

THE PARASITISM TYPES AND PERCENTAGE OF PARASITOIDS *LIRIOMYZA SATIVAE* TREATMENT PLANTS WITH TOMATO AND CONVENTIONAL INTEGRATED PEST MANAGEMENT

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Abstract

To control pests and diseases, farmers usually apply insecticide once or twice a week, resulting in pest resistance, resurgence and secondary blasting. Thus it is necessary alternative control method which is more effective to reduce the negative impact of the insecticide, called Integrated Pest Management (IPM). One of the important control techniques is the use of natural enemies in the tomato planting ecosystem. The study aims to determine the type and parasitoid population and the parasitism percentage of *L. sativae* against pests in IPM and conventional treatment. Materials and tools used are tomato leaves, alcohol 70%, plastic containers, plastic bags, rubber bands, paper towel, distilled water, calculators, scissors, collecting bottle and boxes, dissecting, microscope, labels and stationery. Research using field experiments by comparing the population of natural enemies (parasitoids) on IPM and conventional plots. On IPM plot tomatoes were planted using plastic mulch and without synthetic insecticides, while on conventional plots the synthetic insecticides were used without plastic mulch. Results showed four types of parasitoids, *Hemiptarsenus varicornis*, *Gronotoma* sp., *Opius* sp., and *Neochrysocharis* sp. On IPM treatment, the average parasitism percentage of *H. varicornis* is 23.56%, while only 5.36% resulted on conventional treatment. Parasitoids *H. varicornis* has the potential as a pest control agent *L. sativae* because the population is higher than other parasitoids.

Key words: *Hemiptarsenus varicornis*, *Gronotoma* sp., *Neochrysocharis* sp., *Opius* sp., *Liriomyza sativae*, tomato

INTRODUCTION

Parasitoid is a small insect, or measured as large as the parasitized host; the parasitoid also killed its host [25]. Parasitoid requires only one host to perpetuate the life cycle. There are two kinds of parasitoids, exoparasitoid and endoparasitoid. Exoparasitoid are parasitoids that lay their eggs outside and the progeny growing outside of the host. Eggs are usually laid on the surface of the insect's body, then hatch and the exoparasitoid larvae will suck the host insect liquid. Meanwhile, endoparasitoid is a parasitoid that lays eggs inside the host's body and the progeny growing within the host.

The parasitoid species of *Liriomyza* sp. differ according to the species of the parasitoid, host plant species and their geographic regions [16, 11]. From the research made throughout North America and Hawaii, it is known that there are 40 species of *Liriomyza* sp. parasitoids belonging to the order Hymenoptera [11]. Most of these parasitoids belonging to the family Eulopidae, especially those associated with *L. sativae* and *L. trifolii*, while small portion associated with *L. huidobrensis*, which are *Chrysocharis ainsliei* Crawford, *C. parski* Crawford, *Diglypus begini* (Ashmead), and *D. intermedius* (Girault); all belonging to the family Eulopidae and one species of the family Pteromalidae namely *Halticoptera circulus* (Walker). In Indonesia, only three species of parasitoids associated with *L. huidobrensis* as natural enemies [30].

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The manuscript was received: 17.03.2016
Accepted for publication: 05.04.2016

Three types of hymenopteran parasitoid that parasitized *L. huidobrensis* on potato plants at various altitude in West Java, namely *H. varicornis* (Girault) and *Zagrammosoma* sp. of the family Eulopidae and one species of the family Pteromalidae [32]. There are 11 species of parasitoids associated with *L. huidobrensis* in Indonesia, on various plants. All belong to the order Hymenoptera, consisting of 10 species within the family Eulopidae (*Asecodes* sp., *Chrysocharis* sp., *Cirrospilus ambiguus* (Hansson and Lasalle), *Closterocerus* sp., *Hemiptarsenus varicornis* (Girault), *Neochrysocharis formosa* (Westwood), *Neochrysocharis* sp., *Pnigalio* sp., *Quadrasticus* sp., *Zagrammosoma* sp.) and one species of family Eucolidae (*Gronotoma* sp.) [21]. *Opius* sp. (Hymenoptera: Braconidae) was parasitized *L. huidobrensis* that attacks potato plants other than *H. varicornis* [20]. Parasitoid *H. varicornis* is common and dominant species that parasitized *L. huidobrensis* [32, 21], but its parasitism generally low and vary according to the host plant.

MATERIAL AND METHOD

Sampling was conducted at the Toure Village, District of Tompasso and then continued at Entomology and Pest Plant Laboratory, Faculty of Agriculture, Universitas Sam Ratulangi, from March to June 2015. The materials and equipments used in this research are the tomato leaves, alcohol 70%, plastic bags, plastic container, rubber bands, tissue, aquadest, calculators, scissors, collecting bottles, collecting boxes, dissecting sets, microscopes, labels and stationery.

