ecologically-based participatory IPM for SOUTHEAST ASIA

regional program: cambodia | indonesia | philippines

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Southeast Asia

program summary

Clemson scientists traveled to Cambodia to meet with collaborators, the USAID/Cambodia Mission, and the USAID/HARVEST project director. During this travel, we were able to visit field sites in Kandal, Kampong Cham, and Siem Reap provinces and observe field tests of IPM compared to farmer practice for several important vegetable crops, including bitter gourd, cucumber, tomato, and eggplant. We also observed farm level production of *Trichoderma* and made recommendations for improving the farm level production process.

Data collection and analysis in the Philippines is continuing using samples from areas in which PhilRice has been active with IPM FFS training for many years. Econometric models of survey results show significant reductions of pesticide expenditures by FFS-trained farmers.

Impact assessment in Indonesia is conducted at IPB with focus on specific crops comparing costs of IPM and farmer practice for green onion, broccoli, and chilies. In each case, IPM costs are lower. At UNSRAT, impact evaluation focuses on potential gains from more efficient marketing of agricultural products. This analysis is conducted in villages where IPM training for vegetable farmers is on-going and where there is considerable enthusiasm for organic vegetable production.

The SE Asia project has also been collaborating with the IPM CRSP global themes. The gender team for the SE Asia IPM CRSP is well established with active participation of gender specialists from each country. Surveys have been conducted. Results are given in the gender theme report. Dr. Rayapati traveled to Indonesia to work with virologists at IPB and to survey vegetable production areas in West Java. Two scientists from Indonesia attended the workshop in Coimbatore, India supported by the Plant Virus Disease global theme and Tamil Nadu University.

PHILIPPINES

Rice

Technology transfer, promotion, and dissemination of pest management technologies in rice-vegetable cropping system

H. R. Rapusas, S. E. Santiago, J. M. Ramos

IPM technologies developed earlier by the IPM CRSP in the Philippines were continuously promoted and disseminated in several sites. Promotion and dissemination were done through trainings, field demonstration trials, field days, production and distribution of training and extension materials, and media releases. (See more in the training section.)

Rice straw and stale seedbed techniques to reduce weeds and provide refuge for predators

J. Ramos, H. Rapusas, B. M. Shepard, and G. S. Arida

The use of rice straw mulch and stale seedbed techniques offer several advantages for the management of weeds, preserving soil moisture and soil erosion, and leaching of fertilizers. In pest management, the rice straw mulch provides a good habitat for natural enemies of insect pests. The effect of rice straw mulch on the abundance, movement, and diversity of arthropods was determined using pitfall traps. Besides its being simple and easy to use, pitfall traps is an effective way of qualitatively and quantitatively surveying the ground surface-active arthropods. Five pitfall traps were installed in the field per replication, and they were replicated three times. Arthropods collected in the traps were collected every week, and samples were placed in 70% alcohol and brought to the laboratory for counting and identification. Sampling started at 13 DAT until 80DAT.

Preliminary results showed that higher counts of arthropods were obtained at the earlier stage of plant growth with and without mulch but higher in the treatment with mulch at all sampling dates. A higher number of insect pests was recorded in plots without rice straw mulch while the opposite was recorded on the number of beneficial organisms. Most of the parasitoids collected were *Telenomus* sp., *Oligosita* sp., *Cotesia* sp., and *Tetrastichus* sp. Predators collected were spiders, earwigs, and ground beetles. Common pests collected were grylids, leafminers, and cutworm larvae. Among the detritivores (others), collembolans, observed to be more abundant during the early stages of growth, were most common. Density and weight of weeds was higher in plots without straw mulch compared with plots with mulch.

Onion

Management of the common cutworm, *Spodoptera litura,* with sex pheromones and *Nuclear polyhedrosis virus* (NPV) in Onion

GS Arida, BS Punzal and BM Shepard

Farmers in Central Luzon, Philippines, considered *Spodoptera litura* an important insect pest of onion and other vegetables. Due to its easily recognized damage in vegetables, farmers apply insecticides several times as a preventive measure. However, in most cases, insecticides are applied unnecessarily and wasted, resulting in higher costs of production. In addition, non-target organisms are destroyed, farmers are exposed to pesticides, and the pesticides have a negative effect on the environment. Surveillance and monitoring are important components in a pest management program. Effective monitoring can result to efficient timing of interventions. The use of naturally occurring biological control agents are seldom understood by vegetable farmers. Their use in pest management programs should be investigated and promoted to address costs, health and safety, and the environment.

