Int.J.Curr.Res.Aca.Rev.2021; 9(10): 13-22

EXCELLENT PUBLISHERS

International Journal of Current Research and Academic Review

ISSN: 2347-3215 (Online) Volume 9 Number 10 (October-2021)

Journal homepage: http://www.ijcrar.com

doi: https://doi.org/10.20546/ijcrar.2021.910.003

Diversity of Pests and Natural Enemies in Rice Plant (*Oryza sativa* L.)

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Abstract

Pests and natural enemies of rice plants are monitored at all times in the field, with the hope that their population does not exceed the economic threshold. So if natural enemies are equal to or higher than pests, it can be ascertained that pesticide control is no longer needed. There were six insect pests found during the research in Penatih Dangin Puri Village, namely: Walangsangit (*Leptocorisa acuta*, Hemiptera: Alilydae), House fly (*Musa domestica*, Diptera: Muscidae), Butterfly (*Troides helena*, Lepidoptera: Papilionidae), Caterpillars (*Scirpophaga innotata*, Lepidoptera: Crambridae), Black Ladybugs (*Coptosoma* sp., Homiptera: Plataspididae) and Yellow Ladybugs (*Charidotella sexpucata*, Homptera: Plataspididae). Natural enemies found during the study were: Grasshoppers (*Locusta migratoria* Orthoptera: Acricidae), Spiders (*Oxyopes salticus*, Hymenoptera: Araneidae), Bees (*Apiscerana*, Hymenoptera: Apidae), Wasps (*Amata huebneri*, Homynoptera: Vespidae), Dragonflies (*Choristhemis flavoterminata*, Ordonata: Anisoptera), and Lizards (*Eutropis multifasciata*, Squamata: Scincidae).The highest prevalence of pests was found in walangsangit (*Leptocorisa oratorius)*as many as 94 individuals, while the highest prevalence in natural enemies was spiders as many as 71 individuals. The pest diversity index was 4.0165 with a dominance index of 0.6923. Meanwhile, the natural enemy diversity index was obtained: 3.6781 with a diversity index of 0.7340. Correlation and regression relationship between insect pests and natural enemies with temperature and humidity, as follows: only butterflies with temperature, black ladybugs with humidity were very significantly related. While the relationship between natural enemies with temperature and humidity is only grasshoppers with a significant correlation with temperature, while grasshoppers with humidity have a very significant relationship.

Article Info

Accepted: 18 September 2021
Available Online: 20 October 2021

Keywords

Pests, natural enemies, population dynamics, prevalence, diversity and dominance.

Introduction

The rice harvested area in 2020 is estimated at 10.79 million hectares, an increase of 108.93 thousand hectares or 1.02 percent compared to the harvested area in 2019 which was 10.68 million hectares. Rice production in 2020 is estimated at 55.16 million tons of GKG, an increase of 556.51 thousand tons or 1.02 percent compared to production in 2019 which was 54.60 million tons of GKG. If the potential for rice production in 2020 is converted into rice for the population's food consumption, rice production in 2020 is estimated at 31.63 million tons, an increase of 314.10 thousand tons or 1.00 percent compared to 2019 which was 31.31 million tons (BPS, 2021). The harvested area in Bali in 2020 is 94,730 hectares with a total rice production of

570,319 tons of dry milled grain. If converted into rice, rice production in 2020 is estimated to reach 319,978 tons, or a decrease of 5,050 tons compared to the previous year (BPS Bali, 2021).

The diversity of types of natural enemies (parasitoids and predators) on insect pests of rice fields in order to know the types of natural enemies that are potential and can be developed to control insect pests that are easy, cheap, efficient and environmentally friendly. The results showed that the types of natural enemies found consisted of predators in 5 orders (10 families) namely the orders Araneida, Hemiptera, Odonata, Coleoptera, and Orthoptera; with a total of 16 species. Parasitoid 2 orders (10 families) with a total of 13 species. The results of the diversity analysis showed that the average abundance of 29 species of natural enemies (predators and parasitoids) found was almost the same as the average value of abundance (J) and the same thing showed that the values were not quite different in diversity within the species assemblage (H) during good observations at different age stadia of rice plants and rice planting locations (Moningka *et al.,* 2012).

