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The Effectiveness of Abamectin Insecticide in Suppressing the Population of *Liriomyza* spp (Diptera: Agromysidae) on Red Onions

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ABSTRACT

This research was aimed to analyze the effect of insecticide application on the population abundance and fluctuation, the attack percentage and the production of local Lembah Palu red onions, as well as the abundance of parasitoids *Liriomyza* spp. The work was conducted in the farmers' fields. There were two treatments, namely abamectin insecticide and without abamectin insecticide. The intensity of *Liriomyza* spp. applied with Abamectin insecticide was lower (33.84%) compared with the non-treated one (62% on 6 weeks after planting). The effect of Abamectin insecticide lowered the attack percentage than non-treated. The non-treated plots had more population of *H. varicornis* (67.17%) and *N. formosa* (28.78%). The average production of red onion applied with insecticide was 9.61 tons per hectare it was higher in comparison with the non-treated one (8.20 tons per hectare). The application of Abamectin insecticide was effective in suppressing the growth of *Liriomyza* spp. population.

Key words: Abamectin insecticide, Population of *Liriomyza* spp., Red onion crops.

INTRODUCTION

The main problem of maintaining and increasing the red onion production in Indonesia is the pest attack (OPT) from leafminer flies (*Liriomyza* spp.) (Shahabuddin *et al*., 2015). These leafminer flies increase the damage level up to 60-70% and cause yield loss up to 20-80% (Rauf *et al*., 2000; Shahabuddin *et al*., 2013). So far the controlling method taken by farmers in order to minimize the yield loss by selecting and applying the insecticide (Barbosa *et al*., 2018; Mujica and Kroschel, 2013).

The farmers are apt to apply the insecticides unjudiciously and non-eco-friendly manners of 2-3 of spraying in a week (Jaya *et al*., 2015). It has been found that the intensive, broad-spectrum and unwise insecticide applications cause of disruption of ecosystem stability due to the death of some natural enemies (Kalaisekar *et al*., 2017; Leppla *et al*., 2018; Matthews, 2017; Shearer *et al*., 2016).

Type of insecticides that are commonly used by farmers contained Abamectin and Spinoteram active materials, working in contact, gastric and systemic that can cause cell malfunction in the insects' digestive tract, especially in the midgut (Aljedani, 2017; Srinivasa *et al*., 2014). Therefore, there is a need for pest management by applying broad-spectrum insecticide applications (Salvo and Valladares, 2007).

This research was aimed to analyze the effect of insecticide application on the population abundance and fluctuation, the attack percentage and the production of local Lembah Palu red onion varieties and the effect of insecticide application on the abundance of parasitoids *Liriomyza* spp. on red onion planting.

MATERIALS AND METHODS

Location and Time of Research

The research was conducted in the farmers' fields in Guntarano Village, Tanantovea Subdistrict, Donggala Regency, Central Sulawesi and at the Laboratory of Pest Science, Faculty of Agriculture Tadulako University from August 2016 to June 2017.

Materials

This research was done in a 500-m^2 field of local Palu red onion planting which were divided into two plots, measuring 250 m^2 respectively and the distance between plots was 300 m.

- The first plot was treated with Abamectin insecticide @ 1 ml per litre water, with spraying volume of 500 litre per ha and the second plot was left in treatment.
- Abamectin insecticide was applied in once-a-week schedule, started from the age of 1 week old planting and ended 7 days before the harvest time.
- Each plot was divided into 18 sub-plots of 6 m x 1.25m respectively, the distance between each sub-plot was 35 cm and planting distance was 15x15 cm.

Variables

The Abundance of *Liriomyza* spp.

The observation and the collection of leaf miner fly population

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was carried out at the beginning of the second week, one day before the application and then a week later i.e. the third week until 7 weeks after planting by setting up 18 cylindrical yellow traps (yellow sticky traps) on each plot with 15-25 cm of height position above ground level (Baliadi and Tengkano, 2008). The traps were replaced each week and then, counted and identified them at the Laboratory of Pest Science, Tadulako University.

Liriomyza spp. attack percentage

The observation of *Liriomyza* spp. population was done by counting the number of leaves that showed the symptom of white dots. This population was taken every week, from 2-7 old after planting. For each sub-plot, 32 plants were randomly selected for observation. Type of damage was observed by counting the attack percentage done by *Liriomyza* spp. by using Pedigo and Buntin equation (Pedigo and Buntin, 1994):

$$P = \frac{n}{N} x\ 100\%$$

Where:

P = Percentage of *Liriomyza* spp. attack.

n = Number of red onion leaves showing the symptom of white dots.

