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FINAL REPORT

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BIOLOGICAL CONTROL OF THE SOYBEAN APHID AND COWPEA AHPID IN INDONESIA

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Bogor, Indonesia

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A.I.D. Grant Project Officer: Dr. Wayne Ching

Project Duration: 60 months

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Summary and Research Objectives

The goal of this research project was to develop biological controls for the soybean aphid and cowpea aphid, which are not only serious pests but also are vectors of several virus diseases of soybeans, mungbeans, and other major legume food crops of Indonesia. With effective biological controls for these aphids, soybeans, mungbeans, and other legume crop yields can be increased and the need for insecticides to control these serious pests can be greatly reduced. Other long range benefits include decreased crop production costs, decreased energy use, improved balance of payments, diminished impacts of pesticides on the environment, and reduced pest control costs.

Research Accomplishments

The major aspect of the research project was introducing natural enemies from other parts of the world for the biological control of soybean aphid and cowpea aphid soybeans and mungbeans. Thus, two wasp-parasites were introduced into Indonesia with approval of the Government. One wasp-parasite, Trioxys indicus, was introduced into Indonesia from India via Australia and another wasp-parasite, Lysiphlebus testaceipes, was introduced into Indonesia from southern United States and South America. Both species were first cultured in the laboratory and later released into soybean and mungbean crops in the field. The parasites have established themselves but it is still too early to determine if they will provide effective control of the two aphid pests. We hope that they will provide successful control.

As a part of the biological control project to control the soybean and cowpea aphids, Dr. Oka and I investigated the potential of natural enemies that exist in Indonesia for the biological control of the pest aphids. More than 50 native parasite and predator species attack the soybean aphid and cowpea

aphid in Indonesia. Our goal in conducting this aspect of the research associated with the biological control of the two aphids was to determine if some of these 50 natural enemies have potential for biocontrol.

We found that the effectiveness of the natural enemies might be improved by making suitable changes in the culture of soybean and mungbean crops in Indonesia. This approach would include reducing the use of insecticides and/or using certain insecticides that would have a minimal impact on the natural enemies. The data collected indicate that potential does exist to improve the effectiveness of natural enemies for the biological control of the soybean and cowpea aphids.

In addition to these two aphids, there are at least seven other major insect pests attacking soybeans and mungbeans in Indonesia. These include whiteflies, leafhoppers, thrips, and caterpillars. The severity of these pests in attacking soybean and mungbean crops was found to vary according to the geographic region, weather, cropping pattern, plant health, and pesticides used in the culture of soybeans and mungbeans.

At the same time and related to this biological control project, Dr. Oka was responsible for introducing a coccinellid-insect predatory beetle from Hawaii for control of an introduced psyllid insect pest. This introduced pest was rapidly destroying a valuable leguminous tree in Indonesia that is essential for shading coffee trees and at the same time providing nitrogen for the coffee trees.

The predatory beetle that was introduced from Hawaii has proven highly effective in biological control of the pest psyllid. In addition, the biocontrol beetle has moved onto the coffee trees and is now providing outstanding control of the important cottony-cushion scale pest of coffee. Thus, there has been dual benefit in the introduction of this biocontrol agent -- control of the

psyllid pest and cottony-cushion scale.

Included as a part of this research project was investigating methods for improving the selection of biological control agents for introduction into Indonesia and elsewhere in the world. We believe that we have good evidence to show that selecting "new association biocontrol" agents can be 3-times more effective than employing the classical approach of using "old association biocontrol" agents that come from the native home of the pest. Another benefit of the new association approach is that native pests of crops may also be controlled. In general, most (60% to 80%) of the insect pests of crops in a country are native insect pests that moved from feeding on wild vegetation to feeding on introduced crops.

Note, details of methods and results are covered in the enclosed manuscripts.

Institutional Strengthening and Technology Transfer

Dr. I.N. Oka has developed and now provides the leadership for all Integrated Pest Management (IPM) programs in Indonesia. All proposed and active pest control programs for Indonesia have to be approved by Dr. Oka. Also, he is on the Board of Directors for the International Rice Research Institute in the Philippines and is now invited to speak and give advice on pest control worldwide.

Our project not only made major scientific contributions, but in addition Dr. Oka and I both trained graduate students associated with this research project. Dr. Oka trained two Indonesian graduate students and I trained one in biological pest control. These young scientists are expected to make major contributions to biological pest control in the future.

Also, as a part of this project, an out-door insectary was constructed for

culturing natural enemies that are introduced for release in the country. This will prove a valuable asset in the introduction of new biological control agents into Indonesia.

