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EFFICACY OF STINGLESS BEE *LEPIDOTRIGONA TERMINATA* AS INSECT POLLINATOR OF F_1 HYBRID CUCUMBER

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ABSTRACT: This research aimed to study the efficacy of stingless bee *Lepidotrigona terminata* as insect pollinator of F_1 Hybrid cucumber. The experiments were conducted at experimental farm of the Faculty of Agricultural Technology, Rajamangala University of Technology, Thanyaburi. The experiment was divided into two parts. The first part, efficacy study of stingless bee as insect pollinator of F_1 hybrid cucumber was studied. Experimental design used was Randomized Block Design with four treatments and three replications which were opened – pollination, handed – pollination, stingless bee – pollination, and closed – pollination. The results revealed that cucumber fruit sets were found only in opened – pollination and handed – pollination treatments, with 9.33 and 12.66 fruits, respectively. While no fruit set was found in another two treatments which were closed and stingless bee – pollinations. Second, species diversity and numbers of insect pollinators that visited cucumber flowers during 6.00 a.m. – 18.00 p.m. were determined. As a result, four insect species had visited cucumber flower and the most abundant visitor was European bees (*Apis mellifera*) that had visited, both male and female cucumber flowers at 09.00 a.m.

Keywords: Stingless bee, Lepidotrigona terminata, Insect pollinator, F_1 hybrid cucumber

1. INTRODUCTION

Cucumber (*Cucumis sativus* L.) is a plant in the order of Cucurbitales belonging to the Cucurbitaceae family. It is in the group of dicotyledon with stem in the form of creeping vine consisting of yellow flowers. The fruits contain short thorns which will eventually fall off when the fruit reach maturity. Cucumbers have crisp texture, high water content, and can be cultivated all year round. Production is highest during February and March. Propagation is done by planting seeds and the duration from planting until harvest is approximately 40 - 60 days. Cucumbers can be consumed raw, fried, pickled, boiled, and steamed as a vegetable or juice. Cucumbers also have an aesthetic value where they are commonly used for plate decoration. Cucumber contains erepsin enzyme that aids digestion of protein. The medicinal properties of cucumbers are to aid urination, relief fever, thirst, and diarrhea; and reduce high blood pressure [1].

Pollination of cucumbers, a Monoecious plant characteristic of containing male flowers and female flowers on the same plant. Male flower starts to bloom and release pollen after 25 – 28 days maturation, 2 – 3 days before blossoming of female flower. Both male and female flowers bloom simultaneously in the morning for one day. The male and female flowers are ready for pollination during 8.00 – 10.00 a.m. [2]. This is the reason why cucumber flowers require carrier insects such as bees to carry pollen from one flower to another within the same tree or between trees. Therefore, cucumbers are categorized as cross-breed plants and have a 1 – 47 percent chance of successful self-pollination. Bees are efficient cucumber pollinators, because cucumber flowers are bright yellow which are attractive to bees. Cucumbers flowers contain as high as 36.3% nectar per 57.6 mg of pollen grains with protein composition of 25% [3]. One honeybee colony is equivalent to the utilization of 300 work force to pollinate cucumber flowers [4]. However, beekeeping should be managed appropriately and for many cucumber growers, beekeeping is a complicated task [5]. On the other hand, beekeeping of stingless bees, pollinators of native plants, is relatively easier than honeybees.

