Tropentag 2007
University of Kassel-Witzenhausen and
University of Göttingen, October 9-11, 2007

Conference on International Agricultural Research for Development

Abundance dynamics of selected arthropods in relationship with rice plant growth, pests and their natural enemies

Sarwshri Gangurde[1], Konrad Martin[1], Friedhelm Goeltenboth[1], Joachim Sauerborn[1] and Maria Juliet C Ceniza[2]

[1]Institute of Plant Production and Agroecology in the Tropics and Subtropics, University of Hohenheim, 70593 Stuttgart. Email: svgang@uni-hohenheim.de

[2]Institute of Tropical Ecology, Leyte State University, Leyte, 6521-A Philippines

Abstract

The cultivation of tropical Asian rice, which may have originated 9,000 years ago, represents an agricultural ecosystem of unrivalled ecological complexity. However, this crop is heavily infested with various pests. These pests have been reported to cause > 80 % damage to rice crop. The control strategies of these pests mainly rely on the application of chemical insecticides. However, indiscriminate use of chemical pesticides has led to health as well as environmental hazards and increasing the cost of cultivation. These studies were conducted in the major irrigated tropical rice fields of Leyte, Philippines. We have observed that abundance of various species of arthropod pests including leaf hoppers (Cicadellidae; Nephotettix species and others), plant hoppers (Delphacidae), bugs (Pentatomidae, Scotinophara coarctata and Coreidae), Coleoptera (mainly Chrysomelidae) and grasshoppers (Acrididae and Tettigoniidae), their natural enemies includes dragonflies (Anisoptera), damselflies (Zygoptera), ladybird beetles (Coccinellidae) and spiders (Araneae) were highly associated with various stages of the crop growth. In chemical treated site, maximum number of pest population was observed during the early tillering stage and remain present during the whole duration of the crop. Coreidae and Alydidae infested rice simultaneously, and remained abundant together, while Delphacids pests were noticed fare abundance in early stage of the crop. However in untreated site Cicadellidae pest was found more abundant during the tillering stage, high number of Alydidae, Coreidae were recorded during the milking and maturity stage of the crop. Spiders and Coccinellidae found more during tillering stage to milking stage. These results also give correlation as when the pest population developed; the predator population soon became abundant. On average pests found with more abundance than the predators.

Key words: abundance, Philippines, population dynamics, pests, predators, rice, spiders.

2 Introduction

The Philippines, which is also a prominently rice growing country accounted 11 million tons production on 98,000 hectares in 1995, despite of such a huge production Philippines are facing rice shortage since 1995, which influenced the increase in rice prices (HEONG ET AL., 1995). Among the major constraints of Philippine rice production is the occurrence of pests and misuse of insecticides for their control is a severe problem (ROLA AND PINGALI, 1993). As a result, efforts are being made to evaluate the natural abundance of predators associated with the pest complex towards the rice ecosystem. The study of the community ecology of irrigated tropical rice fields on Leyte, Philippines was undertaken to record, identify and count individuals of selected insect species occurring in different stages of rice growth and to estimate community characteristics which include the proportional abundances of the taxa distinguished and predator/prey ratios in different stages of rice growth and in dependency of the use of insecticides as a supporting study for biological/natural control of the insect pests.

3 Materials and Methods

This study was conducted in the western part of Leyte, Philippines; one area was located in the Leyte State University (LSU) campus at the agroforestry demo farm (site 1) treated with insecticide and the other area was located in the Barangay Pangasugan 2.3 kms. north from the LSU (site 2) left untreated. Each selected plot was 100 m^2 and 3 plots were selected in each site. The rice (var. RC-18) was planted at both sites at the spacing of 20 X 20 cm. and the rice was followed as a succession to the rice crop. In this study, we used net sweeping and malaise trap method for collecting pests and predators in both sites during various stages of rice growth. In sweep method, hand net sweeping (47 cm diameter) was done using a sweep net with a 2m handle. Insects in the upper strata of vegetation and those fly due to the disturbance was trapped and killed using plastic jar containing ethyl alcohol (95%) for 5-10min. and then transferred to the bottle (preservation jar) with 70% alcohol for identification. Total 20 sweeps per plot was used as a standard number for the accuracy in calculating abundance.

The malaise trap was installed in both sites along the border of the rice field facing to the other vegetation. The trap was kept open only in one direction to study the movement/ migration of the insects from the other vegetation i.e. agroforest to the rice fields. Observation was made after every 24 hours once a week. The specimens were identified up to the lowest taxonomic category (SHEPARD ET AL., 1987a & 1987b). Then, based on occurrence of both pest and predators, the predator-pest ratio was computed.

