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The diversity of insects in the plant refugia *Cosmos caudatus* Kunt., *Titania difersifolia* (Hemsley) A. Gray and *Lantana camara* are superimposed on pisang barangan plant with double row method

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Abstract

This research was conducted to determine the diversity of insects on 3 types of refugia plants (*Cosmos caudatus* Kunt., *Titonia difersifoli*a (Hemsley) A. Gray, and Lantana camara) superimposed on the Barangan Banana plant. Banana plants aged 5 months after planting using the double row planting method. In the space between rows of banana plants, refugia, Titonia difersifolia were planted with a spacing of 1 m x 1 m, a spacing of Lantana camara 1 m x 1 m, and a spacing of *Cosmos caudatus* 50 cm x 50 cm. To get the diversity of insects, yellow traps were installed every 10 m at a height of 1.5 meters and soil insect traps were installed. Observations were made for 4 weeks, on the types and number of insects. Observation parameters consisted of population density, determination of insect status (pests, predators, parasitoids, pollinators), insect identification, and assessment of the species diversity index. The results showed that there was a diversity of insects associated with 3 types of refugia superimposed on the Barangan banana plant. In refugia C. *caudatus* (kenikir) found 8 insect orders consisting of 18 families, in *T. difersifolia* found 6 orders, 13 families, and in L. camara 8 orders 16 families. Based on the index value of insect diversity obtained in the three types of refugia, it was classified as moderate, namely the value of 2,899 on *C. caudatus* refugia, 2,906 (*Titonia difersifolia* (Hemsley) A. Gray) and 2,842 (L. camara).

Keywords: Barangan Banana, double row, *Cosmos caudatus* Kunt., *Titonia difersifolia* (Hemsley) A. Gray and *Lantana camara*

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1. Introduction

Bananas are the largest type of fruit growing area and the highest production compared to other types of fruits in North Sumatra province. This province is the second largest area as a national banana producer after Lampung province (Central Bureau of Statistics, 2015). The Province of North Sumatra has a distinctive type of banana, namely the Barangan banana (can also be called the original name Pisang Barangan), so the Pisang Barangan is better known as the Medan Banana and is the most dominant type of table banana developed in North Sumatra. Pisang Barangan is a type of national superior banana that has a very specific taste, sweet taste, has three variants of red, yellow and white colors, on average the weight of per comb-1.5-2.5 kg with the number of fruits 12-20 pieces/comb, straight fruit shape, round base, 11 cm long, 2.9 cm diameter, unbidy, sweet, dry, flavorful and average fruit weight 60 g.

Pisang Barangan was developed using tissue culture seeds and saplings planted by the double row method. With the double row method, there is an increase in the population of plants per hectare reaching 2300-2600 plants compared to a single row with a smaller number of plants 1100 plants (Great Hall for the Assessment and Development of Agricultural Technology, (2015). In each clump maintained 2-3 plants of different ages. So that the banana plantation goods double row system must be intensive maintained because the population of the plant after the first harvest reaches 2600-5200 plants (assuming a total crop of 2600 per Ha, each clump consists of 2 plants of different ages). The high population of plants requires management in the maintenance of plants, especially in pest and disease control. The main pest of the Pisang Barangan plant is the leaf-rolling caterpillar (Erionata thrax. L), corn borer beetle (Cosmopolites sordidus L.), and stem borer (Odoiporus longicollis. Erionota thrax L.)

is a pest whose attack and density are quite high. This pest attack varies between 34-47% with a population density of 1.73-5.47 bananas [1] with an economic loss of yield of 10-30%. The main disease groups are Fusarium oxysporum f sp. cubense and nematodes Radopholus similis, Pratylenchus spp., and Helicotylenchus multicinctus [2]. The high percentage and attack of pests and diseases of Pisang Barangan plants require the management of the presence of pests and diseases in an environmentally friendly manner using natural enemies and improvement of banana plant cultivation techniques. One of the efforts that can be done with the application of planting patterns with various flowering plants is often referred to as refugia. Refugia is a plant that grows around cultivated plants, potentially as a microhabitat for natural enemies (both predators and parasites), feed sources (nectar and pollen), and shelters for pests and natural enemies. Various potentially used refugia plants are *Cosmos caudatus*, *Titonia difersifolia*, and *Lantana camara*. These three types of refugia have various advantages including their growth is relatively fast, can be propagated vegetatively and seeds have a striking flower color and distinctive aroma so that it is liked by insects. In general, the three types of refugia have a striking flower color, small-sized flowers, the position of the flower tends to open, with a long flowering time [3]. In addition, it have compounds that can increase insect visits in plants [4].

The application of cropping patterns will be more efficient in suppressing pest attacks if the plants used can be pest repellent from the main plant. The ride hailing system can reduce the population density of pests compared to the monoculture system due to the role of volatile chemical compounds and there are visual disturbances by non-host plants, which affect the behavior and speed of colonization of insects in host plants [5]. In addition, refugia plants have an ecological role (functional status) that can increase the diversity of herbivorous insects (54.14%), pollinators (28.72%), and predators (17.13%) [6].

