

Journal of Entomology and Zoology Studies

Pollination in chili pepper (*Capsicum annuum* L.)  
by *Trigona laeviceps* and *T. minangkabau*  
(Hymenoptera, Meliponini)

Dewirman Prima Putra, Dahelmi, Siti Salmah, Etti Swasti

# Pollination in chili pepper (*Capsicum annuum* L.) by *Trigona leaviceps* and *T. minangkabau* (Hymenoptera, Meliponini)

Dewirman Prima Putra<sup>1</sup>, Dahelmi<sup>2</sup>, Siti Salmah.M<sup>2</sup>, and Etti Swasti<sup>3</sup>

<sup>1</sup> Department of agronomy, Faculty of Agriculture, Ekasakti University

<sup>2</sup> Department of Biology, Faculty of Science and Mathematics, Andalas University

<sup>3</sup>Department of Agronomy, Faculty of Agriculture, Andalas University

## Abstract

Two species of stingless bees, *Trigona minangkabau* and *T. leaviceps*, have been known to visit chili pepper plantation in West Sumatera. The objective of research was to study pollination by *T. minangkabau* and *T. leaviceps* in increasing chili pepper yield. It was conducted using Randomized Block Design (RBD) with 3 replicates. Pollination by *T. leaviceps* and *T. minangkabau*, each could increase the following parameters: fruit sets 12.32 and 9.66%, number of seeds 56.36 and 45.91%, number of fruits 29.31 and 25.06, fruit weight per plant 66.46 and 49.75%, and yields ha<sup>-1</sup> 54.26% and 40.83% if compared to pollination by wind. However, it did not affect length and diameter of fruit. Average flower handling time by *T. minangkabau* was 26.00±4.52 seconds and by *T. leaviceps* was 26.23±4.46 seconds. Time taken to move to other flower by *T. minangkabau* was 7.64±2.7 seconds and by *T. leaviceps* was 7.87±1.88 seconds. Based on all parameters above it could be concluded that both *T. minangkabau* and *T. laeviceps* had the same effectiveness as pollinators on chili pepper plantations.

**Key words:** *Trigona minangkabau*, *T. laeviceps*, cross pollination, chili pepper

## 1. Introduction

*Trigona* spp. which are called stingless bees can function as pollinator. There are two species of stingless bees, *Trigona minangkabau* and *T. laeviceps*, found in chili pepper plantations in West Sumatera distributing evenly either in low or high lands. These insects have relatively small size, 3.4 ± 0.2 mm and 4.4 ± 0.2 mm, therefore they are able to obtain nectar from small size flowers <sup>[1]</sup>. As a consequence, stingless bees have more various foods than honey bees.

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

Some species of stingless bees that have been used as pollinators to increase production of *Capsicum* are *Melipona favosa* <sup>[3]</sup>, *Trigona carbonaria* <sup>[4]</sup>, *Melipona subnitida* <sup>[5]</sup>, effective to increase production of sweet pepper, but not with *Tetragonisca angustula* which is very small in size. Stingless bee that has been used in research for chili pepper pollination is *Trigona (Tetragonula) minangkabau* and proved to be effective to increase chili pepper production compared to natural pollination or by wind <sup>[6]</sup>.

The chili pepper flower has small size (10-15 mm), *campanulate* to *rotate* flower type with depth to flower base 2 mm <sup>[7]</sup>. Having these characters, chili pepper needs small pollinators to visit. In this case it was interesting and important to study the effectivity of pollination done by *Trigona minangkabau* and *T. leaviceps* in increasing yield of chili chili pepper.

## 2. Materials and Methods

The study was conducted in rice field in Kelurahan Korong Gadang Kuranji Subdistrict, Padang (- 00° 57' LS 100° 21' BT, altitude 20 m dpl., ) from August 2014 – January 2015. A trial was arranged using Randomized Block Design (RBD) with three treatments, pollination by wind, by *T. minangkabau* and by *T. leaviceps*. Each treatment was done with three replicates. Data were analyzed by Analysis of Variance (One way ANOVA) and Duncan's New Multiple Range Test (DNMRT) with 5 % level of confidence <sup>[8]</sup>.

Chili pepper plants were planted in 9 plots (11x1 m<sup>2</sup>) with a distance of 0.5 m among them. To avoid pollination by other insects, the plots area was screened using plastic screen with 36 mesh. Three screen houses (12 x 4 x 3 m) were made and each of them contained 3 plots. Stup of *Trigona* sp. the zise (33 x 25 x 19 cm) with numbers of workers ± 1500 individuals were placed in screen houses when the plants had produced 25% bloom. Parameters measured were fruit set (percentage of flowers resulted in fruits), length and diameter of fruits (cm), fruit weigh (g), number of seeds per fruit, number and weight of fruits per plant, production per ha, and foraging behavior.

## 3. Results

### Fruit set, number of seeds, length and diameter of fruit

*Trigona minangkabau* and *T. leaviceps* as pollinators increased fruit sets significantly in which percentages of fruit set resulted from pollination by *T. minangkabau* and by *T. leaviceps* were 78.84 % and 81,50 %. These numbers were significantly different from the one pollinated by wind, 69,18 %. *T. minangkabau* and *T. leaviceps* could increase fruit sets 9.66 % and 12.32 %.

*Trigona minangkabau* and *T. leaviceps* also increase number of seeds. Chili pepper plants pollinated by *T. minangkabau* and *T. leaviceps* produced 64.20 and 68.80 seeds, which were significantly different from the one pollinated by wind, 44.00 seeds. In this case, *T. minangkabau* and *T. leaviceps* could increase number of seeds 45.91% and 56.36 %. However, pollination by *T. minangkabau* and *T. leaviceps* did not affect length and diameter of fruits. The length of fruits ranged 18.75 -21.06 cm and diameter ranged 1.03-1.07 cm (Table 1).

