Ecological characteristics of nocturnal pest insects and their natural enemies in green bean fields

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Abstract. In agricultural ecosystems, insects can act as potential pests, and insects can also act as natural enemies of insect pests. This study aims to determine the ecological characteristics of nocturnal pest insects and their natural enemies in the agricultural ecosystem, namely in the green bean fields. Sampling is done before and after harvest using light trap method. The results show that the ecological character of nocturnal pest insects of the number of species and diversity before harvest is higher than after harvest. Likewise, the number of species and diversity of natural enemy insects before harvest is higher than after harvest. Ecological characteristics of individual numbers and abundance of insect pests before harvest is higher than after harvest. Similarly, the number of individuals and natural enemies abundance before harvest is higher than after harvest. The dominant pest insects before harvest are the Mycetophilidae, Sciaridae, Pentatomidae, Cicadellidae, and Pyralidae, after harvesting the Chrysomelidae, Curculionidae, Anobiidae, Pentatomidae, Cicadellidae, Pyralidae, and Nolidae. While the dominant natural enemies before harvest are the Staphylinidae, Coccinellidae, Carabidae, Miridae, and Aelothripidae, after harvest the Staphylinidae, Carabidae, Miridae, and Formicidae. The diversity index of insect pests and natural enemy insects is included in the moderate category. The evenness index of pest insects and natural enemies before and after harvest fall into the evenly distributed category. The index of similarity of insect pests before and after harvest shows quite similar results, while for natural enemy insects show unequal results.

1. Introduction
Farmers in the Demak region plant rice only in the rainy season, while in the dry season they plant non-rice crops such as green beans, green bean plants are plants that can withstand low (dry) soil moisture. Green bean production in Demak is always disrupted due to herbivorous insect disturbances. According to Tengkano, et al. (2012) that in pods aged 66-78 days after planting is the most appropriate time for the growth and development of herbivorous insects such as Riptortus linearis and Nezara viridula [1]. The existence of herbivorous insects in the planting area will also invite predatory insects and parasitoid as a group of natural enemies. Parasitoid and predator, both of which are biological control agents play a role in regulating the development of insect disturbing plant populations [2], [3], [4].

The existence of both quantity and quality plants on agricultural land attracts herbivores to come and use them as energy sources. The existence of this herbivore is followed by the presence of natural enemies in the form of parasitoids and predators. As long as there are agricultural crops in the
agricultural and herbivorous ecosystems, the presence of predators and parasitoids can be maintained. When there is no herbivorous plant abundance is limited or rare [3].

Green bean plants at the first trophic level as producers are sources of energy for herbivores who occupy the second trophic level will use green bean plants as an energy source. Thus the existence of green bean plants determines the existence of herbivores. The density of herbivorous populations determines the extent and intensity of damage to mung bean plants and yields. The existence of herbivores determines the presence of natural enemies, especially parasitoids and predators as the third trophic level. Population densities of parasitoids and predators as carnivores control herbivorous populations [3].

The natural balance between pest insects and natural enemies is often confused with the use of chemical insecticides [5], [6], [7].

2. Materials and methods
The research was conducted in the green bean field of Karangsari Village, Karangtengah District, Demak Regency. The study was conducted from August to September 2017. Sampling was conducted twice, i.e., during the season before and post-harvest or be using the light trap method. A sampling of insect pests of green beans and natural enemies with light trap method was carried out by making five sampling points, and diagonal light traps left for 12 hours installed (7.00 p.m. - 7.00 a.m.).

The ecological characteristics of the pest and its natural enemies data were analyzed using the Shannon Wiener diversity index, abundance index, evenness index, and Simpson similarity index.

