International Journal of Agricultural Technology 2016 Vol. 12(7.1):1345-1366
Available online http://www.ijat-aatsea.com
ISSN 1686-9141

Insects Associated with Organic and Inorganic Rice Farming

Labe, M.S., Fernado, N.C. and Fiegalan, E.R.

Department of Crop Protection, College of Agriculture, Central Luzon State University, Science City of Munoz, Nueva Ecija 3120, Philippines

Labe, M.S., Fernado, N.C. and Fiegalan, E.R. (2016). Insects Associated with Organic and Inorganic Rice Farming. International Journal of Agricultural Technology 12(7.1):1345-1366.

A study was conducted in organic and inorganic ricefields to identify all insects present in both methods of farming.
A total of 34, 957 insects and other arthropods were collected; 17, 549 in organic and 17, 408 in inorganic ricefield, respectively, through net sweeping. The orders of insects represented from the collection include the Odonata, Orthoptera, Thysanoptera, Hemiptera, Homoptera, Coleoptera, Strepsiptera, Diptera, Lepidoptera, and Hymenoptera. Spiders (Araneae) and mites (Acari) in the Class Arachnids were also collected.
Among the insects, Diptera and Homoptera had the highest counts in both methods of farming. Both organic and inorganic ricefields had high counts of insect pests. Higher counts of natural enemies were observed in organic ricefield.

Keywords: organic farming, inorganic farming, insect pests, natural enemies

Introduction

Rice (*Oryza sativa* L.) is one of the most important crops in the world and is the primary staple food for over 2 B people. It is grown worldwide in over 124 M hectares under diverse cultural conditions and over a wide geographical range. Rice is also the most important crop to millions of farmers who grown it and others who derive income from working on these hectares of rice fields. Continued population growth in developing countries significantly increased production and consequently increased demand (Barus *et al.*, 2013) especially in Asia where farmers account for about 92% of the world's total rice production and consumption. (Rice production are highest in Asia and continued to increase at a remarkable rate.

In the Philippines, Filipinos decide when to plant the crop according to the occurrence of monsoon rains and the availability of irrigation water. Asian countries practices both the organic or "ecological" and inorganic or

Coressponding Author: Labe, Marita S. **E-mail:** mdslabe@gmail.com

"conventional" mode of farming at varying degrees. Organic agriculture promotes a natural environment and sustains the health of the soil ecosystem and people. It also keeps the soils strong and fertile to have a good produce and maintain the diversity of the entomophagous insects that deals with the pest to have an ecological balance in the environment. Organic farming involves using techniques to achieve crop yields without harming the natural environment. Organic farmers keep and build the good structure of the soils by the use of composted wastes and animal manures, crop rotation, and right cultivation of soil at the right time. Other methods employed are to control pest by increasing genetic diversity, using natural pesticides to encourage predators that eat insect pests and careful planning for the crop choice. Organic agriculture aims not to eradicate all the pests but also to keep them to an acceptable level and make the most of the benefits that it may provide.

Inorganic method of growing rice on the other hand, usually employ synthetic fertilizer and pesticides to control pests of rice and for higher yield. This production system is believed to enhance soil degradation pollution and chemical residues in food and loss in biodiversity. It also intensifies the farm household's actual and physiological burden on high-cash capital expenses

The greater appearance of rice in agricultural ecosystems will tend to increase species richness of both pests and natural enemies (Barrion and Litsinger, 1994). Since organic and inorganic rice farming employ different strategies to ultimately, produce high yield, it might be possible that insects present in each system vary. Hence, this study was conducted with the aim: 1) to identify all insects present in organic and inorganic rice farming; and 2) to determine the occurrence of the insects present in both methods of farming.

Materials and methods

Experimental Fields

Sampling was carried out in separate fields to represent organic and inorganic farming practices.

The organic rice farming field was represented by the project of the College of Agriculture, Central Luzon State University while the inorganic rice farming field was represented by a farm in the nearby Barangay Bagong Sikat, Science City of Munoz, Nueva Ecija, Philippines.

The organic farming field employs multicropping and crop rotation. Crops raised in the area include rice, mango, mungbean and green pepper. Goats are also raised in the area.

The inorganic ricefield employs monocropping of rice from season to season. It is bounded by ricefieds on the north and west, and residential houses on the east and south.

Collection of Samples

Sampling through sweeping using insect net was carried out as early 6:00 o ̧lock in the morning starting from the pre-tillering stage up to maturity of the rice crop or until before harvest. In each field, six predetermined sampling areas measuring $25m^2$ were used as the sampling sites. In each site, five zigzagging lines across the field were determined. Each line were net-swept at least twenty counts. Each sweep sample covered an arch of 180^o or 90^o (straight sweep) repeatedly carried out up to 100 sweeps, with the sweep nets striking the upper 15-20 cm (6-8 inches) of the rice plant. Swept samples were preserved in 70% ethyl alcohol.

Sorting and Identification

The samples were brought to laboratory for sorting and identification. The specimens were identified through diagnostic characters using identification keys developed by various taxonomists or with the help of taxonomists. As was possible, identification was either up to species or genus level.

Results

A total of 34,957 Arthropods were collected through net sweeping; 17,549 and 17,408 from the inorganic ricefields, respectively. The insects were represented in ten orders in the Class Insecta to include the Coleoptera, Diptera, Hemiptera, Homoptera, Hymenoptera, Lepidoptera, Odonata, Orthoptera, Strepsiptera and Thysanoptera. Collections from the Class Arachnida include the Araneae (spiders) and the Acari (mites).

The order Homoptera represents the most number of species of insect pests while the most number of species of natural enemies is represented by the order Hymenoptera.

The collections were identified as presented in the Table 1.

Table 1. Collected specimens categorized as pests, natural enemies and miscellaneous

	Insect Pests	Natural Enemies	Miscellaneous
Odonata		*Agriocnemis sp*	
Orthoptera	*Atractomorpha sp.* *Oxya hyla hyla*	*Anaxipha longipennis* *Conocephalus longipennis* *Metioche vittaticolis*	*Tetrigid*
Thysanoptera	*Frankliniella tenuicornis*		
Hemiptera	*Leptocorisa oratorius* Unidentified *whiteflies*	*Cyrtorhinus lividipennis* *Nabis stenoferus*	*Coptosoma sp.* *Esycoris sp.* *Orius sp.*
Homoptera	*Nephotettix virescens* *Nephotettetix nigropictus* *Cofana spectra* *Cicadulina bipunctata* *Recilia dorsalis* *Sogatella furcifera* *Nilaparvata lugens* *Laodelphax striatellus*		
Coleoptera	*Hydromidius molitor*	*Coccinella repanda* *Micraspis sp* *Ophionea nigrofasciata*	*Monolepta bifasciata*
Strepsiptera		*Halictophagus munroei*	
Diptera		*Condylostylus* *Drapetis (Elpropheza) sp* *Focipomyia sp* *Ochthera brivitibialis* *Ochthera sauteri* *Sepedon sp. 1* *Sepedon sp. 2* *Tachinid* *Tomosvaryella oryzaetora*	*Agromyza* sp. *Anatrichus* sp. *Calliphora* sp. *Chironomus* sp. *Chironomus javanus* *Chironomus keinsis* *Chlorops* *Drosophila sp1* *Drosophila sp2* *Drosophila sp3* *Drosophila sp4* *Orseola oryzaevora* *Notiphila latigens* *Tipula aino*

