

ROLE OF WEED HOSTS ON THE SURVIVAL OF PADDY BUG, *Leptocorisa oratorius* (HEMIPTERA:ALYDIDAE)

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ABSTRACT

Paddy bug, *Leptocorisa oratorius*, (Hemiptera: Alydidae), is a predominant grain-sucking insect pest of rice in Sri Lanka. It also feeds on flowers of a range of graminaceous weeds that occur in and around the paddy-ecosystems. During the flowering stage of rice, the insect multiplies into large proportions and damages the developing grains. Biweekly sampling in rice and adjacent non-rice areas in Kurunegala, Polonnaruwa, Matale and Gampaha for a period of 2 years indicated that the highest proportion of mature females occurred at late booting through early heading stage, and the nymphal stages were confined to the heading through soft-dough stages of rice. Paddy bug does not lay eggs on weeds under natural conditions. It laid significantly low number of eggs on caged *Echinochloa colonum* (no/female 34), *E. glabrescens* (27), *Panicum ripens* (39) and *Cyperus iria* (25) as compared to rice (80). The first generation adults emerged on the above weed-hosts were respectively 1.2, 2.6, 4.2 and 5 as compared to rice (16).

KEY WORDS: *Leptocorisa oratorius*, Rice, Weed management, Paddy bug.

INTRODUCTION

Rice bug is a polyphagous insect. It feeds on flowers of a range of graminaceous weeds that occur in paddy-ecosystems. During the flowering stage of rice, the insect multiplies into large proportions and damage the developing grains. Its feeding on the spikelets at heading causes empty (sterile) grains. Damage at milky stage results in partially filled-grains and at later stages in poor-quality grains (Kobayashi and Nugaliyadde, 1988). Based on the intensity of damage the economic threshold levels for paddy bug are set at 2, 4 and 10 insects/m² at heading, milky and dough stages respectively (Kobayashi and Nugaliyadde, 1988).

Although farmers heavily rely on insecticides for the control of this insect, in correct timing and application methods result to yields poor control (Nugaliyadde *et al.*, 1994). Behaviour of paddy bug to aggregate on weeds grown in and around paddy fields before rice flowers, presents farmers a practical method to control the pest by regular weeding the field before flowering. However, the present understanding on the role of rice habitat-weeds in preserving the natural enemy populations surfaced the need for detailed studies on paddy bug ecology. Experiments were conducted to determine the population dynamics of paddy bug in rice and non-rice habitats

and to determine the influence of non-rice hosts on its reproduction and survival to help design improved management methods for the pest.

MATERIALS AND METHODS

1. Population dynamics of paddy bug

Selection of sampling sites

Four areas to represent diverse agro-climatic regions and different non-rice habitats were selected for sampling of paddy bug and natural enemies (table 1).

Table 1: Some features of the areas selected for sampling

<i>District/ area No. sampling sites</i>	<i>Agro-climatic region</i>	<i>Cropping system</i>	<i>Non-rice</i>
Kurunegala (Batalagoda) (10)	LCIZ	Irrigated Rice – rice	Coconut/ homestead
Polonnaruwa Topawewa) (9)	LCDZ	Irrigated Rice – rice	Forest/ home stead
Matale (Ukuwela) (6)	MCWZ	Rainfed Rice – vegetables	Home stead
Gampaha Yakkala (6)	LCWZ	Rainfed Rice – fallow	Homestead

LC , MC (low and mid country); DZ, IZ and WZ (Dry, intermediate and wet zone) respectively

Sampling and analysis of samples:

In each sampling area, 6-10 sampling sites (each approximately 10 m X 10 m), representing rice and non-rice and spaced approximately 100 m was demarcated for biweekly sampling. From these selected sites, insects were sampled by a sweep net (dia. 35cm) in 20 sweeps. Collected insects were preserved in 70% ethanol for identification and counting in the laboratory. Paddy bug nymphs, adult males and females were separated and their numbers were recorded. Adult females were dissected under a binocular microscope (X 30) to determine the number of mature and immature eggs in them. In each sampling occasion, the number of weed species/m² of the vegetation in each sampling site was recorded.

2. Distribution of paddy bug eggs

In each sampling occasion, the vegetation was observed for paddy bug eggs. Using a 1 m² grid the egg density was estimated.

3. Role of alternate weed hosts on paddy bug survival

Four common weeds grown in and around paddy ecosystems (*Echinochloa colonum*, *E. glabrescens*, *Panicum ripens* and *Cyperus iria*) and rice were planted inside field constructed mesh-cages (1m X 1m X 1m) separately. Five pairs of adults were released into these cages when the weeds and rice start to flower. The number of eggs laid, nymphs emerged and those that became adults were counted at biweekly intervals. This experiment was replicated 5 times.

RESULTS

1. Population dynamics of paddy bug

A regular seasonal variation was observed for paddy bug population at Batalagoda during the sampling period (figure 1). The peak populations synchronized with the crop flowering through harvesting in *maha* (November - March) and *yala* (June - August). Staggered crop establishment in the experimental and seed production areas at Batalagoda provided an uninterrupted supply of rice at heading for the insect's survival.

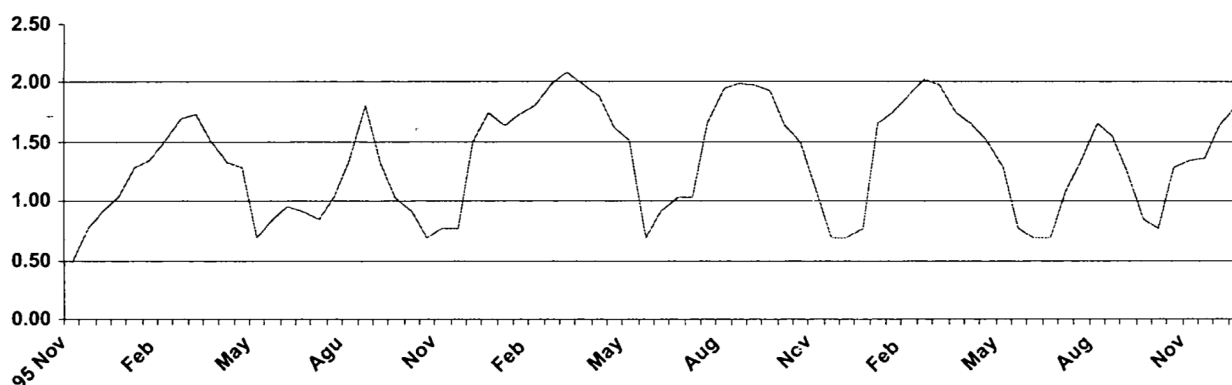


Figure 1. Moving averages for the total biweekly sweep net counts (n=10) of paddy bug ($\log (N+1)$) at Batalagoda from 1995 November to 1998 December.