Table 1. Percentage of fruit sets, number seeds, length, and diameter of fruits of chili pepper pollinated by *Trigona* sp and wind

Pollinator	Fruit set (%)	Number seeds	Fruit length (cm)	Fruit Dia-meter (cm)
<i>Trigona leaviceps</i>	81.50 <sup>a</sup>	68.80 <sup>a</sup>	20,47 <sup>a</sup>	1,07 <sup>a</sup>
<i>T. minangkabau</i>	78.84 <sup>a</sup>	64.20 <sup>a</sup>	21,06 <sup>a</sup>	1,05 <sup>a</sup>
Wind	69,18 <sup>b</sup>	44,00 <sup>b</sup>	18,75 <sup>a</sup>	1,03 <sup>a</sup>

Numbers followed by the same letters were not significantly different according to DNMRT with 5% level of confidence

### Number and weight of fruits per plant, and yield

Since *T. minangkabau* and *T. leaviceps* could increase percentage of fruit sets and number of seeds, they automatically increased number and weight of fruits per plant. As a result, they increased the yield per ha (Table 2)

Table 2. Number and weight of fruits per plant and yield of chili pepper ha<sup>-1</sup> pollinated by *T. leaviceps*, *T. minangkabau* and wind

Pollinator	Fruit Number per plant	Fruit Weight per plant (g)	Yield per ha (kg)
<i>T. leaviceps</i>	82.93 <sup>a</sup>	562.00 <sup>a</sup>	8186.0 <sup>a</sup>
<i>T. minangkabau</i>	80.20 <sup>a</sup>	505.67 <sup>a</sup>	7473.7 <sup>a</sup>
Wind	64.13 <sup>b</sup>	337.67 <sup>b</sup>	5306.7 <sup>b</sup>

Numbers followed by the same letters were not significantly different according to DNMR with 5% level of confidence

The increase in number of fruits per plant by *T. minangkabau* and *T. leaviceps* as pollinator was significantly different from the one done by wind. Average number of fruits per plant pollinated by *T. minangkabau* and *T. leaviceps* were 80.20 and 82.93 individuals, while the one by wind was 64.13 individuals. The increases in fruit numbers by *T. minangkabau* and *T. leaviceps* were 25.06% and 29.31% compared to the one by wind.

Because of increasing number of fruits per plant 25.06 - 29.31%, and number of seeds 45,91 - 56,36 %, there should be an increase in fruit weight per plant which was 505.67 g using *T. minangkabau* and 562,00 g using *T. leaviceps*. That numbers were significantly different from the one pollinated by wind, 337.67 g. Percentage of fruit weight increase per plant was 49.75% by *T. minangkabau* and 66.46 % by *T. leaviceps*. By the increase of fruit weight per plant it would automatically increase yield per ha which were 7473.71 kg by *T. minangkabau* and 8186.00 kg by *T. leaviceps* different significantly from the yield pollinated by wind, 5306.73 kg. As a result, the increases of yield per ha were 40.83 % by *T. minangkabau* and 54.26 % by *T. leaviceps*.

### Food Foraging Behavior

It was found that flower handling time by *T. minangkabau* was 16.81-33.72 seconds with average 26.23±4.46 seconds and by *T. leaviceps* was 17.28 – 35,71 seconds with average 26.00±4.52 seconds. Time taken to move from one to another flower for *T. minangkabau* was 5.04–14.42 seconds with average 7.64±2.7 seconds and for *T. leaviceps* was 5.48–11.28 seconds with average 7.87±1.88 seconds. Both parameters did not show significant different between the two stingless bees (Table 3)

Table 3. Flower handling time and time taken to move from one to another flower by two species of stingless bees

Foraging behavior	Stingless bees spesies	
	<i>T. minangkabau</i>	<i>T. leaviceps</i>
Flower handling time (second)	16.81–33.72 (26.23±4.46)	17.28–35.71 (26.00±4.52)
Time taken to move from one to another flower (second)	5.04–14.42 (7.64±2.7)	5.48–11.28 (7.87±1.88)

Before alighting on flower, *T. leviceps* showed movement like Z letter, while *T. minangkabau* did not show specific pattern.

#### 4. Discussion

Pollination is a sexual reproduction process which result in fruits forming and inside fruits there are seeds. Inside ovule there is ovulum. The perfect pollination mainly supported by insect pollinators would increase yield and in turn increase number of seeds. Generally, pollination supported by eusocial bees would contribute to increase in yield, both qualitatively and quantitatively. <sup>[9][10]</sup>.

Effectiveness of pollination supported by *Trigona minangkabau* and *T. leviceps* could increase yield of chili pepper by increasing 9.66% fruit set, 45.91% seed numbers by *T. minangkabau* and 12.32% fruit set and 56.36% seed numbers by *T. laeviceps*. Increasing fruit set and seed numbers automatically would increase fruit numbers, 25.06% by *T. minangkabau* and 29.31% by *T. laeviceps* (Table 2.).

Many other researchers have found the same result from pollinating by insect pollinators. Santos *et al.* (2004) compared effectivity of pollination on tomatoes by *Melipona quadrifasciata* and *Apis mellifera*. The result showed that the size of tomatoes was bigger, higher weight, and more seeds when pollinated by *M. quadrifasciata* compared to the one pollinated by *A. mellifera* <sup>[11]</sup>: Cruz *et al.*, (2004) also reported the increase in number of fruits 13,51 %, number of seeds 85,85 % and fruit weight 29,69 % on sweet pepper because of pollinating by *Melipona subnitida* compared to pollinating by wind <sup>[5]</sup>. Jarlan *et al.* (1997) reported the increase of yield of *Capsicum* up to 19,3% due to pollinating by stingless bees <sup>[12]</sup>. Kwon and Saeed (2003) found the increase in fruit weight 27,2% and number of seeds of 47,8% of *Capsicum* due to pollinating by bees <sup>[13]</sup>.

Pollination on sweet pepper supported by various species of stingless bees showed that not all species were successful as pollinators. It depended on size of stingless bees. *Melipona favosa*, *Trigona carbonaria*, and *Melipona subnitida* having bigger size were effective to increase yield of sweet pepper, but *Tetragonisca angustula* having smaller size could not make <sup>[5][4][14]</sup>. However, for *T. minangkabau* and *T. laeviceps* with body size  $3.4 \pm 0.2$  mm and  $4.4 \pm 0,2$  mm and included subgenus *Tetragonula* showed the same effectivity as pollinators.

Besides species of pollinator, architecture of flowers like size, the site of reproduction organ, accessibility to nectar, and flower structure, could affect interaction between plant and its pollinator. If there is an incomplete factor like small size of flower, thus a big size of insect is not appropriate to be pollinator <sup>[15][16]</sup>.

Sakagami *et al.* (1985); Osawa and Tsubaki, (2003) described that having smaller size (2-14 mm) enabled the stingless bees to access various flowers with a very narrow opening that could not be accessed by other bees. Therefore, for chili pepper the appropriate pollinator is *Trigona* spp <sup>[17][18]</sup>. Suryani (1999) reported that using *Trigona minangkabau* as pollinator on chili pepper plant could effectively increase fruit set (65%) compared to pollinating by other insects (59%) and wind (56%) <sup>[6]</sup>.