Lepidoptera	*Scirpophaga incertulas*		*Amata sp* *Elasmopalpus*
Hymenoptera		*Brachymeria lasus* *Bracon onukii* *Charops bicolor* *Cotesia flavipes sp. 1* *Cotesia sp. 2* *Cotesia sp. 3* *Euplectros chapidae* *Exoryza (Appanteles)* *Gambrus sp* *Pediobius atamiensis* *Poeciologonalos* *Rogas sp* *Stenobracon* *Scelio muraii* *Trathala flavoorbitalis* *Trichogramma sp* *Trichomalopsis oryzae* *Trissolcus* *Tropobracon schoenobii* *Xanthopimpla enderleini* *Solenopsis geminate*	*Chronoxemos*
Araneae		*Agriope* *Agyrodes bondea* *Araneius sp. 1* *Atypena adelinae* *Oxyopes javanus* *Tetragnatha javanus* *Tetragnatha maxillasa* *Thomisos okenawensis*	

Representative specimens of the insect pests are shown in Figures 1 and 2. The natural enemies are shown in Figures 3 to 9.

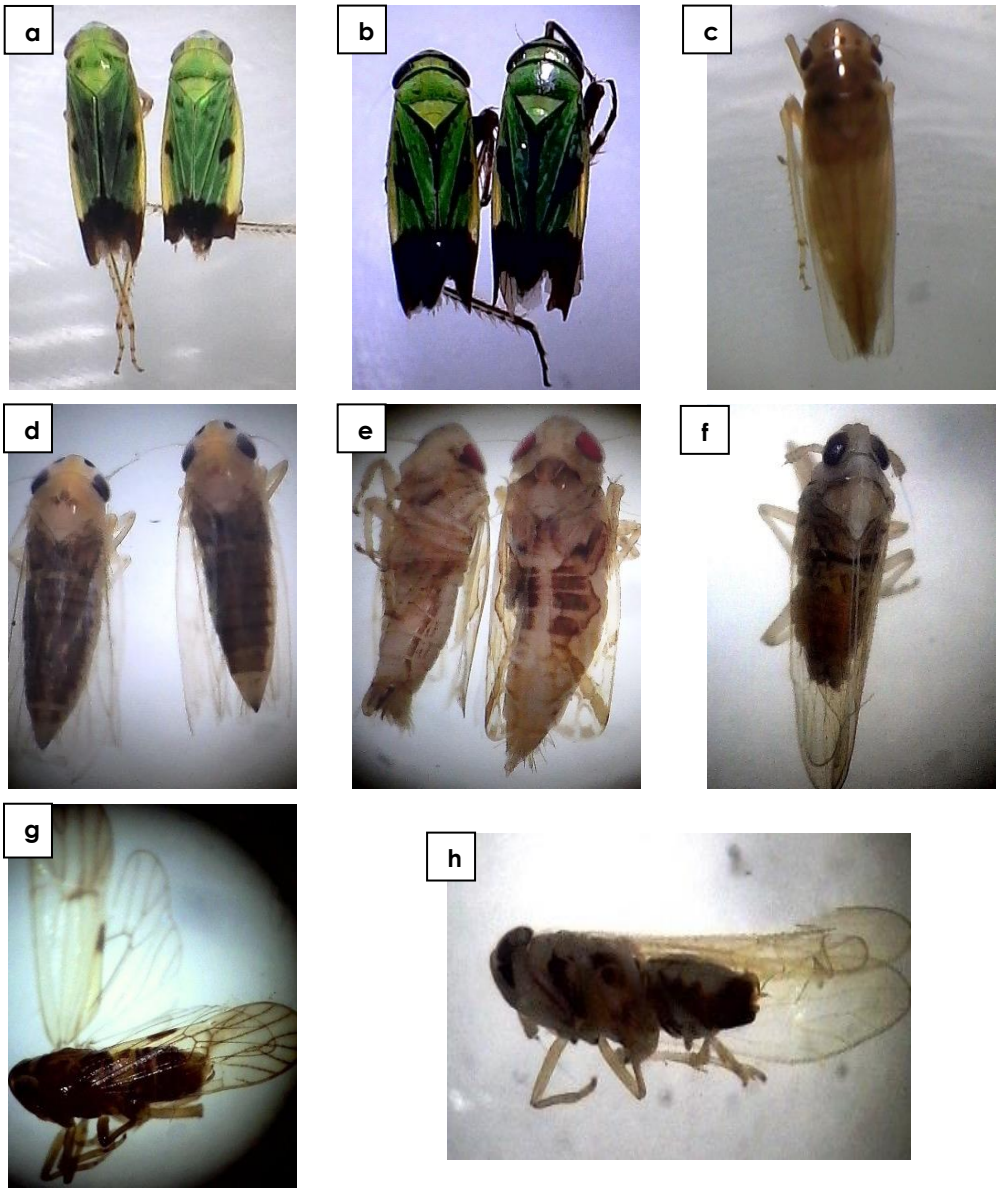

Figure 1. Leafhoppers and planthoppers: (a*) Nephottetix virescens*, (Distant) (b) *N. nigropictus* (Stal) (c) *Cofana spectra, (*Distant) (d) *Cicadulina bipunctata* (Melichar), (e) *Recilia dorsalis* (Motschulsky), (f) *Sogatella furcifera* (Horvath), (g) *Nilaparvata lugens* (Stal), (h) *Laodelphax striatellus* (Fallen)