Paddy bug populations at Polonnaruwa fluctuated in a similar manner to those at Batalagoda (figure 2). However, there were clear inter-seasonal gaps in insect populations representing the fallow dry-periods. At Polonnaruwa the *maha* rice crop flowered in December-January and *yala* crop in June-July - because of the water issues for planting of rice. As a result paddy bug multiplication to be confined to these periods.

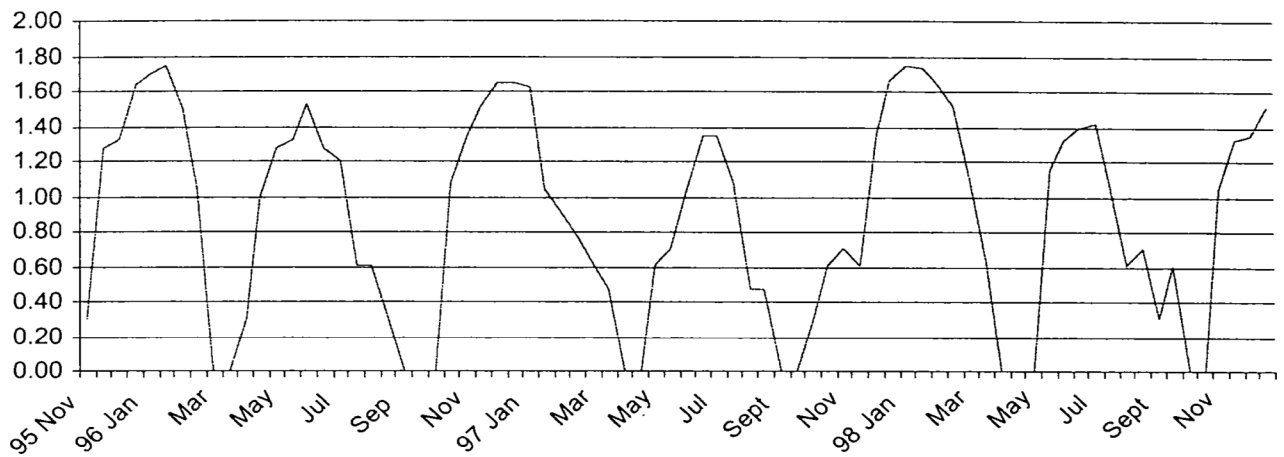


Figure 2. Moving averages for the total biweekly sweep net counts ($n=9$) of paddy bugs ($\log(N+1)$) at Polonnaruwa from 1995 November to 1998 November.

At Ukuwela fields in Matale area, rice was grown mainly during *maha* season (September – February) and in *yala* season (April - August) cultivation was confined to a limited area. During the sampling period (December 1996 – February 1998), paddy bug populations were very high in *maha* compared to *yala* (figure 3). Limited availability of rice during *yala* could have been the main limiting factor for the multiplication of the insect during the season. Paddy bug populations at Gampaha were very low and confined to the rice growing *maha* season (September – February) (figure 4). During the off-season and *yala*, paddy bugs were not recorded in the area. Therefore, in the absence of resident populations, the insects infested the *maha* crop would have migrated from other areas. Therefore, it is evident that field populations of paddy bug composed of both migrating and resident populations.

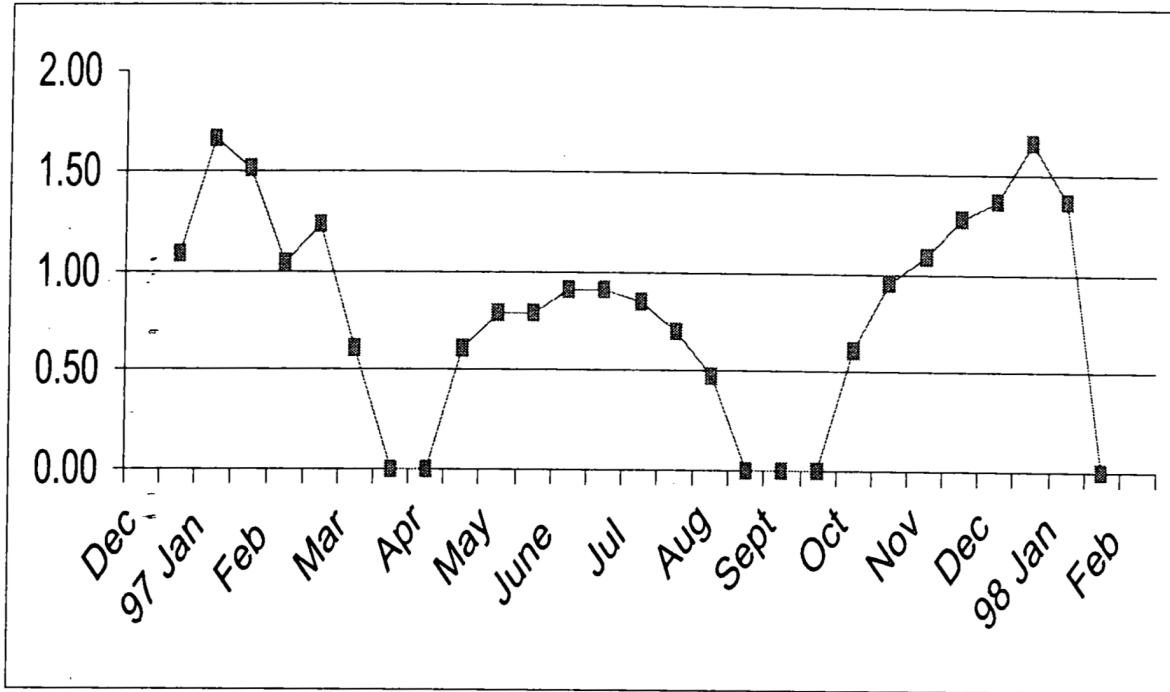


Figure 3. Moving averages for the total biweekly sweep net counts (n= 8) of paddy bug (log (N+1)) at Matale from 1996 November to 1998 February

