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Research Article

Diversity of Arthropods in Different Rice Varieties in Bantul Regency

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ABSTRACT

High-yielding varieties are used as one of the technologies to increase rice productivity in Indonesia. Varieties, however, invite the arrival of arthropod during their growing phase. One of the method to manage arthropods during the growing stage is the use of high-yielding varieties. In this trial, IR-64, Ciherang, Situ Bagendit, Mekongga and Mixed Varieties were used. The mixed variety is a combination of IR-64, Ciherang, Situ Bagendit and Mekongga. These rice varieties are the most common varieties used by farmers in Bantul Regency. To collect arthropods, the traps used were sweep net, yellow sticky and pitfall traps. The purpose of this study was to determine arthropod's diversity, evenness and dominance in different rice plant varieties in one planting season. The study was conducted in the village of Wijirejo, Pandak, Bantul, Yogyakarta. The observations were conducted in the evening between 16.00–18.00 p.m., with the interval of twice a week for 5 observations. Arthropods were identified up to the family level. This research resulted in the diversity index (Shannon-Wienner) of 1.97–2.82 which is categorized as medium, the evenness index of 0.61–0.71, categorized as medium and the dominance index of 0.10–0.22, categorized as lower level. The ecosystem of the research area was unstable in diversity, evenness, and dominance due to the transition process, and it took quite some times to stabilize the rice fields. Therefore, a more thorough research is still necessary, especially for the rice-growing season to follow.

Keywords: arthropods; diversity; dominance; evenness; rice variety

INTRODUCTION

Indonesia rice plant productivity in 2019 amounted to around 54.60 million tons of dry paddy grain, decreased by 4.60 million tons (7.76 percent) compared to 2018. February is the month with the highest production in 2019 compared to 2018 (BPS, 2020). About 20–30% of agriculture products are damaged annually due to insect, disease and pesticide which plays a role in rice plant overprotection (Rahaman *et al*., 2018). The use of pesticide as a protection for rice plant from insects and diseases is considered as one of the obstacles that often changes arthropods and other insects' character that may develop as pests. Insecticide application for early-season are generally considered effective but when it is taken a closer look, it apparently destroys ecological balance and kills predators and parasitoids, leaving a potential increase of pest resistance (IRRI, 2016; Matteson, 2000). This condition affects beneficial arthropods such as natural enemies. Insecticides affect arthropods in the vegetative phase, generative phase, and harvesting phase. Every phase in rice crop has different ecosystem and the any population thereof may be affected. Diversity of insect family can be observed to indicate the types of family among individuals (Siregar & Matondang, 2017).

The development and implementation of IPM (Integrated Pest Management) concept is one of the methods that is expected to increase ecosystem diversity and is environmentally friendly. The implementation of the IPM concept requires taxonomical, ecological, chemical, and basic statistical sciences (Mahrub, 1999). This strategy involves ecological engineering which is expected to create stability in rice plant ecosystem. The ecological engineering is an approach through manipulation of agroecosystem to optimize pest biological control (Gurr *et al*., 2004).

In Indonesia, ecological engineering by planting refugia has been growing since 2012 with the project of implementing landscape-scale IPM conducted by the Food and Agriculture Organization (FAO) with the Ministry of Agriculture. The Ministry of Agriculture in 2019 sought to rebuild IPM through the utilization and conservation of natural enemies by planting refugia in a sustainable way at the field level (Zakaria *et al.*, 2019). Flowering plants can attract beneficial insects because they are attracted by the morphological and physiological characteristics of the flower, namely size, shape, color, fragrance, flowering period, as well as nectar and pollen content (Erdiansyah & Putri, 2017). The purpose of this study was to determine the diversity, evenness and dominance of arthropods in different rice varieties in one planting season.

MATERIALS AND METHODS

The research study was conducted from July until October 2019 in Wijirejo village, Pandak Sub-District, Bantul Regency, Yogyakarta. A completely randomized design with five replications was applied in this study. Five rice varieties e.g. (1) Ciherang – CH, (2) Mekongga – MK, (3) Situ Bagendit – SB, (4) IR-64 – IR, and (5) Rice Mix – CAM (Mix of Ciherang, Mekongga, Situ Bagendit and IR-64) were planted following the designated plot in Figure 1. The rice varieties are often used by farmers in Bantul. IR-64 has high sensibility towards drought whereas Ciherang variety has medium drought sensibility, and Mekongga and Situ Bagendit have low sensibility (Ruminta, 2016). A research field of 781 m^2 was divided into 5 replications and 5 varieties thus making each plot ± 6.25 m^2 wide with a spacing of 25×25 cm. Arthropod samples were collected using sweep net, pitfall and yellow sticky trap and the collection was conducted twice a week from 10–120 days after sowing. Insect collection using sweep net was done by swinging the net to the right and left for 10 times with zig-zag manner on each observation plot. The insects collected were put into plastic with chloroform. Pitfall trap collected the insect using plastic cup placed at 5 points in the observation plot. The pitfall traps were installed parallel to the ground, and the trap used 8 cm in diameter and 6 cm high plastic cups. Soap solution was used to fill the plastic cups and was left for 24 hours. Arthropods collected were stored in small bottle with 70% alcohol. Yellow sticky trap collected the insect using 15×25 cm yellow sticky