Frequency and duration of visit by pollinators to nectariferous depend on nectar production level <sup>[19]</sup>. Nectar consists of 25-75% sugar with various numbers of amino acids and lipids. Generally, biotic pollinators need physical contact with

reproductive organ of flower for pollinating to occur<sup>[20]</sup>. Due to their small body size of *Trigona minangkabau* and *T. leaviceps*, when obtaining nectar their heads could enter up to the base of flower and the their legs contact with pollen so that pollination could occur. Besides that, in foraging behavior, stingless bees tends to show flower constancy<sup>[21]</sup>. In this case there would be repeated visit to the same flower. Thus, *Trigona minangkabau* and *T. leaviceps* were found to be effective as pollinator for chili pepper plants.

## 5. Conclusion

Pollination on chili pepper plants supported by *Trigona minangkabau* and *T. leaviceps* was effective in increasing fruit set and seed numbers. By increasing the fruit set and seed numbers it would automatically increase fruit numbers per plant and weight and in turn would increase yield ha<sup>-1</sup>. *Trigona* spp. as pollinator did not affect length and diameter of fruit. Flower handling time and time taken to move from one to another flower between *T. minangkabau* and *T. leaviceps* were not significantly different. *T. leaviceps* made Z letter movement before alighting while *T. minangkabau* did not show specific pattern before alighting on flower.

## 6. Acknowledgement

It is my pleasure to acknowledge Directorate General of Higher Education Ministry of Research and Technology-Higher Education and Kopertis Area X for providing research fund on Hibah Disertasi Doktor.

## 7. References

1. Putra D. P., Dahelmi, Salmah S., and Swasti, E. Spesies Diversity of Stingless Bees (Hymenoptera: Meliponini) in Chili PEPPER (*Capsicum annuum* L.) Plantation in West Sumatera. International Journal Science Research 2016: Vol. 5 Issue 4: 1527-1532
2. Pickersgill, B. Genetic resources and breeding of *Capsicum* spp. Euphytica 1997:96: 129-133.
3. Meeuwssen F.J.A.J. *Stingless bees for pollination purposes in greenhouses*, in: Sommeijer M.J., Ruijter A. de (Eds.), *Insect Pollination in Green-houses: Proc. specialists' meeting held in Soesterberg, The Netherlands 2000*: 143–147.
4. Occhiuzzi P. *Stingless bees pollinate greenhouse Capsicum*, Aussie Bee 13, 15. Published by Australian Nature Bee Research Centre, North Richmond NSW Australia 2000.
5. Cruz D. de O., Freitas B.M., Silva L.A. da, Silva S.E.M. da, Bomfim I.G.A. Pollination efficiency of the stingless bee *Melipona subnitida* on Greenhouse sweet pepper, Pesq. Agropec. Bras., Brasilia 2005: 40:1197–1201.
6. Suryani, S. D. The role of *Trigona (Tetragonula) minangkabau* Sakagami et Inoue as pollinators on chilli papper plants (*Capsicum annuum* L.) Thesis Graduate University of Andalas Padang 1999.
7. Bosland. P.W. and E.J. Votava. *Peppers, Vegetables and Spices Capsicum*. CABI Publishing. New York 2000: 198
8. Steel, R. G. D., and Torrie, J. H. *Principles and Procedures of Statistics* . 2nd ed. New York: McGraw-Hill 1980.
9. Klein AM, Vaissiere BE, Cane JH, Steffan-Dewenter I, Cunningham SA, Kremen C, Tscharntke TD. Importance of pollinators in changing

- landscapes for world crops. *Proceedings of the Royal Society B: Biological Sciences* 2007: 274:303–313.
10. Klatt B.K, Holzschuh A, Westphal C, Clough Y, Smit I, Pawelzik E, Tschardt T. Bee pollination improves crop quality, shelf life and commercial value. *Proceedings of the Royal Society B: Biological Sciences* 2014: 281(1775):20132440
  11. Santos S.A.B. dos, L.R. Bego, dan A.C. Roselino. Pollination in tomatoes, *Lycopersicon esculentum*, by *Melipona quadrifasciata anthidioides* and *Apis mellifera* (Hymenoptera, Apinae), *Proc. 8th IBRA Int. Conf. Trop. Bees and VI Encontro sobre Abelhas*. 2004: 688.
  12. Jarlan A, De Oliveira D, Gingras J. Pollination by *Eristalis tenax* (Diptera: Syrphidae) and seed set of greenhouse sweet pepper. *Horticultural Entomology* 1997: 90: 1646-1649.
  13. Kwon, Y.J. & Saeed, S. Effect of temperature on the foraging activity of *Bombus terrestris* L. (Hymenoptera: Api-dae) on greenhouse hot pepper (*Capsicum annuum* L.). *Applied Entomology and Zoology* 2003: 38:275-280.
  14. Roubik, D.W. Pollination of Cultivated Plants in the Tropics. FAO. *Agricultural Services Bulletin* No. 118. FAO, Rome, Italy. 1995: 196.
  15. Ghazoul, J. The pollination and breeding system of *Dipterocarpus obtusifolius* (Dipterocarpaceae) in dry deciduous forests of Thailand. *Journal of Natural History* 1997: 31:901–916.
  16. Griffin, A.R. & Sedgley, M. *Sexual reproduction of tree crops*. Academic Press Inc. Harcourt Brace Jovanovich Publishers. San Diego 1989.
  17. Sakagami, S. F., Inoue, T. and Salmah, S. Key to the stinglessbee species found or expected from Sumatra. In: R.I. Ohgushi (Ed.). *Evolutionary Ecology of Insect in Humid Tropics, Especially in Central Sumatra*. Kanasawa University, Japan. Sumatra Nature study (Entomology) 1985: 37-43.
  18. Osawa, N., and Y. Tsubaki, Seasonal variation and community structure of tropical bees in a lowland tropical forest of peninsular Malaysia : the impact of general flowering. Springer.-Verlag. 2003: 315-324.
  19. Nicolson, S. W., and M. Nepi. Dilute nectar in dry atmospheres: nectar secretion patterns in *Aloe castanea* (Asphodelaceae). *International Journal of Plant Sciences* 2005: 166:227–233.
  20. Graham, L. E., J. M. Graham and L. W. Wilcox. *Plant Biology*. Upper Saddle River: Pearson Prentice Hall 2006.
  21. Slaa, E.J., L.A.S. Chaves, K.S. Malagodi-Bragac, and F.E. Hofstede. Stingless bees in applied pollination: practice and perspectives. *Apidologie* 2006: 37:293-315.



