POLLINATION EFFICIENCY OF PERSEA AMERICANACV. HASS BYEUROPEAN HONEY BEEAND ASIATIC HONEY BEEIN CHIANG MAI PROVINCE

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Abstract - Insect pollinating species, especially bees as well as other flower-visiting Hymenoptera (Aculeata), are believed to be among the most ecologically and economically valuable insects. However, recent evidence for declines in both wild bee populations and severe annual honeybee colony losses on a global scale have caused for much concern. Numerous different insect species are responsible for the pollination of avocados (Persea americana) whereby the honeybee plays a major role as a pollinator. The aim of this study was to investigate the pollination efficiency of the Asiatic honey bee (Apis cerana F.) and the European honey bee(Apis mellifera L.) for avocados. Here we applied a completely randomized design (CRD) for three treatmentsas follows: 1) Cage with Asiatic honey bee, 2) Cage with European honey bee and 3) Control uncaged with domestic pollinators. To assess the pollination efficiency we recorded the honeybee flight behavior, the total number of fruits set, the quality of avocados. Our results indicated that there was a significant difference ($P<0.05$) among the Asiatic honeybees and the other treatment groups, with A. ceranashowing the highest rate of flight. The number of avocado fruits fertilized by A. cerana and A. mellifera was not significant difference.Trends of fertilization by pollination showed greater fruit number than by less pollinators in the open condition ($P<0.05$). The quality of avocados was significantly higher in the honeybee treatments when compared to the domestic pollinators($P<0.05$).Our results showed that Hass avocado in Mae Wang district, Chiang Mai, Thailand required adequate number of honey bee for pollination to get higher number of fruit set due to the limitation of domestic pollinators.

Keywords - Avocado, Apis cerana, Apis mellifera, pollinators, fruit set

I. INTRODUCTION

Honeybees are hymenopterans, a group that generally feed on nectar and pollen and constitute about 20,000 species throughout the world.European honey bees (Apis mellifera)and Asiatic honey bee (Apis cerana) are important ecological role as pollinators for native plants and imported plants. They are produce healthy honey that have many benefit such as antioxidants which help reduce the risk of some cancers and heart disease[1]-[6].Honey help disorders such as ulcers and bacterial gastroenteritis. In the other way honey use to be material of cosmetically. Apart from that honey bees also pollinating, many plants were visited by honey bees they have increase product [7]-[9]. The quality and quantity of plant production are going in positive way, some of fruit have bigger yield, heaviness or fruitful. The availability of natural insect pollinators in Thailand is decreasing rapidly as a result of increased and continued use of pesticides. There is timely need for better management of hive honeybees such as A. cerana and A. mellifera in rare pollinator areas to increase fruit production. Information on the role of honey bees in pollination leads to increase in the quality and yield of crops that has been reported worldwide [4] [5] [10].In the present beekeeping are interesting and encouraged because some plant they have some behavior that really unique which mean difficult to pollinating, for example “Avocado” the flowering of avocado. There are two forms of the flower bloom (A type andB type) and a blooming flower and pollination is unique. The male and female flowers that bloom at different times. Thus making the chances of pollination least in a limited timeperiod, so the pollinator are really important for pollinating [4] [5] [11] [10].

Avocado (Persea Americana)is a tree in the family Lauraceae native to south of Mexico and all of the types they have evolution of Central America in the tropical climate [12] [13] [14].Avocado also has grown for a long period of not less than 150 years introduced by an American missionary in Nan province Thailand [15]-[21].

The female and male flowers open at different time of the day. This unique behavior has two types of flower that are “A type” and “B type”. The A type female flowers open in the morning and close at noon.Male flowers will reopen again on the next day at noon, and close on that same afternoon. The B type female flowers open in the afternoon of the first day and male flowers open in the morning of the second day. Thus making the rates of pollination time is in limit only noon to afternoon for pollination, therefore the pollinators are really important factor about fertilization in avocado fruit [17] [22]-[26].The fruit-set of Avocado in naturally is a few because the number of flower rate about 1-2 million per tree, but just about 0.001% actually set fruits. For commercial pollination, A. mellifera have been the main of avocado pollinators [15] [27] [28].Research and studies from several sources showed that the

pollinators mainly are honey bees which are very important factor with avocado fertilizing [24] [26] [28] [29].So the objectives of this study are to compare the pollination efficiency between open pollination by caging with 2 species of pollinators with European honey bee or Asiatic honey bee.

II. MATHERIALS AND MEDTHODS

2.1 Avocado's Variety And Study Areas

Hass avocado plantation area of grains under supervision of Khunwang Royal Project Development Center, Mae Wang district, Chiang Mai, Thailand was selected for the experiment.The elevation is about 1,250 meters above mean sea level and temperature range from 1to 33 degree Celsius. This condition is suitable for Hass avocado variety. The caging was cage was 18×19×3 meters (342 square meters).