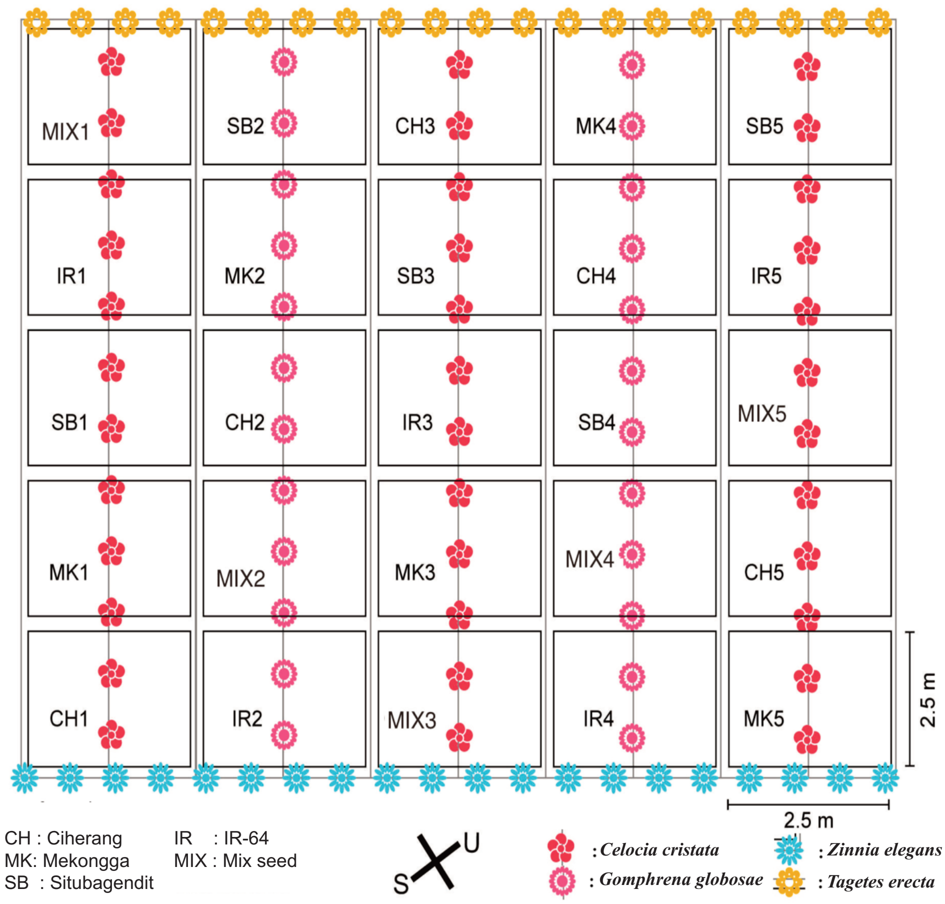

Figure 1. Field-plot observation

board with glue and placed at 5 points in the observation plot above rice plant canopy. The arthropods collected from yellow sticky trap were stored in plastic bag. Yellow sticky traps and pitfall traps were carried out at the day before the observation and retrieved after 24 hours at 16.00 pm. The retrieval of arthropods caught through sweep net method was carried out as the arthropods collected using yellow sticky traps and pitfall traps were taken out.

The soil condition was optimized by adding 400 kg organic and 200 kg basic (NPK) fertilizer for one stretch of landscape. Irrigation was maintained evenly for each plot using water pump. The rice seedlings were transplanted manually 26 days after sowing. A total of 75 kg seeds with 15 kg of each variety was planted. Flowering plants as refugia namely *Tagetes ecerata*, *Zinnia elegans*, *Gomphrena globosae*, *Celosia cristata* were planted on the rice field embankment with 1.5 m spacing (Figure 1). These flowering plants were selected since they are noted as attractive to many arthropods as shelters and complementary nutritional sources (Kurniawati & Martono, 2015).

Arthropods Identification

The identification of arthropod was performed in the laboratory Entomology Molecular, Faculty of Agriculture, Universitas Gadjah Mada. The collected arthropods were identified to family level with identification keys according to (a) *An Introduction to the Study of Insect* (Borror *et al*., 1992), (b) *Hymenoptera of the World: An Identification Guide to Family* (Goulet & Huber, 1993), *Manual of Nearctic Diptera Volume I & II* (McAlpine *et al*., 1981; 1983).

Data Analysis

The number and types of collected arthropods were analyzed using descriptive and quantitative analysis. The observation parameter comprises diversity, evenness and dominance of the family.

Shannon-Wienner

The diversity of arthropods was analyzed using Shannon-Wienner diversity index (Odum, 1994):

$$H' = -\sum_{t=1}^{s} pi \ln pi \quad (1)$$

H' = diversity index
pi = the proportion of each species in the sample
ln pi = natural logarithm of this proportion

Evenness Index

Evenness index values between families (*e'*) (Odum, 1994):

$$e' = H'/\ln S \quad (2)$$

e' = Evenness index (intermediate value 0–1)
H' = Diversity Index Shannon-Wiener
S = number of order or family found
ln = natural logarithm

Dominance Index

Dominance index was calculated by Simpson dominance index (Odum, 1994):

$$D = \sum Pi^2,\ Pi = \frac{ni}{N} \quad (3)$$

D = Simpson index
ni = number of individuals of each other order or family
N = number of individual of all order or family
Pi = the proportion of each species in the sample

RESULTS AND DISCUSSION

Proportion of the Arthropods in Rice Cultivation

The distribution of arthropods and other insects that are categorized as pest and natural enemies of each sampling method showed different results. Three sampling equipments, e.g. sweep net, yellow sticky trap, and pitfall trap, were installed to observe arthropods and other insects as pests and natural enemies in five different rice varieties.

