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Toxicity and Persistence of Insecticides to Rove Beetle *Paederus fuscipes* and Wolf Spider *Lycosa pseudoannulata* Using Semi Field Method

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Abstract: Studies on the safety of selected insecticides to common predators of rice pests brown planthopper to prove of negative effects issues of insecticides on natural enemies. Various methods have been used to measure the effect of insecticides on natural enemies, one of them semi-field studies. The research was carried out in the wet season of 2014 at Subang district of West Java; Indonesia used randomized block design with 10 insecticides treatment (9 insecticides and 1 control) with 3 replications. The results showed that insecticides toxicity of chlorantranilprole + thiamethoxam SC 300, chlorantraniliprole+ abamectin 063SC, pymetrozine, cyantraniliprole + pymetrozine 60WG, lufenuron, abamectin, emamectin benzoate, deltamethrin, and profenofos to *Paederus fuscipes* and *Lycosa pseudoannulata* that belong to category 1 were harmless with mortality rate less than 25%. In the persistence test, all insecticides belong to category 1 are short-lived persistence less than 5 days with mortality rate of *P. fuscipes* and *L. pseudoannulata* less than 25%. Base on insecticides toxicity and persistence tests showed that all insecticides treatment are safe to *P. fuscipes* and *L. pseudoannulata*.
Keywords: Toxicity, insecticides, predators, brown planthopper, rice

INTRODUCTION

The richness of natural enemies is very adequate to control pests in rice crops, but the biological balance of pest-natural enemies are very rarely towards near under the economic threshold. Failure natural enemies pressed to rice pests within reasonable limits, actually do not automatically have to be controlled using insecticides, but people do not want the slightest yield losses caused too many necessities of life. Therefore control to the rice brown planthopper (BPH), *Nilaparvata lugens* Stal. (Hemiptera: Delphacidae) is still base on to insecticides, since they rapidly reduce pest populations to below the economic threshold. In the other hand that chemical applications have negative impacts on the populations of natural enemies are needed some restrictions both in application and type of insecticides. The two natural enemies Spider *Lycosa pseudoannulata* and Staphylinid *Paederus fuscipes* are the important predators for all kinds of agricultural pests in the rice fields.

In rice ecosystem are found three guilds of spiders of orb-weaving spiders, hunting spiders and space-web spiders. Orb-weavers cover the families Araneidae, Tetragnathidae and Theridosomatidae. The most common orb-weaver genera are *Tetragnatha*, *Araneus* and *Argiope*. Lycosids dominate the guild of hunters, while the guild of space-web spiders contains three families Theridiidae, Linyphiidae and Agelenidae [1]. The dominant predator *L. pseudoannulata* is found to be the important predator against BPH and can also suppresses effectively the pest population of leafhoppers, plant hoppers, leaf folders, case worms and stem borers.

L. pseudoannulata was an efficient predator followed by *T. javana* and *O. javanus.* Between sexes of spiders, female was found to be more efficient than male [2]. The most abundant natural enemies found in Cambodian rice field are spiders, mostly *Araneus inustus* and *Pardosa pseudoannulata.* These two hunting and wolf spider, respectively, are believed to actively contribute to brown planthopper (BPH) population control [3]. *Lycosa pseudoannulata* and *Callitrichia formosana* were the maximum during 42 DAT to 53 DAT, while *Argiope catenulata* was predominant from 88 DAT to 113 DAT [4].

Natural enemy from group Staphylinid is *P. fuscipes* observed large number of rove beetles in the rice ecosystem in Kerala [5]. In both *kharif* and *rabi* seasons, four predatory beetles of lady bird beetle *Micraspis discolor* (Fb.) and *Harmonia octomaculata* (Fb.), ground beetle, *Ophionea indica* (Thum.) and rove beetle, *Paederus fuscipes* (Curtis) were prominently recorded in the field predating on various stages of insect pests [6]. From four species of predatory beetles, *P. fuscipes* was found to be the most dominant predator during present investigation. Staphylinid, *P. fuscipes* is polyphage predator attacking newly hatched stem borer larva in the field [7] and also attaking nymph and adults planthoppers.