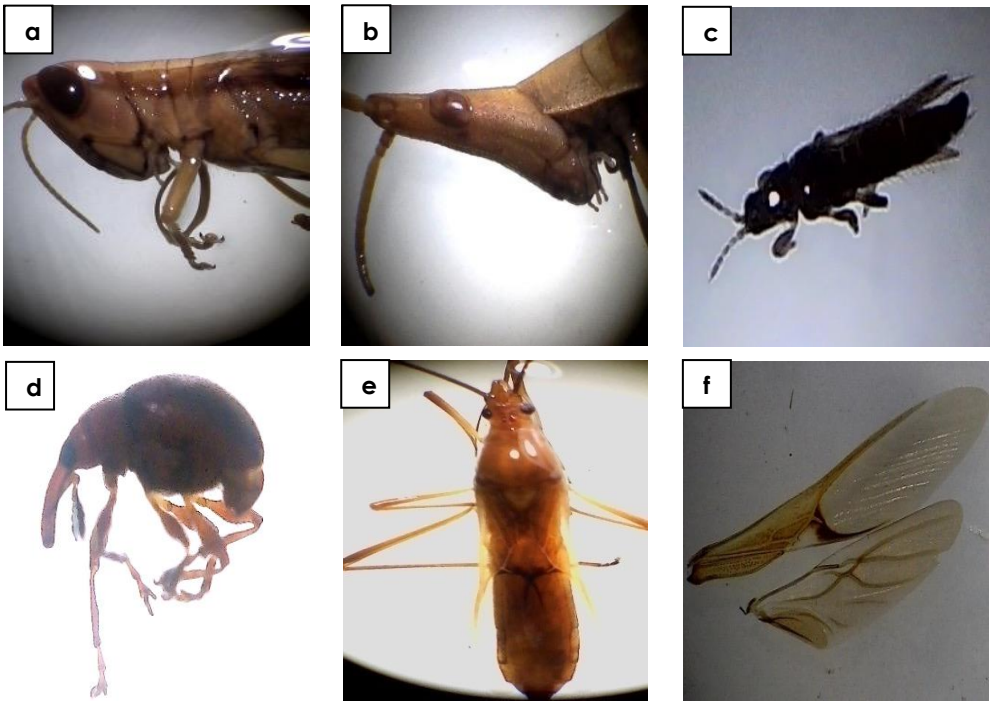

Figure 2. Other insect pests associated with rice: (a) *Oxya hyla hyla***,** (b) *Atractomorpa sp*, (c) *Frankliniella tenuicornis* (Uzel), (d) *Hydromidius molitor*, (e) *Leptocorisa oratorius*, (f) *Leptocorisa oratorius* forewing and hindwing

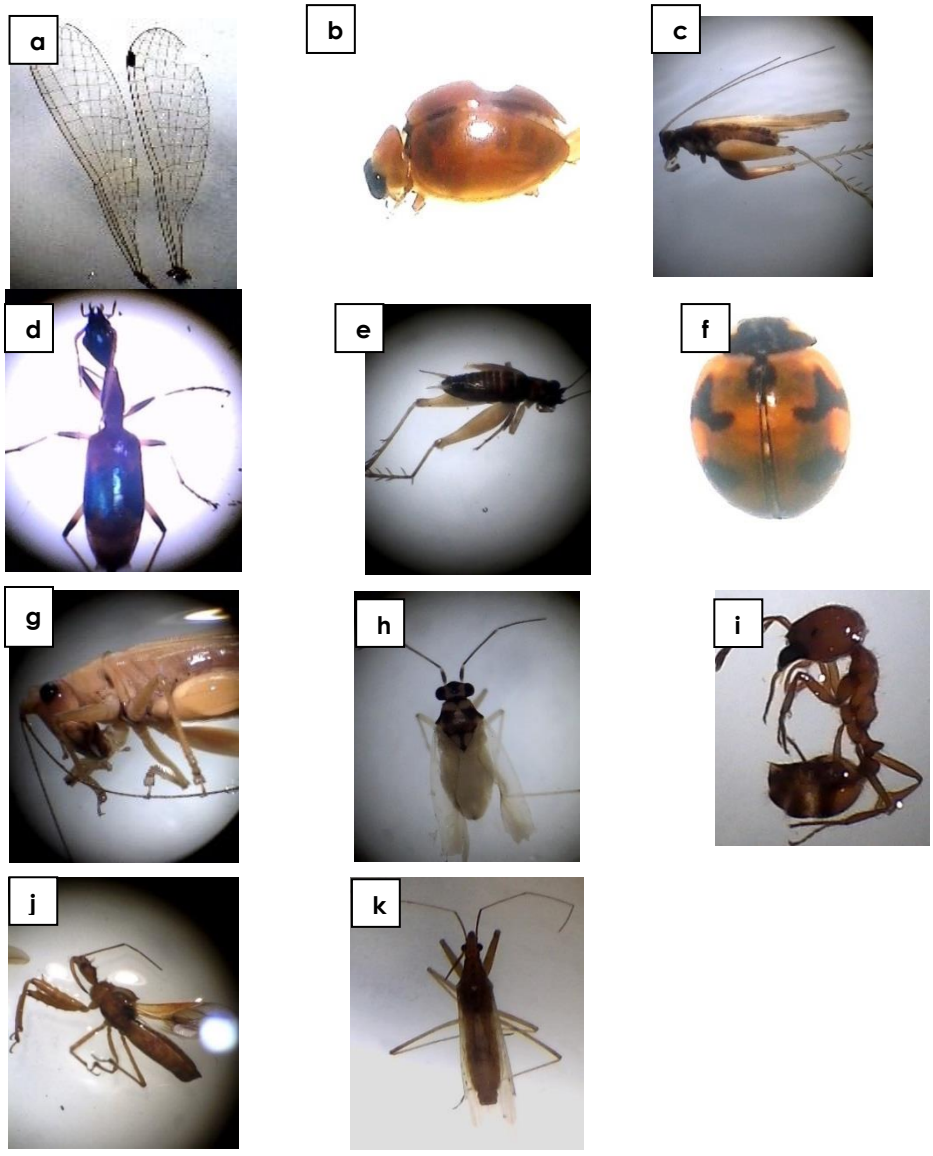

Figure 3. Predators. (a) *Agriocnemis* sp (Brauler), (b) *Micraspis discolor* (Fabricius), (c) *Coccinella repanda* Thunberg, (d) *Ophionea nigrofasciata* Schmidt-Goebel, (e) *Metioche vittaticollis* (Stal), (f) *Anaxipha longipennis (*Serville), (g**)** *Conocephalus longipennis (deHaan)*, (h) *Cyrtorhinus lividipennis* Rauter, (i) *Solenopsis geminata* (Fabricious), (j) *Scipinia horrida*, (k) *Nabis stenoferus*

Figure 4. Predators. (a) *Focifomyi* sp., (b) *Sepedon* sp. 1, (c) *Sepedon* sp. 2, (d) *Octhera sauteri*, (e) *Octhera brivitibialis*, (f) *Tipula aino*, (g) *Drapitea* sp, (h) *Condylostylus* sp. (i) *Condylostylus lateral view*