Dear dewirman,

Thank you for submitting the manuscript to the *Journal of Entomology and Zoology Studies*.

**Article Details:**

Full Name:	dewirman
Institute Address:	Universitas of Eka sakti-Padang -West Sumatera Indonesia Indonesia
Email:	de_wirman_pp@yahoo.com
Phone:	081363303821
Title of submission:	Pollination in chili pepper ( <i>Capsicum annuum</i> L.) by <i>Trigona leaviceps</i> and <i>T. minangkabau</i> (Hymenoptera, Meliponini)

Kind Regards,  
Akhil Gupta  
Manager  
Journal of Entomology and Zoology Studies  
www.entomoljournal.com  
Mob : 01 8741224089



**Manuscript Accepted Ref: Phyto-4-3-152**

[Zoology Journal <zoology.journal@gmail.com>](mailto:zoology.journal@gmail.com)

Ke

[de\\_wirman\\_pp@yahoo.com](mailto:de_wirman_pp@yahoo.com)

Dear Dewirman Prima Putra,

Ref: Ento 4-3-152

Manuscript titled "**Pollination in chili pepper (*Capsicum annuum* L.) by *Trigona leviceps* and *T. minangkabau* (Hymenoptera, Meliponini)**" is very well written and has been accepted,

**Fees:**

1. Without Hardcopy: USD 100 + 14.5 % tax = USD 114.50
2. With one Hardcopy: USD 100 + 30 + 14.5 % tax = USD 148.85
3. With two Hardcopies: USD 100 + 50 + 14.5 % tax = USD 171.875

**A) Credit Card Option (Click following link):**

<https://www.akinik.com/payment/>

**Bank Transfer / Cash Deposit Option**

Bank Name: IDBI Bank

A/C Holder Name: Akinik Publications

A/C Number.: 0163102000020323

A/C type: Current

IFS Code: IBKL0000163,

Swift code: IBKLINBB010

Branch: Rohini Branch,

Delhi, India

OR

Pay pal link

- a) Publication fee without Hardcopy: of the journal US \$ 100 + 12.36% ST tax= US \$ 112.36
- b) Publication fee with one Hardcopy of the journal: \$ 100 + \$ 30 + 12.36% ST tax = US \$ 146.06
- c) Publication fee with Two Hardcopy of the journal: \$ 100 + \$ 60 + 12.36% ST tax = US \$ 179.77

**We are providing you following options to pay the fee. Please choose the option which is suitable to you.**

**Credit Card/Debit Card Option.**

Click following link:

USD 112.36 Link: [https://www.paypal.com/cgi-bin/webscr?cmd=\\_s-xclick&hosted\\_button\\_id=D76Q7FKC8UBGN](https://www.paypal.com/cgi-bin/webscr?cmd=_s-xclick&hosted_button_id=D76Q7FKC8UBGN)  
USD 146.06 Link: [https://www.paypal.com/cgi-bin/webscr?cmd=\\_s-xclick&hosted\\_button\\_id=2BEB8HWGHDF6E](https://www.paypal.com/cgi-bin/webscr?cmd=_s-xclick&hosted_button_id=2BEB8HWGHDF6E)  
USD 179.77 Link: [https://www.paypal.com/cgi-bin/webscr?cmd=\\_s-xclick&hosted\\_button\\_id=7QM6PEY97MZFG](https://www.paypal.com/cgi-bin/webscr?cmd=_s-xclick&hosted_button_id=7QM6PEY97MZFG)

**B) Western Union Money Transfer Option (Beneficiary Details):**

First Name: Akhil

Last Name: Gupta

Nationality: India

If you have any question, then please contact to **Mr. Akhil Gupta**  
**(Business Development Officer)** at +91-9711224068

Kind Regards,

Brij Mohan Gupta

Manager ( Finance)

Journal of Entomology and zoology Studies

[www.entomoljournal.com](http://www.entomoljournal.com)

E-mail: [info@entomoljournal.com](mailto:info@entomoljournal.com)



E-ISSN: 2320-7078

P-ISSN: 2349-6800

JEZS 2016; 4(1): xx-xx

© 2016 JEZS

Received: xx-xx-xxxx

Accepted: xx-xx-xxxx

**Dewirman Prima Putra**

Department of agronomy, Faculty of Agriculture, Ekasakti University

**Dahelmi**

Department of Biology, Faculty of Science and Mathematics, Andalas University

**Siti Salmah**

Department of Biology, Faculty of Science and Mathematics, Andalas University

**Etti Swasti**

Department of Agronomy, Faculty of Agriculture, Andalas University

## Pollination in chili pepper (*Capsicum annum* L.) by *Trigona laeviceps* and *T. minangkabau* (Hymenoptera, Meliponini)

Dewirman Prima Putra, Dahelmi, Siti Salmah, Etti Swasti

### Abstract

Two species of stingless bees, *Trigona minangkabau* and *T. laeviceps*, have been known to visit chili pepper plantation in West Sumatera. The objective of research was to study pollination by *T. minangkabau* and *T. laeviceps* in increasing chili pepper yield. It was conducted using Randomized Block Design (RBD) with 3 replicates. Pollination by *T. laeviceps* and *T. minangkabau*, each could increase the following parameters: fruit sets 12.32 and 9.66%, number of seeds 56.36 and 45.91%, number of fruits 29.31 and 25.06, fruit weight per plant 66.46 and 49.75%, and yields ha<sup>-1</sup> 54.26% and 40.83% if compared to pollination by wind. However, it did not affect length and diameter of fruit. Average flower handling time by *T. minangkabau* was 26.00±4.52 seconds and by *T. laeviceps* was 26.23±4.46 seconds. Time taken to move to other flower by *T. minangkabau* was 7.64±2.7 seconds and by *T. laeviceps* was 7.87±1.88 seconds. Based on all parameters above it could be concluded that both *T. minangkabau* and *T. laeviceps* had the same effectiveness as pollinators on chili pepper plantations.

**Keywords:** *Trigona minangkabau*, *T. laeviceps*, cross pollination, chili pepper

### Introduction

*Trigona* spp. which are called stingless bees can function as pollinator. There are two species of stingless bees, *Trigona minangkabau* and *T. laeviceps*, found in chili pepper plantations in West Sumatera distributing evenly either in low or high lands. These insects have relatively small size, 3.4 ± 0.2 mm and 4.4 ± 0.2 mm, therefore they are able to obtain nectar from small size flowers<sup>[1]</sup>. As a consequence, stingless bees have more various foods than honey bees.

