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# THE PARASITISM OF *Eretmocerus mundus* MERCET (HYMENOPTERA; APHELINIDAE) ON *Bemisia tabaci* GENNADIUS (HOMOPTERA; ALEYRODIDAE) and ITS MASS REARING ON SEVERAL ALTERNATIVE HOSTS

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## ABSTRACT

Sweet potato whitefly *Bemisiatabaci* Gennadius is one of major pests of vegetables. One of techniques to control this pest is the use of parasitic wasp *Eretmocerus mundus* Mercet. This research was aimed to find out the effect of host density on level of parasitization and alternative host for mass rearing of *E. mundus*. This research was carried out at green house of the Departement of Plant Pests and Diseases, Faculty of Agriculture, Universitas Padjadjaran. In parasitization test, the experiment was arranged in a randomized block design consisting of six treatments (50, 100, 150, 200, 250, and 300 nymphs of *B. tabaci*) and four replications. In alternative host test, five treatments (*B. tabaci, Trialeurodes*sp., *Aleurodicus* sp., *Aleurocanthus* sp., and *Aphis gossypii)* were used. The result showed that host density affected on the parasitization level. The highest parasitization occurred at host density of 200 nymphs, that was 29.25%. *Trialeurodes* sp. and *Aleurodicus* sp. can be parasitized by *E. mundus* with levels of parasitization were 19.6% and 2.6%, respectively. There was no significant different between the parasitization on *Trialeurodes*sp. (19.6%) and *B. tabaci* (24%). However, the performances of the parasitoid (parasitization level, adult emergence, and host feeding behaviour) reared on *B. tabaci* was better than those reared on *Trialeurodes* sp.

Key word: *Eretmocerus mundus*, mass rearing, alternative host

# TINGKAT PARASITISASI PARASITOID NIMFA *E retmocerus mundus* MERCET (HYMENOPTERA; APHELINIDAE) PADA *Bemisia Tabaci* GENNADIUS (HOMOPTERA; ALEYRODIDAE) DAN PERKEMBANGBIAKAN MASSAL PADA BEBERAPA INANG ALTERNATIF.

## ABSTRAK

Salah satu hama yang sangat potensial menyerang tanaman sayuran di lapangan yaitu hama kutu kebul *Bemisia tabaci* Gennadius (Homoptera: Aleyrodidae). Salah satu teknik pengendalian yang ramah lingkungan yaitu dengan menggunakan parasitoid nimfa *Eretmocerus mundus* Mercet. Penelitian ini bertujuan untuk mengetahui tingkat parasitisasi *E.mundus* pada berbagai kepadatan nimfa dan mengetahui inang alternatif untuk perkembangbiakan massal parasitoid *E. mundus* Penelitian dilaksanakan di rumah kaca hama Jurusan Hama dan Penyakit Tumbuhan Fakultas Pertanian, Universitas Padjadjaran, Jatinangor. Metode yang digunakan adalah metode eksperimen dengan Rancangan Acak Kelompok (RAK) yang terdiri dari enam perlakuan (50 nimfa, 100 nimfa, 150 nimfa, 200 nimfa, 250 nimfa, 300 nimfa) dan empat ulangan untuk pengujian tingkat parasitisasi, dan lima perlakuan (*B. tabaci, Trialeurodes* sp., *Aleurodicus* sp., *Aleurocanthus* sp., dan *Aphis gossypii)* dengan lima ulangan pada pengujian inang alternatif. Hasil penelitian menunjukan kepadatan inang mempengaruhi tingkat parasitisasi, tingkat parasitisasi tertinggi terjadi pada kepadatan nimfa 200 yaitu sebesar 29.25%. *Trialeurodes* sp. dan *Aleurodicus* sp. dapat terparasit oleh *Eretmocerus* sp. akan tetapi tingkat parasitisasi pada *Aleurodicus* sp. sangat rendah (2.6%) sedangkan pada *Trialeurodes* sp. (19.%) tidak berbeda nyata dengan *B.tabaci* (24%). Namun performa (tingkat parasitisasi, kemunculan imago, dan kemampuan *host feeding*) parasitoid yang dihasilkan dari inang berupa *B.tabaci* lebih baik dibandingkan dengan *Trialeurodes* sp.