We designed an experiment in farmers' fields where sex pheromone was utilized as a monitoring tool for the effective timing of NPV application; this was compared with farmers' practice of insecticide application. The study was conducted in two farmers' fields in Sto. Domingo and Guimba, Nueva Ecija. In each field, two water-oil sex pheromone baited traps were installed 2 weeks after transplanting. Trap catches were recorded 3 times a week, and traps were cleaned whenever necessary. The synthetic pheromones were replaced after 30 days. The number of larvae and percentage of damaged leaves were monitored every week on 20 randomly selected plants per plot. Yield was recorded in 1 sq.m. per plot.

Treatments consisted of the following:

- T1- Farmer's practice (FP)
- T2- Spray NPV at 5 and 7 days after peak in trap catches
- T3- Spray NPV at 7 and 9 days after peak in trap catches
- T4- Spray NPV every week from 14 days after transplanting

Each plot measured 4x5m, replicated four times in a randomized complete block design.

Peaks in male moth catches were recorded at 37 and 71 days after transplanting (DAT) in Sto. Domingo. These peaks were used as the basis for the application of NPV in T2 and T3. There were three peaks in male moth catches recorded in Guimba at 30, 44, and 54 DAT. These peaks were also used as the basis for the applications of NPV. Application rate of NPV was 16 larval bodies per spray load. The number of larvae per 20 plants was very low and difficult to correlate with the treatments. The low larval count was attributed to the behavior of the larvae to hide in the soil during the day making it difficult to record their numbers in the plant during field monitoring. The number recorded in all treatments was less than one larva per 20 plants per sampling. The percentage of damaged leaves in Sto. Domingo was similar in all the treatments at 42, 56, and 63 DAT. The highest damage was recorded in T1 and T4 at 49 DAT. Mean percentage of damage over the crop period was lowest in T2 and highest in T1 in Sto. Domingo while lowest mean damage was T1 in Guimba. This was followed by T2. Highest yield was recorded in T1 and T2 in both locations, showing that spraying NPV at 5 and 7 DAT is comparable with insecticide treated plots. The lowest yields in both sites were recorded in T3 and T4. Farmers in Guimba sprayed insecticides four times while Sto. Domingo farmers sprayed three times.

Results of this preliminary study indicated that sex pheromones are important tool for effective timing of intervention against cutworm in onion. In addition NPV is an effective biological control agent and could be used in the intervention for cutworm in onion. This study will be repeated in the next onion season.

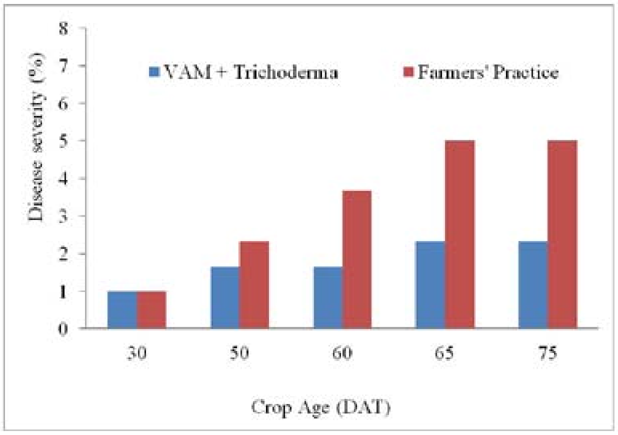

Figure 1. Disease incidence recorded from both treatments. Guimba, Nueva Ecija, 2012 onion season

