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Daily Flight Activity of *Trigona laeviceps* AND *T. minangkabau* in Red Pepper (*Capsicum annuum* L.) Plantations in Low and High Lands of West Sumatra

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Abstract

Red pepper is vegetable commodity which is primary plant in West Sumatra. It can be found every where from low to high lands. Stingless bees are species of insect that visit red pepper plantations. Objective of research was to study daily flight activity of two species of stingless bees, *T. laeviceps* and *T. minangkabau* in red pepper plantations in low and high lands. Stingless bees were captured from red pepper plantations using scan sampling method from 07.00 a.m until 04.00 p.m. Each observation was done for 15 minutes per hour per day per location. *Trigona laeviceps* and *T. minangkabau* were dominant species found, each with 492 individuals (58.16%) and 354 individuals (41.84%). *T. laeviceps* was found in ten locations of red pepper plantations, eight were in high lands. *T. minangkabau* was found in seven locations, four were in high lands. Daily visit of *T. laeviceps* and *T. minangkabau* in red pepper plantations was from 08.00 a.m until 03.00 a.m. The peak of visits of both occurred at 11.00 p.m. *T. laeviceps* was captured in altitudes 50 – 910 m asl. at temperature 22-35.5 ºC and relative humidity (RH) 32-78 %. Locations of *T. minangkabau* captured was at altitudes 30–900 m asl. at

temperature 20-35 ºC, and RH 37-78 %. Population of *T. laeviceps* in high lands was higher than in low lands. In other hand, population of *T. minangkabau* in high lands was the same as in low lands. The presence of *T. laeviceps* and *T. minangkabau* in red pepper plantations was from 08.00 a.m until 3.00 p.m. The peak daily activity of both for food foraging occurred at 11.00 a.m.

Keywords: Stingless bees, *Capsicum annuum*, low land, high land, west Sumatra

1. INTRODUCTION

Red pepper (*Capsicum annuum* L.) can be cultured either in low or high lands, in rice field land or dry land [1]. In West Sumatra red pepper is a vegetable crop having important advantages, and even in Minangkabau society it is considered as primary crop. Therefore red pepper plantations are distributed in many districts and town in West Sumatra which are the centres of red pepper productions.

Red pepper flowers are chasmogamy, pollination occurs at the time of flowers are opened. Thus, in red pepper there is possibility for cross pollination to occur [2]. This is the reason why the production of red pepper per plant is higher when planted in group than individually. The increase of yield due to cross pollination was 7.6-36.8% [3].

Stingless bees are insects visiting red pepper plantations in West Sumatra. The species were dominated by *Trigona laeviceps* (55.85 %) and *T. minangkabau* (40.18 %) [4]. Both species could be found in low and high lands red pepper plantations.

The presence of *T. laeviceps* and *T. minangkabau* as pollinating insects in red pepper plantations could increase fruit set 9.66 % and 12.32 %, number of seeds 45.91% and 56.36 %, and number of fruits per plant 25.06 % and 29.31% [5]. Objective of research was to study daily flight activity of *T. laeviceps* and *T. minangkabau* in red pepper plantations in low and high land of West Sumatra.

2. MATERIALS AND METHODS

The captures of stingless bees were done in red pepper production centers located in high lands (> 500 m asl) and low lands (< 200 m asl) in West Sumatra. High land locations were: Japang Manganti (1) and Koto Panjang (2) Lima Puluh Kota District, By Pass (3) and Baringin (4) Payakumbuh Town, Ganting (5) and Gunung (6) Padang Panjang Town, Sabu (7) and Sikaladi (8) Tanah Datar District, Kubang Putiah (9) and Batu Taba (10) Agam District, Panyangkalan (11) and Batu Banyak (12) Solok

District. Low land locations were: Kampuang Dalam (13) and Lubuk Minturun (14) Padang Town, Kubang Bayang (15) Pesisir Selatan District, Katapiang (16) and Lubuk Alung (17) Padang Pariaman District. The research was conducted from November 2013 until April 2014.

