The Impact of Pesticide Use on Chili Plants (*Capsicum annum* L.) on Soil Arthropod Diversity with Semi-Organic and Conventional Agricultural Systems in Dau District, Malang Regency, Indonesia

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Abstract- This study aims to determine the impact of the use of pesticides on chili (*Capsicum annum* L.) on the diversity of soil arthropods on land with semi-organic and Conventional farming systems in Dau sub-district, Malang regency, Indonesia. Arthropod sampling was carried out using the pitfall trap method, measuring the abiotic factors of soil temperature, soil pH, air humidity, and light intensity as well as the interview method. Arthropod diversity data analysis was analyzed using Microsoft Excel by calculating the Shannon-Wiener diversity index (H '), evenness (E), dominance index (ID), and taxa richness (TR). Then use the SPSS for Windows release 16 application with the Repeated Measure ANOVA test to determine differences in diversity of soil arthropods in semi-organic and Conventional. Previously the Normality test has been done. Interview results were analyzed descriptively. Arthropods found in the two locations showed different results in semi-organic fields before being sprayed with pesticides, found 10 order and 21 families, semi-organic fields after being sprayed with pesticides, found 10 order and 19 families. Then in Conventional land before spraying found 9 order and 18 families and Conventional after spraying found 9 order and 17. The total of all individuals found in semi-organic and Conventional land was 2008 individuals. Semi-organic land before spraying has the highest diversity value with an average of 3.44, while the lowest is Conventional land after spraying with an average diversity value of 2.10. Semi-organic before spraying compared with semi-organic after spraying a significant value of 1000> 0.05 was not significantly different. Conventional before spraying compared to Conventional after spraying showed a significant value of 0.026 <0.05 significantly different.

Keywords: Arthropods, Pesticides, Semi-Organic, Conventional

I. INTRODUCTION

Malang Regency is one of the centers of red chili production in East Java Timur [5]. The need for chilies (*Capsicum annum* L.) every year is getting higher with increasing prices, it is estimated that the need for chili will continue to increase, in 2017 it is estimated to be 2.95 kg/capita/year and in 2020 it is estimated to be above 3.10 kg/capita/year. Chili production in 2017 amounted to 2.35 million tons but decreased in 2018 amounted to 2.30 million tons [7]. One of the decreases in chili production is caused by pests and diseases because it can cause losses in both the quality and quantity of chili, so to overcome this, farmers choose synthetic pesticides.

The use of chemical insecticides caused a reduction in the diversity of arthropods in onion cultivation [9]. The use of pesticides greatly affects the structure of the arthropod community and directly influences natural enemies [4]. Excessive use of synthetic pesticides has a very detrimental effect on insect biodiversity, including Arthropods that cause resurgence and even other insects that have important ecological functions such as pollinating insects. The use of pesticides that are very strong and broad-spectrum which is widespread and excessive has resulted in damaging effects [15].

For the environment, the use of synthetic pesticides is likely to cause accumulation of pesticide residues in the soil which takes a long time to be degraded, causing soil pollution. Pesticides have damaged the natural balance of agricultural soils and reduced the diversity of soil arthropods. Another impact arising from inappropriate use of pesticides is that the presence of pollinator insects as pollinating agents is increasingly difficult to find [8]. Several types of pollinating insects (pollinators) of fruit and seed plants on the island of Java are on a critical threshold [1].

Therefore, to create environmentally friendly agriculture, farmers need knowledge about the wise use of pesticides and organic or semi-organic farming systems that have many benefits. At present, there are no studies that distinguish the impact of the use of pesticides by chili farmers (*Capsicum annum* L.) on the diversity of Soil Arthropods in semi-organic and Conventional land in

Dau District. Based on the background above, it is necessary to research the impact of the use of pesticides by chili farmers (*Capsicum annum* L.) on the diversity of soil arthropods and pesticide residues in Dau District.