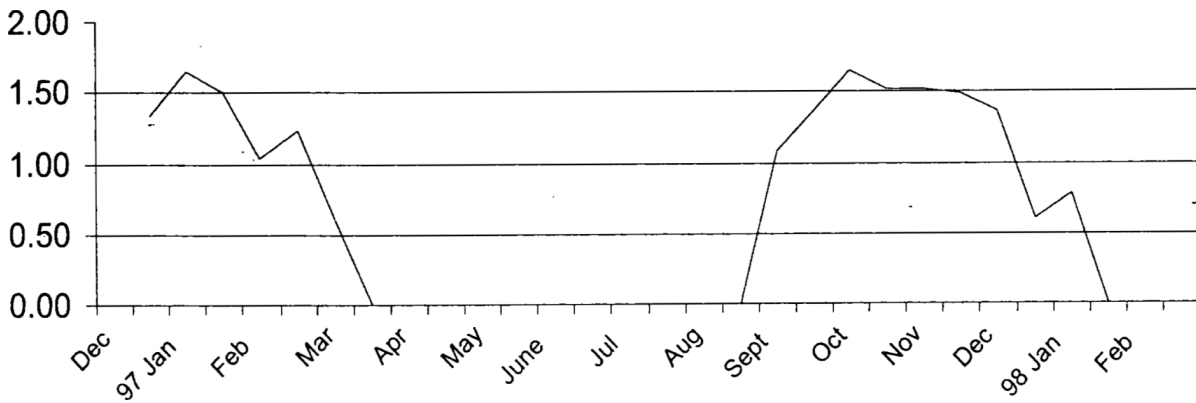


Figure 4. Moving averages for the total biweekly sweep net counts (n=6) of paddy bug (log (N+1)) at Gampaha from 1996 November to 1998 February

Paddy bug populations on rice and non-rice habitats

A close relationship was observed between population densities of paddy bugs on rice and weeds. The peak insect densities on rice and weeds were respectively recorded at heading-milky stage and at harvesting of rice (figure 5, 6, 7 and 8). This could be related to the phenology of rice and weeds in the sampling locations and to the insect's behavior to aggregate on rice at heading for feeding and oviposition and to migrate to weed flowers in the absence of rice panicles. Most weeds in rice and non-rice adjacent areas flower before rice heads and continue until the weeds dry off. As a result a paddy bug populations could sustain on the weed flowers during the off season and vegetative stage of rice.

At Batalagoda, weeds grown under coconut plantations provide shady niches and food supplies for the paddy bug to survive during the off-season. However, at Polonnaruwa paddy bug was not observed in the sampling sites during the off season fallow period. It is possible that paddy bugs migrate to distant forest and shrub areas during this period.

Paddy bugs were not found in the samples collected from the natural vegetation and weedy areas in Matale and Gampaha during the off-season. This is in spite of the availability of alternate weed hosts in these locations. These observations indicated the insect's ability to migrate into distant habitats once the crop is harvested.

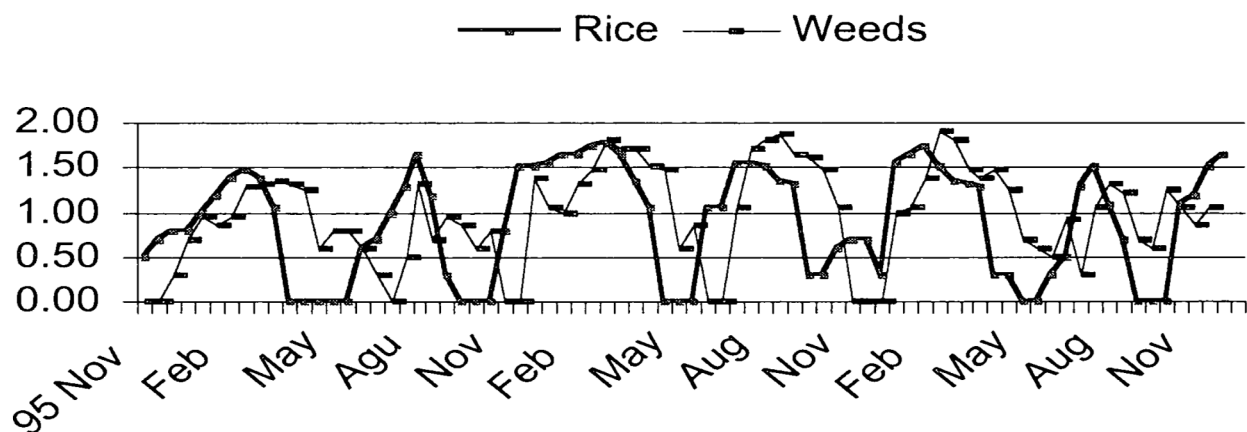


Figure 5. Moving averages for total biweekly sweep net counts ($\log (n+1)$) of paddy bug on rice ($n=5$) and on weeds ($n=5$) at Batalagoda from November 1995-November 1998

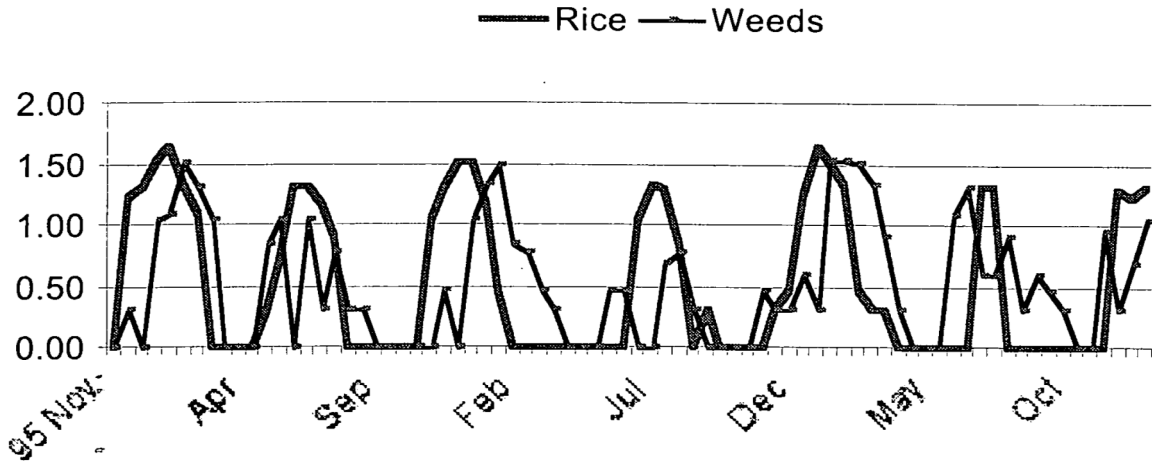


Figure 6. Moving averages for biweekly sweep net counts ($\log(n+1)$) of paddy bug on rice ($n=5$) and on weeds ($n=4$) at Polonnaruwa from November 1995- November 1998