4 Results and Discussion

4.1 Pest and predator abundance

4.1.1 *Pest abundance*

In the net sweeping method, the abundance of the pest species and predators during the seedling stage in the first 2 weeks of the crop growth was zero at both sites (Figs. 1-2 and

Figs. 3-4). The pest incidence emerged after the 3rd week of crop growth (Figs.1and 3). During the pre tillering stage Cicadellids (*Nephotettix* spp., *Recilia dorsalis*) abundance was on increasing trend, which correlate with the 7 years of observations by VREDEN AND AHMADZABIDI (1986), this phytophagous (sap feeding) species indicating their dependence on the leaves for food (BORROR ET AL., 1981 in DAVIES 2002). The next dominant Alydidae appeared to be highly represented family from post tillering to the maturity of the crop. Chrysomelidae abundance was little during the whole growth period of the crop at both sites, only one individual each was recorded during the 5th and 7th week at site 1. In site 1 *Leptocorisa* (Alydidae) and *Pygomenida varipennis* (Coreidae) found abundant during the milking stage (9th week) of the crop and remain abundant during the maturity (13th week) (Fig. 1). Pentatomidae pest was recorded 23 individuals in site 1; it was zero in site 2. Contrarily Acrididae was zero in site 1 and was recorded 14 individuals in site 2.

Malaise trap observations in site 1 indicated Cicadellidae more predominant at tillering stage 10 (4th week), 7(5th week), 8(6th week) and 7(7th week) individuals out of the total population captured in site 1, indicating the migration of the pest to the young crop and was abundant until the crop reached milking stage (Fig. 1). Out of the total 540 Cicadellidae individuals captured, only 40 captured by malaise trapping in Site 1(Table 1), followed by other families including Delphacidae, Acrididae, Alydidae, Pyrgomorphidae, mainly belonging to Orthoptera and Hemiptera. TIEMPO (1996) also reported the abundance of Orthoptera and Hemiptera in the agroforestry area, which gives correlation between the occurrence and migration of these pests.

4.1.2 *Predator abundance*

The collection by net sweeping method indicated the abundance of predator species belonging to Coccinellidae, Coenagrioniidae, Miridae, and Araneae (Figs. 2 and 4). Additionally Carabidae, Tettigoniidae and Gryllidae were also observed. The pest and predator abundance was dropped during 10th week at site 1 due to insecticide spraying (Figs. 1 and 2) while such a trend was not observed in (untreated) site 2 (Figs. 3 and 4). Out of the total 212 Coccinellidae captured only 4 individuals contributed to the population by malaise trapping against net sweeping means no migration of these species in site 1, additionally out of 186 Coccinellidae captured in Site 2 (Table 1), 20 individuals captured by malaise trap. Araneae (*Oxyopus javanus*, *Lycosa pseudoannulata*) found major abundant from tillering to maturity of the crop which found similar to the observations of Didonet et al. (2001). Gryllidae was dominantly recorded with 23 individuals in site 1 but only 5 individuals at site 2.

Tettigonidae was found 19 individuals in site 1 and was abundant from 5th week with maximum of 5 individuals in 9th week. It was recorded 23 in site 2, maximum abundance was during 11, 12, 13 weeks 3, 6, 10 individuals respectively together both methods.

4.1.3 *Other additional observations*

The abundance of predators in terms of number of individuals was little compared to the abundance of the pest meant for the proper regulation and the management of the community structure in the rice ecosystem. In site 2, the additional migratory population found in malaise trap during tillering were the Delphacids (*Nilaparvata lugens, Sogatella furcifera*) (Fig. 3) and Pyrgomorphidae (*Atractomorpha* spp.). Coccinellidae predators found abundant during the whole duration of the crop. *Micraspis* spp. was higher at the onset of flowering stage indicating the most preferred stage for the migration of these species (BURDEOS, 2002). Natural enemies such as dragonflies (Anisoptera), damselflies (Zygoptera) were also observed.