II. METHODS

The research was conducted in December 2018 - December 2019. Arthropod research and sampling and open interviews were conducted in Sumberbondo, Kucur Village, Dau District, Malang Regency, Indonesia. This research was conducted using a combination of research methods (Mixed Methods). The design of this study uses Sequential Explanatory. The method used first is the open interview technique (interview). The first sampling method is done by using purposive sampling with the number of respondents 10 chili farmers. Farmers who use pesticides on their land are grouped into 2 categories, namely: Semi Organic: A chili farmer who uses a mixture of pesticides, chemical, and vegetables. And Conventional: Chili farmers who only use chemical pesticides. The second sample was taken using the pitfall trap method. The pitfall trap used was a 7 cm diameter glass jar filled with 50 ml of 70% alcohol (functioning as a preservative arthropod). Pitfall traps are installed at random zig-zag [16]. At each location, there are 10 pitfall traps performed 6 times 2 days before spraying and 2 days after spraying. Pitfall trap installation is carried out in the morning at 07.00 WIB. Pitfall traps are installed for 24 hours. Observation and identification of soil arthropods were done based on morphological characteristics [4]. Furthermore, diversity analysis was carried out with the Shannon-Wiener index (H ') [2,10], with the following formula:

H= -∑ p i ln pi ……(1)

Explanation : H = index Shanon-Wiener
N = the total number of individuals, it is the following formula:

Diversity index criteria: H <1 = low diversity (number of species and individuals low, presence of dominant dominance), H = 1-3 = moderate diversity (number of species and individuals are moderate, number of individuals does not vary), H> 3 = high diversity (the number of species and individuals is high, there is no dominant type).

$D = \sum_{i=1}^{s} (pi)^2$ ……(2)

Explanation:
D: Index Dominance Simpson
Pi: Proporsi spesies X on jumlah total

$$E = \frac{H}{H\,max}$$ ……(3)

Explanation: E: Evenness

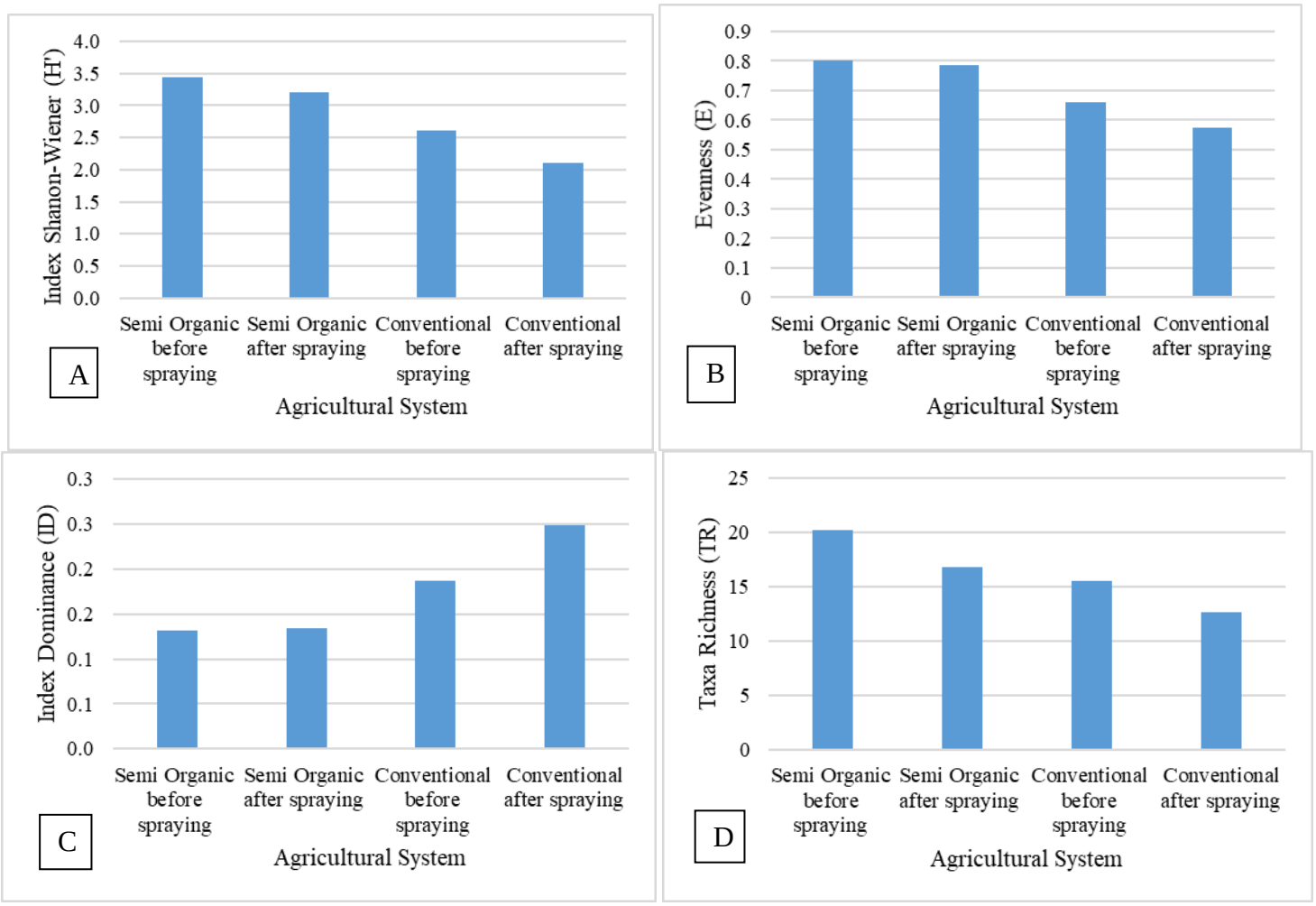
Evenness of species has an E value ranging from 0 - 1. If the value of E = 1 means that in the habitat there are no species that dominates, and vice versa if E approaches 0 there is a species that dominates.

