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Main and Ratooned Rice Pest Populations in Lowland Rice Fields, South Sumatra Applied Bioinsecticide from Entomopathogens

Populasi Hama Padi Utama dan Ratun di Sawah Lebak Sumatera Selatan yang Diaplikasi Bioinsektisida dari Entomopatogen

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ABSTRAK

Hama yang menyerang setiap fase tanaman juga berbeda-beda. Penelitian ini bertujuan untuk membandingkan populasi serangga hama padi utama dan ratun di sawah lebak pada fase vegetatif, berbunga, dan masak susu. Pada padi utama bioinsektisida yang disemprotkan pada tajuk padi berasal dari konidia cendawan entomopatogen *Metarhizium anisopliae*, bakteri entomopatogen *Bacillus thuringiensis*, dan sebagai lahan kontrol tanpa aplikasi bioinsektisida ataupun insektisida sintetik. Hasil penelitian menunjukkan bahwa populasi hama putih palsu (*Cnaphalocrosis medinalis*) dan wereng putih (*Covana spectra*) lebih banyak menyerang pada padi fase vegetatif dibandingkan dengan jenis hama lain seperti wereng hijau (*Nephotettix* spp.), wereng cokelat (*Nilaparvata lugens*), Wereng zig zag (*Recillia dorsalis*), wereng punggung putih (*Sogatella furcifera*), belalang, orong-orong (*Gryllotalpa gryllotalpa*), dan penggerek batang padi kuning (*Scirpophaga incertulas*). *Leptocorisa acuta* dan kepik hijau (*Nezara viridula*) mulai menyerang fase berbunga dan masak susu yaitu saat padi berumur 54-68 hari setelah tanam (hst). Sedangkan pada tanaman padi ratun populasi hama *L. acuta* sudah muncul pada pengamatan pertama pada padi umur 9 hari setelah panen (hsp) sampai padi ratun berumur 58 hsp. Populasi hama tinggi pada lahan yang tanpa aplikasi bioinsektisida dibandingkan dengan lahan yang diaplikasikan bioinsektisida. Pada padi ratun populasi hama antara lahan yang diaplikasikan bioinsektisida *M. anisopliae* dan *B. thuringiensis* tidak berbeda nyata dengan lahan yang diaplikasikan *B. thuringiensis* yang dijual dipasaran.

Kata kunci: bioinsektisida, padi utama, hama, ratoon

ABSTRACT

The pests that attack each plant phase also varies. The aimed of this study was to compare the main population of rice insect pests and ratooned in lowland rice field in the vegetative, flowering and milk ripening phase. The main bioinsecticide rice sprayed on rice canopy were comes from the entomopathogenic fungal conidia *Metarhizium anisopliae*, the entomopathogenic bacterium *Bacillus thuringiensis*, and as a control area without the application of bioinsecticide or synthetic insecticide. The results showed that population of fake white pests (*Cnaphalocrosis medinalis*) and white leafhoppers pest (*Covana spectra*) were more prevalent in vegetative phase rice compared to other types of pests such as green leafhoppers (*Nephotettix* spp.), Brown leafhoppers (*Nilaparvata lugens*), zig zag leafhoppers. (*Recillia dorsalis*), white-back leafhoppers (*Sogatella furcifera*), grasshoppers, mole cricket (*Gryllotalpa gryllotalpa*), and yellow rice stem borer (*Scirpophaga incertulas*). The *Leptocorisa acuta* and green ladybugs (*Nezara viridula*) began to attack the flowering and milk ripening phase, which was when the rice was aged about 54-68 days after transplanting (dat). Whereas in ratooned rice, the pest population of *L. acuta* has appeared on the first observation on rice aged 9 days after harvest (dah) until the ratooned rice was aged 58 days after harvesting. The population of pests was higher in land without bioinsecticide application compared to land applied of bioinsecticides. In ratooned rice, the pest population between the land applied with bioinsecticide *M. anisopliae* and *B. thuringiensis* was not significantly different from the land applied by *B. thuringiensis* which was sold in the market.

