

BIBLIOGRAPHY

KIMBUNGAN, LEO E. APRIL 2012. Pollination on Strawberry by using Stingless Bees *Trigona biroi* Friese, Benguet State University, La Trinidad, Benguet

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ABSTRACT

The study was conducted to determine the number of flowers that set fruit after they are foraged upon by the stingless bees, to determine the number and weight of fruits with normal and deformed fruits, to record the time of the day that the stingless bees will forage and to identify the other flower visitors of strawberries.

All of the strawberry fruits that were excluded from *Trigona* and other insect visitors were deformed and the number of fruit set after the flowering of the strawberries was 49 out of 50 giving a 98% percentage of pollination while those exposed to pollinators were all normal fruits and the number of fruit set was 50 out of 50 giving 100% percentage of pollination with an average weight of 5.096 g per fruit and 11.451 g per fruit respectively.

The stingless bees foraged as early as 7:00 am until late in the afternoon at 5:00 pm with two peaks foraging time between 7:00 and 10:00 am and 1:00 and 2:00 pm. Other insects seen that visited the strawberry flowers aside from the stingless bees belong to the orders Hymenoptera, Diptera, Lepidoptera and Coleoptera.

Stingless bee (*Trigona biroi*) can be integrated in strawberry production to enhance the production of true to type fruits.



RESULTS AND DISCUSSION

Number of Fruits Set

The number of fruit sets after the flowers were exposed to or excluded from *Trigona* is shown in Table 1. The number of fruit set in the plants that were exposed to *Trigona* was 49 out of the 50 sample flowers. In addition the fruits continued to reach maturity. In T₂, the fruit that set was 50. The computed percentage of fruits set for T₁ is 98% while in T₂ the fruit set is 100%. Based on data, there is not much difference on the percentage of fruit set between T₁ and T₂. This conforms to the study of Free in 1993 where he cited that strawberry plants are hermaphrodite or self-pollinating and may not need pollinators at all.

Shape of Fruits

The flowers that were exposed to *Trigona* (T₂) produced fruits that were true to type for the sweet Charlie variety the fruit has wedge and/or conical shape (Figures 7a and 7b). The fruits were also big and fully reddish. All the ovules were fully fertilized resulting in the normal development of the fruits.

Table 1. Number of fruit sets

TREATMENT	NUMBER OF FRUIT SET	NUMBER OF FRUITS THAT DID NOT SET	NUMBER OF SAMPLES	FRUIT SET (%)
T ₁ (flowers excluded from <i>Trigona</i> pollinators)	49	1	50	98
T ₂ (flowers exposed to <i>Trigona</i> pollinators)	50	0	50	100

It was now however evident in T₁ because all or 100% of the strawberry fruits that set after flowering in the treatment where the *Trigona* were excluded were deformed. Majority



were small and irregularly shaped (Figure 7c) as compared to the fruits that set in T₂. The result shows that even though strawberry is self-pollinated it needs pollinators so that all the ovules will be fertilized. It can be noted that there are fewer seeds that were produced in the fruits that had normal shaped indicating a failure of pollination. The fruit maturity also differed with in a fruit Figure 7c.

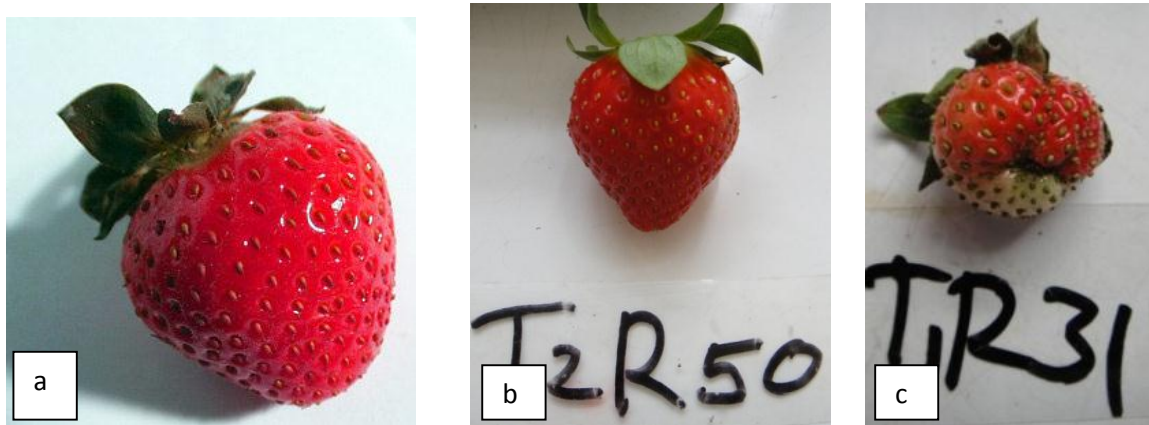


Figure 7. Sample of true to type Sweet Charlie Strawberry fruits a) cone shaped b) wedge shaped c) deformed fruits