There are 79 types of natural enemies of brown stem planthopper (BSP) including 34 parasitoids, 37 predators and 8 pathogens (Chiu, 1979). The potential natural enemies of rice stem borer (RSB) are parasitoids. There are 3 types of RSB parasitoids, namely: *Tetrastichus schenobii* Ferr., *Telenomus rowani* Gah., and *Trichogramma japonicum* Ashm. To date, 36 species of insect pathogenic fungi (IPF) have been identified in rice plants. Among these pathogens *Hirsutellacitriformis, Metarrhizium anisopliae* and *Beauveria bassiana* have the potential to control BSP. The presence of natural enemies of pests, especially rice pests, is very important in determining the population of these pests. Parasitoids and predators are able to reduce pest population density, while JPS infection can kill and affect pest development, reduce reproductive ability, and reduce pest resistance to predators, parasitoids and other pathogens (Santoso, 2007).

Materials and Methods

Place and time of research

The research was carried out in two places: 1) sample collection of pests and natural enemies was carried out in the field in Kertalangu Village, East Denpasar District, and 2) Plant Pests Laboratory, Faculty of Agriculture, Udayana University. The research was conducted from March to June 2021.

Determining the Diversity and the Dominance Index

The diversity and dominance of contaminant fungi can be determined by calculating the Shannon-Wiener diversity index (Odum, 1971) and the dominance of soil microbes is calculated by calculating the Simpson index (Pirzan and Pong-Masak, 2008).

Pest diversity index and natural enemies

The diversity index of pests and natural enemies was determined by the Shannon-Wiener diversity index, namely by the formula (Odum, 1971):

$$H' = -\sum_{i=1}^{s} Pi \ ln \ Pi.$$

Where:

H' = Shannon-Wiener diversity index

S = Number of species

Pi = ni/N as the proportion of the ith species (ni = the total number of individuals of the total pest species i, N = the total number of individuals in the total n)

The criteria used to interpret the diversity of Shannon-Wiener (Ferianita-Fachrul *et al.,* 2005) are: H' value < 1, meaning low diversity, H' value 1 – 3 means diversity is moderate and H' value > 3 means diversity is classified as tall.

Dominance index

The index of dominance of pests and natural enemies is calculated by calculating the Simpson index (Pirzan and Pong-Masak, 2008), with the following formula:

$$C = \sum_{i=1}^{s} Pi^2$$

Where:

C = Simpson's index

S = Number of species

Pi = ni/N i.e. the proportion of individuals of type i and all individuals (ni = total number of individuals of species i, N = number of all individuals in total n)

Furthermore, the species dominance index (D) can be calculated by the 1-C formulation (Rad *et al.*, 2009).

The criteria used to interpret the dominance of pests and natural enemies of the soil are: close to 0 = low index or lower dominance by one pest and natural enemy species or there is no species that extremely dominates other species, close to 1 = large index or tends to be dominated by several species of pests and natural enemies (Pirzan and Pong-Masak, 2008).

Prevalence

Prevalence can be calculated by dividing the total population of certain pests and natural enemies divided by the entire population times 100%.

Population Dynamics

The population and type of pests that appeared in each experimental plot were counted and quantitatively the number was recorded from week to week during the period of plant growth. The exponential growth dynamics of each pest population is then calculated by the Malthus formula (1798):

$Nt = Noe^{r}$ or $dN/dt = rN$

Where:

No = Total initial population, at time t = 0

Nt = Total population at time t

e = Natural logarithm base = 2.71828

r = Constant/intrinsic rate of natural growth

dN = Speed of changing population/time at a certain time

dt = Time interval

Relationship Between Pest Population and Enemies with Temperature and Humidity

The analysis to determine the relationship between the population only with temperature and humidity used a regression analysis approach, and the reciprocal relationship between the two variables was calculated by correlation analysis (Gomes and Gomes, 2007).