Keywords: bioinsecticide, main, pests, ratooned rice

INTRODUCTION

Generally, the lowland farmers in Pelabuhan Dalam village plant rice once a year with a land area of 91% for a one-time cropping pattern while for a two-time cropping pattern (IP 200) is still very low with a land area of only 9% (Khairullah et al., 2021). The efforts to increase rice production in lowland swamps are continuously carried out through cultivation techniques or by increasing the cropping index. The cultivation of high yielding varieties is also carried out considering that lowland swamps rice production is also low with an average of 4.13 tons per ha when compared to national rice productivity (Antoni et al., 2021). Utilization of the remaining stubble of the main rice harvest which is cultivated into ratooned rice also increases the rice cropping index in the lowland swamps (Susilawati, 2013). Ratooned is the main rice stump (transplanting) that has been harvested and new shoots grow on the stump until it is harvested again. To increase main and ratooned rice production cannot be separated from the obstacles, one of which is the presence of pest attacks. Pest control is often carried out in the field using synthetic insecticides. If carried out continuously, this way of control will cause resistance and resurgence of pests. Besides that, it also will have an impact on natural enemies of pests which play a role in suppressing pest populations in the field such as those from the Lycosidae, Tetragnatidae, Oxyopidae families which are predatory spiders for rice pests in the field (Thalib et al., 2013). Natural enemies such as predatory insects play a role in suppressing pests (Qian et al., 2021; P˚uža et al., 2021). Therefore, an alternative control is needed not only to suppresses the pest population but also not to kill predatory insects in the field. The application of entomopathogens can control pests such as Spodoptera litura (Gustianingtyas et al., 2020) and larvae that attack sweet potatoes (Putnoky-Csicsó et al., 2020). Entomopathogenic species such as Beauveria bassiana are also often used to control green leafhoppers (Abdullah et al., 2020). Entomopathogens can be obtained in several habitats such as the rhizosphere of rice plants (Noerfitryani & Hamzah, 2017). The application of entomopathogens is an environmentally friendly and integrated control with integrated pest control (Afandhi et al., 2020).

The *M. anisopliae* fungus (Tobing et al., 2015) and the Bacillus thuringiensis bacterium are biological agents that can be used as alternative controls that are friendly to the environment. Application of B. thuringiensi and B. subtilis can suppress S. litura larvae (Revathi et al., 2014). This study aimed to examine pest control using bioinsecticides with active ingredients of *B. thuringiensis* and *M. anisopliae* to control pests in main rice and ratooned rice in lowland rice fields of South Sumatra.

MATERIALS AND METHODS

This research has been carried out in the lowland rice fields of Pelabuhan Dalam village, Pemulutan District, Ogan Ilir Regency, South Sumatra. The design used in the research on main rice carried out from May to September 2014 was a Randomized Block Design (RBD) with 3 treatments and 4 replications. The treatments given were *M. anisopliae* liquid bioinsecticide, B. thuringiensis liquid bioinsecticide treatment and positive control without synthetic insecticide application. Ratooned rice research was conducted from December to March 2015. The design that used in this study was randomized block design with 3 treatments and 8 replications.

The tools used in this study were specimen bottles or vials, plastic cups, insect nets, cameras, rubber bands, 15 L knapsack sprayers, brushes, meters, binocular microscopes, clear plastic, 1 mm porous filter, and paralon. The materials used in this study were 70% alcohol, Situbagendit rice seeds, *M. anisopliae liquid bioinsecticide*, *B. thuringiensis* liquid bioinsecticide, market Bt and 40% formalin. Liquid bioinsecticide of *M. anisopliae* and *B. thuringiensis* were applied to the main rice canopy on a land area of 2 ha and a dose of 2 L/ha, each of these bioinsecticides was applied to each treatment plot. For *M. anisopliae* bioinsecticide was applied to *M. anisopliae* treatment plots, for *B. thuringiensis* bioinsecticide was applied to B. thuringiensis treatment plots and control without synthetic insecticide application. Liquid bioinsecticide was applied to rice plants 10 days after transplanting (DAT). The application of liquid bioinsecticide was carried out every 14 days until the rice enters the phase of grain filling and ducking. Applications are made in the afternoon at 4 PM.

After the main rice stalk was harvested, then the stubble was cut. The stump was cut 2 cm high from the ground using a sickle. Liquid bioinsecticide of *M. anisopliae* and B. thuringiensis were applied to ratooned rice canopy on a land area of 2 ha and a dose of 2 L/ha, each of these bioinsecticides was applied to each treatment plot. for *M. anisopliae bioinsecticide* will be applied to *M. anisopliae* treatment plots. While for B. thuringiensis bioinsecticide, it will be applied to *B. thuringiensis* treatment plots and control with market Bt Liquid bioinsecticide that was applied to rice plants aged 7 days after harvesting (DAH). The application of liquid bioinsecticide was carried out every 7 days until the rice enters the phase of grain filling and ducking. Applications are made in the afternoon at 4 PM. Two days after application, the population and the attack of important pests of rice will be observed following the method of Khodijah et al. (2012). Direct observations were made in the morning at 6 am.

