Micronesica Supplement 7: 125–132, 2003

Biological Control of Insect and Plant Pests in the Marshall Islands

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Abstract—Pests and diseases, nearly all of which are exotic to the Marshall Islands, cause significant losses to agriculture. The most serious of these include insect pests such as the breadfruit mealybug, coconut scale and spiraling whitefly, which cause severe damage to many food crops and seriously affect crop productivity and overall food security. The number of insect pests and diseases has increased since 1975 as shown by insect survey done in islands of Ailinglaplap, Mejit, Lae, Jaluit, Likiep, Namu, Arno, Woja and Ailuk. Twenty-one new pest species were introduced to Jaluit and Majuro in 1975 of which twelve species were new to the country. Biological control methods have been conducted as an promote environment-friendly pest control method. A number of natural enemies and parasites, including *Chilocorus nigritus* and *Pseudoscymnus anomalus* for coconut scale, *Rodolia limbata* and *R. pumila* for breadfruit mealybug and *Encarsia* sp. for spiraling whitefly have successfully been introduced to some island groups. *Rodolia limbata* has contributed to a significant decline in breadfruit mealybug in the Majuro atoll, Arno atoll, Mejit Island and Ailinglaplap atoll. Pest density for spiraling whitefly and coconut scales are declining, but are, still present the atolls.

Introduction

The Republic of the Marshall Islands consists of 29 low-lying coral atolls and 5 islands in the Central Pacific Ocean. The economically important crops of the country are coconut, breadfruit, pandanus, banana, taro and pumpkin. Pests and diseases, nearly all of which are exotic to the Marshall Islands, cause significant

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losses to agriculture. The most serious of these include insect pests such as the breadfruit mealybug, coconut scale and spiraling whitefly, which cause severe damage to many crops and seriously affect crop productivity and overall food security. In recent years, many of these pests have become more abundant and widespread as they spread from initial points of entry to atolls and islands in both the Ralik and Ratak island chains, where they now undergo outbreaks that seriously damage crops. Pest management in a tropical farming system can be enhanced through the application of various management practices including cultural practices, such as growing resistant varieties, development of cropping systems, use of mechanical control methods, use of sex pheromone traps and by biological control. In general, some natural enemies are able to maintain pest populations in agricultural crops to levels where no or little damage is caused to the crop or the product (Waterhouse & Norris 1987, 1989, 1993). The government of the Republic of the Marshall Islands encourages the use of non-chemical control methods, and seeks to keep pesticide usage to a minimum and for emergencies. Integrated Pest Management (IPM) approaches seek to maintain pest damage at acceptable levels by the manipulation of the crop ecosystem without further damaging it through the application of a range of pest management practices, and a minimal use of pesticides. The IPM approach is therefore the most appropriate means for agriculture in the Marshall Islands.

This paper describes the IPM used in the Marshall Islands and practices which involve identifying the agricultural pest and use of exploitation of biological control agents.

Material and Methods

Insect Pest Survey

Populations of insect pest were surveyed in various islands, namely Arno, Ailinglaplap, Mejit, Ailuk, Jaluit, Lib, Lae, and Likiep including Majuro. Surveys were done on the important crops of the Marshall Islands including breadfruit, coconut, pandanus, banana, papaya, taro and lime. A number of trees of the crops were randomly selected and searched at various sites on each atoll. Where field identification was not possible, specimens of arthropod pests and diseases were collected for incubation to adult stage in the laboratory and if necessary, preserved and sent for identification to outside experts. Samples of plant diseases and weeds were similarly collected and brought to the laboratory for examination under a stereomicroscope. A photographic record was made of pests and diseases to facilitate future field identification and for the development of training, extension and pest identification materials.

Procurement of Predators

Rodolia limbata, a natural predator for *Icerya aegyptiaca*, was obtained from the Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia in 1998 and 1999. One hundred individuals of natural predators, namely

Pseudoscymnus anomalus, Chilocorus nigritus and an unidentified wasp for coconut scale insect pests, were received from the Land Grant Department of the College of the Micronesia (COM), Pohnpei. The Secretariat of the Pacific Community (SPC) supplied over 100 in each of three separate shipments of the parasite *Encarsia* sp. to the control spiraling whitefly in 1999. Specialist technical assistance and advice were received from Secretariat of the Pacific Community (SPC), the University of Guam, and CSIRO to identify of pests and establish appropriate quarantine and rearing procedures.

