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The Effect of Perimeter Trap Cropping Using Lemon Grass (*Andropogon nardus*) as Pest Management Improvement on Rice Paddy (*Oryza sativa* Var.IR 64) in Purwoasri, Indonesia

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ABSTRACT

The aim of the research was to determine if lemon grass (*Andropogonnardus*) is an appropriate trap crop for the Integrated Pest Management (IPM) in the production of rice (Paddy Var. IR 64). To evaluate the perimeter trapping strategy as a pest control method, field tests were conducted in herbivores and beneficial arthropods abundance and diversity on paddy field in Purwoasri, Pasuruan, East Java. Yellow pan traps and sweep nets were applied in each 10 days during paddy growth stages(vegetative -reproductivestages)on main crop paddy (MC) and main crop with lemon grass trap crop(TCs) fields.Statistically not significant difference among the abundance of all arthropods between both fields, MC and TCs. In TCs,the abundance of herbivorous and detritivorous arthropods was differed significantlyat each paddy growth stages(P=0,05 and P=0,003, respectively), but not significantdifferent on the beneficial arthropods (predator and parasitoid). Species composition data among paddy growth stages showed that the proportion of predator species increased in generative and reproductive stages (i.e. *Conochephalus longipennis*, *Oxyopes javanus*,*Chrysosoma leucopogon*). Therefore, we concluded that lemon grass grown as perimeter trap crop with the main crop paddy Var. IR 64 is not a suitable control for reducing the number of herbivores, but able to increase the proportion of natural enemy arthropods.

KEY WORDS—Lemon grass, perimeter trap crop, integrated pest management, rice production, arthropod herbivores, natural enemy arthropods.

INTRODUCTION

Trap crops are composed of one or more plant species that are grown to attract a pest species in order to protect a nearby cash crop (Hokkanen, 1991). Trap crops may be manipulated in time or space to attract insects at a critical period in the phenology ofthe pest or crop, or both (Shelton and Nault, 2004). The effectiveness of the trap crop can be further improved by adding other perimeter defenses, such as border sprays or biological, mechanical, and cultural controls to form a pest management system known as "perimeter trap cropping" (PTC). Perimeter trap cropping functions by intercepting pest migration, regardless of the direction of attack. It then concentrates the pest populations in the border area, where they can be controlled, thus preserving natural enemies in the main crop (Boucher et al., 2003; Mitchell et al., 2000). Perimeter trap cropping does not work on every pest or for every crop. However, it has the potential to improve andsimplify pest management on a variety of crops grown on diversified paddy field.

The genus *Andropogon* quite enough used as a trap crop plants for herbaceous plants and has another function, which prevents erosion on agricultural land. Klein et al. (2012) showed that genus *Andropogon* able to resist and reduce insect populations of Pentatomidae family. Van den Berg et al. (2000) explained that the vetifer plant (*Andropogonzizanioides*) is repellent plants for insects, that have potential as a trap crop plants applied “push-pull strategy” to concentrate *Chilopartellus*oviposition. “Push-pull strategy” to keep it away from the main crops corn, thereby reducing pest *Chilopartellus*.One of the natural substances that have the potential to be used as a trap crop citronella (*Andropogon nardus*) are able to attract flies. Additionally *Andropogon nardus* have repellent properties to aphids, grasshoppers and mites (Amalia, 2012).

In this study, we use lemon grass (*Andropogon nardus*) as a trap crop for applying ecological IPM. The trap crop planting method that is used is the perimeter trap cropping were useful as a protection from pests that may come from many or unknown direction.Perimeter trap cropping is one of the conservation management of agricultural habitats. Habitat management is becoming very important to maintain the existence of natural enemies (Perfectoet al., 2009), so the existence of herbivorous pests that potentially reduce paddy productivity can be controlled. This study was conducted to determine the effect of the application of lemon grass trap crop on the main paddy crop to the composition and diversity of herbivorous arthropods and natural enemy arthropods.