N = Number of red onion (groups) observed.

The Abundance of Parasitoid _Liriomyza_ spp.

To find out the diversity of parasitoids in the plots by collecting 24 leaves that showed the symptom of being attacked by leaf miner flies. Each leave sample was kept in a plastic container in 3 cm diameter and 7 cm height. The emerged adult parasitoids were counted.

Insecticide residue

The analysis of chemical insecticide residue on local Lembah Palu red onions spraying with Abamectin insecticide from the Carbamate group every week, since the age of 2 weeks after planting until 7 weeks by employing LCMS-MS method.

Data analysis

Observed data was analyzed by using T-test at significance level of 5% by comparing treated and non-treated population, damage level, the number of natural enemies in plant samples and yield of treated and non-treated data. Prior to the analysis by means of T-test at significance level of 5%, the data was first tabulated into Excel software and continued with the T-test by the help of MINITAB program.

RESULTS AND DISCUSSION

Based on the observation data and laboratory identification, there were two types of *Liriomyza* spp. associated with the local Lembah Palu red onion varieties in Guntarano Village during the planting period from September to November, 2016, namely *Liriomyza chinensis* and *Liriomyza sativae*. Whereas, planting period from March to May 2017, there were three species of *Liriomyza* namely *L. chinensis, L. sativae* and *L. huidobrensis* (Fig 1).

The observation data indicated that the abundance of adult *Liriomyza* spp. population during the planting period from September-November 2016 was lower as compared to the planting period of March-May 2017 (Table 1). Among the three *Liriomyza* species, the population of *Liriomyza chinensis* in red onion crops since the age of 7 days up to 4 weeks after planting, both in treated and non-treated plots and increase of population was observed. Whereas, the population of adult *Liriomyza sativae* was very low at the age of 2-4 weeks after planting both for treated and non-treated plots (Fig 2).

Observed population of *Liriomyza sativae*, revealed that it tended to increase its population at the age of 4, 5 and 6 in coincidence with the decreasing population of *Liriomyza chinensis* during the observation of 5 and 6 weeks after planting for all treatments. It was observed that *Liriomyza. sativae* population increased in line with the increase in the plant age. The decreasing population of adult *Liriomyza. chinensis* could probably be influenced by the red onion leaf morphology which suffered from hardening in their tissues thus stylet were unable to support and perform the eating activities.

The research results revealed that attack intensity of *Liriomyza spp*. applied with Abamectin insecticide was lower (33.84%) compared with the non-treated one (62% on 6 weeks after planting). Fig 2a and 2b presented the population of *Liriomyza chinensis* and *Liriomyza. sativae* was dominant on the red onion plots location non-treated

Scale 1:16,4 mm. *L. sativae* | Scale 1:16,4 mm. *L. huidobrensis* | Scale 1:16,4 mm. *L. chinensis*

Fig 1: Liriomyza spp species associated with the red onion varieties of the Palu Valley variety.

Table 1: Abundance of Liriomyza, spp Imago Population at Application Treatment and Without Application of Abamectin Insecticide in Red Onion Plants.

Planting Time	Treatment	Species	Population	Abundance (%)
September - November 2016	Application of Insecticide	*L.* chinensis	338	27,5
		L. sativae	70	5,7
	Without Insecticide Application	*L.* chinensis	408	33,25
		L. sativae	411	33,5
March - May 2017	Application of Insecticide	*L.* chinensis	637	30,94
		L. sativae	103	5,00
		L.huidobrensis	29	1,41
	Without Insecticide Application	*L.* chinensis	1154	56,05
		L. sativae	136	6,61
		L. huidobrensis	41	1,99
	Total		2059	100

