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ABUNDANCE OF *Metioche vittalicollis* (ORTHOPTERA: GRYLLIDAE) AND NATURAL ENEMIES IN A RICE AGROECOSYSTEM AS INFLUENCED BY WEED SPECIES

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ABSTRACT

Weeds in the rice fields impact the population of *M. vittaticollis* and several predators on rice habitat. A study was conducted during rainy season 2004-2005 and dry season 2005, which selective weeding and weed strips were applied. In selective weeding, *Monochoria vaginalis, Fimbristylis miliacea, Cyperus iria,* and *Limnocharis flava* were left, and made a weed strip at the periphery of rice plot which was consisted of those four species. Clean weeding as farmers usually do was also applied as a control treatment. Results showed that the presence of weed plant species in the earlier planting season of dry season 2005 tended to maintain the population of the predatory insects of rice pests, in particularly *M. vittaticollis* and *Anaxipha longipennis.* Population of *Ophionea nigrofasciata, Paederus* spp. and *Micraspis inops* were not different among the treatment plots during rainy season (2004-2005) and dry season (2005). The species number of predator and parasitoids seemed to increase slower in the clean weeded plot in comparing with the species number in selectively weeded or weeds strip's plot at early planting season. Rice yield in the experimental plots were not significantly different. Some weeds in the rice fields may not have adverse effects on rice productivity.

Keywords: generalist predator, weeding, predatory cricket

INTRODUCTION

Weed growth in cropping systems is generally considered to be deleterious to production and profit, but in some cases the vegetation diversity inherent to weeds supports higher numbers of prey arthropods in that in turn support natural enemies (Showler, 2004). According to Yu *et al.* (1996) the quantity and the quality of egg parasitoids in rice fields could be enhanced by regulating the amount of vegetation and arthropods in surrounding non-rice fields. There were slightly more egg parasitoids collected on the sedges, *Fimbristylis miliacea* (Poales: Cyperaceae) and *Cyperus difformis* (Poales: Cyperaceae) with flowers. Therefore, noncrop plants within and around fields can be used to benefit biological control agents.

Some habitat management activities that have a positive influence on the abundance of the natural enemies of rice insect pests are managing vegetated rice field bunds, in non crop areas such as field margins, hedgerows, irrigation canals, roadsides, and wildlands near cropland and refuges within cropland. Vegetated rice bunds support many herbivore species (including a few pests) and many species of natural enemies (Islam, 2002). They can be a very important source of natural enemy colonization in rice fields just after planting. Bund vegetation provides alternative and supplementary food for predators and parasitoids, and also provide shelter for natural enemies at critical time during harvesting, land preparation and between seasons (Marcos *et al.*, 2001). Many natural enemies take shelter on the rice bunds at puddling and the presence of vegetation on the bunds greatly increases their survival. Managing the vegetation around the field edges will probably have even greater advantage to beneficial insects (Islam, 2002).

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According to Mortimer (*in* Heong and Schoenly, 2001) all non-rice plants in a field are often beneficial. If weeds can be identified which promote natural enemy density and diversity, and deleterious for pests, it can be recommended, when farmers selectively weed their fields. It is evident that enhancement of broadleaf weeds can provide vital sources of insect natural enemies (Marcos *et al.*, 2001). For natural enemies need year-round continuity of prey and places to leave when there's no crop in the field. Therefore, these non-rice plants are undoubtedly home to some pests, but these can also be home for the insect predators. Creating the best possible mix where the positives out of weigh the negatives are needed to be considered (Heong and Schoenly, 2001).

Generally, grasses and other vegetation in habitats adjacent to rice fields serve as habitats of natural enemies and also provide supplementary and complimentary food, over-wintering, or off-season habitats. The precise composition of plants species that will make the greatest contribution to the conservation of natural enemies of rice insect pests has not yet been determined. Therefore, this experiment was conducted to elucidate the influence of weeds within rice fields to the population of *M. vittaticollis* and several predators in rice habitat.