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MATERIALS AND METHODS

In Purwoasri paddy fields, Pasuruan, we monitored the rice arthropod dynamics in a lemon grass trap crop planted surrounding rice crop (*Oryza sativa* Var. IR-64). Rice is planted twice a year alternately with tobbaco. The paddy fields are planted to paddy variety IR-64, which a dry tolerance rice variety. Paddy was planted in Main Crop fields (MC), which surrounded by lemon grass in Main Crop + Trap Crop fields (TCs). The main purpose of quantifying rice arthropod, especially herbivores dynamics and diversity, was to provide information on the perimeter trap crop using lemon grass to local farmers. They need to validate the perimeter crop method in the development of an ecological sustainable pest management.

Rice arthropods were sampled using standard insect sweep nets and yellow pan traps. Each sweep net sample was composed from 10 strokes. Yellowpan trap is a method of trapping insects trapped using yellow plastic tray which contains 1/3 water mixed with detergent. Traps installed as many as 5 pieces of each rice terraces placed as high as 3/4 of the rice plant height and left for 24 hours. Each MC (rice main crop) and TCs (rice crop with lemon grass trap crop) were sampled 10 times starting on 10 DAP (Day After Planting) until harvesting (reproductive stage). In all these treatments, samplings were done at 10 day intervals. Rice arthropods were sorted and identified on the basis of functional roles: herbivores, detritivores and beneficials arthropods (predators and parasitoids).

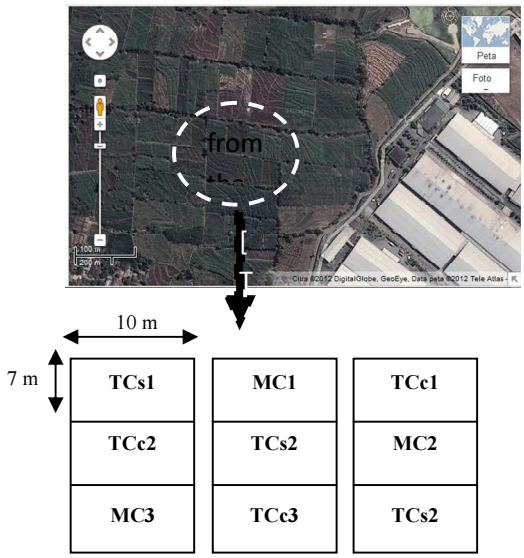

Figure 1. The site map of habitat modification in paddy fields at Purwosari, Pasuruan, Indonesia. Insert : habitat modification designs, TCs 1, 2, 3 : Main crop paddy + lemon grass trap crop; MC 1, 2, 3 : Main crop paddy; TCc 1, 2, 3 : Main crop paddy + paddy ciherang trap crop.

Habitat modification treatment with lemongrass (plot TCs1, TCs2, TCs3) planted on the edge of rice terraces as much as 2 layers thoroughly before planting paddy varieties IR-64.In the main crop plot (plot of MC1, MC2, MC3), paddy IR-64 are grown without the lemon grass as a perimeter trap crop.

RESULTS

On MC and TCswere found 85 species of arthropods, but there are differences in the number of families and species. The abundance orders in MC are Diptera (15 species from 12 families), Coleoptera (12 species from 5 families), and Araneae (10 species from 7 families).While in TCswere found mostly order Hyme-noptera (17 species from 6 families), Coleoptera (16 species from 4 families), and Araneae (12 species from 8 families).

This study was also evaluated the total composition of arthropods based on the functional role between the MC and TCs during paddy growthstages (vegetative, generative and reproductive).

Figure 2. The composi B of arthropods based on the functional role: A. Main crop paddy (MC), B. Main crop paddy + lemon grass (TCs) at Purwosari paddy fields, Pasuruan, Indonesia.

Figure 2 shows that the number of herbivor was higher on TCs (54%) than that of MC(52%). While predator on MC was higher (42%) than that of TCs (39%). The number of detritivore slightlyhigher on TCs than that of MC (6% and 5%, respecively). Parasitoids show the similar abundance on both paddy fields (1%).