RESULTS

From the results of direct (visual) observations in the field, the population of pests in the main rice plants include false white pests (*C. medinalis*), mole cricket (*G. gryllotalpa*), yellow rice stem borer (*S. incertulas*), grasshoppers (*O. chinensis*), rice stink bugs (*L. acuta*), green leafhoppers (*Nephotettix* spp.), brown leafhoppers (*N. lugens*), white leafhoppers (*C. spectra*), zig zag leafhoppers (*R. dorsalis*) white-back leafhoppers (S. furcifera), and green ladybugs (N. viridula) (Table 1-2).

At the age of 9-23 days after harvesting of ratooned rice, the pests caught in the net were the same as the pests found during direct observation in the field and the mole cricket pests were also not found at the time of observation with nets (Table 3-4).

Table 1. Visual pest population (tail/20 clumps) in main rice 12-26 days after transplanting (DAT) on land applied liquid bioinsecticides *Metarhizium anisopliae*, *Bacillus thuringiensis* and control

Rice Aged (DAT)	Insect Spesies	Visual			BNT 5%	*p-value*
		A	B	C		
12	*Nilaparvata lugens*	0[a]	0.25[a]	0.25[a]	0.19[ns]	0.670
	Recillia dorsalis	0.25[a]	0.25[a]	0.25[a]	0.26[ns]	1
	Sogatella furcifera	0[a]	0.5[a]	0.25[a]	0.27[ns]	0.635
	Nephottetix virescens	0[a]	0.25[a]	0.5[a]	0.27[ns]	0.635
	Nephottetix nigropictus	0[a]	0.75[b]	0.75[b]	0.29[ns]	0.276
	Nephottetix cinticeps	0[a]	0[a]	0[a]	0[ns]	0
	Cofana spectra	2[a]	1.75[a]	2.5[a]	0.45[ns]	0.279
	Leptocorisa acuta	0[a]	0[a]	0[a]	0[ns]	0
	Nezara viridula	0[a]	0[a]	0[a]	0[ns]	0
	Scirpophaga incertulas	0[a]	0[a]	0.5[b]	0.15[ns]	0.125
	Cnaphalocrosis medinalis	1.25[b]	0.5[a]	1.25[b]	0.29[ns]	0.350
	Gryllotalpa gryllotalpa	0.5[a]	0.25[a]	0.5[a]	0.28[ns]	0.824
	Tetrix subulata	0[a]	0[a]	0[a]	0[ns]	0
	Oxya chinensis	0[a]	0[a]	0[a]	0[ns]	0
	Acrida turita	0.25[a]	0[a]	0.75[b]	0.20[ns]	0.178
26	*Nilaparvata lugens*	0.25[a]	0.5[a]	0.5[a]	0.28[ns]	0.824
	Recillia dorsalis	0[a]	0.75[b]	0.25[a]	0.16[ns]	0.072
	Sogatella furcifera	0.5[a]	0.5[a]	0.75[a]	0.17[ns]	0.651
	Nephottetix virescens	0.5[a]	0.5[a]	0.5[a]	0.3[ns]	0.983
	Nephottetix nigropictus	0.5[a]	0.75[a]	0.75[a]	0.35[ns]	0.903
	Nephottetix cinticeps	0[a]	0[a]	0[a]	0[ns]	0
	Cofana spectra	3[ab]	2.25[a]	4[b]	0.29[ns]	0.225
	Leptocorisa acuta	0[a]	0[a]	0[a]	0[ns]	0
	Nezara viridula	0[a]	0[a]	0[a]	0[ns]	0
	Scirpophaga incertulas	0.75[a]	0.5[a]	1.25[a]	0.37[ns]	0.614
	Cnaphalocrosis medinalis	2.75[a]	2.75[a]	4.5[b]	0.18[*]	0.036
	Gryllotalpa gryllotalpa	0.5[a]	0.5[a]	1[a]	0.31[ns]	0.640
	Tetrix subulata	0.25[a]	0.5[a]	0.25[a]	0.24[ns]	0.770
	Oxya chinensis	1[ab]	0.5[a]	1.5[b]	0.34[ns]	0.298
	Acrida turita	0.5[a]	0.25[a]	1.25[b]	0.3[ns]	0.204

