POLLINATION EFFICIENCY OF THE STINGLESS BEE, *Heterotrigona itama* (HYMENOPTERA: APIDAE) ON SOLANACEAE AND CUCURBITACEAE CROPS IN GREENHOUSE

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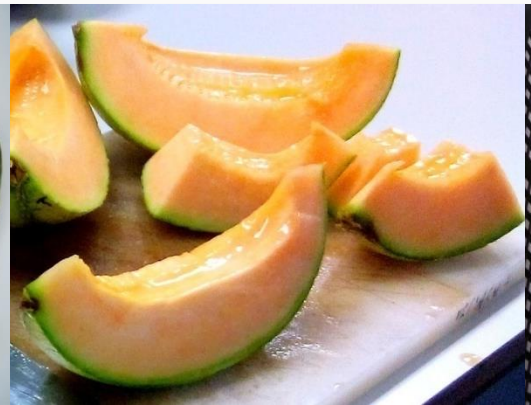
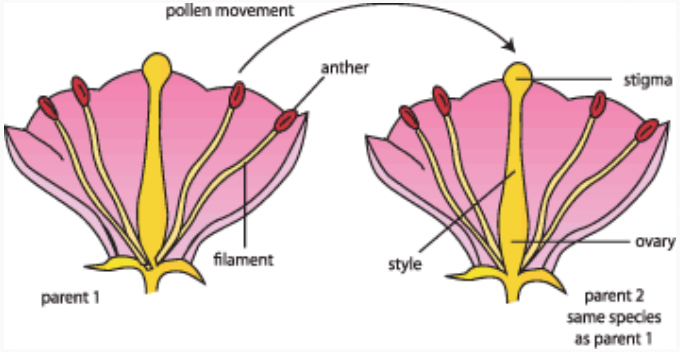



Outline

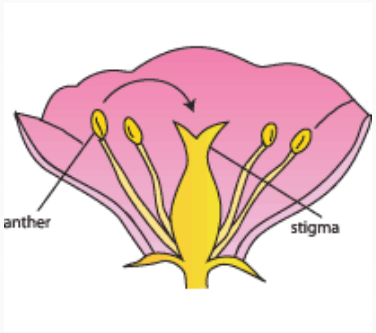
- Introduction on Pollination
- The potential use of stingless bees as pollinator for agriculture crops
- Objective of Study
- Materials & Methods
- Results & Discussion
  - Rock melon
  - Cucumber
  - Chili
- Conclusion

Introduction

- Pollination is the transfer of pollen from the anther (the male part of the flower) to the stigma (the female part of the flower) of the plant.



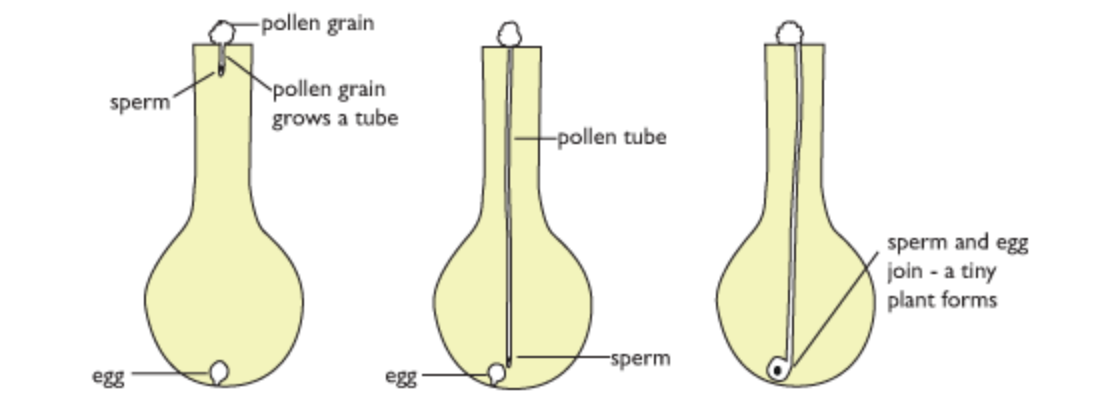
Cross pollination

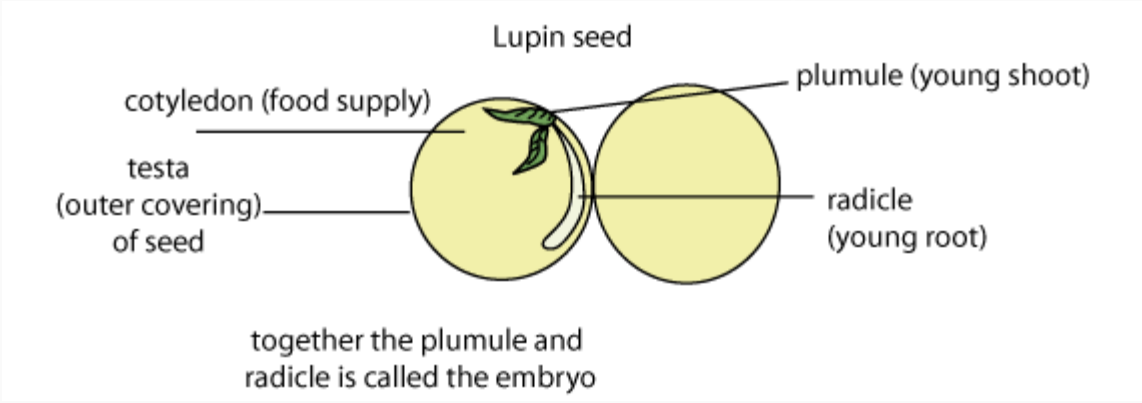


Self pollination

- Insect pollinators pollinate about 80% of flowering plants (FA0, 2007).
- Insects are largely responsible for a major part of the angiosperm pollination process (Zanette et al., 2004).