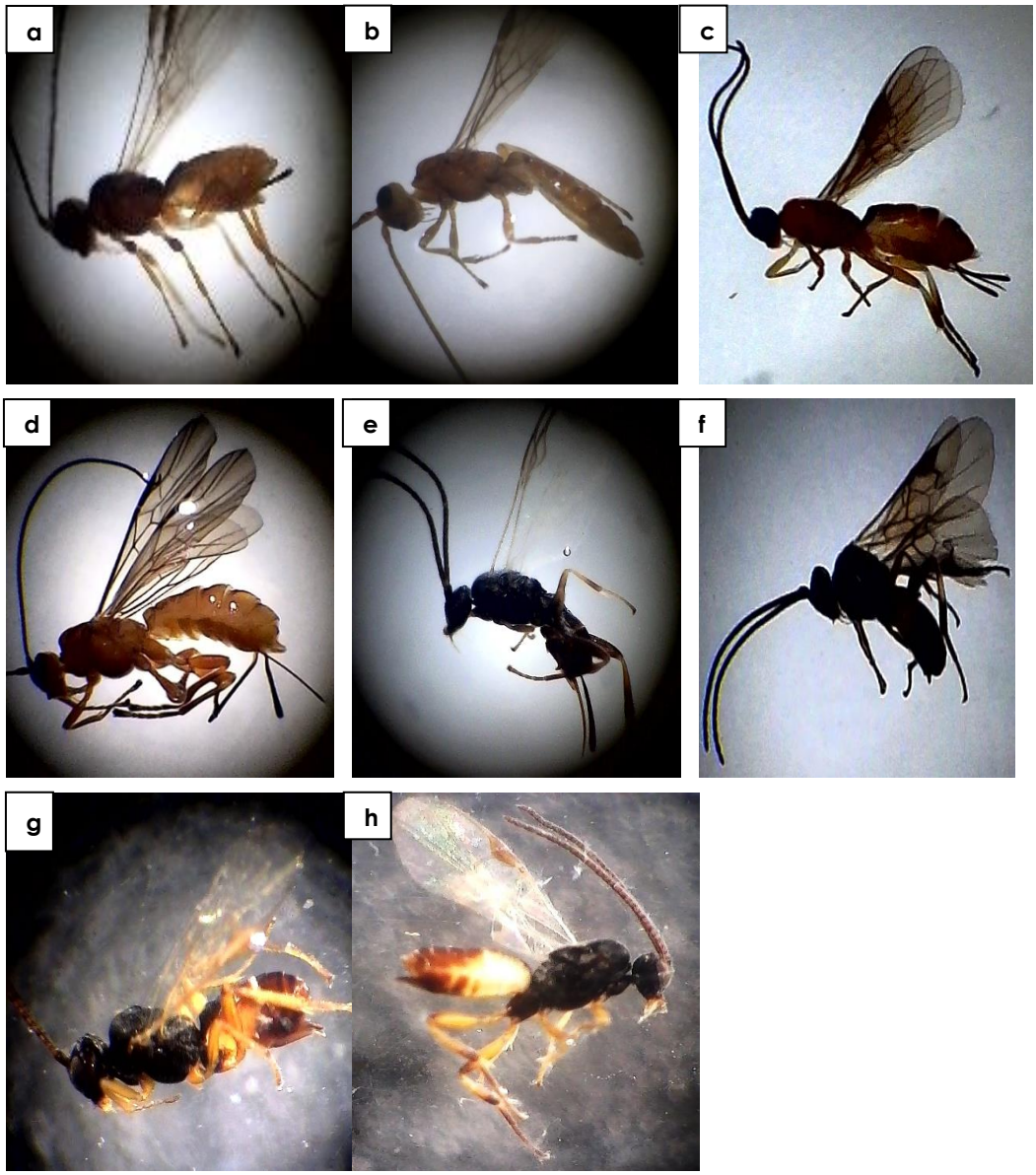

Figure 5. Parasites/Prasitoids. (a) *Bracon onukii*, (b) *Stenobracon nicevillei*, (c) *Tropobracon shoenobii*, (d) *Rogas* sp., (e) *Exoryza (=Apanteles) shoenobii*, (f) *Cotesia flavipes*, (g) *Cotesia* sp. 1, (h) *Cotesia* sp 2.

Figure 6. Parasites/Parasitoids. (a and b) *Amauromorpha accepta shoenobii*, (b) *Amauromorpha* sp. (male), (c) *Gambrus* sp., (d) *Trathala flavoorbitalis*, (e) *Xanthopimpla enderleini*, (f) *Charops bicolor* (g) *Poecilogonalos sp.*,(h) *Brachymeria lasus*, (i) *Trissolcus*

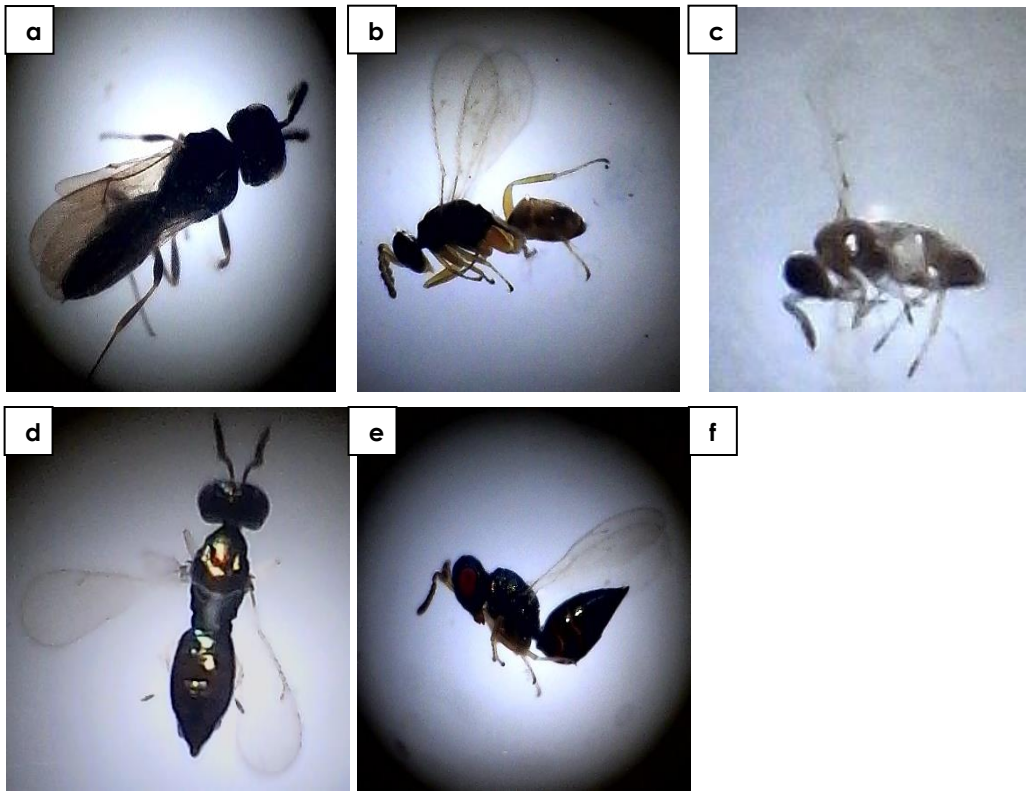

Figure 7. Parasites/Predators. (a) *Scelio muraii*, (b) *Euplectruschapidae*, (c)*Trichogramma*, (d) *Trichomalopsis oryzae*, (e) *Pediobius atamiensis*.

