Comparison of Yield and Fruit Quality between Different Melon Varieties using Fertigation Approach

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Comparison of Yield and Fruit Quality between Different Melon Varieties using Fertigation Approach

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A thesis submitted in partial fulfilment of the Requirement of The Degree Bachelor of Science with Honours
(Resource Biotechnology)

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Programme of Resource Biotechnology
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2022

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ABSTRACT

The melon, *Cucumis melo* L. is a species known as most diverse in the genus *Cucumis*, with widely varying morphological fruit traits. This study involves nine varieties (n=7) of *Cucumis melo* L. that are classified as dessert fruit melon types. They are cultivated within a duration of 3 months. Fertigation method was applied to cultivate the melon plants in a greenhouse with the amount of nutrients and water supplied under control. Variety B was found to yield the best fruits in terms of weight (1.442kg), transverse (44.76cm) and longitudinal (45.95cm) circumferences, and highly preferred qualitative traits in terms of sweetness (4.143, n=7) and appearance (4.714, n=7), as well as a high percentage of yield per plant (80.77%). *Cucumis melo* L.varieties under the cultivar group *reticulatus* have greater sizes compared to varieties of *cantalupensis*. Further studies can be conducted in the future with improved methodologies involving sensory and instrumental evaluations for more detailed observations on preferred fruit traits. Effects of different fertilizer concentration towards plant growth and fruit yield, disease resistance, and sugar and nutrient content may also be explored on the preferred melon varieties.

Key words: Melon, dessert fruit, fertigation, yield, fruit quality.

ABSTRAK

Melon, Cucumis melo *L. merupakan spesies yang paling berbagai dalam genus* Cucumis*, dengan perbezaan morfologi buah yang sangat luas. Kajian ini melibatkan sembilan variasi (n=9)* Cucumis melo *L. yang dikelaskan sebagai melon jenis pencuci mulut. Variasi-variasi ini ditanam dalam tempoh tiga bulan. Cara fertigasi telah diaplikasikan untuk penanaman melon di dalam rumah hijau dengan bekalan nutrisi dan air yang dikawal. Melon variety B telah ditemu menghasilkan buah yang terbaik dari segi ciri-ciri kuantitatif, iaitu berat (1.442kg), lilitan melintang (44.76cm) dan membujur (45.95cm), dan ciri-ciri kualitatif terpilih seperti kemanisan (4.143, n=7) dan penampilan (4.714, n=7), dan juga peratusan hasil setiap tumbuhan yang tinggi (80.77%).* Cucumis melo *L.varieti di bawah kumpulan kultivar* reticulatus *mempunyai saiz yang lebih besar berbanding dengan kultivar* cantalupensis*. Kajian lanjut boleh dijalankan pada masa akan datang dengan metodologi yang lebih baik yang melibatkan penilaian deria dan instrumental untuk pemerhatian yang lebih terperinci mengenai ciri-ciri buah pilihan. Kesan kepekatan baja yang berbeza terhadap pertumbuhan tumbuhan dan hasil buah, rintangan penyakit, dan kandungan gula dan nutrien juga boleh diterokai pada variasi* Cucumis melo *L. pilihan.*

***Kata kunci**: Melon, buah pencuci mulut, fertigasi, penghasilan, kualiti buah.*

TABLE OF CONTENT

	Page
DECLARATION	i
ACKNOWLEDGEMENT	iii
ABSTRACT	iv
ABSTRAK	iv
TABLE OF CONTENT	v
LIST OF TABLES	vii
LIST OF FIGURES	viii
LIST OF ABBREVIATIONS	ix
CHAPTER 1: INTRODUCTION	1
1.1 Study Background	1
1.2 Problem Statement and Objectives	2
CHAPTER 2: LITERATURE REVIEW	3
2.1 *Cucumis melo* L.	3
2.1.1 Dessert Fruit Type	4
2.1.2 Nutritional Value	6
2.2 Global and Local Production and Market of Melons	6
2.2.1 Consumption Intention towards Local Food	8
2.3 Fertigation to Maximize Plant Yield	9
2.3.1 Application of fertigation for melons in Malaysia	11