Baehaki *et al*. [8] reported that the use of insecticides to control pests can give side effects to reduce the population of natural enemies or neutral insects. Therefore, the impact of control practices on natural enemies must be minimized by seeking traits that relate to selectivity, thus, the strengths or weaknesses of a specific pesticide input must be identified before use [9].

The main problem of insecticides used to control on rice pests also will kill many natural enemies and many times the use of insecticides was blamed for the explosion of the BPH populations. Therefore is needed to evaluate the use of insecticide, whether it is safe to natural enemies, but can still effectively control planthoppers. The Objective of this study to evaluate the insecticides safety, based on toxicity and persistence of diamides (chlorantraniliprole and Cyantraniliprole) and avermectins (abamectin and Emamectin benzoate) insecticides to insect predators *P. fuscipes* and *L. pseudoannulata* under semi-field conditions.

MATERIALS AND METHODS

Mass rearing *Paederus fuscipes* predators of brown planthopoer

P. fuscipes was reared in the laboratory in cylindrical plastic rearing unit with 20 cm in diameter and 80 cm in height. The bottom part was left open while the upper part is covered by gauze of fine mesh so that the parents and offspring could not escape. Each unit has 2 windows opposite to each other; each is close to the bottom and upper part. The windows are also covered by gauze of fine mesh.

Rice plants in a plastic pot were placed on each rearing unit. Through the window, 10 pairs of *P. fuscipes* and brown plant-hoppers were added. BPH served as *P. fuscipes* food and must be checked constantly, to limit the possibility of *P. fuscipes* die of starvation. Each 10 pairs produced about 150-200 *P. fuscipes* off spring in more than one month.

Mass rearing *Lycosa pseudoannulata* predators of brown planthopoer

Females of *L. pseudoannulata* spider with egg sac were collected from field using sweeping net for mass culturing in the laboratory. Every five of them were kept in rearing unit along with BPH as food source. By using this method, each rearing unit was able to produce about 80-120 offspring of *L. pseudoannulata* in more than one month.

Toxicity tests of insecticides against *P. fuscipes* and L. *pseudoannulata* in semi-field

The research was carried out in the wet season of 2014 at Subang district of West Java using randomized block design with 10 treatments of insecticides (9 insecticides and 1 control) with 3 replications. The research contains to series, first for *P. fuscipes* and second for *Lycosa pseudoannulata*. Insecticides treatment were chlorantranilprole + thiamethoxam 300SC (200&100g/l), chlorantraniliprole+ abamectin 063SC (45/18g/l), pymetrozine 50WG (500 g/kg), cyantraniliprole + pymetrozine 60WG (500&100g/kg), lufenuron 050SC (50g/l), abamectin 018EC (18g/l), emamectin benzoate05WG (50g/kg), deltamethrin 25EC (25 g/l), profenofos 500EC, and control without insecticide, with amount insecticides concentration of formulation were 750, 3750, 1500, 1500, 1000, 8333, 1000, 1500, 2500and 0ppm respectively.

Ciherang rice variety seedlings of 21 days old were planted 2 tillers per hole at a spacing of 25 cm x 25 cm on 5 m x 8 m (= 40 m2) plot size. The recommended dose as basal fertilizer of 40 kg N/ha (from urea) and 40kg P2O5 (from TSP) was given at 10 days after transplanted and then 80 kg N/ha (from urea) were applied in two equal split doses at 25 and 50 days after transplanting.

The each liquid of insecticides application was 200 l/ha or 0.8 l liquid/40m^2 were sprayed on rice plots at 35 days after transplanting. After the insecticide had dried out, one hill rice plants were covered by cage nylon trial unit (Figure 1). Twenty *P. fuscipes or L. pseudoannulata* adults and its food source (BPH nymphs, 1:3 ratio) were placed inside cage nylon trial unit. Observations on predator's mortality were assessed after 24, 48 and 72 hours of exposure. Mortality rate converted to percentages and All data were analyzed by analysis of variance (ANOVA) and differences in the value being tested by Duncan's Multiple Range Test = DMRT) in 5% least significance different (LSD) level. Predator mortality caused by insecticide is divided into four categories: 1 = harmless (< 25%), 2 = slightly harmful (25-50%), 3 = moderately harmful (51-75%), 4 = harmful (> 75%).