Many researches had been conducted using stingless bees' efficacy to pollinate plants. From several studies on the diversity of insect species that can help pollinate durian flowers, Somnook [7] had found that stingless bees *Lepidotrigona terminata* had a rate of durian flower visits of 80 percent in comparison to all the insects that visited durian flowers. However, the experiment of Taweepol [8] had found that stingless bees had only collected nectar and pollen but were not involved in pollination. For the experiment of Samorkorn et.al. [9], the efficacy of the stingless bee *Trigona pegdeni* to pollinate cucumbers had been studied and was found that by using stingless bee to pollinate cucumber, the fruit set rate was lower than opened

pollination. It might be due to the fact that *Trigona pegdeni* stingless bees are smaller than *Lepidotrigina terminata* stingless bees. This study investigated the potential of *Lepidotrigina terminata* stingless bees as pollinators of F_1 hybrid cucumbers.

a. Male flower b. Female flower

Fig.1 Cucumber flower

2. MATERIALS AND METHODS

2.1. The Efficacy of Stingless Bee as Insect Pollinator of F_1 Hybrid Cucumber

The experiment was conducted at the Faculty of Agricultural Technology, Rajamangala University of Technology. The F_1 hybrid cucumbers were planted at the spacing of 50 x 50 cm per plant. The experiment was designed using Randomized Complete Block Design (RCBD) with three replicates and four treatments as follows: 1) opened - pollination (the cucumber flower ready for pollination were marked and released for natural pollination). 2) Handed - pollination (male and female flowers that were about to bloomed were marked and covered with bags, when the female flowers bloom in the bag, the male flowers were brought to pollinate with the female flowers that bloom then covered with original bags). 3) Closed - pollination (female flowers were covered until they wither to prevent pollination by insects.) and 4) Stingless bee - pollination (a cage was built around the cucumber plants and stingless bees were introduced into the cage, one hive per cage, for one week and the cucumber flowers that were ready for pollination were marked).

2.1.1 Data collection and analysis

Fruit set rate was randomized and the characteristics of the fruits were observed through collection of 15 fruits per replicate and the maturation of the fruit was determined. The fruit weight, diameter, and uniformity were measured and were divided into three categories: 1) fully-developed fruit, 2) under-developed fruit, and 3) non-uniform fruit. The data was analyzed using analysis of variance, RCBD and the difference was compared with Least Significant Difference (LSD).

Fig. 2 stingless bee - pollination

Fig.3 Stingless bee Lepidotrigona terminate visited cucumber flower

2.2. Diversity of Insect Species That Visited F_1 Hybrid Cucumber Flowers in Five Days

The number of insects that visited male and female cucumber flowers was recorded, five flowers per sex for all three replicates, between 06:00 a.m. – 17:00 p.m. for 10 minutes within five days.

3. RESULTS AND DISCUSSION

3.1. The Efficacy of Stingless Bee as Insect Pollinator of F_1 Hybrid Cucumber

Table 1 and 2 present the results of the four treatments (open, closed, manual, and stingless bee - pollinations) that were conducted in the first part of the study. The results were evaluated using the RCBD experimental design, comparing the efficacy of the stingless bee - pollination to other treatments. It was found that the fruit set of the F_1 hybrid cucumbers in opened and handed - pollination are significantly different with the mean fruit set values of 9.33 and 12.66 fruits, respectively. The two treatments are significantly different to the stingless bee- and closed - pollination treatments in which both treatments did not exhibit fruit set.

The size of the fruits in opened - pollination were 7.21 cm in length and 3.38 cm in diameter on

average. In handed - pollination, the average length and diameter were 6.09 cm and 2.72 cm respectively.

The results showed that the average weight of the cucumber fruits in opened – pollination treatment was 50.73 g. and the average weight for handed – pollination was 34.09 g. The results from the opened and handed – pollinations had shown statistically significant differences that includes the quality of fully-developed fruits from both treatments. Under-developed fruits from opened - and handed – pollinations were also significantly different; however, there was no significant difference in non-uniform fruits.

Table 1 Fruit set, size, diameter, and weight of the F_1 hybrid cucumbers of the different pollination treatments.

