainfall is around 2,714 mm/year. The driest months are April (110 mm) and May (120 mm) and the wettest months are December (380 mm) and January (374 mm) (https://weatherspark.com). Rainfall increases gradually from April to December and decreases markedly from January to April. The daylight hour at the study area is around 12 hours every day throughout the year.

Propagation and planting

The grapevines were propagated on March 2018 from green but mature and dormant 6-mm thick 3-node stem cuts obtained from woody shoot of 6 months old 'Isabella' grapevine. The shoot was cut off at the base and the top 30-cm tip was removed….

to prevent weeds from growing in the pots. The grape shoots, old or new, were assisted to creep on the PVC pipe with the help of cable ties.

Placement for landscaping

The grapevines were placed at 84 cm interval (distance between edges of pot mouths) to beautify a semi-shaded sidewalk of a house.

Maintenance

Tap water was supplied as 2 L/grapevine once in two days during the first three months and after that, 4 L/grapevine, following a 1-1-0-0-1-0-0 cycle per week (1 = watered; 0 = not watered);

concurrently on the same grapevine to improve the beauty of the vine. In other words, the maintenance regime described here was indirectly a planting system tested for future use in maintaining 'Isabella' grapevine or other grapevines as ornamental plant in pot planting system.

Growth, productivity and yield

An in-depth selective data collection was carried out to minimise measurement variation and at the same time, to reduce workload.

as the average cluster weight of the ripened grapes × the number of grape clusters that the grapevines had produced. It has to be noted that in this study, the grapes on the grapevines were at different developmental stages, as the pruning was designed to create this situation.

Phenology

The phenology, or timing of biological events, was observed for shoot and inflorescence development [dormant buds (1); bud scale opening (2–3); and budburst either with or without

system to classify the growth stages of grape (see Coombe, 1995). These events were observed for all buds on the grapevines.

Grape quality

The assessment was carried out following the procedures explained by Ningonda (2007) with a minor modification of the equation to estimate the acidity value. Berry disorder was assessed as the

amount of juice aliquot (mL). Sugar to acidity ratio was calculated as °Brix ÷ % acidity. The pH of the juice was measured using Eutech pH6+ (Thermo Fisher Scientific). Juice recovery (%) was estimated as the weight (g) of juice obtained from all berries per cluster ÷ weight (g) of the berries × 100.

Fruit predators, pests and diseases

Fruit predator was observed at 7–8 am and 9–10/11 pm every day from Monday to Friday and at 8–9 am, around noon, and 3–6 pm on Saturday. The presence and severity of pests and diseases were checked every day during early morning and late evening. Attack by pests or infection by diseases close to 50% of the leaf or grape was considered to be severe. The number of pests or the pest-disease affected leaves or grapes was counted. During the daily checking routine, visible leaf eaters were collected for taxa identification and infestation control. Leaves affected close to 50% (area) by pests or diseases were removed.

RESULT

Growth, productivity and yield attributes

The average physical size of the grapevines was 1.25 m (height) × 0.75 m (width), or occupied roughly 3.142 × $(0.375\ m)^2$ × 1.25 m or 0.55 m^3 area (Figure 2). The trunk diameter was 18 mm (1.8 cm) on average (Figure 3). The cordon and cane were 0.54 mm (diameter) × 69.2 cm (length) and 0.49 cm (diameter) × 32 cm (length), respectively. The average diameter of the cordons, canes and shoots

was closely similar, although the average length was markedly different (Figure 3). The fruitful shoots were longer but slender than the non-fruitful shoots (Figure 3). As expected from the pruning regime practised in this study, the cordons were longer than the shoots (Figure 3). Internode length of the cordons was also longer than that of the shoots.