The arthropod sampling resulted in the collected pest arthropods in observation 1 (Figure. 2) with the highest insect percentage of 14.26 from sweep net in Mekongga variety and the lowest percentage of 0.82 from yellow sticky trap in Ciherang variety. Natural enemies were found the highest with 65.80 from yellow sticky trap in IR-64 and the lowest percentage was found with 2.00 from yellow sticky trap in IR-64 variety. Other insects were found the highest with 4.60 from yellow sticky trap in Ciherang variety and the lowest with 0.14 from pitfall trap in IR-64, Mekongga and Ciherang varieties.

Observation 2 (Figure 3) appeared to have the highest approximate percentage of 13.40 in IR-64 from yellow trap and the lowest percentage of 0 in Mix variety from pitfall trap. Natural enemies in observation 2 was found the highest in IR-64 with the percentage of 51.40 from yellow sticky trap and the lowest in Ciherang with 0.72 from pitfall.

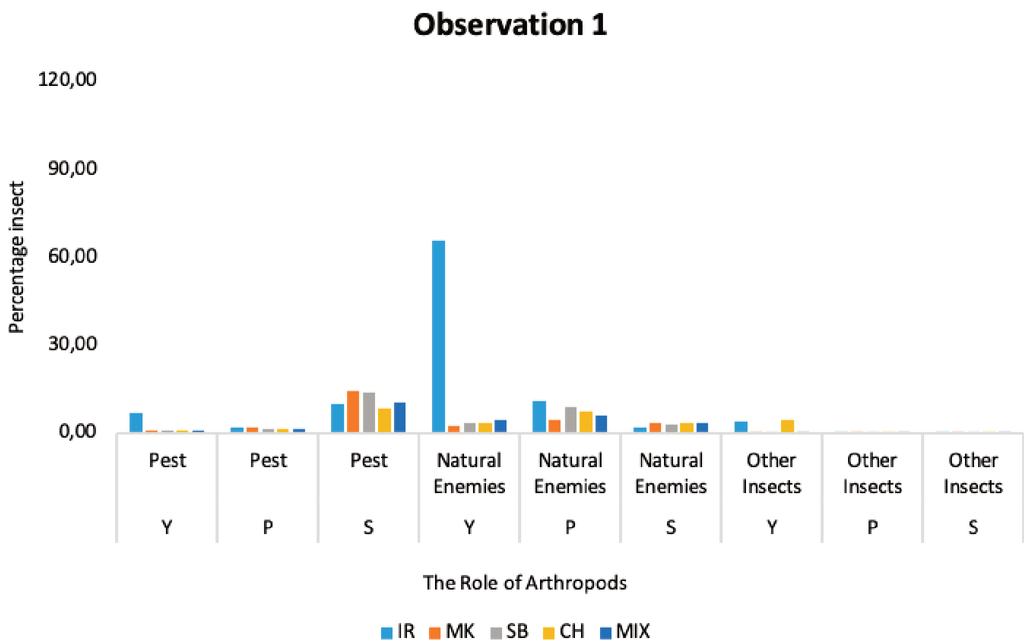

Figure 2. Percentage of arthropods in week one observation, Y: Yellow Sticky Trap, P: Pitfall Trap, S: Sweep net; IR: IR-64, MK: Mekongga, SB: Situ Bagendit, CH: Ciherang, Mix : Mix seed

Other insects from observation 2 were found the highest in Ciherang with 4.60 from yellow sticky trap and the lowest with 0.00 in all varieties from pitfall trap.

Observation 3 (Figure 4) acquired the highest percentage of pest with 22.60 from yellow sticky trap in IR-64 and the lowest with 0.22 from pitfall trap in IR-64. Natural enemies' highest percentage reached 84.60 from yellow sticky trap in IR-64 and the lowest reached 1.34 from pitfall trap in IR-64. Other insect highest percentage reached 4.80 from yellow sticky trap in IR-64 while the lowest ended up with 0 from pitfall trap in IR-64, Mekongga, Situ Bagendit and Mix varieties.

Observation 4 (Figure 5) revealed that the highest percentage of pest reached 26.00 from yellow sticky trap in IR-64 and the lowest came with 0.44 from pitfall trap in IR-64. Natural enemies' highest percentage is 101.60 from yellow sticky trap IR-64 and the lowest is 1.30 from sweep net in Situ Bagendit. Other insect highest percentage is 4.80 from yellow sticky trap in IR-64 and the lowest is 0 from pitfall trap in all varieties.

Observation 5 (Figure 6) discovered the highest pest percentage of 11.60 from yellow sticky trap in IR-64 and the lowest with 0.30 from sweep net in IR-64. Natural enemies was found the highest with 76.00 from yellow sticky trap in IR-64. Other insects was found the highest with 11.60 from yellow sticky trap in Ciherang and the lowest with 0.00 from pitfall trap in IR-64, Mekongga, Ciherang and Mix. The observations of pests, natural enemies and other insects showed that the highest percentage on average was found in IR-64 caught with yellow sticky trap. IR-64 is the eldest of several high-yielding varieties, therefore it is undeniably resistant against insects. IR-64 has been replaced by new varieties such as Ciherang, because Ciherang attributes similar qualities (Mackill & Khush. 2018). Additionally, the yellow sticky trap is in fact favored by many insects entomologically due to their preference to particular light wavelengths. It also has been an insect management tool for decades in a number of researches (Pinto-Zevallos & Vänninen. 2013).

The arthropods obtained from each trap were identified up to family taxa (Table 1, 2, 3). The use of different types of trap may increase the diversity of arthropods collected since each trap has different type of targeted insects. The yellow sticky trap is a trap that captures more winged adult insects. Sampling with this trap is the commonly used method for monitoring pest population. Various recent studies mainly focused on how to use the yellow sticky trap to capture adult insect pest species that belong to Lepidoptera and Aphididae (Lu *et al.*, 2012).

