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Management of Rice Bug, *Leptocorisa oratorius* (F.) (Hemiptera: Alydidae) Using White Muscardine Fungus *Beauveria bassiana* (Bals.) Vuill. In Upland Rice + Legume Cropping Systems

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Abstract

Field experiment was conducted to evaluate the development and infection of *B. bassiana* on *L. oratorius* in rice + legume intercropping system. Field population of *L. oratorius* was significantly affected by *B. bassiana* application. Highest population at 7 DAS was recorded in the control treatment with 2.73 bugs per linear meter followed in the decreasing order of population number by 1 (1.0 x 10^{12} conidia/ha), dose 2 (1.0 x 10^{13} conidia/ha) and chemical insecticide (malathion, recommended rate) with 2.26; 1.39 and 1.15 bugs per linear meter. No significant differences were observed in field bug population as influenced by *B. bassiana*, 15 DAS. Population of *L. oratorius* as influenced by *B. bassiana* application at different rice-based cropping systems was not significant 7 DAS but significant at 15 DAS. Bug population was highest in untreated (control) monoculture rice with 3.48 bugs per linear meter. Lowest population of bugs in the field was observed in R+Bb and R+Pn+Mal treatment.

Application of *B. bassiana* as myco-insecticide at the rate of 1.0 x 10^{13} conidia/ha regulated the population of *L. oratorius* in rice and did not influence the extent of damage caused by *L. oratorius* on rice grains. Intercropping system had less influence on the development and infection of *B. bassiana* against *L. oratorius* but enhanced the management of insect pests affecting upland rice including *L. oratorius.* Likewise, the influence of *B. bassiana* and that of *B. bassiana* x cropping systems interaction on the damage on grains caused by the bug were not significant. The results revealed that the use of *B. bassiana* as microbial insecticide against *L. oratorius* under upland rice environment did not give a significant protection against *L. oratorius*: instead intercropping rice with legumes lessened may have bug damage on rice grains.

Key Words: *B. bassiana*, *L. oratorius, cropping systems*, conidia, *substrate*, *myco- insecticide*

INTRODUCTION

The *Leptocorisa spp*. (Hemiptera: Alydidae), commonly known as rice bugs, cause extensive loss in rainfed lowland or upland rice. Several species of rice bugs occur in the Philippines, but *L. oratorius* is the most prevalent (Reissig et al., 1986; Litsinger et al., 1987). Nymphs and adults feed on developing grains resulting in partially or entirely empty grains and account for a yield reduction ranging from 10% (Pathak, 1968) to total crop failure depending on the degree of infestation.

Control strategies in current use against the pest are largely based on chemical insecticides which are prohibitively expensive for most rice farmers. In addition, intensive use of insecticides creates an ecological imbalance through destruction of non-target beneficial insects, and accumulation of toxic residues in the environment. There is, therefore, a need to develop a safer and integrated approach to pest management to promote a more sustainable and ecologically sound pest management strategy.

Attempts to find resistant rice varieties and the use of natural enemies like predators and parasites in the management of rice bug population have not been promising (Litsinger et al., 1987). However, nymphs and adults of *Leptocorisa spp* are host to insect pathogenic fungus like *Beauveria bassiana*. The fungus was frequently collected in the population of *Leptocorisa spp* and was also reported to infect the pest in the laboratory (Rombach, 1986).

In contrast to other natural enemies, *B. bassisna* can be mass produced relatively easily on cheap media without danger to humans. Hitherto attempt, however, was made to evaluate the infectiveness of this fungus against *L. oratorius* in the field particularly under rainfed or upland conditions through rice + legume cropping systems. This strategy, besides increasing farm productivity and farmers income, also favors the development and multiplication of some predators and parasites in addition to entomogenous fungi that may further enhance the control of pests (Midega, et al., 2010; Lai, et al., 2011; Tang, et al., 2013; Zhou, et al., 2013). Maniania (1990), cited that the problem associated with unfavorable agroecosystems for development and infection of fungal insect pathogen can be alleviated through modification of cultural practices such as intercropping. Despite the general acceptance of intercropping in increasing farm productivity and control of pests, its usefulness in microbial control has not been explored to full advantage. This study was conducted in the University of Eastern Philippines, Catarman, Northern Samar, Philippines to evaluate the development and infection *of B. bassiana* on *L. oratorius* in an intercropping system.