2. Materials and methods

2.1. Materials

Barangan Banana, *Cosmos caudatus* Kunt., *Titonia difersifolia* (Hemsley) A. Gray and *Lantana camara*.

2.2. Planting

The research was conducted on the banana plantation of Barangan which was 3 months old after moving planting on the land of the Sampali Village Masyarakat Bersatu community farming group, Percut Sei Tuan District, Deli Serdang. Among the bananas there are refugia plants *Titonia difersifolia* (Hemsley) A. Gray and Lantana camara aged 2 months after planting, planting distance 1 m x 1 m, and *C. caudatus* planting distance of 50 cm x 50 cm. The three plants are planted along the rows of banana plants (40 m x 100 m) each of two rows for each type of refugia.

2.3. Treatment and Observation

The capture of natural enemies and pests is done using sweep nets or swing nets and yellow sticky trap and pithfall traps for creeping insects. Installation of yellow sticky trap, pitfall trap is done at 07.00 am. The new trap observation and installation period are carried out once a week between 07.00-09.00 am. Observational parameters consist of the population density of each insect, the species diversity index using the Shannon Wiener formula [7].

3. Results and discussion

3.1. The Diversity of Insects Associated with Refugia

The results of observation and identification of insects found the diversity of insects associated with refugia *C. caudatus* consisting of 8 orders consisting of 18 families, namely the order Lepidoptera as many as 1 family (Lycaenidae), Coleoptera 3 families (Coccinellidae, Staphylinidae, Lathridiidae), Hymenoptera 3 family (Formicidae, Megachilidae, Sphecidae), Diptera 6 family (Psilidae, Choloropidae, Drosophilidae, Culicidae, Tephritidae, Stratiomydae), Hemiptera 3 families (Reduviidae, Pentatomidae, Miridae), Orthoptera 1 family (Acrididae), Mantodea 1 family (Mantidae) and Araneae 1 family (Araneae).

In T. difersifolia plant found insects associated as many as 6 orders and 13 families namely the order Lepidoptera 3 families (Yponomeutidae, Papilionidae, Hesperioidae, Coleoptera (Coccinellidae), Hymenoptera (Formicidae), Diptera (Micropezidae, Drosophilidae, Culicidae, Tephritidae, Muscidae, Stratiomydae), Hemiptera (Cicadidae, Pentatomidae), Orthoptera (Acrididae), Mantodea (Mantidae) and Araneae (Salticidae). In L. camara plant found insects associated with 8 orders consisting of 16 families, namely: Lepidoptera (Hesperioidae, Nymphalidae), Coleoptera (Coccinellidae), Hymenoptera (Formicidae), Diptera (Vermileonidae, Micropezidae, Calliphor, Drosophilidae, Culicidae, Tephritidae, Tephritidae), Hemiptera (Pentatomidae), Orthoptera (Gryllidae, Acrididae), Mantodea (Mantidae) and Araneae (Salticidae). The diversity of insects in 3 refugia can be seen in Table 1.

3.2. Number of Insects and Status of Insects Associated with Refugia

In 3 types of refugia found insects as many as 266 individuals were observed during 4 weeks of observation. In refugia *C. caudatus* found 95 individuals, in *Titonia difersifolia* 91 individual and in *L. camara* found 80 insects

(Table 1). Insects commonly found in the three refugia are natural enemy insects (predators and parasitoids) 74.43%, pest insects 24.45%, and organic ingredient eaters as much as 1.12%. The number of insects that act as natural enemies is 3 times compared to the number of pest insects. The results were found following the opinion of Rizka [5] where the ride system, able to reduce the population density of pests compared to monoculture systems. The results of Straub and Snyder's [8] study of vegetation diversity increase the diversity of natural enemy species that have the potential to suppress populations of plant-disrupting organisms on mustard and potato farming. Increased diversity of plant types around the agroecosystem Brassicaceae plant (crucifer, cubism) can increase the effectiveness of the work of parasitoid Oomipus sokolowski against cabbage pests (Plutella xylostella) [9].

The three types of refugia were proven to increase the diversity of insect species, especially natural enemy groups. The dominant natural enemy groups were found from the order Coleoptera (13.91%), Hemiptera (7.14%), Araneae (6.66%), and Mantodea (5.26%). The diversity of natural enemies found in the refugia (*C. caudatus, T. difersifolia* and *L. camara*) with banana plants Barangan is much higher (predatory and parasitoid as much as 74.43%) than the results obtained by Keppel et al. [6] predators (17.13%), the composition of insect pests (herbivores) reached 54.14% and pollinators 28.72%. The high diversity of natural enemy insects in the cultivation of Barangan bananas is due to the presence of refugia plants around the Barangan banana plants which generally have striking flower colors. C. caudatus has pink/pink flowers, the number of flowers that bloom a lot (10-15 flowers bloom/day), L. camara has purplish pink flowers, the number of flowers that bloom per day is 15-50 flowers, the position of the flowers tends to be open, with long flowering times (Figure 1).