Project Publications

Hokkanen, H.M.T., and D. Pimentel. 1989. New associations in biological control: theory and practice. Can. Entomol. 121 : 828-840.

Oka, I.N. 1990. Developing Biological control for the soybean aphid, Aphis glycines, and cowpea aphid, Aphis craccivora, in Indonesia. Progress Report. Bogor Research Institute for Food Crops : 3 pp.

Oka, I.N., D. Pimentel, A. Iqbal, and I.B. G Suryawan. 1991. Ecology and Population Dynamics of Aphids and Other Arthropods Associated with Soybean and Mungbean Crops. Bogor, Indonesia: Agency for Agricultural Research and Development, Bogor Research Institute for Food Crops. 93 pp.

Pimentel, D. and M.H. Hunter. 1992. Status of the biological control of pests. Evolutionary Trends in Plants. In press.

Project Productivity

Indeed, Dr. Oka and I are pleased with our accomplishments. We feel that we accomplished much more than we anticipated. Of course, a great deal more remains to be done in biological pest control in Indonesia.

Future

Both Dr. Oka and I plan to continue our research in biological control of

pests and the graduate students that we trained will also continue to be involved in biological control.

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Progress Report

abstract

DEVELOPING BIOLOGICAL CONTROL FOR THE SOYBEAN APHID, *APHIS GLYCINES* AND COWPEA APHID, *APHIS CRACCIVORA* IN INDONESIA.

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Soybean, mungbean and some other legumes have been given highest priority in the food intensification programs of Indonesia for increasing the food quality (protein) for the people. Acreages for planting the legumes gradually increased, but the yield per Ha remains very low, averaging 1.03 and 0.78 tons/Ha for soybean and mungbean, respectively. This is due to poor management techniques, attacks of insect pests, diseases and weeds. About 111 insect pest species were documented attacking soybean, among which 15 species are considered most important economically, including soybean aphids, *Aphis glycines* and cowpea aphids, *Aphis craccivora*. Both aphids are important mainly because they are effective transmitters of a number of virusses: soybean yellow mosaic virus (SYMV), mungbean mosaic virus (MMV), peanut mottle virus (PMV), cucumber mosaic virus (CMV), cowpea little leaf virus (CLLV), bean yellow mosaic virus (BYMV), soybean dwarf virus (SDV), and soybean stunt virus (SSV), all together may reduce crop yield up to 30 - 40%.
Currently only pesticides have been used to control the insect pests attacking legumes in Indonesia, applied at regular intervals 3 - 4 times/season; off-season crops may receive up to 8 times pesticidal treatments. However, little results have been achieved, pests remain abundant with serius unwanted side effects. Gradual reduction of pesticide subsidies for food crops in 1986 and its total withdrawal early in 1989 resulted in 4-5 times increase of the pesticide costs, which has become too expensive for the farmers to raise legumes.

Therefore, it is urgent to develop **integrated soybean pest management**, including biological control to better cope with pest attacking the crops. Biological control has never been tried to combat legume pests in Indonesia.

In collaboration with Cornell Univ. the Institute carried out biological control research activities as follows:

1. Survey of natural enemies of the Aphids in Indonesia,
2. Biiogical control (literature search and informations, collecting natural enemies for introduction into Indonesia and its release and evaluation).

Results of research activity 1:

Following is a highlight of the Draft II report entitled:

Ecology and Population Dynamics of Arthropods Associated with Soybean and Mungbean Crops.

Aphis glycines, and *Aphis craccivora*, insect pests of soybean and mungbean, respectively, occurred in the two experimental sites (Bogor, 250m and Brebes, 5m), throughout within and off-season crops. Two other sucking insect pests (*Bemisia tabaci* and *Empoasca* sp.) were also recorded. Some

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leaf feeders, like Thrips, *Longitarsus suturellinus*, *Spodoptera litura*, *Chrysodeixis chalcites*, and *Lamprosema indicata* were also present, but their numbers were very low. The recorded natural enemies were *Coccinellids*, *Scymnus* spp, Spider, Syrphids (predators), and Aphidiids (parasitoid), also at low densities.