Figure 8. Parasites/Parasitoids (a) *Halictophagus* sp., (b) *Tomosvaryella oryzaetora*, (c) *Tachinid* sp.

Figure 9. Arachnida/spiders (a and b) *Tetragnatha spp*., (c and d) *Oxypes spp*., (e) *Thomisus okenawensi*, (f) *Atypena adelinae*, (g) *Agyrodes*, (h) *Agriope sp*. (i) *Araneus* sp.

Representative specimens of miscellaneous insects associated with the rice crop are presented in Figures 10 to 13.

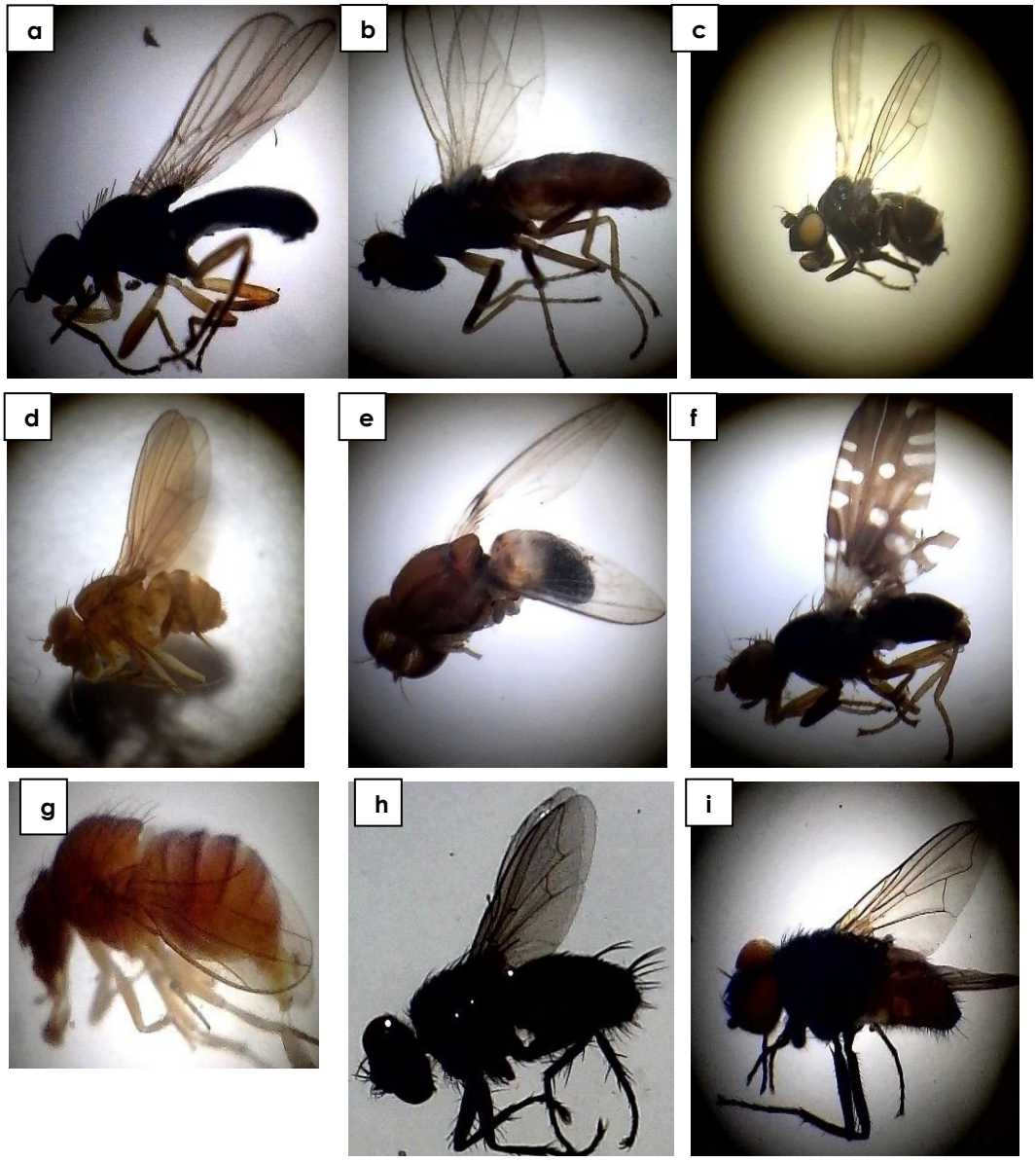

Figure 10. Miscellaneous Insecs. (a) *Anatrichus* sp. (b) *Agromyza oryzae*, (c-f) *Drosophilla* spp., (g) *Scaptodrosophila* sp., (h) *Calliphora* sp., (i) *Musca domestica.*

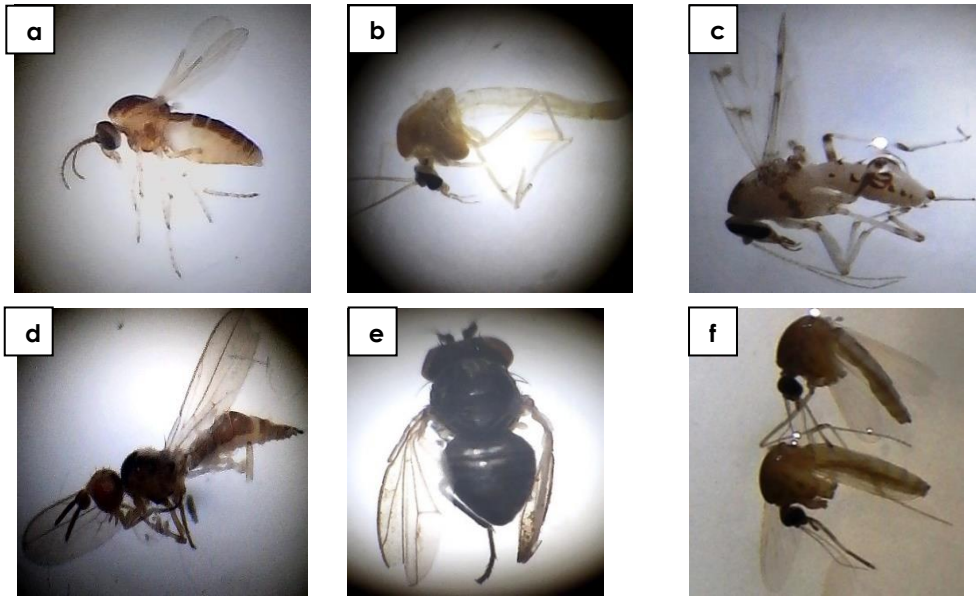

Figure 11. Miscellaneous Insects (a) *Chironomus sp*., (b) *C. javanus*, (c) *C. kiensis*, (d) *Chlorops sp*., (e) *Notiphila latigenis*, (f) *Orseolia oryzaevora*.

