PESTS AND DISEASES INCIDENCE AT DIFFERENT GROWTH STAGES OF MELON MANIS TERENGGANU (*Cucumis melo* var. *Inodorus* cv. Melon Manis Terengganu)

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ABSTRACT

Melon Manis Terengganu (MMT) is a newly developed cultivar of *Cucumis melo* that is exclusively planted in Terengganu and have been recognized as Terengganu's iconic fruit in 2015. Currently, the occurrence of pests and diseases is one of the major constraints in MMT cultivation. Thus, the study on pest and disease incidence at different growth stages of MMT plants were conducted as very little information about it on MMT has been reported. Collection of pest samples and observation on diseases incidence were conducted for eight weeks following the growth stages of MMT. A total of 176 individuals belonging to six orders, 15 families and 37 species of insects were collected throughout this study. Results revealed that red pumpkin beetle (RPB) (*Raphidopalpa foveicollis*: Chrysomelidae: Coleoptera) was the most dominant pest found on almost all growth stages of MMT. RPB were recorded in Week 1 until Week 5 with infestation on the MMT leaves and stems that caused severe damage on the plants. The second dominant pest was melon worm (*Diaphania hyalinata*: Crambidae: Lepidoptera) which was more abundant during foliage expansion stage (Week 3), followed by leaf miner fly (*Liriomyza trifolii*: Agromyzidae: Diptera) which was mostly found during the fruit maturation stage of MMT plants. A few diseases were recorded from week three until week eight. The most dominant diseases recorded were Cucurbits Yellow Stunting Disorder Virus (CYSDV), Powdery Mildew and Verticillium wilt. Findings from this study may provide important information on pests and diseases of MMT which is the first step in developing effective pest and disease control strategy.

Keywords: Melon, insect pest, disease, *Cucumis melo,* Terengganu.

ABSTRAK

Melon Manis Terengganu (MMT) adalah satu kultivar baru *Cucumis melo* yang ditanam secara eksklusif di Terengganu dan telah diiktiraf sebagai buah ikon Terengganu pada tahun 2015. Pada masa ini, kehadiran perosak dan penyakit menjadi salah satu kekangan utama dalam

penanaman MMT. Oleh itu, satu kajian mengenai perosak dan penyakit pada peringkat pertumbuhan yang berbeza pokok MMT telah dijalankan kerana hanya terdapat sedikit maklumat mengenai perosak dan penyakit bagi pokok MMT yang dilaporkan. Pengumpulan sampel perosak dan pemerhatian terhadap kejadian penyakit dilakukan dalam tempoh lapan minggu mengikut kepada peringkat pertumbuhan MMT. Sejumlah 176 individu daripada enam order, 15 famili dan 37 spesies serangga telah dikumpulkan sepanjang kajian ini. Keputusan kajian menunjukkan kumbang labu merah (*Raphidopalpa foveicollis*: Chrysomelidae: Coleoptera) adalah perosak paling dominan yang terdapat di hampir setiap peringkat pertumbuhan MMT. Kumbang labu direkodkan pada minggu 1 hingga minggu 5 dengan serangan pada daun dan batang MMT yang menyebabkan kerosakan teruk pada tumbuhan. Perosak dominan kedua ialah ulat melon (*Diaphania hyalinata*: Crambidae: Lepidoptera) yang banyak dikumpulkan semasa peringkat pengembangan dedaunan (minggu 3), diikuti dengan lalat pelombong daun (*Liriomyza trifolii*; Agromyzidae; Diptera) yang kebanyakannya ditemui semasa peringkat pematangan buah di mana larva menyerang daun MMT. Terdapat beberapa penyakit direkodkan telah menyerang MMT bermula dari minggu tiga sehingga minggu lapan. Penyakit paling dominan dicatatkan adalah 'Cucurbits Yellow Stunting Disorder Virus' (CYSDV), embun tepung (Powdery mildew) dan 'Verticillium wilt'. Hasil dapatan daripada kajian ini boleh menyumbangkan maklumat penting tentang perosak dan peyakit MMT yang merupakan langkah pertama untuk penghasilan strategi kawalan yang efektif.

Kata kunci: melon, serangga perosak, penyakit, *Cucumis melo*, Terengganu.

INTRODUCTION

Cucumis melo or commonly known as muskmelon or rockmelon is a species of tendrilbearing plants that belongs to the family Cucurbitaceae (Zainal et al. 2013). The crop is predominantly tropical and shared the same genus with cucumber, squash and pumpkin. Based on the past study, there are more than 500 varieties of melon worldwide as it is cultivated all around the globe with China as the largest producer (Muhammad & Masdek 2016). In South Korea, melon fruit production and cultivated area increased to 16% in 1990's due to the increased of the fruit consumption and price (Na et al. 2012). In 2011, the production of melon from all over the world has reached up to 30 million tonnes with the total of 1.3 million hectares harvested area. Muhammad and Masdek (2016) reported that in Malaysia, the melon production in year 2014 was more than 200,000 metrics tonnes.