MATERIALS AND METHODS

A study to examine the influence of weed species on the abundance of *M. vittaticollis* and other predators was conducted in the irrigated rice fields District Pakisaji, Malang (7^{o}58' S, 112^{o}42' E) during rainy season of 2004-2005 and drought season of 2005. The experiments were laid out in a randomized complete block design, with three treatments in three replications on 15 x 20 m plot. The treatment were 1) selective weeding, remove all weeds except *Monochoria vaginalis* (Liliales: Pontederiaceae)*, Fimbristylis miliacea, Cyperus iria,* and *Limnocharis flava*, and left those weeds 1-3 plants per m^2, 2) make a weed strip at the periphery of rice plot which consist of *M. vaginalis, F. miliacea, C. iria, and L. flava*, and 3) clean weeded by hands as farmers usually do. *M. vittaticollis* preferred laying eggs on *F. miliacea* and *C. iria* (Karindah *et al.,* 2007), *M. vaginalis* and *L. flava* were common weeds in rice habitat.

Agronomic practices, such as land preparation, varietals choice, fertilizer-use, and weeding time were left to the farmer to decide, except no insecticides and herbicides application. The rice variety planted was Ciherang. Three weeks old rice seedlings were transplanted in 20 x 20 cm spacing. Weeding, at the third treatment plots, were done twice, at 15 and 38 Days After Transplanting (DAT) respectively.

Special treatment was done on rice bunds surrounding the experimenal field after the rainy season planting. In this experiment 'an island of weeds' on rice bunds (Figure 1) was established which could be used by some insects as shelter or refuge. These weeds were managed on the bunds surrounding of the plot with selective weeding and weed strip (Treatments 1 and 2).

Figure 1. An island of weeds on rice bunds' surrounded selectively weeded and weed strip's plots

Ten sample units were taken in transect across the experiment plots on two weekly schedules from two weeks after transplanting until just before harvest for each field. There were eight sampling dates. Samples were taken with a vacuum suction device powered by an automobile-interior vacuum and a 12-volt car battery, known as a "*Farmcop*" (Carino *et al.,* 1979). The samples were taken by dropping a 70 cm tall zinc funnel with a 35 cm diameter of opening at the base over the rice plant (Schoenly *et al*., 2003). Samples were taken to the laboratory and frozen in their original cloth sample bags, and later thawed and put into plastic film bottles containing a 70% alcohol solution for later sorting and identification. Samples of arthropods on the rice bunds were taken by sweep net. Twenty hills were sampled diagonally to observe the yellow rice-stemborer *Tryporyza incertulas* (Lepidoptera: Pyrallidae) attack. Observation was also taken for the rice production.

Test for significance of the treatments was carried out using Two-ways ANOVA and means were compared by Least Significant Difference test, and were done by MINITAB 13.

RESULTS AND DISCUSSION

The population fluctuations of *M. vittaticollis* in rice during the rainy and dry seasons are shown in Figure. 2. In the rainy season planting the population of *M. vittaticollis* was not significantly different among the experimental plots. Weeding intended to increase the cricket population did not show any increase during the rainy season, but during the dry season the population of predatory crickets were significantly influenced of weeding practice at two Weeks After Planting (WAT) (p=0,001), four WAT (p=0.043), eight WAT (p=0,005), and sixteen WAT (p=0,027) among the experimental plots.

The population of *Anaxipha longipennis* (Orthoptera: Gryllidae), another orthopteran predator, in the rainy season was not significantly different. In the dry season, however the average population of *A. longipennis* was lower than that on the rainy season. The population in the selectively weeded and weed strip plots were higher than the population of the clean weeded plot. Compared to *M. vittaticollis,* the population of *A. longipennis* reached the peak at the vegetative stage of rice and declined as thereafter rice entered the generative stage.

Other generalist predators caught in high numbers during the experiment were *Ophiona nigrofasciata*, two species of *Paederus* and *Micraspis inops.* The population of *O. nigro-fasciata* fluctuated about the same pattern among the population in the treatment plots in rainy and dry season, respectively (Figure. 5 and 6). The population of *Paederus* spp. and *M. inops* also fluctuated about the same pattern among the population in treatment plots during rainy season and dry seasons. The average population of *Paederus* spp. and *M. inops* were low in the early planting season and increased after six weeks.

The increased number of predators, parasitoids and herbivores species caught by farmcop during one planting season are shown in Figure 7. The predator species increased gradually in the clean weeded plot compared to in selectively weeded and weeds strip plots. A similar trend was observed for parasitoid and herbivores too. The number of herbivores species was lower in the clean weeded plot than at the other treatment.