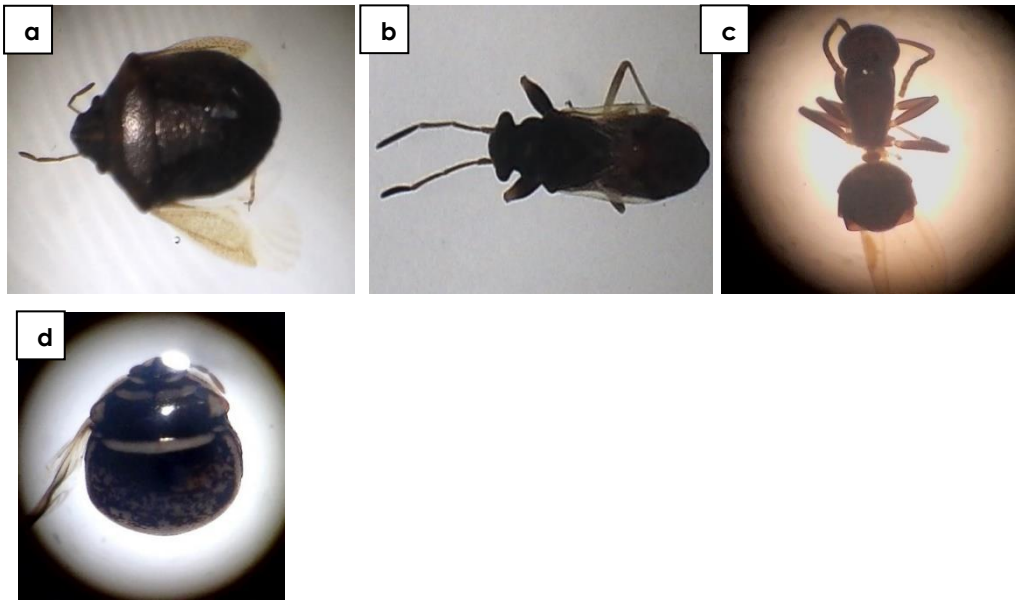

Figure 12. Miscellaneous Insects. (a) *Eysarcoris* sp., (b) *Horridipamera nietneri,* (c) *Chronoxemus* sp., (d) *Coptosoma* sp.

Figure 13. Miscellaneous Insects. (a.) Mites, (b) Tetrigid, (c) whiteflies, (d) *Orius.*

The comparative counts of arthropods between organic and inorganic ricefields are shown in Figure 14.

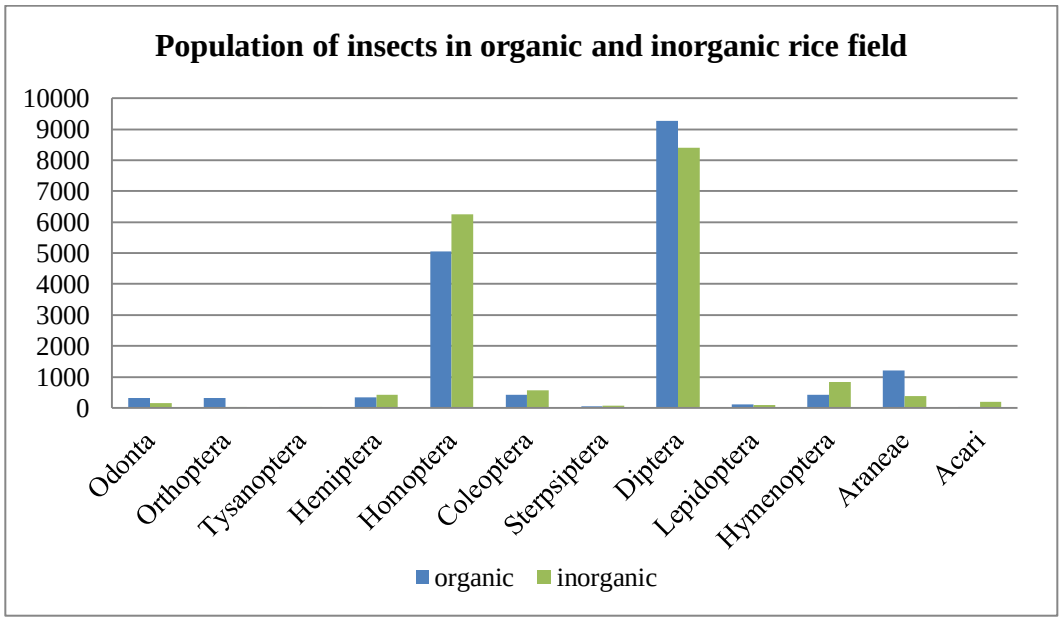

Figure 14. Comparative counts of arthropods (insects and spiders) between organic and inorganic rice fields.

In organic rice fields, Diptera had the highest population with the total number of 9,264, followed by Homoptera (hoppers) with a total population of 5,056, Araneae (1214), Hymenoptera (433), Coleoptera (415), Hemiptera (331), Orthoptera (326), Odonata (312), Lepidoptera (109), Strepsiptera (59), and Thysanoptera (28). (Table 2)

The highest population of insects recorded in inorganic rice fields belong to Diptera with a total population of 8,406, followed by (Homoptera) hoppers with a total count of 6,260, Hymenoptera (839), Coleoptera (564) and Hemiptera (420).

Higher number of Hymenoptera in inorganic fields, most of which are parasitoids could be attributed to the abundance of their host, the hoppers.

Table 2. Number of arthropods collected from organic and inorganic ricefields

CLASS INSECTA	ORGANIC	INORGANIC
Orthopera	326	25
Thysanoptera	28	2
Hemiptera	331	420
Homoptera	5056	6260
Coleoptera	415	564
Strepsiptera	59	73
Diptera	9264	8406
Lepidoptera	109	83
Hymenoptera	433	839
Sub-total	**16333**	**16817**
CLASS ARACHNIDA		
Araneae	1214	390
Acari	2	201
Sub-Total	17549	17408
Grand Total		34,957

Natural Enemy Occurrence

Organic Ricefield Insects

A total of 2,986 individuals of natural enemies classified under the Class Insecta into 7 orders, 12 genera, and 37 species were collected in the area. The collections belong orders namely, Odonata, Strepsiptera, Orthoptera, Hemiptera, Coleoptera, Diptera, and Hymenoptera. Sub-Class Araneae (Class Arachnida) was also observed.