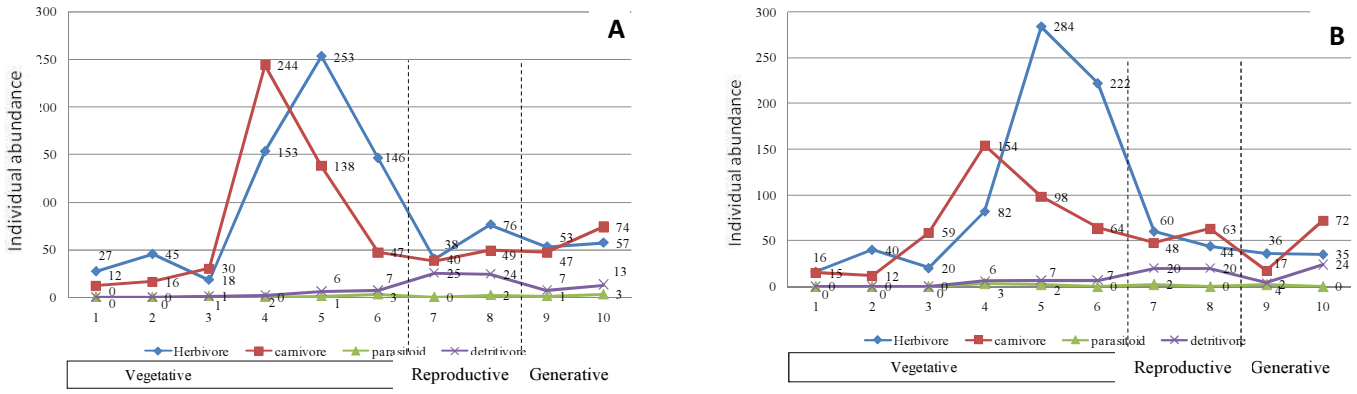

Figure 3. Abundance of arthropods based on the functional roles : A. Main crop paddy (MC), B. Main crop paddy + lemon grass (TCs) in Purwosari paddy fields, Pasuruan, Indonesia during paddy growth stages.

Figure 3 shows that the number of arthropods in both MC and TCswere changed in every stage of paddy growth..There were changed in abundance patterns, especially on herbivores and predators.In the vegetative and reproductive stages, herbivores abundance were higher than that of the predators. During the vegetative growth stage,TCs supports high numbers of herbivores, as it shows an increase in the abundance of high (284 and 222 individuals). Probably due to the availability of the young leaves of paddy as a food resource for herbivores during the vegetative stages. In TCs, the number of predators increased following the number of herbivores in vegetative phase (154 individuals). In the reproductive stage, paddy grain growth may attract many insects. While in the reproductive stage (ripening), predators abundance were higher than of herbivores. Fluctuations in the pattern of parasitoid abundance were not clear due to their small numbers.The fluctuations in the pattern ofdetritivor abundance increased mainly on generative and reproductivestages.

At the both stages, the paddy leaves dried up and then felt to the ground, so that it provides food for detritivore arthropods (Vergara, 1992).

Table 1. Comparative abundance of the functional roles of arthropods between paddy growth stages on the MC and TCs fields.

Functional role	MC			P value	MC+TC			P value
	Vegetative	Reproductive	Generative		Vegetative	Reproductive	Generative	
Herbivore	642	114	110	0,047 *	664	104	71	0,055 *
Predator	487	89	121	0,174 (ns)	402	111	89	0,232 (ns)
Parasitoid	5	2	4	0,666 (ns)	5	2	2	0,937 (ns)
Detririvore	16	49	20	0,001 **	20	40	28	0,003 *

Numbers followed by asterisk are significantly different (* P<0.05; ** P<0.001) and ns(not significantly different) using T test.

Table 2. Comparative abundance of the functional roles of arthropods between two fields during in each paddy growth stage on the MC and TCs fields.