2.2 Planning And Preparation Of Study Areas

Three treatments were set up as follows: 1) Caged with Asiatic honey bee, 2) Caged with European honeybee and 3) Uncaged with domestic pollinators (A. cerana,A. andreniformis, A. florea and Tetragonula sp.)each treatment consisted of 9 trees as a replications. The experiment was done in January to October 2017. The experiment design was completely randomized design (CRD). Each cage, European honey bee or Asiatic honey bee. Hive was added in the cage.Avocado nectar and pollen and the size of the area inside a cage is enough for one hive of honey bee. Honey bees flying, number in or out of hive, number of honey bees carrying pollens for every 15 minutes of an hourwere collected to compare the efficiency of honey bee pollination. The examination time was 06:00 O'clock in the morning until 06:00 O'clock in the evening.Data record was conducted for 3 days. Honey bee still inside the cage for 1 month since January to February 2017. The avocado fruits were harvested in October. Fifteen avocado fruits were randomly selected and measured for fruit weight, the width and length of fruit, weight of seed and circumference of seeds. All parameters were analyzed using analysis of variance. Least significant difference (LSD) were calculated for each significant attribute.

III. RESULTS

3.1 The Honey Bee Flight Behavior

There was a significant difference ($P<0.05$) among the Asiatic honey bees and the other treatment groups, with A. ceranashowing the highest rate of flight (91.82 bees) in to the hive of. In comparison, no significant difference of flight in hive was observed between A. mellifera and the domestic pollinator species ($P>0.05$), with a mean number of pollen of 91.82 bees / hour, 43.03 bees / hourand 19.53 bees / hour,respectively. For the case of flight out to the hive, there was a significant difference ($P<0.05$) among the Asiatic honey bees and the other treatment groups, with A. cerana showing the highest rate of flight (91.05 bees / hour) followed by A. mellifera (41.62 bees / hour) and uncaged control (5.97 bees / hour), respectively. The number of honey bees carrying pollens in all three treatment groups did not significantly differ ($P>0.05$), with 3, 0.79, and 0 bees / hour of Asiatic honey bee,European honey bee and domestic pollinators (Table 1).

Table 1: Number of flight of honey bee in difference circumstance during flowering stage of Hass avocado in January 2017.

Pollinators	Flight in hive (bees / hour)	Flight out of hive (bees / hour)	Flight of pollen carried honey bee (bee / hour)
A. cerana	91.82 a	91.05 a	3.00 ^{ns}
A. mellifera	43.03 b	41.62 b	0.79
Domestic pollinators	19.54 b	5.97 c	0.00

***Meansfollow by: The same letter with in a column were not significantly difference.**
^{ns}: not significantly ($P<0.05$, n=3)

3.2 The Number Of Hass Avocado Fruits Fertilized By Pollinators

Due to the number of fruits was not from a normally distributed population so the data were applied with log transformation prior for analysis of variance. Number of Hass avocado fruits was significant difference between the treatments with caged either A. cerana or A. mellifera and those with uncaged avocado trees without insect proof net ($P<0.01$). The number of avocado fruits fertilized by A. cerana and A. mellifera was not significant difference. Trends of fertilization by pollination showed greater fruit number than by less pollinators in the open condition (Table 2.). In addition the minimum (min.) number of fruit production in open condition with domestic pollinators was 28 friuts while the min. numbers of fruits fertilized in caged with either A. cerana (128 fruits) and A. mellifera (119 fruits) were higher.

Table 2: Number of avocado fruits per tree after caging and releasing a colony of honey bee compared to open condition which only domestic pollinators were available. Avocado trees in cages were allowed to expose to honey bees for 1 month during flowering stage.

Treatment	Number of fruits/tree		
	Mean ±SD[1]/	Minimum	Maximum
Caged with A. cerana	178.89 ± 43.05a	128	243
Caged with A.mellifer	164.22 ± 42.05a	119	228

a			
Domestic pollinators	123.89 ± 82.85b	28	287

*** 1/ Means followed by the same letter in the column were not significantly different at 95% confidence level by Least Significance Difference (LSD).**

3.3 Pollination Efficiency By Honey Bees And Domestic Pollinators Of The Quality Of Avocado

The quality of avocados measured as weight was significantly higher in the honeybee treatments than in the domestic pollinators (P<0.05), with average weight 138.74, 141.74 and 90.52 g / fruit in Asiatic honeybee, European honey bee and domestic pollinators (Table 3, Figure 1).

The width of the avocado fruit was significantly wider in the honeybee treatments than in the domestic pollinator treatment (P<0.05), with average width 18.59, 20.07 and 16.09 cm / fruit in Asiatic honey bee, European honey bee and domestic pollinators(Table 3).