Five egg parasitoids of stemborer caught during rice season were *Trichogramma* sp., *Tetrastichus schoenobii, Telenomus rowani, T. dignoides,* and *T. dignus.* The accumulative numbers of those egg parasitoids as in Table 1.

The rice yield was not significantly influenced by the treatments (Table 2) both in the rainy and dry seasons. Implying that some weeds within the rice fields for certain extend would not decrease the rice yield substantially. Indeed such weeds may favor the predators and parasitoids.

In this experiment there was stemborer's attack as in Table 3. Although the percentage of stemborer attack was not high weeding practices gave a significant effect on stemborer attack. In both seasons the percentage of stemborer's attack was lower in the selectively weeded plot.

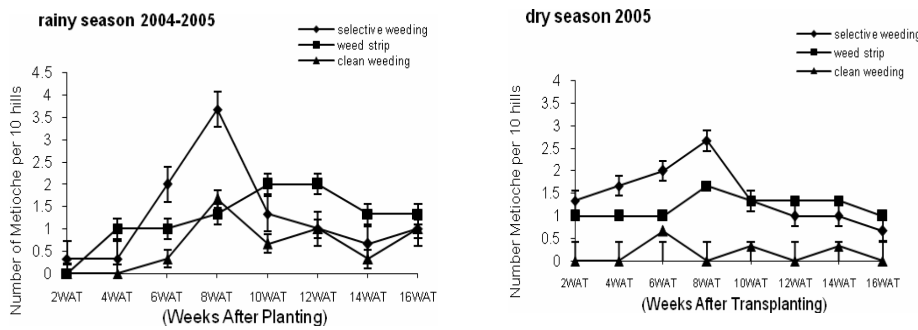

Figure. 2. *Metioche vittaticollis* population dynamic's in the rice fields Pakisaji, Malang during of rainy season 2004-2005 and dry season 2005

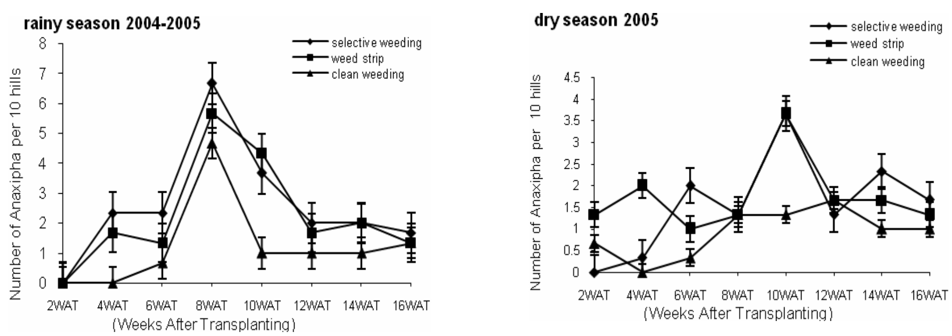

Figure. 3. *Anaxipha longipennis* population dy namic's in the rice field Pakisaji, Malang during of rainy season 2004-2005 and dry season 2005

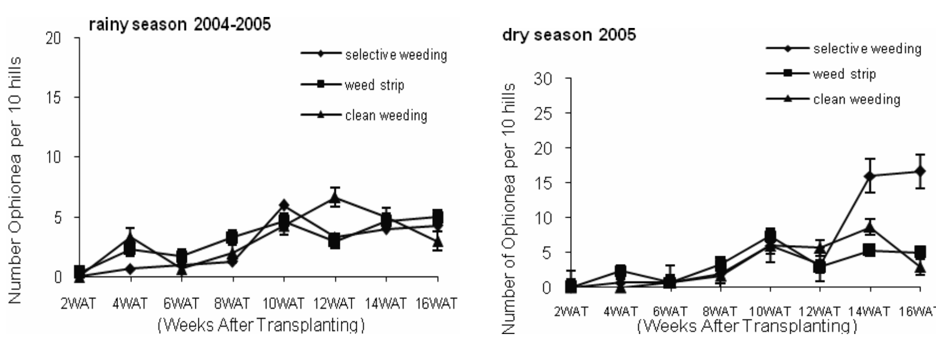

Figure. 4. The fluctuation numbers of *O.nigrofasciata* in the rice field Pakisaji, Malang during of rainy season 2004-2005 and dry season 2005

