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Species Diversity of Insects on Tobacco (*Nicotiana tabacum* L. 'Bligon' and 'Grompol') Plantation in Sokorini Village, Muntilan, Magelang, Central Java

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ABSTRACT
Tobacco is an agricultural export commodity important for Indonesia. Therefore, tobacco farming, especially in optimizing production, is an attractive point for research. The challenges in optimizing tobacco production are insect pests causing loss on tobacco production. This study aimed to identify the insect species on the plantation of Bligon and Grompol tobacco variety in Dukuh Curah III, Sokorini Village, Muntilan, Magelang, Central Java. The collection of insect samples was done using hand collection and pitfall trap methods. The insect collected from both Bligon and Grompol tobacco variety plantations consisted of 29 species, belonged to 17 families from 6 orders of insects with *Anthicus* sp. (Coleoptera) as the most abundant species found (128 individuals). In conclusion, the diversity of the insect species on Bligon and Grompol tobacco variety in Sokorini Village, Muntilan, Magelang, Central Java were in moderate level with the value of diversity index Shannon-Wiener for Bligon and Grompol tobacco variety respectively were 2.3668 and 1.8578.

Keywords: *Bligon, Grompol, Insect pest, Natural enemy, Shannon-wiener index.*

1. INTRODUCTION

Tobacco farming is one of the important agricultural sectors for Indonesia. Tobacco farming contributed 0.09% of total export in the forms of tobacco leaf and 0.48% in the forms of cigarettes in 2018 [1]. Indonesia is on the 6th rank as the world's largest tobacco producer under China, Brazil, India, The United States, and Zimbabwe [2]. The Central Java Province is the 3rd largest tobacco-producing province in Indonesia. Tobacco production in Central Java reached 56,205 tons, equivalent to 20.83% of Indonesia's total tobacco production in 2019 [3].

Biotic and abiotic factors strongly influence tobacco farming. One of the biotic factors that have a crucial role in tobacco farming is insects. Insects have an important role in maintaining the balance of the tobacco farming ecosystem by acting as predators, pollinators, and natural enemies. Insects also play a detrimental role by becoming pests and reducing tobacco production. The two most cultivated tobacco varieties on Magelang Regency's tobacco farm, especially in Muntilan District, are Bligon and Grompol varieties. Insect collection and identification were done to determine the species diversity for all insects on the two tobacco plantations. The research will be crucial for future tobacco farming as a reference for insect pest management, primarily on tobacco farming in Muntilan.

2. METHODS

2.1. Location and Time of Research

The research was conducted on September 30th - October 10th 2018 on Bligon and Grompol tobacco varieties plantation in Dusun Curah III, Sokorini Village, Muntilan, Magelang, Central Java, Indonesia. Each specific location coordinate for each variety is (7°37'43.0"S 110°14'50.7"E) for Bligon varieties and (7°37'36.3"S 110°14'55.4"E) for Grompol varieties.

2.2. Procedures

2.2.1. Sampling of insect

The collection of insect samples was carried out using direct and indirect methods. The direct method used was the direct hand collection method, while the indirect method used was pitfall traps. Hand collection was carried out in the morning (08.00 AM - 11.00 AM), during the day (01.00 PM - 02.00 PM), and in the afternoon (03.00 PM - 05.00 PM). The hand collection was carried out by tracing a row of 30 tobacco plants, such as the pattern depicted in **Figure 1.**

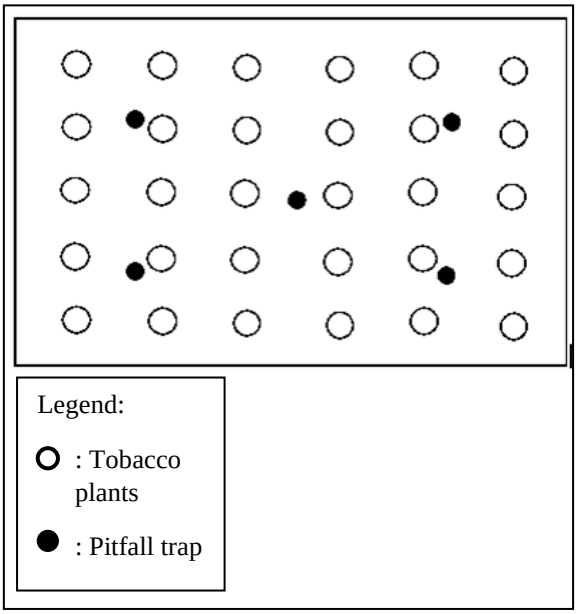

Figure 1. The design scheme for sampling area and installation of pitfall trap in the research location.

The installation of 5 pitfall traps was carried out at noon (02.00 PM) and repeated 3 times during the research period. Solution of detergent and tap water with the ratio of 1:4 was used for the pitfall trap. Pitfall trap installation follows the scheme depicted on **Figure 1.** Samples were collected 24 hours after the installation and preserved in ethanol 70% solution.