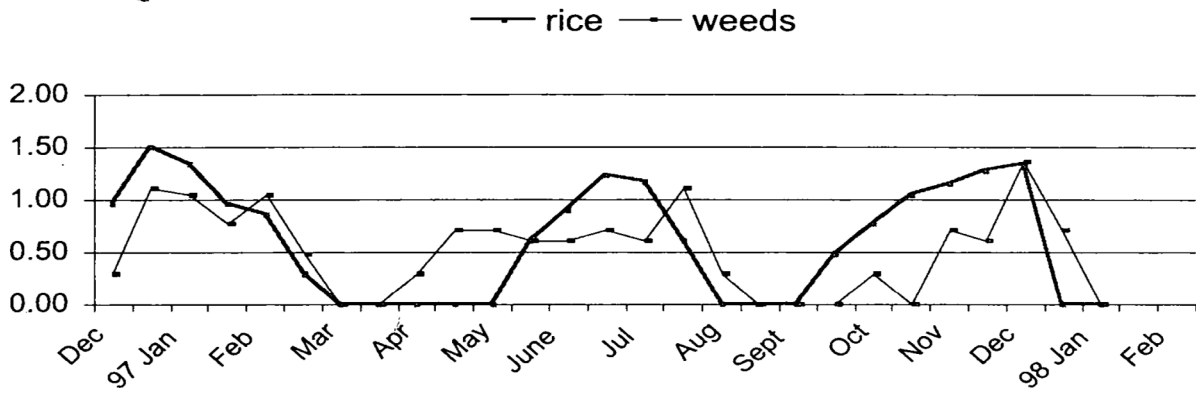


Figure 7. Moving averages for biweekly sweep net counts ($\log(n+1)$) of paddy bug on rice ($n=4$) and on weeds ($n=4$) at Matale from December 1996- February 1998

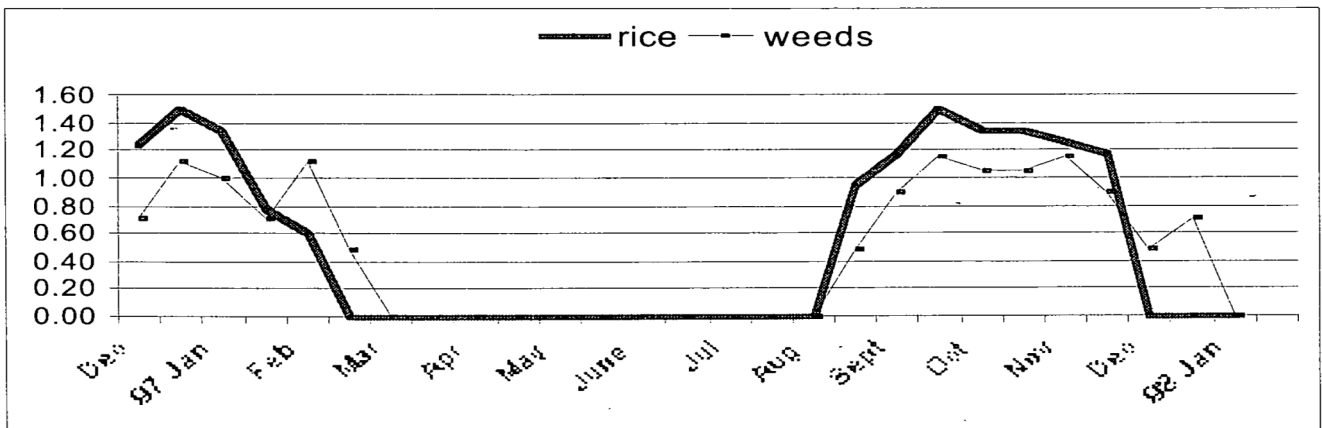


Figure 8. Moving averages for sweep net counts ($\log(n+1)$) of paddy bug on rice ($n=3$) and on weeds ($n=3$) at Gampaha from Dec 96- Feb 98

Population structure of paddy bug

For convenience the first, second and third instar nymphs were grouped as young nymphs and the fourth and fifth instars as mature nymphs. While the young nymphs were confined mainly to rice, the mature nymphs were detected on rice at milky through harvesting stage and on weeds soon after rice is harvested (figures 9, 10, and 11).

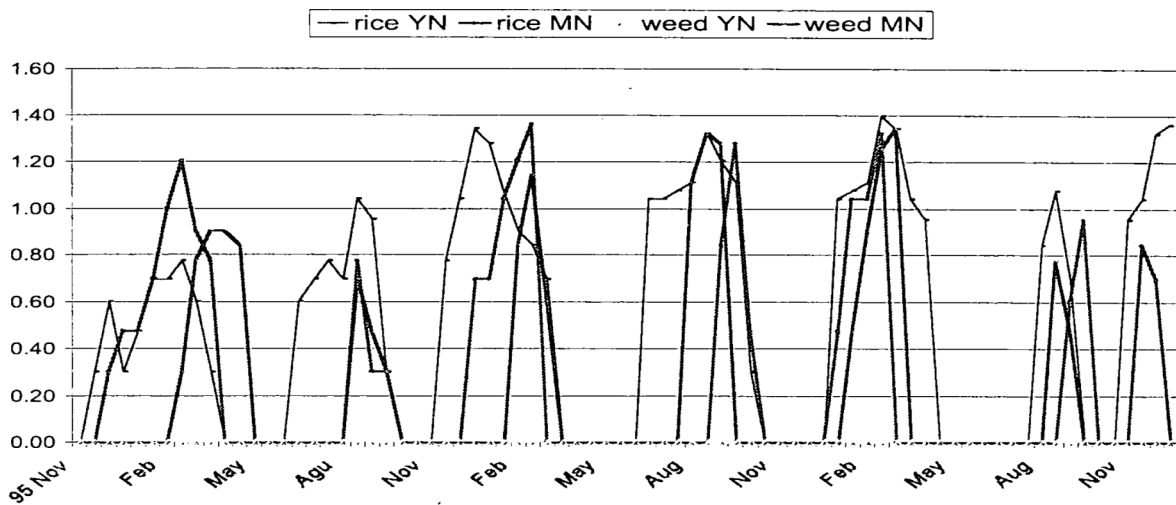


Figure 9. Moving averages for the total sweep net catches (log (n+1)) of young and mature nymphs of paddy bug from rice and non-rice areas at Polonnaruwa Nov 95 Dec 98