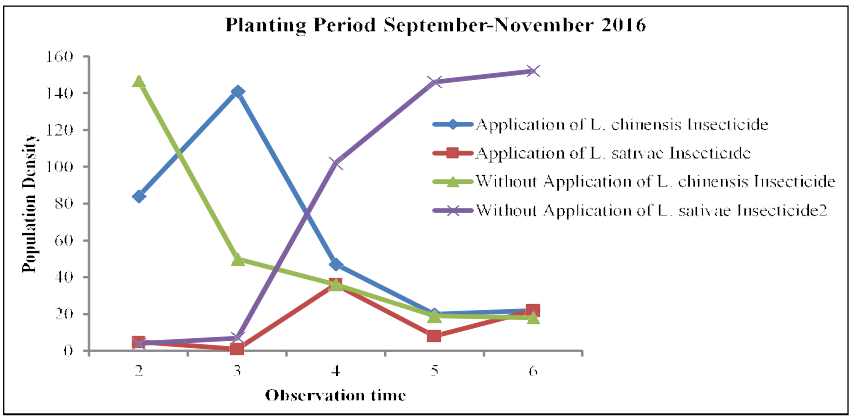

Fig 2a: Fluctuations in Liriomyza, spp Imago Population in Application Treatment and Without Application of Abamectin Insecticide by Using Yellow Likat Trap, Planting Period September-November 2016.

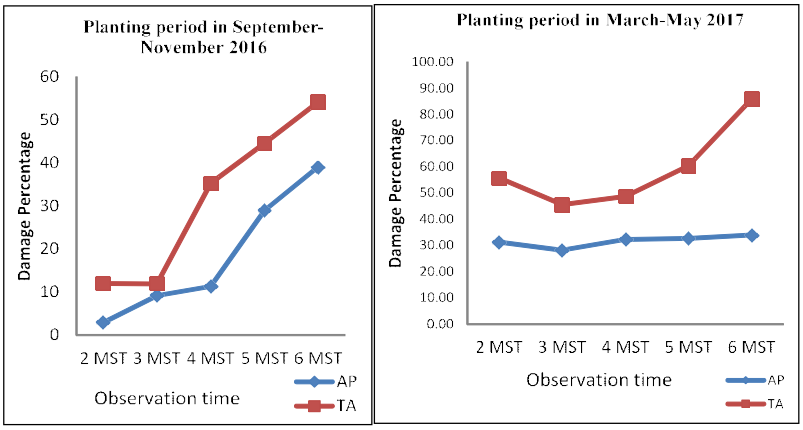

Fig 2b: Fluctuation of Liriomyza Imago Population, spp at Application Treatment and Without Application of Abamectin Insecticide by Using Yellow Likat Trap, Planting Period in March-May 2017.

plots. For the next planting period of March-May 2017, a new species emerged, i.e. *Liriomyza Huidobrensis* as the phenomenon from farmers changed their planting pattern.

***Liriomyza* spp. attack percentage**

In general, the attacks on red onions during September-November 2016 demonstrated that *Liriomyza* spp. attack percentage were lower than the planting period of March - May 2017. Based on T-test analysis results, the planting season of September-November 2016 indicated that Abamectin insecticide application had influenced on lower attack percentage than without insecticide application (Table 2), with average of 2.91-39.02% as compared with

the non-treated one on an average of 11.91-54.12% attack percentage per observed plots.

Fig 3 shows the percentage of leaves attacked by leafminer flies up to the age of 6 weeks after planting was lower in comparison with the non-treated with Abamectin insecticide application. Therefore, it can be said that the application of Abamectin insecticide was effective in suppressing the leafminer flies despite the data of high population abundance on the Abamectin insecticide treatment. During the planting period of March-May 2017, adult *Liriomyza* spp. population increased, which causes high attack percentage above 50% in the second week, resulted in red onions non-treated with Abamectin insecticide application were severely damaged.

Abundance of parasitoids *Liriomyza* spp.

According to the morphological identification results done in the laboratory, there were two parasitoid species associated with *Liriomyza* i.e.*Hemiptarsinus varicornis* and *Neochrysochaeres Formosa* (Hymenoptera: Eulophidae) (Fig 4). Research results showed that the non-treated plots had more abundant population of *H. Varicornis* (67.17%) and *N. Formosa* (28.78%), in comparison with the -treated ones, the population abundance of parasitoids *H. Varicornis* was 4.04% (Table 3). The field observation results showed that Abamectin insecticide application had effect on the abundance of parasitoid species and lower number of individuals compared with the non-treated ones.

The abundance of *H. varicornis* and *N. Formosa* populations was influenced by their main abiotic factor, namely environment. Field observation results revealed that red onion cultivation practice by implementing high insecticide application had negative influence on the parasitoid species life sustainability and lower number of individuals compared with the one without Abamectin insecticide application. Decreased number of natural enemies found in the area treated with Abamectin insecticide application caused harmful effect on natural enemies of parasitoids.