Fig-1: Door with zipper models for in /out of natural enemies and observations

Fig-2: Innoculation of natural enemies and BPH as food source

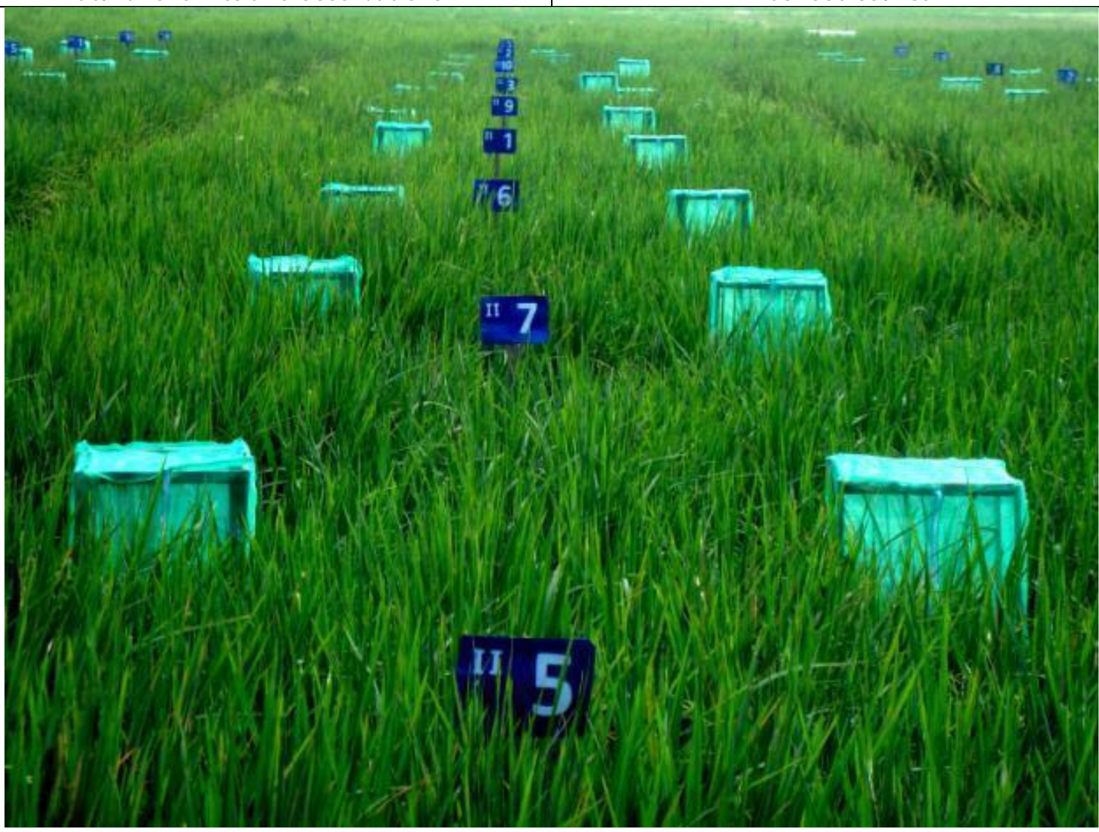

Fig-3: Lay out of toxicity/persistence tests of insecticides to natural enemies in semi-field

Persistence tests of insecticides against *P. fuscipes* and *L. pseudoannulata* in semi-field

The research contains to series, first for *P. fuscipes* and second for *L. pseudoannulata*. The research were conducted using randomized block design with 10 treatments of insecticides (9 insecticides and 1 control) with 3 replications. Insecticides treatment were chlorantranilprole + thiamethoxam 300SC (200&100g/l), pymetrozine 50WG (500 g/kg), chlorantraniliprole+ abamectin 063SC (45/18g/l), cyantraniliprole + pymetrozine 60WG (500&100g/kg), lufenuron 050SC (50g/l), abamectin 018EC (18g/l), emamectin benzoate 05WG (50g/kg), deltamethrin 25EC (25 g/l), profenofos 500EC, and control without insecticide, with amount insecticides concentrate of formulation were 750, 3750, 1500, 1500, 1000, 8333, 1000, 1500, 2500and 0ppm respectively.