Research using field experiments by comparing the population of natural parasitoids on Integrated Pest Management (IPM) and the Conventional System. At the IPM plot, the tomatoes was covered with plastic mulch and without synthetic insecticides, and at the Conventional system the tomatoes didn't covered with plastic mulch but was used synthetic insecticides. The leaves with symptoms of pests *Liriomyza* sp. was randomly sampling from IPM and the conventional plot, 100 leaves each. Sampling at each sub-sample location six times in two weeks, from four week old until harvesting time. And then put it in the plastic container

that has been layed with wet tissue paper, and then covered with soft gauze. Some *Liriomyza* sp. was dipped in alcohol 70%, and then identified at the Laboratory of Entomology and Pest Plants, Faculty of Agriculture Universitas Sam Ratulangi.



Figure 1 Rearing *L. sativae* to get parasitoid parasitism

RESULTS AND DISCUSSIONS

Parasitoid identification

Things observed in this study are parasitoids found and the population. The observations of parasitism percentage were done to count and record the number of parasitoids was found.

The population of parasitoid, was counted by:

$$P = \frac{\sum \text{Imago parasitoid A}}{\sum \text{Imago Liriomyza sp.} + \sum \text{Imago Parasitoid A}} \times 100\%$$

Notes: P = rate of parasitism (%);

Σ = Number of one parasitoids imago emerged;

Σ = Number of *Liriomyza* sp. imago which emerged from the pupae that do not parasitized [22].

Sample collection of pests *Liriomyza* sp. was identified using Key Polyphagoes Agromyzid leafminers - Lucid Key [15, 31, 17, 28]. Identification of parasitoid using Lucid Key Parasitoids leafminers [4].

The identification of tomato leaves samples with symptoms of pests which are taken from the location, was found that there are four species of parasitoids, namely: *Hemiptarsenus varicornis*, *Gronotoma* sp., *Opius* sp., and *Neochrysocharis* sp.

H. varicornis black imago (Figure 2), the leg is mostly white except the femur rear legs and tarsi. The body length of females ranking from 1.18-2.05 mm, and the males between

0.80-1.70 mm. The female wing length ranges between 0.96-1.62 mm and the males 0.88-2.27 mm. Morphological features of these parasitoids are very distinctive, namely the form of insect antennae of males and females are different, the antenna of male insects nested in 2nd and 3rd panicle and went out of the apex segment. The female insects' antenna has no forked shape antenna, curved and on the last segment of the antenna is white and the curved shape of the elbow called the *lateral geniculate*. The wing shaped thin membranous without clear venation and also without stigma [27].

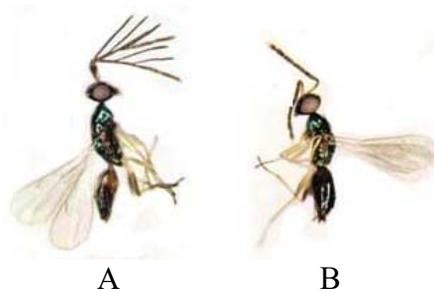


Figure 2 Imago of *H. Varicornis* (A. male, B. female)

In this parasitoid, female offspring produced from a fertilized egg. During his lifetime, the female *H. varicornis* able to lay eggs between 16-92 grains with the average 51, 65 grains, and spawning rate about 2 grains per day. The life cycle of *H. varicornis* ranges from 12-16 days. The eggs, larvae and pupae period, each 1-2 days, 5-6 days and 6-8 days, respectively. The life span of females between 8-22 days, and a female is able to produce 24-42 grains [8].

The *H. varicornis* larvae consist of four instar, with total larval development period of about five days. Parasitoid *H. varicornis* was cocoon in the channel/mining near the skin of the host. At the beginning, the colour of newly formed pupa is white, and then change to a yellowish colour, with a yellow-coloured compound eye, then turned red and finally brown. At the end the pupa stadium, the whole body turned black. The pupa stage last for 7.72 days. The average time required since the egg is laid until the imago appears is 16.15 days [1].

Parasitoid *H. varicornis* is the most common parasitoid larvae that parasitized *Liriomyza* sp. in Indonesia [21, 32, 26]. The characterized of *H. varicornis* female imago behavior are the drumming and probing process. The drumming process performed by touching the antenna repeatedly to the leaves surface, and the intensity will be increased if it finds the channel leaves, then the parasitoid will walk through the channel leaves as the probing process while occasionally stuck the ovipositor and if it finds a host, will stuck more then once. The stuck usually for paralyzing the host, while the next stick is doing to lay the egg or oviposition [8, 34].