As the melon cultivation can generate higher profit to farmers, the government has invested millions of Malaysia Ringgit to boost this industry (FAMA 2016). In Malaysia, melons are mostly planted in Terengganu, Kedah, Johor and Kelantan.The most popular melon cultivars in Malaysia are Super Dragon, Jade Dew and Glamour. Interestingly, *Cucumis melo* var. *inodorus* cv. Manis Terengganu 1 or locally known as Melon Manis Terengganu (MMT) has been introduced into Terengganu in 2015. This cultivar is one of the most popular among Terengganu entrepreneurs and planters as it offers high profit return to local farmers. Currently, the retail price for grade A MMT is RM 8 to RM 12/kg and for farm price is about RM 6 to RM 8/kg. It has been estimated that the 5 of hectare of MMT plant can produce up to RM 5 million per year. As the MMT cultivation can generate higher profit to local farmers, the Terengganu state government has committed to open up more areas and expand MMT cultivation. The government has opened 10 MMT projects covering 5.7 ha involving 52 participants and to date, 40 to 60 tonnes have been produced (Department of Agriculture of Terengganu, personal comm.).

Although many farmers are involved in cultivation of MMT, the production is still limited to meet the local demand. Many factors may contribute to this problem that limit MMT potential productivity which later downgrade the fruit quality. One of the problems is serious occurrence of pests and fungal diseases. Muskmelon or rockmelon is reported to have been attacked by numerous insect pests which include of red pumpkin beetle (RPB), Hudda beetle, fruitflies, jassids and aphids with the RPB as the most destructive pest (Khan & Jehangir 2000). Rashid et al. (2016) stated that RPB have caused damage losses up to 75% to seedlings of cucurbits leaves and fruits stage. In most of the cases, the damage is done by both the grubs and the beetle. The roots will eventually be bored by the grubs while the adult beetle defoliated the plants. In addition, Toba et al. (1977) reported that plant viruses, aphid-borne have caused economic losses to spring musk melon growers in United States. *Aphis gossypii* has been categorized as an important insect pest in agriculture since it can caused damage by several ways such as direct feeding affects, transmission of plant viruses and support the growth of black sooty mould that inhibit photosynthesis (Andrews et al. 2004).

Moreover, Garzo et al. (2002) reported that melon aphid is a major pest of crops and an efficient vectors of plant viruses such as Watermelon Mosaic Virus-2 (WMV2), Cucumber Mosaic Virus (CMV) and Zucchini Yellow Mosaic Virus (ZYMV). One of the major diseases of cucurbits is the downy mildew (Cohen et al. 2015). Downy mildew is a disease caused by *Pseudoperonospora cubensis* (Kauret al. 2016). According to Cohen et al. (2015), over 40 host plant species that belong to 20 genera from family Cucurbitaceae have been infected by *Pseudoperonospora cubensis* which is an obligate biotrophic. *Helicoverpa armigera* or commonly known as hubner is one of the insect pests that usually attack musk melon. Hubner is a polyphagous pest and it attacked the crop in the month of April and May which is at the crop's flowering stage (Kaur et al. 2016). Besides, Gummy stem blight is another common disease caused by *Didymella bryoniae* which can cause a severe damage on cucurbits crop including melons (Zhang et al. 2017).

So far, research and documentation that has been done on pests and diseases occurrence in local melon production are lacking. Since MMT is a new variety of melon, there is lack of study hadbeen conducted to identify the specific species of the pest and disease for MMT. It is necessary to have an adequate knowledge on the common insect pests and disease that usually attack the plants in order to manage the pest and disease efficiently. Thus, the main objective of this study was to determine the pests and disease incidence at different growth stage of MMT.

MATERIALS AND METHODS

Study Site

The study was conducted in Amtani Farm Enterprise, owned by Tuan Haji Abdul Manaf bin Tahir which is located at Kampung Pecah Rotan, Kuala Nerus, Terengganu, 11 km from UMT Campus. The farm area is about 2 ha and surrounded by rubber estate. The farm has more than 20 greenhouses with 20 to 400 MMT plants each. The MMT plants were grown using the fertigation method,which is a common technique used in melon cultivation that maximizes crop yield through controlled application of water and fertilizers. Plants were irrigated daily by automated-drip fertigation system. There was no other plants grown in the greenhouses during this study was conducted.