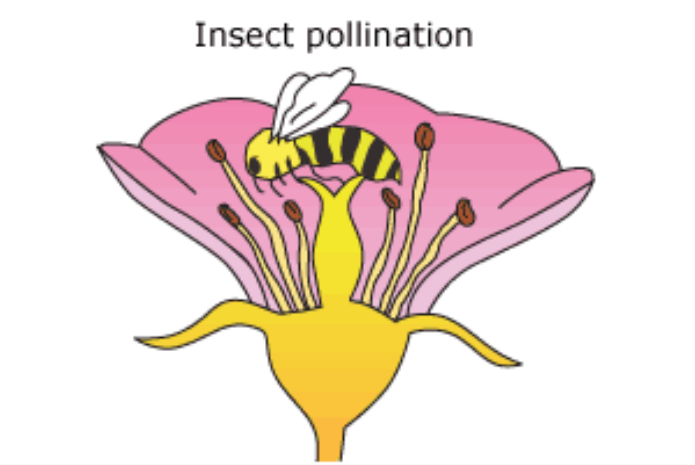
Insect pollination


pollen grain
sperm
pollen grain grows a tube
pollen tube
egg
egg
sperm
sperm and egg join - a tiny plant forms


Lupin seed
cotyledon (food supply)
plumule (young shoot)
testa (outer covering) of seed
radicle (young root)
together the plumule and radicle is called the embryo

Pollination

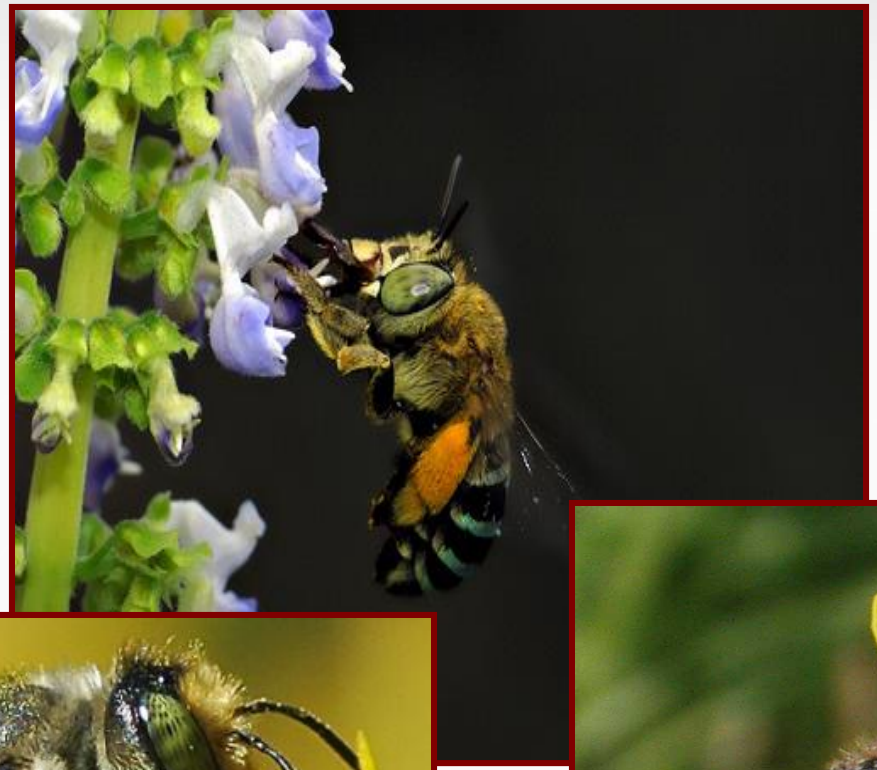
- Self pollination and cross pollination can occur in the same plant or different plant of the same species.
- Pollination may be aided by the presence of the pollinators :
  - Abiotic (wind, water)
  - Biotic (bats, birds, insects, human)



Elaeidobius kamerunicus, the African oil palm weevil

Pollination by Bees

- Solitary Bees
- Social Bees



Solitary Bees

Xylocopa, Amegilla, Megachile & Halictus

Social Bees

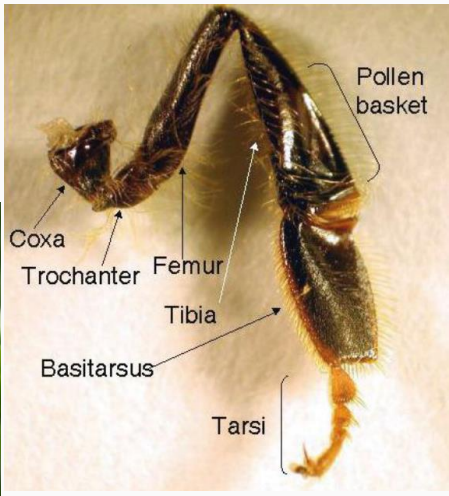
Stingless bees

- Stingless bees can be found in most tropical or subtropical regions of the world.
- Stingless bees are known to be important pollinator in tropical rainforest (Eltz et al., 2003).
- They are also good candidates for providing pollination services in agricultural ecosystem such as star fruits, mango, durian, watermelon, guava and coconut (Slaa et al., 2006).

Heterotrigona itama

- Tribe to Meliponini, family Apidae
- Native to Malaysia
- Active throughout the year
- Harmless / safe
- Resistance to diseases and parasites
- Low cost in rearing them
- Modified hind leg called corbiculae or pollen basket
- One of the potential candidates in commercial pollination
- Largely domesticated stingless bee in Malaysia

Heterotrigona itama



Advantages of stingless bee:

- Polylecty
- Adaptability
- Floral fidelity
- Can be domesticated
- Perenial colonies
- Large food reserves
- Important and effective pollinators of many crop species

- Several studies found that pollination by stingless bees can affect the fruits produced especially for major cultivated crops.
- Santos *et al.,* 2008 - cucumber pollination by the stingless bees helped in increasing fruit quantity and improving quality of the fruit produced.
- Klatt *et al.* (2013) - bee-pollinated strawberries produced were heavier, had less malformed fruits and reached higher commercial grades.
- Cruz et al. 2005; Slaa et al. 2006 - stingless bee pollination increases chilli production.
- However, most of the studies on the effects of the stingless bee pollination on crops were conducted outside Malaysia.
- In Malaysia, most of the greenhouse farmers still use the hand pollination method which require more time, laborious and costly especially on large scale plantations.

Rockmelon,

(*Cucumis melo* var. glamour).

- Family: Cucurbitaceae
- Commercial crop in Malaysia
- Monoecious flower
- Pistillate and staminate both in the same plant but different branches.
- The female flower has different shape of receptacle than male flower.