INP : KR + FR ……(4)

Explanation: KR : Density Relative
FR : Frekuensi Relative
INP : Important Value Index

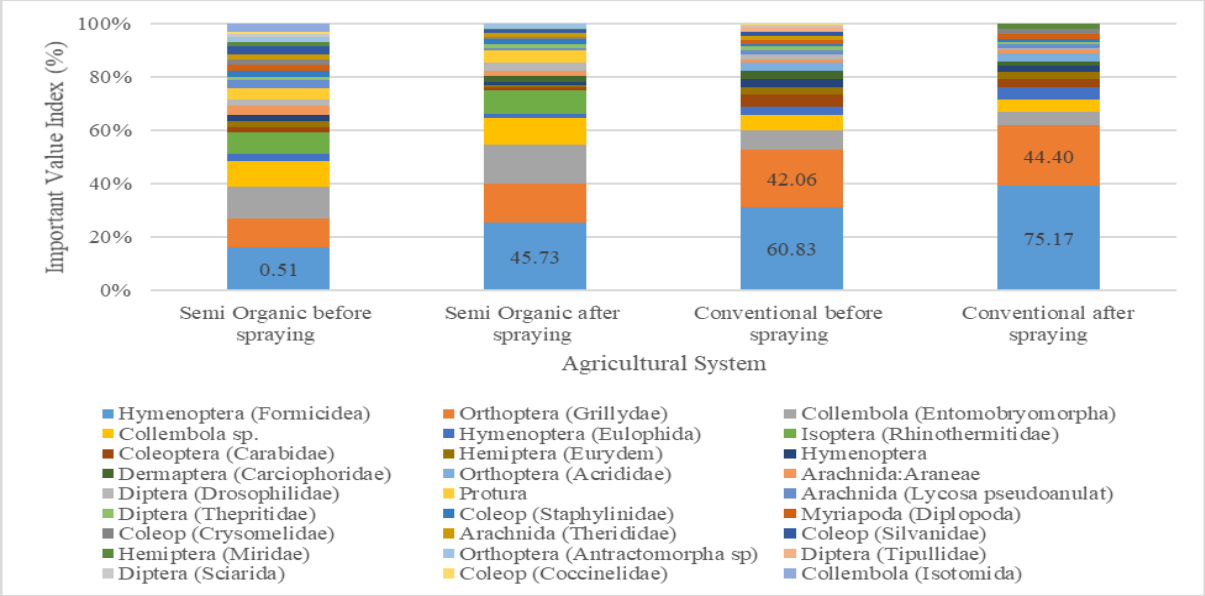
Arthropod diversity data analysis was analyzed using Microsoft Exel. Then use the SPSS for Windows release 16 application with the Repeated Measure ANOVA test to determine differences in diversity of soil arthropods in semi-organic and conventional land. Previously normality and homogeneity tests have been done. Interview results were analyzed descriptively.