Weight of Fruits

It was observed that the flowers that were excluded from pollinators had fruits that were lighter than those that were exposed to *Trigona*. The minimum weight of fruit in T₁ is 0.74 g and the maximum is 15.94 g per fruit those in T₂ had a minimum weight of 5.08 g and a maximum is 18.29 g per fruit. On the average, the fruits in T₁ had an average weight of 5.10 g, while in T₂ the average weight is 11.45 g. Result of the t-test on the average weight of strawberry fruits between the two treatments, T₁ and T₂, yielded significant differences at the 0.05 level of significance ($p\text{-value}=0.000<0.05$). This suggests that flowers that were pollinated by stingless bees bear fruits that have superior weight than those that were not pollinated by stingless bees. The reason for this is that most of the fruits

in T₁, those that were not pollinated by stingless bees, had deformed fruits as compared to T₂, where fruits were normal in shape.

The study shows that the average weight of the Sweet Charlie strawberry is lower than that was gathered in the study that was reported by Free (1993) which is 17g per fruit. Probably the difference maybe attributed to difference in crop management and climatic condition in both study areas.

Other Floral Visitors of the Strawberry Flowers

There were several insects that were seen visiting the strawberry flowers aside from the stingless bees. They were insects belonging to the orders Hymenoptera, Diptera, Lepidoptera and Coleoptera (Table 3). Of the order Hymenoptera, other honey bees such as (*Apis mellifera*) and *Apis cerana* were observed. It was also seen that the housefly (*Musca domestica*), hoverfly (*Simosyrphus grandicornis*), blowfly (*Chrysomya megacephala*) and dung fly (*Sepsis fulgens*) from the order Diptera were found foraging on the strawberry flowers. The cabbage butterfly (*Pieris raphae*) and a moth (*Thorybes diversus*) from the order Lepidoptera and the beetle (*Heliotaurus ruficollis*) from the order Coleoptera were also seen foraging among the strawberry flowers. The different insect pollinators were captured in picture while they were foraging as seen in Figure 8. These results suggest that there are many locally available insect pollinators of strawberry flower.



Table 2. Number and Average Weight of Normal and Deformed Fruits

TREATMENT	NUMBER OF FRUITS SET	MINIMUM WEIGHT (g)	MAXIMUM WEIGHT (g)	AVERAGE WEIGHT(g)*
T ₁ (covered)	49	0.74	15.94	5.10a
T ₂ (uncovered)	50	5.08	18.29	11.45b

*t=-9.980, p-value=0.000, Reject Ho:μ₁=μ₂

Table 3. Other floral visitors of strawberry (December, 2011; La Trinidad, Benguet)

COMMON NAME	SCIENTIFIC NAME	FAMILY	ORDER
European bee	<i>Apis mellifera</i>	Apidae	Hymenoptera
Wild honey bee	<i>Apis cerana</i>	Apidae	Hymenoptera
Housefly	<i>Musca domestica</i>	Muscidae	Diptera
Hoverfly	<i>Simosyrphus grandicornis</i>	Syrphidae	Diptera
Blowfly	<i>Chrysomya megacephala</i>	Calliphoridae	Diptera
Dung fly	<i>Sepsis fulgens</i>	Sepsidae	Diptera
Cabbage butterfly	<i>Pieris raphae</i>	Pieridae	Lepidoptera
Moth	<i>Thorybes diversus</i>	Hespiidae	Lepidoptera
Beetle	<i>Heliotaurus ruficollis</i>	Tenebrionidae	Coleoptera