CHAPTER 3: MATERIALS AND METHODS 12

3.1 Materials 12

3.2 Methods 13

3.2.1 Plant materials and germination growth condition 13

3.2.2 Transplantation 13

3.2.3 Fertilizer application 16

3.2.4 Plant Management 17

3.2.5 Pollination and Fruiting 18

3.2.6 Harvesting 19

3.2.7 Sensory Test 20

3.2.8 Statistical analysis 23

CHAPTER 4: RESULTS 24

4.1 Melon Growth and Production 24

4.2 Sensory Test 29

CHAPTER 5: DISCUSSION 32

5.1 Melon Growth and Production 32

5.2 Sensory Test 33

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS 36

REFERENCES 37

APPENDICES 41

LIST OF TABLES

Table		Page
2.1	Nutrient content in one cup of muskmelon.	6
3.1	List of *Cucumis melo* L. varieties cultivated, represented by letters A to I.	14
3.2	Plant position of melon seedlings in polybags in the greenhouse. X represents polybags without seedlings. Row 1 is located closest to the front entrance of the greenhouse. A to I represents polybags planted with melon varieties A to I respectively.	17
3.3	Estimated amount of fertilizer from Lotus Agritech Premix AB fertilizer in grams.	18
3.4	Estimation concentration of element in Lotus Agritech Premix AB fertilizer in ppm.	18
3.5	Irrigation schedule for melon plants.	19
3.6	EC value of AB fertilizer solution to be irrigated to melon plants.	19
3.7	Weekly foliar application for melon plants.	19
3.8	Weekly chemical application for melon plants.	21
4.1	Germination percentage of melon seeds of nine varieties.	24
4.2	Number and percentage of melon plants that yielded at least one fruit according to variety.	25
4.3	Morphology of nine varieties of melon.	26

LIST OF FIGURES

Figure		Page
2.1	Group *inodorus* sub-group honeydew, with smooth and white exocarp, round fruit shape. (Adapted from Pitrat, 2016).	4
2.2	Group *cantalupensis* sub-group saccharinus, with orange thick flesh, exocarp with vein tracts and speckles, round fruit shape and slightly ribbed. (Adapted from Pitrat, 2016).	5
2.3	Group *cantalupensis* sub-group American western, exocarp with heavy netting and vein tracts, round fruit shape. (Adapted from Pitrat, 2016).	5
2.4	Group *cantalupensis* sub-group rockmelon, with slight vein tracts, golden smooth exocarp, round fruit shape. (Adapted from Pitrat, 2016).	5
2.5	The cultivated area, harvested area and production of melon in Sabah from 2011 to 2016. (Adapted from Mazwan Muhammad et al., 2017)	8
2.6	The cultivated area, harvested area and production of melon in Sarawak from 2011 to 2016. (Adapted from Mazwan Muhammad et al., 2017)	8
2.7	Golden melon plants cultivated with fertigation method in a greenhouse. (Photo taken at Agriculture Research Centre, Semongok.)	10
2.8	Automated fertigation system to control fertilizer content and irrigation and storage tanks. (Photo taken at Agriculture Research Centre, Semongok.)	10
2.9	Rock melon farmer, Hamid applying fertigation in melon cultivation. (Adapted from Mahpar, 2016)	12
3.1	Melon seedlings germinated in germination trays at day 3.	15
3.2	Melon seedlings showing first true leaves at day 7.	15
3.3	Melon seedlings transplanted into polybags at day 11.	16
3.4	Melon seedlings transplanted into polybags in the greenhouse.	16
3.5	Figure 3.5 Melon plants twined along the nylon strings.	20
3.6	A: Male flower. B: Petals of male flower were removed to expose the pollen. C: Pollen from male flower was brushed over the stigma of the female flower.	21
3.7	Harvested and cleaned melon fruits.	22
4.1	The percentage of melon plants that yielded at least one fruit according to variety.	25

4.2	Mean fresh fruit weight of each melon variety.	27
4.3	Mean transverse circumference of each melon fruit variety.	28
4.4	Mean longitudinal circumference of each melon fruit variety.	29
4.5	Mean scores of the flesh texture of each melon fruit variety.	30
4.6	Mean scores of the sweetness of each melon fruit variety.	30
4.7	Mean scores of the aromatics of each melon fruit variety.	30
4.8	Mean scores of the appearance of each melon fruit variety.	31
4.9	Mean scores of the juiciness of each melon fruit variety.	31