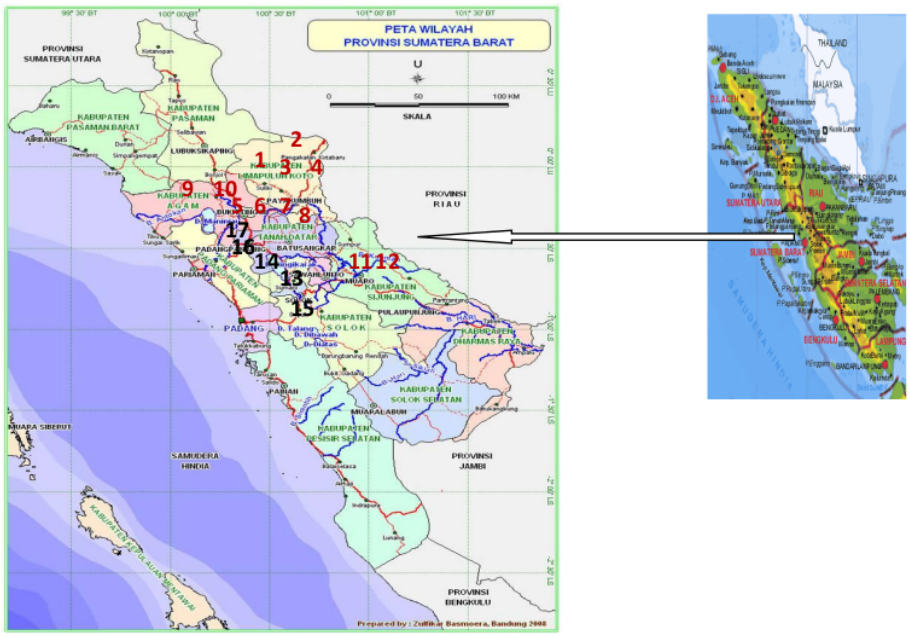

Figure 1. Locations of stingless bees captures in red pepper production centers of West Sumatra (number in red = high land, number in black = low land).

Method used to capture stingless bees was scan sampling [6], counting number of species and individual insects visiting red pepper flowers. The observations were done in 10 m^2 red pepper plantations. The insects were captured from 07.00 a.m until 04.00 p.m. Each observation was done for 15 minutes per hour per day per location. Temperature and relative humidity were noted for every periode of time.

Identification of stingless bees

Stingless bees captured were preserved as wet collections in 70% alcohol, then were grouped based on morphological characters using binocular microscope. Species identification was conducted using binocular microscope linked to Optilab Viewer, reference books [7,8].

Data Analysis

Data on species and number of individuals of stingless bees captured in each location of red pepper plantation per time period were presented descriptively. Stingless bees captured and climatic factors (temperature and relative humidity) were display in tables and graphs.

3. RESULTS AND DISCUSSION

Two species of stingless bees were found visiting red pepper plantations in production centres in West Sumatra. They were *Trigona laeviceps* with 492 individuals (58.16%) and *T. minangkabau* with 354 individuals (41.84 %). *T. laeviceps* and *T. minangkabau* were captured more in highlands than in the lowlands.

Trigona laeviceps was found in ten locations of red pepper plantations. Eight were in high lands (Koto Panjang Suliki and Japang Manganti in Lima Puluh Kota District, By Pass and Baringin in Payakumbuh, Ganting and Gunung in Padang Panjang, Sabu in Tanah Datar, and Batu Banyak in Solok) with 399 individuals (81,10 %). Two locations were in low lands (Kampung Dalam in Padang and Kubang in Bayang Pesisir Selatan) with 93 individuals (18.90%).

T. minangkabau was found in seven locations, four in high lands (Sikaladi in Tanah Datar, Kubang Putiah and Batu Taba in Agam, and Panyangkalan in Solok) with 198 individuals (55.93%). Three locations were in low lands (Lubuk Minturun in Padang, Ketapiang and Lubuk Alung in Padang Pariaman) with 156 individuals (44.07%). The number of individuals of *T. laeviceps* and *T. minangkabau* captured in various locations was presented in Table 1.