Their numbers throughout the season,particularly the aphids, were mainly affected by physical environments (locations, seasons, climate, crop pattern, plant health, pesticide), and to a limited extend, biological (natural enemies). Bogor site is an experimental field with limited soybean/mungbean acreages of about 1-2 Ha during within- season, including our field. The experimental field is surrounded by houses. During off-season only our experiments were planted with the crops. In Brebes, however, the experiments were carried out right amidst thousands of Ha soybean/mungbean fields during within-season crop (July-October). During off-season crop (November-February), there were always some older legume fields around, from where the pests migrated to our plots. Continued legume croppings throughout the year in Brebes gave chance for the insect pests to develop continuously. Bogor has highest rainfall (4000 mm/y), with almost always wet dry season. Heavy showers washed off most of the Aphid population. In Brebes, however,the yearly rainfall was with distinct dry season, when mosty legumes were raised. These physical factors could be the causes why the populations of both Aphids in Bogor were less in numbers as compared to that in Brebes. Heavy aphid infestations during the vegetative plant stage weaken the plants,which in turn cause drastic drops of the Aphid populations. Pesticide (monocrotophos) significantly reduced both aphid populations in both places.

In general, the population numbers of the natural enemies of the aphids were somewhat higher in Brebes than in Bogor, although all at very low densities. All of them were adversely affected by pesticide sprays. The very low densities of the natural enemies on both treated and control plots made their effects on the aphid populations inconclusive.

Sucking insect pests (*Bemisia tabaci*, *Empoasca* sp.) in Bogor were also somewhat reduced by insecticide, but *Bemisia tabaci* in Brebes tended to be more abundant after pesticide (Nuvacron, a.i. monocrotophos) treatments, a phenomena known as **resurgence**. Resurgence of *Bemisia tabaci* would cause more serious virus problems to the crops. Although both occupied the same niche as the aphids, it was difficult to access how far they compete among them. Both insect pests also are known to transmit a number of virusses to the legume crops.

Among the leaf feeding insect pests, the Thrips definitely showed **resurgence** to pesticide in Brebes on both crops during both seasons. Increased population of Thrips, which prefer feeding on the flowers might cause reduction of pod setting. Other monocrotophous insecticides usually used by the farmers are Azodrin and Gusadrin. Most commonly used are Thiodan and Nuvacron, still very often mixed with DDT and HCH, although both chlorinated pesticides were already banned in Indonesia.

Other leaf feeding insect pests (*Spodoptera* sp., *Heliothis* sp., *Lamprosema* sp., and *C. chalcites*), because of their very low densities throughout the seasons, would not be too seriously affecting the crops.

The very few numbers of species of the natural enemies of the aphids observerd in the fields in both places throughout the seasons and the adversed effects of pesticide to them could not effectively control the aphids. It is anticipated, that the situations in other legume centers are similar as that in Brebes.

Therefore, importation of exotic natural enemies into Indonesia is nescessary to help the domestic ones to control the aphids.

Results of research activity 2 (preliminary):

The parasitoid species *Tryoxis indicus*, imported from Australia late 1987, were reared in the insect free greenhouse in Bogor, but due to unknown causes, all were dead a few months later. A second batch was imported medio 1988.Tests of its potentials of parasitism in the greenhouse was fairly satisfactory and therefore, it was further tested in the field in Bogor, where the sample plants were caged. Percentage of parasitism was 83,69%, which was very promising.

Another parasitoid species *Lysiphlebus testaceipes* was imported in January 1989 from USA. It consisted of three cultures (A: collected on *Aphis craccivora* and *Aphis gossypli* on wild flower; B: collected on *A.craccivora* on cow peas, and C; on green bug *Schizaphis graminum*. All were doing well under laboratory condition in Bogor. After a few generations, a hyperparasite species, suspected to belong to Aphelinidae, was found attacking both Tryoxis and *Lysiphlebus* in the laboratory, significantly reducing their populations untill culture B was annihilated by the hyper. To reduce the work load and to save the other cultures they were mixed. Purification of the colonies from the hyper was successfull after a few months. A few months later the colony of *Tryoxis indicus* in the laboratory gradually degenerated as shown by increasing males produced in the successive generations until all died out.

Starting August 1989 periodic mass releases were made of the parasitoid *Lysiphlebus* in Lampung, southern tip of Sumatra in the experimental field of the Institute, surrounded by farmers fields. Mummified craccivora aphids were detected in both the experimental and farmers fields one week after each mass release. The collected sample mummies were kept in the laboratory for observing hatched adults. Out of 1182 mummies collected, 36% hatched into adults. Unfortunately, a hyper species, suspected to be the same species as that found in Bogor, were attacking the parasitoid colony in the field laboratory as well those released in the fields. This would reduce its effectiveness. Periodic field sampling of mummies in Lampung is being continued to obtain informations about its establishment.

Mass releases of the parasitoid have also been carried out in Bogor on 2 places about 10 km apart and one in Brebes. Evaluation on its establishment is underway.

Studies were made in the laboratory on the functional response and behavior of *Lysiphlebus* carried out by Mr.W.Supartha, a graduate student of the Bogor Agricultural University.