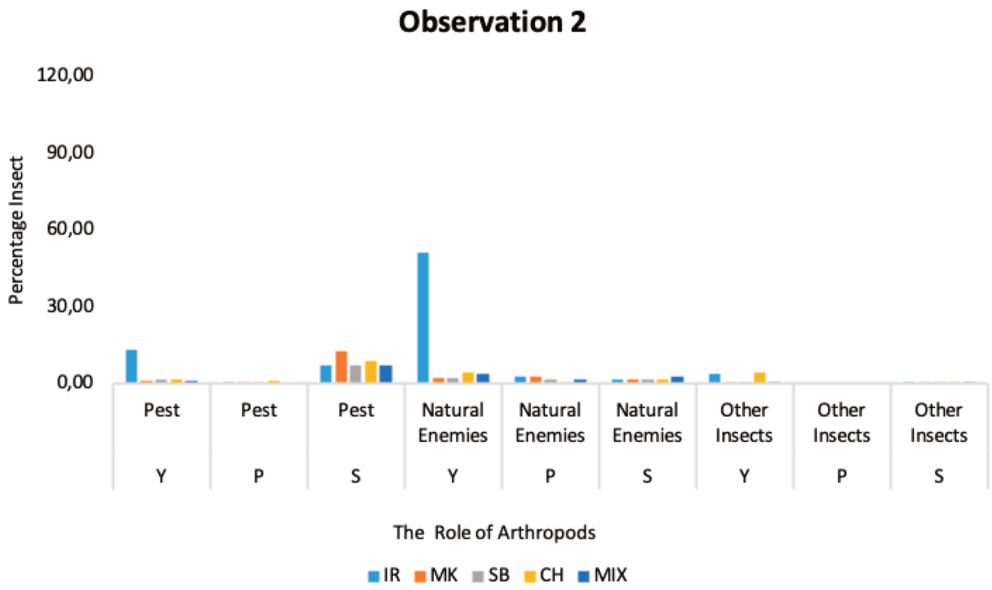

Figure 3. Percentage of arthropods in week two observation, Y: Yellow Sticky Trap, P: Pitfall Trap, S: Sweep net; IR: IR-64, MK: Mekongga, SB: Situ Bagendit, CH: Ciherang, Mix: Mix seed

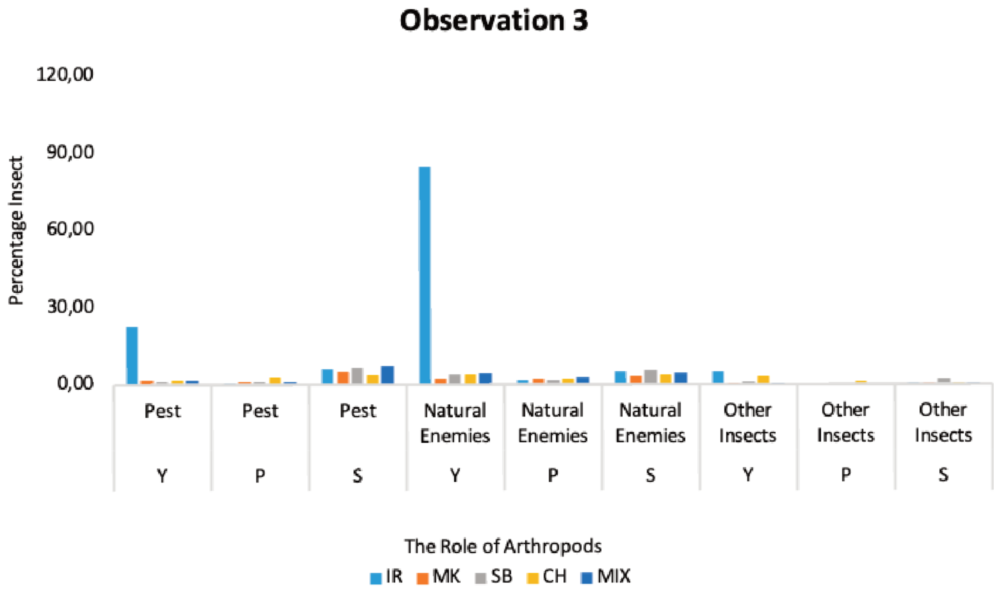

Figure 4. Percentage of arthropods in week three observation, Y: Yellow Sticky Trap, P: Pitfall Trap, S: Sweep net; IR: IR-64, MK: Mekongga, SB: Situ Bagendit, CH: Ciherang, Mix : Mix seed

Besides, yellow is a color that is able to catch various insect pests. Yellow sticky trap attracts more numbers because hemipteran insects are attracted to yellow more than blue color (Kisimoto, 1968; Cooper *et al*., 2010; Hall *et al*., 2010; Matsukura *et al*., 2011). Sweep net is also a frequently used sampling method for arthropods that randomly captures insects in the vegetation or above the ground level. The diversity of arthropods obtained from sweep net traps more often resembles malaise traps (Guevara & Aviles, 2009; Grootaert *et al*., 2010). Pitfall trapping is an approved self-sampling method for collecting ground-dwelling arthropods in ecological and faunistic studies (Siewers *et al.,* 2014). According to Jobin & Coulombe (1987), pitfall is a widely used trap that captures ground beetles and crawling insects above the ground. Therefore, arthropods obtained using pitfall traps are the arthropods living on the ground surface.