Table 1. Number of individuals of *T. laeviceps* and *T. minangkabau* captured on various red pepper locations in high and low lands in West Sumatra

No	Location	Altitude (m)	*T. laeviceps* (individual)	*T. minangkabau* (individual)
	High lands			
1.	Japang Manganti	520	50	-
2.	Koto panjang Suliki	650	49	-

3.	By Pass Payakumbuh	600	62	-
4.	Baringin	600	37	-
5.	Gantiang	740	51	-
6.	Gunung	760	54	-
7.	Sabu Tanah Datar	910	53	-
8.	Sikaladi Tanah Datar	880	-	60
9.	Kubang Putiah Agam	900	-	40
10.	Batu Taba Agam	900	-	49
11.	Batu banyak Solok	800	43	-
12.	Panyangkalan Solok	830	-	49
Total			399 (81,10 %)	198 (55,93 %)
	Low lands			
1.	Kampung Dalam Kota Padang	50	57	-
2.	Lubuk Minturun Kota Padang	30	-	61
3.	Kubang Bayang Pessel	100	36	-
4.	Ketaping Padang Pariaman	30	-	44
5.	Lubuk Alung Padang Pariaman	40	-	51
Total			93 (18,90 %)	156 (44,07 %)
	Total number of individuals		492	354

In high lands 66.67% of *T. laeviceps* and 33.33% of *T. minangkabau* were captured. While in low lands they were 40% of *T. laeviceps* and 60 % of *T. minangkabau*. *T. laeviceps* was captured in altitudes 50 – 910 m asl. at temperature 22-35.5 ºC and relative humidity (RH) 32-78 %. Locations of *T. minangkabau* captured was at altitudes 30–900 m asl. at temperature 20-35 ºC, and RH 37-78 %.

Daily visit of *T. laeviceps* and *T. minangkabau* to red pepper plantations was from

08.00 a.m until 03.00 p.m. The peak of visit of both occurred at 11.00 a.m. (106 individuals of *T. leaviceps* at 30.2 ± 2,4 ^{0}C and RH 46.9 ± 5,9 %, and 85 individuals of *T. minangkabau* at 30 ± 2,6 ^{0}C and RH 49.57 ± 5,1 %). There was no visit made by the two species before 08.00 a.m and after 3.00 p.m.

Food foraging of *T. laeviceps* occurred at temperature of locations 22.8-32.75 ^{0}C and RH 71.1-40.9 % and those of *T. minangkabau* 23.29-32.78 ^{0}C and RH 73.14-44.01%. Population density of *T. laeviceps* and *T. minangkabau* in daily food foraging in high and low land at temperature and RH of red pepper plantations was presented in Figure 2 and 3.

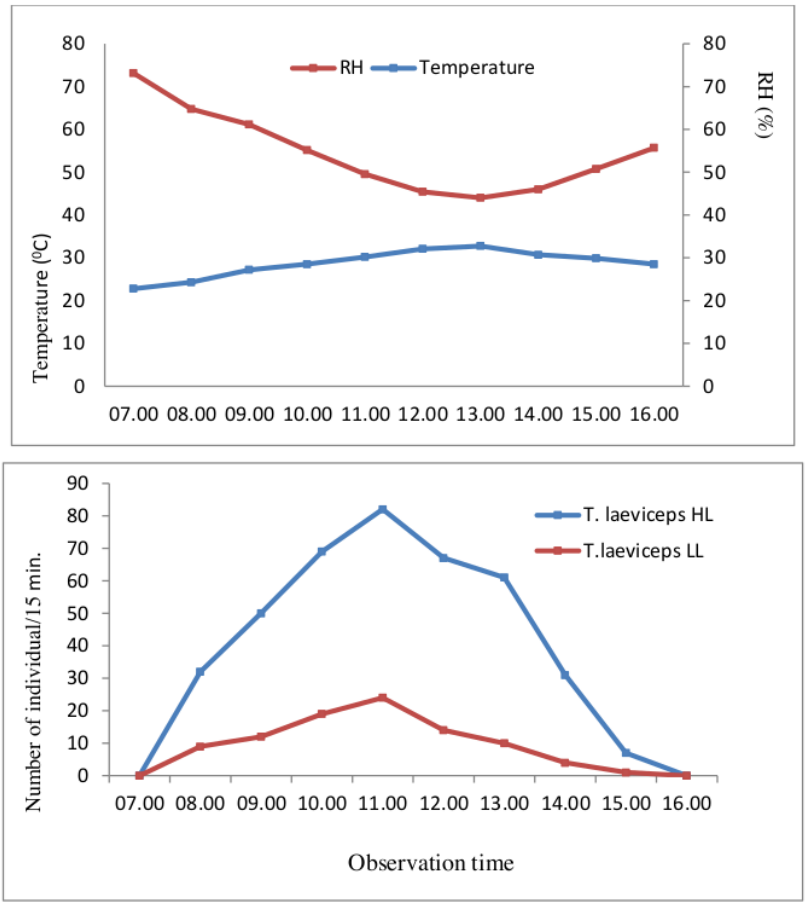

Figure 2. Population density of *T. laeviceps* in daily food foraging at temperature and RH of red pepper plantations at low land (LL) and high land (HL).