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

Some species of stingless bees that have been used as pollinators to increase production of *Capsicum* are *Melipona favosa*<sup>[3]</sup>, *Trigona carbonaria*<sup>[4]</sup>, *Melipona subnitida*<sup>[5]</sup>, effective to increase production of sweet pepper, but not with *Tetragonisca angustula* which is very small in size. Stingless bee that has been used in research for chili pepper pollination is *Trigona (Tetragonula) minangkabau* and proved to be effective to increase chili pepper production compared to natural pollination or by wind<sup>[6]</sup>.

The chili pepper flower has small size (10-15 mm), campanulate to rotate flower type with depth to flower base 2 mm<sup>[7]</sup>. Having these characters, chili pepper needs small pollinators to visit. In this case it was interesting and important to study the effectivity of pollination done by *Trigona minangkabau* and *T. laeviceps* in increasing yield of chili pepper.

### Materials and Methods

The study was conducted in rice field in Kelurahan Korong Gadang Kuranji Subdistrict, Padang (- 00° 57' LS 100° 21' BT, altitude 20 m dpl.,) from August 2014 – January 2015. A trial was arranged using Randomized Block Design (RBD) with three treatments, pollination by wind, by *T. minangkabau* and by *T. laeviceps*. Each treatment was done with three replicates. Data were analyzed by Analysis of Variance (One way ANOVA) and Duncan's New Multiple Range Test (DNMRT) with 5 % level of confidence<sup>[8]</sup>.

Chili pepper plants were planted in 9 plots (11x1 m<sup>2</sup>) with a distance of 0.5 m among them. To avoid pollination by other insects, the plots area was screened using plastic screen with 36 mesh. Three screen houses (12 x 4 x 3 m) were made and each of them contained 3 plots.

**Correspondence****Dewirman Prima Putra**

Department of agronomy, Faculty of Agriculture, Ekasakti University

Stup of *Trigona* sp. the size (33 x 25 x 19 cm) with numbers of workers  $\pm$  1500 individuals were placed in screen houses when the plants had produced 25% bloom. Parameters measured were fruit set (percentage of flowers resulted in fruits), length and diameter of fruits (cm), fruit weight (g), number of seeds per fruit, number and weight of fruits per plant, production per ha, and foraging behavior.

## Results

### Fruit set, number of seeds, length and diameter of fruit

*Trigona minangkabau* and *T. leviceps* as pollinators increased fruit sets significantly in which percentages of fruit set resulted from pollination by *T. minangkabau* and by *T. leviceps* were 78.84 % and 81,50 %. These numbers were significantly different from the one pollinated by wind, 69,18 %. *T. minangkabau* and *T. leviceps* could increase fruit sets 9.66 % and 12.32 %.

*Trigona minangkabau* and *T. leviceps* also increase number of seeds. Chili pepper plants pollinated by *T. minangkabau* and *T. leviceps* produced 64.20 and 68.80 seeds, which were significantly different from the one pollinated by wind, 44.00 seeds. In this case, *T. minangkabau* and *T. leviceps* could increase number of seeds 45.91% and 56.36 %. However, pollination by *T. minangkabau* and *T. leviceps* did not affect length and diameter of fruits. The length of fruits ranged 18.75 -21.06 cm and diameter ranged 1.03-1.07 cm (Table 1).

**Table 1:** Percentage of fruit sets, number seeds, length, and diameter of fruits of chili pepper pollinated by *Trigona* sp and wind

Pollinator	Fruit set (%)	Number seeds	Fruit length (cm)	Fruit Diameter (cm)
<i>Trigona laeviceps</i>	81.50 <sup>a</sup>	68.80 <sup>a</sup>	20,47 <sup>a</sup>	1,07 <sup>a</sup>
<i>T. minangkabau</i>	78.84 <sup>a</sup>	64.20 <sup>a</sup>	21,06 <sup>a</sup>	1,05 <sup>a</sup>
Wind	69,18 <sup>b</sup>	44,00 <sup>b</sup>	18,75 <sup>a</sup>	1,03 <sup>a</sup>

Numbers followed by the same letters were not significantly different according to DNMR with 5% level of confidence

### Number and weight of fruits per plant, and yield

Since *T. minangkabau* and *T. leviceps* could increase percentage of fruit sets and number of seeds, they automatically increased number and weight of fruits per plant. As a result, they increased the yield per ha (Table 2)

**Table 2:** Number and weight of fruits per plant and yield of chili pepper ha<sup>-1</sup> pollinated by *T. leviceps*, *T. minangkabau* and wind

Pollinator	Fruit Number per plant	Fruit Weight per plant (g)	Yield per ha (kg)
<i>T. leviceps</i>	82.93 <sup>a</sup>	562.00 <sup>a</sup>	8186.0 <sup>a</sup>
<i>T. minangkabau</i>	80.20 <sup>a</sup>	505.67 <sup>a</sup>	7473.7 <sup>a</sup>
Wind	64.13 <sup>b</sup>	337.67 <sup>b</sup>	5306.7 <sup>b</sup>

Numbers followed by the same letters were not significantly different according to DNMR with 5% level of confidence

The increase in number of fruits per plant by *T. minangkabau* and *T. leviceps* as pollinator was significantly different from the one done by wind. Average number of fruits per plant pollinated by *T. minangkabau* and *T. leviceps* were 80.20 and 82.93 individuals, while the one by wind was 64.13 individuals. The increases in fruit numbers by *T. minangkabau* and *T. leviceps* were 25.06% and 29.31% compared to the one by wind.

Because of increasing number of fruits per plant 25.06 - 29.31%, and number of seeds 45, 91 - 56,36 %, there should be an increase in fruit weight per plant which was 505.67 g

using *T. minangkabau* and 562,00 g using *T. leviceps*. That numbers were significantly different from the one pollinated by wind, 337.67 g. Percentage of fruit weight increase per plant was 49.75% by *T. minangkabau* and 66.46 % by *T. leviceps*. By the increase of fruit weight per plant it would automatically increase yield per ha which were 7473.71 kg by *T. minangkabau* and 8186.00 kg by *T. leviceps* different significantly from the yield pollinated by wind, 5306.73 kg. As a result, the increases of yield per ha were 40.83 % by *T. minangkabau* and 54.26 % by *T. leviceps*.