III. RESULTS AND DISCUSSION



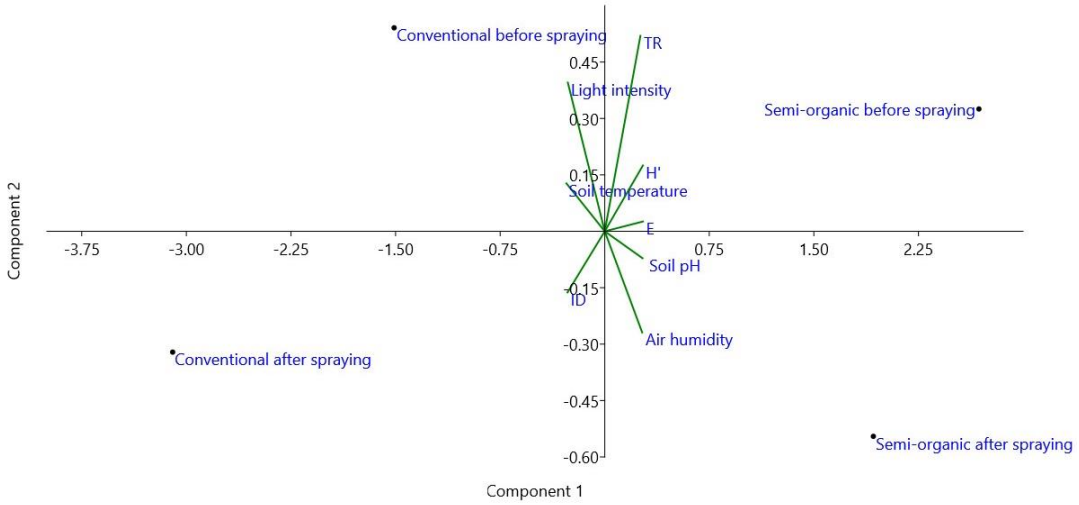
Picture 1. (A) Index Shanon-Wiener (H'), (B) Evenness (E), (C) Index Dominace (ID), (D) Taxa Richness in semi-organic and conventional land before and after spraying pesticides.

Based on the results of data analysis shows that semi-organic land before spraying has the highest diversity value with an average of 3.44, an average evenness value of 0.80, an average taxa richness value of 20.2, and the lowest dominance index 0,13. This shows that semi-organic land before spraying still has a diverse diversity of arthropods, a high number of species and individuals, and no species dominate. While the lowest is conventional land after spraying with an average diversity value of 2.10, an evenness index of 0.57, taxa richness value of 12.7, and the highest dominance index value is an average of 0.25. This is because the pesticides used in semi-organic fields are chemical pesticides mixed with vegetable pesticides and organic fertilizers so that the killing rate of the arthropods is still low and the availability of arthropods food is also high because many organic materials are contained in the soil. Organic material from fertilizer is a food source for microarthropods or mesoarthropods [17]. The use of synthetic pesticides has an impact on arthropods such as a decrease in natural enemy populations, pest resistance, and pest resurgence [6]. That the more types of insects and the more evenly distributed of each type of insect, the higher the diversity [13]. States that the total population of a families that does not dominate other families, the evenness value will tend to be high and vice versa if a families has a population that dominates the number of other populations then the equality will tend to below [18].