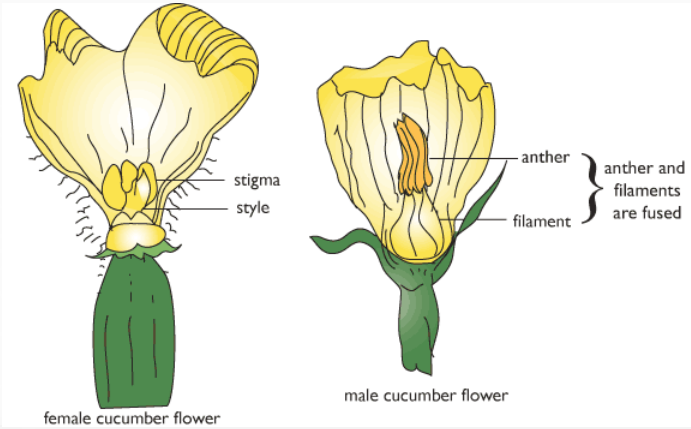
Rock melon

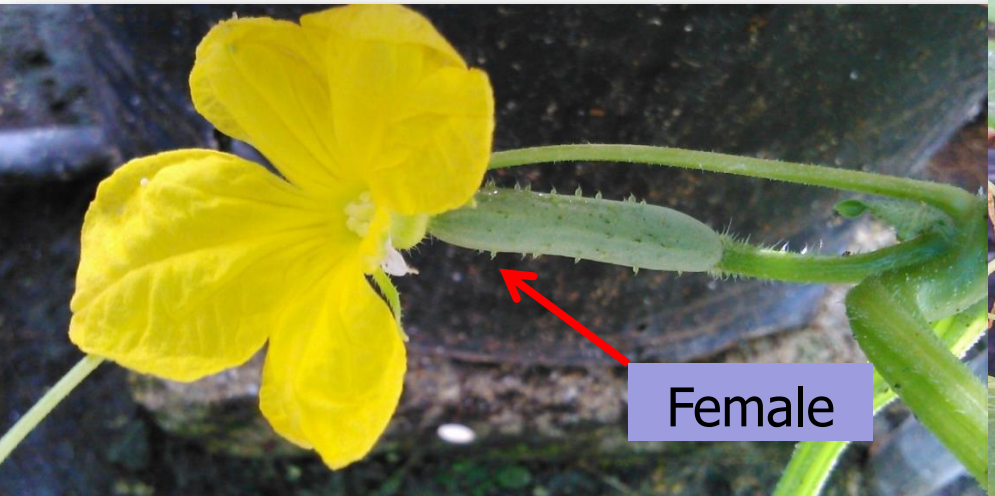
Female flower

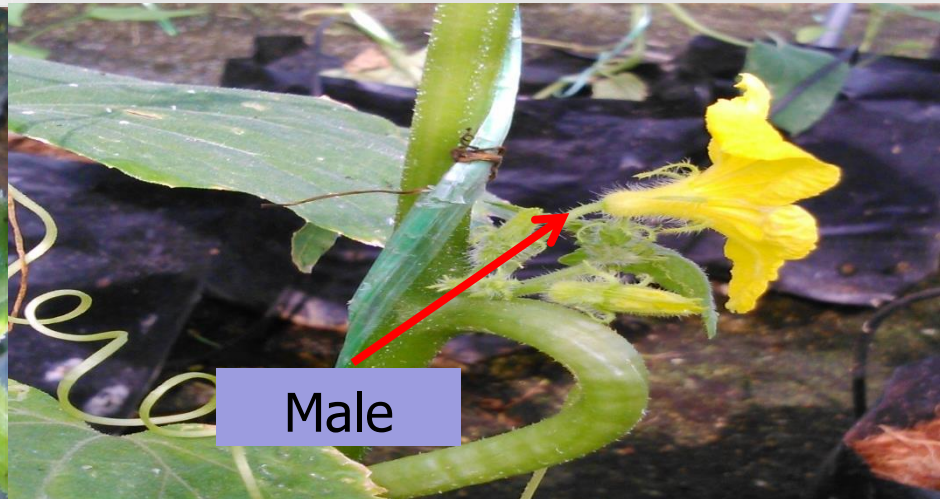
Male flower

Cucumber (*Cucumis sativus*)

- Family: Cucurbitaceae
- Commonly cultivated and consumed in Malaysia.
- **Monoecious** plants - separate male and female in the same plant.
- Most Cucurbitacea family depends on **insect-pollination** (Richards, 2001).
- Native stingless bee role in pollination is still poorly understood.







Chili (*Capsicum anuum)*

- Family: Solanaceae
- One of the important cultivated crops in Malaysia & a source of income for thousands of Malaysian farmers.
- Chili flowers are self-pollinated , the anthers need to be shaken to allow effective pollen release.
- The role of stingless bees in producing quality fruits of this crop is still unknown.




Objective of Study

- To determine the effects of stingless bee, *Heterotrigona itama* pollination on greenhouse rock melon (*Cucumis melo* var. *glamour),* cucumber (*Cucumis sativus)* dan chili *(Capsicum annum).*