Functional role	MC			MC+TC			P value		
	Vegetative	Reproductive	Generative	Vegetative	Reproductive	Generative	Veg MC vs TCs	Rep MC vs TCs	Gen MC vs TCs
Herbivore	642	114	110	664	104	71	0,925 (ns)	0,756 (ns)	0,102 (ns)
Predator	487	89	121	402	111	89	0,553 (ns)	0,506 (ns)	0,567 (ns)
Parasitoid	5	2	4	5	2	2	1 (ns)	1 (ns)	0,596 (ns)
Detririvore	16	49	20	20	40	28	0,666 (ns)	0,549 (ns)	0,543 (ns)

Numbers followed by letter : ns are not significantly different (P>0.05) using T test.

Table 1 shows that the number of herbivores was significantly higher among the paddy growth stages, both on MC and TCs fields (P = 0.047 and 0.055, respectively). Detritivore also showed significant differences in abundance during the growth phase of paddy on both fields (P = 0.001 and 0.003, respectively). The results shows that all functional roles in both fields have a value

that is not significantly different (P>0.05). The results of T test showed that the abundance of arthropods was not influenced by the treatment, but more influenced by the growth stage of paddy, that causes the abundance of certain species (Table 2).

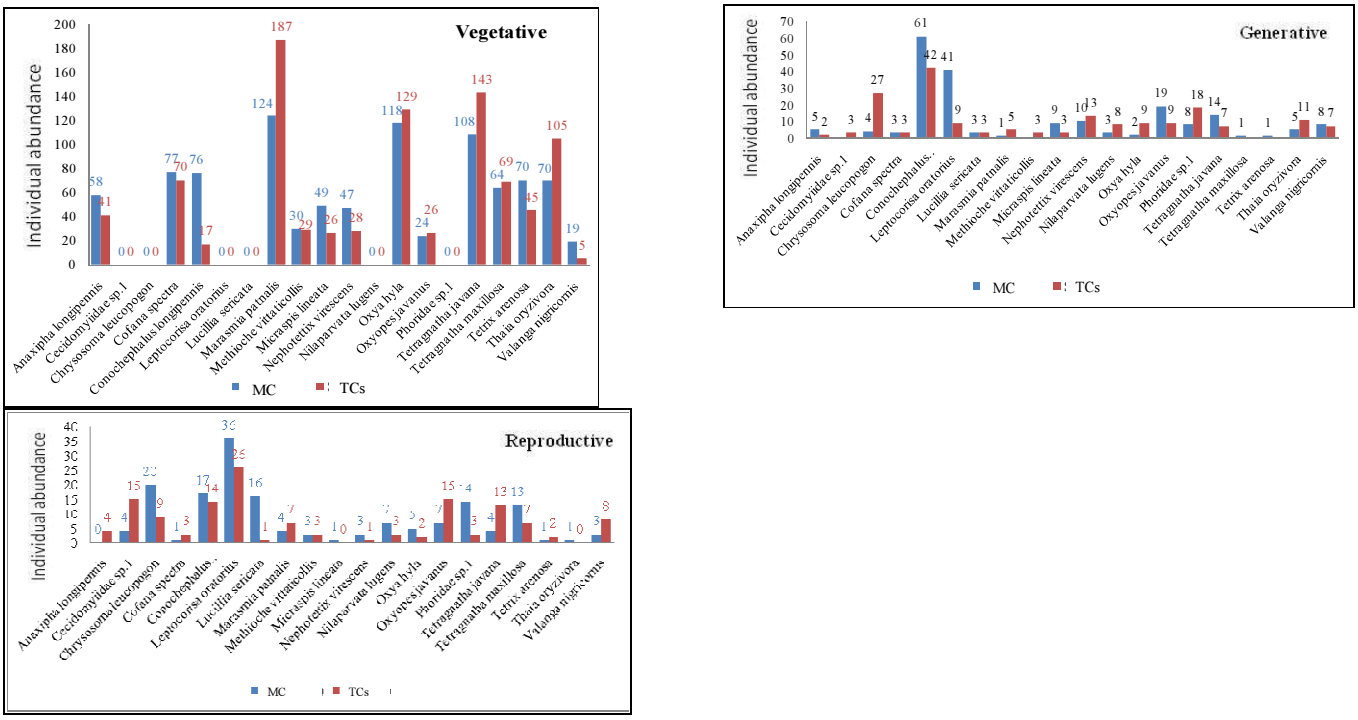

Figure 4. Species composition of arthropods in the three growth stages of paddy: Vegetative, Reproductive and Generative stages on Main crop paddy (MC) and Main crop paddy + lemon grass (TCs) in Purwosari paddy fields, Pasuruan, Indonesia.