LIST OF ABBREVIATIONS

% DV	Percent Daily Value
IU	International unit
GP	Germination percentage
Ha	Hectare
ppm	Part per million
N	Nitrogen
P	Phosphorus
K	Potassium
Ca	Calcium
Mg	Magnesium
Fe	Iron
Mn	Manganese
Zn	Zinc
B	Boron
Cu	Copper
Mb	Molybdenum
CaNO3	Calcium nitrate
NH4	Ammonium nitrate
KNO3	Potassium Nitrate
MKP	Monopotassium Phosphate
MgSO4	Magnesium sulphate
H3BO	Sodium Borate
MO	Ammonium Molybdate

CHAPTER 1

INTRODUCTION

1.1 Study Background

The melon is a fruit known as *Cucumis melo* L., produced in all warm regions (Adeoluwa & Amao, 2015). It exists in various unique traits, while this study involves varieties that have orange or green flesh, sweet, and juicy, classified as dessert fruit melon types. They also release a pleasing aroma once cut open. In general, this fruit brings many health benefits as it is rich with vitamin C, vitamin A, vitamin B6, calcium, zinc, fiber, magnesium, iron, potassium, and omega-3 and 6. With these nutrients taken adequately, they improve our mental health, immunity, blood pressure, cholesterol level, anti-diabetic activity, prevent constipation and cardiovascular diseases (Public Health Nigeria, 2018).

In Malaysia, melons are mainly cultivated in Sabah and Sarawak. The local records were broken with a total yield of 12,149.40 metric tons in 2012 worth RM18.47 million. However, melon production declined drastically over the following years due to several factors. To solve the issue, melon cultivators have been encouraged to apply new knowledge and technologies. Fertigation was one of the promoted cultivation methods more suitable for rock melons (Mazwan Muhammad et al., 2017).

Hydroponics is one of the emerging technologies in Malaysia that allows plants to grow directly with nutrient solution for higher product quality and quantity, applied to cultivate fruits including melons. One of the soilless systems applied is fertigation. It functions to improve nutrient uptake of crops by water supplied through drip irrigation along with precise, uniform rate of fertilizer application without wastage. Fertigation can be

conducted in an open, closed, or a semi-closed system. It allows less labor and water usage per unit area, while giving higher productivity within a small area (Mazwan Muhammad et al., 2017).

According to the Italian Trade Agency (2018), the arising Malaysian consumer awareness in nutrition value and food fortification for healthcare has created the demand for food that are functional, minimally processed, organic and natural. Premium fruits and vegetables produced in Malaysia which complies to food safety standards are also exported to Europe and the Middle East, which have contributed to more than 50% of the global premium fruit and vegetable production. Fertigation-based rock melons cultivated in Terengganu, for example, has received high demand from European and Asian countries, thus are expected to contribute to an increase in the state's annual revenue (David, 2015).

1.2 Problem Statement and Objectives

With fertigation being identified as a better cultivation method for melons, farmers need to identify fertigation-based varieties of melons that can produce the best fruit yield with quality and quantity to satisfy the market locally and abroad. Improvements in terms of cultivation technology and knowledge towards melon varieties will help to direct the farmers to overcome the declining trend of quality melon production. Therefore, comparisons of different varieties of melons can be tried to provide suggestions of better variety choices for farmers to cultivate with fertigation technology.

The objectives of this study are:

1. To observe the growth and yield of different varieties of *Cucumis melo* L.
2. To compare the fruit qualities of different varieties of *Cucumis melo* L.

CHAPTER 2

LITERATURE REVIEW

2.1 *Cucumis melo* L.

The melon, *Cucumis melo* L. is a crop with high importance globally, with its cultivation recorded in ancient history especially in Egypt and China. It is a species known as most diverse in the genus *Cucumis*, with widely varying morphological fruit traits such as the shapes, sizes, colour of flesh and skin, taste, texture, and composition (Stephansky et al., 1999) (Kirkbride, 1993; Whitaker and Davis, 1962; Jeffrey, 1980; Bates and Robinson, 1995). Their varieties come as wild, feral, and cultivated whereas the latter suits consumers preferences by taste, consumed raw, pickled, or cooked (Stephansky et al., 1999). Cultivated melons may be classified into three different types, which are vegetable, dessert fruit, and fragrance types (Manchali et al., 2021).