Kata Kunci : *Eretmocerus mundus*, perkembangbiakan massal, inang alternatif

## INTRODUCTION

*Bemisia tabaci* Gennadius (Homoptera; Aleyrodidae) is a key pest of many vegetables, ornamentals, and agronomic crops throughout the world (van Lenteren and Noldus, 1990; Gerling *et al*., 2001). In Indonesia, *B. tabaci* was detected for the first time in 1938 (Kalshoven, 1981). Nowadays, *B. tabaci* can be found trough out Indonesia. *B. tabaci* can cause serious plant damage in many agricultural areas in Jawa, Kalimantan, Sulawesi and Bali (Setiawati, *et al.* 2005). Recently, *B. tabaci* is reported to be a major pest of tomato and chili at horticultural center areas in Java such as Bogor, Cianjur, Brebes, Wonosobo, Magelang, Klaten, Boyolali, Kulonprogo, Blitar, and Tulungagung (Wiyono, 2007).

According to Byrne *et al.* (1990), the life cycle of whiteflies consists of an egg stage, four nymphal stages, and adults (both sexes). Eggs are deposited on the underside of leaves of the host plants. The first nymphal stages (crawler) are able to move short distance. The other three nymphal stages, however, settle down and feed the leaves before adults emerge. Approximately 4-5 days before adult emergence, the red eyespots of the developing adults are visible, the phase called the "pupal stage". An adult female whitefly can start laying eggs 1-3 days after emerging. They can oviposit up to 800 eggs and live about 25 to 30 days, depending on environmental conditions .

The control of white flies includes the components of integrated pest management (IPM) such as cultural and physical control, host-plant resistance, chemical control, and biological control. Farmer in Indonesia mostly use chemical pesticides for controlling *B. tabaci*. However, whiteflies adults, eggs and nymphs are located on the underside of leaves where they are protected from overtop applications of insecticides. Therefore, chemical control of whiteflies not always effective. In addition, the control of whiteflies with chemical pesticides is often problematic because of the wide occurrence of resistance in whiteflies to these pesticides (Palumbo *et al*., 2001 *cit. in* Ardeh, 2004). Because of the negative impacts of chemical control, research was directed at developing biological control by searching for efficient natural enemies of white flies (Gerling *et al*., 2001; van Lenteren & Martin, 1999). Biological control is an effective method to protect agricultural products and to reduce the use of pesticides, which are applied to control whiteflies (Hoddle, 1999).

The biological control for *B. tabaci* includes the uses of parasitoids, predators and enthomopatogenic microorganisms. Several biocontrol agents for *B. tabaci* was found in several agricultural areas in West Java Province. One of the most effective biocontrol agents for *B. tabaci* is *E. mundus* (Sudarjat, 2009). Commercial biological programs aimed at controlling greenhouse whiteflies are often use the parasitoid *E. mundus* (van Lenteren& Martin, 1999).

*Eretmocerus s*pecies are tiny wasps; their body length are 0,72-0,77 mm for females, and 0,582-0,801 mm for males (Hafez *et al.* 1978 *cit. in* Ardeh, 2004). *Eretmocerus*is an ectoendoparasitoid; females stand beside their host and oviposit between the venter of the host nymph and the leaf surface. Newly deposited eggs are oval and transparent and they turn brown on the next day (Hafez *et al.* 1978 *cit. in* Ardeh, 2004). The first instar larva penetrates into the host through a complex procedure, which apparently involves puncturing the host with its mandibles and the host engulfing the young larva (Gerling *et al*., 2001). In addition to using host for oviposition, where eggs develop during the adult life of the parasitoid, often use hosts for feeding to obtain essential nutrients (Ardeh, 2004). Host feeding is the consumption of host fluids exuding from a wound which is usually made by female ovipositor. As host feeding may result in killing of the hosts, a parasitoid female may selest lower quality host for feeding and higher quality hosts for egg laying. Consequently, the female must make a decision whether to use a host for egg laying or for host feeding (Jervis & Kidd, 1986 *cit. in* Ardeh, 2004).