Herbivorous species that dominated both fields in vegetative stage (Fig. 4) is *Marasmia patnalis* and *Oxya hyla* which are herbivorous arthropods (family Pyralidae andAcrididae, respectively). Amalia (2012) explained that the family Pyralidae is prevalent in various crop plants both dry and wetlands. Almost all Pyralidae act as an important pest on various crops. One species of Pyralidae are *Marasmia patnalis*, which the larval stadia will be rolled or folded leaves of paddy (paddy leaffolders). *Marasmia patnalis* is potentially fitofagus as common pests found in all paddy growth stages, mainly in the vegetative stage (Litsinger et al., 1995). *Oyxa hyla* is a group of grasshoppers that have mouth appendage to chew paddy leave (Litsinger et al., 1995). In generative stage, *Leptocorisa oratorius* dominated rice which is herbivorous arthropods may potentially as a pest in paddy.Theirnymph and adult insert needle-shaped mouth appendage needle into the grain. Seeds were attacked on the generative phase can be empty grains or small grains (Litsinger et al., 1995).It can be concluded that the modified habitat use lemon grass trap crop only effective against some families of herbivorous arthropods associated with the differences of paddy growth stage.

The differences in nutrient content were likely found in different stages of paddy, causing differences in the arthropod found in every paddy growth stages Species composition data among paddy growth stages shows that the proportion of predator (natural enemy) species were increased in vegetative and generative stages (Fig. 4). *Chrysosoma leucopogon, Oxyopes javanus* and *Conocephalus longipennis* are predator species which were increased in abundance during the vegetative and generative stages. *Chrysosoma leucopogon* are small insectivorous arthropods belongs to order Diptera (Sinclair and Cumming, 2006). This species is a small fly with big eyes and has a shiny green body, and have long legs (Litsinger et al., 1995). *Conocephalus longipennis* is a carnivorous arthropods belonging to a long aperture grasshopper group that eat eggs of herbivor insects. This species is a predator of eggs of paddy steem borer and stinky bug pest. The high abundance of this species as well as the land began to dry on generative stage. Grasshopper groups prefer a dry place to breed (Vergara, 1992).*Oxyopes javanus* is a generalist predator and direct hunter.The spider prefers drier habitats and colonizes rice fields after canopy development (Anonim, 2009).

CONCLUSION

Agroecosystem management with trap crop applications using lemon grass (*Andropogon nardus*) had no effect on the composition and diversity of arthropods based on the functional role.This is supported by the non significant difference (P>0.05) between the abundance of the herbivores in main crop (MC) with lemon grass perimeter trap crop surrounding the main crop (TCs).The lemon grass trap crop is less effective on reducing the abundance of herbivorous arthropods,but able to increase the abundance proportion of natural enemy arthropods during different paddy growth stages, i.e. vegetative and reproductive stages. T test shows that the abundance of arthropods was more influenced by the growth stage of paddy, that causes the abundance of

some species.High abundance of herbivorous and detritivorous arthropods were found in the vegetative TCs (P=0.055 and P=0.003, respectively). Some herbivorous species (*Marasmia patnalis* and *Oxya hyla*) was likely influenced by the presence of the lemon grass trap crop at different paddy growth stages.Some predator (natural enemy) species, i.e.*Chrysosoma leucopogon*, *Oxyopes javanus* and *Conocephalus longipennis,*were influenced during vegetative and generative stages.Ineffectiveness of habitat modification using lemon grass trap crop were related to thelemongrass growth period is longer than that of paddy. It is recommended to planting lemongrass trap crop early 2 months before planting rice on the subsequent habitat modification activities.

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