Picture 2. Important Value Index (%)

Based on picture 2, the important value index of all agricultural systems having the highest INP value is Formicidae. In semi-organic fields before spraying, the average value of formicidae was 0.51%, whereas in semi-organic fields after spraying, they showed formocidae of 45.73%. On conventional land before spraying showed an average value index of 60.83%, while on conventional land the average value of the index was 75.17%. The results of this study indicate that the two locations have the same community structure. The abundance of formicidae in both locations is due to their clustered habitat. Most order of the Hymenoptera, especially the formicidae group, have many types that act as predators of insect pests [4]. They show great diversity and increased the complexity of behavior in terms of a social organization so that their existence is almost everywhere.



Picture 3. *Biplot* analysis.

Based on *Biplot* analysis, it is known that semi-organic land before spraying and after spraying is influenced by microclimate factors, namely air humidity, and soil pH, but it is less affected by light intensity and soil temperature. This group has a high index value of diversity, evenness, and taxa richness and a low dominance index. In the second group, conventional land before spraying and after spraying are affected by light intensity and soil temperature but are slightly affected by soil pH and humidity. This group has a high dominance index.

Tabel 1. Pairwise comparisons of semi-organic and conventional land before and after spraying pesticides.

Pairwise Comparisons

Measure: Spraying						
(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
1	2	.600	.452	1000	-.635	1.835
	3	2.250*	.485	.000	.927	3.573
	4	3.450*	.467	.000	2.176	4.724
2	1	-.600	.452	1000	-1.835	.635
	3	1.650*	.418	.001	.510	2.790
	4	2.850*	.385	.000	1.798	3.902
3	1	-2.250*	.485	.000	-3.573	-.927
	2	-1.650*	.418	.001	-2.790	-.510
	4	1.200*	.404	.026	.097	2.303
4	1	-3.450*	.467	.000	-4.724	-2.176
	2	-2.850*	.385	.000	-3.902	-1.798
	3	-1.200*	.404	.026	-2.303	-.097

Based on the analysis of *Repeated Measures* ANOVA, it shows semi-organic before spraying (1) compared to semi-organic after spraying (2) the average decrease in arthropod abundance is 0.600, and the difference in decrease is not significant because the significant value is 1000> 0.05. This is because spraying in semi-organic agriculture uses chemical pesticides mixed with organic fertilizers and vegetable pesticides so that there is no significant change because organic fertilizers contain organic material which is a food source for arthropods in addition to the dose of chemical pesticides used below the recommended dose. Before being sprayed semi-organic (1) compared with conventional farming systems before spraying, there was an average decrease of 2,250, and the difference in reduction was significant because of a significant value of 0,000 <0.05. Semi-organic before spraying (1) was compared with conventional farming systems after spraying 3,450, and the difference in reduction was significant because of a significant value of 0,000 <0.05. Semi-organic after spraying (2) compared to conventional before spraying showed an average decrease of 1,650, and the difference in reduction was significant because of a significant value of 0.001 <0.05. Semi-organic after spraying (2) compared to conventional after spraying showed an average decrease of 2,850, and the difference in reduction was significant because of a significant value of 0,000 <0.05. Conventional before spraying (3) compared to conventional after spraying showed an average reduction of 1,200, and the difference in reduction was significant because of a significant value of 0.026 <0.05. The diversity between the two locations is very different. This is caused by a comparison between the number of certain species with the total number of species found in a particular community. Arthropods found in the two locations showed different results in semi-organic fields before being sprayed with pesticides found 10 order and 21 families. Semi organic land after being sprayed with pesticides found 10 order and 19 families. Then in conventional land before spraying found 9 order and 18 families. The last, conventional land after spraying found 9 order and 17 families. The total of all individuals found in semi-organic and conventional fields was 2023 individuals. The individual most commonly found in the 4 types of sampling is formicidae. Natural enemies of insects are divided into two, namely parasitoids and predators. Ants including natural insect insects that act as predators. Ants are insects belonging to the order Hymenoptera and families Formicidae which have an abundant number of species and populations [3]. Ants are included in predatory insects because they are active and strong and prey on smaller, weaker insects.