Results and Discussion

Total Pest Population and Natural Enemies

The total population of insect pests per nine weeks of observation was dominated by *Leptocorisa acuta*, namely 94 individuals, followed by house flies, black ladybugs, caterpillars, butterflies, and yellow ladybugs, each with 71, 26, 15, 10 and 4 tails. The number of insect species observed was 6 species. The dominant insect was *Leptocorisa acuta*, that is, just before *Leptocorisa acuta* had grown panicles and panicles began to turn yellow, at that time the population of *Leptocorisa acuta* began to increase. Likewise, the highest population of house flies occurred at week 7 as many as 20 individuals. The development of grasshoppers is almost evenly distributed every week, as well as the populations of butterflies and caterpillars are few in number (Table 1, Figure 1 and Figure 2).

Manueke *et al.*, (2017) stated in the results of his research that there were 11 insect pests and 4 natural enemies in the habitat of lowland rice plants in Makalonsow Village, East Tondano District, Minahasa Regency. These pests are the white rice stem borer (*Tryporyza innotata*), the striped rice stem borer (*Chilo suppressalis*), the purple rice stem borer (*Sesamia inferens*), the white leafhopper (*Nymphula depunctalis*), the brown planthopper (*Nephotettix virescens*), the green leafhopper (*Nilaparvata lugens*), Walang Sangit (*Leptocorisa acuta*), Black Ladybug (*Pareaucosmetus* sp.), Rice Powder (*Sitophilus oryzae*), Golden Snail (*Pomacea caniculata*), Rice Bird Pest (Passer spp.), and Rice Rat Pest (*Ratus argentiventer*). The natural enemies are praying mantis (Mantis sp.), Dragonfly (*Sympetrum flaveolum*), Coccinelid beetle (*Coccinella septempunctata*), and Hunting Spider (*Pardosa* sp.).

While Sianipar *et al.*, (2015) stated that the dominant insect pests obtained in the vegetative phase were *Scirpophaga incertulas*, *Thaia oryzivora*, and *Orselia oryzae*. Minor pests obtained were *Dicladispa armigera*, *Leptispa pygmaea*, and *Melanitis ledaismene*. The dominant insect pests obtained in the generative phase were *Leptocorisa acuta*, *Scirpophaga incertulas*, and *Thaia oryzivora*. Minor pests obtained were *Nilaparvata lugens*, *Sogatella furcifera*, and *Cofana spectra*.

The total population of natural enemies from the total observations were 71 spiders, 34 wasps, 41 grasshoppers, 15 dragonflies, 11 more, and 4 lizards (Table 2, Figure 3 and Figure 4). The population of grasshoppers fluctuated from the first observation to the end of the observation, and the highest was reached at the first observation. The highest spider population seen in the VIII observation was 29 individuals. Likewise, the highest wasp population was achieved at the VIII week of planting.

The large population of natural enemies is thought to be able to inhibit the rate of development of insect pests so that a spraying strategy with insecticides has not yet been determined. If you look at the population of insect pests as much as 220 heads while natural enemies are 176 tails. If it is assumed that a pest insect is eaten by a natural enemy, a natural enemy eats 2 insect pests, it means that there is a shortage of food for the natural enemy. Therefore spraying is eliminated.