Ciherang rice variety seedlings of 21 days old were planted 2 tillers per hole at a spacing of 25 cm x 25 cm on 5 m x 8 m (= 40 m2) plot size. The recommended dose as basal fertilizer of 40 kg N/ha (from urea) and 40kg P_2O_5 (from TSP) was given at 10 days after transplanted and then 80 kg N/ha (from urea) were applied in two equal split doses at 25 and 50 days after transplanting.

The each liquid insecticides application was 200 l/ha or 0.8 l liquid/40m^2 were sprayed on rice plots at 35 days after transplanting. After the insecticide has dried out, one hill rice plants were covered by cage nylon trial unit (Fig.1) and sequence treatments as follows:

- On 2 days after spray, releasing 20 adult *P. fuscipes* or *L. pseudoannulata* adults and its food source BPH nymphs (1:3 ratio). Observations on predator mortality were assessed after 1 day of exposure. After observation all BPH and *P. fuscipes* or *L. pseudoannulata* that still alive and died to removed.
- On 9 days after spray, releasing new 20 adult *P. fuscipes* or *L. pseudoannulata* adults and its food source BPH nymphs (1:3 ratio). Observations on predator mortality were assessed after 1 day of exposure. After observation all BPH and *P. fuscipes* or *L. pseudoannulata* that still alive and died to removed.
- On 14 days after spray, releasing new 20 adult *P. fuscipes* or *L. pseudoannulata* adults and its food source BPH nymphs (1:3 ratio). Observations on predator mortality were assessed after 1 day of exposure. After observation all BPH and *P. fuscipes* or *L. pseudoannulata* that still alive and died to removed.
- On 34 days after spray, releasing new 20 adult *P. fuscipes* or *L. pseudoannulata* adults and its food source BPH nymphs (1:3 ratio). Observations on predator mortality were assessed after 1 day of exposure.

Mortality rate converted to percentages and All data were analyzed by analysis of variance (ANOVA) and differences in the value being tested by Duncan's Multiple Range Test = DMRT) in 5% least significance different (LSD) level. Predator mortality caused by insecticide is divided into four categories: 1 = short-lived (< 5 days), 2 = slightly persistent (5-15 days), 3 = moderately persistent (16-30 days), 4 = persistent (> 30 days) [10].

RESULTS AND DISCUSSIONS

Toxicity of insecticides against *P. fuscipes* in semi-field

Mortality of *P. fuscipes on* toxicity test was very low and only occurs due to treatment with chlorantranilprole + thiamethoxam SC 300 by dose of 750ppm. The cumulative mortality of *P. fuscipes* by chlorantranilprole + thiamethoxam SC 300 insecticide in 24 hours of exposure was 6.7%, in 48 hours of exposure was 8.3% and in 72 hours of exposure still steady on 8.3% (Table 1). This is because after 72 hours of exposure there was not added death recorded.

In the other hand the insecticides of chlorantraniliprole+ abamectin 063SC (45/18g/l), pymetrozine 50WG (500 g/kg), cyantraniliprole + pymetrozine 60WG (500&100g/kg), lufenuron, abamectin, emamectin benzoate, deltamethrin, and profenofos did not caused death, as well in control treatment.

Table-1: Mortality of *P. fuscipes* in toxicity tests in Semi-field

Treatments	Dose rate in ppm of formulated product	Cumulative predator mortality in hours (%)*		
		24h	48h	72h
Chlorantranilprole + Thiamethoxam 300 SC	750	6.7a	8.3a	8.3a
Chlorantraniliprole+ abamectin 063SC	3750	0b	0b	0b
Pymetrozine 50WG	1500	0b	0b	0b
Cyantraniliprole + Pymetrozine 60WG	1500	0b	0b	0b
Lufenuron 050SC	1000	0b	0b	0b
Abamectin 018EC	8333	0b	0b	0b
Emamectin benzoate 05WG	1000	0b	0b	0b
Deltamethrin 25EC	1500	0b	0b	0b
Profenofos 500EC	2500	0b	0b	0b
Untreated	-	0b	0b	0b

Mean values in each column followed by the same letter are not significantly different at 5% level base on Duncan's Multiple Range Test (DMRT).