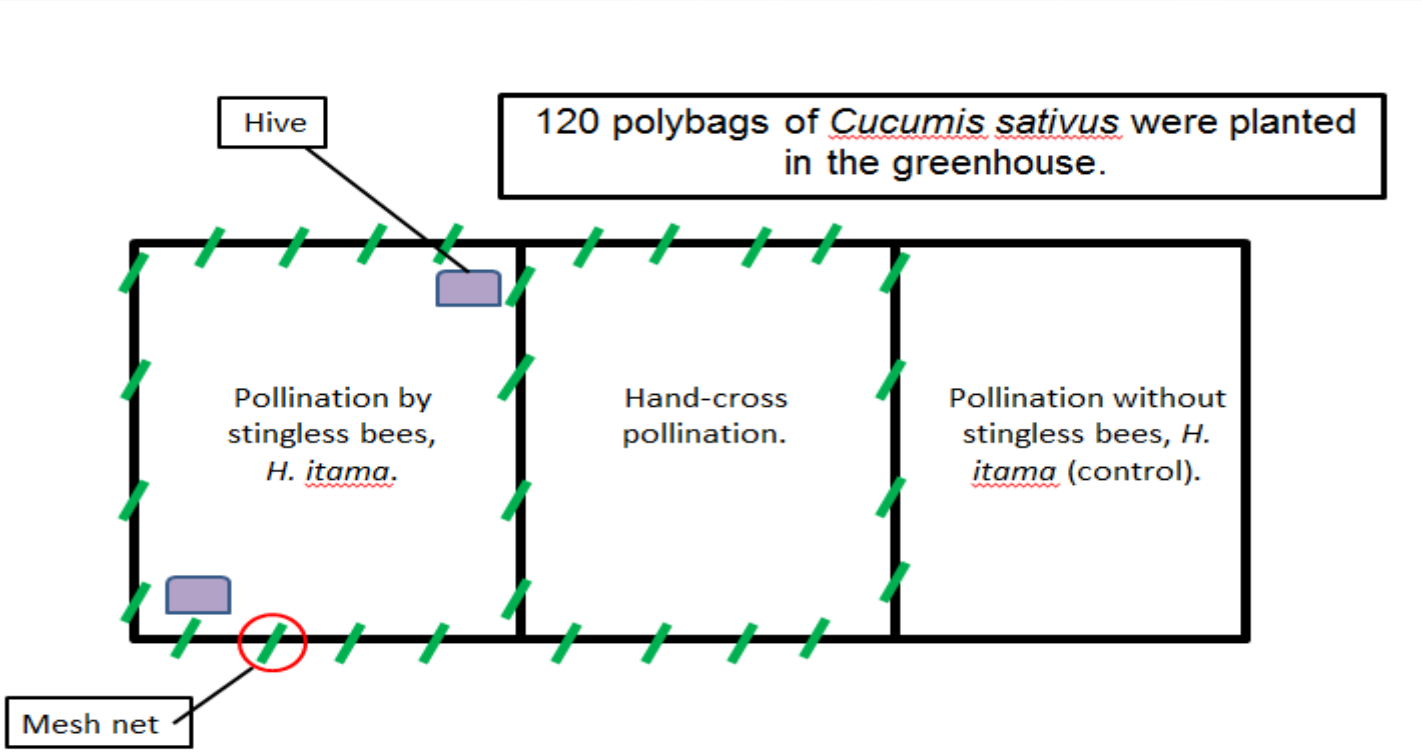
Materials & Methods

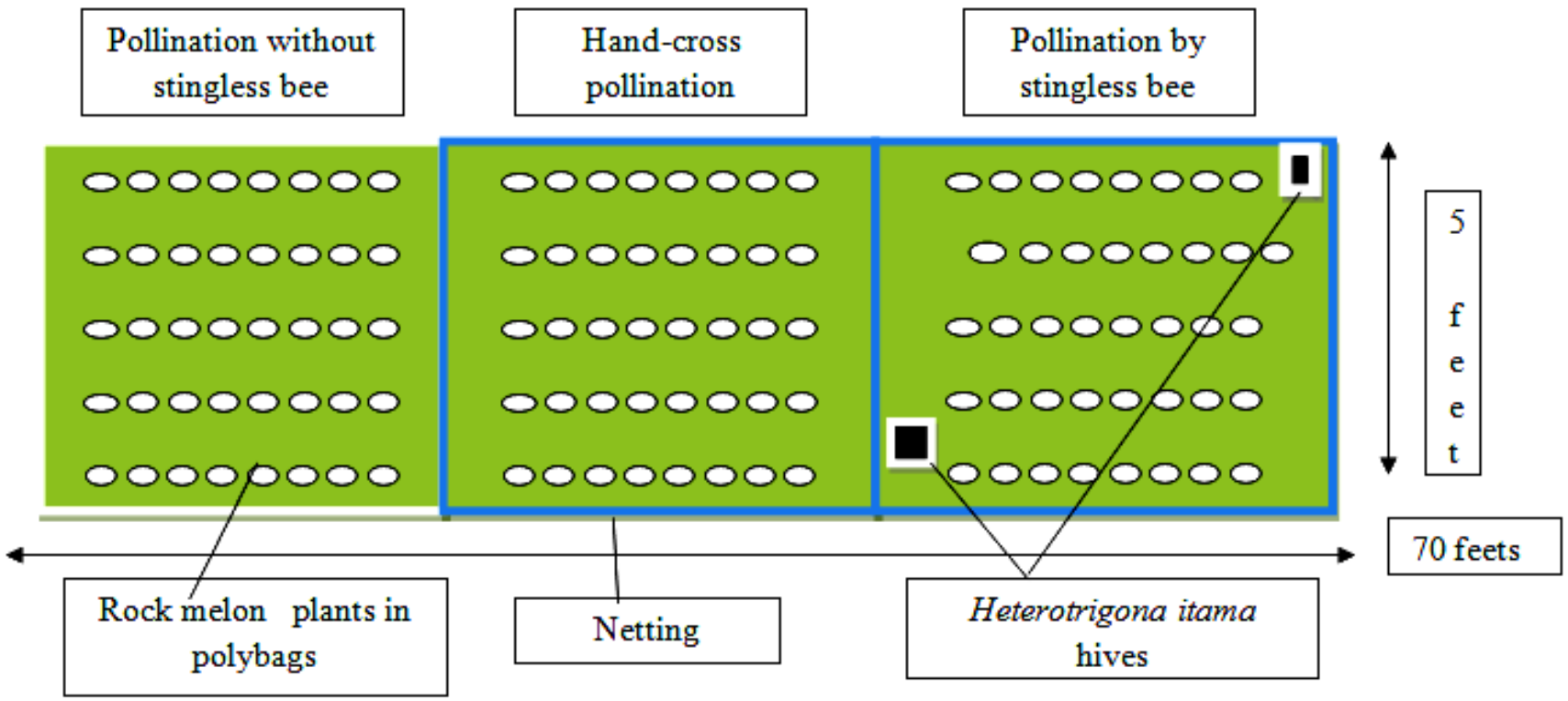
- **Experimental location:**

Greenhouses at GM Peladang Sdn. Bhd. Kuala Ibai, Terengganu (5°20'19.8"N103°07'07.4"E)

Greenhouse at the School of Food Science and Technology, UMT (N05^{0}24.541', E103^{0}05.347').

- The greenhouse was divided into three sections which have three different treatments; pollination without stingless bees (1), manual cross-pollination (2) & pollination with stingless bees (3).
- There were 120 polybags of the studied crop were planted in the greenhouse where each section have 40 replicates.