Release of Natural Enemies and Monitoring of Insect Pests

Selected atolls and islands were visited at least two to three times each to survey, release predators against and further monitoring insect pests. The first shipment of 400 *R. limbata* from CSIRO, Australia was received in late 1998. One hundred and three hundred *R. limbata* were released in the atolls of Arno and Ailinglaplap, respectively. Another shipment of 200 *R. limbata* from CSIRO, Australia was received in early 1999 and 50 released in Majuro atoll and 150 in Mejit Island. Later, 150 *R. limbata* collected from Mejit Island and released in of Ailuk and Jaluit atolls. Majuro atoll is headquarters and central facility for rearing the insect pests or receiving predators and airport. The various crops mentioned earlier and their plant parts including branches, fruits, leaflets etc. were observed carefully for infestation and disease control. A number of trees on the surveyed atoll/island were screened for the presence of insect pests or predators. On each atoll the number of trees screened varied, as the land area and number of plants in each crop differed.

Results and Discussion

Serious pests in the Marshall Islands include coconut scale, *Aspidiotus destructor,* spiraling whitefly, *Aleurodicus disperses* and breadfruit mealybug, *Icerya aegyptiaca.* Although all three were observed causing serious damage to breadfruit trees on Majuro, the most serious appeared to be the coconut scale. Many trees supported extremely high densities of this pest and showed extensive yellowing of the leaves. The yield reduction in breadfruit was considerable. Two natural enemies were commonly found among high-density scale infestations. These were the ladybird beetle *Pseudoscymnus anomalus* and *Chilocorus nigritus.*

Infestation of Breadfruit Mealybug and Biological Control

Icerya aegyptiaca (breadfruit mealybug/ Egyptian fluted scale) was very abundant on breadfruit and several other hosts namely banana, coconut, pandanus, taro, tomato and a variety of ornamentals throughout the atolls of Arno, Ailinglaplap, Majuro, Mejit, Jaluit, Likiep, Lae and Lib. On breadfruit, the high numbers of mealybug causes leaves to turn yellow and drop prematurely. Heavily infested shoots die and occasionally even mature breadfruit is killed. Yield is reduced by up to 50%. Honeydew excreted by the insects encourages the growth

Table 1. Insect pests and release of natural predators throughout the atolls in the Marshall Islands.

SN	Atoll	Insect Pest	Predator	Number of predators released	Source
1	Arno	*Icerya aegyptiaca* (Mealybug)	*Rodolia limbata*	100	CSIRO, Australia
2	Ailinglaplap	*Icerya aegyptiaca*	*R. limbata*	300	CSIRO, Australia
3	Majuro	*Icerya aegyptiaca*	*R. limbata*	50	CSIRO, Australia
4	Mejit	*Icerya aegyptiaca*	*R. limbata*	150	CSIRO, Australia
5	Ailuk	*Icerya aegyptiaca*	*R. limbata*	100	Mejit Atoll
6	Jabot-Jaluit	*Icerya aegyptiaca*	*R. limbata*	50	Mejit Atoll
7	Lib, Lae, & Likiep	*Icerya aegyptiaca*	—	—	—
8	Majuro	*Aspidiotus destructor* (Coconut scale)	*Pseudoscymnus anomalus*	100	Land Grant, Pohnpei
9	Majuro	*A. destructor*	*Chilocorus nigritus*	100	Land Grant, Pohnpei
10	Majuro	*Aleurodicus disperses* (Spiraling whitefly)	*Encarsia* sp.	Few	SPC

—No release of predator

Table 2. Monitoring of insect pests and natural predators throughout the atolls.

SN	Atoll	Insect Pest	Predator	Number of Trees Observed	Crops	Decline in the Insect Pest
1	Arno	*Icerya aegyptiaca* (Mealybug)	*Rodolia limbata*	73	Taro, Banana, Breadfruit, Coconut,	+++
2	Ailinglaplap	*Icerya aegyptiaca*	*R. limbata*	24	Breadfruit, pandanus, banana,	++
3	Majuro	*Icerya aegyptiaca*	*R. limbata*	67	Taro, Banana, Breadfruit, Coconut,	+
4	Mejit	*Icerya aegyptiaca*	*R. limbata*	52	Taro, Banana, Breadfruit, Coconut,	+++
5	Ailuk	*Icerya aegyptiaca*	*R. limbata*	36	Taro, Banana, Breadfruit, Coconut	+++
6	Majuro	*Icerya aegyptiaca*	*R. pumila*	58	Taro, Banana, Breadfruit, Coconut,	+
7	Majuro	*Aspidiotus destructor* (Coconut scale)	*Pseudoscymnus anomalus*	86	Taro, Banana, Papaya, Breadfruit, Coconut	++
8	Jabor-Jaluit	*A. destructor*	*Pseudoscymnus anomalus*	43	Coconut, breadfruit, banana	+++
9	Majuro	*A. destructor*	*Chilocorus nigritus*	86	Papaya, Taro, Banana, Breadfruit, Coconut	+
10	Majuro	*Aleurodicus disperses* (Spiraling whitefly)	*Encarsia* sp.	71	Taro, Banana, Papaya, Breadfruit, Coconut	+