One of obstacles in mass rearing of *E. mundus* was theavalaibility the host for mass production. *B. tabaci* is usually used as host for mass rearing of *E. mundus*. However, as the size of *B. tabaci* nymph is very small and very hard to handle, therefore, alternative hosts for mass rearing of the parasitoid in laboratory are required. The aims of this study were to evaluate the effects of various density levels of host insects on parasitization rate and to search alternative hosts for mass rearing of *E. mundus*.

## MATERIAL AND METHOD

This experiment was held in a green house at the Department of Plant Pests and Diseases, Faculty of Agriculture, Universitas Padjadjaran, at ±700 meters above sea level. Average temperature during research was 25,28$^{o}$C, with relative humidity 68%.

This research consisted of two different experiments. First experiment was parasitization test aimed to examine the effect of host density (*B. tabaci)* on level of parasitism by *E. mundus*. Second experiment was a test on alternative host of *E. mundus* for its mass rearing.

### The level of parasitism

The experiment was arranged in a randomized block design consisting of six treatments of nymph density with four replications in each. The treatments were

A. = 50 nymphs
B. = 100 nymphs
C. = 150 nymphs
D. = 200 nymphs
E. = 250 nymphs
F. = 300 nymphs

*B. tabaci* was taken from several agricultural areas in West Java, especially in horticulture plantation. *B. tabaci* was reared in two week-old pumpkin plants. Pumpkin plants were fertilized with organic fertilizer. Each pumpkin plant was placed into a cage and infested with approximately twenty adults of *B. tabaci.*

*E. mundus* was obtained from field-grown tomato, bean and pumpkin in several horticultural center areas in West Java; Lebak Muncang, Ciwidey (Bandung) and Tirtamulya (Karawang). *E. mundus* was reared on *B. tabaci* nymph in pumpkin plants grown in green house.

Parasitoid pupae were collected from the leaves and put separately in a glass vial. The emerging adults were used for experiment in the next day. Level of parasitism test was held in a pumpkin plant infested by nymphs of *B. tabaci*, with the density were according to each treatment. Six adults *E. mundus* were then infested.

The cumulative number of parasitized nymphs was observed every day during 20 days, and then calculated by the following equation:

Note:

$$P = \frac{N2}{N1} X\ 100\%$$

P = level of parasitism (%)
N2 = total parasitized *B. tabaci* nymphs by eretmocerus
N1 = total *B. tabaci* on treatment

### The alternative host

The experiment was arranged in a randomized block design consisting of five treatments of alternative host with four replications in each treatment.

A. = *B. tabaci*
B. = *Trialeurodes* sp.
C. = *Aleurodicus* sp.
D. = *Aleurocanthus* sp.
E. = *Aphis gossypii*

Alternative hosts of *E. mundus* used in this research were several species from the order of Homoptera, family Aleyrodidae. They were *Aleurocanthus* sp. from citrus plantation in Arboretum Unpad., *Trialeurodes* sp. from ornamental plant “kastuba” (poinsettia) in Lembang, and *Aleurodicus* sp. from cassava in Unpad area. We also used one species from the order of Aphidoidae, that was *A. gossypii* from pumpkin plant.