Collection of Sample of Pests and Observation on Diseases Incidence

The collection of pests and observation on diseases incidence were conducted in eight weeks (mid January to mid March 2018) which started from the seedling stage until the MMT fruits were harvested, thus the pests and disease occurred for every stages of MMT life cycle could be identified. A total of three greenhouses that occupied a total of 1200 MMT plants were selected from 200 hundreds greehouses available. For each greenhouse, there were 400 MMT plants that were observed randomly. The insect pests were colllected by using forceps or hand picking, placed in properly labelled universal bottles, preserved in 75% ethanol and taken back to the laboratory for identification. For every visit, the samples were collected started early in the morning (8.00 to 9.00 am) and ended in the afternoon (11.00 am – 12.00 noon). The condition of the plants were also recorded or photographed for disease identification. The sample of insects were brought back to the laboratory for identification.

Identification of Pests and Diseases

The specimen of insect samples were sorted and dried before they were observed under the microscope for identification. The binocular stereoscopic microscope was used and the insect specimens were identified using Borror & White (1998) and Fenemore & Prakash (2006). The diseases were identified based on the sign and symptom of the diseases displayed on the affected plants (Lucas et al. 1992).

Data Analysis

One-Way ANOVA was used to determine whether or not there were any statistically significant differences in total abundance of insect pests from week 1 to week 8 among plants. Disease incidence was calculated using the following formula:

Disease incidence (DI) = (Number of diseased plant/ Total number of sampled plant) x 100

RESULTS AND DISCUSSION

Insect Pests of Melon Manis Terengganu (MMT)

A total of 176 individuals of insect pests representing 37 species from six orders and 15 families were collected from Amtani Farm Enterprise for eight weeks of MMT growth stages. There were significant differences in total abundance of insect pests from week 1 to week 8 at Amtani Farm ($F = 12.69$, $df = 7$, $p = 0.004$) among plants. Week 3 which was during the foliage expansion stage recorded significantly the highest total number of insects with 48 individuals, followed by week 8 with 32 individuals, week 7 with 26 individuals and week 5 with 22 individuals. Other weeks were considered low as the total captured insects were less than 20 individuals. The lowest catches were during the establishment and foliar development stage in week 2 which was only 11 individuals. The most abundant family overall was Crambidae (Order: Lepidoptera) with 36 individuals, followed by Chrysomelidae (Order: Coleoptera) with 33 individuals and Agromyzidae (Order: Diptera) with 25 individuals. Other commonly found families were Thripidae (Order: Thysanoptera), Aleyrodidae (Order: Hemiptera) and Cicadellidae (Order: Hemiptera). The rest of other families were represented by less than 10 individuals of total abundance in each week of samplings. Table 1 presents the total number of insects captured for eight weeks of MMT growth stage.

Table 1. The list of insect pests found on Melon Manis Terengganu plants from week 1 to week 8 after planting.

Week	Order	Family	Species	Stage	No. of Individuals
1	Coleoptera	Chrysomelidae	*Raphidopalpa foveicollis*	Adult	5
			Aulacophora frontalis	Adult	1
	Hemiptera	Aleyrodidae	*Bemisia tabaci*	Adult	4
	Orthoptera	Tetrigidae	*Paratettix aztecus*	Adult	1
			Unidentified 1	Nymph	1
2	Coleoptera	Chrysomelidae	*Raphidopalpa foveicollis*	Adult	8
	Orthoptera	Acrididae	*Achurum carinatum*	Adult	1
3	Coleoptera	Chrysomelidae	*Raphidopalpa foveicollis*	Adult	11
			Unidentified 2	Adult	1
	Hemiptera	Meenoplidae	*Nisia carolinensis*	Adult	1
		Aleyrodidae	*Bemisi atabaci*	Adult	2
		Cicadellidae	*Nephotettix nigropictus*	Adult	2
			Unidentified 3	Adult	1
			Unidentified 4	Adult	1
	Diptera	Agromyzidae	*Liriomyza trifolii*	Larva	4
		Unidentified	Unidentified 5	Adult	1
			Unidentified 6	Adult	1
	Lepidoptera	Crambidae	*Diaphania hyalinata*	Larva	23
4	Coleoptera	Chrysomelidae	*Raphidopalpa foveicollis*	Adult	1
	Hemiptera	Cicadellidae	*Nephotettix nigropictus*	Adult	1
			Cofana spectra	Adult	1
			Circulifer tenellus	Adult	1
		Unidentified	Unidentified 7	Adult	1
	Orthoptera	Acrididae	*Achurum carinatum*	Adult	2
		Tettigonidae	*Conocephalus fasciatus*	Adult	1
	Diptera	Muscidae	Unidentified 8	Adult	1
			Unidentified 9	Adult	1
		Dolichopodidae	*Condylostylus* sp.	Adult	1
		Unidentified	Unidentified 10	Adult	1
5	Coleoptera	Chrysomelidae	*Raphidopalpa foveicollis*	Adult	5
			Aulacophora frontalis	Adult	1
	Hemiptera	Cicadellidae	*Bothrogonia addita*	Adult	3
			Cicadella viridis	Adult	1
			Cofana spectra	Adult	1
	Diptera	Agromyzidae	*Liriomyza trifolii*	Adult	3
		Muscidae	*Neomyia cornicina*	Adult	1
			Hydrotaea aenescens	Adult	1
		Dolichopodidae	*Dolichopus* sp.	Adult	1
			Condylostylus sp.	Adult	1
		Lauxaniidae	Unidentified 11	Adult	1