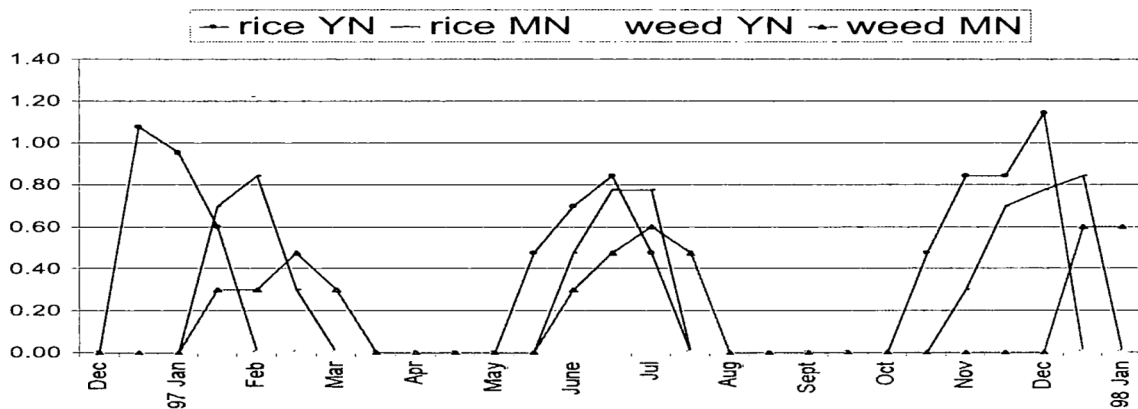


Figure 10. Moving averages for the total sweep net catches (log (n+1)) of young and mature nymphs of paddy bug from rice and non-rice areas at Matale from Nov 96 to Jan 1998

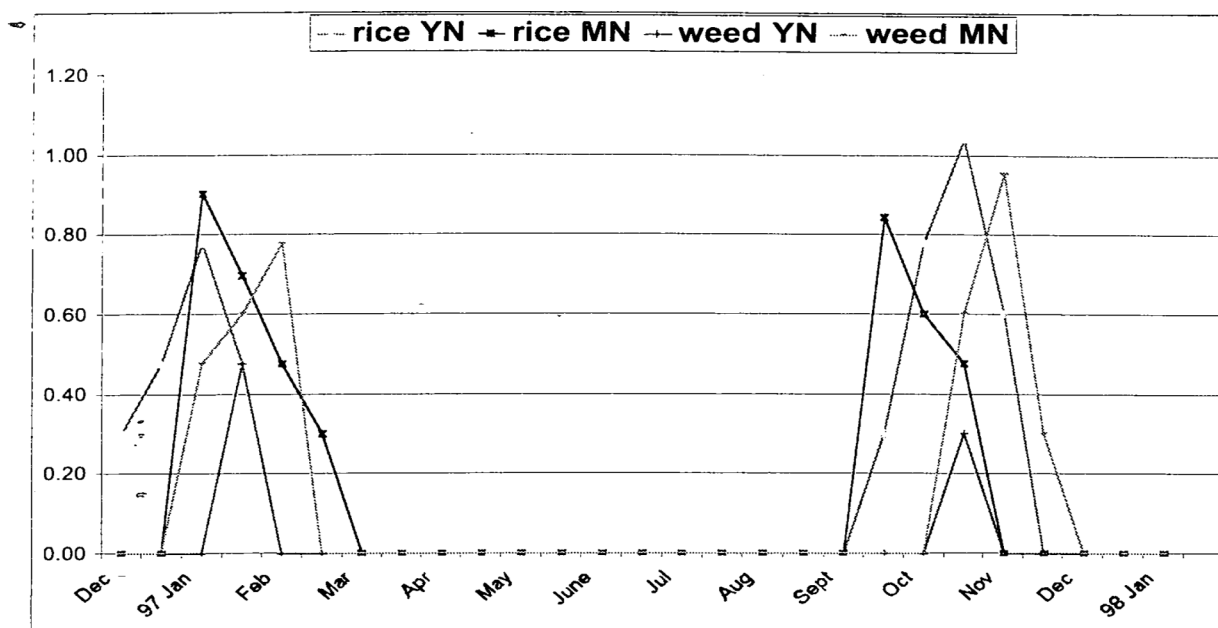


Figure 11. Moving averages for the total sweep net catches ($\log(n+1)$) of young (YN) and mature nymphs (MN) of paddy bug from rice and non-rice areas at Gampaha from Nov 96 to Jan 1998

Populations of young and mature nymphs collected from rice and weeds showed a gradual succession through out the sampling period. These findings confirmed that paddy bugs lay eggs only on rice, and the young nymphs are unable to migrate and survive on weeds. Paddy bugs lay eggs at heading – milky stage of rice to enable all nymphs to mature before the crop harvest.

Maturity of female paddy bug

The percentage of mature females varied from 5% to 95% in all the samples collected (figure 12). Populations collected from heading through milky stage of rice had more than 40% mature females in them.

In all sampling locations the percentage of mature females increased abruptly with the onset of flowering stage of rice. Therefore, it is possible that the insect has a strong response to the rice plant's allelochemicals composition at heading for ovarial development.

Weed flora associated with rice

Of more than 30 species of weeds observed to occur in the sampling areas the commonest ones are listed in table 2. Of these weed species, paddy bugs were found to aggregate more on *Echinochloa colonum*, *E. crus gali*, *E. glabrescens*, *Panicum ripens*, *Ischaemum rugosum*, *Leptochloa* sp, *Digitaria adscendens* (= *D. ciliaris*).