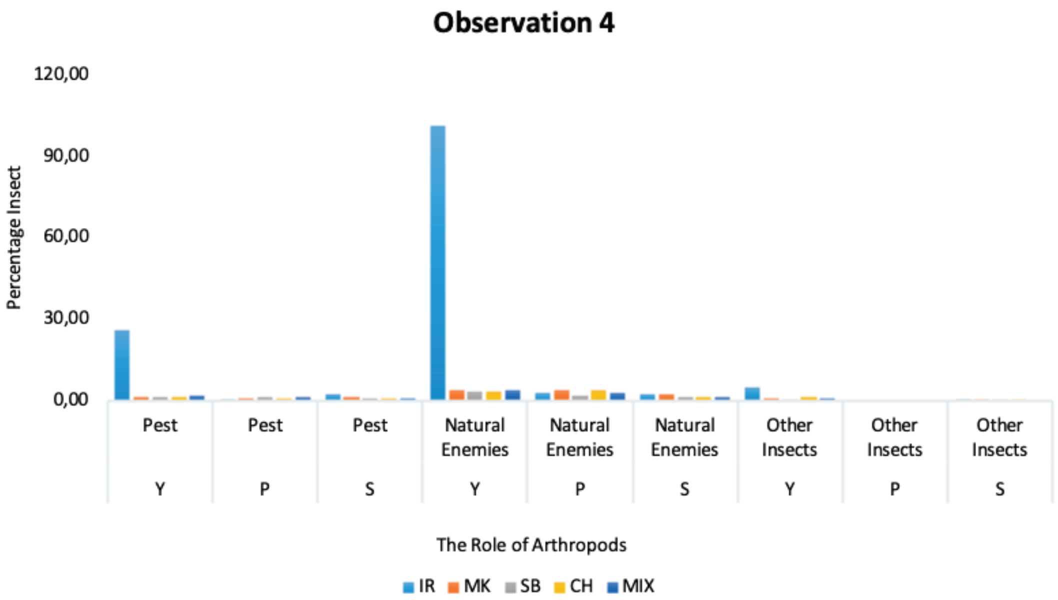

Figure 5. Percentage of arthropods in week four observation, Y: Yellow Sticky Trap, P: Pitfall Trap, S: Sweep net; IR: IR-64, MK: Mekongga, SB: Situ Bagendit, CH: Ciherang, Mix: Mix seed

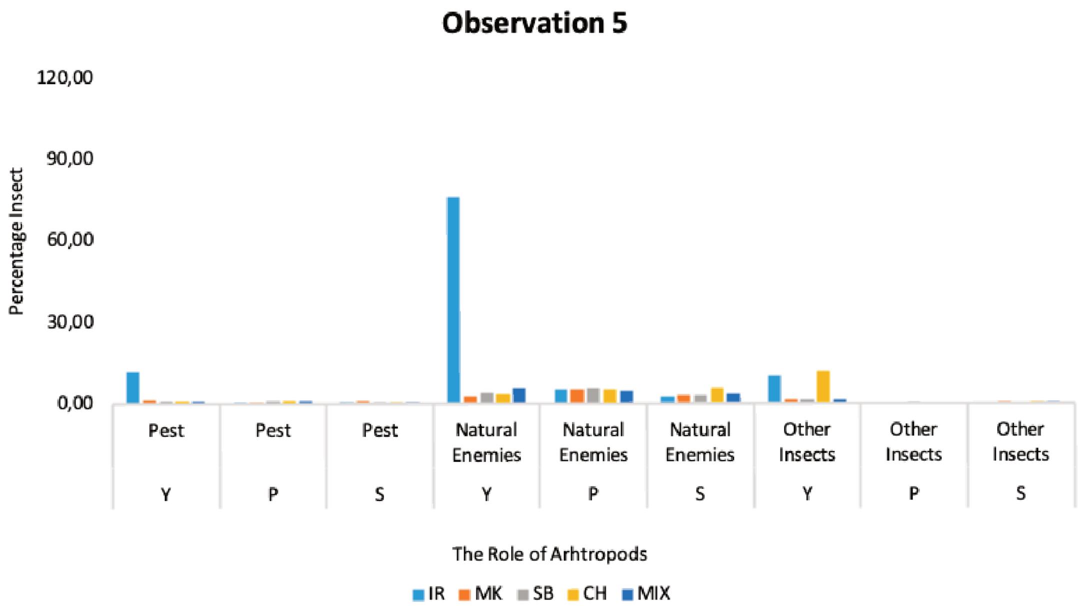

Figure 6. Percentage of arthropods in week five observation; Y: Yellow Sticky Trap, P: Pitfall Trap, S: Sweep net; IR: IR-64, MK: Mekongga, SB: Situ Bagendit, CH: Ciherang, Mix: Mix seed

The highest proportion of arthropods obtained from the three different type of traps was the natural enemy. In general, the observations from the first week to the fifth week showed that the highest abundance of natural enemy arthropod populations was occurred in the IR-64 variety. Planting rice resistant varieties is one of the main barriers to suppress pest attacks (Herlina & Silitonga, 2011; Muslim *et al.*, 2012; Iswanto *et al.*, 2015) because various insects have different response to the environment as a form of self-defense. Insects are able to respond with sensitivity to environmental changes such as the optimal environment in each development of these insects (Maisyaroh *et al.*, 2012). Environmental changes with the addition of non-rice plants may increase natural enemies by contributing to 46.60% of the increase (Xu *et al.*, 2004; Hong-xing *et al.*, 2017).