Diversity and Dominance Index of Pests and Natural Enemies

The diversity index achieved in insect pests was 4.0165 (Table 3), meaning that the category of community structure was very stable, with a very good category and a scale of 5 (Table 4). The dominance index reached 0.6923, meaning that this figure was included in the criteria of 0.5 < D 0.75 (moderate dominance), there were insect species that dominated the community. The insect pest species was *Leptocorisa acuta* with a total population of 94 individuals, meaning that the highest prevalence was achieved by house flies. The dominance index was classified into three groups, namely 0 < D 0.5 (low dominance), 0.5 < D 0.75 (moderate dominance), and 0.75 < D 1.0 (high dominance) (Rahmawati *et al.*, 2020).

The diversity index of natural enemies in rice plants obtained based on observations was 3.6781 with a dominance index of 0.7340 (Table 3). The magnitude of the diversity index means that the ecosystem community is very stable with a very good category on a scale of 5 (Table 4). While the dominance index means that in the medium category (0.5 < D 0.75) there is a species that dominates and the highest prevalence is spiders as many as 71 individuals. Along with the results of research Rahmawati *et al.*, (2020) Spiders as natural enemies of arthropods are the most dominant pests found in rice fields.

Sianipar *et al.*, (2015) in their research results stated that the insect pest diversity index obtained in the three experimental fields was between medium to high. In the vegetative phase the highest diversity index was 4.74 in the 6th observation and the lowest was 2.22 in the 1st observation. In the generative phase, the highest diversity index was at the 9th observation of 4.86 and the lowest was at the 12th observation of 1.37. While the research results of Moningka *et al.*, (2012) showed that the results showed that the types of natural enemies found consisted of predators in 5 orders (10 families) namely the orders of Araneida, Hemiptera, Odonata, Coleoptera, and Orthoptera; with a total of 16 species. Parasitoid 2 orders (10 families) with a total of 13 species. The results of the diversity analysis showed that the average level of abundance of the 29 species of natural enemies (predators and parasitoids) found was almost the same as the average value of abundance and the same thing showed that the values were not quite different in diversity within the species assemblage during good observations at different age stadia of rice plants and rice planting locations.

Insect Population Dynamics Pests and Natural Enemies

The population dynamics of the insect pest of *Leptocorisa acuta* was highest at week 6-7 of 0.83, house flies at week 8-9 were 0.80 butterfly at week 8-9 of 1.47, caterpillars at week 8 week 6-7 was 0.49, similarly to black ladybugs at week 6-7 it was 1.10 and lastly for yellow ladybugs was 0.20 (Table 5).

The population dynamics of natural enemies in grasshoppers was highest at week III-IV of 0.74, the highest spiders were the same at weeks VI-VII of 2.02, while in bees there was no population dynamics because they were very small and moving around, wasps the highest was at week VI-VII at 1.10, the highest dragonfly was achieved at week IV-V at 0.74, while the lizard population was very low and also mobile like to move (Table 5). Population dynamics means that there is an increase and decrease in population every week that is practiced on insect pests and natural enemies. Population dynamics 1.10 means that in a hundred the population will increase every week by 110 individuals. The small population growth of insect pests is caused by the dynamics of the population of natural enemies that are balanced and can compensate for the increase in the population of insect pests.

Table.1 Number of insects observed every week

Pest name	Observation time per week (individu) /100 m^2									
	I	II	III	IV	V	VI	VII	VIII	IX	Jumlah
Walangsangit (*Leptocorisa acuta*, Hemiptera: Alilydae)	2	3	10	10	4	9	19	19	18	94
House fly (*Musa domestica*, Diptera: Muscidae)	-	5	9	7	4	7	20	6	13	71
Butterfly (*Troides helena*, Lepidoptera: Papilionidae)	-	-	1	-	-	3	1	1	4	10
Caterpillar (*Scirpophaga innotata*, Lepidoptera: Crambridae)	-	-	-	-	6	3	4	1	1	15
Black ladybug (*Coptosoma* sp., Homiptera: Plataspididae)	-	2	-	-	8	2	6	8	-	26
Yellow ladybug (*Charidotella sexpucata, Homptera:* Plataspididae)	-	1	-	-	-	3	1	-	-	4
Total	2	11	19	17	22	27	35	37	36	220
Temperature (^oC)	28	29	27	28	28	28	28	28	27	
Relative humidity (%)	80	81	84	80	85	65	80	82	85	