In order Odonata, 312 individual *Agriocnemis sp*. were collected, Strepsiptera (*Halictophagus*) with 59, Coleoptera (*Micraspis spp*) had 328. In Order Diptera, the dominant genera (counts) were *Condylustylus* (Dolichopodidae) with 113, *Focipomyia sp*. (67) and *Octhera sauteri* 179 (Ephydridae). In order Hymenoptera the dominant species was *Trichogramma* (Trichogramatidae) with a total of 64 individuals *Trichomalopsis oryzae* (85) and *Amauromorpha accepta* (178). *Tetragnatha spp* under Subclass Araneae have 989 individuals.

Inorganic Ricefield

There were 2,462 individauals of natural enemies collected in the inorganic ricefields. They were classified into 7 orders and 34 species. The insects belong to Orders Odonata, Orthoptera, Strepsiptera, Hemiptera, Coleoptera, Diptera, and Hymenoptera. Araneae (Class Arachnida) was also represented. It is notable that all orders represented in the organic rice fields were also represented in the inorganic ricefields.

The dominant species in inorganic ricefieds are *Micraspis spp*. with a total of 362 individuals, *Cyrtorhinus lividipennis* (Hemiptera) (392), and long-jawed spiders, *Tetragnatha spp* in order Araneae (363).

Population Trends

The population trend of natural enemies and selected pests are shown in Figures 15 and16.

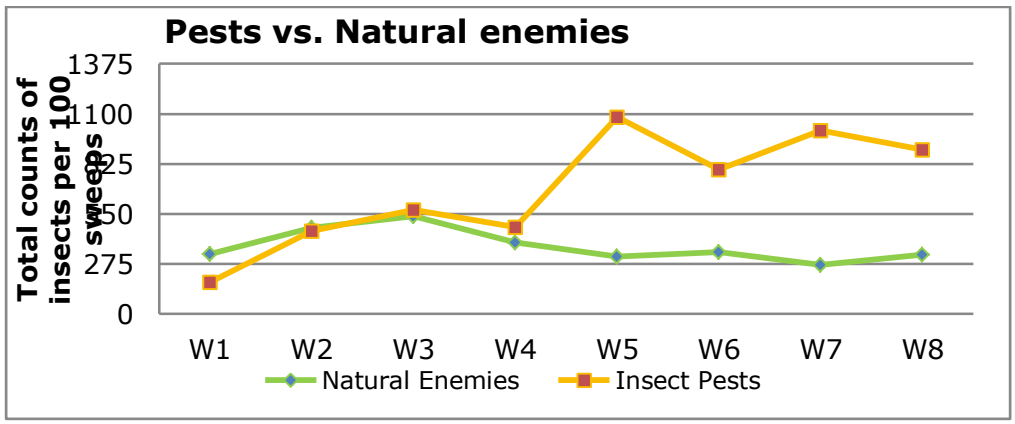

Figure 15. Population of insect pests and natural enemies in organic ricefield.

The graph above shows the trend of pest versus natural enemies in organic ricefields. Pest increased as growth stage of crops progressed. The minimum number of insect pests can be observed at the early stage of the rice crop from week 1 to week 3 and increasing later until the reproductive stage (week 4 to week 8) then decreased until before harvest or when the crops reach maturity.

During week 1 up to week 3 (vegetative stage of rice), the most abundant insect pests are *Nephotettix virescens, Nephotettix nigropictus, Sogetella furcifera, Recilia dorsalis, and Nilaparvata lugens*. At weeks 4 to 8 (reproductive stage of rice), the most abundant pest species collected represent

the order Hemiptera (*Leptocorisa oratorius*), Lepidoptera (*Scirphophaga incertulas*) and whiteflies.

The population of the pest and natural enemies depend on their food supply the population of pests increased as the crop grew thereby providing more abundant food supply.

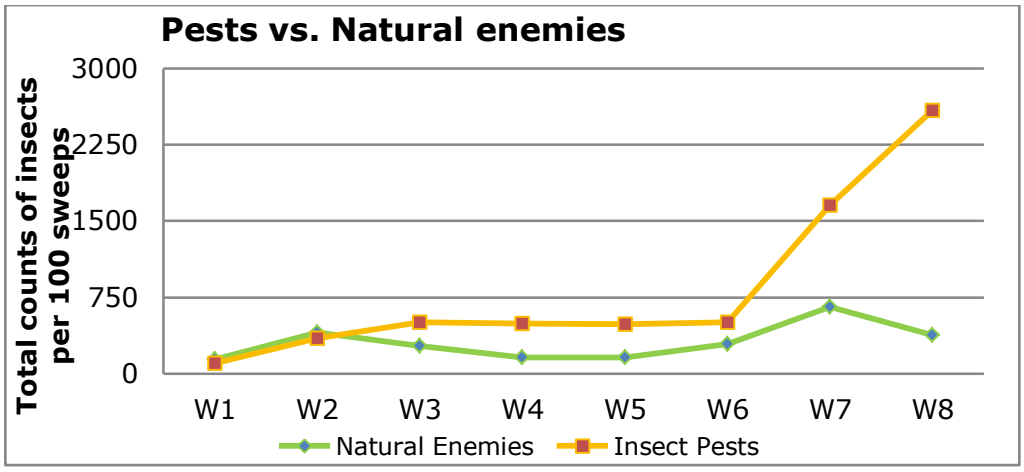

Figure 16. Population of insect pests and natural enemies in inorganic ricefield.

The graph above shows the trends of insect pests versus the natural enemies in inorganic ricefields. The insect pests during week 6 up to week 8 are increasing and fluctuate while the natural enemies are decreasing.

The increasing number of insect pests may be attributed to the monocropping system that resulted to abundant food supply. It is also possible that the insect pests might have developed resistance to the insecticides that were sprayed during the course of the study.

Generally insect pests such as hoppers in both methods of farming are dominant, while natural enemies in organic are diverse.

Higher Counts of Insects and Other Arthropods in Inorganic Ricefield

The higher counts of hymenopterans and mirids in the inorganic ricefield could be attributed to the abundance of their host, the hoppers. Inorganic farming typically involves monocropping that creates uniformity in the entire field. A uniform crop is ideal because it reduces labor cost and makes harvesting easy, but it can also impact to biodiversity and makes crops susceptible to the pathogens (Gabriel *et al.*, 2013). Uniformity of varieties cultivated and injudicious use of pesticides that may result to insecticide resistance and cause ecological problems. (Kabir 2011). Excessive nitrogen

fertilizers lead to pest problems by increasing the birth rate, longevity and fitness of certain pests (Jhan, 2004; Jhan et al., 2005).