MATERIALS AND METHODS

Experimental Design

A 4 x 4 factorial experiment in a randomized complete block design (RCBD) with three replications was used. Four rice + legume intercropping systems were used including control to wit: Rice (monoculture), (R): Rice + Mungbean, (R+Mg); Rice + Peanut, (R+Pn); and Rice + Soybean, (R+Sb) and four dosages (1×10^{12} conidia/ha), (D1); (1.0×10^{13} conidia/ha), (D2) including chemical insecticide (malathion, recommended rate) and control (water only) were evaluated. . The treatments were designated as follows:

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T1	=	Rice monoculture, control
T2	=	Rice monoculture, (*B. bassiana* 1 x 10^{12} conidia/ha)
T3	=	Rice monoculture, (*B. bassiana* 1 x 10^{13} conidia/ha)
T4	=	Rice monoculture, (Insecticide, malathion)
T5	=	Rice + Mungbean, control
T6	=	Rice + Mungbean, (*B. bassiana* 1 x 10^{12} conidia/ha)
T7	=	Rice + Mungbean, (*B. bassiana* 1 x 10^{13} conidia/ha)
T8	=	Rice + Mungbean, (Insecticide, malathion
T9	=	Rice + Peanut, control
T10	=	Rice + Peanut, (*B. bassiana* 1 x 10^{12} conidia/ha)
T11	=	Rice + Peanut, (*B. bassiana* 1 x 10^{13} conidia/ha)
T12	=	Rice + Peanut, (Insecticide, malathion)
T13	=	Rice + Soybean, control
T14	=	Rice + Soybean, (*B. bassiana* 1 x 10^{12} conidia/ha)
T15	=	Rice + Soybean, (*B. bassiana* 1 x 10^{13} conidia/ha)
T16	=	Rice + Soybean, (Insecticide, malathion)

Land Preparation and Planting

Prior to land preparation, soil samples were taken randomly from the experimental field for chemical and mechanical analysis (Table 1). The field was prepared thoroughly by alternate plowing and harrowing. Double plowing and harrowing was done to make the soil a little finer to achieve a high degree of seed emergence.

Table 1. Chemical and physical properties of the soil at the experimental site, UEP, Catarman,. Northern Samar, Philippines.

SOIL CHARACTER	ANALYSIS
pH	4.4
Organic matter	2.57%
Extractable phosphorus	5.27 ppm
Extractable potaqssium	0.34 meg/100 g soil

Furrows were prepared at a desired spacing for both rice and legume intercrops in monoculture and intercropping treatments. All crops (rice and legumes) were planted simultaneously in each unit plot measuring 5.4 m x 8.0 m and spaced at 50 cm between plots and 1,0 m between blocks, respectively. Rice furrows in monoculture and intercropping treatments were spaced at 30 cm. Pre-germinated rice seeds were drilled uniformly over the furrowed surface at 100 kg seeding rate per hectare. The seeds were covered with thin layer of soil using a rake.

Legume seeds were interplanted between rice rows at a distance of 40 cm between rice and legumes and 50 cm legume rows. Mungbean and soybean seeds were drilled uniformly in a furrow and seedlings were thinned to 20 plants per linear meter 14 days after emergence (DAE). For peanut, 3 to 4 seeds were interplanted at a distance of 25 cm between hills and seedlings were thinned to 2 plants per hill at 14 DAE.

The crops were maintained following the recommended cultural management practices for upland rice and upland rice-based cropping systems. Weather data (Figures 2 and 3) were taken throughout the duration of the study.