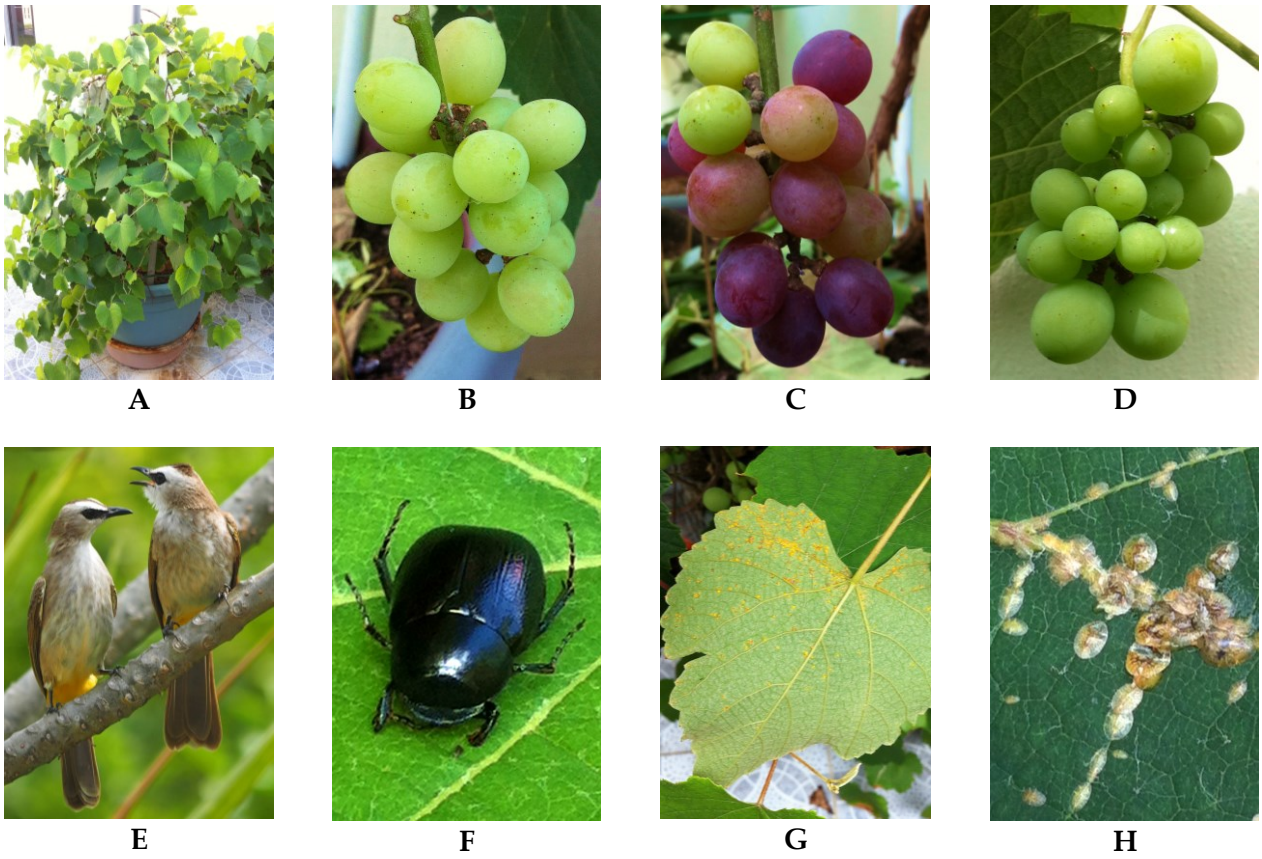

Figure 2. **A**: One of the 'Isabella' grapevines in this study. **B**: A grape cluster of the grapevine at berry softening (there are pinkish shades on the skin) and (**C**) at late veraison. **D**: Cluster with hens and chicks berry problem. **E**: Yellow-vented bulbul (photo credit: Dannie Polley, IBC1106749; Accessible at hbw.com/ibc/1106749). **F**: *Apogonia* beetle. **G**: Leaf rust. **H**: Scale insects on one or two leaves of the grapevines.

Figure 3. Vigour attributes. Error bars show standard deviation.

The average numbers of cordons, canes and shoots were 14, 49 and 53/grapevine, respectively (Figure 4). The average nodes/cordon, nodes/cane or nodes/shoot were 4–7 (Figure 4). On average,

Figure 4. Productivity attributes. Error bars show standard deviation.

On average, there were 37 clusters/grapevine. The clusters hanged under the compact dome-

average. There was only 1–2 seed/berry. The actual yield was 16.1 g ripened berries/cluster and the potential yield was 570 g berries/grapevine.

Figure 5. Cluster and yield attributes. Error bars show standard deviation.

Phenological attributes

About 14 days after pruning, the dormant buds sprouted to produce the first leaf. For the fruitful buds, the inflorescence, the flowers and the berries developed markedly during the first 43 days (Figure 6).

leaves) did not have a problem to ripe. On the other hand, there were clusters fully exposed to sunlight but were not yet ripe even after 124 days.