N = 120 plants / experiment

Pollination without stingless bee

- No mesh net.
- 40 buds of female flowers- tagged.
- Bagged when fruit started to form.

Hand-cross pollination

- 40 buds of female flowers- tagged & bagged before anthesis (7.00 am – 10.00 am).
- After anthesis, the flower was unbagged and the pollen (male) were rubbed into stigma (female) - bagged again (1 week).

Pollination with stingless bee, *H. itama*

- Placed two hives of *H. itama* (2 days before first anthesis).
- Observed activity of stingless bee visited the flower.
- Tagged and bagged (1 week).

GREENHOUSE PROCEDURE

1) Germination process

2) Seeds took 5 days to germinate

3)Plants were transferred into polybags

4) The development and growth in a good condition

5) 2 days before pollination day- introduce stingless bees

DAY 30 - 37

6) Pollination day – hand cross

- 2 male flowers from another cultivar - touched the flower stigma with stamen

DAY 30 - 35

7) Pollination day – Stingless bees pollination - activity of stingless bees visiting flowers were observed.

8) The female flowers that already pollinate were bagged and tagged. (Fruit set formation)

9) Bigger fruits – unbagged the mesh net

10) Growth perfectly

11) Harvest day !

12) Samples collection – brought to the lab

- **Self pollination**: Flower was bagged during anthesis until setting of fruits.

- **Stingless bees pollination**

Two hives were placed in greenhouse when flowering start.

Stingless bees were monitored.

Flower visited by stingless bee was bagged.

- **Hand cross pollination**:

Flower was bagged during anthesis.

↓

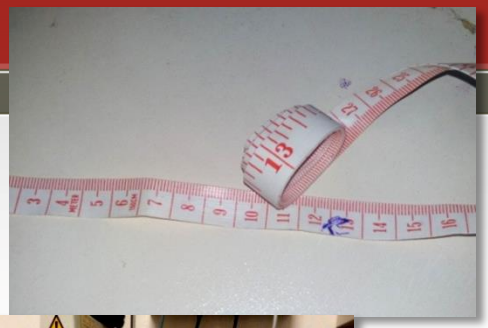
Flower from another plant was picked and rubbed gently to the bagged flower.

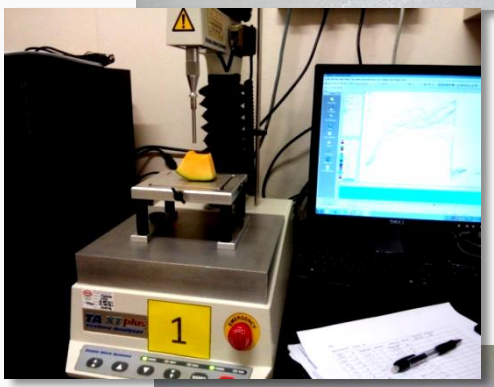
↓

Flower was bagged again until setting of fruit.

Production-related parameters

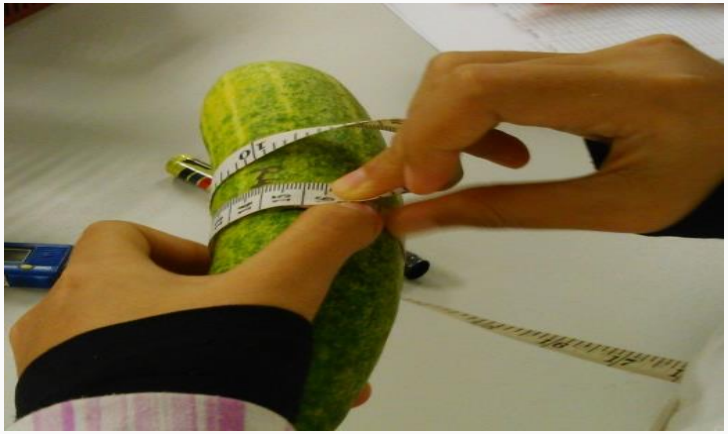
Parameters	Apparatus/ machine/ way
Weight (kg)	Weighing balance
Diameter (cm)	Measuring tape
Thickness of the fleshes (cm)	Caliper
Sweetness (%)	Refractometer
Firmness (N)	Texture analyzer
Number of Seed	Dried, count



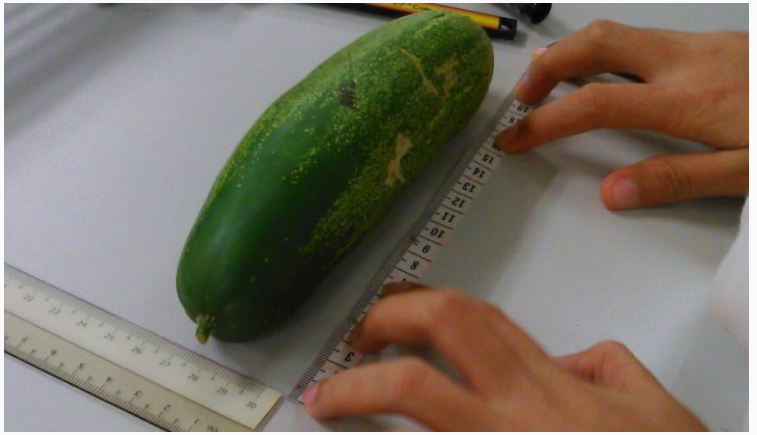


Harvested cucumber

Cutting process



Measuring diameter of cucumber



Measuring length of cucumber

Stable macro system, TA.
XTplus texture analyzer

Dried cucumber seed at room temperature

Cucumis sativus

Data analysis

- One-way ANOVA to determine differences between the treatments (weight, length, diameter, color, firmness, dried seed weight, etc.).

- Post Hoc tests of Tukey to determine which treatment is significantly difference from others.

