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The impact use of insecticide active ingredient *dimehipo* and *methomyl* on the abundance and diversity of arthropoda predator on soybean

[1]Rahayu M., [1]La Ode Santiaji Bande, [1]Asmar Hasan, [1]Agung Yuswana, [1]H. Syair, [1]Abdul Rahman, [1]Muhammad Taufik, [2]Muhidin, [3]Fatma Rinambo

[1]Department of Plant Protection, Faculty of Agriculture, Halu Oleo University, Kendari 93232, Southeast Sulawesi, **Indonesia**

[2]Department of Agrotechnology, Faculty of Agriculture, Halu Oleo University, Kendari 93232, Southeast Sulawesi, **Indonesia**

[3]Agricultural Quarantine Center Kendari, Ministry of Agriculture, Kendari 93212, Southeast Sulawesi, **Indonesia**

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***Correspondence:** yayukmallarangeng@yahoo.com **Accepted: 10** Feb 2018 **Published online:** 27 Mar. 2018

Increasing soybean need causes farmers to intensively use insecticides in controlling plant pests to reduce yield loss. *Dimehipo* and *Methomyl* is an active ingredient that works as a contact poison and as a gastric poison that is often used by farmers in soybean crops. Both types of insecticides are effective in controlling plant pests, but have a negative impact on non-target organisms such as soybean pest predators. The aim of this research is to know the effect of insecticide using an active ingredient of dimehipo and methomyl on the abundance and diversity of predator arthropods in soybean cultivation. Taking arthropod predators using hand picking techniques and nets. The results showed that (1) the abundance of predator arthropods in soybean application without insecticide application was 24,413 tail consisted of 5 orders with 8 families and 10 species while in application of insecticide dimehipo was found 1,178 tail consisting of 4 orders with 7 families and 9 types. In the application of methomyl insecticide found 1,979 tail consists of 4 orders with 5 families and 7 species; (2) Planted soybean applied by insecticide dimehipo showed predominant (H') arthropod predator index was 0.748 lower than soybean applied by methomyl insecticide (1.008) and not applied synthetic insecticide (1.683). It is not advisable to use any type of synthetic insecticides to control pest attacks in soybean crops and be wiser if switching to more environmentally friendly vegetable or organic insecticides.

Keywords: Insecticide, Dimehipo, Methomyl, Diversity, Arthropod Predator, Soybean

INTRODUCTION

The soybean crop is an important food crop in addition to rice that is needed by people in Asia (He and Chen, 2013) including Indonesia, as a source of vegetable protein, industrial raw materials and animal feed ingredients (Hartman et al., 2011; Swain et al., 2014). The need for soybeans increases with increasing population growth, but this is inversely related to low soybean production caused by various factors. One of the main factors causing low soybean production is the presence of pests in the crop (Hartman et al., 2016; Cerda et al., 2017; Rahayu et al., 2018). To deal with insect pests farmers are now too dependent on the use of insecticides because it is considered very effective practical and rapid killing effect.

Intensive use of synthetic insecticides has been successful in spurring soybean production, but has a negative effect on changes in the composition of organisms in agroecosystems (Aktar et al., 2009; Chandler et al., 2011; Sugiarto et al., 2013). Farmers generally use synthetic insecticides that work systemically (stomach poison), non-systemic (contact poison), and both on soybean commodities. Dimehipo and Methomyl are examples of active insecticidal ingredients that can act as contact poison and gastric toxins and most often used by farmers in soybean crops.

The continuous and prolonged use of pesticides can lead to new and serious problems for farmers called resistance pest resurgence environmental pollution and health problems (Regnauld-Roger, 2005; Laba, 2010). The use of synthetic insecticides is not only able to kill insects that act as pests in plants, but also can kill insects that act as natural enemies such as predators (Purwanta and Rauf, 2010). Predators as components of the ecosystem should be maintained in the plant so that the pest population can be controlled naturally. Nowadays the role of predators in pest control is noticed because of the integrated pest control program (IPM) so that farmers begin to awaken their awareness to understand the role of predators and the negative impact of synthetic insecticide use. The high predator population indicates a stable agroecosystem balance so that predators can play an optimal role in controlling pest populations to remain below the economic threshold (Radiyanto et al., 2010).

There have been numerous reports explaining that the application of synthetic insecticides has an impact in reducing the diversity and abundance of predatory arthropods (Herlinda et al., 2008; Purwanta and Rauf, 2010), but directly comparing the impact of different types of active ingredients on the diversity and abundance of predatory arthropods is rarely reported. Based on this it is necessary to conduct research that aims to determine the impact of the use of insecticides made from active dimehipo and methomyl to the abundance and diversity of predatory arthropods in soybean crops.