2.2.2. Identification of insect

The insects samples were then identified in the Laboratory of Entomology, Faculty of Biology Universitas Gadjah Mada by observing the morphological characteristics and comparing the images of characters and descriptions of the samples insects to the book of Borror and DeLong's Introduction to the Study of Insects [20] and websites such as: www.cabi.org; www.idtools.org; www.itis.gov; and Iowa State University's www.bugguide.net site.

2.2.3. Environmental parameter measurement

Environmental parameters measured in this study were temperature and relative air humidity. Measurement was done by placing the thermo-hygrometer (Dekko® 637) prior to direct sampling for 30 minutes.

2.2.4. Data analysis

The diversity of insect species from each location was analyzed by calculating insect samples obtained with the Shannon-Wiener index of species diversity (Equation (1)), where H' is diversity index and pi is proportion of each species found [5]. Jaccard Similarity Index is shown in Equation (2), where SI is similarity index, A is number of insect species found only at location 1, B is number of insect species found only at location 2, and C is number of insect species found on both locations [6]. Shannon evenness index is shown in Equation (3), where E' is evennesss index, and S is total species found [7].

$$H' = -\sum_{i=1}^{s} pi \ln pi \quad (1)$$

$$SI = \frac{C}{A+B-C} \quad (2)$$

$$E' = \frac{H'}{\ln(s)} \quad (3)$$

3. RESULTS AND DISCUSSION

The insect collected from both Bligon and Grompol tobacco variety plantations were 536 individuals, part of 29 species, members of 17 families from 6 orders of insects (**Table 1)**. Orders obtained in this study include the order of Coleoptera, Dermaptera, Hemiptera, Hymenoptera, Lepidoptera, and Orthoptera. Orders of Lepidoptera and Dermaptera were only found on the Grompol variety, while Orthoptera was only found on the Bligon variety.

Insect species found on Bligon variety were as many as 25 species members of 23 genera from 15 families and 4 orders, while insect species on Grompol variety were 11 species members of 11 genera from 9 families and 5 orders. The majority of insects found in the Bligon varieties were insects' members of the subfamily Dolichoderinae (Hymenoptera) and *Engistatus modestus* (Hemiptera). In the Grompol variety, the majority of insects found were *Anthicus* sp. (Coleoptera) and insects from Family Carabidae (Coleoptera) (**Figure 2**). Eight species, including *Anoplolepis gracilipes, Aphis craccivora,* Carabidae A, *Engytatus modestus, Anthicus* sp., *Nesidiocoris tenuis,* and *Pangaeus* sp. on Grompol varieties are the same as those found on Bligon varieties. Therefore only three species are exclusively found on Grompol varieties, so Bligon varieties have 17 exclusive species.

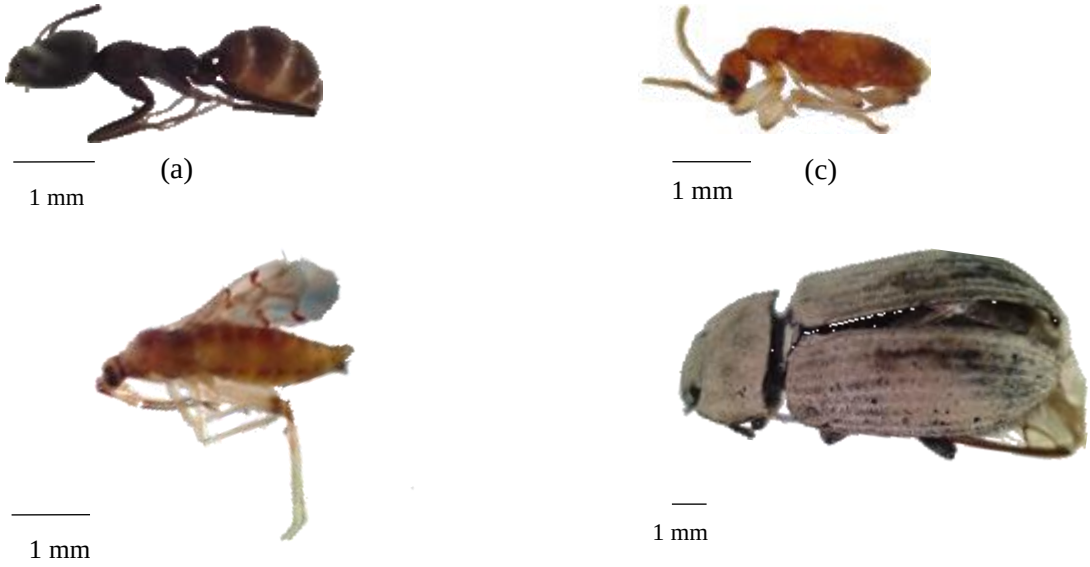

Figure 2 Most abundant Insect specimens found on each Bligon (a,b) and Grompol (c,d) tobacco varieties. Dolichoderinae (a), *Engistatus modestus* (b), *Anticus* sp. (c), Carabidae (d). (Scale bar: 1 mm).