		Stratiomyidae	*Microchrysa polita*	Adult	1
		Unidentified	Unidentified 12	Adult	1
	Lepidoptera	Unidentified	Unidentified 13	Adult	1
7	Hemiptera	Unidentified	Unidentified 14	Adult	1
	Diptera	Agromyzidae	*Liriomyza trifolii*	Adult	4
				Larva	7
	Lepidoptera	Unidentified	Unidentified 15	Adult	1
			Unidentified 16	Adult	1
8	Hemiptera	Aleyrodidae	*Bemisia tabaci*	Adult	5
		Cicadellidae	*Bothrogonia addita*	Adult	2
	Lepidoptera	Crambidae	*Diaphania hyalinata*	Larva	9
	Thysanoptera	Thripidae	*Thrips palmi*	Adult	10

From the survey, red pumpkin beetle, RPB (*Raphidopalpa foveicollis*: Chrysomelidae: Coleoptera) was the most common and serious insect pest of MMT observed. RPB was found to occur in most of the surveyed weeks with infestation varies from mild to serious (Figure 1). RPB occurrence varied between weeks of sampling (Table 1). Week 3 recorded the highest occurrence (11 individuals), followed by week 2 (8 individuals), weeks 1 and 5 (5 individuals) and week 4 which was the lowest with 1 individual. Adult of RPB were found attacking the leaves and stems of MMT plants by consumed the foliage and caused damage on the leaves (Figure 2). Our result shows that RPB feed only on young leaves of MMT which is contradicting to report of Khan (2016), where RPB can be found more on mature leaf compared to young leaf. Based on previous study by Rahaman et al. (2008), both larval and adult stages of RPB are injurious and can caused severe damage to almost all cucurbits at seedlings, young and tender leaves and also flowers. According to Rashid et al. (2016), RPB caused damage losses about 35% to 75% to seedlings of cucurbits, leaves and fruit stage.

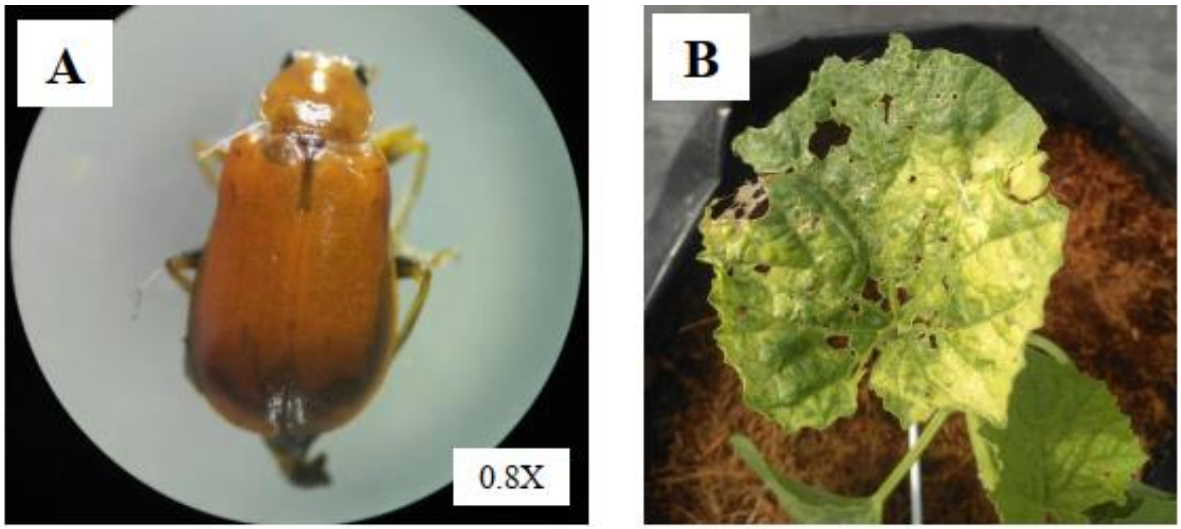

Figure 1. Red pumpkin beetle, RPB (A) and the sign and symptom of RPB infestation on MMT plants (B).