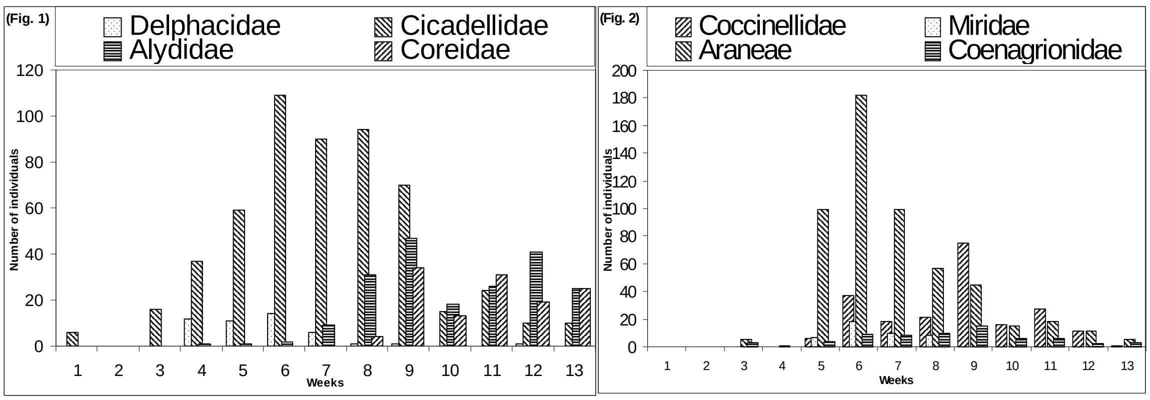

Figure 1 and 2: Abundance of insect pests and predators in site 1.

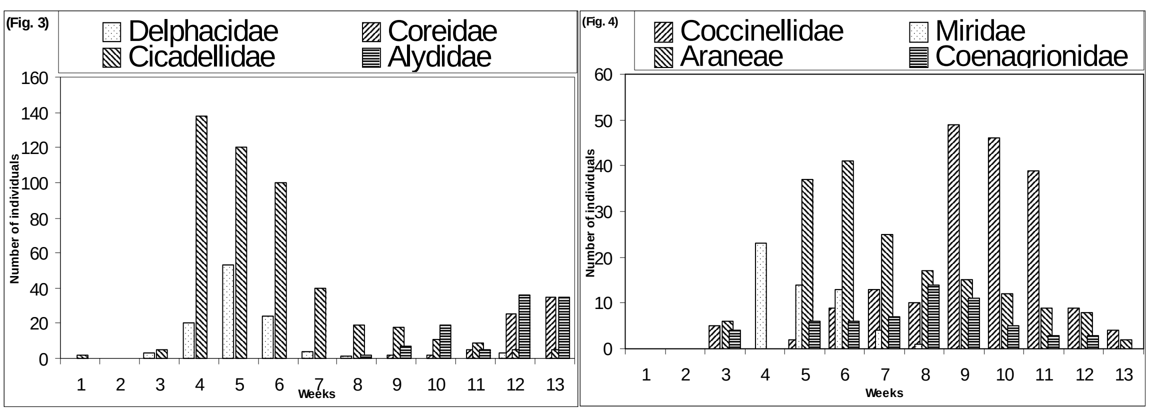

Figure 3 and 4: Abundance of insect pests and predators in site 2.

Regression analysis of the data at the 5% significance level showed that pest species such as Acrididae, Alydidae, Cicadellidae, Coreidae, and Pentatomidae had no significant insecticide effect. Delphacidae (*Nilaparvata lugens* and *Sogatella furcifera*) found with significant effect on their abundance (P=0.007). Delphacidae pests appear during the milk stage and tillering of the crop and the insecticide treatment was done during the 10th week of the plant growth, where the plant almost approached maturity.

Regression analysis of predators showed that spider population with highly significant negative insecticide effect (P=< .0001), as they prefer mainly Delphacidae pest.

Gryllidae, Miridae, Tettigonidae not significant effect of insecticide treatment, this is due to the single reason that they are predators and do not feed on the plant directly.

Table 1: Standard deviation (S.D) and coefficient of variation (CV) of the pests and predators abundance of both sites.

Pests	Site 1	Site 2	Total	Mean	S.D	CV
Pentatomidae	23	0	23	11.5	16.26	141.39
Delphacidae	46	108	154	77	43.84	56.93
Cicadellidae	540	472	1012	506	48.08	9.5
Alydidae	201	104	305	152.5	68.58	0.44
Coreidae	126	69	195	97.5	40.3	41.33
Acrididae	0	14	14	7	9.89	1.41
Predators	**Site 1**	**Site 2**	**Total**	**Mean**	**S.D**	**CV**
Coccinellidae	212	186	398	199	18.38	9.23
Tettigonidae	19	23	42	21	2.82	13.42
Gryllidae	23	5	28	14	12.72	90.85
Miridae	43	55	98	49	8.48	17.3
Araneae	537	172	709	354.5	258.09	72.8
Coenagrionidae	66	59	125	62.5	4.94	7.9

4.2 Predator-Pest Ratio

The predator: pest ratio during the seedling was zero indicating no appearance of pest and predator species, while during the tillering stage of the crop the ratio was calculated 1:1 (Table.2) which is also expected in an out balanced ecosystems. Interestingly at 10th week in site 1 which was treated once at that time was found more abundant with pest species as compared to (untreated) site 2.