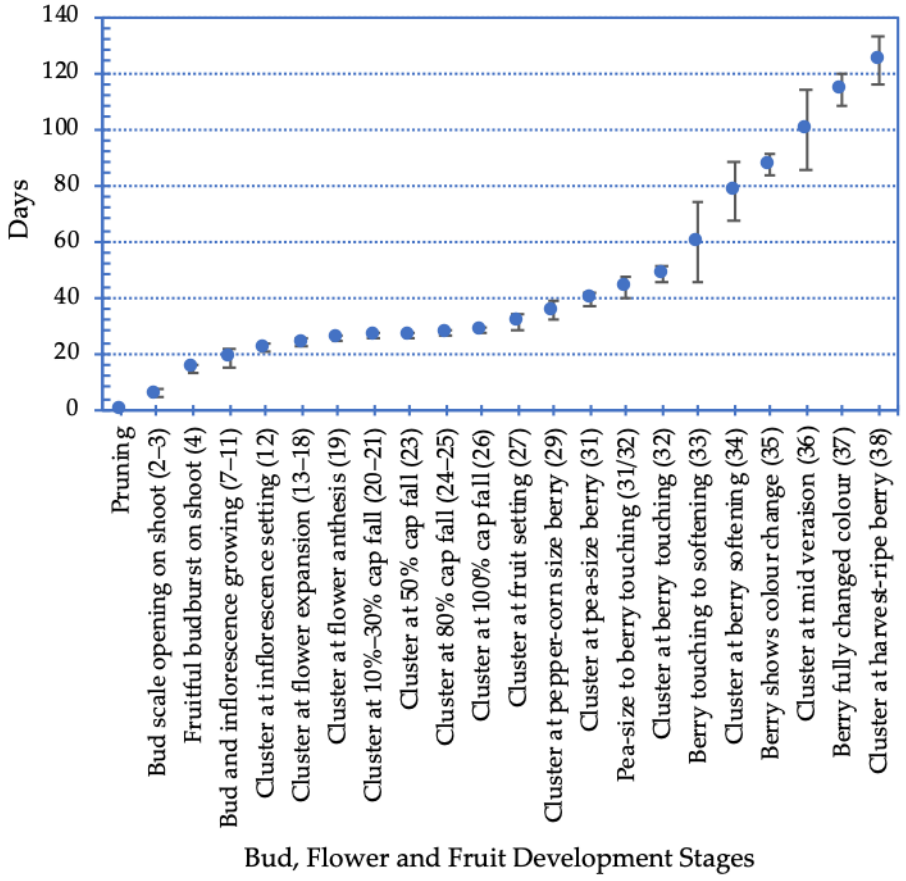

Figure 6. Time line of bud, flower and fruit development stages starting from pruning. Error bars show standard deviation. Numbers in parenthesis denote the numbers of the modified Eichhorn-Lorenz (E-L) code to classify the growth stages of grape (see Coombe, 1995).

Of the 1,426 nodes (buds) observed, about 46% either on the shoots or canes were dormant when the first batch of grape clusters ripened (Figure 7).

Dormant buds on older canes or shoots rarely sprouted, but if these buds did burst, there was a trend that the shoots produced huge grape clusters.