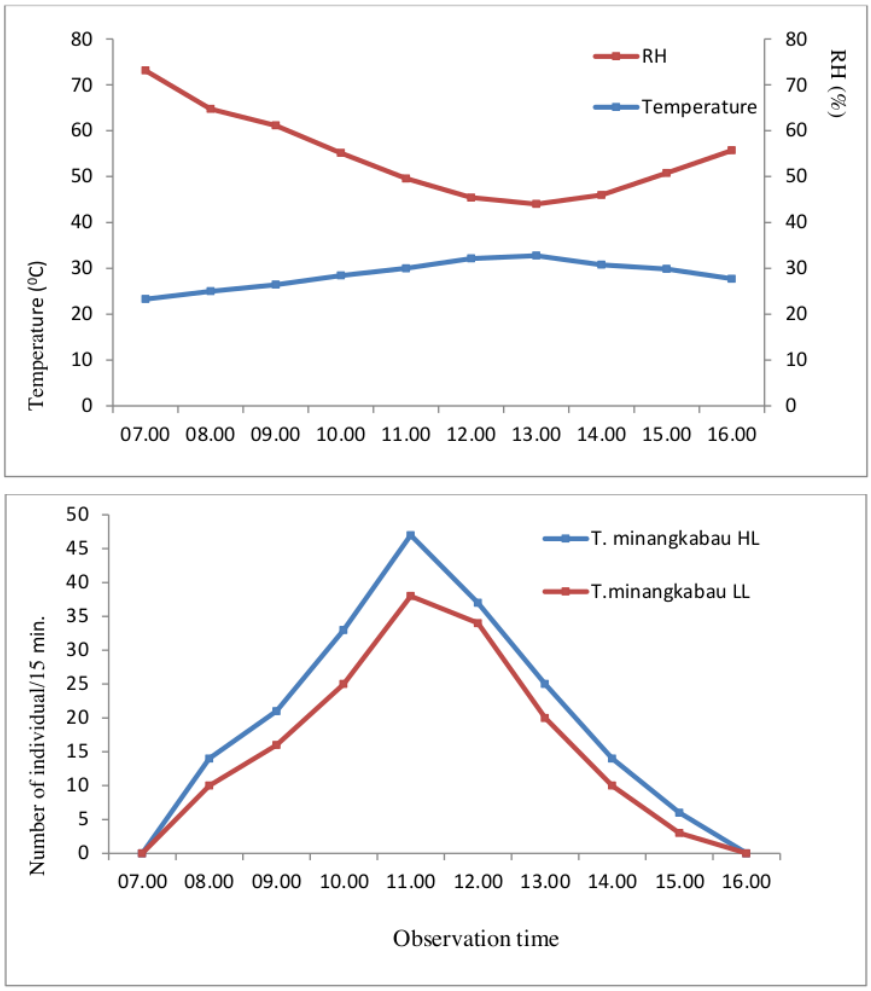

Figure 3. Population density of *T. minangkabau* in daily food foraging at temperature and RH of red pepper plantations at low land (LL) and high land (HL).

Trigona laeviceps is one species of stingless bees living in tropical and subtropical regions [9]. Daily activity of stingless bees is influenced by climate like temperature, RH, and light intensity [10,11,12]. Three hundred ninty nine individuals (81.10 %) of *T. laeviceps* were captured in high lands and 93 individuals (18,90%) in low lands. The higher persentage of *T. laeviceps* capture in high land was assumed to be caused by most of red pepper production centres in West Sumatra were located in high land

(>500 m asl). Out of 12 locations of *T. laeviceps* capture, eight locations (66.67%) were high lands and out of five locations of *T. laeviceps* capture, two of them (40 %) were low land. Salmah *et al*.[13] reported that 53.8% of *T. laeviceps* were found in low lands and 37.5% in high lands. However, the center of red pepper plantations are often found in the highlands. thus *T. laeviceps* also mostly found in the highlands. Temperature at research locations in high lands ranged 22-35.5 ºC and in low lands was 21-35 ºC. Even though stingless bees can live at 34-36°C [14], however *T. laeviceps* preferred cool areas of high land.