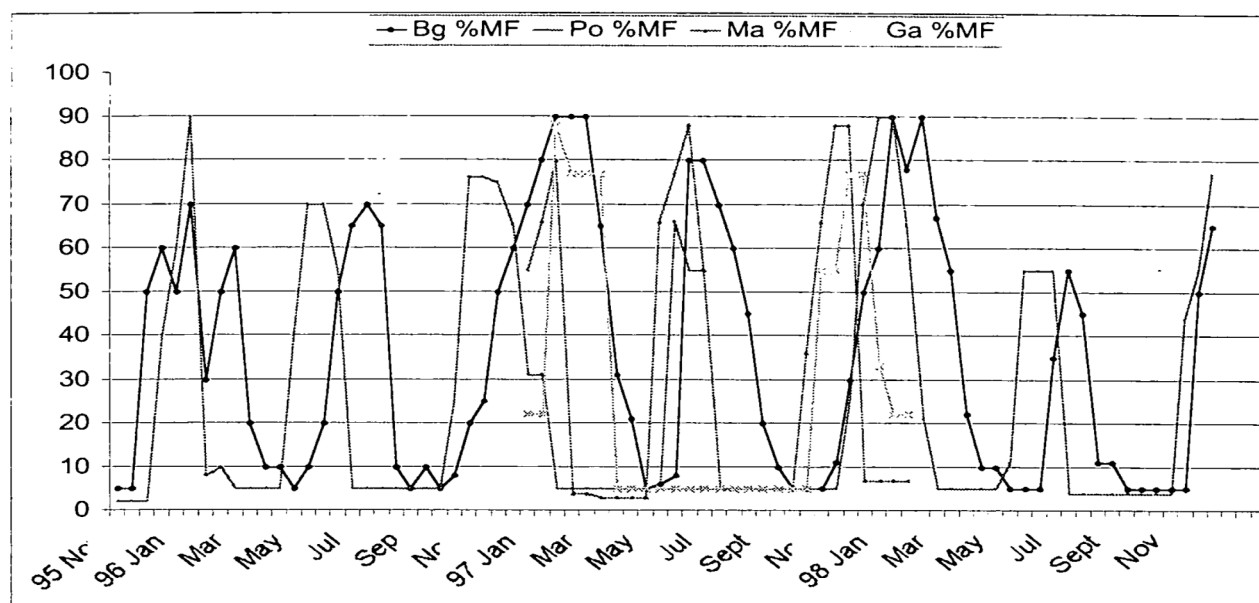


Figure 12. Maturity of paddy bug females (MF) as a percentage of total females collected at Batalagoda (Bg), Polonnaruwa (Po), Matale (Ma) Gampaha (Ga)

3. Distribution of paddy bug egg masses

During the sampling period paddy bug egg masses were seen only on the leaf surfaces (flag leaf and the second upper most leaf) and panicles of rice at heading through milky stage of grains. Paddy bug eggs were not observed on the weeds in all sampling locations. The density of paddy bug egg masses (No. / m²) ranged from 1 to 4 /m² (figure 13). These observations gave further evidences on the role of panicle bearing rice on the insect's life cycle.

Table 2. Abundant weed species observed in the sampling areas

Weeds	Areas			
	Bg	Pol	Mat	Gam
<i>Ipomoea</i> sp	-	X	-	XX
<i>Monocoria vaginalis</i>	X	X	-	X
<i>Sphenoclea zeylanica</i>	X	-	-	X
<i>Digitaria</i> sp	X	X	X	X
<i>Echinochloa colonum</i>	Xx	XX	X	X
<i>E crus- galli</i>	XX	X	Xx	X
<i>Ischaemum rugosum</i>	X	X	X	X
<i>Leptochloa</i> sp	X	X	X	X
<i>Cyperus diformis</i>	X	X	XX	Xx
<i>C iria</i>	X	X	XX	Xx
<i>C rotundus</i>	x	X	XX	XX
<i>Fimbristylis</i> sp	x	X	X	X

Mean weed density - = < 1/m², x = 1- 10/ M², xx = > 10/ m²

Bg = Bathalagoda, Pol = Polonnaruwa, Ma = Matale, Gam = Gampaha

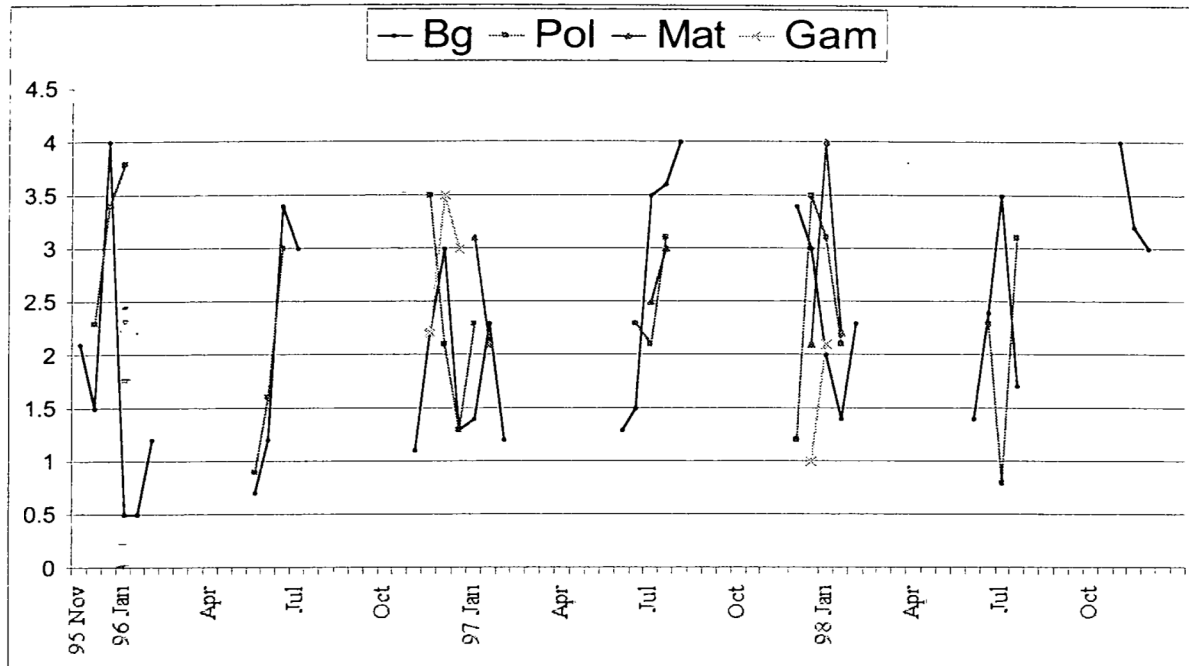


Figure 13. Mean densities of the paddy bug egg masses (No/ m²) at Batalagoda (n=10), Polonnaruwa (n=9), Matale (n=8) and Gampaha (n=6)

4. Identification of alternate hosts of paddy bug

During the fallow period and vegetative stage of rice, paddy bugs rest and feed on the inflorescence of a number of weed species found commonly in rice and non-rice habitats. However, paddy bug eggs were not observed in the field on these weeds. Under no-choice situation paddy-bugs laid significantly lower number of eggs on panicle bearing *Echinochloa colonum* (34), *E. glabrescens* (27), *Panicum ripens* (39) and *Cyperus iria* (25) as compared to rice (81) (tables 3). The number of first generation adults (no/female) that emerged on weed-hosts were significantly lower on *E. colonum* (1.2), *E. glabrescens* (2.6), *P. ripens* (4.2) and *C. iria* (5) as compared to rice (16). Adults emerged on these weeds did not mature to produce eggs on the same host. Rice was found to be the only host-plant that could sustain the total community structure of the insect.