Table 1. The variation of arthropods family in the pitfall trap

Ordo	IR-64	Mekongga	Situ Bagendit	Ciherang	Mixed
Acarida	Macrochelidae	Macrochelidae	Macrochelidae	Machrochelidae	Macrochelidae
Arachnidae	Aranea, Lycosidae	Araneae, Lycosidae	Araneae, Lycosidae	Araneae, Clubionidae, Lycosidae	Araneae, Clubionidae, Lycosidae
Coleoptera	Chrysomelidae, Tenebrionidae, Carabidae, Coccinelidae, Staphylinidae	Chrysomelidae, Tenebrionidae, Carabidae, Coccinelidae, Staphylinidae, Hydrophilidae,	Chrysomelidae, Carabidae, Coccinelidae, Staphylinidae, Hydrophilidae,	Chrysomelidae, Tenebrionidae, Carabidae, Coccinelidae, Staphylinidae, Hydrophilidae.	Chrysomelidae, Tenebrionidae, Carabidae, Coccinelidae, Hydrophilidae.
Decapoda	-	-	-	-	Gecarcinucidae
Dermaptera	-	Labiduridae	-	-	Labiduridae
Diptera	Muscidae, Dolichopodidae	Muscidae, Tipulidae	-	Muscidae, Ceranophoridae, Dolichopodidae	Muscidae, Doliccopodidae, Tipulidae
Hemiptera	Belostomatidae, Dysticidae, Gerridae, Veliidae, Nepidae, Notonectidae, Saldidae	Delphacidae, Belostomatidae, Gerridae, Hydrometridae, Mesoveliidae, Nepidae	Delphacidae, Belostomatidae, Gerridae, Hydrometridae, Veliidae	Belostomatidae, Dysticide, Nepidae, Saldidae	Delphacidae, Gerridae, Mesovellidae, Miridae, Notonectidae, Saldidae
Hymenoptera	Dorylinae, Eulophidae, Sub Family Formicinae, Sub Family Myrmicinae, Ponerinae, Sub Family Pseudomicinae	Mymaridae, Sub Family Formicinae, Sub Family Myrmicinae, Sub Family Ponerinae, Sub Family Pseudomircinae	Sub Family Formicinae, Sub Family Ponerinae	Sub Famili Formicinae, Myrmicinae, Sub Family Ponerinae	Mymaridae, Sub Family Formicinae, Sub Family Ponerinae
Isoptera	-	-		Termitidae	-
Julida	-	-	Julidae	Julidae	-
Lepidoptera	-	-	Geometridae	-	-
Orthoptera	Acrididae, Pyrgomorphidae, Tetrigidae, Gryllidae, Gryllotalphidae	Acrididae, Pyrgomorphidae, Tetrigidae, Gryllidae, Gryllotalphidae	Acrididae, Pyrgomorphidae, Tetrigidae, Gryllidae, Gryllotalphidae	Acrididae, Tetrigidae, Gryllidae, Gryllotalphidae	Acrididae, Tetrigidae, Gryllidae, Gryllotalphidae
Polydesmida	-	-	Paradoxosomatidae	-	-
Scolopendromorpha	-	Scolopendridae	-	-	-
Squamata	-	-	-	Scindidae	-

Table 2. The variation of arthropods family in sweep net

Ordo	IR-64	Mekongga	Situ Bagendit	Ciherang	Mixed
Arachnidae	Lycosidae, Lynipidae, Oxyopidae ,Tetragnathidae, Dysderidae, Theriidae	Lycosidae, Tetragnathidae, Dysderidae	Lycosidae, Tetragnathidae, Araneidae	Lycosidae, Oxyopidae, Tetragnathidae, Dysderidae, Araneidae	Lycosidae, Tetragnathidae, Corinnidae, Dysderidae
Coleoptera	Scarabaeidae, Chrysomelidae, Curculionidae, Anthicidae, Carabidae,Staphylinidae, Coccinelidae	Chrysomelidae, Curculionidae, Carabidae, Staphylinidae, Coccinelidae	Chrysomelidae, Curculionidae, Carabidae, Staphylinidae, Coccinelidae	Scarabaeidae, Chrysomelidae, Curculionidae, Carabidae, Staphylinidae, Coccinelidae	Chrysomelidae, Curculionidae, Carabidae, Staphylinidae, Coccinelidae
Dermaptera					Labiduridae
Diptera	Agromyzidae, Anthomyzidae, Ephydridae, Curtoniidae, Muscidae, Tephritidae, Simuliidae, Asilidae, Dyomyzidae, Dolicophodidae, Tachinidae, Culicidae, Micropezidae, Lauxaniidae, Calliphoridae, Syrphidae, Ceratopogonidae, Phoridae, Tipulidae	Agromyzidae , Anthomyzidae, Ephydridae, Curtoniidae, Muscidae, Tephritidae, Simuliidae, Sciomyzidae. Dolicophodidae, Culicidae, Micropezidae, Lauxaniidae, Calliphoridae, Tipulidae	Agromyzidae, Anthomyzidae , Ephydridae , Curtoniidae, Muscidae, Tephritidae, Sciomyzidae. Dolicophodidae, Culicidae, Lauxaniidae, Calliphoridae, Cixiidae, Dryomyzidae, Tachinidae, Chironimidae, Sphaeroceridae, Syrphidae, Clusiidae, Chloropidae ,Phoridae, Tipulidae	Agromyzidae, Anthomyzidae, Ephydridae, Curtoniidae, Muscidae, Tephritidae, Dolicophodidae, Culicidae, Calliphoridae, Syrphidae, Lauxaniidae, Ceratopogonidae, Drosophila, Coelopidae, Fanniidae, Tipulidae	Agromyzidae, Anthomyzidae, Ephydridae, Curtoniidae, Muscidae, Tephritidae, Dolicophodidae, Culicidae, Calliphoridae, Syrphidae, Asilidae, Dryomyzidae, Tipulidae
Hemiptera	Alydidae, Pentatomidae, Cicadellidae, Delphacidae, Miridae, Reduviidae	Alydidae, Cicadellidae, Delphacidae, Miridae,	Alydidae, Pentatomidae, Cicadellidae, Delphacidae, Miridae, , Reduviidae.	Alydidae, Pentatomidae, Cicadellidae, Delphacidae, Miridae, , Reduviidae	Alydidae, Cicadellidae, Delphacidae, Miridae, Reduviidae
Hymenoptera	Formicidae, Braconidae, Ichneumonidae, Mymaridae, Tichogrammatidae, Eulophidae, Encyrtidae	Pteromalidae; Braconidae, Ichneumonidae, Mymaridae, Eulophidae, Eurytomidae, Torymidae, Adrenidae	Formicidae,Braconidae, Ichneumonidae, Mymaridae, Tichogrammatidae, Eulophidae, Eurytomidae, Sphecidae.	Braconidae, Ichneumonidae, Mymaridae, Tichogrammatidae, Eulophidae, Encyrtidae, Chalcididae, Eurytomidae	Pteromalidae, Braconidae, Ichneumonidae, Tichogrammatidae, Eulophidae, Chalcididae, Diapriidae
Lepidoptera	Nymphalidae, Noctuidae, Pieridae , Pyralidae	Hesperiidae, Saturniidae, Noctuidae, Pyralidae	Nymphalidae,Hesperiidae, Noctuidae	Nymphalidae, Noctuidae	Nymphalidae,Hesperiidae, Noctuidae, Pyralidae, Satyridae
Mantodea	-		Mantidae		
Odonata	Coegnagronidae	Coegnagronidae	Coegnagronidae	Coegnagronidae, Libellulidae	Coegnagronidae, Libellulidae
Orthoptera	Acrididae, Tetrigidae, Tettigonidae, Gryllidae	Acrididae, Pyrgomorphidae, Tetrigidae, Tettigonidae, Gryllidae	Acrididae, Pyrgomorphidae, Tetrigidae, Tettigonidae, Gryllidae	Acrididae, Pyrgomorphidaae ,Tetrigidae, Tettigonidae, Gryllidae	Acrididae, Tetrigidae, Tettigonidae, Gryllidae