### Food Foraging Behavior

It was found that flower handling time by *T. minangkabau* was 16.81-33.72 seconds with average 26.23 $\pm$ 4.46 seconds and by *T. leviceps* was 17.28 - 35,71 seconds with average 26.00 $\pm$ 4.52 seconds. Time taken to move from one to another flower for *T. minangkabau* was 5.04-14.42 seconds with average 7.64 $\pm$ 2.7 seconds and for *T. leviceps* was 5.48-11.28 seconds with average 7.87 $\pm$ 1.88 seconds. Both parameters did not show significant different between the two stingless bees (Table 3)

**Table 3:** Flower handling time and time taken to move from one to another flower by two species of stingless bees

Foraging behavior	Stingless bees spesies	
	<i>T. minangkabau</i>	<i>T. leviceps</i>
Flower handling time (second)	16.81-33.72 (26.23 $\pm$ 4.46)	17.28-35.71 (26.00 $\pm$ 4.52)
Time taken to move from one to another flower (second)	5.04-14.42 (7.64 $\pm$ 2.7)	5.48-11.28 (7.87 $\pm$ 1.88)

Before alighting on flower, *T. leviceps* showed movement like Z letter, while *T. minangkabau* did not show specific pattern.

## Discussion

Pollination is a sexual reproduction process which result in fruits forming and inside fruits there are seeds. Inside ovule there is ovulum. The perfect pollination mainly supported by insect pollinators would increase yield and in turn increase number of seeds. Generally, pollination supported by eusocial bees would contribute to increase in yield, both qualitatively and quantitatively<sup>[9, 10]</sup>.

Effectiveness of pollination supported by *Trigona minangkabau* and *T. leviceps* could increase yield of chili pepper by increasing 9.66% fruit set, 45.91% seed numbers by *T. minangkabau* and 12.32% fruit set and 56.36% seed numbers by *T. laeviceps*. Increasing fruit set and seed numbers automatically would increase fruit numbers, 25.06% by *T. minangkabau* and 29.31% by *T. laeviceps* (Table 2.).

Many other researchers have found the same result from pollinating by insect pollinators. Santos *et al.* (2004) compared effectivity of pollination on tomatoes by *Melipona quadrifasciata* and *Apis mellifera*. The result showed that the size of tomatoes was bigger, higher weight, and more seeds when pollinated by *M. quadrifasciata* compared to the one pollinated by *A. mellifera*<sup>[11]</sup>. Cruz *et al.*, (2004) also reported the increase in number of fruits 13, 51 %, number of seeds 85,85 % and fruit weight 29,69 % on sweet pepper because of pollinating by *Melipona subnitida* compared to pollinating by wind<sup>[5]</sup>. Jarlan *et al.* (1997) reported the increase of yield of *Capsicum* up to 19,3% due to pollinating by stingless bees<sup>[12]</sup>. Kwon and Saeed (2003) found the increase in fruit weight 27,2% and number of seeds of 47,8% of *Capsicum* due to pollinating by bees<sup>[13]</sup>.

Pollination on sweet pepper supported by various species of stingless bees showed that not all species were successful as

pollinators. It depended on size of stingless bees. *Melipona favosa*, *Trigona carbonaria*, and *Melipona subnitida* having bigger size were effective to increase yield of sweet pepper, but *Tetragonisca angustula* having smaller size could not make [5, 4, 14]. However, for *T. minangkabau* and *T. leviceps* with body size  $3.4 \pm 0.2$  mm and  $4.4 \pm 0.2$  mm and included subgenus *Tetragonula* showed the same effectivity as pollinators.

Besides species of pollinator, architecture of flowers like size, the site of reproduction organ, accessibility to nectar, and flower structure, could affect interaction between plant and its pollinator. If there is an incomplete factor like small size of flower, thus a big size of insect is not appropriate to be pollinator [15, 16].

Sakagami *et al.* (1985); Osawa and Tsubaki, (2003) described that having smaller size (2-14 mm) enabled the stingless bees to access various flowers with a very narrow opening that could not be accessed by other bees. Therefore, for chili pepper the appropriate pollinator is *Trigona* spp [17, 18]. Suryani (1999) reported that using *Trigona minangkabau* as pollinator on chili pepper plant could effectively increase fruit set (65%) compared to pollinating by other insects (59%) and wind (56%) [6].

Frequency and duration of visit by pollinators to nectariferous depend on nectar production level [19]. Nectar consists of 25-75% sugar with various numbers of amino acids and lipids. Generally, biotic pollinators need physical contact with reproductive organ of flower for pollinating to occur [20]. Due to their small body size of *Trigona minangkabau* and *T. leviceps*, when obtaining nectar their heads could enter up to the base of flower and the their legs contact with pollen so that pollination could occur. Besides that, in foraging behavior, stingless bees tends to show flower constancy [21]. In this case there would be repeated visit to the same flower. Thus, *Trigona minangkabau* and *T. leviceps* were found to be effective as pollinator for chili pepper plants.

## Conclusion

Pollination on chili pepper plants supported by *Trigona minangkabau* and *T. leviceps* was effective in increasing fruit set and seed numbers. By increasing the fruit set and seed numbers it would automatically increase fruit numbers per plant and weight and in turn would increase yield  $\text{ha}^{-1}$ . *Trigona* spp. as pollinator did not affect length and diameter of fruit. Flower handling time and time taken to move from one to another flower between *T. minangkabau* and *T. leviceps* were not significantly different. *T. leviceps* made Z letter movement before alighting while *T. minangkabau* did not show specific pattern before alighting on flower.

## Acknowledgement

It is my pleasure to acknowledge Directorate General of Higher Education Ministry of Research and Technology-Higher Education and Kopertis Area X for providing research fund on Hibah Disertasi Doktor.

## References

- Putra DP, Dahelmi Salmah S, Swasti E. Spesies Diversity of Stingless Bees (Hymenoptera: Meliponini) in Chili PEPPER (*Capsicum annum* L.) Plantation in West Sumatera. International Journal Science Research. 2016; 5(4):1527-1532.
- Pickersgill B. Genetic resources and breeding of *Capsicum* spp. Euphytica 1997; 96:129-133.
- Meeuwswen FJAJ. Stingless bees for pollination purposes

in greenhouses, in: Sommeijer M.J., Ruijter A. de (Eds.), Insect Pollination in Green-houses: Proc. specialists' meeting held in Soesterberg, The Netherlands 2000, 143-147.