Note: [ns]: not significantly different in variance, *: significantly different in variance, the numbers followed by the same letter were not significantly different in the LSD 5% further test from the data that had been transformed by roots ($\sqrt{(y + 0.5)}$) for each treatment A: liquid bioinsecticide *M. anisopliae*, B: liquid bioinsecticide *B. thuringiensis* and C: control (without treatment)

Table 2. Visual pest population (tail/20 clumps) in main rice 40-68 days after transplanting (DAT) on land applied liquid bioinsecticides *Metarhizium anisopliae*, *Bacillus thuringiensis* and control

Rice Aged (DAT)	Insect Spesies	Visual			BNT 5%	*p-value*
		A	B	C		
40	*Nilaparvata lugens*	0.25^{a}	0.25^{a}	0.25^{a}	0.25^{ns}	1
	Recillia dorsalis	0.25^{a}	0.25^{a}	0.5^{a}	0.29^{ns}	0.910
	Sogatella furcifera	0.25^{a}	0.5^{a}	0.25^{a}	0.24^{ns}	0.770
	Nephottetix virescens	0.25^{ab}	0.25^{a}	1^{b}	0.29^{ns}	0.330
	Nephottetix nigropictus	0.5^{a}	0.25^{a}	0.5^{a}	0.29^{ns}	0.865
	Nephottetix cinticeps	0^{a}	0^{a}	0^{a}	0^{ns}	0
	Cofana spectra	2^{a}	3^{b}	3.25^{b}	0.36^{ns}	0.360
	Leptocorisa acuta	0^{a}	0^{a}	0^{a}	0^{ns}	0
	Nezara viridula	1^{a}	4^{a}	3^{a}	0.38^{ns}	0.624
	Scirpophaga incertulas	1^{a}	0.75^{a}	2.25^{b}	0.23^{*}	0.049
	Cnaphalocrosis medinalis	2.75^{a}	2.5^{a}	5.75^{b}	0.22^{**}	0.009
	Gryllotalpa gryllotalpa	0.5^{ab}	0.25^{a}	0.75^{b}	0.22^{ns}	0.422
	Tetrix subulata	0.5^{a}	0.25^{a}	0.75^{a}	0.34^{ns}	0.748
	Oxya chinensis	0.5^{a}	0.25^{a}	0.75^{a}	0.19^{ns}	0.422
	Acrida turita	0.5^{ab}	0.25^{a}	1^{b}	0.31^{ns}	0.445
54	*Nilaparvata lugens*	0^{a}	0.25^{a}	0^{a}	0.13^{ns}	0.422
	Recillia dorsalis	0^{a}	0^{a}	0.25^{a}	0.13^{ns}	0.422
	Sogatella furcifera	0^{a}	0^{a}	0^{a}	0^{ns}	0
	Nephottetix virescens	0.25^{a}	0.25^{a}	0.5^{a}	0.24^{ns}	0.770
	Nephottetix nigropictus	0.25^{a}	0.25^{a}	0.5^{a}	0.24^{ns}	0.770
	Nephottetix cinticeps	0^{a}	0^{a}	0^{a}	0^{ns}	0
	Cofana spectra	1.25^{a}	3^{b}	2.5^{b}	0.19^{*}	0.032
	Leptocorisa acuta	1.75^{a}	3^{b}	4^{c}	0.22^{*}	0.037
	Nezara viridula	0.25^{a}	0.75^{b}	1.5^{c}	0.19^{*}	0.034
	Scirpophaga incertulas	1.75^{a}	1.25^{a}	2.5^{b}	0.17^{ns}	0.065
	Cnaphalocrosis medinalis	0^{a}	0^{a}	0^{a}	0^{ns}	0
	Gryllotalpa gryllotalpa	0.25^{ab}	0^{a}	0.5^{b}	0.22^{ns}	0.422
	Tetrix subulata	0.5^{a}	0.25^{a}	0.5^{a}	0.24^{ns}	0.770
	Oxya chinensis	0.75^{ab}	0.25^{a}	1.25^{b}	0.36^{ns}	0.403
	Acrida turita	0.75^{a}	0.25^{a}	1.25^{b}	0.14^{*}	0.018
68	*Nilaparvata lugens*	0.25^{a}	0.25^{a}	0.5^{a}	0.24^{ns}	0.770
	Recillia dorsalis	0^{a}	0^{a}	0.5^{a}	0.22^{ns}	0.422
	Sogatella furcifera	0^{a}	0.25^{a}	0.25^{a}	0.19^{ns}	0.670
	Nephottetix virescens	0.25^{a}	0.25^{a}	0.5^{a}	0.26^{ns}	0.892
	Nephottetix nigropictus	0.25^{a}	0.5^{a}	0.5^{a}	0.24^{ns}	0.770
	Nephottetix cinticeps	0^{a}	0^{a}	0^{a}	0^{ns}	0
	Cofana spectra	2^{b}	3^{c}	1.25^{a}	0.21^{*}	0.050
	Leptocorisa acuta	2.75^{a}	3^{a}	4.5^{b}	0.2^{ns}	0.071
	Nezara viridula	0.75^{a}	1.25^{ab}	1.75^{b}	0.27^{ns}	0.227
	Scirpophaga incertulas	2^{b}	1.25^{a}	2.75^{c}	0.17^{*}	0.03724
	Cnaphalocrosis medinalis	0^{a}	0^{a}	0^{a}	0^{ns}	0
	Gryllotalpa gryllotalpa	0^{a}	0^{a}	0^{a}	0^{ns}	0
	Tetrix subulata	0.5^{ab}	0.25^{a}	0.75^{b}	0.22^{ns}	0.422
	Oxya chinensis	0.5^{ab}	0.25^{a}	1^{b}	0.31^{ns}	0.445
	Acrida turita	0.25^{a}	0^{a}	1^{b}	0.18^{*}	0.041