Table.2 Number of natural enemies observed each week

Enemies name	Observation time per week (individual)									
	I	II	III	IV	V	VI	VII	VIII	IX	Jumlah
Grasshopper (*Locusta migratoria* Orthoptera: Acricidae)	6	-	5	2	4	5	5	4	5	41
Spiders (*Oxyopes salticus*, Hymenoptera: Araneidae)	6	3	3	9	2	2	11	29	6	71
Bees (*Apiscerana*, Hymenoptera: Apidae)	3	-	-	6	-	1	-	1	-	11
Wasps (*Amata huebneri*, Homynoptera: Vespidae)	4	1	2	1	-	2	6	12	6	34
Dragonfly (*Choristhemis flavoterminata*, Order: Anisoptera)	-	2	2	2	4	-	-	3	2	15
Lizard (*Eutropics multifasciata*, Squamata: Scincidae)	-	-	-	1	-	2	-	1	-	4
Total	19	6	12	21	10	11	22	50	19	176
Temerature (^oC)	28	29	27	28	28	28	28	28	27	
Relative humidity (%)	80	81	84	80	85	65	80	82	85	

Table.3 Diversity and dominance index of pest and enemies

Index	Insect pest	Natural enemies
Diversity (H)	4,0165	3,6781
Dominance (D)	0,6923	0,7340

Table.4 Criteria for weighting environmental quality (Tauruslina *et al*., 2015)

Diversity index	Condition of community structure	Category	Scale
>2,41	Very stable	Very good	5
-2,4	More stable	Good	4
1,21 – 1,8	Stable enough	Currently	3
0,61 – 1,2	Less stable	Bad	2
<0,6	Unstable	Very bad	1

Table.5 Dynamics of insect pest population

Name of insect pests	Population dynamics figures							
	I-II	II-III	III-IV	IV-V	V-VI	VI-VII	VII-VIII	VIII-IX
Walangsangit (*Leptocorisa acuta*, Hemiptera: Alilydae)	0,55	0,37	0,37	0,19	0,83	0,78	0,37	0,35
House fly (*Musa domestica*, Diptera: Muscidae)	-	0,66	0,29	0,21	0,64	1,05	0,11	0,80
Butterflies (*Troides helena*, Lepidoptera: Papilionidae)	-	-	-	-	-	0,12	0,37	1,47
Caterpillars (*Scirpophaga innotata*, Lepidoptera: Crambridae)	-	-	-	-	0,18	0,49	0,09	0,37
Black ladybug (*Coptosoma* sp., Homiptera: Plataspididae)	-	-	-	-	0,90	1,10	0,49	-
Yellow ladybug (*Charidotella sexpucata*,Homptera: Plataspididae)	-	-	-	-	0,20	-	-	-

Fig.1 Total pest population (individu)