Table 3. The variation of arthropods family in yellow sticky trap

Ordo	IR-64	Mekongga	Situ Bagendit	Ciherang	Mixed
Arachnidae	Lycosidae, Oxyopidae, Tetragnathidae	Lycosidae, Oxyopidae, Tetragnathidae	Lycosidae, Oxyopidae, Tetragnathidae	Lycosidae, Oxyopidae, Tetragnathidae	Lycosidae, Oxyopidae, Tetragnathidae
Coleoptera	Scarabaeidae, Curculionidae, Carabidae, Staphylinidae, Coccinelidae, Anthocoridae, Tenebrionidae	Scarabaeidae, Chrysomelidae, Curculionidae, Carabidae, Staphylinidae, Coccinelidae, Anthocoridae, Tenebrionidae, Lampyridae	Scarabaeidae, Chrysomelidae, Curculionidae, Carabidae, Staphylinidae, Coccinelidae, Anthocoridae, Tenebrionidae, Lampyridae	Scarabaeidae, Chrysomelidae, Curculionidae, Carabidae, Staphylinidae, Coccinelidae, Anthocoridae, Tenebrionidae	Scarabaeidae, Chrysomelidae, Curculionidae, Carabidae, Staphylinidae, Coccinelidae, Anthocoridae, Tenebrionidae
Diptera	Agromyzidae, Muscidae, Tephritidae, Dolicophodidae, Culicidae, Dexiedae, Phoridae Sarcophagidae, Tipulidae, Syrphidae	Agromyzidae, Muscidae, Tephritidae, Dolicophodidae, Culicidae, Dexiedae Phoridae Sarcophagidae Tipulidae, Syhrpidae	Agromyzidae, Muscidae, Tephritidae, Dolicophodidae, Culicidae, Chironomidae, Dexiedae, Phoridae Sarcophagidae Tipulidae, Syhrpidae	Agromyzidae, Muscidae, Tephritidae, Dolicophodidae, Culicidae, Chironomidae, Dexiedae ,Phoridae, Sarcophagidae Tipulidae	Agromyzidae, Muscidae, Tephritidae, Dolicophodidae, Culicidae, Chironomidae, Dexiedae, Phoridae, Sarcophagidae Tipulidae, Syhrpidae
Hemiptera	Cicadellidae, Delphacidae, Miridae, Reduviidae	Cicadellidae, Delphacidae, Miridae, Reduviidae, Alydidae	Cicadellidae, Delphacidae, Miridae, Reduviidae	Cicadellidae, Delphacidae, Miridae, Reduviidae	Cicadellidae, Delphacidae, Miridae, Reduviidae
Hymenoptera	Braconidae, Ichneumonidae, Mymaridae, Tichogrammatidae, Eulophidae, Vespidae, Pteromalidae	Braconidae, Ichneumonidae, Mymaridae), Tichogrammatidae, Eulophidae, Formicidae, Sphecidae, Vespidae,	Braconidae, Ichneumonidae, Mymaridae), Tichogrammatidae, Eulophidae, Formicidae , Sphecidae, Vespidae, Pteromalidae,	Braconidae, Ichneumonidae, Mymaridae), Tichogrammatidae, Eulophidae, Formicidae, Sphecidae Vespidae	Braconidae, Ichneumonidae, Mymaridae), Tichogrammatidae, Eulophidae, Formicidae Sphecidae, Vespidae, Pteromalidae, Proctrotrupidae
Lepidoptera	Crambidae	Crambidae	Crambidae	Crambidae	Crambidae
Orthoptera	Acrididae, Tetrigidae,	Acrididae, Tetrigidae	Acrididae, Tetrigidae	Acrididae, Tetrigidae, Gryllidae	Acrididae, Gryllidae
Blattodea				Blattidae	

The application of ecological engineering is a form of pest management, such as cultivation practices based on environmental management with the application of a "bottom up" system to improve pest biological control (Gurr *et al*., 2004). Using trap method to deter pests from the main crops is one of the ways to prepare the habitat, namely nectar and pollen as a place where natural enemies increase their biological control in the planting area (Lu *et al*., 2015).