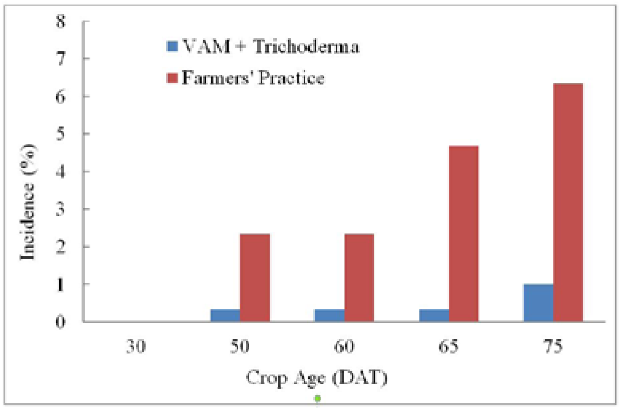

Figure 2. Disease severity recorded from both treatments. Guimba, Nueva Ecija, 2012 onion season

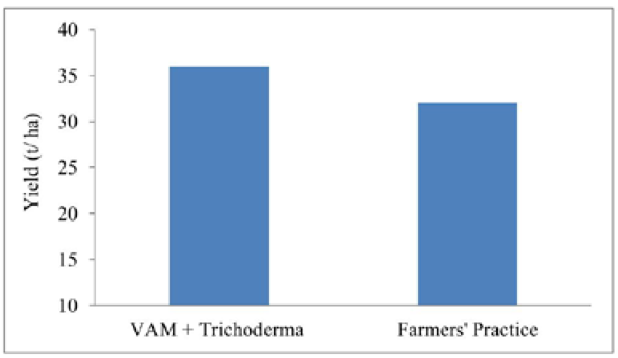

Figure 3. Yield recorded from both treatments, Guimba, Nueva Ecija, 2012 onion season

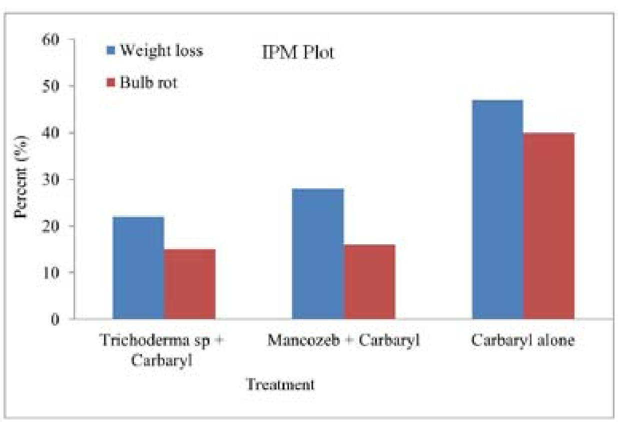

Figure 4. Incidence of bulb rot and weight loss in farmers' practice plot, Guimba, Nueva Ecija

Effect of pre-harvest application of VAM and *Trichoderma* sp. on the shelf life of onion

S.E. Santiago, S.R. Brena, H. Rapusas, B.M. Shepard, and M. Hammig

The effect of pre-harvest application of VAM and *Trichoderma* sp. on the shelf life of onion was conducted from December 2011 to July 2012 in Bunol, Guimba, Nueva Ecija. Treatments consisted of: T1- onion plots applied with VAM + *Trichoderma* sp. at transplanting; and T2- the farmer's practice (FP) (no VAM, no *Trichoderma* sp.).

A very low incidence of disease was recorded during the seedling stage of onion in plots treated with VAM + *Trichoderma* sp. compared with the FP. Anthracnose disease was monitored and recorded from 30DAT until 75DAT. Disease incidence (fig. 1) and disease severity (fig. 2) was low on the VAM + *Trichoderma* sp. treated plots, at 1% and 2.33%, respectively. Yield was recorded at 36 tons/ha on the plot treated with VAM + *Trichoderma* sp., while the farmers' practice plot had 32 tons/ha (fig. 3).

Four months after storage, percent weight loss and the occurrence of bulb rot disease were recorded. Results showed that all treatments had high percentages of weight loss (70% to 72%), but the percentage of rotten onion bulbs was observed to be low (20% to 24%). Both treatments applied with VAM + *Trichoderma* sp. increased income by 58% over those with the FP plots. This indicates that, with the use of the combination of VAM + *Trichoderma* sp. as opposed to the usual practices adopted by farmers, farmers can generate higher incomes.