The ratio has been proved to be true in many natural ecosystems and was also found in the studies carried out in the rice fields in Palawan Island (Martin et al., 1997). At milk stage higher number of pests was found at site 1 than site 2 (Table 2). This might be due to the resistance to insecticide as well as partial migration from agroforestry area at site 1 (Table. 2). At both sites when crop reached maturity stage there was twice to five times more pests than the predators. At maturity it was found out to be almost more than double of the predator arthropods (Table. 2). It indicated from all observations that the pests remain more abundant than the predators.

Table 2: Predator-pest ratio in both sites (net sweeping in weeks).

Weeks	Predator pest ratio	
	Site 1 (treated)	Site 2 (untreated)
1	0:0	0:0
2	0:0	0:0
3	1:2.6	1:1
4	0:0	1:7.1
5	1:0.5	1:2.4
6	1:0.6	1:2
7	1:0.9	1:1.4
8	1:1.6	1:0.9
9	1:1	1:0.4
10	1:1.2	1:0.5
11	1:1.5	1:0.4
12	1:2.6	1:2.8
13	1:5.6	1:5.5

5 Conclusion

The data gathered and observations on the natural abundance of the pest and predators families gives the direction which helps in understanding the diversity of the insect pests and predators, which might be helpful in developing the strategy in the natural biological control of the pest using different predator population in the ecosystem context in understanding the proper regulation of the rice agroecosystem without any inputs outside the agroecosystem.

Acknowledgements

The Eiselen Masters Research Grant from the **Eiselen Foundation, Ulm** funded this work.

References

BURDEOS, M.M. (2002). The role of *Micraspis crocea* Mulsant (Coleoptera: Coccinellidae) in the rice ecosystem. - M. Sc Thesis, Baybay, Leyte, Leyte State University. pp 24-29.

DAVIES, K. (2002). Diversity and abundance of Coccinellidae in different land use systems of Leyte, Philippines. - M. Sc Thesis. University of Hohenheim, 70593 Stuttgart, Germany.pp 20-26.

DIDONET, J., DIDONET, A. P., ERASMO, E. L. AND SANTOS, G.R. (2001). Incidence and population dynamics of pests and their natural enemies in upland rice in Gurupi, Tocantins. - Bioscience Journal. 17(1): 67-76.

HEONG, K.L., ESCALADA, M.M AND LAZARO, A.A. (1995). Misuse of Pesticides among Rice Farmers in Leyte, Philippines. - In: Impact of Pesticides on Farmer

Health and the Rice Environment (eds: PINGALI, P.L & ROGER, P.A.) Kluwer Academic Publishers, MA: 97-108.

MARTIN, K., KNAPP, M., CENIZA, M.J.C., BROKMANN, I., HOLSCHACH, V., FRANS, T. M. AND NICKEL, E. (1997). Arthropods and Weeds in and around rice fields of Tondano Lake Area, North Sulawesi. - In Proceedings of the 5th International Seminar and Work shop on Tropical Ecology, 4-18 August 1997 Tomohon-Manado, North Sulawesi,Universitas Kristen Indonesia. pp 17-21.

ROLA, A.C AND PINGALI, P.L. (1993). Pesticides, Rice Productivity and Farmers Health- An Economic Assessment. - World Resources Institute and International Rice Research Institute, Los Banos, Laguna, Philippines. pp 9-17.

SHEPARD, B.M., BARRION, A.T. AND LITSINGER, J.A. (1987a). Helpful insects, Spiders and Pathogens. - International Rice Research Institute (IRRI), Los Banos. pp 1-45.

SHEPARD, B.M., BARRION, A.T. AND LITSINGER, J.A. (1987b). Rice feeding insects of Tropical Asia. - International Rice Research Institute (IRRI), Los Banos. pp 1-87.

TIEMPO, V.P. (1996). Diversity of arthropod fauna associated with *Acacia auriculiformis*. A.Cunn. Ex Benth (Leguminoceae). – M. Sc Thesis, Baybay, Leyte, Leyte State University. pp. 17-54.

VREDEN, G. AND AHMADZABIDI, A. L. (1986). Pests of rice and their natural enemies in peninsular Malaysia. Pudoc Publishers. pp 15-19.