This is following the results of Kurniawati and Martono's research [3], that refugia which have a striking flower color, small-sized flowers, the position of flowers tend to open, with a long flowering time higher the diversity of insects found. In addition to having flower morphology that can attract groups of natural enemy insects, *C. caudatus* and *L. camara* refugia plants have volatile chemical compounds that affect the behavior and speed of insect colonization in host plants. The diversity of fauna due to the presence of flowering plants will lead to the formation of a more stable ecosystem, which in turn will maintain the balance of ecosystem components. The presence of flowering plants is thus essential to preserving natural enemy populations in an ecosystem such as agroecosystems.

In addition to having the morphology of flowers favored by insects, the three types of refugia also have secondary metabolite compounds that can affect the behavior of insects to visit the plants *C. caudatus, L. camara* and *T. difersipholia*. Leaves of *Cosmos caudatus* contain several metabolite compounds such as essential oils, flavonoids, saponins, tannins, pilofenol, and alkaloids [10]. According to Hariana [11] that L. camara contains chemical compounds such as alpha-lantadene (0.31-0.68%), beta-lantadene (0.2%), lantanolic acid, lactic acid, essential oils (a pungent odor that insects dislike; 0.16-0.2%), beta-caryophyllene, gamma-terpinene, alpha-pinene, and p-cymene. Tithonia has sesquiterpene lactone chemical compounds, polyphenol compounds (flavonoids and tannins), saponins [12] and Tithonia flowers, leaves, stems and roots contain α-pinene essential oils (60.9 -75.7%), δ-pinene (7.2–11.0%) limonene (0.9–4.3%) [13].

Fig. 1 Refugia plants are superimposed on the banana wicket of Barangan on the land of the Masyarakat Bersatu Community farmers group, Sampali, Percut Sei Tuan, Deli Serdang North Sumatra. A. *Cosmos caudatus*. B. *Titonia difersifolia* and C. *Lantana camara*. Source: Suswati documented.

Table 1: The Diversity and Population of Insects Associated with Refugia

No	Ordo	Famili	Stadia	Status	Refugia			Total
					*Cc**	*Td*	*Lc*	
1	Lepidoptera	Lycaenida	Imago	Polinator	4	0	0	4
		Yponomeutidae	Imago	Polinator	0	2	0	2
		Papilionidae	Imago	Polinator	0	2	0	2
		Hesperioidae	Imago	Polinator	0	2	8	10
		Nymphalidae	Imago	Polinator	0	0	4	4
2	Coleoptera	Coccinellidae	Eggs,larvae,imago	Predators	5	7	4	16
		Staphylinidae	Imago	Predators	8	0	0	8
		Lathridiidae	Imago	Organic ingredient eaters	3	0	0	3
		Lampyridae	Imago	Predators	0	3	2	5
3	Hymenoptera	Formicidae	Eggs,larvae,pupae,imago	Predators	2	2	9	13
		Megachilidae	Imago	Polinator	6	0	0	6
		Sphecidae	Imago	Parasitoid	6	0	0	6
4	Diptera	Vermileonidae	Imago	Predators	0	0	2	2
		Micropezidae	Imago	Polinator	0	2	4	6
		Calliphoridae	Imago	Polinator	0	0	4	4
		Psilidae	Imago	Polinator	6	0	0	6
		Choloropidae	Imago	Polinator	5	0	0	5
		Drosophilidae	Imago	Pest	3	5	5	13
		Culicidae	Imago	Polinator	2	3	4	9
		Tephritidae	Imago	Pests	11	7	11	28
		Muscidae	Imago	Polinator	0	5	0	5
		Stratiomydae	Imago	Polinator	2	12	7	21
6	Hemiptera	Cicadidae	Imago	Pests	0	3	0	3
		Reduviidae	Eggs,nimpa,imago	Predators	13	0	0	13
		Pentatomidae	Eggs,nimpa,imago	Pests	4	8	3	15
		Miridae	Eggs,nimpa,imago	Predators	6	0	0	6
7	Orthoptera	Gryllidae	Imago	Pests	0	3	4	7
		Acrididae	Imago	Pests	5	5	1	11
8	Mantodea	Mantidae	Eggs,pupae,imago	Predators	2	9	3	14
9	Araneae	Araneae	Imago	Predators	2	0	0	2
		Salticidae	Imago	Predators	0	11	5	16
Total					95	91	80	266

4. Conclusions

In conclusion, the results showed that the abundance of visitor insects in the Barangan plantation with the double row system had the effect of attacking predators and parasitoids as much as 74.43%, insect pests 24.45% and insects eating organic matter as much as 1.12%. The number of insects that act as natural enemies is 3 times the number of insect pests.All three types of refugia plants can increase the diversity of insect species, especially natural enemy groups. The dominant natural enemy groups were found from the order Coleoptera (13.91%), Hemiptera (7.14%), Araneae (6.66%), and Mantodea (5.26%)..

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