The length of the avocado fruit was significantly longer in the honey bee treatments than in the domestic pollinator treatment (P<0.05), with average width 23.41, 22.63 and 19.28 cm / fruit in Asiatic honey bee, European honey bee and domestic pollinators (Table 3).

The weight of seeds was significantly heavier in the honey bee treatments than in the domestic pollinators(P<0.05), with average weight of seeds 25.91, 20.47 and 11.58 g / fruit in Asiatic honey bee, European honey bee and domestic pollinators(Table 3).

The circumference of seeds produced was significantly longer in the honeybee treatments when compared to the domestic pollinators(P<0.05), with average of seed circumference11.62, 10.75 and 9.24 cm / fruit in Asiatic honeybee, European honey bee and domestic pollinators(Table 3)

Table 3: Hass avocado fruit quality pollinated by different pollinators during January – February 2017 harvested in October 2017

The quality of avocado fruits and seeds	Pollinators		
	A. cerana	A. mellifera	Domestic pollinators
measured as weight (g)	141.74 a	138.74 a	90.52 b
length of the avocado(cm)	23.41 a	22.63 a	19.28 b
width of the avocado (cm)	20.07 a	18.57 a	16.09 b
eight of seeds (g)	25.91 a	20.47 a	11.58 b
circumference of seeds produced (cm)	11.62 a	10.75 a	9.24 b

***Means follow by the same letter with in a row were not significantly difference. (P<0.05, n=3)**

CONCLUSIONS

The flight activity of A. cerana was higher than A. mellifera in the areas of avocado plantation areas. Honey bee activity could enhance close pollination of avocado by collecting the pollen from male flower to female flower in our cage arena with the same tree/ or same cultivar [30] [31] had results from experiment done with Hass avocado with honey bee also showed better fruit set than without honey bee [26]. Efficiency of both honey bee in this experiment also showed significantly higher number of fruit set compared to domestic pollinators which are very few of stingless bee, syrphid flies and others in low density. The minimal fruit set from this experiment was decreaed to 8 fruit per tree in open condition with domestic tree. By the observation in this experiment the A. cerana tend to fly in the early morning with peak of insect flight at 8-9 am while the A. mellifera has a peak of flight in the afternoon (2-3 pm). Moreover, A. cerana tried to open the close flowers in the early morning. In the characters of fruit, it appears that with honey bee pollination, avocado fruit size, weight and seed size are significantly higher than pollination with domestic pollination. In conclusion, Hass plantation in Mae Wang district, Chiang Mai, Thailand required adequate number of honey bee for pollination to get higher number of fruit set due to the limitation of domestic pollinators.

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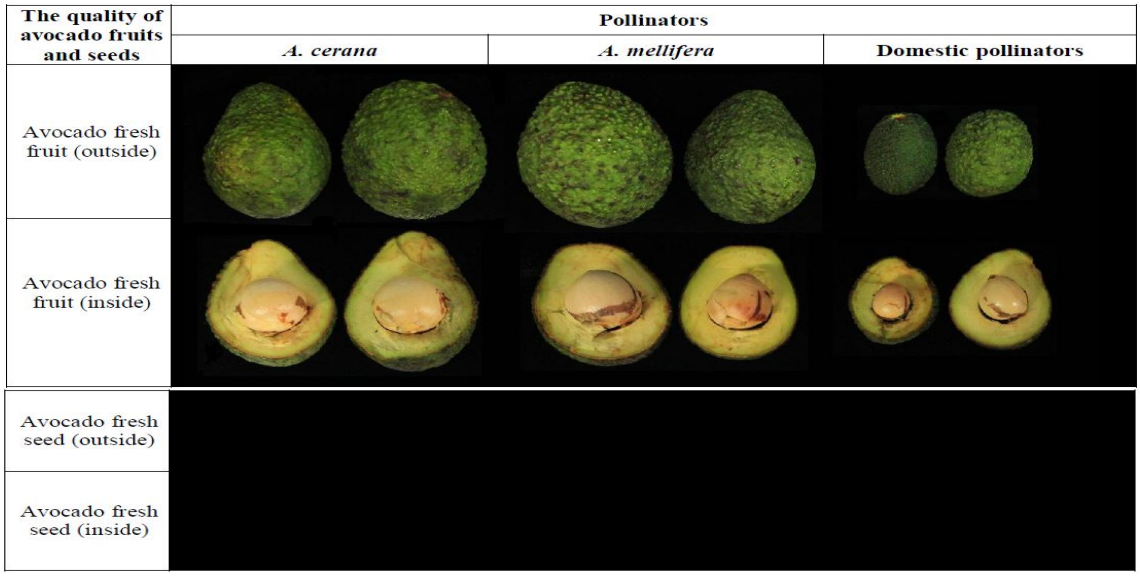

Figure 1.The characters of avocados that were pollinated by honey bees and domestic pollinators

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