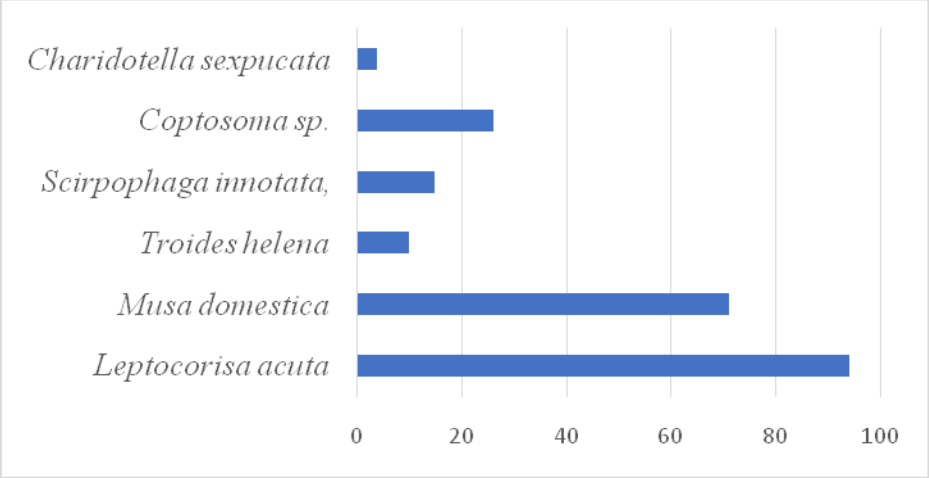

Fig.2 Insect pests observed in rice fields (A = *Leptocorisa acuta*, B = house fly, C = butterfly, D = yellow ladybug, E = caterpillar, and F = black ladybug) (personal documentation)

Fig.3 Total population of natural enemies (individuals)

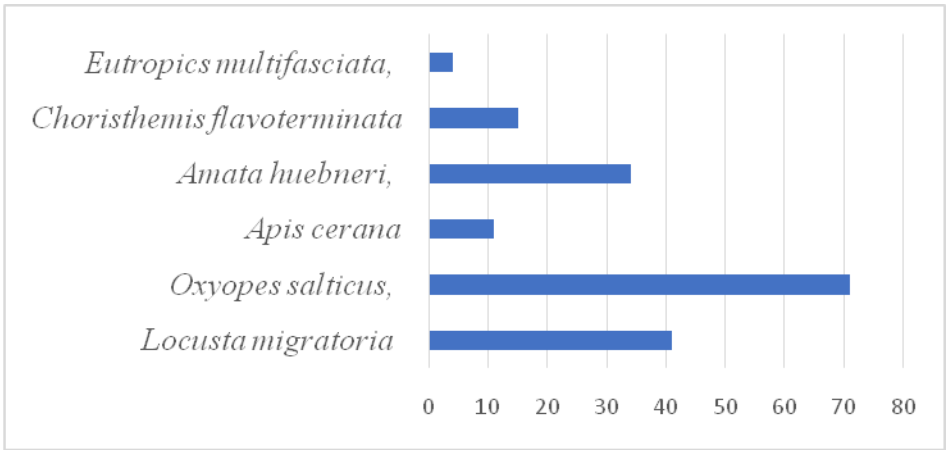

Fig.4 Observations of natural enemies (A = spiders, B = lizards, C = grasshoppers, D = dragonflies, E = bees, and F = wasps) (personal documentation)

Correlation and Regression Relationship Between Insect Pests and Natural Enemies with Temperature and Humidity

The results of correlation and regression analysis between insect pests and temperature were not significantly different, while the correlation and regression between insect pests and humidity turned out to be only butterflies and black ladybugs which showed a very significant difference. The correlation coefficient of the relationship between butterflies and temperature is -0.78** with a determination coefficient (r^2) of 61%, but the regression relationship is not significantly different, while the relationship between black ladybugs and humidity correlation coefficient (r) is 0.98* * with a coefficient of determination of (r^2) = 96%. It means that the relationship is determined to be 96% caused by humidity, while the rest is caused by unexplained factors. Based on the correlation relationship, the regression relationship was found to obtain the forecast line Y_5 = -18.25 + 0.31 X_2 (Y_5 = black ladybug and X_2 = humidity).

The correlation and regression relationship between natural enemies and temperature and humidity is only grasshoppers which have a negative correlation with the temperature factor, the correlation coefficient is -0.67 which means the termination coefficient (r2) is 45%. This means that 45% of the grasshopper relationship is determined by temperature. The rest is determined by unexplained factors. The regression relationship is very significantly different from the forecasting line as follows Y_7 = 61.92 - 2.08 X_1** (Y_7 = grasshopper and X_1 = temperature). While the correlation between lizards and humidity is very significant with a correlation coefficient (r) of 0.82** and a coefficient of determination of 67%. The regression relationship between lizards and humidity was very significant with the forecast line Y_{12} = 8.29 - 0.098 X_2** (Y_{12} = lizard and X_2 = humidity).