Information: ^{ns}: not significantly different in variance, *: significantly different in variance, the numbers followed by the same letter were not significantly different in the LSD 5% further test from the data that had been transformed by roots ($\sqrt{(y + 0.5)}$) for each treatment A: liquid bioinsecticide *M. anisopliae*, B: liquid bioinsecticide *B. thuringiensis* and C: control (without treatment)

Table 3. Pest population (tails per 120 double swings) in ratun rice aged 9-23 days after harvest (HSP)

Rice Aged (HSP)	Insect Spesies	nets			BNT 5%	*p-value*
		A	B	C		
	Nilaparvata lugens	0.375^{a}	0.375^{a}	0.5^{a}	0.12	0.948
	Recillia dorsalis	0.25^{a}	0.5^{b}	0.375^{ab}	0.1	0.731
	Sogatella furcifera	0.25^{a}	0.5^{ab}	0.5^{b}	0.11	0.645
	Nephotettix virescens	0.375^{a}	0.375^{a}	0.5^{a}	0.1	0.935
	Nephotettix nigropictus	0.25^{a}	0.375^{ab}	0.5^{b}	0.07	0.393
	Nephotettix cinticeps	0.25^{a}	0.25^{a}	0.375^{a}	0.07	0.742
	Cofana spectra	0.5^{a}	0.75^{b}	0.65^{ab}	0.1	0.687
9	*Leptocorisa acuta*	0.375^{a}	0.5^{a}	0.375^{a}	0.12	0.948
	Nezara viridula	0^{a}	0^{a}	0^{a}	0	0
	Scirpophaga incertulas	0.25^{a}	0.375^{a}	0.25^{a}	0.07	0.742
	Cnaphalocrosis medinalis	0.25^{a}	0.375^{a}	0.25^{a}	0.09	0.838
	Gryllotalpa gryllotalpa	0^{a}	0^{a}	0^{a}	0	0
	Tetrix subulata	0.375^{b}	0.125^{a}	0.25^{ab}	0.1	0.637
	Oxya chinensis	0.625^{b}	0.375^{a}	0.5^{ab}	0.14	0.773
	Acrida turita	0.75^{a}	0.875^{a}	0.625^{a}	0.14	0.799
	Nilaparvata lugens	0.5^{a}	0.5^{a}	0.5^{a}	0.13	0.991
	Recillia dorsalis	0.375^{a}	0.625^{b}	0.5^{ab}	0.1	0.731
	Sogatella furcifera	0.375^{a}	0.625^{ab}	0.75^{b}	0.14	0.585
	Nephotettix virescens	0.625^{a}	0.875^{b}	0.75^{ab}	0.1	0.729
	Nephotettix nigropictus	0.375^{a}	0.75^{b}	0.625^{b}	0.11	0.419
	Nephotettix cinticeps	0.375^{a}	0.625^{a}	0.5^{a}	0.13	0.872
	Cofana spectra	0.5^{a}	1.25^{b}	1.5^{b}	0.14	0.122