Application of *B. bassiana* as Myco-insecticide

Two-week-old culture of *B. bassiana* (GLH isolate) was used as myco-insecticie against *L. oratorius*. Application of fungal suspension was done by spraying the plants late in the afternoon 1 week before heading using a 16-liter capacity knapsack sprayer.

Population count of *L. oratorius* per linear meter was done visually, 7 and 15 days after spraying (DAS). Acid fuchsin test was carried out on 10 randomly selected panicles per plot to determine the efficacy of the treatment. Data were taken at harvest and analyzed statistically using analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Effects of *B. bassiana* on Field Population of *L. oratorius*

Field population of *L. oratorius* was significantly affected by *B. bassiana* application at 7 DAS. Highest population was recorded in the control treatment with 2.73 bugs per linear meter followed in the decreasing order of population number by 1 (1.0 x 10^{12} conidia/ha), dose 2 (1.0 x 10^{13} conidia/ha) and chemical insecticide (malathion, recommended rate) with 2.26; 1.39 and 1.15 bugs per linear meter, respectively (Table 2). However, there were no significant differences observed in field bug population 15 days with B. bassiana.

Table 2. Field population of *L. oratorius* as influenced by *B. bassiana*, 7 and 15 days-after spraying (DAS)

DOSE (conidia/ha)	POPULATION* (NO./LINEAR METER) 7 DAS	15 DAS
Control	2.73^{a}	1.48
B. bassiana (1.0 x 10^{12})	2.26^{ab}	0.93
B. bassiana (1.0 x 10^{13})	1.39^{bc}	1.26
Malathion (recommended rate)	1.15^{c}	0.60

**Means with the same letter are not significant at 5% level, DMRT.*

Population of *L. oratorius* as influenced by *B. bassiana* application at different rice-based cropping systems was not significant 7 DAS but significant 15 DAS. Reduction in bug population in most treatments sprayed with *B. bassiana* suspension both in monoculture and intercropping treatments was observed. Bug population was highest in untreated (control) monoculture rice with 3.48 bugs per linear meter. This was followed by R+Sb+Bb2; R+Pn+Bb and R+Mb+Bb2 cropping systems with 2.17, 1.76 and 1.34 bugs per linear meter, respectively. No significant differences in bug population, however, were observed between R+Sb+Bb2 and R+Pn+Bb treatment. Lowest population of bugs in the field was observed in R+Bb and R+Pn+Mal treatment. Cropping systems and *B. bassiana* failed to induce any significant difference on field population of *L. oratorius* on the following treatments: R+Mal; R+Mb+Bb1; R+Sb+Bb1; R+Sb control; R+Mb+Mal; R+Pn+Bb2; R+Bb2; R+Mb control and R+Sb Mal (Table 3).

These results agree with previous observations about the regulatory effect of microbial insecticides in the field population of some insect pests (Aguda et al., 1987; Rombach et al., 1986; 1987; Krueger et al., 1991) including *L. oratorius* (Burdeos, 1994). Although in this present study the number of *L. oratorius* was significantly suppressed, the same failed to regulate the population below economic threshold levels. This would mean the bugs could still inflict a considerable or substantial damage on the crop. A drastic reduction in field population of bugs was noted at 15 DAS. The decline in bug population in the control plants might give an impression that factors other than fungal application were operational and contributed to this reduction.

In an agro-ecosystem, a disease phenomenon was influenced by three-way interaction that included the susceptible host, virulent pathogens and favorable environment (Carruthers and Soper, 1987). Under such circumstances, unfavorable environment appeared to influence the erratic population density of bugs as affected by the treatment. Suitable insect host plants and movement of insect in and out of an area were also considered as additional factors that influenced population of insect in the field. Morill et al., (1990) observed that although weeds and ratoon rice in fields and bunds provide potential habitats for nymphs after rice is harvested, adults abandoned mature rice plants. This would indicate that insect movement in the field is inevitable which, in turn, would result in increase or decrease in the population. It is worth mentioning that when this field trial was conducted adjoining fields were also planted to rice allowing bugs to migrate to adjacent plants. Burdeos (1994) also mentioned about the decline of insect population as a result of emigration.