Based on Hassan [10] catogeries, chlorantranilprole + thiamethoxam SC 300 insecticide belong to the category 1, as well as other insecticides chlorantraniliprole+ abamectin 063SC (45/18g/l), pymetrozine 50WG, cyantraniliprole + pymetrozine 60WG (500&100g/kg), lufenuron, abamectin, emamectin benzoate, deltamethrin, and profenofos) with mortality of *P. fuscipes* less than 25%. It shows that the insecticides are safe to be used when natural enemy *P. fuscipes* present.

Toxicity of insecticides against L. *pseudoannulata* in semi-field

Chlorantranilprole + thiamethoxam 300 SC, chlorantraniliprole+ abamectin 063SC, cyantraniliprole + pymetrozine 60WG, and lufenuron 050SC did not caused death to *L. pseudoannulata* since 24hours after exposure, as well in control treatment. The cumulative mortality of *L. pseudoannulata caused* by pymetrozine dose of 1500 ppm and deltamethrin treatment dose of 1500 ppm in the 24, 48, and 72 hours exposure was 3.3% for all observation (Table 2). This is because after 48 and 72 hours of exposure there was not added death of *L. pseudoannulata* recorded.

The cumulative mortality of L. *pseudoannulata* caused by abamectin of 8333 ppm in 24 and 48 hours of exposure was 3.3% and 6.7%, but in 72 hours of exposure was sill steady on 6.7%. This is because in 72 hours exposure there was not added death of L. *pseudoannulata*. The cumulative mortality of *L. pseudoannulata* by emamectin benzoate dose of 1000 ppm in 24, 48, and 72 hours of exposure was 1.7 % for all observation. This is because after 48 and 72 hours of exposure there was not added death of *L. pseudoannulata* recorded. The cumulative mortality of *L. pseudoannula* by profenofos treatment dose of 2500 ppm in 24 and 48 hours after exposure was 0 and 1.7% resoectively. In 72 hours of exposure still steady on 1.7% (Table 2). This is because after 72 hours of exposure there was not added death of *L. pseudoannulata*.recorded.

Table -2: Mortality of *L. pseudoannulata* in *toxicity* tests in Semi-field

Treatments	Dose rate in ppm of formulated product	Cumulative predator mortality in hours (%)*		
		24h	48h	72h
Chlorantranilprole + Thiamethoxam 300 SC	750	0a	0b	0b
Chlorantraniliprole+ abamectin 063SC	3750	0a	0b	0b
Pymetrozine 50WG	1500	3.3a	3.3a	3.3ab
Cyantraniliprole + Pymetrozine 60WG	1500	0a	0b	0b
Lufenuron 050SC	1000	0a	0b	0b
Abamectin 018EC	8333	3.3a	6.7a	6.7a
Emamectin benzoate 05WG	1000	1.7a	1.7b	1.7 b
Deltamethrin 25EC	1500	3.3a	3.3ab	3.3ab
Profenofos 500EC	2500	0a	1.7b	1.7b
Untreated	-	0a	0b	0

Mean values in each column followed by the same letter are not significantly different at the 5% level base on Duncan's Multiple Range Test = DMRT.

The pymetrozine, abamectin, emamectin benzoate, deltamethrin, profenofos insecticides included in the category1, as well as other insecticides (chlorantranilprole + thiamethoxam SC 300, chlorantraniliprole+ abamectin 063SC (45/18g/l), pymetrozine 50WG (500 g/kg), cyantraniliprole + pymetrozine 60WG (500&100g/kg), and lufenuron) are in category1, that is considered harmless insecticides with mortality of *L. pseudoannula* less than 25%. It shows that the insecticide can be used when natural enemy *L. pseudoannula* present.

Persistence of insecticide against P. *fuscipes* in Semi-field

In two days after of insecticide application, the *P. fuscipes* were placed inside trial unit for 24 hours of exposure were not death recorded on any insecticides treatment. Furthermore at 9, 14, 34 days after insecticide application, the *P. fuscipes* were also placed again inside trial unit and observations mortality on 1 day after exposure were not death observed in all insecticides treatments. It means that all insecticides did not effect after three and next day's insecticides application. This is consistent with the results of toxicity tests that on third day there were no deaths of *P. fuscipes* caused by insecticide treatments.