Melon worm (*Diaphania hyalinata*: Crambidae: Lepidoptera) was the second highest abundant of insect pest found in this study (Figure 2). Interestingly, the melon worms were found only in weeks 3, 7 and 8. Melon worms were more abundant during week 3 (23 individuals) orfoliage expansion stage. The larvae of melon worm moth were mostly found attacked MMT leaves and the leaf vein were left intact resulting in lace-likeplant remain. In weeks 7 and 8, which were during fruit set and maturation stages, thelarvae was found on the surface of the fruit. Based on Capinera (2005), melon worm can caused yield loss up to 33% due to foliage damage. The new emerged larvae of melon worm moth feed on the leaves mesophyll and leaving the epidermis, but later feeds greedily before entering the pupation stage and leave only the veins (Mohaned et al. 2013).

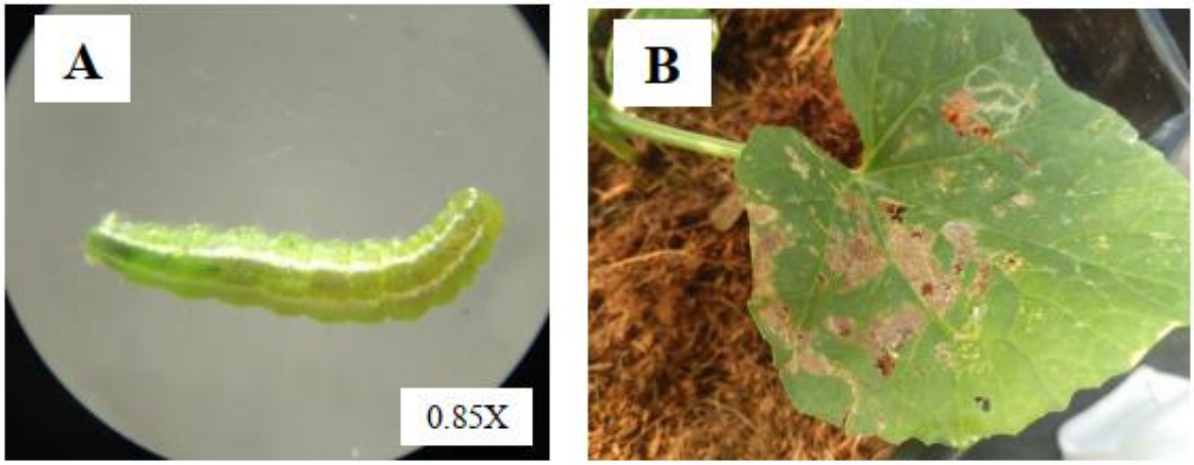

Figure 2. Melon worm larvae (A) and the sign and symptom of melon worm infestation on MMT plants (B).

Leaf miner fly (*Liriomyza trifolii*: Agromyzidae: Diptera) was the third commonly insect that became threat to MMT plants (Figure 3). It was commonly found in weeks 6 (11 individuals) and 8 (13 individuals) which were at the fruit set and fruit maturation stage respectively. The larvae of leaf miner fly feed between the upper and lower surfaces of MMT leaves. MMT leaves were damaged as the larvae tunnel through the inner leaf tissue producing whitish “mines” and also appeared to be mottled. According to Dogimont et al. (1999), leaf miner fly is not just attacked tomato, cucumber, lettuce and pepper, it also caused a major problem on melon sparticularly in greenhouses. After the larvae of leaf miner fly hatched from the eggs it will formed a serpentine mine as it feeds in leaf mesophyll tissue (Dogimont et al. 1999).

Besides that, other common insect pests found on MMT were also observed. They were melon thrips (*Thrips palmi*: Thripidae: Thysanoptera) which were abundant in weeks 7 and 8, silver leaf whitefly (*Bemisia tabaci*: Aleyrodidae: Hemiptera) which were recorded in weeks 1, 3, 7 and 8 and orange colour leafhopper (*Bothrogonia addita*: Cicadellidae: Hemiptera) that were collected in weeks 5 and 7. The presence of these species can be recognised by the sign and symptom showed on the leaves or other part of MMT plants. Melon thrips have caused severe injury on MMT plants as the leaves become yellow, white or brown and crinkle. It usually attacked the young foliage, sap sucking the leaves and can caused the leaves to become mottled and bronzing. *Thrips palmi* or melon thrip was reported as one of the common pests on eggplant, chili and bell pepper in Cameron Highlands, Malaysia (Tan et al. 2016). The melon thrips can causes economic damage to vegetable crops by decreasing the quality and

harvested yield (Palm Beach County 1994). Silverleaf whitefly was the fifth most dominant insect pest found. It was commonly collected in week 1 and week 7 which were at the stage of transplant and fruit set and maturation stage respectively. Silverleaf whitefly attack the MMT leaves by sucking the liquids from the leaves surfaces. The leaves will become yellow with spots of chlorosis. Pan et al. (2011) reported that *Bemisia tabaci* is an invasive and damaging pests of protected crops and field crops worldwide. This whitefly species is a polyphagous insect that caused damage directly on plants through its feeding and indirectly by vectoring plant viruses.