Abamectin insecticide application had influence on red onion production per square meter. The average production of red onion during planting period of September-November 2016 applied with insecticide was 9.61 tons per hectare; it was higher in comparison with the non-treated red onion production (8.20 tons per hectare) (Table 4).

That may be influenced by the planting season of September-November 2016 when the attack percentage of parasitoids *Liriomyza* spp. is lower. Meanwhile, the planting season of March-May 2017 mean yield of red onion applied with Abamectin insecticide is 2.07 tons per

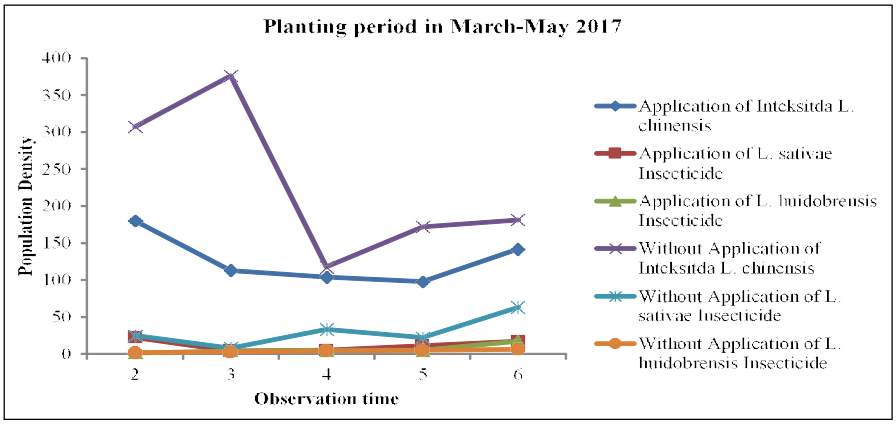

Fig 3: Percentage of leaves of red onion plants attacked by Liriomyza, spp for 6 weeks of observation.

Hemiptarsenus variconis *Neochrysochaeres formosa*

Fig 4: Parasitoid species associated with Liriomyza, spp. Varieties of the Palu Valley variety.

Table 2: Average percentage of Liriomyza, spp attacks on Palu Valley Varieties onion plants applied and without the application of Abamectin insecticides.

Planting Time	Treatment	Obs (N)	Attack Percentage (%)				
			Observation time (MST)				
			2	3	4	5	6
September - November 2016	Application of Insecticide	18	12,02[a]	11,91[a]	35,24[a]	44,51[a]	54,12[a]
	Without Insecticide Application	18	2,91[b]	9,15[b]	11,32[b]	28,90[b]	39,02[b]
March - May 2017	Application of Insecticide	18	55,77[a]	45,62[a]	48,72[a]	62,00[a]	71,10[a]
	Without Insecticide Application	18	28,55[b]	29,44[b]	32,28[b]	33,84[b]	34,05[b]

Table 3: Parasitoid Liriomyza, spp and its abundance in shallot plants that are applied and without insecticide application.

Treatment	Order	Family	Species	Total	Abundance
Application of Abamectin Insecticide (TA)	Hymenoptera	Eulophidae	*Hemiptarsinus varicornis*	133	67,17
		Eulophidae	*Neochrysochaeres formosa*	57	28,78
Without the Application of Abamectin Insecticide(TA)	Hymenoptera	Eulophidae	*Hemiptarsinus varicornis*	8	4,04
		Total		198	

Table 4: Red Onion Bulbs per hectare applied and without the application of Abamectin Insecticide.

Planting Time	Treatment	Average (ton/ha)	Standard Deviation (%)	t	p-value
September-November 2016	Without the Application of Abamectin Insecticide (TA)	8,20[a]	1,10	3,19	0,003
	Application of Abamectin Insecticide (AP)	9,61[b]	1,52		
March-May 2017	Without the Application of Abamectin Insecticide (TA)	0,27[a]	0,12	13,36	0,000
	Application of Abamectin Insecticide (AP)	2,07[b]	0,55		

Table 5: Residual Value and LOD of Abamectin Insecticide in the Contents of Shallot Bulbs in Palu Valley Varieties.

Sample Code	Parameter	Unit	Result	LOD	Method
Red Onion Varieties of Palu Valley	Residues of Carbamate Pesticide: Abamectin	Mg/kg	Not Detected	0,005	LCMS-MS

hectare, higher than without insecticide application (0.27 tons per hectare).