Results – Rock melon

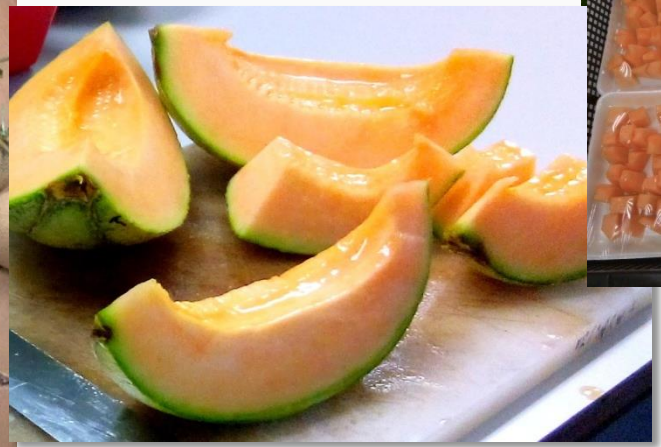
Fruit weight, diameter, sweetness, flesh thickness and number of seeds of rock melon fruits produced from self-pollination, hand-cross pollination and *Heterotrigona itama* pollination.

*Means + SD in column with same letter are not significantly different ($p>0.05$) according to Tukey Post Hoc test (n = 20).

Type of pollinations	Weight (kg)	Diameter of fruits (cm)	Percentage of sweetness (%)	Average of firmness (N)	Thickness of flesh (cm)	Number of seeds
Without stingless bee	1.2 ±0.14a	42.86±1.37a	8.6±1.39a	9.64±5.60a	3.30±0.23a	521±93.3a
Hand cross	1.5±0.24b	46.24±3.04b	9.95±1.66a	8.93±4.49a	3.46±0.30b	656±98.4b
By stingless bees, *H. itama*	1.6±0.18b	48.02±1.86b	11.01±1.35b	11.85±3.95a	3.62±0.11b	625±131.6b

Source: Wahizatul et al. (unpublished)

Pollination by *H. itama* produced rock melon fruits with higher number of seeds per fruit, larger, heavier and sweeter than rock melons produced by other pollination treatments.



Economic Analysis

	Pollination	
	Hand-cross pollination	Stingless bee pollination
(A) Cost of production per plant (RM)	RM 4.00	RM 4.00
(B) Yield per plant (kg)	1.8kg	3.2 kg
(C) Average market price (RM/kg)	RM 5.00/kg	RM 5.00/kg
(D) Sale revenue per plant (B)x(C)	RM 9.00	RM 16.00
(E) Net profit per plant (D)-(A)	RM 9.00- RM 4.00 =RM 5.00	RM 16.00- RM 4.00= RM 12.00

The stingless bee pollinated treatment had added about RM 12.00 to the net profit of rock melon sales price per plant set (per polybag). Whereas, hand-cross had proved to have about at least RM 5.00 per plant set for the net profit of sale

Results – Cucumber

Table 1. Results of fruit weight, length, diameter, firmness and dried seed weight of cucumber fruits produced from pollination without stingless bee, hand-cross pollination and *Heterotrigona itama* pollination

Treatment	Weight (g)	Length (cm)	Diameter (cm)	Firmness (Brixmeter)	Dried seed weight (g)
Without stingless bee	0.30±0.09a	19.61±1.62a	15.75±2.07a	26.49±4.51a	0.46±0.23a
Hand-cross pollination	0.42±0.07b	17.58±1.90b	17.58±1.21b	25.42±3.16b	0.82±0.32b
H. itama pollination	0.43±0.08b	22.20±1.12b	17.84±1.01b	23.85±2.12b	0.79±0.25b

*Means ± SD in column with the same letter are not significantly different (p>0.05) according to Tukey Post Hoc test (n=20).

Table 2. Comparison of colour (L, a, b) between pollination without stingless bee, hand cross-pollination and pollination by stingless bee (*Heterotrigona itama*)

Treatment	Colour (mean)		
	Brightness (L*)	Greenness (a*)	Yellowness (b*)
Without stingless bee	48.21±6.43a	-9.99±0.95a	23.82±7.77a
Hand-cross pollination	48.66±5.08b	-8.80±1.01b	18.15±3.39b
H. itama pollination	45.24±5.24b	-9.07±0.99b	16.66±3.89b

*Means ± SD in column with the same letter are not significantly different (p>0.05) according to Tukey Post Hoc test (n=20).

Source: Wahizatul et al. (2017)

- Results showed that the cucumbers pollinated by stingless bee and hand-cross pollination produced heavier, longer and larger cucumbers compared to those produced from pollination without stingless bees.

Results – Chili

Table 1. Number of seeds, fruit weight and size of chilli (*Capsicum annuum*) fruits produced from self-pollination, hand-cross pollination and *Heterotrigona itama* pollination.

Treatment	No. of seeds (no/fruit)	Weight (g)	Length (cm)	Diameter (mm)
Self-pollination	48.54 ±15.28a	8.63 ±1.45a	9.02 ±0.77a	11.38 ±1.28a
Hand-cross pollination	102.92 ±24.25b	9.77 ±1.54a,b	9.23 ±1.89a	11.58 ±1.05a
H. itama pollination	112.54 ±21.15b	11.61 ±0.86b	13.00 ±0.59b	12.40 ±0.94a

*Means ± SD in column with same letter are not significantly different ($p>0.05$) according to Tukey Post Hoc test ($n = 20$).

Table 2. Percentage of fruit malformation, firmness, Total Soluble Solid and Titratable Acidity of chilli (*Capsicum annuum*) fruits produced from self-pollination, hand-cross pollination and *Heterotrigona itama* pollination.

Treatment	Percentage of malformation (%)	Firmness (N)	Total Soluble Solid (°)	Titratable Acidity (%)
Self-pollination	0a	1.702 ±0.30a	9.64±1.07a	0.369±0.03a
Hand-cross pollination	10.00 ±2.00a	1.789 ±0.31a	9.48±2.18a	0.325±0.05a
H. itama pollination	0a	1.839 ±0.37a	7.35±0.51a	0.313±0.06a

*Means ± SD in column with same letter are not significantly different ($p>0.05$) according to Tukey Post Hoc test ($n = 20$).

Source: Wahizatul et al. (2016)

Results showed that chilies produced from pollination by the stingless bees, H. itama and hand-cross pollination were significantly heavier, longer and containing greater number of seeds per fruit than self-pollinated chilies.

Discussion

- Rock melons, cucumbers & chillies produced from pollination by stingless bee were higher in fruit set and less malformed fruits than other treatments.
- Nicodemo *et al.* (2013) - the production of cucumber increased by 26% when the stingless bees placed in the greenhouse.
- Amano (2005) - stingless bee pollination produced higher number of fruit sets than honey bees.
- The rock melon, cucumber & chili pollens are sticky and cannot be dispersed by wind or air. Thus, they need the bees as pollination agent.
- Lower number of malformed cucumber from stingless bee pollination - *H. itama* deposited a great number of viable, compatible pollen as placed on the flower stigmas .