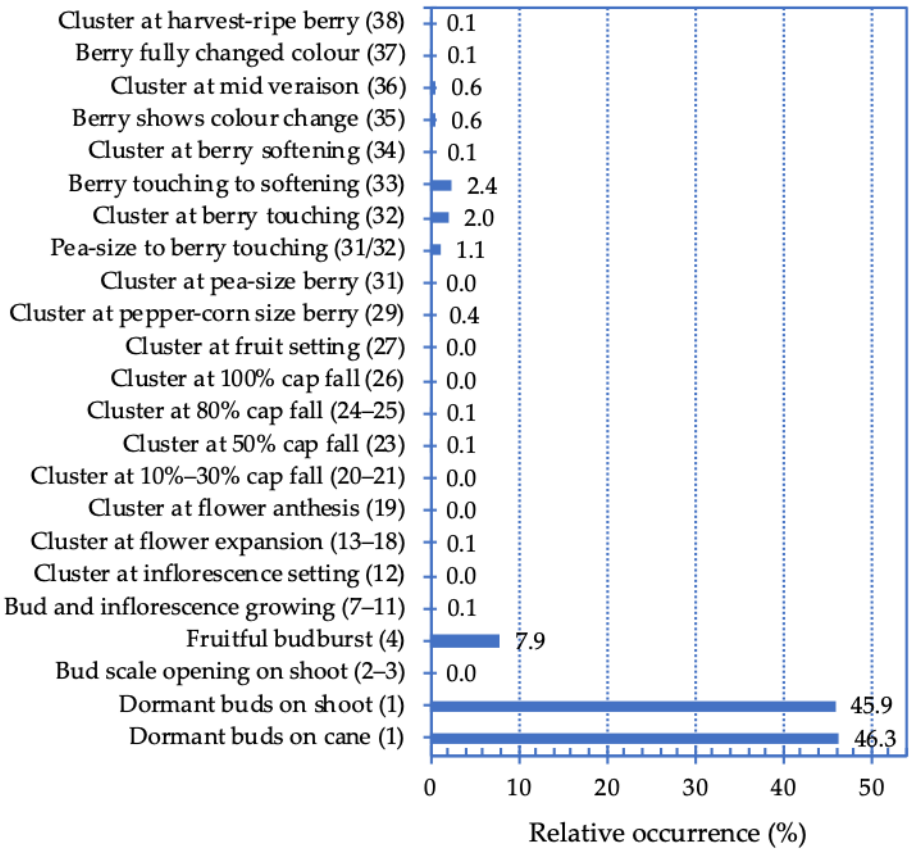

Figure 7. Phenological trait composition of the grapevines at the time the first batch of grape clusters ripened. There were 1,426 nodes (buds) observed and monitored. Numbers in parenthesis denote the numbers of the modified Eichhorn-Lorenz (E-L) code to classify the growth stages of grape (see Coombe, 1995).

Grape quality attributes

During veraison, the berries changed colour from pale green (once starting to soften) with light pink smear, to pale green-orangish, orangish, orangish-reddish, reddish, reddish-violet, and at ripening, dark (black) violet. There was no berry mummification issue, but uneven berry ripening problem was 14%, and hens and chicks berry problem of affected clusters was 64% versus 36%. The average sugar content or °Brix of the freshly extracted juice at 27°C–29°C was 18.5 (Figure 8). The acidity (titratable acidity) was 1.55 g/100 mL of juice (or 6.1 meq/L). °Brix to acidity ratio was 13.6. The pH was 3.3. Juice recovery was 40%.

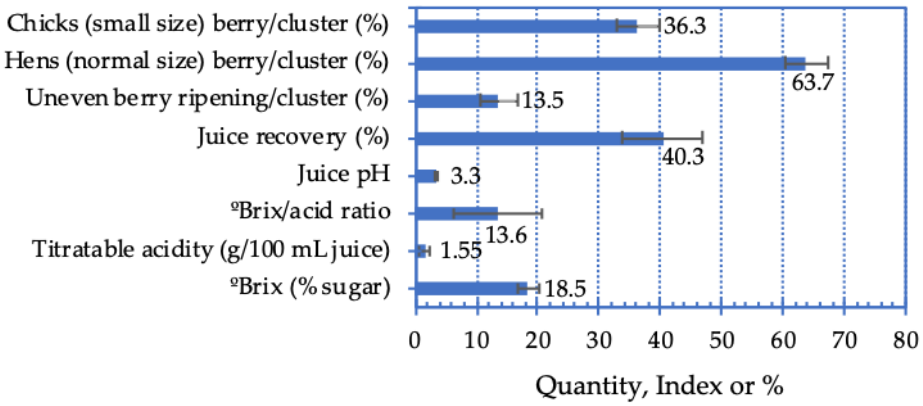

Figure 8. Grape quality attributes. Error bars show standard deviation.