Within the genus *Cucumis*, this crop stands in the subgenus *melo* with 2n=24 chromosomes. The subgenus *Melo* is divided into four groups: *'metuliferus'* and *'hirsutus'* each represented by one species, *C. metuliferus* Naud. and *C. hirsutus* respectively; *'anguria'* with twenty representing species; and '*melo*' by four species, including *C. melo.* Later studies (Lija & Beevy, 2021) show intraspecific classifications on *C. melo* with 18 groups that belongs to the subspecies *melo* and *agrestis* (Naud.). Till today, the evolution and divergence of melons is still questionable. *C. melo* was considered the most developed ancient cultivated species and through many changes, it has evolved into current elite form. The main traits of the plants that distinguishes the subspecies include ovary hairiness and seed size (Lija & Beevy, 2021).

Cucumis melo L. is cultivated for short terms, with fruits generally harvested 60 days after planting. Thus, melons can be planted for three to five seasons annually. The fruit can be stored freshly for two weeks or longer, depending on the condition (Muhamad & Nurul Adillah, 2019).

2.1.1 Dessert fruit type

The significant traits of melons from dessert fruit type include bold aromas, high sugar content, attractive colours of flesh, and fruit texture (Manchali et al., 2021). These traits are often highly preferred by consumers. Examples of melons groups under this category include *inodorus* (honeydew), muskmelons, and *cantalupensis* (cantaloupes) as shown in Figures 2.1 to 2.4. The melon varieties from the cultivar group *cantalupensis* within this study are rock melons, or commonly named as golden melons in Malaysia. The golden melons are not to be confused with "golden melons" that lookalike with pumpkins with the nomenclature *Cucurbita pepo* L. var. *Medulla* Alef, which are widely cultivated in China (Chen et al., 2021).

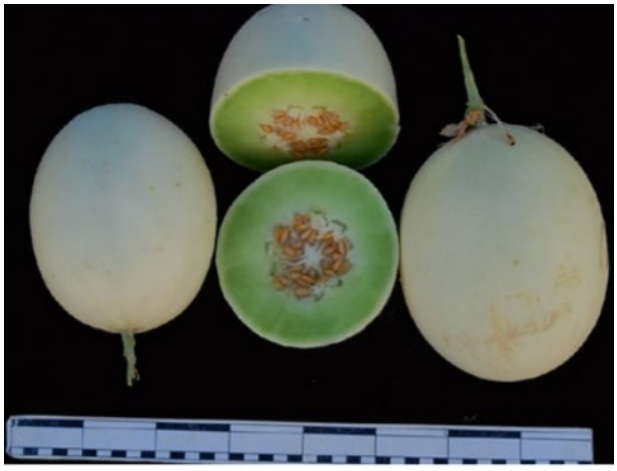

Figure 2.1 Group *inodorus* sub-group honeydew, with smooth and white exocarp, round fruit shape. (Adapted from Pitrat, 2016).

Figure 2.2 Group *cantalupensis* sub-group saccharinus, with orange thick flesh, exocarp with vein tracts and speckles, round fruit shape and slightly ribbed. (Adapted from Pitrat, 2016).

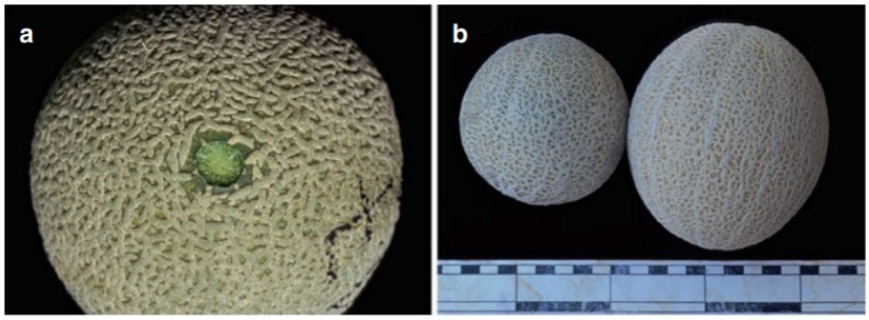

Figure 2.3 Group *cantalupensis* sub-group American western, exocarp with heavy netting and vein tracts, round fruit shape. (Adapted from Pitrat, 2016).

Figure 2.4 Group *cantalupensis* sub-group rockmelon, with slight vein tracts, golden smooth exocarp, round fruit shape. (Adapted from Pitrat, 2016).