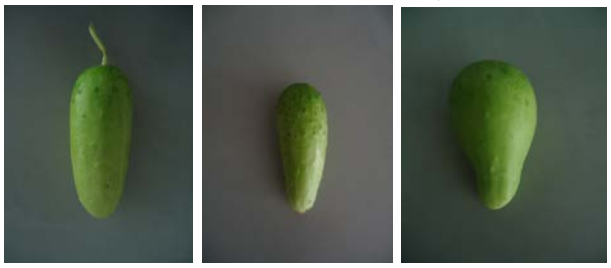
Treatment	Fruit set (fruit)	Length (cm)	Diameter (cm)	Weight (g)
Opened - pollination	9.33 [a]	7.21 [a]	3.38 [a]	50.73 [a]
Handed - pollination	12.66 [b]	6.09 [b]	2.72 [b]	12.66 [b]
Stingless bee - pollination	0 [c]	0 [c]	0 [c]	0 [c]
Closed - pollination	0 [c]	0 [c]	0 [c]	0 [c]
LSD 0.01	**	**	**	**
C.V. (%)	4.43	2.74	2.54	8.25

[a,b,c] Different superscript letters in the same column indicate significant difference ($P < 0.01$)

Table 2 Quality of F_1 hybrid cucumbers from the different pollination treatments

Treatment	Fully-developed fruit (fruit)	Under-developed fruit (fruit)	Non-uniform fruit (fruit)
Opened - pollination	9 [a]	2.33 [a]	3.67 [a]
Handed - pollination	6.33 [b]	5.33 [b]	3.33 [a]
Stingless bee - pollination	0 [c]	0 [c]	0 [b]
Closed - pollination	0 [c]	0 [c]	0 [b]
LSD 0.01	**	*	**
C.V. (%)	7.15	6.57	8.12

[a,b,c] Different superscript letters in the same column indicate significant difference ($P < 0.01$)



a. Fully-development. b. Under-development. c. Non-munifor

Fig. 4 Cucumber fruits

3.2. Species Diversity and Numbers of Insect Pollinators That Visited F_1 Hybrid Cucumber Flowers

Diversity of insects that visited F_1 hybrid cucumber flowers, both male and female flowers, of the five flowers per sex in three replicates over a period of five days were observed. The study period was from 06:00 a.m. - 18:00 p.m. for the duration of 10 min hourly. It was found that insect pollinators had visited both sexes and there were five species present as follows: European bees, dwarf honeybees, stingless bees, beetles, and butterflies at 06.00 a.m. European bees were most common from 07:00 a.m. to 10:00 a.m. and was found most abundant at 09.00 a.m. in both male and female flowers. Stingless bees were found mostly from 10:00 a.m. to 13:00 p.m., and were most abundant in female flowers between 11.00 a.m. and 12.00 p.m. and in male flowers at 11.00 a.m. Other insect pollinators were minimal throughout the day (Figure 1 and 2) and no insect pollinators visited flowers during high-cloud periods.

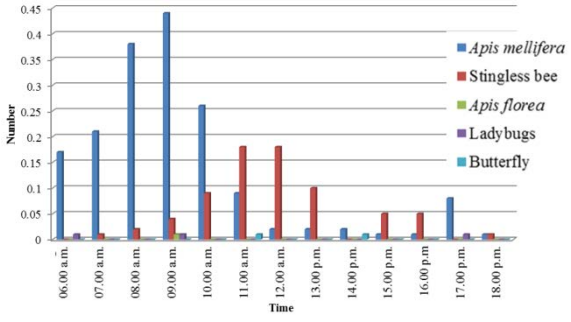


Fig. 5 The average number of insect pollinators that visited female cucumber flowers conducted in five-day period between 06:00 a.m. - 18:00 p.m.

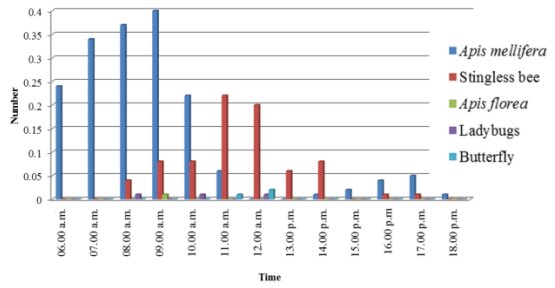


Fig. 6 The average number of insect pollinators that visited male cucumber flowers during a five-day period between 06:00 a.m. to 18:00 p.m.