Different from *T. laeviceps, T. minangkabau* captured was 198 individuals (55.93 %) in high lands and 156 individuals (44.07 %) in low lands. It indicated that the activity of *T. minangkabau* was not influenced by altitude. This condition could be seen at percentage of capturing locations of *T. minangkabau*, out of five capturing locations three of them were low lands (60.00 %) and out of 12 locations, four of them were high lands (33.33 %). Salmah *et al*. [13] reported that 55.8 % of *T. minangkabau* (include *T.minangkabau* f. darek) were found in low lands and 43.8 % in high lands.

The presence of *T. laeviceps* and *T. minangkabau* in red pepper plantations was from 08.00 a.m. until 3.00 p.m. The peak daily activity of both for food foraging occurred at 11.00 a.m (*T. laeviceps* 106 individuals and *T. minangkabau* 85 individuals) (Fig. 2 and 3). This case relates to the occurrence of red pepper flowers to blossom which happen in the morning (07.00-09.00 a.m) and corollas usually open in the first 3 hours after the sun rises [15]. The same result was also reported by Putra *et al*. [16] that the peak of daily activity of *Apis cerana* for food foraging in red pepper plantations occurred at 11.00 a.m and of *T. laeviceps* occurred from 11.00-12.00 a.m. However, the activity of *A. cerana* started from 07.00 a.m and *T. laeviceps* started from 08.00 a.m. Al Abbadi [17] reported that the peak daily activity of honey bees in eggplants happened from 09.00-10.00 a.m at temperature 28-33^{0}C, and of Bombus bee from 08.00-09.00 a.m at 25-28^{0}C local time. The same condition also happened on red pepper and bell pepper plants, the peak daily activity of honey bees occurred from 09.00-10.00 a.m and of Bombus bee from 08.00-09.00 a.m. Jordan time.

The higher number of *T. laeviceps* captured in high lands and *T. minangkabau* in low lands was caused by size and color of these both *Trigona* were little different. *T. minangkabau* had body length 3.2 – 3.5 mm, metasoma was predominantly chesnut brown, while *T. laeviceps* had body length 4-4.5 mm and blackish brown body color. Willmer and Corbet [18] stated that small and light color of stingless bees were more resistant to full sun shine than those having big size and dark body color.

The insects visit to flowers decreased by the decrease of nectar volume and the increase of temperature. At 12.00-13.00 a.m the temperature was at its culminated peak, while RH was at its lowest condition and therefore the weather was very dry.

This conditions caused the volume of nectar decreased even though its concentration increased due to evaporation of nectar solution. Besides that, the reduce of stingless bees activity for food foraging in day time was caused by the reduce of food stock. Roubik *et al*. [19] reported that the concentration of nectar sugar ranged from 20-67%. The optimum concentration of nectar sugar was 40-50%. Further, Biesmeijer *et al*. [20] stated that concentration of nectar sugar increased from 07.00 until 11.00 a.m and it was stable at 11.00 a.m.

Gojmerac [21] stated that when temperature increased the energy needed for flying to search food was higher, while the amount of nectar available in nature as energy source was little. Therefore, in their activity for food foraging, stingless bees considered the potential energy that could be obtained. If energy spent for food foraging was higher than energy obtained the stingless bees would decrease their activity. In the morning the availability of nectar was higher so that the energy obtained was higher too compared to in a day time. Therefore, in a day time stingless bees activity decreased.

4. CONCLUSION

T. laeviceps was captured in locations at altitudes 50 – 910 m asl and that of *T. minangkabau* was at altitudes 30–900 m asl. Population of *T. laeviceps* at high lands was higher than in low lands, in other hand the population of *T. minangkabau* at high lands was the same as in low lands. The presence of *T. laeviceps* and *T. minangkabau* in red pepper plantations was from 08.00 a.m. until 3.00 p.m. The peak daily activity of both for food foraging occurred at 11.00 a.m.

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