There were six insect pests found during the research namely: Walangsangit (*Leptocorisa acuta*, Hemiptera: Alilydae), House fly (*Musa domestica*, Diptera: Muscidae), Butterflies (*Troideshelena*, Lepidoptera: Papilionidae), Caterpillars (*Scirpophaga innotata*, Lepidoptera: Crambridae), Black Ladybugs (*Coptosoma* sp., Homiptera: Plataspididae) and Yellow Ladybugs (*Charidotella sexpucata*, Homptera: Plataspididae). Natural enemies found during the study were: Grasshoppers (*Locusta migratoria* Orthoptera:

Acricidae), Spiders (*Oxyopes salticus*, Hymenoptera: Araneidae), Bees (*Apis cerana*, Hymenoptera: Apidae), Wasps (*Amata huebneri*, Homynoptera: Vespidae). Dragonflies (*Choristhemis flavoterminata*, Ordonata: Anisoptera), and Lizards (*Eutropis multifasciata*, Squamata: Scincidae). The highest prevalence of pests was found in *Leptocorisa acuta*as many as 94 individuals, while the highest prevalence in natural enemies was spiders as many as 71 individuals. The pest diversity index was 4.0165 with a dominance index of 0.69227. Meanwhile, the natural enemy diversity index was obtained: 3.6781 with a diversity index of 0.7340. Correlation and regression relationship between insect pests and natural enemies with temperature and humidity, as follows: only butterflies with temperature, black ladybugs with humidity are very significant. Meanwhile, the relationship between natural enemies with temperature and humidity is only grasshoppers with a significant relationship with temperature, while grasshoppers with humidity have a very real relationship.

Acknowledgements

Authors wish to thank to the Rector of Udayana University for their assistance and the opportunity given so that research can be resolved, Dean of the Faculty of Agriculture, Udayana University, and Chairman of the Institute for Research and Community Service Udayana University, for their help and cooperation so that research can be funded to completion.

References

Badan Pusat Statistik (BPS). 2021. Jl. Dr. Sutomo 6-8 Jakarta 10710 Indonesia, Telp (62-21) 3841195, 3842508, 3810291, Faks (62-21) 3857046, Mailbox: bpshq@bps.go.id.

Badan Pusat StatistikProvinsi Bali (Statistics of Bali Province). 2021. Jl. Raya Puputan (Renon) No 1, Denpasar 80226, Telepon: (0361) 238159, 243696, Whatsapp: 081-810-5100,

Bolo Tani. 2014. Membuat perangkapwalangsangit (*Leptocorisa oratorius* Fabricius). Bolo Tani.

Gomes, K. A. dan A. A. Gomes, 2007. *Prosedur Statistikuntuk Penelitian Pertanian*. Edisikedua. Penerbit Universitas Indonesia (UI-Press). Jakarta.

Joko Santoso, S. 2007. Perananmusuha lamihamautamatanamanpadi pada ekosistem sawah. *Inforfarm: JurnalInovasiPertanian* 6(1): 1-10.

Kartohardjono, A. 2011. Penggunaanmusuha lamisebagai komponenpengendalian hamapadiber basisekologi. *Pengembangan Inovasi Pertanian* 4(1): 29-46.

Kartohardjono, A., D. Kertoseputro, dan T. Suryana. Ny. Hama padipotensial dan pengendaliannya. Balai Besar Peneltian Tanaman Padi: 405-440.

Malthus, R. 1798. A essay on the principle of population. London: Electronic Scholarly Pbublishing Project

Manueke J., B. H. Assa, dan E. A. Pelealu. 2017. Hama-Hama Pada Tanaman Padi Sawah (*Oryza Sativa* L.) Di Kelurahan Makalonsow Kecamatan Tondano Timur Kabupaten Minahasa. Eugenia 23(3): 120-127.

