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Diversity and Abundance of Insect on Shallot (*Allium Ascalonicum L.*) with Integrated Pest Management (IPM) and Conventional Patterns

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KEYWORDS

abundance;
diversity;
insect;
IPM;
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Abstract Research on diversity and abundance of insect on shallot with Integrated Pest Management (IPM) and conventional patterns has been carried out. This study aims to analyze diversity and abundance of insects, damage level of shallot, and relationship between diversity and abundance of insects with growth and production of shallot in IPM and conventional land. This research was conducted in Junrejo village, Batu City in September to December 2017 while identification of insect was carried out at the Laboratory of Plant Pest and Disease, University of Brawijaya. This study uses *Yellow pan trap* and *Pitfall trap* methods. The result showed diversity index (H') of IPM land was 2.50 and of conventional land was 2.67, which both are moderate diversity. The abundance of insect on IPM land is higher (8672 individuals) compared to conventional land (3475 individuals). The level of crop damage is lower in IPM land compared to conventional land, while shallot growth and production is higher in IPM land compared to conventional land.

Introduction

National productivity of shallot in 2011 based on statistical data is 9.54 tons per hectare and national production in the same year is 893,124 tons (Statistics Indonesia, 2011). This productivity of shallot in 2011 declined from 2010 where national production reached 1,048,934 tons with productivity of 9.57 tons per hectare. It shows that national productivity of shallot is still low, while the need of shallot nationally continues to increase along with the rate of population growth. This is caused by various factors, one of it is pest and disease.

According to Sasmito (2011), there are several important pests in shallot plantation, namely *Spodoptera exigua*, *Thrips tabaci*, *Liriomyza chinensis* and *Agrotis ipsilon*. So far, to obtain high yield, farmers still rely on chemical fertilizer and dependon chemical pesticides. The negative effects of insecticide are high level of residual chemical in plant, reduced soil organic matter, lower soil pH, resulting in hard and barren soil, resistance, resurgence, the occurrence of pest attacks, and the emergence of new pest and disease of plant. These conditions require a new paradigm in farming management based on farmer groups with agroecosystem management through a multi-strategic approach thus agricultural ecosystems become stable, control of Pest Disturbance Organisms (PDO), increased production and productivity at a high level, stable and environmentally sound can be achieved.

The policy direction of horticulture crop protection that is being developed is the application of good crop cultivation through Integrated Pest Management (IPM) program in order to be able to increase the quantity and quality of production and economic benefits, environmental sustainability and production cost efficiency (Ditlintanhor, 2009). Good shallot cultivation for increased production

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includes understanding of diversity and abundance of insect in shallot. Insect biodiversity is one of the important information in concept of insect ecology management.

Biodiversity is number and variety of species in ecosystem. Agricultural cultivation practice affects biodiversity, then biodiversity affects insect population. IPM agriculture can reduce the population growth of pest insect and increases natural enemy insects (Ovawanda et al., 2016). David et al., 2005, report that organic rice farming system can suppress the abundance of thrips and conventional system trigger explosion of insect pest, for example increasing the abundance of Nilaparvata lugens.

The biodiversity index is measured by wealth, evenness, and abundance of species. Species wealth is the number of species in a community. Evenness of species measures the community of species. Abundance measures the incorporation of wealth and abundance of species in the diversity index (Magurran, 1988). Evenness and abundance of species in IPM are generally higher than conventional one. Biodiversity that exists in agricultural ecosystem affects growth and production of plants (Altieri, 1999).

This study aims to analyze diversity and abundance of insects, damage level of shallot, and relationship between diversity and abundance of insects with growth and production of shallot in IPM and conventional land.

Materials and Methods

The research was conducted from September to December 2017, located in the farms of Junrejo village, Junrejo District, Batu City and at the Laboratory of Plant Pest and Disease, University of Brawijaya.

The tools used in this study are: pitfall trap, yellow pan trap, film tube, filter, plastic bag, brush, hoe, bamboo stick, petridish, microscope, insect identification book (Borror *et al*., 1996) and camera. The materials used are 70 % alcohol, sterile aquades, detergent, shallot plants of farmers, insects caught in trap, organic and in organic fertilizers, biological agents, refugia plants.