16	*Leptocorisa acuta*	0.25^{a}	0.375^{ab}	0.5^{b}	0.12	0.635
	Nezara viridula	0^{a}	0^{a}	0^{a}	0	0
	Scirpophaga incertulas	0.5^{a}	0.375^{a}	0.375^{a}	0.1	0.884
	Cnaphalocrosis medinalis	0.5^{b}	0.375^{ab}	0.25^{a}	0.1	0.637
	Gryllotalpa gryllotalpa	0^{a}	0^{a}	0^{a}	0	0
	Tetrix subulata	0.25^{a}	0.25^{a}	0.125^{a}	0.08	0.801
	Oxya chinensis	0.875^{b}	0.5^{a}	0.5^{a}	0.13	0.535
	Acrida turita	1.125^{b}	0.875^{ab}	0.75^{a}	0.13	0.592
	Nilaparvata lugens	0.75^{a}	1^{a}	0.875^{a}	0.14	0.842
	Recillia dorsalis	0.25^{a}	0.375^{a}	0.5^{a}	0.12	0.782
	Sogatella furcifera	0.25^{a}	0.5^{ab}	0.625^{b}	0.13	0.583
	Nephotettix virescens	0.125^{a}	0.5^{b}	0.625^{b}	0.08	0.126
	Nephotettix nigropictus	0.5^{a}	0.875^{b}	0.75^{b}	0.11	0.393
	Nephotettix cinticeps	0.25^{a}	0.5^{a}	0.5^{a}	0.12	0.754
	Cofana spectra	0.75^{a}	1.375^{b}	1.25^{b}	0.11	0.198
23	*Leptocorisa acuta*	0.5^{a}	0.75^{ab}	0.875^{b}	0.12	0.581
	Nezara viridula	0^{a}	0^{a}	0^{a}	0	0
	Scirpophaga incertulas	0.375^{b}	0.25^{ab}	0.125^{a}	0.09	0.579
	Cnaphalocrosis medinalis	0.5^{a}	0.25^{a}	0.25^{a}	0.11	0.688
	Gryllotalpa gryllotalpa	0^{a}	0^{a}	0^{a}	0	0
	Tetrix subulata	0.25^{a}	0.125^{a}	0.25^{a}	0.08	0.801
	Oxya chinensis	1.125^{b}	0.75^{a}	0.625^{a}	0.14	0.480
	Acrida turita	0.75^{b}	0.625^{a}	0.625^{a}	0.13	0.911

Note: ^{ns}: not significantly different in variance, *: significantly different in variance, numbers followed by the same letter were not significantly different in the LSD 5% further test from data that had been transformed by roots ($\sqrt{}$ (y + 0.5)) in each treatment A: liquid bioinsecticide *M. anisopliae*, B: liquid bioinsecticide *B. thuringiensis,* and C: market application of *B. thuringiensis*

Table 4. Pest population (tails per 120 double swings) in ratun rice aged 44-58 days after harvest (HSP)