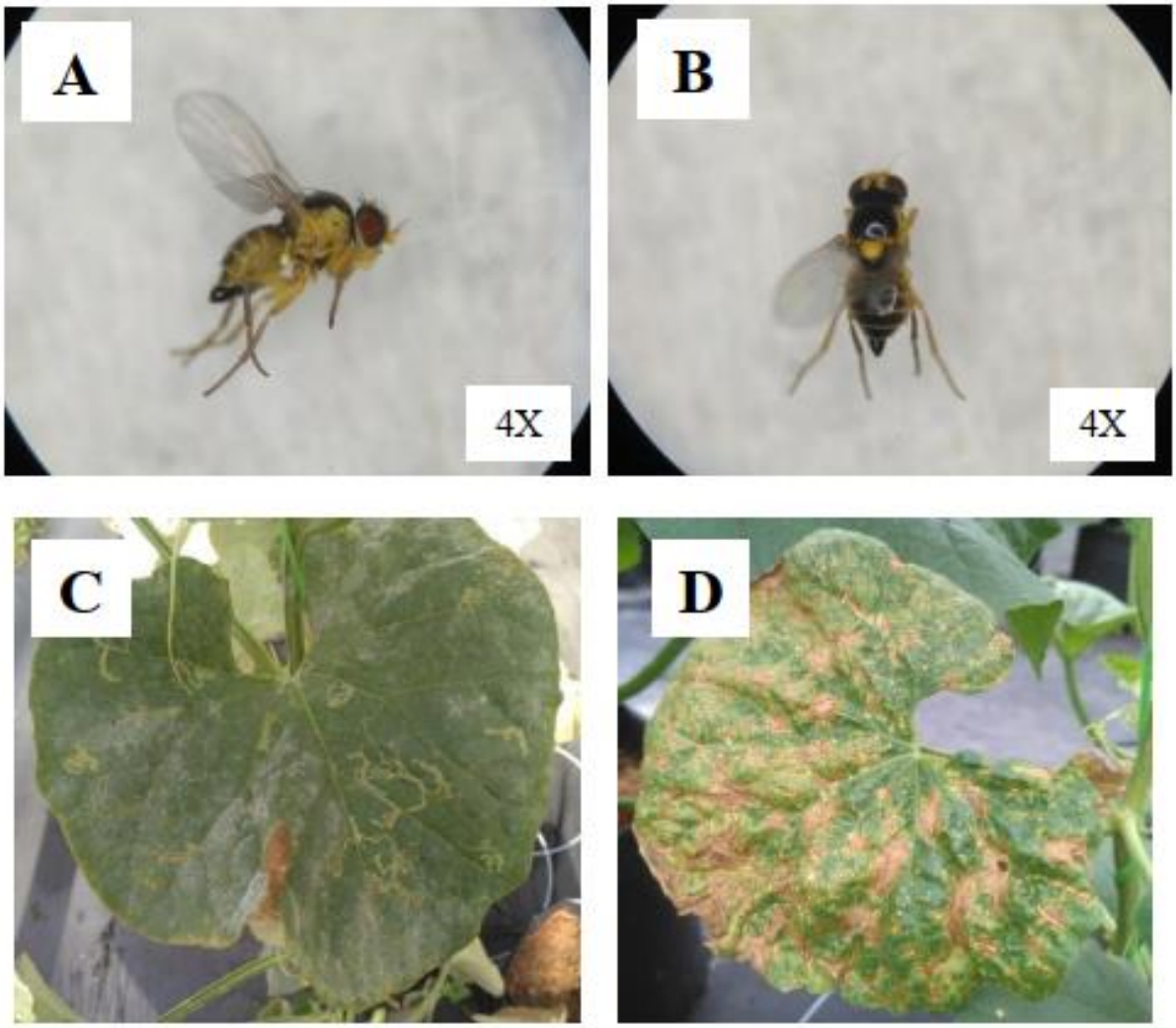

Figure 3. Leaf miner fly, side view (A) and dorsal view (B). The sign of leaf miner (C) and mottled leaf on MMT plant.