Table 1. The number of egg parasitoid of rice stemborer caught by Farmcop

Treatment	No.of egg parasitoid	
	Rainy season 2004-2005[1]	Dry season 2005[2]
selective weeding	44.00 ± 3.51 a	94.00 ± 2.96 a
weed strip	38.00 ± 1.73 ab	136.00 ± 2.60 b
clean weeding	32.00 ± 1.73 b	105.00 ± 2.52 ab

Remarks = in a column, means followed by a common letter are not significantly different at the p=0,05 by Tukey' Test; [1] p=0.038 ; [2] p=0.025

Table 2. Average rice yield in rainy and dry season rice planting, in year 2004-2005 and 2005 respectively in Pakisaji, Malang

Treatments	Rice yield (rainy season 2004-2005) Average ± SE		Rice yield (dry season 2005) Average ± SE	
	Kg/ 6.25 m^2 [1]	**Mg ha^{-1} [2]**	**Kg/ 6.25 m^2 [3]**	**Mg ha^{-1} [4]**
Selective weeding	4.03 ± 0.99	6.45 ± 0.19	3.63 ± 0.20	3.08 ± 0.31
Weed strip	4.33 ± 0.27	6.93 ± 0.24	3.42 ± 0.10	5.47 ± 0.18
Clean weeding	4.83 ± 0.24	7.73 ± 0.09	3.46 ± 0.16	5.54 ± 0.28

Remarks: [1] p=0.514, [2] p=0.514, [3] p=0.859, [4] p=0.416

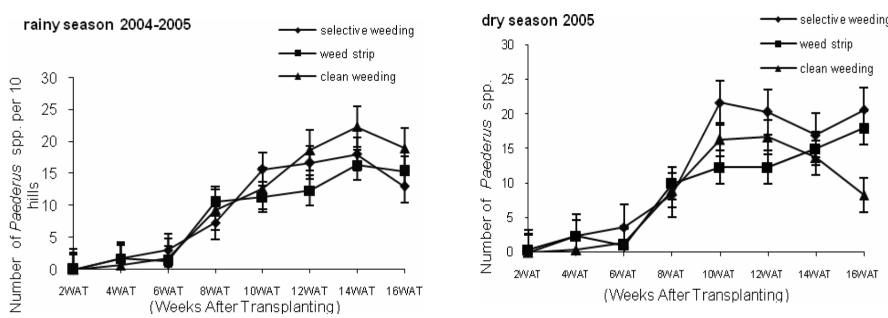

Figure. 5. The fluctuation numbers of *Paederus* spp. in the rice field Pakisaji, Malang during of rainy season 2004-2005 and dry season 2005

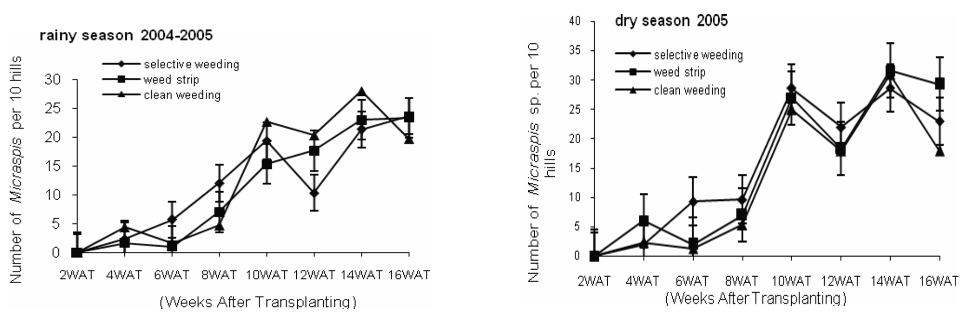

Figure. 6. The fluctuation numbers of *Micraspis inops* in the rice field Pakisaji, Malang during of rainy season 2004-2005 and dry season 2005