The abundance of phytophagous pests increased rapidly and reached its peak within 25–45 days after sowing (DAS). Predator abundance increased gradually and reached its peak in 90–120 DAS. The pattern of fluctuation in predators and parasitoids is similar yet the abundance is lower than pests in all varieties. The abundance of parasitoids and predators increases as the number of phytophagous pests grows (Bambaradeniya & Edirisinghe, 2008).

Diversity Index of Arthropods in Rice Plant

The arthropod diversity in rice plant at Wijirejo is presented in Table 4. Diversity analysis using Shannon-Wiener index on arthropods collected from the three different traps (yellow sticky trap, pitfall trap, and sweep net) in Ciherang, IR-64, Situ Bagendit, Mekongga, and Mixed rice varieties ranged from 1.97–2.82 (Table 4) and was categorized as moderate diversity. According to Pradhana *et al*. (2014), the Shannon diversity Index (H') has three categories, e.g. low, moderate, and high diversity. Low diversity is when the H' reaches less than 1.00, moderate is when the H' reaches 1.00–3.00, and high is when the H' is greater or equal to 4.00. In this study, the diversity of arthropods in all rice varieties were found to be moderate since the diversity indexes amounted to more than 1.00 but less than 3.00. The land studied is a conventional transition to IPM since there was a possibility of the diversity index results obtained to be low, conventional with insecticide for carnivorous and dangerous to the growth of herbivorous insects thus making the soil less healthy for herbivorous insect development. Meanwhile, organic fertilizer showed positive effects on organism and herbivorous insect diversity (Birkhofer, 2008; Ovawanda *et al.*, 2016). The Shannon-Weiner index is higher in organic fields rather than conventional counterparts during the tillering stage (Yuan *et al.,* 2019).

Table 4. Diversity index of arthropods in different rice varieties from different traps (Lestari, 2020)

Rice varieties	Traps		
	Pitfall	Sweep net	Yellow sticky trap
IR-64	2.22	2.78	2.47
Mekongga	220	2.72	2.43
Situ Bagendit	2.20	2.65	2.25
Ciherang	1.97	2.82	2.36
Mix seed	2.09	2.72	2.33

Evenness Index of Arthropods in Rice Plant

The arthropods evenness index in IR-64, Situ Bagendit, Ciherang, Mekongga and Mix seed rice plant varieties with yellow sticky trap, pitfall trap, and sweep net was obtained to range from 0.61 to 0.71, categorized as medium level (Table 5).

Table 5. Evenness index of arthropods in different rice varieties from different traps (Lestari, 2020)

Rice varieties	Traps		
	Pitfall	Sweep net	Yellow sticky trap
IR-64	0.66	0.69	0.69
Mekongga	0.65	0.69	0.67
Situ Bagendit	0.61	0.69	0.61
Ciherang	0.62	0.71	0.64
Mix seed	0.63	0.69	0.63

According to Tarno *et al.* (2016), the evenness category index of $0.00<E<0.50$ is considered low meaning the community is under pressure, $0.50<E<0.75$ is categorized as medium level meaning that the community is unstable, $0.75<E<1.00$ is categorized as high meaning that the community is stable. Diversity and evenness index of predatory arthropod species tends to increase as the rice plants get older (Hendrival *et al.,* 2017) and the species evenness in the organic rice agro ecosystem becomes higher than that of the non-organic rice ecosystem (Ovawanda *et al.,* 2016).

Dominance Index of Arthropods in Rice Plant

Dominance index is the result of insect data to see whether or not an insect community dominates in plantation as sample data (Odum, 1994). The dominance index of arthropods in rice field obtained ranged from 0.10 to 0.22 with a category of low since no species were found to be dominating the result in different traps (Table 6).

Table 6. Dominance index of arthropods in different rice varieties from different traps (Lestari, 2020)

Rice varieties	Traps		
	Pitfall	Sweep net	Yellow sticky trap
IR-64	0.17	0.10	0.13
Mekongga	0.19	0.11	0.14
Situ Bagendit	0.22	0.11	0.18
Ciherang	0.21	0.10	0.17
Mix seed	0.21	0.11	0.18

The ecology of rice cultivation in several varieties affects the diversity and dominance of arthropods. Temperature is the major factor in rice cultivation which may increase or decrease arthropod population. In addition, diverse cultural conditions and geographical area may basically affect the survival and propagation of insects in rice cultivation such as humidity in the planting environment (Pathak, 1968).

CONCLUSION

This research showed that the high-yielding variety of IR-64 is the mostly used variety for pest and natural enemies compared to Mekongga, Ciherang, Situ Bagendit and Mix varieties since the observation was done for merely one rice growing season. Yellow sticky trap was found the highest in pest and natural enemies' population percentage due to their preference towards wavelengths. In spite of that, this research would be more effective if it were done for several growing seasons.

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