Observation of Insect Community

Observation of insect community on shallot plants were carried out 9 times i.e. a week before planting and every week after planting until harvesting (7, 14, 21, 28, 35, 42, 49, 56 at age dap). Getting insect is by installing traps, namely *yellow pan trap* and *pitfall trap*.

The *yellow pan* is used to catch insects that are attracted to yellow. *Yellow pan* is made of plastic container with 25 cm diameter and 7 cm height. Collecting insects with *yellow pan* are done by placing one *yellow pan* on each sample of field in IPM land with a distance of 5 m, 10 m, 15 m, 20 m and 25 m along land area of 4 plots, so that there are 20 *yellow pan* traps. Like wise, the same thing is done in conventional land, but without refugia.

The *yellow pan* is filled with water up to one-third the height of the pan, mixed with a little detergent. Giving detergent aims to reduce the pressure of water surface, thus insects that enter will sink and die. Installation of yellow pan is done in the morning around 9 o'clock and left for 24 hours, then taken back in the morning by filtering, taken with a brush and put in a film bottle filled with 70 % alcohol.

The pitfall used is a plastic cup with 6.5 cm diameter and 5 cm height, aimed at insects that actively walking on the ground. Pitfall trap made of plastic cups are added with water in it about half of the height of the glass and added a little detergent. Then it is immersed into the ground according to the placement of yellow pan, i.e. at every distance of 5 m to 25 m from the distance refugia is placed 1 trap. The surface of the top of the glass is immersed equally with the surface of the ground. This trap was installed in the morning around 9

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o'clock and left for 24 hours in the field. Samples trapped in the pitfall trap was filtered, taken with a brush and put in a film bottle with 70 % alcohol.

Identification is carried out at the laboratory. Insects are separated by order, while identification at the family level is separated by morphology (Borror *et al*., 1996).

Observation Parameter

Plant Damage, Plant Height, Number of Leaves, and Productivity of Wet and Dry Bulbs.

Data Analysis

Species diversity. Species diversity (biodiversity) was analyzed using the Shannon-Wiener diversity index (Odum, 1998)

$$H = -\sum_{i=1}^{s} Pi\ ln\ Pi$$

where

H = Diversity index and Pi = proportion of each species

Evenness. Species evenness was calculated by using the Pilow (E) index on program of volume guid indexer (Magurran, 1988), with formula:

$$\mathrm{E} = \frac{(\mathrm{H}')}{\ln \circ \mathrm{S}}$$

where

E = Evenness of species

H'= Species diversity

S = Number of species

Abundance. Abundance is determined by the Simpson index (D) (Magurran, 2004) with formula:

$$Id = \frac{\Sigma\ Ni\ (Ni-1)}{N(N-1)}$$

where:

Id = Dominance index

Ni = Number of individuals, type -1

N = total number of individuals

Community Similarity. The species composition of two communities is compared using the Sorensen community similarity index (Cs), with formula:

$$Cs = \frac{2j}{a+b}$$

where

Cs = Index similarity of 2 habitats

a = Number of species in habitat a

b = Number of species in habitat b

j = The smallest number of the same species from two fields

T Test (Difference Test)

Comparing the diversity index, evenness, abundance of insects, community similarity, level of crop damage, growth and production of shallot, using paired t-test with Microsoft Excel program.

Results and Discussion

Insect Diversity

Based on diversity index analysis, the result shows the diversity index value on conventional land was higher (2.67) compared to IPM land (2.50). However, the two lands are still included in moderate diversity (Table 1).