The insecticides in dose treatment of chlorantranilprole + thiamethoxam SC 300, chlorantraniliprole+ abamectin 063SC (45/18g/l), pymetrozine 50WG (500 g/kg), cyantraniliprole + pymetrozine 60WG (500&100g/kg), lufenuron, abamectin, emamectin benzoate, deltamethrin, and profenofos those belong to category 1, that are short-lived persistence less than 5 days with mortality less than 25%. It shows that all insecticides were safe against insect's predator *P. fuscipes*.

Persistence of insecticides against L. *pseudoannulata* in Semi-field

In two days after of insecticide application, the *L. pseudoannulata* were placed inside trial unit for 24 hours of exposure were not death recorded on any insecticides treatment. Furthermore at 9, 14, 34 days after insecticide application, the *P. fuscipes* were also placed again inside trial unit and observations mortality on 1 day after exposure were not death observed in all insecticides treatments. It means that all insecticides did not effect after three and next days insecticides application. This is consistent with the results of toxicity tests that on third day there were no deaths of *L. pseudoannulata* caused by insecticide treatments.

The insecticides in dose treatment of chlorantranilprole + thiamethoxam SC 300, pymetrozine, chlorantraniliprole+ abamectin 063SC (45/18g/l), cyantraniliprole + pymetrozine 60WG (500&100g/kg), lufenuron, abamectin, emamectin benzoate, deltamethrin, and profenofos those belong to category 1, that are short-lived persistence less than 5 days with mortality less than 25%. It shows that all insecticides were safe against insect's predator *P. fuscipes*.

Insecticides are still needed in the control of BPH, because increasing of BPH population can not be overcome by the presence of predators, this are due to the performance of *Lycosa pseudoannulata*, other spiders, *Paederus fuscifes*, and *Cyrtorhinus lividipennis* can not to be counterbalanced to BPH is being increasing population growth. Therefore good insecticides are effective against pests, but little influence on natural enemies. Ray [11] reported that Voliam flexi 300 SC (200 g thiamethoxam and 100 g chlorantraniliprole/l) had given the highest mortality to BPH in the laboratory and rice field, but the lowest mortality to spider *L. pseudoannulata* and lady bird beetle *Micraspis discolor*. Application of Virtako (thiamethoxam+ chlorantraniliprole) provides good control of insect pests in paddy fields, but predators *Cyrtorhinus lividipennis* and *Paederus fuscipes* recovered quickly after the in insecticide application [12]. The insecticide chlorantraniliprole has the best efficacy in controlling the pest and at same time it has the least effects to non-target arthropods in the field [13]. Shanwei *et al*. [14]. Evaluated the newer insecticide, chlorantraniliprole 20 SC at 40 g a. i. / ha was highly safe to beneficial arthropods in the fields and Karthick *et al*. [15] also reported that was no complete elimination of coccinellids and spiders in the treated plots.

The pymterozine 50 WG @ 350- 400 ga.i/ha provided excellent control of BPH, in the other hand the population of natural enemies coccinellids, mirid bugs and spider populations showed no significant differences among the insecticidal treatments (Pymetrozine and thiamethoxam) and untreated control at 3 and 7 days after spray [16]. Govindan *et al*. [17] showed that emamectin benzoate 5 SG was found safer to coccinellids at all the tested concentrations. Vitthal [18] showed that the plots without any insecticidal supported highest number of spider population and was followed by the spinosad which was safe to the predatory spiders, followed by emamectin benzoate to be relatively less toxic and profenofos was intermediate toxic to predatory spiders.

CONCLUSIONS

In toxicity test, all insecticides on dose treatment of chlorantranilprole + thiamethoxam SC 300, chlorantraniliprole+ abamectin 063SC (45/18g/l), pymetrozine 50WG (500 g/kg), cyantraniliprole + pymetrozine 60WG (500&100g/kg), lufenuron 050SC (50g/l), abamectin 018EC (18g/l), emamectin benzoate05WG (50g/kg), deltamethrin 25EC (25 g/l), profenofos 500EC belong to category 1 that is harmless with mortality less than 25%. In long live persistence all insecticides on dose treatments belong to category 1 that short-lived persistence less than 5 days with mortality less than 25%. It shows that the insecticides are safe against natural enemies *P. fuscipes* and *L.pseudoannulata.* It shows that the insecticides are safe against natural enemies *P. fuscipes* and *L. pseudoannulata.*

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