Fruit predator, pests and diseases

The yellow-vented bulbuls (*Pycnonotus goiavier* Scopoli), or locally known as Momporok (Figure 2), and bats were found eating the berries. The predation happened from early veraison to berry-ripe. Berry damage and loss were marked. The grapes had to be protected by wrapping the clusters with baking sheets or plastic bottles. Unwrapped clusters were all eaten. *Apogonia* beetle (Figure 2) was found eating some parts of the leaves at night. Leaf damage was noticeable especially on young leaves. Larvae of bagworm moth and nymph and adult of *Valanga* grasshopper were also found eating some parts of the leaves. Thrips and scale insect were found on a few leaves. Probably the scale insect was a *Hemiberlesia* species (Figure 2). The scale, however, infested only old leaves. Leaf rust (Figure 2), *Phakopsora meliosmae-myrianthae* (Henn.) Y. Ono (=*P. euvitis* Ono), grew on leaves exposed to rain, and if the infected leaves were not removed, the infestation became severe. A few berries on some clusters detached at veraison. The flesh at the pedicel base of the detached berries decomposed with visible presence of fungus hyphae. Most probably the fungus was the Botrytis bunch rot (*Botrytis cinerea* Pers.). Overall, however, there was no visible harmful effect of the pests (other than the bird and bats) or diseases on the wellbeing of the grapevines or the grapes.

DISCUSSION

Growth, productivity and yield

The average physical size of the grapevines meets the purpose of the planting, *i.e.*, to beautify a home sidewalk. Each grapevine occupies only a small area (1.25 m tall × 0.75 m width) and somewhat has not obstructed the pathway (0.9–1.2 m width).

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expected to have led to nutrient and space competition between the berries, which eventually brought to lighter berries. On most commercial grape farms, gibberellic acid is used to induce berry thinning and to increase berry size (Vyver, 2016; Rombough, 2002).

Phenology

The data indicate that the grapes grow and ripen well within the expected time. Grapes will ripen in around 120 days (Serrano *et al*., 2017),

easily but less vigorous, which overall means there is a trend that when energy demand increases to support various physiological processes, the grapevines would not have much energy to fruit or to grow.

Grape quality

The physical quality attributes of the grapes are acceptable for grapevines grown for aesthetic purposes. As stated earlier, the grapevines are vigorous, have noticeable number of grape clusters, and have normal phenological traits. The only issue is the hens and chicks berry problem, as it

at a side of a building. It has long been postulated (see Hedrick, 1919) that grapevines grown for aesthetic purposes rarely fruitful, as the canopies are seldom managed properly, but the grapevines can be trained so as to serve as ornamental and fruit-bearing plants.

Fruit predators, pests and diseases

Grapevines grown for aesthetic reason outside of greenhouse will face a serious problem with predation of grapes by birds and bats. The tropical yellow-vented bulbul has even been reported to eat figs and palm fruits (Peh & Chong, 2003; Wee, 2009),

reported to be successful (Angelotti *et al*., 2014). 'Isabella' grape berries are largely resistant to fungus due to the volatile substances released by the berries (Kulakiotu *et al*., 2004), meaning the use of fungicides to control the attack of fungus on 'Isabella' grape berries is unnecessary. The application of those chemicals at home compound or at public areas, however, requires a great consideration. A correct identification of the pests and diseases is also important to justify the decision to use the chemicals.

CONCLUSION

The data indicated that 'Isabella' grapevines grown as ornamental plants in pot system without greenhouse to decorate a semi-shaded home sidewalk have no issues in terms of vigour, cluster production, grape ripening and grape quality. In other words, this cultivar and the pot system used in the present study have the potential to be a viable option to beautify semi-shaded verandas, lobby or walkway of buildings or houses in tropical humid areas. In fact, there is a trend found from the data that 'Isabella' grapevines can be trained so as to serve as ornamental and fruit-bearing plants. The data also indicated that one of the problems expected from the cultivation of 'Isabella' and other grapevines without the use of greenhouse is a marked grape predation by birds and bats of which, so far, the prevention method has yet to be devised. Since grape yield of grapevines is expected to improve at third or fourth year, the grapevines used in the present study will be assessed again during that time to evaluate the realisation of the fruit-bearing potential of ornamentally planted grapevines. If that potential turns to be a reality, it is also hoped that on that time the price of locally produced grapes in Sabah has been decided and that it matches the price of the imported grapes, as the fulfilment of this expectation will encourage the development of local vineyards and grape industry as a new source of wealth for local people.

ACKNOWLEDGEMENTS

We would like to thank Andrea Joyce Maludin for carrying out a few of the chemical analyses. This publication is part of the work under the collaborative research project between the Faculty of Sustainable Agriculture, Universiti Malaysia Sabah and Jongrapevines and Figs Garden Enterprise.

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