Table 1. Diversity (H'), Evenness (E), Abundance (D) of Insects on Shallot in IPM and Conventional Lands

Index	Land		Category
	IPM	Conventional	
H'	2.50	2.67	Moderate
E	0.66	0.75	Moderate
D	0.87	0.91	High

Remark: 1 <H'<3 : moderate diversity
0.50 <E <0.75 : moderate evenness
0.75 <C <1.00 : high abundance

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Diversity index (H') in conventional land is higher than IPM land because there are several families in IPM land that dominate, namely *Entomobryidae* (*Collembola*) and *Reduviidae* (*Hemiptera*). According to Yaherwandi (2006), high and low of diversity index (H') is strongly influenced by the number of families and population. If there are more species but only in one family, the diversity is low compared to the number of fewer species but is included in several families (Subagja, 1996). In addition, the occurrence of the same diversity in two lands is due to the near distance, abiotic factors (temperature, humidity, light intensity, pH) and plants around the land are almost the same.

Insect Abundance

The abundance of insects found in IPM and conventionalis different. Shallot on IPM land (8672 individuals) have a higher population compared to conventional land (3475 individuals). In the IPM land, dominant individuals were found from *Entomobryidae* family (2067 individuals) and the lowest was *Cerambycidae* family (1 individual).Where as, in conventional land, the dominant individuals are *Sciaridae* family (470 individuals) and the lowest are *Blattidae*, *Curculionidae*, *Lampyridae*, *Encyrtidae*, *Eucoilidae*, and *Ichneumonidae*, each with 1 individual.

Abundance in IPM land is higher because IPM land has a diversity of vegetation as a microhabitat for insects. According to Alltieri (1999), IPM farming systems have potential to create diversity of fauna with a more complex food nets, including stimulate the presence of biological controllers. In addition, IPM farming systems consider more ecological sustainability in practice than the continuous use of synthetic pesticides.

Community Similarity

Based on the analysis of community similarity (Cs) (Figure 1) between IPM and conventional land, the trap method that has the most similar insect is the *yellow pan trap* of IPM and *yellow pan trap* of conventional because it has the lowest value (0.48). This is because the location of the two lands is nearby each other and insects in *yellow pan trap* are active flying insects so they can move from one land to another, also the surrounding land which is also planted with the same plants and the planting system simultaneously causing similarities community.

According to trap method, the highest difference in insect groups i.e. *pitfall trap* of IPM and *pitfall tra p*of the conventional because it has the highest value (0.75). This is because in IPM land, ecological engineering techniques were carried out which inseparable from the strategy of ecosystem manipulation, such as planting refugia plants by planting types of plants that are preferred by natural enemies around the main plants as shelter i.e. kenikir plants, paper flowers, sun flowers, and water hyacinthas a barrier, also the provision of organic material such manure and straw which can restore biological soil for fertility of soil and plants (Nurjanah & Pratiwi, 2012). According to Indriyati and Wibowo, 2008, land containing a lot of organic matter has an alternative prey population higher for predators than for soils that contain little organic matter. Where as, in conventional land, there is schedule of pesticides spraying to eradicate and destroy pests as much as possible, there fore the target pest develops to be resistant to pesticides, occurrence of pest resurgence (the number of pest offspring becomes larger compared to if not treated with pesticides) and non-target organism also death (Oka, 2005).

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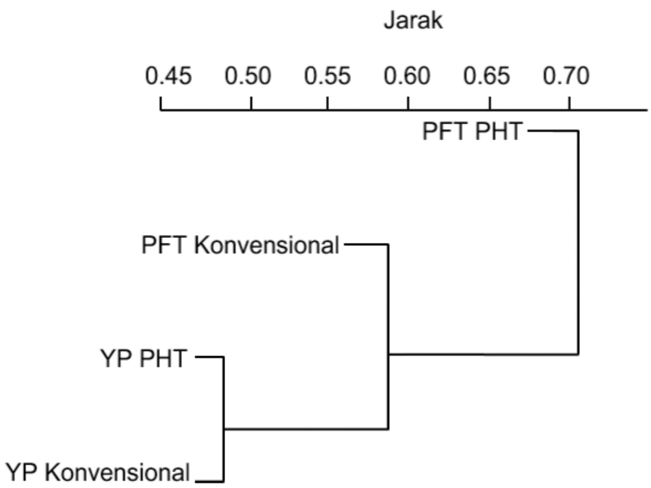

Figure 1. Community similarity (Cs) of Insects in Each Type of Trap
(This similarity index can range from 0 to 1, if values close to 0 indicate higher similarity)

Diversity and Abundance of Insect Based on Role of Ecology

Insects have various roles in food chain in an ecosystem, including as herbivores, predators, parasitoid, detritivore, as well as other insects that are not included in these four roles because it does not have a very clear role in the natural ecosystem (Odum, 1998) of onion. In this study, insects were grouped according to their respective roles (Figure 2).