3. Results and discussion
The abundance of types of pests that were obtained before harvest had various values, there were 8 families included in the dominant category (Table 1). The value of diversity obtained is included in the medium category with an evenness index evenly distributed. One of the dominant species is species 8 belonging to the Pentatomidae family. This type is an insect that does not like the blazing light, but when sampling is done in the morning when the sun is not too hot so that the abundance of species found is quite large. Pest Sp 8 insects, known as green ladybugs, attack plants by damaging pods. An attack before harvest can cause pods to dry because the liquid is sucked and attacks the plant from the age of 35 days after planting [8].

In accordance with the table of observations, 7 pest insects are belonging to the dominant family. Diversity values obtained are included in the medium category with an evenness index evenly distributed. One of the dominant species obtained is species 1 from the Chrysomelidae family which damage the mung bean plants by chewing and punching holes in leaves and pods so that it can reduce crop yields from legumes [9].

The results of the two pests obtained before and after harvest are then calculated on the similarity index. The results obtained indicate that pest insects before and after harvest show a fairly similar index. This shows that there are several types of pests found before and after harvest, including family Chrysomelidae, Curculionidae, Pentatomidae, Cicadellidae, Pyralidae, and Gryllidae. This similarity is due to the presence of green bean plant residues that can still be used by pests as food.

Table 1. The Pest Index of Abundance, Diversity, and Evenness a Before and Post Harvest

| No | Ordo       | Family         | Species | Before harvest | Post-harvest |
|----|------------|----------------|---------|----------------|--------------|
|    |            |                |         | ni | Di (%) | ni | Di (%) |
| 1  | Blattelida | Blattodea      | sp 63   | 0  | 0      | 1  | 3,03   | SD |
| 2  | Diptera    | Cecidomyiidae | sp 13   | 7  | 4,19   | 0  | 0      |    |
| 3  |           | Mycetophilidae| sp 28   | 11 | 6,58   | 0  | 0      |    |
| 4  |           | Sciaridae     | sp 29   | 13 | 7,78   | 0  | 0      |    |
| 5  |           | Culicidae     | sp 37   | 2  | 1,19   | 0  | 0      |    |
| 6  |           | Ephydridae    | sp 38   | 3  | 1,79   | 0  | 0      |    |
| 7  |           | Tephritidae   | sp 40   | 6  | 3,59   | 0  | 0      |    |
Natural enemies before harvest were found, there were 5 families included in the dominant category (Table 2). The value of diversity obtained is included in the medium category with an evenness index evenly distributed. One of the dominant species is Paederus Sp which belongs to the Staphylinidae family with its role as a predator. This beetle is a predator of several types of pests, including green leafhoppers from the Cicadellidae family [10]. While natural enemies obtained after harvest, it is known that 4 families are belonging to the dominant family. Diversity values are included in the medium category with evenness index which is evenly distributed. The presence of several types of natural enemies from the Formicidae family when post-harvest is found. The Formicidae family not only acts as a natural enemy but also as a decomposer, according to the post-harvest conditions many dry crop residues that fall on the ground due to harvesting cause the family's insects to be attracted. In addition to environmental conditions that spur the arrival of this family, the presence of pest insects on the land causes the high presence of Formicidae to eat it. The index of natural enemy similarities before and after harvest is also calculated with the results of the similarity index which is not the same.