- Occhiuzzi P. Stingless bees pollinate greenhouse *Capsicum*, Aussie Bee 13, 15. Published by Australian Nature Bee Research Centre, North Richmond NSW Australia, 2000.
- Cruz D. de O, Freitas BM, Silva LA da, Silva SEM da, Bomfim IGA. Pollination efficiency of the stingless bee *Melipona subnitida* on Green-house sweet pepper, Pesq. Agropec. Bras., Brasilia 2005; 40:1197-1201.
- Suryani SD. The role of *Trigona* (*Tetragonula*) *minangkabau* Sakagami et Inoue as pollinators on chilli papper plants (*Capsicum annum* L.) Thesis Graduate University of Andalas Padang, 1999.
- Bosland PW, Votava EJ. Peppers, Vegetables and Spices *Capsicum*. CABI Publishing, New York, 2000, 198.
- Steel RGD, Torrie JH. Principles and Procedures of Statistics. 2nd ed. New York: McGraw-Hill, 1980.
- Klein AM, Vaissiere BE, Cane JH, Steffan-Dewenter I, Cunningham SA, Kremen C *et al.* Importance of pollinators in changing landscapes for world crops. Proceedings of the Royal Society B: Biological Sciences 2007; 274:303-313.
- Klatt BK, Holzschuh A, Westphal C, Clough Y, Smit I, Pawelzik E *et al.* Bee pollination improves crop quality, shelf life and commercial value. Proceedings of the Royal Society B: Biological Sciences. 2014; 281(1775):20132440.
- Santos SAB dos, Bego LR, dan Roselino AC. Pollination in tomatoes, *Lycopersicon esculentum*, by *Melipona quadrifasciata anthidioides* and *Apis mellifera* (Hymenoptera, Apinae), Proc. 8th IBRA Int. Conf. Trop. Bees and VI Encontro sobre Abelhas, 2004, 688.
- Jarlan A, De Oliveira D, Gingras J. Pollination by *Eristalis tenax* (Diptera: Syrphidae) and seed set of greenhouse sweet pepper. Horticultural Entomology. 1997; 90:1646-1649.
- Kwon YJ, Saeed S. Effect of temperature on the foraging activity of *Bombus terrestris* L. (Hymenoptera: Api-dae) on greenhouse hot pepper (*Capsicum annum* L.). Applied Entomology and Zoology. 2003; 38:275-280.
- Roubik DW. Pollination of Cultivated Plants in the Tropics. FAO. Agricu-ltural Services Bulletin No. 118. FAO, Rome, Italy. 1995, 196.
- Ghazoul J. The pollination and breeding system of *Dipterocarpus obtusifolius* (Dipterocarpaceae) in dry deciduous forests of Thailand. Journal of Natural History. 1997; 31:901-916.
- Griffin AR, Sedgley M. Sexual reproduction of tree crops. Academic Press Inc. Harcourt Brace Jovanovich Publishers. San Diego, 1989.
- Sakagami SF, Inoue T, Salmah S. Key to the stinglessbee species found or expected from Sumatra. In: R.I. Ohgushi (Ed.). Evolutionary Ecology of Insect in Humid Tropics, Especially in Central Sumatra. Kanasawa University, Japan. Sumatra Nature study (Entomology) 1985, 37-43.
- Osawa N, Tsubaki Y. Seasonal variation and community structure of tropical bees in a lowland tropical forest of peninsular Malaysia : the impact of general flowering. Springer.-Verlag. 2003, 315-324.
- Nicolson SW, Nepi M. Dilute nectar in dry atmospheres: nectar secretion patterns in *Aloe castanea* (Asphodelaceae). International Journal of Plant Sciences

2005; 166:227-233.

20. Graham LE, Graham JM, Wilcox LW. Plant Biology. Upper Saddle River: Pearson Prentice Hall, 2006.
21. Slaa EJ, Chaves LAS, Malagodi-Bragac KS, Hofstede FE. Stingless bees in applied pollination: practice and perspectives. *Apidologie* 2006; 37:293-315.



**Pengirim uang**  
**To send money**

**WESTERN UNION MONEY TRANSFER®**

*Cara cepat mengirim uang ke seluruh dunia*  
*The fastest way to send money world wide*

Tujuan (kota, negara) Destination (city, country)		Jumlah/Amount		JANGAN MENULIS DIBAGIAN INI DO NOT WRITE THIS AREA	
Rohini, Delhi, India		US 115 \$			
Jumlah terbilang Amount in words		Sumber dana Source of fund		Tujuan penggunaan dana Purpose of fund	
Penerima / Receiver		ID Penerima Receiver ID		Agen Agency	
Nama depan First name (s)				No. Operator Operator No.	
AKHIL GUPTA				PAK 82	
Nama belakang Last Name (s)				Tanggal Date	
				23/5/16	
Alamat Address				Waktu Time	
POCKET C-12 PLAT NO 107 SEKTOR 03 ROHINI DELHI INDIA				11:27	
Kota/City		Negara/Country		Kode Pos/Post Code	
Padang, Indonesia					
Pengirim / Sender		Jumlah Amount		Biaya Charge	
Nama depan First name (s)		1.682.262		90.000	
DEWIRMAN PRIMA PUTRA					
Nama belakang Last Name (s)				Biaya telepon/pengiriman Telephone/delivery charge	
Alamat Address				Pesanan Message	
KOMP. PELANGI INDAH B5/15 PADANG INDONESIA					
Kota/City		Negara/Country		Kode Pos/Post Code	
Padang, Indonesia					
No. Telepon Telephone no.		No. rek. nasabah/Preferred Customer No.		Pajak Tax	
Biaya dikenakan untuk layanan tambahan, pilihlah layanan yang diinginkan Optional services available at additional cost. check services desired		Jumlah yang diterima Total amount received		Tanda pengenal Identification	
<input type="checkbox"/> Saya ingin cek dikirim kealamat berikut I want a check delivered to the following address <input type="checkbox"/> Saya ingin WU menghubungi penerima I want to WU telephone the receiver <input type="checkbox"/> Pesan yang dikirim Message to be sent		1.682.262		KTP	
Apakah penerima memiliki tanda pengenal yang berlaku? Will the Receiver have valid identification? <input type="checkbox"/> Yes <input type="checkbox"/> No		Bila tidak ada, buat Pertanyaan Test : (max. 4 kata) If no, provide a test Question : (Limit 4 Words)		Tipe Type	
Jika lebih dari 1.000.000,- diperlukan keterangan Fisik Penerima If over @500,- a physical Description of the Receiver is needed				Berlaku s/d Expiration	
Warna Mata Eye Color		Jenis Kelamin Sex		Nomor Number	
				1371091012610003	
Tinggi Height		Warna Rambut Hair Color		Tanda Tangan Agen Agent's Signature	
				[Signature]	

E 2014 215 X 1616 500.000 sat NCR SP/2014

Syarat dan kondisi tentang layanan yang diberikan terdapat pada halaman belakang formulir ini. Dengan menandatangani formulir ini, saya menyatakan bahwa saya telah membaca dan menerima syarat dan kondisi tersebut.  
The terms and conditions on which the services is provided are set out on the reverse side of this forms. By signing this forms acknowledge that I have read, understand and accepted terms and conditions.