Development of alternative storage techniques to prolong storage shelf life of onion

S.E. Santiago, S. R. Brena, H. Rapusas, B. M. Shepard, and M. Hammig

A study was conducted in Bunol, Guimba, Nueva Ecija from April to July 2012 to determine the effect of varying alternative techniques to prolong storage shelf life of onion. Bulb samples were harvested from the plots treated with VAM + *Trichoderma* sp. before transplanting (IPM plot) and in the farmer's practice (FP) plots. After harvest, onion was allowed to cure for 2 weeks before treatment applications. Treatments used were onion dusted with *Trichoderma* sp. + Carbaryl (T1), Mancozeb + Carbaryl (T2), and Carbaryl alone (T3).

Four months after storage, onion bulb samples from the FP plots had a high percentage of weight loss and bulb rot caused by *Fusarium* spp. compared with the IPM plot. Bulb samples from the plots treated with VAM + *Trichoderma* sp. (IPM plot) had lesser infection: at 22% and 15% in *Trichoderma* sp. + Carbaryl; 28% and 16% for Mancozeb + Carbaryl; and 47% and 40% on the Carbaryl alone in weight

Figure 5. Packaged VAM from farmer cooperative in Sto. Domingo, Neuva Ecija, Philippines

loss and bulb rot (fig. 4). For the FP plots, samples dusted with *Trichoderma* sp. + Carbaryl had 35% weight loss and 25% bulb rot. On the other hand, samples dusted with Mancozeb + Carbaryl had 32% weight loss and 22% bulb rot. Onion bulbs dusted with the Carbaryl alone had 48% weight loss and 40% bulb rot.

Vegetable crops

Utilization of fungal microbial agents for the management of whiteflies and thrips on selected vegetables

H. X. Truong, H. R. Rapusas, B. M. Shepard, G. Carner

Whitefly *Bemisia tabaci,* a sucking insect pest of cabbage, cauliflower, tomato, and melon, is also vector of several related viruses causing leaf curl and yellowing. There are no insecticides available on the local market to control whitefly. *Paecilomyces* species can cause the epizootic of whitefly under humid weather. Lab-formulated myco-insecticide using *Paecilomyces* isolate 15 in powder form was evaluated in a small field trial in melon. Whitefly adult dispersal on the crop was monitored by yellow sticky trap while whitefly eggs and nymphs on the leaf surface were counted on a 2 sq-cm area. Myco-insecticide was foliar sprayed from 44-55 days after transplanting melon.

Peak population dispersal of whitefly on muskmelon crops was 44-52 DAT. *Paecilomyces* isolate 15 and isolate 174 were the most promising myco-insecticides, reducing 95% of sweet potato whitefly adult population and causing 85% mortality of whitefly nymphs on muskmelon after 4th application. This is a preliminary trial, and future studies will be done next season.

Village-level production and utilization of VAM, *Trichoderma* sp., and NPV

Figure 6. Farmer from a cooperative in Talavera, Nueva Ecija, Philippines, who produces VAM

Figure 7. Farmer from a cooperative in Santo Domingto, Ilocos Sur, Philippines, with packaged VAM and healthy garlic

Figure 8. Mass production of *Trichoderma* sp. in Urdaneta City, Pangasinan, March 2012

Figure 9. FFS participants weighing the Trichoderma sp. product produced in Urdaneta City, Pangasinan.

H. R. Rapusas, G. S. Arida, S. E. Santiago, J. M. Ramos, and B. S. Punzal, M. B. Brown

See figures 5 through 9 (above).

CAMBODIA

Vegetable crops

Use of *Trichoderma* on various vegetable crops

Vegetables are in high demand in Cambodia for local consumption and to supply the tourist industry. However, both soilborne and above ground fungi have severely affected yields, with soilborne fungi having been shown to reduce yields by 70%. To combat these problems, farmers typically apply chemical fungicides with little success.

The IPM CRSP - Cambodian project is conducting field demonstrations using *Trichoderma harzianum* to replace chemicals. Experiments were conducted on crucifers, cucumber, and tomato in three provinces: Kandal, Kampong Cham, and Siem Reap. The objective of this effort was to determine if *T. harzianum* can control soilborne diseases and improve yields and income for farmers.