Table 3. Number of eggs laid, nymphs survived to adult hood when 5 pairs of adults confined to different weed hosts 1997 yala (n=5)*.

Host	No egg masses/cage	No. eggs/cage	No. of eggs hatched/cage	No. 2nd instar nymphs/cage	No. 1 st generation adults emerged/cage
<i>E. colonum</i>	12.3 a	171 b	152 b	14 a	6 a
<i>E. glabrescens</i>	9.2 a	137 b	115 b	26 a	13 a
<i>P. repens</i>	6.3 a	198 b	178 b	42 a	21 a
<i>C. iria</i>	5.5 a	126 b	109 b	11 a	5 a
<i>O. sativa</i> (Control)	31.3 b	421 c	367 a	307 b	238 b

In a column means followed by the same letter are not statistically significant at 5% level by DMRT.

DISCUSSION

Leptocorisa oratorius

The genus *Leptocorisa* is distributed in the Orient-Australian region and includes some of the most serious pests of rice. Five species of *Leptocorisa* are recorded in rice: *L. acuta*, *L. chinensis*, *L. oratorius*, *L. biguttata*, *L. palawanensis* (Pathak and Khan, 1994). Of these, *Leptocorisa oratorius* is the commonest paddy bug species recorded in the tropical Asia. Although *Leptocorisa acuta* has been reported earlier in many tropical Asian countries like India, Philippines and Sri Lanka (Ahmad, 1965; Grist and Lever, 1969), specimens of this species were not observed during the present study. Therefore, it is assumed that *Leptocorisa oratorius* is the only *Leptocorisa* sp. present in rice in Sri Lanka.

Host plants of *Leptocorisa oratorius*

Rice is found to be the only host plant that could sustain the total community structure of paddy bug (*Leptocorisa oratorius*). During the sampling period, paddy bug eggs and young nymphs were not observed on weed hosts. This is in spite of numerous reports on alternate host plants of the insect (Corbett, 1923; Grist and Lever, 1969; Sands, 1977; Rajapaksa and Kulasekera, 1980; Pathak and Khan, 1994). The present study also established that paddy bug could lay eggs and the emerging nymphs could develop up to adult hood on some weed species (*Echinochloa* spp. *Panicum* spp. *Cyprus* spp) under no-choice situation. However, the first generation adults thus developed could not reach maturity and lay eggs on the same weed host.

Therefore, it is clear that availability of rice (especially at flowering stage) is essential for the sustenance of paddy bug. The role of rice in paddy bug biology may be either nutritional or allelochemical in nature. This aspect needs to be further investigated. In some insect-plant interactions, secondary plant substances are known to influence insect's reproductive behaviour (Bernays and Chapman, 1994).

Population structure of *Leptocorisa oratorius*

L. oratorius is found to migrate to long distances after the rice crop is harvested especially in the absence of its alternate hosts in the nearby areas. This was evident in Polonnaruwa, Gampaha and Matale populations. In these locations, no paddy bugs were observed during off-season (fallow periods) even after extensive search for the insect. However, in contrast, paddy bugs were found to occur in sampling sites at Batalagoda throughout the sampling period. Therefore, in a given location the insect population could be composed of both residential and migratory insects.

In a given location, paddy bugs were found to migrate back and forth between rice and weed during the vegetative stage of rice. However, the paddy bug tends to aggregate on rice as the crop matures and reach reproductive stage. Depending on the availability of rice panicles over time and space paddy bug completes 2-3 generations before the season ends. Similar population trends have been observed for paddy bug in Indonesia (Rothschild, 1970a and b).

Young nymphs of paddy bug were rarely observed on weeds, indicating their inability to migrate from rice to weeds and to survive on weeds. Paddy bugs collected during milky stage of rice had the highest percentage of mature females indicating a close relationship between crop phenology and the insect's reproductive biology. More paddy bug females were observed on weeds, indicating that female have a higher survival rate than males.

Several species of general predators found commonly in rice ecosystems are known to predate on paddy bug (Manley, 1985). Of these predatory groups, only the populations of web spinning spiders are found to be closely related to those of paddy bug. The role of predators in the management of paddy bug is not well known. Therefore, the effectiveness of these predators in controlling paddy bug needs to be estimated.

Inter habitat movement of *Leptocorisa oratorius*:

If a paddy tract is planted to a single variety (or to varieties with similar maturity) and the planting is done within a shorter period, the paddy-bug population follows a typical distribution pattern (figure 14). The insect's distribution and density levels at heading are determined by the insect abundance on weeds at early vegetative stage, abundance of weed flora (flowering) and the farmer's interventions like insecticide application and

weeding. Therefore in order to design management methods for paddy bug, considerations should be given to a multitude of factors that influence the insect's initial density, availability of alternate hosts for resting/feeding and for migration within the paddy tract and abundance of flowering rice over space and time.