The host plants used in this experiment were citrus (*Citrus* sp.) for *Aleurocanthus* sp.,bean (*Vigna* sp.) for *Aleurodicus* sp., kastuba (*Euphorbia peulcherrima)* for *Trial-*

*eurodes* sp., and pumpkin (*Cucurbita* sp.) for *A. gossypii*. They were fertilized with organic fertilizer. Six adult parasitoid were infested in every alternative host, when the nimphs of each approximately 200 per plant.

The observed response variable is the number of offspring parasitoids emerged and their vitality. Observation was done daily for 21 days. Level of parasitism was calculated using the same formula as previous experiment.

## RESULT AND DISCUSSION

### Level of Parasitism of *E. mundus* on *B. tabaci*

The highest level of parasitism of *E. mundus* on *B. tabaci* was found in the treatment of 200 nymphs density (Table 1). At higher density (250 and 300 nymphs), the parasitization rate was lower. According to Kfir (1983) *cit.* Djuwarso *et al*. (1997) too high host density can result in a decrease of parasitization, a reduction of fertility rate, and a decline in female population. One of the most influential factor in the level of parasitization by parasitoid is host population density (De Bach, 1973). In high density there were probably lack of nutrition and therefore caused reduction of fertility of parasitoid.

Table 1. The level of *E. mundus* parasitization various density of *B. tabaci* nymphs

| Treatment | The level of parasitization (%) |
|---|---|
| A = 50 nymphs *B. tabaci* | 24.50 bc |
| B = 100 nymphs *B. tabaci* | 20.25 abc |
| C = 150 nymphs *B. tabaci* | 19.64 ab |
| D = 200 nymphs *B. tabaci* | 29.25 c |
| E = 250 *B. tabaci* nymphs | 21.47 bc |
| F = 300 nymphs *B. tabaci* | 13.47 a |

Note: The average number marked by the same letter are not significantly different according to Duncan's Multiple Range Test at level of 5%.

In this study, all treatments of *B. tabaci* density resulted in parasitization by *E. mundus* at rates of no more than 50%. This could be due to the difference in the host plant of *B. tabaci* in the field (pumpkin plants) and in the experiment (bean plants). This might be related to the fact that natural enemies often use chemicals derived from host plants for stimulating host searching and egg laying (Ardeh., 2004; Purnomo, 2007).

The rejection of host by the parasitoid may be cause the host has been used in the process of parasitoid host feeding. The low level of parasitization could also due to the host insects (*B. tabaci* nymphs) already entered the fourth instars. Ardeh, (2004) stated that *E. mundus* prefers the second and the third instar nymph of *B.tabaci* instar rather than the fourth instars.

Eventough in this experiment the level of parasitization was quite low, *Eretmocerus* sp. the parasitoid *E. mundus* can be considered as an effective parasitoid because their level of parasitization did not decline significantly at low host density (50 nymphs). According to De Bach (1973), one indicator of an effective natural enemy is still capable of doing high levels of parasitization of the host even though at low density (De Bach, 1973).

### Potency of *E. mundus* as a bicontrol agent for *B. tabaci*

In parasitoid augmentation, an effective parasitoid must have ability to produce their progeny in field for their sustainability. The result showed that the percentages of parasitoid emergence were not significantly different among treatments, ranging from 70-90% (Table 2). The emergence can be noticed from a circular exit holes on the dorsal surface of the fourth instar nymphs (pre-pupa) of *B. tabaci.*

In the augmentation of parasitoids, sex ratio is an important factor in determining their potential for field application. Ardeh (2004) suggested that the sustainability of the female offspring parasitoids was preferred compared male offspring. The result showed that sex ratio of parasitoid *E. mundus* was approximately 50:50 (Table 2), therefore releasing *E. mundus* into the field will be