Rice aged (hsp)	Insect Spesies	nets			BNT 5%	*p-value*
		A	B	C		
44	*Nilaparvata lugens*	0.125^{a}	0.375^{b}	0.375^{b}	0.09	0.541
	Recillia dorsalis	0.125^{a}	0.25^{ab}	0.375^{b}	0.1	0.718
	Sogatella furcifera	0.25^{a}	0.375^{a}	0.5^{a}	0.12	0.786
	Nephotettix virescens	0^{a}	0.25^{b}	0.5^{c}	0.08	0.136
	Nephotettix nigropictus	0.25^{a}	0.375^{a}	0.375^{a}	0.13	0.958
	Nephotettix cinticeps	0.125^{a}	0.25^{a}	0.25^{a}	0.09	0.867
	Cofana spectra	0.25^{a}	0.375^{a}	0.5^{a}	0.14	0.794
	Leptocorisa acuta	0.375^{a}	0.875^{b}	0.875^{b}	0.14	0.413
	Nezara viridula	0^{a}	0^{a}	0^{a}	0	0
	Scirpophaga incertulas	0.125^{a}	0.125^{a}	0^{a}	0.06	0.637
	Cnaphalocrosis medinalis	0.125^{a}	0.25^{a}	0.125^{a}	0.07	0.742
	Gryllotalpa gryllotalpa	0^{a}	0^{a}	0^{a}	0	0
	Tetrix subulata	0.125^{a}	0^{a}	0.125^{a}	0.06	0.637
	Oxya chinensis	0.375^{a}	0.375^{a}	0.25^{a}	0.08	0.801
	Acrida turita	0.25^{a}	0.25^{a}	0.375^{a}	0.08	0.801
	Nilaparvata lugens	0.25^{a}	0.375^{a}	0.25^{a}	0.07	0.742
	Recillia dorsalis	0.125^{a}	0.25^{ab}	0.375^{b}	0.1	0.637
	Sogatella furcifera	0.125^{a}	0.375^{b}	0.375^{b}	0.09	0.478
	Nephotettix virescens	0.125^{a}	0.375^{ab}	0.5^{b}	0.11	0.414
	Nephotettix nigropictus	0.125^{a}	0.375^{a}	0.25^{a}	0.11	0.754
	Nephotettix cinticeps	0^{a}	0.125^{a}	0.25^{a}	0.07	0.601
	Cofana spectra	0.125^{a}	0.5^{b}	0.375^{b}	0.1	0.355
51	*Leptocorisa acuta*	0.375^{a}	1.5^{b}	1.5^{b}	0.14	0.040
	Nezara viridula	0.125^{a}	0.375^{b}	0.25^{ab}	0.09	0.686
	Scirpophaga incertulas	0^{a}	0.125^{a}	0.125^{a}	0.06	0.637
	Cnaphalocrosis medinalis	0.125^{a}	0.125^{a}	0^{a}	0.06	0.637
	Gryllotalpa gryllotalpa	0^{a}	0^{a}	0^{a}	0	0
	Tetrix subulata	0^{a}	0^{a}	0^{a}	0	0
	Oxya chinensis	0.5^{b}	0.25^{a}	0.375^{ab}	0.12	0.702
	Acrida turita	0.375^{b}	0.25^{ab}	0.125^{a}	0.08	0.502
	Nilaparvata lugens	0.125^{a}	0.25^{a}	0.25^{a}	0.08	0.801
	Recillia dorsalis	0^{a}	0.125^{ab}	0.25^{b}	0.07	0.393
	Sogatella furcifera	0^{a}	0.375^{b}	$0.^{25b}$	0.1	0.393
	Nephotettix virescens	0^{a}	0.125^{a}	0.125^{a}	0.06	0.637
	Nephotettix nigropictus	0^{a}	0.375^{b}	0.25^{b}	0.09	0.319
	Nephotettix cinticeps	0^{a}	0.25^{b}	0.375^{b}	0.1	0.393
	Cofana spectra	0^{a}	0.375^{b}	0.375^{b}	0.09	0.541
58	*Leptocorisa acuta*	1^{a}	1.75^{b}	1.625^{b}	0.13	0.029
	Nezara viridula	0^{a}	0.25^{b}	0.25^{b}	0.09	0.519
	Scirpophaga incertulas	0^{a}	0^{a}	0^{a}	0	0
	Cnaphalocrosis medinalis	0.125^{b}	0^{a}	0^{a}	0.04	0.393
	Gryllotalpa gryllotalpa	0^{a}	0^{a}	0^{a}	0	0
	Tetrix subulata	0^{a}	0^{a}	0^{a}	0	0
	Oxya chinensis	0.375^{a}	0.25^{a}	0.25^{a}	0.07	0.742
	Acrida turita	0.125^{a}	0.125^{a}	0^{a}	0.06	0.637

Note: ^{ns}: not significantly different in variance, *: significantly different in variance, numbers followed by the same letter were not significantly different in the LSD 5% further test from data that had been transformed by roots (√ (y + 0.5)) in each treatment A: liquid bioinsecticide *M. anisopliae*, B: liquid bioinsecticide *B. thuringiensis*, and C: market application of *B. thuringiensis*