Occurrence of Diseases Found on MMT Plants

Five diseases were recorded, namely Cucurbit Yellow Stunting Disorder Virus (CYSDV), Watermelon Mosaic Virus (WMV), anthracnose, powdery mildew and verticillium wilt (Figure 4). The highest disease incidence was CYSDV (58%), followed by powdery mildew (45%) and verticillium wilt (38%). CYSDV was commonly found observed in week 4 until week 8. The disease was recognised by the symptom such as the entire leaf becomes yellow except for the veinswhich remain green (Figure 5A). The WMV was recorded during weeks 3, 4 and 5. The symptom of infection was included leaf distortion, mosaic and vein chlorosis (Figure 5B). For

anthracnose, it was observed in weeks 4 and 5. It was able to be identified based on the presence of irregular yellow, brown or black spots on the leaves (Figure 5C).

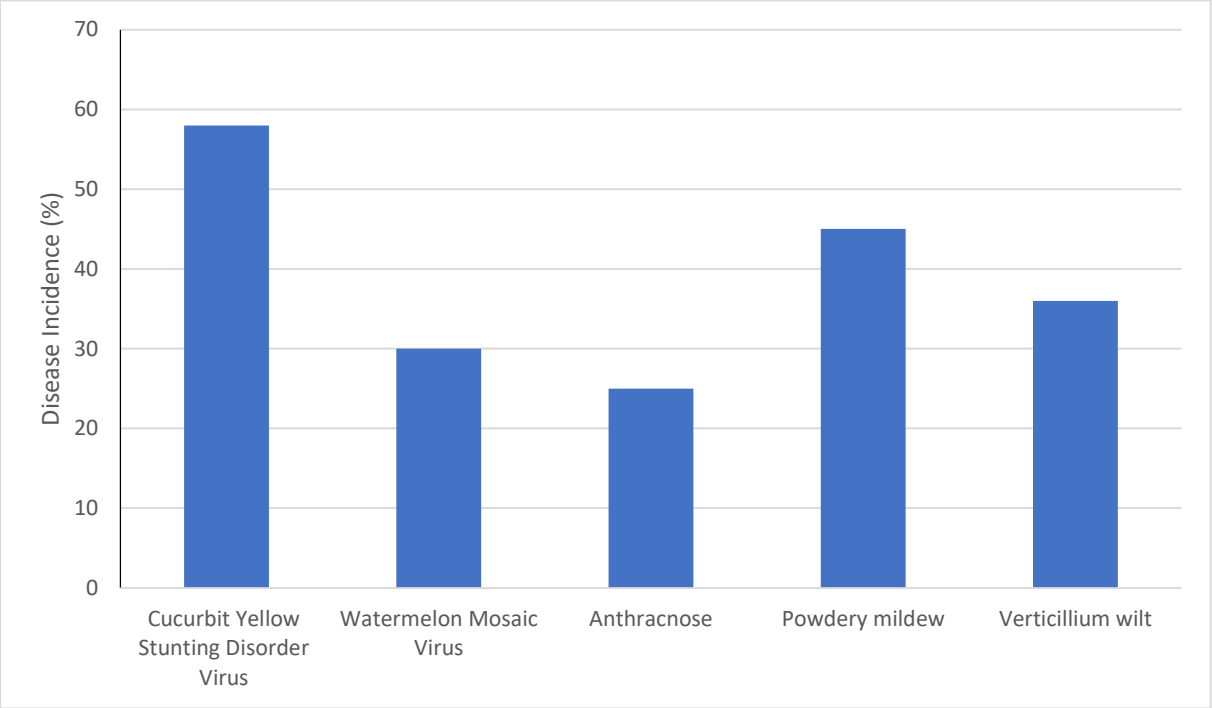

Figure 4. Percentage of disease incidence on MMT plants.

Powdery mildew was recorded in last three weeks namely weeks 6, 7 and 8. The infected plants displayed white powdery spots on the leaves and stems (Figure 5D). Lastly, the verticillium wilt, this disease was found in weeks 7 and 8 which was during the fruit set and fruit maturation stage. It can be recognized because the symptoms generally appeared after the fruit set which caused the chlorotic leaves that develop necrotic areas and most obvious was the leaves collapsing (Figure 5E).