Table 2 : Potency of *E. mundus* as a bicontrol agent for *B. tabaci*

| Treatments | Number of 1stprogenyP | Percentage of emergence (%) | Sex Ratio *Eretmocerus* sp. | Number of Host Feeding (%) |
|---|---|---|---|---|
| A = 50 nymphs *B.tabaci* | 9.50 a | 81.16 a | 0.58 a | 28.00 d |
| B = 100 nymphs *B.tabaci* | 18.50 b | 89.80 a | 0.50 a | 19.50 c |
| C = 150 nymphs *B.tabaci* | 27.25 c | 92.27 a | 0.53 a | 14.83 bc |
| D = 200 nymphs *B. tabaci* | 42.75 d | 74.69 a | 0.52 a | 15.50 bc |
| E = 250 *B. tabaci* nymphs | 43.75 d | 79.92 a | 0.56 a | 11.98 ab |
| F = 300 nymphs *B.tabaci* | 36.75 cd | 84.82 a | 0.53 a | 9.33 a |

Note : The average number marked by the same letter are not significantly different according to Duncan's Multiple Range Test at level of 5%.

sustainable control, because *E. mundus* can produce offspring for their sustainability in field. The sex ratio of *E. mundus* in the field was usually 1:1 (50% male and 50% females) (Ardeh, 2004).

Another potency of *E. mundus* is host feeding ability. Based on data in Table 2, host feeding ability among treatments showed differences. The highest level of host feeding (28%) occurs at low densities (50 nymphs). The average capacity of host feeding ranged from 2 to 6 nymph *B.tabaci.* Hoddle (1999) suggests that the ability of host feeding of the parasitoid *Eretmocerus* sp. ranges from 2 to 3 nymphs /day.

**The level of parasitization in various alternative host.**

Three types of insect pests parasitized by *E. mundus* were *B. tabaci* (which was the main host), *Trialeurodes* sp. and *Aleurodicus* sp. (Table 3). No parasitization occurred on two other types of pests, *Aleurocanthus* sp. and *A.gossypii.*

The highest level of parasitization by *Eretmocerus* sp. occurred on *B. tabaci* that was 24%. The percentage was not significantly different with the level of parasitization occurred on *Trialeurodes* sp. (19,6%). This could be due to similarities in the characteristics of the nymphs of both pests. For *Aleurodicus* sp., the parasitization rate by *Eretmocerus* sp. was very low (2,6%). *Aleurodicus* sp. nymph was covered by a quite thick layer of wax (Hodges, 2007). That may hinder the parasitoid to detect and lay eggs in the nymph. Parasitization did not occur in two of the tested pests, *Aleurocanthus* sp. and *A. gossypii*. This could be due to differences in the nutrients availability and also the texture of the insect host. Nymphs *Aleurocanthus s*p. is relatively harder than *B. tabaci* and therefore it is difficult to be penetrated by the parasitoid.

Table 3. Level of parasitization by *Eretmocerus* sp. on several alternativehost.

| Treatment | Parasitization level (%) |
|---|---|
| A= nymph of *B.tabaci* on pumpkin plants | 24,00 a |
| B=nymph of *Trialeurodes* sp. on *Euphorbia pulcherrima* | 19.60 a |
| C = nymph of *Aleurodicus* sp. on bean plant | 2.60 b |
| D = nymph of *Aleurocanthus* sp. on citrus plant | 0.00 c |
| E = nymph of *A.gosypii* on pumpkin plants | 0.00 c |

.Note : The average number marked by the same letter are not significantly different according to Duncan's Multiple Range Test at level of 5%.

According to Pengemanan (2005), several companies that produce parasitoids in Germany use nymphs of *Trialeurodes* sp. for the mass production of parasitoids *Encarsia formosa* (Hymenoptera; Aphelinidae), whereas the mass production of parasitoids *Eretmocerus* sp. can be performed on *B. tabaci* nymphs (Eliyahu 2008). Both *B. tabaci* and *Trialeurodes* sp. require host plants for development. Since it is not possible to remove the leaf because the nymphs will die, therefore, in the mass production of the parasitoids *Eretmocerus* sp. in the hosts *B. tabaci* and *Trialeurodes* sp. can only be conducted on the host plant. The removal of the parasitized pupa should be performed when the color turning into blackish-brown by using a spatula to a *paper pale*.