2.1.2 Nutritional Value

Cucumis melo L. in general are rich with nutrients, with an example of nutrients of muskmelon listed below in Table 2.1. Besides the nutrients stated in the list, *C. melo* L. also has trace amounts of copper, phosphorus, and manganese (Link, 2019). The health benefits it provides for humans include boosted immunity, supported healthy vision, promoted digestive health, supported weight loss, reduced risk of cardiovascular diseases, reduced inflammation, and supplement of antioxidants. Phenolic compounds, ascorbic acid, and carotenoids are the main antioxidants found in melons (Manchali et al., 2021). Other compounds in melons, that benefit human health are flavonoids and alkaloids, especially for vegetable type melons (Gómez-García et al., 2020).

Table 2.1 Nutrient content in one cup of muskmelon. (Adapted from Link, 2019)

Nutrients	Amount
Calories	60
Carbohydrate	15.6 g
Protein	1.5 g
Fat	0.3 g
Dietary fiber	1.6 g
Vitamin A	5,987 IUs (120% DV)
Vitamin C	65 mg (108% DV)
Potassium	473 mg (14% DV)
Folate	37.2 µg (9% DV)
Vitamin B6	0.1 mg (6% DV)
Niacin	1.3 mg (6% DV)
Vitamin K	4.4 µg (6% DV)
Thiamine	0.1 mg (5% DV)
Magnesium	21.2 mg (5% DV)

2.2 Global and Local Production and Market of Melons

Melons are shipped around the world: from Africa, the Middle East, and South America to Europe; from Central America and Mexico to the USA and Canada; and from the USA to Japan and Southeast Asia (McCreight et al., 1993). According to FAO (2019), the global melon production has reached 32 million tons from 1.14 million ha of land. Its production trend recorded great increases from 1980 to 2011. The countries that produced melons with the largest scales include China, Turkey, Iran, Egypt, and India (Lija & Beevy, 2021).

Melons cultivated in Malaysia are said to have received high demand from developed countries as well, such as Terengganu's rock melons which were destined to have a huge hit in Asian and European markets (David, 2015). Due to excellent qualities of melons in terms of nutritional value, antioxidant properties, and essential vitamins, the market demand for this fruit is also high (Mohd et al., 2019). The number of seasons to cultivate melons each year and the lengthy storage period of the fruit allows farmers to market and export the fruits more efficiently with high profit returns (Zainol et al., 2021).

With a potent increase in export volume and value of our local melons, the need to improve quality and quantity of local melons correlatively increases. Sabah and Sarawak are big contributors for Malaysian melon production (Mazwan Muhammad et al., 2017). Unfortunately, melon production declined drastically over the last decade as shown in Figures 2.5 and 2.6 due to several factors, therefore requiring the cultivators to apply new knowledge and technologies to solve the issue.

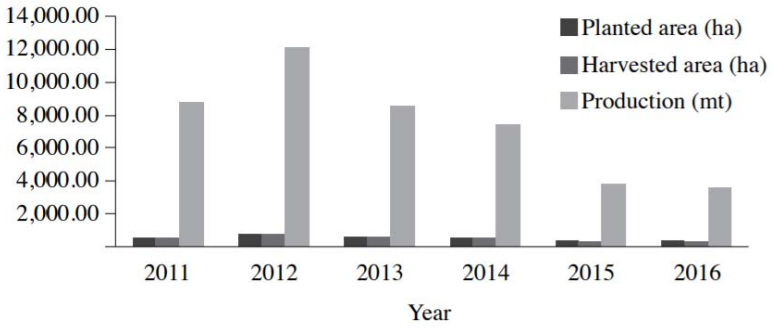

Figure 2.5 The cultivated area, harvested area and production of melon in Sabah from 2011 to 2016. (Adapted from Mazwan Muhammad et al., 2017)

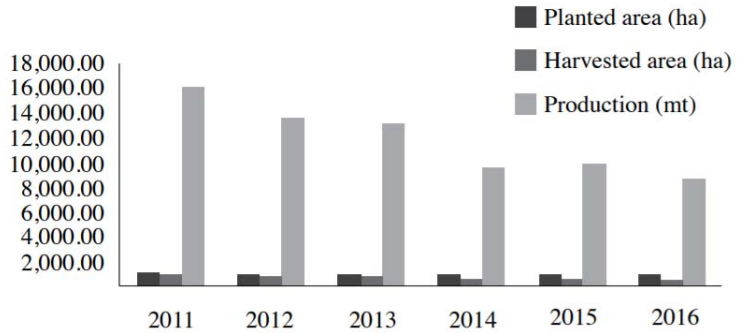

Figure 2.6 The cultivated area, harvested area and production of melon in Sarawak from 2011 to 2016. (Adapted from Mazwan Muhammad et al., 2017)

2.2.1 Consumption Intention towards Local Food

Purchase is often influenced by the perception and attitude of consumers (Lusk, 2018), thus becomes a highlight for agripreneurs when it comes to planning on which food variety to produce and promote. According to several studies, a few factors having positive relationship with purchase and consumption intention include health consciousness and perceived availability of the food product, especially organic food, whereas one of the factors with negative relationship is the perceived price of the products (Mhlophe, 2016). Local food products receive higher demand from consumers as they also have a better guarantee of food safety and climate friendliness (Feldmann and Hamm, 2015).