The role of ants in nature can have positive and negative effects on animals and humans. Positive benefits cannot be directly enjoyed by humans such as the role of predators, decomposing organic matter, controlling pests, and even helping pollination [12]. Ants can be used as predators for pest control on plantations. Solenopsis sp. in Brazil it can be used as an agent for controlling the density of larvae of the Diatrasa saccharalis, a sugar cane borer [14]. The abundance of formicidea tends to be abundant in semi-organic land compared to conventional, this is because conventional land uses synthetic pesticides which cause death and displacement of soil arthropods in conventional rice fields. The high diversity shows the availability of good food energy sources. The existence of elements and organic matter is one factor, the low level of ants in conventional land. Organic material will be used by soil animals as an energy source. The high and low wealth of land arthropods is influenced by the presence of food and climate [4]. Stable climate conditions cause the wealth of insect species to be high.

Interview results show semi-organic chili farmers using chemical pesticides mixed with vegetable pesticides and organic fertilizers. Chemical pesticides used are active ingredients of imidacropid, permectrin, supermectrin, and mankeb, with an average dose of 75 cc: 200L. the spraying of semi-organic spills is done once every 7 days. Conventional chili farmers use synthetic pesticides with high doses above the recommended dose. The active ingredients of pesticides used by conventional chili farmers are dursban, chlorpirifos, methamidopos, dimethoate and malation usually at a dose of 1 ml: 200 L. The average spraying of conventional land is 5-6 days. Most farmers do not understand the role of land animals so they are less concerned about the environment and the

ecosystem of rice fields. The low diversity of conventional land is caused by the killing of soil nutrients by chemical pesticides. The continuous use of chemical pesticides will cause more serious problems, namely the killing of natural enemies, the occurrence of resistance, secondary pest outbreaks and environmental pollution [11].

IV. CONCLUSION

1. Semi-organic land before spraying has the highest diversity value with an average of 3.44, an average evenness value of 0.80, average taxa richness value of 20.2, and the lowest dominance index is 0.13. While the lowest is conventional land after spraying with an average diversity value of 2.10, an evenness index of 0.57, taxa wealth value of 12.7, and the highest dominance index value is an average of 0.25.
2. Semi-organic before spraying is compared with semi-organic after spraying with an average decrease in arthropod abundance of 0.600, and the difference in decrease is not significant because the significant value is 1000> 0.05. While other comparisons were significant, namely semi-organic before spraying compared with conventional farming systems before spraying a significant value of 0,000 <0.05 was significantly different. Semi-organic before spraying compared to conventional farming systems after spraying a significant value of 0,000 <0.05 was significantly different. Semi-organic after spraying compared to conventional before spraying showed a significant value of 0.001 <0.05 significantly different. Semi-organic after spraying compared to conventional after spraying showed a significant value of 0,000 <0.05 significantly different. Conventional before spraying compared to conventional after spraying showed a significant value of 0.026 <0.05 significantly different. This shows that the use of chemical pesticides can reduce the value of arthropod diversity.
3. Types and frequency of pesticide use in *Capsicum annum* L. chili on semi-organic farming system farmers using pesticides, organic fertilizers and imidacloprid chemical pesticides Imidacropid, permectrin, supermectrin and mankoseb, with an average frequency of watering pesticides once every 7 days. In chili farmers, conventional farming systems that use synthetic pesticides only are active ingredients of mextomil, mankozeb, dimethoate, profenofos, chlorpirifos and dursban. With a frequency of spraying as much as 5-6 days. Pesticides have been shown to reduce the diversity of soil arthropods, so they need to be considered for their use, and adjustments are recommended on the packaging label.

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