**Potency of *E. mundus* reared on several alternative host**

The parasitoids reared on *B. tabaci* produced more offspring that was 24 progeny per 3 *E. mundus* or 8 progeny per parasitoid, produced only 10 progenies or about 3 to 4 progenies per parasitoid (Table 4). Suitable parasitoid hosts are not only able to provide a high level of parasitization but also has a capacity to produces off springs, to ensure the success of release parasitoid in the field.

The average *sex ratio of* 1st progeny of *E. mundus* reared in *B. tabaci* and *Trialeurodes* sp. did not show significant differences. In this experiment *sex ratio E. mundus* was 1:1 (female: male). However in field, the *sex ratio* tend to be more females than males (Hoddle, 2008). The ability of *host feeding* by parasitoids *Eretmocerus* sp. on both host did not show marked differences, which is 11-14% or 2 to 3 nymph for individual parasitoid. This could be due to a similarity in the nutritional content of *Trialeurodes* sp. and *B. tabaci* that influenced the performance of the parasitoid *E. mundus*.

The level of first parasitization of 1st progeny *E. mundus* reared on *B. tabaci* was significantly higher than *E. mundus* reared on *Trialeurodes* sp. (Table 4). This perhaps because the difference in nutrient in *B. tabaci* and *Trialeurodes* sp., therefore it can affected the capability of parasitization. The mass rearing of parasitoids conducted in a greenhouse by using alternative hosts is intended for field application to control *B. tabaci.* There were significant differences between parasitoids reared on *B. tabaci* and on the alternative host *Trialeurodes* sp.. Parasitoid yang dikembangkan pada inang *Trialeurodes* sp.Parasitoids that reared on *Trialeurodes* sp. show considerable decline parasitization level in subsequent progeny, whereas on *B. tabaci* reported that the performance (i.e. number of 1st progeny, percentage of adult emergence, parasitization level, host feeding) of *E. mundus* was better on *B. tabaci* than on *Trialeurodes*sp. Considering that fact mass production of parasitoids *E. mundus* should be done on *B. tabaci* because their progeny has high level of parasitization and a good performance in the field.

Table 4: Potency of *E. mundus* reared on several alternative hosts

| Treatments | Number of Progeny *) | adult parasitoid emergence (%) | Imago Sex Ratio (%) | *Host Feeding* (%) | Level of parasitism test (%) |
|---|---|---|---|---|---|
| A = nymph *B. tabaci* | 24.00 a | 80.00 a | 0.52 a | 14.80 a | 25.20 a |
| B = nymph *Trialeurodes* sp. | 10.00 b | 45.45 b | 0.54 a | 11.60 a | 13.00 b |
| C = nymph *Aleurodicus* sp. | 0.00 c | 0.00 c | - | 0.00 b | - |
| D = nymph *Aleurocanthus* sp. | 0.00 c | 0.00 c | - | 0.00 b | - |
| E = nymph *A. gossypii* | 0.00 c | 0.00 c | - | | - |

Note : The average number marked by the same letter are not significantly different according to Duncan's Multiple Range Test at level of 5%.
*) were based on 3 parasitoids infestation

## CONCLUSSION

The level of *E. mundus* parasitization was influenced by *B. tabaci* nymph density. The highest level of parasitization (29.25%) occurred at density of 200 nymphs. *Trialeurodes sp*. and *Aleurodicus* sp. could be parasitized by *E. mundus*.The level of parasitization on *Aleurodicus* sp. was very low (2.6%) while in *Trialeurodes* sp. (19.6%) was not significantly different from that on *B. tabaci* (24%). The level of parasitization, the emergence of imago, and the ability of host feeding of *E. mundus* reared on host *B. tabaci* was better than that on *Trialeurodes* sp.

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