Counts of Insects and other Arthropods in Organic Ricefield

Insects and other arthropods collected from the organic ricefield are diverse. This may be attributed to the cultural practices such as multi-cropping and crop rotation employed in the area. Crops raised in the area include mango, mungbean, green pepper and others.

Organic cultivation of rice has been regarded as a sustainable system because it avoids problems such pest resistance, resurgence, pesticides residue and other problems. (Regannold *et al.*, 1990).

Natural enemies are vital components of an agrecosystem and are consistently used as agents of ecological control. Worldwide, nearly 2000 arthropod species, the majority of which are parasitoids, have been used as biological control agents (Letourneau *et al.,* 2009). The important components of biological environment are the predators and parasitoids that make insect pest population less. The absence of conventional pesticides will likely encourage the natural enemies.

The diversified plant environment buffers pest problems by reallocating insect population to larger areas encouraging natural control. The plants growing inside and outside cultivated area must be considered in designing systems to suppress pest. Plant diversity on the farm and absence of conventional pestides contribute to provision of suitable habitat for beneficial insects (Linker and Barbercheck 2005).

Acknowledgement

The authors would like to thank Mr. Rudy Fernando and the College of Agriculture, Central Luzon State University, for the sites in the collection of the specimens.

References

Barrion, AT. and Litsinger, JA. (1994). Taxonomy of rice insect pests and their arthropod parasite and predator. Division of Entomology International Rice Research Institute. P.O. Box 933, Manila Philippines 1099.

Barrion, AT. and Litsinger, JA. (1984). The spider fauna of the Philippines rice agroecsystem. II. Wetland. Philipp. Entomol. 6 (1): 11-37. Retrieved on September 15, 2015 at Rice and Spider of south and Southest Asia. Entomology Division. IRRI.

Barus, W A, Rauf, A, Damanik, SJ and Rosmayati. (2013). Screening and Adaptation in Some Varieties of Rice Under Salinity Stress. Rice Research:Open Access. 1:2. Retrieved on January 7, 2014 at http://www.escience central.org/journals/screening-and-adaptation-in

some varieties-of rice-under-salinity-stresscase-study-arpaluh-merbau-deli-serdand-district-north-sumatra-indonesiajrr.1000112.pdf.

Blackith, RE. (1990). Tetrigidae (Orthoptera) with partly exposed wings. 1990 (March-December).Insect mundi. 4 (1-4):87-92. Probottetix Mazarredia Pseudoparattetic, Parattetix Orthotettix Andriana.

Brooks, SE. (2005). Characteristics and natural history of Dolichopodidae. Retrieved on September 30, 2015 at www.radsdiptera.org

Calub, B., Matienzo, E. and Tenorio, MA. (2011). Organic Vegetable Project. Agricultural Systems Cluster, College of Agriculture University of the Philippine Los Baňos, College, Laguna. (Handbook IE Material) UPLB-NEDA, DA-BAR. 24pp. Retrieved on April 04, 2014 at www.bar.gov.ph/organic- ricevegetable farming.

Delate, K. (2013). Organic Agriculture. Retrieved on September 18, 2013 at www.iastate.edu.

De Meijere, JCH. (1908). Studienuber Sudostasiatische Diptera. II Tijdsch. Entomol. 51:8-180. Retrieved on August 15, 2015. at Management and Biology of Rice Insects. (Book) http://www.wiley.com/wileyCDA/wileyTitle/productCd0470218142.html

Distant, WL. (1902). The Fauna of British India including Ceylon, London, 438 p. Retrieved on July 14, 2015 at Biology and Management of Rice Insects. (Book) http://www.wiley.com/wileyCDA/wileyTitle/productCd-0470218142.html

Espino, RC. and Atienza, S. (1989). Crop Diversification in the Philippines. Retrieved on April 03, 2014 at www.fao.org.

Food and Agriculture organization.(2014). A regional rice strategy for sustainable food security in Asia and the Pacific. Retrieved January 13,2014 at http://www.fao.org/3/a-i3643e.pdf

Figueroa, J. (2007). The history of rice in the Philippines: Filipino Culture Living. Retrieved on February 08, 2014 at http://www.livingcebuforums.com/ipb/topic/2084-the-history-of-rice-th.

Gabriel, D., Salt, SM.; Kunin, WE, and Benton, TG. (2013). Food Production vs. Biodiversity: Comparing Organic and Conventional agriculture. Journal Applied Ecology Online. Volume 50, issue 2:355-546. Retrieved on April 09, 2016 at http://www.webrofknowledge.com.libproxy.cc.stonybrook.edu.

General, DM. and Alpert, GD. (2012). A synoptic review of the ant genera (Hymenoptera: Formicidae) of the Philippines. 200 keys 20:1-111. Retrieved on July 17, 2015 at www.ncbi.nml.gov.

Jhan, GC. (2004). Effect of soil nutrient on the growth, survival and fecundity of insect pests of rice: An overview and a theory of pest outbreaks with consideration of research approaches. Multitrophic interaction in soil and integrated control. International Organization for Biological Control (IOBC) wprs Bulletin; 27 (1): 115-122. Retrieved on April 09, 2016 at http://www.ccsenet.org/journal/index.php/jas/article.

Jhan, GC., Almazon, LP. and Pacia, J. (2005). Effect of nitrogen fertilizer on the intrinsic rate of increase of the rusty plum aphid. *Hysteroneura setariae* (Thomas) Homoptera: Aphididae) on rice (*Oryza sativa L.*). Environmental Entomology, 34 (4); 438-943. Doi: 10.603/0046-225X-344-938. Retrieved on April 09, 2016 at http://www.ccsenet.org/journal/index.php/jas/article.

Kabir, H. (2001). Sustainability of intensive production threatened. Retrieved on April 09, 2016 at http://www.agriculturenetwork.org.

Letourneau, DK., Jedlick, JA., Bothwell, SG., and Moreno, CR. (2009). Effects of Natural Energy Biodiversity on Suppression of Arthropod Herbivores in Terrestrial Ecosystem. Retrieved on April 09, 2016 at http://www.izt.ciens.ucv.ve/ecological/archivos.

Linker, HM., Dorr, D., and Barbercheck, ME. (2005). Insect Management. Center for Environment Farming System. Retrieved on April 09, 2016 at http://www.cefs.ncsu.edu.

Regannold, JP., Papendick, RI., and Parr, TF. (1990). Sustainable Agriculture. Sci. Amer. 262:112-120. CnossRef. Retrieved on April 09, 2016 at http://www.bioone.org.

Richan, DB., Sutherland, CA. and Oseto, CY. (2005). One Hundred Common Insects of New Mexico.Retrieved Septerber 09, 2015 at www.aces.nmsu.edu/pubs-ciralans/ CR570.pdf.