Table 1. Insects found in Bligon and Grompol tobacco varieties plantation, Sokorini Village, Muntilan, Magelang, Central Java.

No.	Orders	Families	Genera	Species	Number of individuals
1.	Coleoptera	Carabidae	*Ophionea*	*Ophionea* sp.	1
2.			-	Carabidae A	55
3.		Anthicidae	-	Herpalinae. B	1
4.			*Anthicus*	*Anthicus* sp.	128
5.		Chrysomelidae	*Altica*	*Altica* sp.	1
6.			-	Chrysomelidae. A	1
7.				Chrysomelidae. B	1
8.				Chrysomelidae. C	2
9.		Dytiscidae	*Copelatus*	*Copelatus* sp. A	1
10.				*Copelatus* sp. B	2
11.		Elateridae	*Conoderus*	*Conoderus* sp.	1
12.		Scarabaeidae	*Rhyssemus*	*Rhyssemus* sp.	1
13.		-	-	Coleoptera. A	1
14.	Dermaptera	Carcinophoridae	*Euborellia*	*Euborellia* sp.	24
15.	Hemiptera	Aphididae	*Aphis*	*Aphis craccivora*	9

No.	Orders	Families	Genera	Species	Number of individuals
16.		Cydnidae	*Pangaeus*	*Pangaeus* sp.	30
17.		Lygaeidae	*Nysius*	*Nysius* sp.	18
18.		Miridae	*Engytatus*	*Engytatus modestus*	75
19.			*Nesidiocoris*	*Nesidiocoris tenuis*	39
20.		Reduviidae	*Rhynocoris*	*Rhynocoris* sp.	2
21.		-	-	Eriococcidae A.	5
22.		-	-	Hemiptera. A	1
23.	Hymenoptera	Formicidae	*Anoplolepis*	*Anoplolepis gracilipes*	34
24.			*Cardiocondyla*	*Cardiocondyla Mauritanica*	13
25.			*Paratrechina*	*Paratrechina* sp.	31
26.			*Pheidole*	*Pheidole* sp.	4
27.			-	Dolichoderinae. A	52
28.	Lepidoptera	Noctuidae	*Spodoptera*	*Spodoptera* sp.	2
29.	Orthoptera	Gryllotalpoidea	-	Gryllotalpoidea. A	1

The diversity of the insect species on Bligon and Grompol tobacco varieties in Sokorini Village, Muntilan, Magelang, Central Java was at a moderate level. The diversity index of Shannon-Wiener evidences this for Bligon and Grompol tobacco varieties, respectively were 2.3668 and 1.8578. Slight difference on diversity value between Bligon and Grompol variety (0.509) also observed. The difference in nicotine content with the higher nicotine content on the Grompol variety relative to the Bligon variety may play a role in the relatively lower number of insect species found on the Grompol plantation [8][9][10].

Table 2. Indexes of insects found in Bligon and Grompol tobacco varieties plantation, Sokorini Village, Muntilan, Magelang, Central Java.

Indexes	Bligon Variety	Grompol Variety
H'	2.366761294	1.857887569
E'	0.74	0.77
SI	0.666	

Diversity of the insect species on Bligon and Grompol tobacco varieties in Sokorini Village, Muntilan, Magelang, Central Java were in moderate level. The value of diversity index of Shannon-Wiener for Bligon and Grompol tobacco varieties respectively were 2.3668 and 1.8578. Slight difference on diversity value between Bligon and Grompol variety (0.509) also observed. It is possible that the difference in nicotine content with the higher nicotine content on Grompol variety relative to Bligon variety play a role in the relatively lower number of insect species found on the Grompol plantation [8][9][10].

Dolichoderinae ants are predators of smaller insects and detritivores of organic materials [11]. *Engytatus modestus*, known as zoophytophagous insect acts as both natural enemies for some insect pests such as *Bemisia tabaci* and also as herbivores potentially damage their host plant. However, their role as biocontrol agents outweighs the damage they cause [12]. Adults of Anticidae species are scavengers feeding on organic debris and opportunistic predators feeding on small and weak invertebrates. They also feed on pollen, glands exudates, fungal hyphae, and spores [13]. Carabidae are omnivores feeding on smaller insects and some parts of plants [14].

The potential role of each most found insect species is relatively dominated by predatory and omnivorous insects. Even so, the Evenness index (**Table 2**) shows that the insect species distributed relatively evenly [14]. Temperature and relative humidity measured during sample collection on the Bligon variety range from 27.8ºC-33.3ºC and 48%-72% respectively. Temperature and relative humidity on Grompol variety range from 29ºC-34.2ºC and 48%-67% respectively. Environmental parameters measured shows an optimum range of value in which most insect can live [15][16][17][18]. The moderate diversity value and even distribution of insects species can be translated as an indication of a relatively healthy ecosystem [19].

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