From this research, it was found that *Gronotoma micromorpha* imago is black and measured between 1.0 to 1,4 mm (Figure 3). The shape of male and female antenna is *setaceous* or *moniliform* but curved at the end. The wings are thin and have a clearly visible *stigma* (triangular shape). The skutela plate much higher than mesoskutum and the longitudinal trench (*notaulices*) fused at the rear end [27].



Figure 3 Imago of *Gronotoma* sp.

The *Gronotoma* sp. which lives on host mustard greens has an average of body length, wing span, and wing length of consecutive 123.85 μm , 253.45 μm and 42.85 μm ; while on beans hosts 97.7 μm , 214.3 μm and 37.2 μm . The *Gronotoma* sp. immature insect phase which thrives on *Liriomyza* sp. with a host of mustard green has a relatively faster growth than on the host beans. *Gronotoma* sp. which started

parasitized larvae and pupae have average immature insect to develop is 18.4 days and 17.3 days, respectively [2].

The *Gronotoma* sp. parasitoid, first search and found the mining of larval host. While walking, the antennae touched the leaf surface, then after finding a host, the activities more intensive while turning his body and the same time. After being at the top of the surface of the host, the parasitoid thrust the ovipositor directly at the larval body part with body position is almost formed 90° angle which lasted in 3-10 minutes. Further stated that parasitoid *Gronotoma* sp. in finding the host more influenced by the presence of larval host. The existence of host larvae in the leaf mesophyll can be detected by *Gronotoma* sp. because the fluid is removed from the mouth of *L. sativae* or it can also result of the aroma of the host leaves have been bite by larvae, earlier. The parasitoid is able to detect the host because of the fluid emitted by the insect host and / or plants that attacked the host insect [6].

Parasitoids *Opius* sp. can be distinguished easily because of the body morphology, the first abdomen is shrink-like petiole. The edge cell is very narrow, the front wings did not have 2 m-cu crosswise venous whereas vein transverse r-m from behind wings meet with Sc + R [27].

Parasitoids *Opius* sp. (Figure 4) are solitary and the endoparasitoid larva-pupa, a parasitoid that is quite important to pests *L. iriomiza* sp. [14]. The average longevity of adult males' parasitoid *Opius* sp. about two days longer than of adult females. Imago female that appear, either already married or not, can be directly laid eggs. Oviposition period lasts at maximum of 14 days and a minimum of 5 days, with the average between 9.86 ± 2.47 days. The number of offspring produced by a female imago during her lifetime ranges from 68-163 flies, with the average 104.73 ± 22.09 flies [23]. Further stated that the parasitoid *Opius* sp. has Ro value of 28.55. This value shows that the average number of female offspring produced by a female parent is 28.55 per parent per generation or in other words that the population of each generation of *Opius* sp. multiply 28.55 times.

The *Opius* sp. length of generation time (T) was 15.96 days, this value indicates that within 15.96 days, the *Opius* sp. female capable to produce half of its offspring. Intrinsic growth rate (r) of *Opius* sp. is 0.21 females per sow per day. This value indicates the magnitude of the parasitoid population *Opiusi* sp. multiples per day [23]. *Opius* sp. has intrinsic rate (r) more higher (0.21) compared to *L. huidobrensis* pests (0.17). Therefore this parasitoid potentially used as biological leaf miner agents, because of its intrinsic rate higher than its host [32].



Figure 4 Imago of *Opius* sp.

The imago of *Neochrysocharis* sp. (female), has a body size length between 0.75 to 1.30 mm, has a green-blue shiny body coloured (Figure 5). The legs are black metallic koksa, femur and tibia whitish yellow. The males body length, between 0.60 to 1.15 mm. There is no obvious difference between males and females. *Geniculate* shaped antenna is curved, elbow form on the *scape*, and the 1st and 2nd segment are wide and elongated, thin front wing and without *stigma* [5].



Figure 5. Imago of *Neochrysocharis* sp.

Neochrysocharis sp. parasitoids is endoparasitoid on *Liriomyza* sp. pest, and has not information if host in other than snorer leaves pest. There are three species of *Neochrysocharis* spp. ie *N. beasleyi*, *N. formosa* and *N. okazakii* [5]. All three species has rather dark colored coxa with yellowish-white legs. *N. parasitoids. okazakii* and *N. formosa* parasitized encountered a number of pests that attack vegetable crops in Vietnam [35].