- Nicodemo et al. (2013);
- Done in the greenhouses at Ribeirao Preto, Brazil.
- Brazilian native stingless bee, Irai (*Nannotrigona testaceicornis*) contributed to a significant **increase in cucumber diameter & length**.

- Santos et al. (2008) reported that stingless bees (*Scaptotrigona depilis & Nannotrigona testaceicornis*) effectively pollinated the greenhouse cucumber (located at Universidade de Sao Paolo, Brazil); higher fruit production and **higher fruit weight**.

- Cruz et al. (2005) found that higher number of seed developing inside fruits produced from *Melipona subnitida* pollination would lead to bigger and heavier sweet peppers in the greenhouse.

- Stingless bees were active during morning and evening to collect nectar and pollen due to anthesis of the flowers (in the morning), energy requirements and better condition in the greenhouse (Cruz et al., 2005).

- More pollens are being transferred, more seeds will developed and the fruit size become larger and also contribute to increase of fruit weight than fruits with less seed (Delaplane & Mayer, 2000).

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PUBLICATION

1. **Wahizatul Afzan, A.**, Nurhidayah, S., Muhammad Firdaus, M.H., Roziah, G. and Chuah, T.S. (2017) Effects of stingless bee (*Heterotrigona itama*) Pollination on greenhouse cucumber (*Cucumis sativus*). *Malaysian Applied Biology* 46(1): 51-55.
2. **Wahizatul Afzan, A.**, Chuah, T.S. and Nur Suhaili, S. (2016) Pollination efficiency of the stingless bee, *Heterotrigona itama* (Hymenoptera: Apidae) on chilli (*Capsicum annum*) in greenhouse. *Journal of Tropical Plant Physiology* 8: 1-11.
3. **Wahizatul Afzan, A.**, Nur Syuhadah, Z. and Roziah, G. (2015) Melissopalynology and foraging activity of stingless bees, *Lepidotrigona terminata* (Hymenoptera: Apidae) from an apiary in Besut, Terengganu. *Journal of Sustainability Science and Management* 10(1): 27-35.

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EFFECTS OF STINGLESS BEE (*Heterotrigona itama*) POLLINATION ON GREENHOUSE CUCUMBER (*Cucumis sativus*)

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ABSTRACT

Stingless bee is one of the important pollinators in open field crops as well as in the greenhouse crops. However, the potential use of stingless bees as pollinator for greenhouse cucumber is less documented in Malaysia. In this study, the stingless bees, *Heterotrigona itama* were placed together with the greenhouse cucumbers, *Cucumis sativus* in order to investigate the effects of *H. itama* pollination on greenhouse cucumber. This experiment involved three pollination treatments; namely pollination without stingless bee, hand-cross pollination and pollination by stingless bee, *H. itama*. Two hives of stingless bees were introduced into the greenhouse at least two days before the cucumber flowers started to bloom. Results showed that the cucumbers pollinated by stingless bee and hand-cross pollination produced heavier, longer and larger cucumbers compared to those produced from pollination without stingless bees. However, in terms of dried weight seed, firmness and colour of cucumbers, no significant difference between the treatments were detected. Further study is required in order to determine the pollination efficiency of stingless bees in greenhouse crops.

Key words: Stingless bees, *Heterotrigona itama*, pollination, greenhouse, cucumber

INTRODUCTION

Pollination is the process of transferring the pollen grain from anther of male flower to the stigma of female flower to enable fertilization to take place (Abrol, 2013). There are two types of pollination; namely self-pollination and cross-pollination which can occur in the same plant or different plant of the same species. Pollination may be aided by the presence of the pollinators such as water, wind, human and animals (Tepedino, 1981).

According to Abrol (2013), there are about 25,000 to 30,000 bee species worldwide, which are considered as obligate flower visitor and are the efficient pollinators to the cultivated crops and wild nature. One of the efficient pollinators is the stingless bees. The stingless bees can forage effectively in glasshouses (Heard, 1999). Most of the species of bees such as honeybees and stingless bees can be managed for crop pollination.

Several studies found that pollination by stingless bees can affect the fruits produced, especially for major cultivated crops. For example, cucumber pollination by the stingless bees helped in increasing fruit quantity and improving quality of the fruit produced (Santos *et al.*, 2008). However, most of the studies on the effects of the stingless bee pollination on crops were conducted outside Malaysia. For instance, a study done by Klatt *et al.* (2013) conducted at Gottingen, Germany showed that bee-pollinated strawberries produced were heavier, had less malformed fruits and reached higher commercial grades. Another study done by Koffi *et al.* (2013) showed that *Citrullus lanatus* produced more fruits and seeds from cross pollination with multiple sources compared to natural pollination and self-pollination. This showed that bee species can be an effective pollinator for specific crops which can be beneficial for improving fruit quantity and quality.

In Malaysia, cucumbers are usually grown outdoors. However, due to better control of plant growth and environmental conditions, cucumbers are grown in the greenhouse where bees are excluded. To overcome the problems, most farmers use many workers to help in manual cross-pollination of the

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POLLINATION EFFICIENCY OF THE STINGLESS BEE, *Heterotrigona itama* (HYMENOPTERA: APIDAE) ON CHILI (*Capsicum annuum*) IN GREENHOUSE

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ABSTRACT

Chili (*Capsicum annuum*) is one of the important cultivated crops in Malaysia and is a source of income for thousands of Malaysian farmers. Even though chili flowers are self-pollinated, the anthers need to be shaken to allow effective pollen release. Many researchers found that pollination by stingless bees can increase fruit size and weight, pericarp volume, high percentage of seed per fruits and fastens harvesting time. This study aimed to investigate and determine the quality of chili produced by three different pollination treatments; (1) self-pollination, (2) hand-cross pollination and (3) stingless bees (*Heterotrigona itama*) pollination. Results showed that chilies produced from pollination by the stingless bees, *H. itama* and hand-cross pollination were significantly heavier, longer and containing greater number of seeds per fruit than self-pollinated chilies. Overall results showed that the effects of stingless bee pollination on chili production was similar to the chilies produced from hand-cross pollination. Thus, it can be concluded that besides manual pollination, *H. itama* can be considered as an effective pollinator for the chilies grown in greenhouse. This study provides important information on the potential use of *H. itama* as an alternative pollinator for crop pollination purpose.