The number of individuals caught in IPM land was 8672 individuals and the dominant insect on this land was detritivore (3831 individuals). The high of detritivore abundance is caused by organic material from manure used during land preparation. Whereas, in conventional land the individuals caught as many as 3475 individuals and the dominant insects on this land are herbivores (2176 individuals). Herbivorous insects that dominate conventional land from ordo *Diptera*, namely *Sciaridae* then *Agromyzidae* (leaf miner) which are important pests on shallot. One of the causes of high herbivorous insects on conventional land is the schedule of pesticides spraying this occurrence of pest resistance and resurgence, as stated by Georghiou and Taylor (1977), and Reynolds (1971) the use of broad-spectrum pesticides is almost always followed by pest resistance and resurgence.

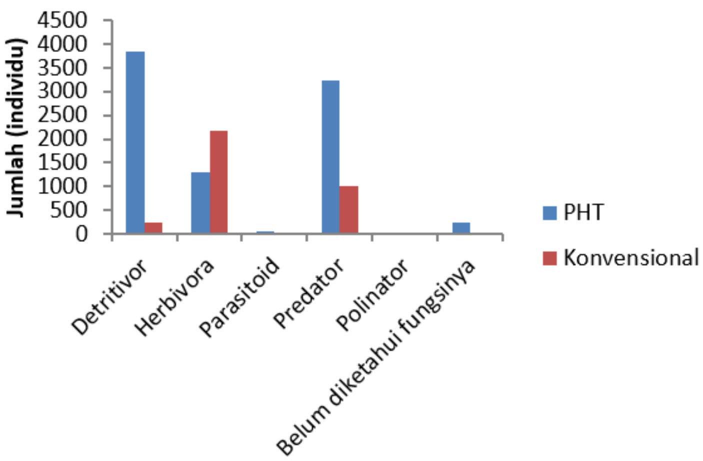

Figure 2. Grouping of Insects Based on Role of Ecology

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Damage on Onion

Based ont test, the damage of plants in IPM land shows a significantly different (p<0.05) with conventional land (Table 2). This is because in IPM land, there are a variety of vegetation such as long bean, beans, and lettuce (*Romaine lettuce*) which can affect or spread pests, thereby reducing the level of density of pest population on onion. In addition, in IPM land is planted barriers or repellents which aim to inhibit pest migration. Water hyacinth besideis being useful as a physical barrier to the entry of pests into shallot, it can also function as hosts for predatory insects such as *Coccinellidae* beetle (*Menochilus sexmaculatus*). This is in accordance with the research conducted by Siswati *et al*. (2017), that yellow flowers of water hyacinth are favored by natural enemies, which can minimize the occurrence of pest attacks on cultivated land.

Table 2. Damage on Shallot

	Damage on Shallot (%)						
	7	14	21	28 at age (dap)	35	42	49
IPM	0.02*	0.03*	0.06*	0.07*	0.08*	0.10*	0.13*
Conventional	0.05	0.08	0.11	0.12	0.16	0.17	0.19

Remark: *Significant different based on paired t-test at level of 5%

Growth of Shallot

a. Plant height

Growth of plant height was observed by measuring plant height (cm) of oshallot and carried out 7 observations, starting from 7 to 49 age after planting at 1-week interval (Table 3).