**WESTERN UNION SENDING RECEIPT** 414668696

MITCH : 117-829-7841  
 Counter : Kantor Pos PADANG 25000  
 Date : 23-05-2016 Time : 11:52:18  
 Trx ID : 2500000-12/16/000377  
 Sender ID : 250001600002574 Customer No : 1371091012610003  
 Sender Name : Mr. DEWIRMAN PRIMA PUTRA NO LAST NAME Phone : 081363303821  
 KOMP PELANGI INDAH BLOK B5 PADANG KURANJI  
 KOTA PADANG 25000 / INDONESIA  
 Receiv ID : 250001600002574 Customer No :  
 Receiv Name : MR. AKHIL GUPTA Phone : 00  
 POCKET C 12 PLAT NO 107 SEKTOR 03 ROHINI INDIA  
 INDIA 00 / INDIA  
 Source Fund : LAINNYA Question :  
 Purpose Fund : LAINNYA Answer :  
 Principal : Rp. 1.592.262,00 Employee ID  
 Exchange Rate : 0.0048390  
 Expected Payout : INR 7.705,00  
 Total Charge : Rp. 90.000,00  
 Discount : Rp. 0,00  
 Total Collect Amount : Rp. 1.682.262,00

RIRI YEMALBERTA

**KANTOR POS** POS INDONESIA

Syarat dan ketentuan berlaku Lacak status : <http://www.posindonesia.co.id>

Printed by TRISAKTI (024) 7603855 (TRW-JLAN III/2015)



• **Dewirman Prima Putra** <de\_wirman\_pp@yahoo.com>  
Kepada: zoologyjournal@gmail.com



Sab, 21 Mei 2016 jam 09.26 ☆

Dear Submiission Desk JEZS

I submit improvements manuscript journal  
a.n. Dewirman with Reffrence (Ento-4-3-152)

I wait further information from team JEZS,

If I want to payment for journal the next day,

I hope to via Western Union: thank you

Regards me

Dewirman





**Journal of Entomology and Zoology Studies**

**ISSN Print: 2349-6800 | ISSN Online: 2320-7078**

This certificate confirms that "Dewirman Prima Putra, Dahelmi, Siti Salmah M, Etti Swasti" have published manuscript titled "Pollination in chili pepper (*Capsicum annuum* L.) by *Trigona laeviceps* and *T. minangkabau* (Hymenoptera, Meliponini)".

Details of Published Article as follow:

Volume : 4

Issue : 4

Year : 2016

Page Number : 191-194

Certificate No. : 4-3-152

Date : 25-06-2016

[↓ Unduh semua lampiran sebagai file zip](#)

ISSN Print: 2349-6800 | ISSN Online: 2320-7078

## *Publication Certificate*

This certificate confirms that "**Dewirman Prima Putra**" has published manuscript titled "**Pollination in chili pepper (*Capsicum annuum* L.) by *Trigona laeviceps* and *T. minangkabau* (Hymenoptera, Meliponini)**".

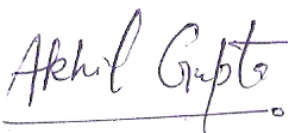
Details of Published Article as follow:

Volume : 4  
Issue : 4  
Year : 2016  
Page Number : 191-194

Certificate No.: 4-3-152

Date: 25-06-2016

Yours Sincerely,



**Akhil Gupta**

Publisher

Journal of Entomology and Zoology Studies

[www.entomoljournal.com](http://www.entomoljournal.com)


Journal of Entomology and Zoology Studies

Email: [zoology.journal@gmail.com](mailto:zoology.journal@gmail.com) Website: [www.entomoljournal.com](http://www.entomoljournal.com)

Contact Us
Invitation
Open Access
Peer Review and Publication Policy
Terms & Conditions

<b>SPECIAL ISSUE</b>
Special Issue

<b>COPYRIGHT FORM</b>
Download Copyright Form

<b>IDENTIFIER</b>


5	<p>Biology of <i>Pontia daplidice</i> (Lepidoptera: Pieridae) on its New Host Plant <i>Lepidium pinnatifidum</i> from Potohar Region, Pakistan</p> <p>Syed Waqar Shah, Muhammad Ather Rafi and Syed Ahmed Zia</p> <p><a href="#">[ABSTRACT]</a> <a href="#">[DOWNLOAD]</a></p> <p>PAGES: 179-183   1470 VIEWS 47 DOWNLOADS</p>	Pakistan
6	<p>Pollination in chili pepper (<i>Capsicum annum</i> L.) by <i>Trigona laeviceps</i> and <i>T. minangkabau</i> (Hymenoptera, Meliponini)</p> <p>Dewirman Prima Putra, Dahelmi, Siti Salmah M, Etti Swasti</p> <p><a href="#">[ABSTRACT]</a> <a href="#">[DOWNLOAD]</a></p> <p>PAGES: 191-194   1407 VIEWS 67 DOWNLOADS</p>	Indonesia
7	<p>Fidelity Analysis among Mates of Different Breeds of <i>Columba livia</i>, District Kohat, KPK, Pakistan</p> <p>Shehzad Zareen, Hameed Ur Rehman, Raqeebullah, Abid Ur Rehman</p> <p><a href="#">[ABSTRACT]</a> <a href="#">[DOWNLOAD]</a></p> <p>PAGES: 195-197   1295 VIEWS 16 DOWNLOADS</p>	Pakistan
8	<p>The efficiency of food utilization by the small orange tip butterfly <i>Colotis etrida</i> (Boisduval, 1836) (Lepidoptera: Rhopalocera: Pieridae) in the Eastern Ghats of Southern Andhra Pradesh-India</p> <p>P Harinath, K Suryanarayana, S P Venkata Ramana</p> <p><a href="#">[ABSTRACT]</a> <a href="#">[DOWNLOAD]</a></p> <p>PAGES: 198-204   1390 VIEWS 16 DOWNLOADS</p>	India