Keywords: Stingless bees, *Heterotrigona itama*, *Capsicum annuum*, pollination, greenhouse

INTRODUCTION

Chili (*Capsicum annuum*) is one of the most widely grown vegetable crops in the world, and is commonly cultivated and consumed in Malaysia. Departments of Statistics Malaysia (2011) recorded that chili production in Malaysia was consistent from 2005 to 2009 with average production of 33.1 thousand tons. The imports of chili recorded fluctuating trends where 2005 was the highest chili imported with 39.1 thousand tons, and the lowest was in 2008 with 22.1 thousand tons (Departments of Statistics Malaysia 2011). Compared to imported chili, only small quantities of chilies were exported and they range about 4.9 to 5.8 thousand tons (Departments of Statistics Malaysia 2011). This shows that chili production in Malaysia still cannot meet the high demand by local consumer.

The major obstacle in achieving high chili production is the susceptibility of chili plants to diseases, pests and viral attacks (Touhidur et al. 2006). In Malaysia, available control measures developed for the control of viruses are the use of reflective plastic mulch, intercropping chili with maize and spraying insecticide against vectors (Touhidur et al. 2006). Currently, greenhouse cultivation is widely practiced by the local farmers to meet the urban demands on chilies. In addition, greenhouse cultivation also protects from direct sunlight, bad weather and pest attack. However, the major problem of cultivation in greenhouse is poor pollination due to the protected structure of the greenhouse which may result in low production and low quality of yield (Yong and Shafqat 2003). Thus, pollination agents are of absolute importance for a high quality fruit sets and seeds formation. Insufficient pollination causes low pollen supply which also affects the progeny vigor by reducing the selectivity among the gametes before and during fertilization (Bertin 1990).

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MELISSOPALYNOLOGY AND FORAGING ACTIVITY OF STINGLESS BEES, *LEPIDOTRIGONA TERMINATA* (HYMENOPTERA: APIDAE) FROM AN APIARY IN BESUT, TERENGGANU

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Abstract: Melissopalynology or study of pollen is crucial in understanding the crops and plants that are foraged by bees as their food source because bees have species-specific preferences of pollens. Pollen analysis is also important to the sustainable development of apiculture industry especially for the premium marketable honey and honey products. The aims of this study were to identify the pollens collected by stingless bees, *Lepidotrigona terminata* (Hymenoptera: Apidae) in an apiary of Besut, Terengganu from November 2012 until February 2013 and to investigate the effective time of foraging activity by the stingless bees. A total of 11 types of pollens were collected from the *L. terminata* foragers, however only 9 types of the pollens were successfully identified. The identified pollens were *Murraya paniculata*, *Citrus hystrix*, *Calophyllum inophyllum*, *Ixora coccinea*, *Bougainvillea glabra* (Type 1 and 2), *Mimosa pudica*, *Azytacta gangetica* and *Suregada multiflora*. *Ixora coccinea* was the most dominant pollen collected by *L. terminata*. Morning (0800-1100) and late afternoon (1400-1800) were found to be the most effective times for foraging activity of *L. terminata*. Our findings provide information on the favored bee plant species which is clearly an important pre-requisite for launching apiary industry in any locality. It is hoped that this study will enhance the knowledge of beekeepers on crop preferences for stingless bee cultures.

Keywords: Pollen, stingless bee, *Lepidotrigona terminata*, foraging, apiary.

Introduction

Melissopalynology or study of pollen is well established and has been used to determine floral sources, geographical origin and genus of the plants that the bees visited (Ponnuchamy *et al.*, 2014). Previous studies suggested that numerous pollen types commonly found on honey combs and bee hives affords the possibility of identifying the botanical and geographical origin of the honeys as well as the biochemistry and quality determination of honeys (Herrero *et al.*, 2002; Montenegro *et al.*, 2010). Therefore, pollen analysis is important to the apiculture industry in developing the premium marketable honey and honey products.

Malaysia hosts a great number and diverse of honey bees and stingless bees species that forage on various plants and vegetation zones including grasses, herbs, forest trees and cultivated plants. However, information on the pollens collected by bees in Malaysia is poorly understood. Microscopic analysis of the pollen contents of seasonal honeys and pollen loads supplemented with phenology and floral biological study will provide reliable information regarding to the floral types which serve as major or minor nectar and /or pollen sources for the bees.

Malaysia is home to diverse species of stingless bees which consists of ~33 species (Mohd Norowi *et al.*, 2008). Stingless bees are known to be important pollinator in tropical rainforest (Eltz *et al.*, 2003) and also good candidates for providing pollination services in agricultural ecosystem such as starfruits, mango, durian, watermelon, guava and coconut (Slaa *et al.*, 2006). The value of insect pollination service of these crops was estimated more than USD 19 million. However to date, very little attention has been made to study the melissopalynology and foraging activity of the stingless bees, specifically in Malaysia region.

Beekeeping endeavor in Terengganu has been taken up on a modest commercial scale by beekeepers in some districts. Besut district has great potential of beekeeping; however, reliable information on the bee plants in this district is

Conclusion

- Our study revealed that pollination by stingless bees can increase fruit size and weight, seed number, pericarp volume, high percentage of fruitsets and fastens harvesting time.
- This study provides important information on the potential use of *H. itama*as an alternative pollinator for crop pollination purpose based on scientific findings.
- Outcome from this study is hoped will be used to develop application strategies suitable for future use in crop pollination success.
- It is hoped that this study will enhance the awareness of the importance of stingless bee as an alternative pollinator in agricultural ecosystem in Malaysia.

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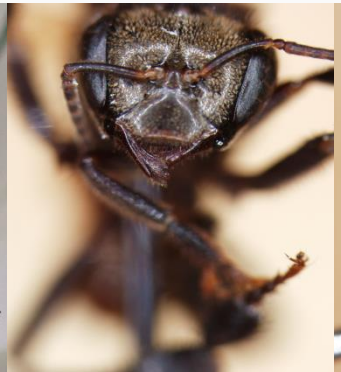
**Do not over-hunting of wild stingless bees...*
** Protect wild habitat and host plants of stingless bees..*



Thank you....

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