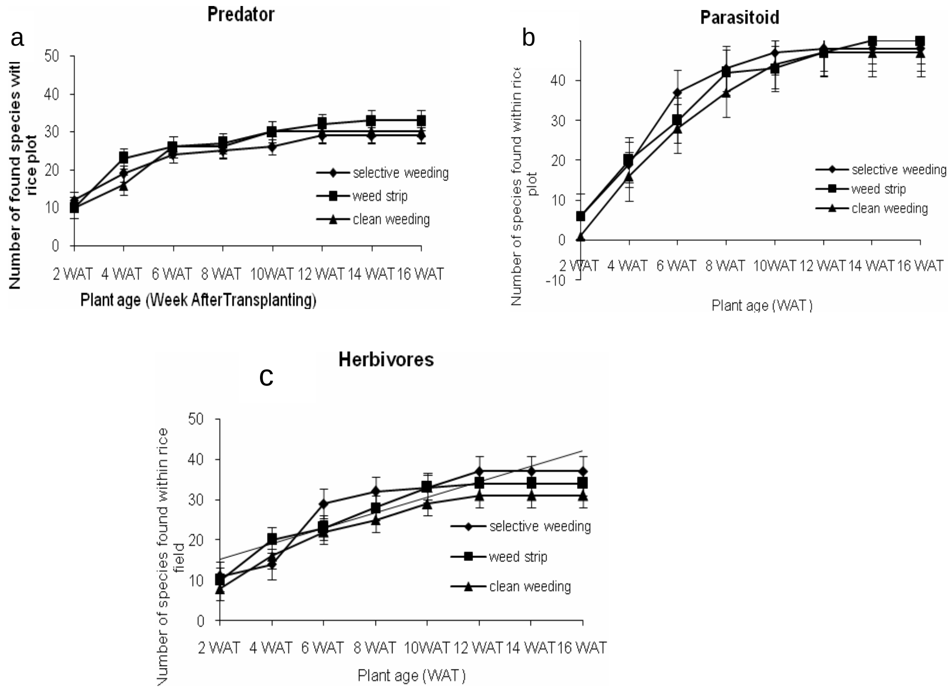

Figure 7. The accumulation number of predators (a); parasitoid (b) and herbivore (c) species caught by farmcop in the rice plots during dry season 2005

Table 3. The average percentage of stemborer attack during rainy and dry season rice planting, in year 2004-2005 and 2005 respectively in Pakisaji, Malang

Treatments	**Percentage of Stemborer attack (rainy season 2004-2005) Average ± SE**	**Percentage of Stemborer attack (dry season 2005) Average ± SE**
Selective weeding	3.24 ± 0.16 a	3.50 ± 0.22 a
Weed strip	4.77 ± 0.17 b	5.15 ± 0.21 b
Clean weeding	6.32 ± 0.15 c	5.88 ± 0.23 b

Remarks: in a column, means followed by a common letter are not significantly different at the p=0.05 by Tukey' Test

DISCUSSION

The population fluctuation of *M. vittaticollis* in rice during rainy season was not significantly different among the experiment plots. In rainy season experiment the influence of weeding practice which was intended to encourage the increase of cricket population had not been shown yet. However, in the dry season rice planting the population of predatory cricket *M. vittaticollis* was significantly influenced of weeding practice at early planting season among the experimental plots. This fact indicated that 'the island of some weeds' or a group of weeds which were left on the rice bund surrounding the selectively weeded or weeds strip plots could deliver some predator, such as

M. vittaticollis, to enter the field in the early planting season. While at the clean weeded plot during the land preparation, the rice bunds were cleaned up. That is why no insect stayed near the plot. Weeds grow in the rice bunds could be a shelter for many species of arthropods. Many natural enemies take shelter on the rice bunds at puddling and the presence of vegetation on the bunds greatly increases their survival (Heong and Schoenly, 2001). When there is no vegetation for shelter, the insect predators have often had to immigrate out of the field, with the result that they were not present in the early season before the pest populations developed. At the rest of planting season the population number of *M. vittaticollis* were similar among the treatment's; however the population of predatory cricket in the clean weeded plot seemed to fluctuate in the lower level of the population in the selective weeding and the weeds strip plots. As regards *M. vittaticollis,* the population of *A. longipennis* reached the peak at the vegetative stage of rice and decline as the rice enter the generative stage. *A. longipennis* and *M. vittaticollis* have the same kind of prey, they are mostly a pest of rice in vegetative stage, such as leaf folder' eggs and small insects (Rubia *et al.,* 1987; de Kraker, 1996). Therefore, the prey decrease could also affect the predator.