Table 3. Population of *L. oratorius* as influenced by *B. bassiana* at different rice + legume cropping systems, 7 and 15 days-after-spraying (DAS).

TREATMENT	POPULATION (NO,/LINEAR METER)	
	7 DAS	15 DAS
Rice monoculture (control)	4.17	3.48[a]
Rice monoculture (*B. bassiana*, 1x10^{12} conidia/ha)	2.08	0.00[c]
Rice monoculture (*B. bassiana*, 1x10^{13} conidia/ha)	1.42	1.14[bc]
Rice (Malathion, recommended rate)	0.86	0.86[bc]
Rice + Mungbean (control)	2.60	1.00[bc]
Rice + Mungbean (*B. bassiana*, 1x10^{12} conidia/ha)	1.89	0.79[bc]
Rice + Mungbean (*B. bassiana*, 1x10^{13} conidia/ha)	1.09	1.34[ac]
Rice + Mungbean (Malathion, recommended rate)	1.71	0.68[bc]
Rice + Peanut (control)	1.82	0.70[bc]
Rice + Peanut (*B. bassiana*, 1x10^{12} conidia/ha)	3.23	1.76[ab]
Rice + Peanut (*B. bassiana*, 1x10^{13} conidia/ha)	1.22	0.40[bc]
Rice + Peanut (Malathion, recommended rate)	0.79	0.00[c]
Rice + Soybean (control)	2.32	0.75[bc]
Rice + Soybean (*B. bassiana*, 1x10^{12} conidia/ha)	1.73	1.17[bc]
Rice + Soybean (*B. bassiana*, 1x10^{13} conidia/ha)	1.84	2.17[ab]
Rice + Soybean (Malathion, recommended rate)	1.23	0.87[bc]

**Means with the same letters are not significant at 5% level, DMRT.*

Damage caused by *L. oratorius* on Rice Grains

Acid fuchsin test was conducted to determine the damage caused by *L. oratorius* to rice grains. Results of the test are shown in Table 4. The different rice-based cropping systems significantly influenced the damage grains caused by *L. oratorius*. Highest percentage of damaged grains was recorded on rice-monoculture with 53.53%, followed by the intercropping treatments: Rice + Mungbean (35.74%); Rice + Peanut (34.93%) and Rice + Soybean (34.55%). No significant differences exist, however, on damage to grains caused by *L. oratorius* among the intercropping treatments. Likewise, the influence of *B. bassiana* and that of *B. bassiana* x cropping systems interaction on the damage on grains caused by the bug were not significant. The results suggest that the use of *B. bassiana* as microbial insecticide against *L. oratorius* under upland rice environment could not give a significant protection against *L. oratorius*: instead intercropping rice with legumes may have lessened bug damage on rice grains.

Table 4. Damaged grains caused by *L. oratorius* as influenced by different rice-based cropping systems.

DOSE (conidia/ha)	DAMAGED GRAINS (%)
Rice (Monoculture)	53.53[a]
Rice + Mungbean	35.74[b]
Rice + Peanut	34.93[b]
Rice + Soybean	34.58[b]

***Means with the same letters are not significant at 5% level, DMRT.**

CONCLUSION AND RECOMMENDATIONS

The use *of B. bassiana* suspension as myco-insecticide caused a substantial reduction in *L. oratorius* population one and two weeks after spraying in comparison with the control. In general, *B. bassiana* as myco-insecticide has a great potential in the management of *L. oratorius.* However, its efficiency under field conditions particularly under upland agro-ecosystems appeared to have been inhibited by unfavorable environmental conditions such as low relative humidity and inactivation of conidia caused by exposure to sunlight.

More detailed experimentation is necessary to elucidate the influence of the important experimental factors under rice-based cropping systems. A similar study against *L. oratorius* using *B. bassiana* under lowland conditions is necessary to substantiate the effect of various environmental conditions.

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