MATERIALS AND METHODS

Observation plots and application of insecticides

The research was conducted at farmer's soybean cultivation in Belatu Village Pondidaha Sub-district Konawe District Southeast Sulawesi, Indonesia. The soybean cultivation plots observed were plots without application of insecticides and plots applied by insecticides with the area of plot observed in each plot was 64 m^2 (8 m × 8 m) with the distance between the plots being 5 m. Soybean varieties used in this study are varieties Anjasmoro cultivated following the local farmers, including the use of insecticides that they often do. Soil cultivation is not done and the seeds are grown tugally at a spacing of 35 cm × 40 cm with the number of 2-3 seeds per hole then covered with soil. Synthetic insecticides applied by farmers to planting are synthetic insecticides with theactive ingredient of Dimehipo and Methomyl. Prepared each one plot of crops for no application of insecticides Dimehipo and Methomyl. The insecticidal dosage used was 40 cc insecticide/15 L water for aninsecticide with active ingredient Dimehipo and 3 g insecticide/15 L water for aninsecticide with theactive ingredient of Methomyl. The time of insecticide application begins ± 10 days after weeding, then repeated every 10 days until harvest time. The type, frequency, and current of insecticide applications are based on the local farmer's habits.

Determination of sub-sampling plot

The subplot of research sampling in the observation plot is determined diagonally as five subplots with the size of each subplot is 1.5 m × 1.5 m so that in one subplot observation there are 12 soybean crops.

Arthropod Predator Observation

Direct observations were found to be active in theplant canopy. Observations performed every week starting at the vegetative phase 7-42 days after planting (DAP) and generative phase 49-77 DAP. Taking arthropod predators using hand picking techniques and nets. Arthropods are distinguished by family recorded in number and subsequently inserted into a film tube containing 70% alcohol. The diversity and abundance of predatory arthropods are known to use the equations:

Important Value Index (IVI): An important value index represents the amount of mastery a species have given its community. According to Sugianto (1994), IVI can be used to calculate the dominance of an insect species to its community by using the following formula:

Density (D) :

$$AD_i = \frac{n_i}{A}$$

Remark:

ADi = Absolute density type to-i

ni = Total individual types to-i

A = Total area of plot sampling

$$RD = \frac{AD_i}{\sum AD} \times 100\%$$

Remarks:

RD = Relative density of type to-i

ADi = Absolute density of type to -i

∑AD = Total absolute density for all types

Frequency (F)

$$AF_i = \frac{J_i}{K}$$

Remarks ::

AFi = Absolute frequency type to -i

Ji = The number of plots that contain the type to -i

K = Total plot created

$$RF = \frac{AF_i}{\sum AF} \times 100\%$$

Remarks :

FR = Relative frequency type to -i

Afi = Absolute frequency type to -i

∑AF = Absolute total frequency for all types

$$IVI = RD + RF$$

B. Index of species diversity

To know the diversity of insect species used Shannon indices of general of diversity formula (Antoko et al., 2006) as follows.

$$H' = -\sum \left[\frac{n_i}{N} ln \frac{n_i}{N}\right]$$

Data analysis

Data analysis result of this research done by using the aid of a program of MS. Excel and PAST 3.14. Independent sample t-test was used to test the difference in mean diversity of insects based on Shannon's statistically value between applied and non-applied soil synthetic insecticides.

RESULTS AND DISCUSSION

Types of predators

The results of observation and identification of predator arthropods in the presence of variation in the level of the order and family on predators found. Generally found 5 orders 8 families and 10 species of predator arthropods in soybean crops at the study site. the composition of predators that inhabit soybean crops is very abundant (Radiyanto et al., 2010), and its existence can be disrupted due to the application of synthetic insecticides (de Castro et al., 2013; Nicolopoulou-Stamati et al., 2016). The results of observation and identification indicate the presence of several types of predatory arthropods as presented in Table 1. Based on Table 1 it is known that the population of predatory arthropods is higher in plots without application of insecticide followed by application of methomyl insecticide and the lowest population in the application of insecticide dimehipo. In the plots, without insecticides, Oxypoidae is the most abundant spider. The type found is *Oxyopes sertatus*. Also found another family spiders are Clubionidae type *Clubiona deletrix*. On the predatory insect classes, the most abundant are the Staphylinidae family the roaming beetle of *Paederus fuscipes*, Coccinellidae, Reduviidae, Formicidae, Mantidae, and the Ground Beetle (Carabidae).