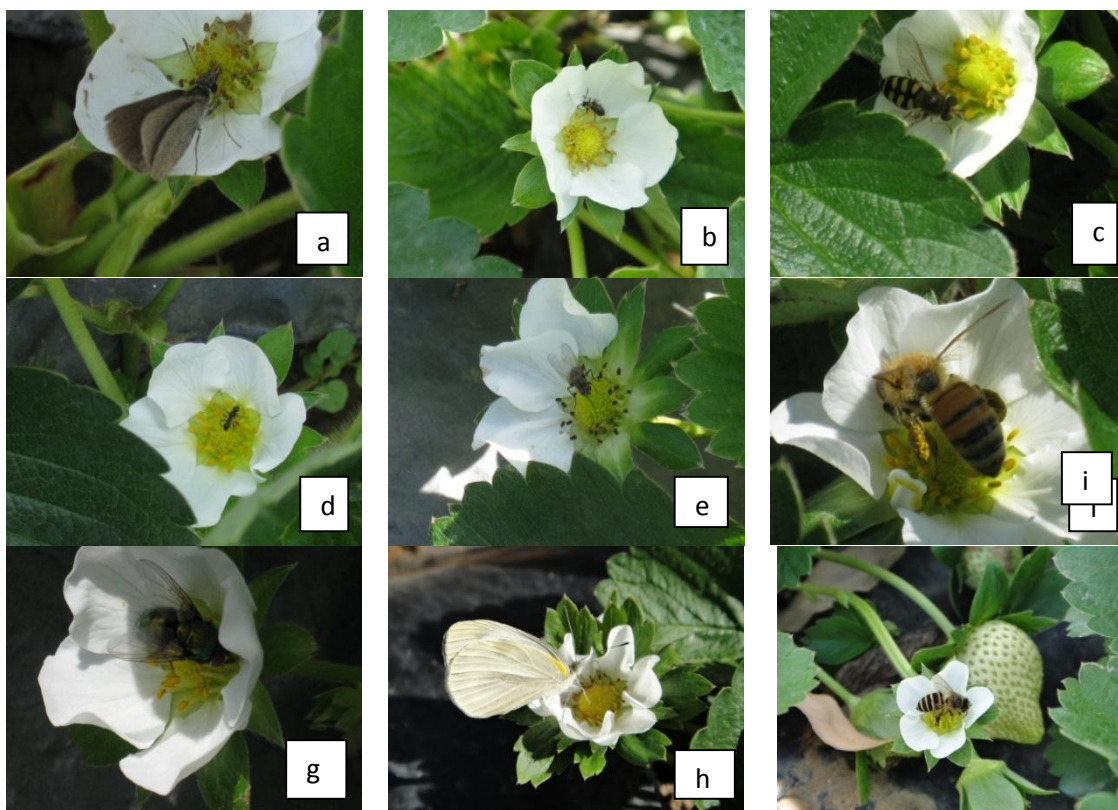


Figure 8. Other floral visitors of Strawberry: a) Lepidoptera (*Thorybes diversus*), b) Coleoptera (*Heliotaurus ruficollis*), c) Diptera (*Simosyrphus grandicornis*), d) Diptera (*Sepsis fulgens*), e) Diptera (*Musca domestica*), f) Hymenoptera (*Apis mellifera*), g) Diptera (*Chrysomya megacephala*), h) Lepidoptera (*Pieris raphae*), i) Hymenoptera (*Apis cerana*)

These insect visitors were seen to forage among the strawberry flowers between 10:00 am to 5:00 pm. Most of these insect visitors forage during the hottest part of the day between 12:00nn to 1:00 pm though some were seen as late as 5 pm.

Foraging Time of Stingless Bees

The strawberry flowers and the hive was observed for one week from Dec. 4 to 10, 6:00 am to 6:00pm, to note the foraging behavior of the stingless bees (Table 4). The foraging time of the stingless bees was observed to start as early as 7:00 am and lasted until 5:00 pm. On the average, the foraging of stingless bees starts from 7:30.57 am and lasts till

4:50.57 pm. The peak of their foraging in the morning was observed to be between 7:00 am to 10:00 am and in the afternoon it is 1:00 pm to 2:00 pm. However, it was noted that when the weather went cold, the stingless bees were somewhat “lazy” to forage as was also noted in the study of Kimbungan (2011).

Table 4. Foraging time of *Trigona biroi* (La Trinidad, Benguet)

DAY	DATE	EARLIEST FORAGING TIME	LATEST FORAGING TIME
1	December 4, 2011	7:48 am	4:56 pm
2	December 5, 2011	7:30 am	5:00 pm
3	December 6, 2011	7:05 am	4:55 pm
4	December 7, 2011	7:21 am	4:33 pm
5	December 8, 2011	7:59 am	4:48 pm
6	December 9, 2011	7:51 am	4:42 pm
7	December 10, 2011	7:00 am	5:00 pm



SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The study was conducted at the Balili, La Trinidad, Benguet on the lot operated by Mr. Victor Atonen Jr. from December 2011 to January 2012 to observe and document the stingless bee in pollination of strawberries.

The number of fruit set after the flowering of the strawberries is 49 out of 50 for treatment 1 and 50 out of 50 for treatment 2 giving a 98% percentage of pollination for treatment 1 and 100% for treatment 2.

All of the strawberry fruits that were excluded from *Trigona* and other insect visitors were deformed while those exposed to pollinators were all normally-shaped fruits with an average weight of 5.096 g per fruit and 11.451 g per fruit respectively

Other insects seen visiting the strawberry flower aside from the stingless bees belong to the orders Hymenoptera, Diptera, Lepidoptera and Coleoptera. The stingless bees forage were as early as 7:00 am until late in the afternoon at 5:00 pm with two peak foraging time between 7:00 and 10:00 am and 1:00 and 2:00 pm.

Conclusion

Stingless bee (*Trigona biroi*) can be integrated in strawberry production to enhance the production of fruits with true to type fruits in true of shape and weight.

Recommendation

A study should be conducted in a commercial area using stingless bee to evaluate the yield and production of strawberries.



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