DISCUSSION

The population of leafhoppers such as *N. lugens, R. dorsalis, S. furcifera, N. virescens, N. nigropictus* and *C. spectra* in the land where the liquid bioinsecticide of *M. anisopliae* is applied is lower than the land with *B. thuringiensis* liquid bioinsecticide and control land. This shows that the *M. anisopliae* fungus is effective in controlling leafhoppers. Herlinda et al. (2008) stated that the *M. anisopliae* fungus which is formulated in liquid form is effective in controlling the brown leafhoppers nymph pest population. The population of C. spectra pets is more common in the field compared to other types of leafhoppers since the rice plants are aged 12-68 days after planting (Table 1). At the age of 40 days after planting, the population of leafhoppers is significantly different on the land that applied with liquid bioinsecticide of *M. anisopliae* with the liquid bioinsecticide field for B. thuringiensis and control land without synthetic insecticide application with an average population of 2 individuals in the bioinsecticide *M. anisopliae* land, 3 leafhoppers on the bioinsecticide field. *B. thuringiensis* and 3.25 leafhoppers in the control land without synthetic insecticide application. This suggests that the *M. anisopliae* fungus takes time to infect its host. Jiang et al. (2020) stated that *M. anisopliae* infection starts from contacting the propagule *M. anisopliae* then the propagules germinate on the insect integument and penetration occurs using the germination tube mechanically and chemically, namely by producing enzymes and toxins for insects then this fungus develops into hemolymph and will form hyphae in the insect's body which causes the insect to die. Bioinsecticide application does not kill predatory spiders (Herlinda et al., 2014).

The results of the analysis of variance shows that the population of S. incertulas at the age of 68 days after transplanting in the land that is applied with liquid bioinsecticide of B. thuringiensis is significantly different from the liquid bioinsecticide field of *M. anisopliae* and control. Bioinsecticide *B. thuringiensis* is a bioinsecticide that is toxic to the stomach. So that this bioinsecticide is effective for killing pests with mandibular mouth type. The results of the analysis shows that the population of C. medinalis is significantly different from the treated land in the control area, but in each treatment area M. anisopliae and B. thuringiensis are not significantly different. Pujiastuti et al. (2013) and Pujiastuti (2004) also stated that *B. thuringiensis* is effective in killing *Erionata trax* larvae from the Lepidotera order. Arsi et al. (2019) also stated that *B. thuringiensis* is effective in controlling *Spodoptera litura* larvae.

The leafhoppers pests that are caught in ratooned rice fields are also small because the population of leafhoppers pest is low either. The leafhoppers pests that are caught in the net on the land applied with liquid bioinsecticide of *M. anisopliae* are lower than the population of leafhoppers pets in the market liquid bioinsecticide land of *B. thuringiensis* and Bt. This shows that the application of liquid bioinsecticide of *B. thuringiensis* and Bt on the market is not effective in controlling the leafhopper pest population in ratooned rice in the field. The populations of white leafhopper *C. spectra* and green leafhoppers *N. nigropictus* are significantly different in the treatment of *M. anisopliae* with other treatments at the age of 9-58 days after harvesting of rice plants. The results of the analysis shows that the leafhoppers pest population in the land that applied with liquid bioinsecticide of *M. anisopliae* is lower than the population of leafhoppers pests in the field of liquid bioinsecticide treated with *B. thuringiensis* and Bt on the market.

The rice stink bug population is still low when the ratooned rice plants are 9-23 days after harvesting. This pest population increases when the rice plants are aged 44-58 days after harvesting. This is happened because the rice plant has produced flowers and panicles so it become a suitable place as a niche for rice stink bugs. The rice stink bug is a potential pest because its population is abundant in ratooned rice compared to other pests. The population of rice stink bugs is low in the land that is applied with liquid bioinsecticide of *M. anisopliae* compared to other treatments. The highest rice stink bug population is when the ratooned rice plant is aged 58 days after harvesting. The rice stink bug population in *M. anisopliae* land is significantly different from other treatments, while the land applied with *B. thuringiensis* and Bt on the market is not significantly different, namely 1 rice stink bug in *M. anisopliae* land, 1.75 rice stink bugs in *B. thuringiensis* land and 1.625 rice stink bugs in market applied Bt.

CONCLUSION

To sum up, the population of pests is higher in land without bioinsecticide application compared to land that applied with bioinsecticide. In ratooned rice, the pest population between the land applied bioinsecticide *M. anisopliae* and *B. thuringiensis* is not significantly different from the land that applied with *B. thuringiensis* which is sold in the market. The application of bioinsecticides is able to reduce the pest population in main rice and ratooned rice.

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