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Study of Arthropod Communities in a Virginia Tobacco Agro-Ecosystem

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ABSTRACT

The cultivation of tobacco is one of users of agro-chemical substances such as insecticides, herbicides, defoliants, and fertilizers among other food crops and plants with high economical value. The use of these chemicals may bring negative effects regarding the richness and abundance of arthropods. The study of arthropod community in the Virginia tobacco ecosystem was carried out in Central Lombok, West Nusa Tenggara Province, during the 2010 plantation year. It was aimed at finding the composition, structure, and dynamic of the arthropod diversity around the tobacco field. Samples were obtained by using trapping techniques (pitfall traps, yellow-pan traps, and sweep net). The number of arthropods found in Virginia tobacco field are 69, consisting of 65 species of insects (belonging to 46 families and 8 orders) and 4 species of spiders (belonging to 4 families). The majority of insects found was Hymenoptera, dominated by bees. Based on the ecological functions, the major group of arthropods documented was phytophagous (20 species), mostly Coleoptera and Orthoptera. Yet, the number of predators was relatively more abundant than that of the phytophague. The number of kinds of arthropods commonly interacting around the field fluctuated during the growing period, while in the cultivation period the number decreased. The diversity of the species (H') and the ratio of abundance of the natural enemies and phytophagous in the field was high.

Keywords: *arthropods, diversity, natural enemies, phytophage, species richness, Virginia tobacco field*

INTRODUCTION

Virginia tobacco is one of best farming commodity in West Nusa Tenggara and planted widely across Lombok island. Planting this kind of tobacco is an intensive farming activity with high input of agrochemical, employing the techniques of monoculture [1]. Conceptually this farming activity belongs to a modern agroecosystem that keeping its high productivity depends on agrochemical inputs from non-farming activity such as fertilizers, pesticides, and other chemical substances commonly used in farming [2, 3, 4]. In many cases, it has proven that monoculture technique research has also proven that the use of agrochemical inputs may lead to an imbalance in agro-ecosystem [5, 6]. To be more explicit, the imbalance is possibly caused by a mismanagement of natural habitats in which principles of ecosystem are neglected [2]. The future wrongdoings in the management of agro-ecosystem will decline the species diversity and cause certain species to dominate in terms of its population [7]. For instance, the overuse of syntetical chemical substances in modern farming, like insecticides, to control the number of insects will decrease the number of natural predator [8]. During the planting season in 2004 and 2005, there was an explosion of pest *Spodoptera litura* (Lepidoptera: Noctuidae) in Puyung, Lombok island. The intensity of the explosion was quite high, reaching as much as 57.13 %, affecting greatly the low productivity and quality of Virginia tobacco in that area [9]. The current study aims at finding out the composition, structure, and dynamic of arthropods within the Virginia tobacco ecosystem.

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RESEARCH METHOD

The research was conducted on June-October 2011. The sampling activity was carried out in the Virginia tobacco field in Puyung, Central Lombok, West Nusa Tenggara. The identification of arthropods was carried out in the Biology Laboratorium of Faculty of Science and Mathematics, Soil Protection Laboratory of Fa-

culty of Agriculture at Mataram University, and Institute of Zoology Research and Development, Biology Department of LIPI, Cibinong.

The research was carried out in the three-hectare-wide Virginia tobacco field. The way the seed was prepared, planted, fertilized, and grown referred to the one commonly used by local farmers with regard to technical standards set by the partner company (PT. Sadhana Arifnusa). The scope of the research included the observation on arthropods living around the tobacco field.

The sampling activity was not initiated until two weeks after the seed was planted with the interval of 14 days (or two weeks) until cultivation period and one week after the cultivation. The attempt to catch samples of arthropods from the plants' canopy were use of a swing trap net (with 20 doubled swings) and 60 yellow-pan traps (for three-time use) which were spread equally on the ground. Meanwhile, samples of arthropods from the surface of the ground were obtained by using 60 pitfall traps (for three-time use) which were placed in equal level with the surface of the ground. The duration of the trapping activity was 24 hours.

Sample of arthropods were soaked into ethyl acetate, filtered with filter paper, rinsed with water, and stored in a tube contained 70% alcohol for further identification in the lab. The identification of the types arthropods and spiders found were based on the morphology suggested by Kalshoven (1981) [10], Lawrence and Britton (1984) [11], and Hadlington and Johnston (1987) [12]. The data were put into an observation table. They were further analyzed by using diversity index (Formula 1) [13], domination index (Formula 2) [14], evenness index (Formula 3) [15], and equality index (Formula 4) [16]` as shown in the following set of formulas.

$$H' = - \Sigma pi \ln pi \quad \ldots (1)$$

Note: Pi = proportion of species i

$$D = ni / N \times 100\% \quad \ldots (2)$$

Note: Ni = number of individuals i species
N = total number of individuals that were found

$$E = H' / \ln (S) \quad \ldots (3)$$

Note: H '= diversity index
S = species entirely

$$Cs = 2j / (a + b) \quad \ldots (4)$$

Note: A = number of species in a habitat
b = number of species in b habitat
j = number of the same species was found from two habitats

RESULTS AND DISCUSSION

The number of arthropods from Virginia tobacco field in Puyung, Central Lombok was 915 individu, comprising 880 insects and 35 spiders. The insect orders were Hymenoptera (13 families), Coleoptera (5 families), Diptera (8 families), Lepidoptera (6 families), Hemiptera (5 families), Orthoptera (4 families), Homoptera (4 families), and Odonata (1 family). The spiders caught were 4 species belonging to 4 families. Based on the observation, the species of natural enemies (predators and parasitoids) were more diverse than the phytophages (including the pests and non-pests of the tobacco) (Table 1).