Table 2. The Natural Enemies Index of Abundance, Diversity, and Evenness of Before and Post Harvest:
| No. | Ordo  | Family       | Species    | Before harvest | Post-harvest |
|-----|-------|--------------|------------|----------------|--------------|
|     |       |              |            | ni  | Di (%) | ni  | Di (%) |
| 1   | Diptera | Phoridae    | Sp 39      | 1   | 2.7    | SD  | 0    | 0    |
| 2   | Coleoptera | Staphylinidae | sp 25    | 6   | 16.2   | D   | 7    | 30.4 | D    |
| 3   |       | sp 44       | 2          | 5.4 | D      | 0    | 0    |      |
| 4   |       | sp 46       | 1          | 2.7 | D      | 0    | 0    |      |
| 5   | Coccinellidae | Menochiles sexmaculata | 5 | 13.5 | D   | 0    | 0    |
| 6   |       | Micraspis lineata | 4 | 10.8 | D   | 1    | 4.34 | SD   |
| 7   | Carabidae | sp 34       | 1          | 2.7 | SD     | 0    | 0    |      |
| 8   |       | sp 27       | 3          | 8.1  | D     | 0    | 0    |      |
| 9   |       | sp 57       | 0          | 0    | 0      | 6    | 26.1 | D    |
| 10  |       | sp 68       | 0          | 0    | 0      | 1    | 4.34 | SD   |
| 11  | Hemiptera | Miridae    | sp 15      | 1   | 2.7    | SD  | 0    | 0    |
| 12  |       | sp 30       | 3          | 8.1  | D     | 0    | 0    |      |
| 13  |       | sp 59       | 0          | 0    | 0      | 2    | 8.69 | D    |
| 14  | Homoptera | Aleyrodidae | sp 14      | 1   | 2.7    | SD  | 0    | 0    |
| 15  | Hymenoptera | Ichneumonidae | sp 16  | 1   | 2.7    | SD  | 0    | 0    |
| 16  |       | SP 47       | 1          | 2.7  | D     | 0    | 0    |      |
| 17  | Formicidae | SP 32      | 1          | 2.7  | D     | 2    | 8.69 | D    |
| 19  |       | sp 61       | 0          | 0    | 0      | 1    | 4.34 | SD   |
| 20  |       | sp 64       | 0          | 0    | 0      | 1    |      |      |
| 21  | Thysanoptera | Aelothripidae | sp 34  | 5   | 13.5   | D   | 0    | 0    |
| 22  | Araneae | Thomisidae  | sp 55      | 1   | 2.7    | SD  | 0    | 0    |

|         | Total   |         |           |
|---------|---------|---------|-----------|
| S       | 15      | 9       |
| N       | 37      | 21      |
| H’      | 2.3     | 1.89    |
| e       | 0.9     | 0.86    |

D: Dominant, SD: sub-dominant,
Figure 1. Nocturnal Natural Enemies: Family Coccinellidae (yy. Menochiles sexmaculata zz. Micraspis lineata, dan hhh. Sp 34), Famili Staphylinidae (aaa. Paederus sp, kkk. Sp 44 dan lll. Sp 46), Famili Aleyrodidae (bbb.Sp 14), Famili Miridae (ccc. Sp 15, fff. Sp 30, dan qqq. Sp 59), Famili Ichneumonidae (ddd. Sp 16 dan mmm. Sp 47), Famili Carabidae (eee. Sp 27, ppp. Sp 57 dan ttt. Sp 68), Famili Phoridae (iii. Sp 39), Famili Formicidae (nnn. Sp 32, rrr. Sp 61, dan sss. Sp 64, Famili Thomisidae (ooo. Sp 55), Famili Aelothripidae (jjj. Sp 43)
4. Conclusion
Ecological characteristics of individual numbers and abundance of insect pests before harvest is higher than after harvest. Similarly, the number of individuals and natural enemies abundance before harvest is higher than after harvest. The dominant pest insects before harvest are the Mycetophilidae, Sciaridae, Pentatomidae, Cyclorrhapha, and Pyralidae, post-harvest the Chrysomelidae, Curculionidae, Anobiidae, Pentatomidae, Cicadellidae, Pyralidae, and Nolidae. While the dominant natural enemies
before harvest are the Staphylinidae, Coccinellidae, Carabidae, Miridae, and Aelothripidae, post-harvest the Staphylinidae, Carabidae, Miridae, and Formicidae. The diversity index of insect pests and natural enemy insects is included in the moderate category. The evenness index of pest insects and natural enemies before and after harvest fall into the evenly distributed category. The index of similarity of insect pests before and after harvest shows quite similar results, while for natural enemy insects show unequal results.

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