Table 3. Height of Shallot

Land	Height of Shallot (cm)						
	7	14	21 at age (dap)	28	35	42	49
IPM	11.45*	15.1*	19.1*	23.1*	27.25*	32.15*	37.15*
Conventional	8.75	11.95	16.6	19.6	23.65	27.8	32.2

Remark: *Significant different based on paired t-test at level of 5%

Based on the t-test, the growth of plant height in IPM land shows a significant different (p<0.05) compare to plant height that growth in conventional land. This is because in IPM land, the use of organic fertilizers has an effect on the growth of plant height (cm) where macro and micro nutrients found in organic fertilizers play an important role in maximizing nutrient absorption needed by plants. As stated by Setyorini (2005) that organic fertilizers containing macro and micro nutrients are very important for plants.

b. Number of Leaves

The increase in number of plant leaves was observed by counting the number of leaves (strands) of shallot and 7 observations were carried out starting from 7 to 49 age after planting at 1-week interval (Table 4).

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Table 4. Number of Leaves of Shallot

Land	Number of Leaves of Shallot (Strands)						
	7	14	21	28 at age (dap)	35	42	49
IPM	8.0*	11.3*	15.15*	19.2*	23.75*	28.6*	33.6*
Conventional	5.35	8.6	12.2	16.15	20.15	24.2	28.65

Remark: *Significant different based on paired t-test at level of 5%

Based on the t test, the increase in number of leaves each week in IPM land shows a significant different (p <0.05) compare to the increase in number of leaves in conventional land. This is because of the weathering of organic matter which can provide elements of N, P, and K in the soil needed by plants. High N nutrients are very influential in the development of leaves resulting in a different number of leaves. In accordance with the statement of Lingga & Marsono (2008) which the main role of N for plants is to stimulate overall growth, especially stems, branches and leaves.

Onion Production

Based on the t-test, shallot production in IPM and conventional land shows a significant different (p<0.05) with shallot production in IPM land i.e. 9.2 t.ha-1, with an average production per plot of 1.090 kg and in conventional land, the shallot production is 8.07 t.ha-1, with an average production per plot of 0.95 kg (Figure 3). This is because in IPM land contains organic material that can store water (water availability), nutrient availability (soil chemical properties), and increase the activity of microorganisms in the soil to help build soil fertility (biologically) so that the organic matter given can increase the weight of the tuber produced. As stated by Indahwati *et al*. (2012) that soil insects function to overhaul organic matter into simpler nutrients available to plants. Likewise, nutrient N and nutrient elements in organic matter which is released slowly through the mineralization process, greatly helps soil fertility and spurs the translocation of photosynthesis from leaves to other parts so that it can increase the size, amount, and yield of tuber (Rosliani & Basuki, 2013)

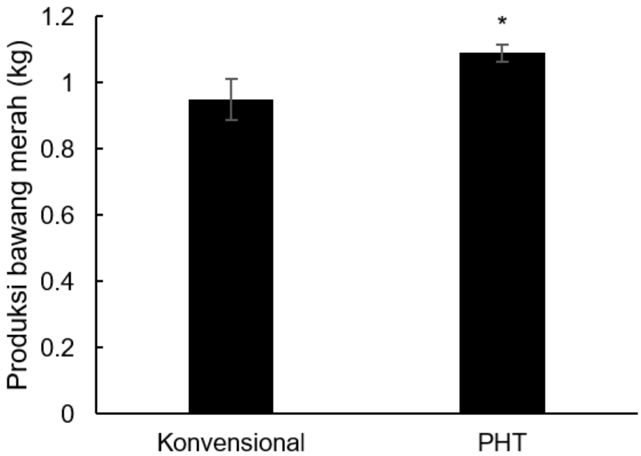

Figure 3. Onion Production
Remark: *Significantly different based on paired t-test at level 5%

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Conclusions and Suggestion

Conclusion

The diversity index value on conventional land is higher than IPM land. However, these two lands are still included in moderate diversity. While the abundance of insects in shallot is higher in IPM land than in conventional land. The level of damage of onion is lower in IPM land compared to conventional land. Diversity and abundance of insects associated with the growth and production of shallot in IPM and conventional land.

Suggestion

The distance between IPM and conventional land which not too far away should be considered because it affects the diversity index value.

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