Moningka, M., D, Tarore, dan J. Krisen. 2012. KeragamanJenisMusuhAlami Pada Serangga Hama Padi Sawah Di KabupatenMinahasa Selatan. Eugenia 18 (2): 89-95.

Moningka, M., D. Tarore, dan J. Krisen. 2012. Kergamanjenismusuhalamioadaseranggahamapa di sawah di kabupaten Minahasa Selatan. *Eugenia* 18(2): 89-95.

Mosamandiri. 2016. Penggerekbatangpadiputih (*Tryporyza innotata*). Hama da penyakit. Agrokomplek MMC.

Ndendong, A. P. 2015. Hama dan penyakittanamanpadi. BerandaPenyulihPertanianKab. Manggarai.

Nuansatani. 2018. Mengenal dan mengendalikanwerenghijau (*Niphotettixvirescens*). Nuansatani.com. Tips dan Info Bertani.

Odum, E. P. 1971. *Fundamentals of Ecology*. Third Edition. W.B. Saunders Company. Philadelphia, Toronto, London. Toppan Company, Ltd. Tokyo, Japan.

Pirzan, A. M., dan P. R. Pong-Masak. 2008. Hubungan Keragaman Fitoplanktondengan Kualitas Air di Pulau Bauluang, Kabupaten Takalar, Sulawesi Selatan. *Biodiversitas*, 9 (3) 217-221.

Puslatan. 2018. Musuhalamihamapadi sawah. *etraining.puslatan.info/.../index.php. Diakses 7/2/2018.*

Rad, J. E., M. Manthey and A. Mataji. 2009. Comparison of Plant Species Diversity with Different Plant Communities in Deciduous Forests. *Int. J. Environ. Sci. Tech*, 6(3): 389-394.

Rahmawati, D., Samrin dan A. R. Kumala Sari. 2020. Keragaman Hama dan MusuhAlami pada Pertanaman Padi di Wawotobi, Sulawesi Tenggara. Penelitian Pertanian Tanaman Pangan 4(3) 145-151.

Sianipar M. S., L. Djaya, E. Santosa, R C. H. Soesilohadi, W. D. Natawigena, dan M. P. Bangun. 2015. Indeks Keragaman Serangga Hama Pada Tanaman Padi (*Oryza sativa* L.) Di Lahan Persawahan Padi Dataran Tinggi Desa Sukawening, Kecamatan Ciwidey, Kabupaten Bandung. Bioma 17 (1): 9-15.

Siregar, A. Z. 2007. Hama-hamaTanamanPadi. USU Repositoy: 1-5.

Tauruslina, E, Trizelia, Yaherwandi dan Hasmiandy, H. 2015. Analisiskeanekaragamanhayatimusuhalami pada eksosistem pada sawah di daerahendemik dan non – endemikWereng Batang Cokelat Nilaparvatalugens di Sumatera Barat. Pros Sem NasMasyBiodivIndon 1(3): 581 – 589.

Thippaiah, M. 2018. Identification of mayor insect pest of Paddy and their damage symptoms. Dept. of Entomology College of Agriculture GKVK, UAS. Bangalore-65.

WordPress and Hostinger, 2018. Werengbatangcoklat (WBC). Jogjatnai. IlmuPengetahuan, Informasi da TeknologiPertanian. Leaflet SRI (*System of Rice Intensification*).

How to cite this article:

I Made Sudarma, Ni Nengah Darmiati and dan Ni Wayan Suniti. 2021. Diversity of Pests and Natural Enemies in Rice Plant (*Oryza sativa* L.). *Int.J.Curr.Res.Aca.Rev*. 9(10), 13-22.
doi: https://doi.org/10.20546/ijcrar.2021.910.003