Predators in nature have a very important role in suppressing pest populations (Rahayu et al., 2018). Several types of predators that play an important role in suppressing pest populations in soybean crops include (1) *Oxyopes javanus* (spider) which has many pests as its prey ie pod borer *Etiella zinckenella*, *Helicoverpa armigera*, *Spodoptera litura*, instar nymph 2 Suckers of *Riptortus annulicornis*, *Nezara viridula*, and *Piezodorus hybneri*. (2) *Paederus fuscipes* which prey on eggs and larvae of *Helicoverpa armigera*, *Spodoptera litura* larvae, *Bemisia tabaci*, and Aphid, (3) *Coccinella* sp. which preys on insects from the Hemiptera Order, the Family of Coccidae, Pseudococcidae, Diaspidae, and Aphididae.

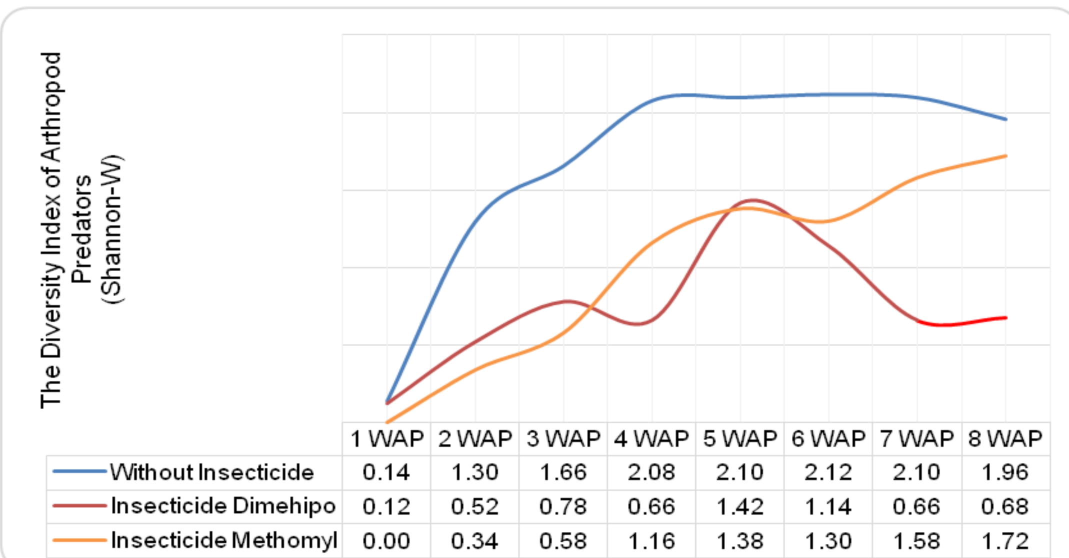
The high population of predators in non-treated insecticides are thought to be caused by these predators not getting environmental stresses so that predators can thrive. The abundance of predators in the plots without the application of insecticides is also supported by the circumstances surrounding soybean cultivation is still much-overgrown vegetation. This is in accordance with Herlinda (2007) that if on the edge of the land there is a growing vegetation, then the vegetation provides prey or host source of feed shelter reservoir and become the source of natural enemies in the next season. In addition to these factors are also suspected of the availability of host predators in the form of insect pests and other useful insects.

The total number of predator populations found in insecticidal applications of dimehipo is lower than that of predator populations in methomyl insecticide applications. There are 3 types of predators found in the application of methomyl insecticides but not found in the application of insecticides dimehipo namely *Coccinella transversalis*, *Paederus fuscipes*, and *Mantis religiosa*

Table 1. Important Populations and Values Index of each type of predatory insect found in the soybean cultivation plots from the age of 1 WAP (week after planting) to harvest (8 WAP)

Predators			Without Insecticides		Insecticide Dimehipo		Insecticide Methomyl	
Species	**Families**	**Ordor**	**Population (tail)**	**IVI**	**Population (tail)**	**IVI**	**Population (tail)**	**IVI**
Oxyopes sertatus	Oxyopidae	Araneae	4056	9.12	28	1.63	522	9.88
Clubiona deletrix	Clubionidae	Araneae	3363	7.05	53	3.82	159	3.04
Phaedorus fuscipes	Staphylinidae	Coleoptera	3628	11.49	248	19.33	-	-
***Micraspis* sp.**	Coccinellidae	Coleoptera	3195	14.22	173	15.03	566	14.45
Harmonia octomaculata	Coccinellidae	Coleoptera	2978	10.46	296	21.86	324	6.42
Amara patruelis	Carabidae	Coleoptera	1165	8.31	94	12.40	226	10.66
Coccinella transversalis	Coccinellidae	Coleoptera	569	4.10	15	1.49	-	-
Rhynocoris kumari	Reduviidae	Hemiptera	2433	5.82	-	-	62	1.38
Pheidole guineensis	Formicidae	Hymenoptera	2200	5.47	209	14.79	120	2.73
Mantis religiosa	Mantidae	Mantodea	826	3.13	62	4.61	-	-