Four important attitudes were found through studies that can potentially manipulate melon purchase, which are health consciousness, the craving for sweetness, food enjoyment, and variety-seeking. General health interest may lead to a higher preference to consume fruits, including melons. Given that sweetness as an attribute was a highly desirable attribute (Lester and Shellie, 1992), sweet food cravers may also be related to consumption of sweet melon varieties. Lastly, researchers considered individuals who seek food variety in diet to be more inclined to try melons and become ideal targets for new cultivars marketing (Torres et al., 2020).

2.3 Fertigation to Maximize Plant Yield

In agriculture, water and fertilizer are two crucial elements required for plant growth. Water is needed for photosynthesis and nutrient transport in the plant body (Gonzalez-Dugo et al., 2010), whereas nutrients required for plant growth are supplied by fertilizers (Singh et al., 2013). Fertigation is a practice of dissolving nutrients at proper concentrations in water of required quantity, followed by irrigation at correct times in the root zone of plants. This system targets to maximize yield with an optimized use efficiency of water and fertilizer, as well as to minimize labor, water and fertilizer wastage, and environmental pollution (Sureshkumar et al., 2017). It is an agronomy practice that enables plant cultivation on infertile land with maximized crop yield (Zainol et al., 2021). Figure 2.7 shows golden melons cultivated in a greenhouse using fertigation method for maximized production.

Figure 2.7 Golden melon plants cultivated with fertigation method in a greenhouse. (Photo taken at Agriculture Research Centre, Semongok.)

Types of fertigation widely applied in our country include the open system, the closed system, and semi-closed system, which preferences depend on the plants type, space, and capital. Upgrades of fertigation systems to integrate modern technology, such as sensors, to detect moisture, acidity, and electrical conductivity of the soil are also adopted to determine the quality of nutrient solutions before being irrigated to the plants (Zainol et al., 2021). Figure 2.8 shows an automated fertigation system to control fertilizer content and irrigation.

Figure 2.8 Automated fertigation system to control fertilizer content and irrigation and storage tanks. (Photo taken at Agriculture Research Centre, Semongok.)

Many local food crops have been cultivated with this farming technology, such as chilies, tomatoes, leafy greens, and melons. Among all these crops, melon cultivations using fertigation can be seen with higher assurance of better gains for the farmers with the high nutritional quality of the fruits (Rolbiecki et al., 2021) (Zainol et al., 2021). For example, melon farmers who used this technology in Terengganu were showing a gain of high profit despite the more costly business start-up ("Inovasi pertanian diperlukan untuk lonjak potensi Melon Manis Terengganu", 2018).

2.3.1 Application of fertigation for melons in Malaysia

One of the examples of melons in high demand for export from Malaysia is the Melon Manis Terengganu (MMT). As its cultivation can generate higher profits through higher yield when compared to other crops, the state government of Terengganu invests in expansions of such cultivation with fertigation facilities. More than 400 fertigation facilities in Terengganu aiming to cultivate more than 200,000 melon plants had been established (Zainol et al., 2021). Many more testimonies of successful, profitable rock melon cultivation with fertigation were heard from young and old agropreneurs in West Malaysia with the help from training courses (Mahpar, 2016) (Bajat, 2021).

Figure 2.9 Rock melon farmer, Hamid applying fertigation in melon cultivation. (Adapted from Mahpar, 2016)

As for Sabah and Sarawak, MARDI (Muhammad et al., 2017) has been encouraging more farmers to adopt fertigation for melon projects with additions of modern technology application. According to Mazwan Muhammad et al. (2017), the higher the level of technology that is adopted, the greater the revenue and total production will be. Agrofood Statistics (2014) too stated that the rise in production is linked with technology injection. The fertigation system which applies automated drippers and enhanced fertilizers is amongst the significant technology that contributed to improved production rate.