+, Poor (20%), ++: Moderate (40%), +++ Clean (90%)

of sooty mould, which reduces photosynthesis. Serious problems were experienced on some atolls namely Imij (Jaluit), Ailinglaplap, Mejit. The lady beetle, *R. pumila*, introduced to the Marshall Islands, was present in very low levels. However, no significant decline in pest density was observed. *R limbata* was procured from CSIRO and released in the various atolls (Table 1). A summary of the results and monitoring of insect pests is shown in Table 2. It is clear from the data that *R. limbata* has successfully controlled the mealybug population and 60% reduction in the population is observed in the Arno atoll, Mejit Island, Ailuk atoll and Jaluit atolls. A fairly significant decline 40% in the density of insect pest was observed in the Ailinglaplap atoll, Jabot atoll and Majuro atoll. However, only 20% drop in the infestation level was observed in the Majuro atoll.

Coconut Scale (*Aspidiotus destructor*)

The coconut scale was abundant on the Majuro atoll, Wotje atoll and Likiep atoll. A high infestation in most breadfruit trees was observed. The undersides of the leaves were completely covered with scales, and few were on the upper surfaces. Leaves turned yellow and fells prematurely as did fruits. Infestation of coconut scale in papaya and pandanus was also observed. One hundred each of the lady beetle, *Pseudoscymnus anomalus* and *Chilocorus nigritus* were introduced in Majuro atoll in 1999. More than 86 trees of breadfruit, papaya and pandanus were sampled for the infestation. *Pseudoscymnus anomalus* caused greater decline (40%) in pest density than compared *Chilocorus nigritus* (20%).

Outbreak of Spiraling Whitefly (*Aleurodicus dispersus*) and Biological Control

There was an outbreak in 1998 of spiraling whitefly in the Marshall Islands infesting breadfruit, banana, coconut crops and some ornamentals. The occurrence of spiraling whitefly constitutes a new record for the Marshall Islands (K Englberger, SPC, personal communication). No record of spiraling whitefly is reported in the survey done by Nafus in the Marshall Islands. Spiraling whitefly has been reported to from Majuro, Jaluit, Mejit, etc. The pest is abundant and covers the lower surface of leaves, sucks sap and reduces plant vigor. Sooty mould grows on the honeydew excreted by the insects and forms a black crust on the upper surface of the leaves. Heavy infestation reduces crop yield. A biological control agent is the parasite *Encarsia* sp., which was introduced by the Plant Protection Project, Secretariat of the Pacific Community, in Majuro in the 1999. *Encarsia* sp. is now established in Majuro, and some were collected and distributed in the outer islands. Further monitoring of insect pests revealed that large populations of whiteflies can be found on some isolated breadfruit trees and ornamentals. More parasites should be collected and released in rest hot spots.

In 1988 and 1989 the South Pacific Commission implemented surveys to identify pests and diseases in the Marshall Islands. Nafus (1996) assessed arthropod pests, while McKenzie & Jackson (1996) surveyed fungi and bacteria. Nafus

(1996) recorded 21 new pest species that had been introduced to Jaluit and Majuro since 1975, of which 12 were new to the country. In view of these data it was assumed that the number of pests and diseases has subsequently increased, given the increasing frequency of shipping and air transportation. Many of these new pest introductions are likely to have arrived in the country without their natural enemies, and thus have the potential to cause significant outbreaks in the near future. In recent survey of insect pest in Marshall Islands, two insect pests have been found so far, that were not recorded by Nafus during his 1989 survey, and are likely to be new records for the Marshall Islands. A bagworm was very common on coconut leaves, although no serious leaf damage was noticed. A heavy infestation of what is likely to be citrus snow-scale, *Unaspis citri*, was detected on a lime tree.

Table 1 contains information on the insect pests which have been observed, and natural predators which have been released and monitored in the Marshall Islands. Table 2 indicates the number of samples and the relative decline in insect pests due to introduced predators.

The government of the Republic of the Marshall Islands realizes the vulnerability of the atolls, and the impact that pesticides and many other non-natural control methods may have on the environment. It has therefore adopted guidelines to promote environment-friendly pest control methods. These methods are part of the IPM approach of which a major focus is biological control.

Acknowledgments

We wish to acknowledge President Alfred Capelle, Dr. Singeo Singeru, Mr. Fred Muller and the RMI government for their continued and generous support for land grant programs. Our sincere thanks are extended to the Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia and the Secretariat of the Pacific Community (SPC) for providing the valuable assistance and information for the project. Financial support received from the US Department of Agriculture (Smith Lever funds) through COM and Republic of the Marshall Islands is gratefully acknowledged. CRECMI Publication #2.

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