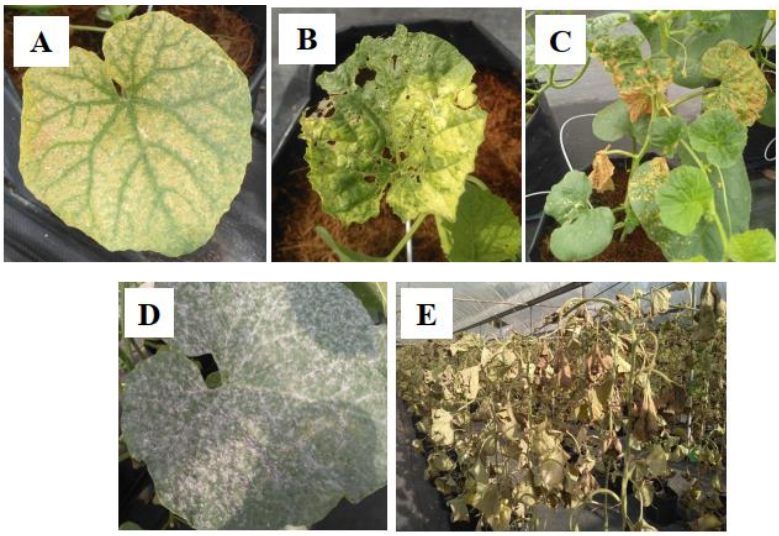

Figure 5. Cucurbit Yellow Stunting Disorder Virus (A), Watermelon Mosaic Virus (B), Anthracnose (C), Powdery Mildew (D) and Verticillium Wilt (E).

During weeks 1 and 2, there was no disease recorded based on the observation of theMMT plants condition. However in week 3 (foliage expansion stage) there was a symptom of Watermelon Mosaic Virus (WMV) on MMT plants. While in week 4, there were 3 diseases observed which were CYSDV, WMV and Anthracnose. The viruses might have be carried by water, rain, wind or insect pests. Duffus (1995) stated that CYSDV was transmitted by whitefly. From Table 1, it shows that there were presence of silverleaf whitefly in weeks 1 and 2. This finding can be supported by the previous statement by Duffus (1995). Insecticide such as furathiocarb, malathion and prothiophos were usually being applied to control the whitefly occurrence andto prevent the whitefly from spread the virus on the plants.

The WMV was observed in week 3, 4 and 5 with the symptoms of leaf distortion, mosaic and vein chlorosis. The disease that recently known as Watermelon Mosaic Virus – 2 (WMV2), is plant pathogenic virus. It can caused infection in many vegetable crops such as cucumber, cantaloupe and melon. Purcifull et al. (1984) reported that WMV infection will decrease the fruit quality and production in squash and other cucurbits. Due to the early infection of WMV on melon there were up to 30% reduction in production which is the number of fruits per plant (Alonso-Prados et al. 1997). Powdery mildew that caused by the existence of biotrophic fungus, *Erysiphe necator* occurred from week 6 until week 8. It was when the MMT at the stage of flowering, fruitset and fruit maturation stage where the fruits were ready to be harvested. Powdery mildewwas susceptible to number of vegetable crops, however the most severely affected were cucurbits (Pérez-García et al. 2009). Besides, Jarvis et al. (2002) reported that cucurbits crop that grown in field and greenhouse are usually threatened by the disease which can reduce yield and cause important economic losses. The disease can be recognised by the presence of white, powdery mould on both side of leaf surfaces, on petioles and on stems (Romero et al. 2004).

Anthracnose was recorded in week 4 (beginning of flowering stage) and 5 (flowering and fruit set stages) with the symptom of wilting, withering and dying of tissues. This disease was caused by *Colletotrichum* species, appear in both developing and mature plant tissues (Freeman et al. 1998). Lastly, Verticillium wilt that affected MMT plants in the last two weeks which was during the fruit set and maturation stage. The disease generally attack the plant after fruit set stagewhich have caused the plants become flaccid and also have affected the quality and the fruit taste. *Verticillium* spp. are the soil-borne plant pathogens that responsible for this disease. Fradin and Thomma (2006) in their study mentioned that Verticillium wilt symptoms are vary between hosts, but it may comprised of wilting, chlorosis, stunting, necrosis and vein clearing. In addition, brown vascular discoloration may be observed in stem tissue cross-sections.

CONCLUSION

A checklist of pests and disease incidence of new melon cultivar, MMT was finally provided. It is clearly that in every growth stage of MMT plants, there were different type of insect pests and diseases were recorded. There were also certain insect pests that only occurred at certain growth stage but absent in the other stages. Every insect pests and diseases showed different signs and symptoms of infestation on the MMT plants. Certain symptom and sign might be seem normal but can caused a great effect on the plants in the next growth stage. Hence, MMT growers can determine to control the possible dominant pest at each stage to avoid excessive used of pesticide. As the plants grow, the type of insect pests increased and more diseases were found to attack the plants. Some diseases that affected the plants might be carried by the insect

pests that infest on the plants. Thus, by knowing the possible insect pests that will attack the plants beforehand can also help the growers to mitigate the diseases from affecting the plants.

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