During the planting period of March-May 2017, there was severe attack by parasitoids *Liriomyza* spp. that caused most of the plants severely damage. It was found that higher production was obtained from the area applied with Abamectin insecticide than the area without Abamectin insecticide application, even though the obtained yields were highly different with the planting period of September-November 2016. That low production during planting period of March-May 2017 was caused by high attack percentage of parasitoids *Liriomyza* spp., above 50% in the second week.

The application of Abamectin insecticide had positive impact on the production, yet on the contrary had negative impact on the existence of some natural enemies. For cultivation of local Lembah Palu red onion varieties, it requires an integrated pest management concept for handling the attack from parasitoids *Liriomyza* spp. By this time and the presence of OPT are two determinant factors in deciding the policy for cultivation local Lembah Palu red onion varieties in Guntarano Village. In addition, monitoring steps should be taken for use of insecticide, when approaches economic level.

Abamectin active residue

The results of Abamectin insecticide residue analysis of Carbamate group (Table 5) on local Lembah Palu red onion varieties by using LCMS-MS method with weekly spraying application since the age of 2 to 7 weeks after planting showed the presence of pesticide residue on red onions with very low LOD value of 0.005. An interesting thing from this study was despite the fact of weekly Abamectin insecticide application on those red onions, the insecticide residue was low and hence it was safe for consumption.

In accordance with the research results, the population of adult *Liriomyza chinensis* tended to be stable and dominant on red onions even since in the early age of 7 days to 4 weeks after planting and showed the tendency of increased population in line with the increased plant age. *Liriomyza chinensis* species attack red onion since the age of 2 weeks after planting, they belong to monophagous insects with limited hosts of shallots and onions usually grown on low-lands and highlands (Rauf, 2005; Saleh *et al*., 2014). At the age of 4-5 weeks after planting, the presence of adult *Liriomyza chinensis* tended to decrease in number and replaced by adult *L. sativae*. Another research result showed that the decreasing number of *Liriomyza chinensis*

was influenced by the morphology of red onion leaves that suffered from hardening in their tissues thereby the style were unable to support and perform eating activities (Arfan *et al*., 2018).

The increased population of *Liriomyza sativae* was likely influenced by some environmental factors, in which there were insecticide spraying applications nearby the experiment location resulted in migration, *Liriomyza* entered the experiment areas due to insecticide application. There was a phenological compatibility of parasitoids *Liriomyza* spp., in which the crops in the experiment area had been harvested and in coincidence with the crop that turning into their fifth-week age.

Low *Liriomyza* spp. population in the treated plots was probably caused by the effectiveness of applied Abamectin insecticide, which was able and effective in suppressing the growth of *Liriomyza*, spp. larvae. Some other research results showed that Abamectin indeed was highly effective in suppressing the population of *Liriomyza* (Ramesh and Ukey, 2007; Saad *et al*., 2007). Abamectin insecticide has caused the malfunction of some cells in those insects' digestion, more especially in the midgut (Aljedani, 2017). Abamectin application had decreased *Liriomyza* larvae significantly lower population of adult *Liriomyza*, spp. The treatment with abamectin 1.9 EC @ 0.4 ml/l (0.0007%) was found most effective in recording the least nymphal population of citrus psylla at 3rd, 7th and 14th days after sprays over rest of the treatments (Wankhade *et al*., 2015)

The decreasing number of natural enemies found in the areas applied with Abamectin insecticide had caused the lessening role of parasitoid natural enemies. One of determinant factors that affected the life of natural enemies of parasitoids was mainly due to the spraying intensity and the application of broad-spectrum insecticide (Pratama *et al*., 2013). Insecticide application, particularly the organic synthetic one, is highly effective in controlling the pests and helping to maintain the production and quality of yields.

CONCLUSION

The application of Abamectin insecticide was effective in suppressing the growth of *Liriomyza* spp. population, there were two species that attacked red onion crops, i.e. *Liriomyza chinensis* and *Liriomyza sativae*, with population abundance of 33.2%, attack percentage of 39.02% and production of 9.61 tons per hectare. Abamectin insecticide application had real influence on the parasitoid species, with population abundance of 4.04% for *H. varicornis.* There are two parasitoid species associated with *Liriomyza*, namely *Hemiptarsinus varicornis* and *Neochrysochaeres Formosa* (Hymenoptera: Eulophidae).

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