The observation found that the number of predators was relatively the highest (41.13 %) among other functional group of creatures such as phytophages (33.33 %), parasitoids (7.54 %), and unknown insects (18 %). It has been predicted since the beginning of the research that the number of predators would be the highest among all. The five dominating kinds of predators were from Carabidae, Staphylinidae, Coccinellidae, Dolichopodidae, and Lycosidae. *Sciapus* sp. (Diptera order and Dolichopodidae.

Table 1. The number of arthropod species based on order and ecological function in virginia tobacco field puyung, central Lombok

Order	Phytophage	Predator	Parasitoid	Decomposer	Pollinator	Other
Hymenoptera	-	4	9	-	5	1
Coleoptera	6	6	-	1	-	
Diptera	3	4	-	2	1	
Lepidoptera	4	1	-	-	1	1
Hemiptera	4	1	-	1	-	-
Orthoptera	5	-	-	-	-	-
Homoptera	3	-	-	-	-	1
Odonata	-	1	-	-	-	-
Aranae	-	4	-	-	-	-
Total	**25**	**21**	**9**	**4**	**7**	**3**

family) dominated the number of predators with the percentage of 63.25 %. This fly is known as a predator of insects with a small, soft, and annelid body [17]. One kind of Carabidae beetles, called as *Pheropopus occipitalis*, was the dominant predator found in the tobacco field, along with Coccid *Verania lineata* beetle and *Rhinocoris fuscipes* bug (Reduvidae). *Rhinocoris* was a predator for *Spodoptera* sp., while *Helicoverpa armigera* was the main pest for Virginia tobacco. As the number of holes increased with the growing number of the tobacco, the number of predators increased. They can explore places in far distance from their home to find preys [18, 19]. The abundance number of parasitoids found in the research belonged to the family of Sarcophagidae from Hymenoptera order. Meanwhile, the kind of phytophage mostly found in the field was Orthoptera, particularly Tetrigidae family.

Among the spider population caught by the pitfall traps, as many as 65.71 % were one type of spiders called *Pardosa* sp. (Lycosidae). This spider is one of important predators on the ground that hunts Lepidoptera larvae, moths, and leaf-hoppers as its food [20, 21]. Other kinds of spiders caught from the ground and the canopy were *Oxyopes javanus* (Oxyopidae), *Tetragnatha* sp. (Tetragnathidae), and *Cyclosa* sp. (Araneidae). One needs to pay attention to not only the diversity and abundance but also the existence of natural predators. A good predator should be the one which is able to colonize the planting as early as possible [18].

The kinds of parasitoids found in Virginia tobacco were dominated by Hymenoptera order which consisted of Braconidae, Ichnemonidae, Evaniidae, Sphecidae, Calcididae, Scelionidae, and Coropidae families. There was only one kind of parasitoid found from Diptera order, that is, Sarcophagidae. The rest of orders were not found. This phenomenon may be caused by the fact that most parasitoid species belong to Hymenoptera which is commonly found at all land ecosystem [22, 23]. Braconidae and Ichneumonidae families were two most important members of Hymenoptera order in hunting Coleoptera, Diptera, Lepidoptera, Aphids, Hemiptera, and any other larvaes.

The result of the observation also shows that the ratio of the arthropods' diversity fluctuates in every observation time. The highest diversity was achieved in the 7th observation (14 weeks after planting (WAP)) when the leaves were about to be picked up. The lowest diversity was in the 4th observation (8 WAP) (Figure 1). The latest phenomenon may be caused by the application of insecticides to control pests of the tobacco. Another research showed significant decline (90 %) of the population of Coccinelidae beetle and various kinds of spiders within 3-5 days after the pesticides were applied into the rice field.

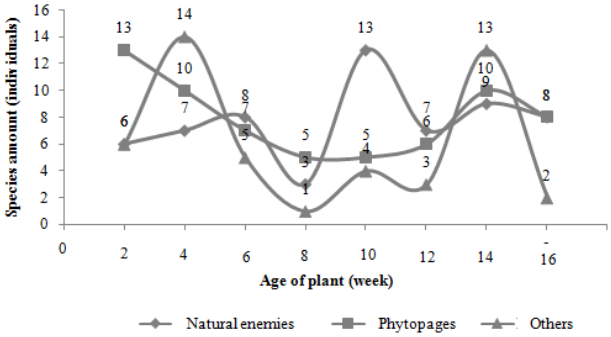

Figure 1. Fluctuation of arthropods species richness in Virginia tobacco field, Puyung, during the 2010 growing season