The percentage of parasitism parasitoid

The results showed that the average percentage of overall parasitism parasitoid, are higher in IPM plots compared to the conventional plot (Figure 6). This condition is suspected because at the IPM plots, the maintenance of plants for pest controls using only botanical insecticides. The use of botanical insecticides allegedly not adversely affects the development of the parasitoid. Botanical insecticides are highly selective, only killed the plant pests or pest targets. Conversely, the use of synthetic insecticides in the cultivation of crops will directly kill the natural enemies of pests at the same time. In general, farmers in the village Toure using insecticide Deltamethrin (Decis 25 EC) and profenofos (Curacron 500 EC) to control the pests on tomato plants.

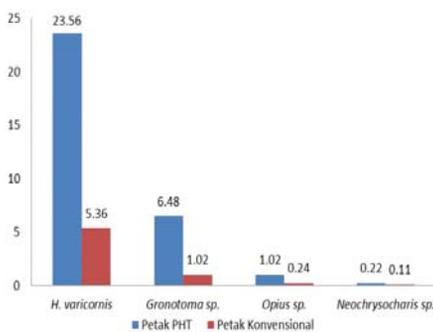


Figure 6. Histogram displaying the average parasitism percentage of parasitoid on IPM and conventional treatment.

From Figure 6, it appears that the average percentage of parasitism parasitoids against pests *L. sativae* showed fluctuate numbers. In the IPM plot treatment, the percentage of

parasitism *H. varicornis* showed the highest number (23.56%) compared to the parasitoid *Gronotoma* sp., *Opius* sp., and *Neochrysocharis* sp., which was respectively 6.48%, 1.02% and 0.22%. While on conventionally plots treatment, has lower percentage parasitism. The average percentage parasitism of each conventional parasitoid compartments sequentially treatment, *H. varicornis* only 5.36%, *Gronotoma* sp. 1.02%, *Opius* sp. 0.24% and *Neochrysocharis* sp. 0.11%. In general, the percentage of parasitism parasitoid of *Gronotoma* sp., *Opius* sp., and *Neochrysocharis* sp. was lower, both in the IPM plots and conventional plots when compared to parasitism of parasitoid *H. varicornis*.

In North Sulawesi, Indonesia, indicates that the parasitoid *H. varicornis* has the highest percentage of parasitism in Tonsewer village which is 18.20% compare to Toure village (10.89%), compared to other parasitoids on tomato plants [27]. *H. varicornis* parasitism in Tomohon 29.10% tomato plants, 37.33% on cabbages plants and 11.88% chrysantemum, while in District Tompasso, 20.43% on tomato plants, and 40.00% cabbages, while in Manado city, 26.77% on tomato plants, and 3.70% on long bean plants [13].

The parasitoid *H. varicornis* can parasitized *Liriomyza* sp. up to 62, 00% on a variety of vegetable crops in the Valley of Palu [30]. Tomato plants on Bali island were attacked by *Liriomyza* sp. can be parasitized by *H. varicornis*, but the parasitism percentage was very low (0.39%) [18]. *H. varicornis* parasitism on *Liriomyza* sp. pest can reach more than 50% on highland vegetable crops [33].

In general, the parasitism parasitoid percentage is relatively low, in conventional plot treatment. Low parasitoid population, presumably because of the effects of excessive synthetic insecticides by local tomato farmers. The effect of synthetic insecticides to the natural enemies can be generally grouped into direct and indirect influence. The direct effect occurs because of directly contact to natural enemies with insecticides or insecticide residues that can kill the natural enemies. The indirect effect

is reduced the host population, that is a food source for predators as natural enemies [12]. Spraying the Lipidoptera insecticides to control pests on tomatoes turns down the parasitoid population snorer leaves [10]. The low percentage of parasitism against *L. sativae* pests in the Toure village, Tompaso allegedly because the farmers abundantly use synthetic insecticides, regularly 4-6 times a week [27].

The high intensity of synthetic pesticides direct use can cause negative effects on the parasitoid development. The application of synthetic insecticides active ingredient *dimehipo*, killed the imago parasitoid *Opius* sp., *G. micromorpha*, and *H. Varicornis*; and has negative impact on parasitoid snorer leaves [19, 9, 7]; and increased the resistance of *Liriomyza* sp. to insecticides [3, 24]. Therefore, in the future, should be assessment snorer control techniques that still leaves can conserve parasitoids and other natural enemies.

CONCLUSIONS

There are four types of parasitoids that attack *L. sativae*, pests namely *H. varicornis*, *Gronotoma* sp., *Opius* sp. and *Neochrysocharis* sp. The highest parasitism of *H. varicornis* found either in the IPM plots (23.56%) or in conventional plots (5.36%).

H. varicornis is a parasitoid that has the potential as biological agents to control *L. sativae* pests.

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