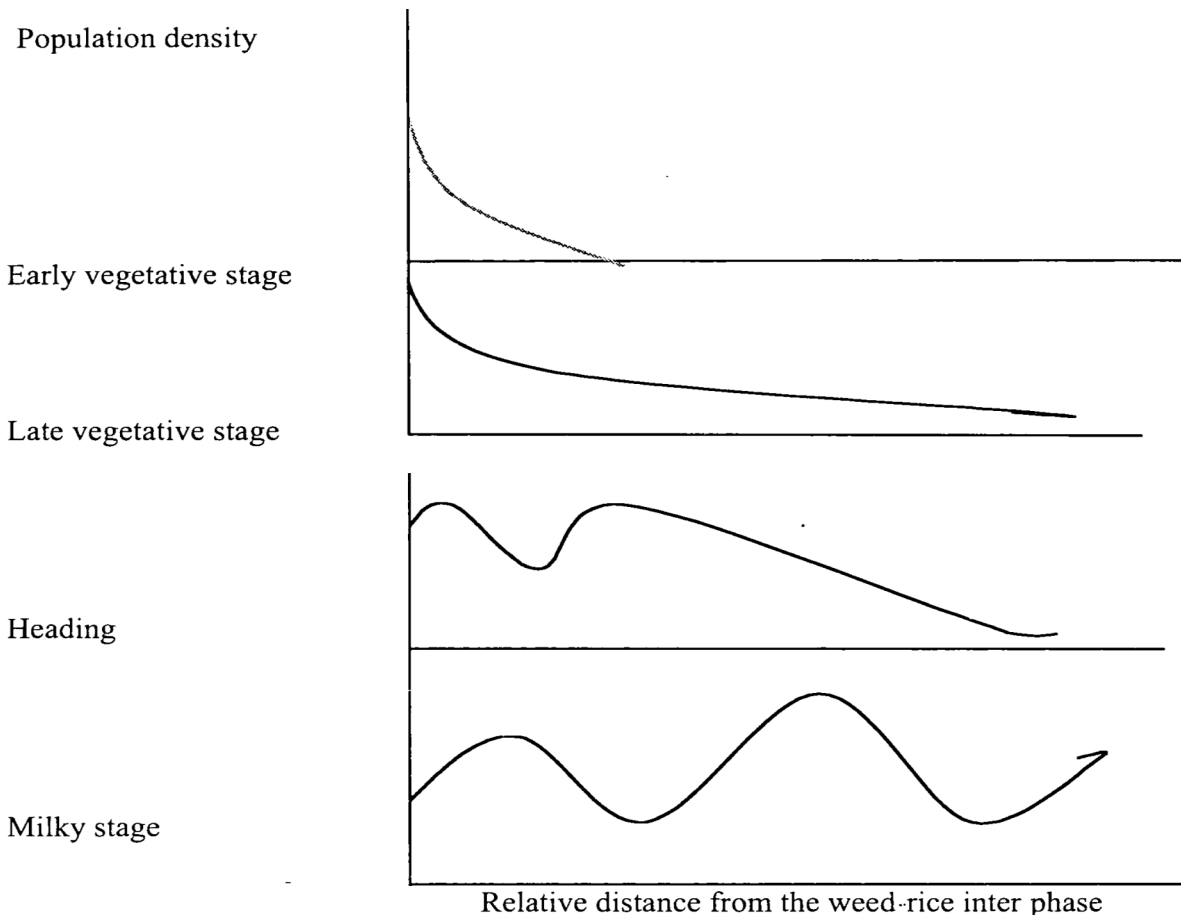


Figure 14. Schematic diagram to indicate the population density trends of paddy bug in relation to the crop growth and the distance from weed-rice inter-phase

Improvement of paddy bug management system

The following facts need to be considered in developing improved management methods for paddy bug: 1. Paddy bug could sustain only in the presence of rice at reproductive stage. 2. Weeds (especially gramineae) provide food (flowers) and niche for the insect during off-season and early vegetative stage of rice. 3. The insect is highly mobile and migrates to rice from long distances before heading stage of rice. 4. Under natural conditions, paddy bug lays eggs only on rice at flowering through milky stage. 5. There is a close relationship between phenology of rice crop and the egg maturity of

the insect. The eggs mature with the onset of flowering of rice. 6. Paddy bug first infests and multiplies on paddies closer to the periphery of the paddy tract. In general, it is the second-generation insects, that migrate to interior of the tract. 7. Paddy bug damage is severe in paddy areas where flowering stage rice is available over a longer period. 8. Farmers are not well aware of the insect's economic significance, critical stage of the crop most vulnerable for insect attack and insects abundance in the crop.

CONCLUSION

Base on the findings of the present study, the following strategies are suggested to improve the management of paddy bug; 1. Plan crop establishment (varieties with similar or different maturity) in a paddy tract in such a way that flowering will be completed within a shorter period. 2. Monitor rice and adjacent non-rice areas for paddy bugs from late vegetative stage of rice (first monitor the non-rice border areas of the paddy tract). 3. Weed the rice and adjacent non-rice areas to keep the populations of flower bearing weeds low. 4. Apply insecticides if the paddy bug population exceed economic threshold level before the flowering stage of rice. This would reduce the population of mature female paddy bugs before they lay eggs, and thus help reduce the population size of the next generation. 5. Since paddy bug is a migratory pest management methods should be undertaken at community level. 6. Develop an awareness programme to farmers to improve their present knowledge and paddy bug management methods.

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REFERENCES

- Ahmad, I. 1965. The Leptocorisinae of the world. Bulletin of the British Museum (Nat. Hist) Supplement 5. pp 156
- Bernays, E.A. and R.F. Chapman 1994. Host-plant selection by phytophagous insects. Chapman and Hall, New York 285 p.
- Grist, D.H. and R.J.A.W. Lever, 1969. Pests of rice. Tropical science series. Longmans Publ. Pp520
- Manley, G.V. 1985. The predatory status *Gonocephalus longipennis* in rice in west Java. Entomological News 96 (4): 167-70, Michigan State University, USA

- Nugaliyadde, L. 1995a. Damage of rice grains caused by rice bug *Leptocorisa oratorius* JIRCAS Journal 2 : 13-17
- Nugaliyadde, L. 1995b. Relation between density of the rice bug *Leptocorisa oratorius* and damage of the rice grains JIRCAS Journal 2: 59-64
- Nugaliyadde, L. 1996. Effect of intensity of weed infestation on the occurrence of *Leptocorisa oratorius* in paddy fields of Sri Lanka JIRCAS Journal 3: 69-74
- Nugaliyadde, L. and T. Hidaka 1994. Pest management practices of rice farmers in Sri Lanka. In (KL Heong and MM Escalada eds) Pest management practices of rice farmers in Asia. International Rice Research institute, Philippines. pp 171-84
- Rajapaksa, R.H.S and V.L. Kulasekera 1980. Survival of rice bug on graminaceous weeds during fallow period between rice cropping in Sri Lanka. IRRN. 5:5. 18-19
- Rajapaksa, R.H.S. and V.L. Kulasekera 1982.. Predators of rice bug in southern Sri Lanka. IRRN 7:1.13p
- Rothschild, G.H.L. 1970a. Observations on the ecology of rice ear bug *Leptocorisa oratorius* in Sarawak. J appl entomol. 7 147-167
- Rothschild, G.H.L. 1970b. some notes on the effect of rice ear bug *Leptocorisa oratorius* on grain yield. Trop. Agriculture, Trinidad 47 147-9
- Rothschild, G.H.L. 1970c. *Gryon flavipes* (Hymenoptera: Scelionidae) an egg parasite of rice bug *Leptocorisa oratorius*. Entomophaga 15: 15-20