The population of *Anaxipha longipennis,* another orthopteran predator, in rainy season was not significantly different in most of sampling time. In dry season the average population of *A. longipennis* seemed lower than that in the rainy season. However, the population in the selectively weeded and weed strip plots were higher than population in the clean weeded plot. It seemed that wet habitat is more suitable for *A. longipennis*. Other generalist predators caught in high numbers; during the experiments were *O. nigrofasciata*, *Paederus* spp. and *M. inops.* The population of *O. nigrofasciata* fluctuated among treatment plots in rainy season and dry season to the same degree. *Paederus* spp. and *M. inops* populations also followed a similar pattern. The average population of *Paederus* spp. and *M. inops* were low in the early planting season and increased after 6 WAT. The population of *Ophionea* or *Paederus* showed steady increase in all treatment plots. These insect are laid their eggs in the crack soil not in the plants (Kalshoven, 1981), therefore, the breeding site is not influenced by the presence of living plants. Whereas, *M. vittaticollis* and *A. longipennis* need plants for their oviposition site. *M. inops* is a predator which is also known as a pollen feeder, its population of which increased as the rice crop matured (Kalshoven, 1981).

The presence of weeds such as *Monochoria, Fimbristylis, Cyperus iria,* and. *Limnocharis* thus may promote the occurrence of herbivores. This in turn could increase the number of predator and parasitoid in the field (Showler, 2004). The abundance of economically unimportant herbivores assists in regulating the economically important herbivores. Those herbivores could become an alternative prey or host for them. Rice ecosystems in the broad sense are richly endowed with numerous predator species that live outside the rice fields on weed-covered bunds, uncultivated vegetation, and other crops, such as cowpea, banana and maize (Marcos *et al.*, 2001; Heong, 2002). Farmers often destroy vegetation around the rice fields during land preparation or for sanitary purposes. However, studies on the impact of such practices on pest management are still negligible. Both generalist and specialist natural enemies should be more abundant and effective in more diverse cultures than monocultures because prey or host refuges in diverse cultures enable the prey or host populations to persist (Andow, 1991). In turn it stabilizes predator-prey and parasitoid-host interactions, while in monocultures predators and parasitoids drive their prey or host populations to extinction and become extinct themselves shortly thereafter (Root, 1973 *in* Andow, 1991).

Rice yield was not significantly influenced by treatments both in the rainy and dry seasons. This fact showed that some weeds within the rice fields for certain extend would not decrease the rice yield significantly. *Limnocharis flava* is a weed of minor importance, but it may become noxious when overgrowing the area, *Monochoria vaginalis* is a typical weed of lowland rice and common in wet rice fields. Whereas *Cyperus iria* and *Fimbristylis* are important weed in rice, the extend population of them may reduce the rice production significantly (Soerjani *et al,* 1987). However, *M. vittaticollis* seemed to use this weed species as the breeding site, since the cricket laid more eggs in these two species (Karindah *et al.*, 2007). Therefore to maintain the cricket population in the rice field, weeds stripe in the edge of rice field is to be considered as a refuge for predatory cricket. In addition this method of conservation of natural enemies in rice habitat can be suggested only in the area which is not *rat-endemic area*.

The percentage of stem borer's attack was lower in selectively weeded and weed strip plot either in rainy season or dry season. This might be caused by the higher number of egg parasitoid in those plots compared to the number of parasitoids in clean weeded plots. The number of parasitoid was significantly different among the treatment plots, the individual number of caught parasitoid at one planting season of rice tended higher in the weed strip and selectively weeded plot.

This study may stimulate some thought and discussion among ecologist and agriculturist by suggesting a mechanism that explains how tropical rice fields are robust and stable in the diverse habitat and the absence of pesticides as a result of a rich web of generalist natural enemies. Weeds are not always harmful for the agriculture production. The presence of weeds among our plants might be useful for arthropods population specially predators and parasitoids which in turn might be beneficial for us too.

CONCLUSIONS

The presence of weed species in the earlier planting season in the rice habitat tended to maintain the population of the predatory insects of rice pests, in particular *M. vittaticollis* and *A. longipennis.* Population of *O. nigrofasciata, Paederus* spp. and *M. inops* were not markedly different among the treatments. The numbers of parasitoids also tended to be higher in the selective weeding and weed strip plots. The percentages of stemborer's attack were lower in the selective weeding and weed strip's plots either in rainy season or dry season. The weed strip application might be suggested to enhance the conservation of predator and parasitoid in rice agrosystem.

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