According to the indicators in Shannon indexing (H'), the arthropods' index of diversity is 2.79 (categorized as intermediate) that show some dominated species. That cause the low of diversity [13]. The index of evenness is 0.76 and the index of richness is 9.46. The analysis indicates that the equality of population of the arthropods is low and the richness of individual species is different between one to another. the evenness inter species of the arthropods is low, the individual number of each species is much different one to another [24]. The regular two-week observation indicates the fluctuative number of existence of the arthropods (Figure 2). In the earlier growing time (2 MST), the number of phytophaguos dominated by Delphacidae. That was much higher than the number of the natural enemies. This is caused by the abundance number of phytophagues is high but the population of individual species was low. The significant decline to the number of phytophagues and the natural enemies occured in week 4, 6, and 8 after the plantation, while it increased beginning from week 8 and reached its highest point in week 14. The pattern of phytophagues' abundance was likely to be similar with the one of the natural enemies during the whole period of the tobacco's growth but at a lower level. Pertinent to the cultivation period, the existence of arthropods declined sharply, leading to an assumption that the natural enemies were mana-ged to balance their existence with phytophagues since the period of vegetation.

The analysis shows that the existence of natural enemies around the tobacco field was dynamic. Predators such as *Pherosophus occipitalis* (Carabidae), *Sciapus* sp. (Dolicophodidae), and *Pardosa* sp. spider (Lycosidae) were found around

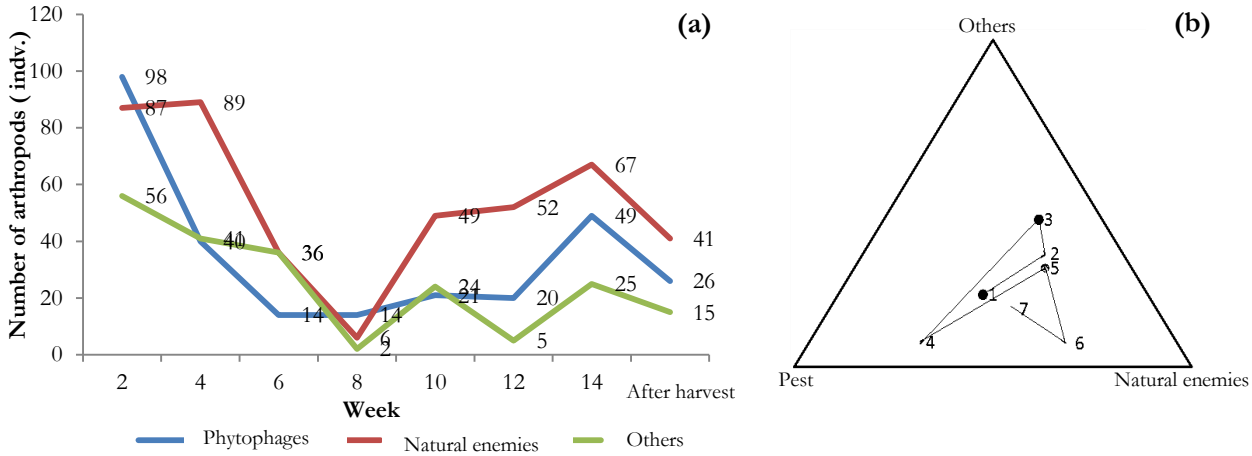

Figure 2. The dynamic of arthropods' existence based on their ecological functions (a) and ecological condition in the virginia tobacco field based on fi torial analysis (b)

the field since the first observation (2 WAP) and remained there in the cultivation period. This fact shows that the three species are said to be important in the whole ecosystem of Virginia tobacco. Carabidae was always found in a huge number since the beginning of the plantation and on. Also, spiders belonging to Lycosidae (i.e. *Pardosa sp.*) could be easily caught every time the observation was carried out but in the the 4th (8 MST) and 6th observation.

The fly *Sciapus* sp. had the highest number of existence among other predators; when the tobacco was 2 weeks old, the number of the fly found was 51. However, it could be hardly found in the next two-time observation until the next month. When the tobacco was two months old, the number began to raise again.

The analysis based on the fictorial display above shows the points of coordinate being close between the pest and natural enemy corners. It also indicates that other types of insects are only a few. This can be concluded that the ecological circumstance of Virginia tobacco field in Puyung is less normal. The existence of the natural enemies depends greatly on the population of pests as their source of food.

CONCLUSION

The number of arthropods found in Virginia tobacco field are 69, consisting of 65 species of insects (belonging to 46 families and 8 orders) and 4 species of spiders (belonging to 4 families). The diversity of the arthropod community is said to be "intermediate" based on Shannon's index of diversity (which is 2.79). The composition and structure of the community fluctuate depending on the growth of the tobacco. The natural enemies (i.e. predators and parasitoids) may take an important role in controlling the balance of the Virginia tobacco ecosystem. However, the ecosystem is said to be less normal as the existence of other insects as an alternative to the food source of the predators is not much. The existence of the natural enemies depends greatly on the population of pests as their source of food.

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