4. DISCUSSION

Efficacy test of stingless bee as F_1 hybrid cucumber pollinator were evaluated using two experiments.

In the study of stingless bees as pollinator, the results showed that fruiting only occurred in opened and handed – pollination treatments which exhibited high significant difference with the stingless bee - and closed –pollination treatments. This shows that stingless bees have lower potential as pollinators for F_1 hybrid cucumber than European bees. This result is consistent with the observation by Taweepol [8] that in durian, stingless bees were limited to nectar and male pollen collection from durian flowers but did not assist in pollination. European bees are better pollinators than stingless bees [10] because European bees are larger than stingless bees and can collect large quantities of nectar at a time resulting in higher visitation and transfer of male pollen to female pollen rates. One European bee can have visitation rate as high as nearly 11,000 times; however, introduction of bee colony to cucumber flowers should occur when the flowers are approximately 5% in bloom. During which, bees are at higher risk of foraging at alternative source if the right conditions are not met. Efficacy of such bee is correlated to the increased production of uniform cucumber fruits, including gynoecious cucumbers [11]

On the contrary, stingless bees which are smaller in size exhibited lower transfer rate of pollen from male flower to the female flower resulting in no fruit set.

The efficiency of the stingless bee pollination is dependent on the type and characteristic of the flower. According to the study by Namwong [12], it was found that high fruit yield of dragon fruit was obtained with stingless bees than opened- and handed- pollination. Additionally, Kutani et al [13] compared the performance of stingless bee *Trigona minangkabae* with *Apis mellifera* to pollinate strawberries in greenhouse and the results showed that both bee types have similar efficiency. On the contrary, Roselino et al [14] reported that when comparing two stingless bee species, *Nannotrigona testaceicornis* and *Scaptotrigona depillis*, as strawberry pollinators, it was found that *N. testaceicornis* was a superior pollinator to *S. depillis*. This might be due to the foraging habit of the bees for pollen and nectar in which *N. testaceicornis* take longer to forage than the *S. depilli*. Moreover, stingless bees are efficient pollinators for egg plant [15], tomatoes [16. , 17], sweet peper [18] grown in the greenhouse, and macadamia flower grown in field conditions [19]. It can be observed that floral characteristics, small-sized blossom and perfect flowers, influence performance of stingless bee as pollinators. Therefore, for the use of stingless bee species as pollinators it should be taken into account the characteristic and size of the flowers, the size of the stingless bees, and foraging habit to obtain nectar and pollen.

The study of species diversity of insect pollinators had shown that insects that visited both male and female flowers were predominantly European bees which visited around 06.00 a.m. onwards, and was found most abundant at 09:00 – 10.00 a.m. Stingless bees were found most abundant from 11:00 a.m. - 12:00 p.m. which is outside the optimum timeframe for cucumber pollination.

5. CONCLUSION

Efficacy of stingless bees *Lepidotrigona terminata* as pollinators of F_1 hybrid cucumber is divided into two parts.

1. Efficacy of the stingless bees as pollinators in comparison between opened – pollination and handed – pollination showed that fruit set occurred only in opened and handed – pollination treatments resulting in 9.33 and 12.66 fruits, respectively.

2. The study of diversity of insect species and number that visited cucumber flowers showed that European bees visited most frequently between 06:00 a.m. - 10:00 a.m. and was found most abundant at 09.00 a.m. in both male and female flowers. Stingless bees visited female flowers most during 11.00 a.m. - 12.00 p.m. and visited male flowers most at 11.00 a.m. All other insects were found in minimal quantity throughout the day.

6. ACKNOWLEDGEMENTS

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