Figure 1. Diversity of insects in applications without insecticides methomyl insecticides and insecticides dimehipo



Diversity of predatory arthropods (Shannon-W Index)

Adverse effects of insecticide use on predatory arthropod diversity are illustrated in Figure 1. Figure 1 shows that the index of predatory arthropod diversity at no insecticide application each week is on average higher than that of synthetic insecticide application. This proves that the use of any type of insecticide and its properties can affect the condition of various types of organisms in thesoybeancrop, especially predatory organisms compared to without the use of insecticides.

In line with this, Krauss et al. (2011) reported that organic soils have a plant species richness that is five times higher and the pollinator species richness is about twenty times higher than that of conventional land. The abundance of pollinators is even a hundred times higher on organic land. In contrast, the proportion of aphids is five times lower in organic farms while the predator abundance is three times higher in organic soil, suggesting the potential for biological control is much higher in organic soil. The application of insecticides on conventional land causes low aphid predator abundance throughout the season and significantly reduces top-down control of the aphid population. The application of insecticides on conventional land has only a short-term prevention effect on tick density, but has long-term negative effects on biological control of pests.

Figure 1 also shows that the application of methomyl insecticides has a higher index average compared to the insecticide dimehipo which means the use of insecticides dimehipo worse than methomyl insecticides. Although methomyl has been classified by WHO (World Health Organization) EPA (Environmental Protection Agency the USA) and EC (European Commission) as a highly toxic and harmful pesticide material with a very soluble form in water and has a low absorbency capacity on the ground making it easy Causes groundwater contamination in agricultural areas and is widely used around the world due to its strong control over various types of pests (Strathmann and Stone, 2001; Malato et al., 2002; Fernandez-Alba, 2002), but research results elsewhere support this research result. Nemoto (1986) reports that methomyl applications cause lycosid spiders to act As an important predator of larvae of diamondback larvae in instars 3 to 4 have decreased population. On the other hand, Yurista et al., (2014) reported that found two species of parasitoid *Hemiptarsenus varicornis*and *Simpiesis* sp. On the red onion field with no insecticide application associated with Liriomyza chinensis with parasitization levels ranging from 20% to 40% while on the applied land insecticide dimehipo not found the parasitoid.

Table 2. The independent of t sample paired test result of predator predominant diversity averages

Diversity Arthropod predator		Insecticide Dimehipo	Insecticide Methomyl
	Average	0.748	1.008
Without Insecticides	1.683	0.935**	0.675**
Insecticide Methomyl	0.748		0.260**
Insecticide Dimehipo	1.008		

Description **: very significant; *: significant

The results of the statistical analysis (independent of t sample paired) in Table 2 strengthen the findings in the field ie the average index of predator arthropod diversity without different insecticidal applications was very significant with the application of insecticide with an average difference of 0.935 in dimehipo insecticide and 0.675 on methomyl insecticide. Furthermore, the use of methomyl insecticide is very different compared to the insecticide dimehipo with the difference in the average of diversity index is 0.260. Synthetic insecticides reduce the value of the predator diversity index in soybean crops. This shows that soybean cultivation environment applied with synthetic insecticides is not suitable for thepredatory activity. The presence of different types of predators in agroecosystem areas suggests that the area is a habitat suitable for predators in terms of food sources breeding grounds and shelter (Samharinto, 2011).

CONCLUSION

Based on the results of this study can be concluded (1) Abstinence of predator arthropods in soybean application without insecticide application is 24,413 tail consisting 5 orders with 8 families and 10 species in application of insecticide dimehipo found 1,178 tail consisting 4 order with 7 family and 9 species Whereas in the application of methomyl insecticide found 1,979 tail consisting of 4 orders with 5 families with 7 species; (2) The soybean plant applied by the insecticide dimehipo showed a lower predator Diversity (H ') arthropod index of 0.748 compared with soybean applied with methomyl insecticide (1.008) and no synthetic insecticide (1,683). It is advisable not to use synthetic insecticides in controlling pest attacks in soybean crops but if forced to use insecticides then it is better to use methomyl insecticides or wiser if switching to a more eco-friendly organic or organic insecticide.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

RM designed and performleed the experiments and also wrote the manuscript. LOSB, AH, AY, HS and FR performed field experiment, collected data and data analysis. MT and MHD prepared and reviewed the manuscript. All authors read and approved the final version.

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