Five field demonstrations were conducted in Kampong Cham, five in Siem Reap, and seven in Kandal Province. The demonstrations were set up to compare 15 m x 15 m plots, with one using *T. harzianum* (the IPM plot) and the other using the usual farmer's practice (FP). The use of bio-pesticides and chemical pesticides were compared to determine differences in control of damping off, root rot, and other above ground fungal diseases on vegetables under farmer field conditions. Compost along with chemical fertilizers was used in both plots to improve soil conditions for plant growth. *Trichoderma harzianum* was incorporated in the IPM plot but not in the farmer practice plot.

The *T. harzianum* treatment used 15 tons/ha compost inoculated with *Trichoderma harzianum*; chemical fertilizers (200 kg/ha 15-15-15 for crucifers); neem 2L/tank; and *Trichoderma harzianum* powder as a bio-fungicide 20g/20L water for spray application. The *Trichoderma harzianum* compost mixture was prepared by mixing 1 kg *Trichoderma harzianum* per ton of compost and incubating 1-2 weeks before applying. Compost was applied before seeding or transplanting. The fertilizer 15-15-15 was applied as 20% basal dose followed by 20% after 3 weeks, 30% after 4 weeks, and 20% after 5 weeks.

The FP plots used compost (15 tons/ha); chemical fertilizers (100 kg/ha urea and 130 kg/ha 15-15-15); chemical insecticide (Abamecthin 20-50ml/17 liters water [one tank]); and chemical fungicide (Mancozeb 20g/tank). In FP treatments, Mancozeb was applied weekly. *Trichoderma harzianum* powder was applied weekly on the soil rhizosphere and on the plants. All IPM and FP plots were irrigated by hand sprinkler once or twice daily.

Results of the demonstrations are shown in figures 10-19.

Farm level production of *Trichoderma* was introduced in the three target provinces. Provincial agriculture technicians were trained in the propagation process, and selected farmers were provided with the basic materials, including pure culture from the GDA; they propagated the material on the farm (figs. 21 and 22).

The on-farm experience with *Trichoderma* production provided insights into problems involved in this process. Lessons learned during the first year

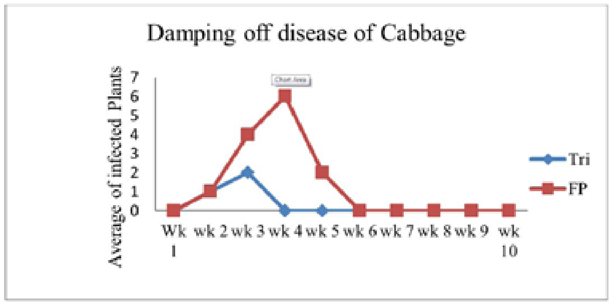

Figure 10. Cabbage – Kandal Province

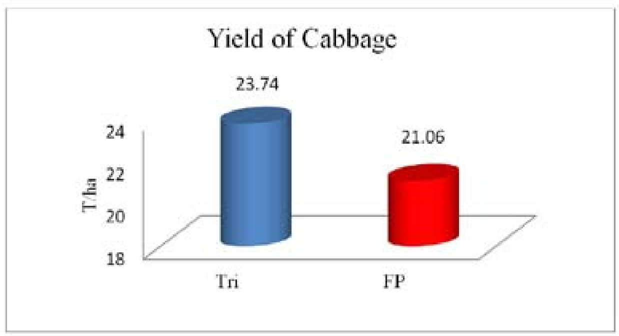

Figure 11. Cabbage – Kandal Province

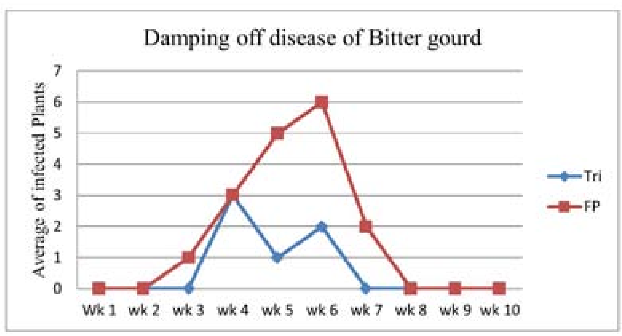

Figure 12. Bitter Gourd– Kandal

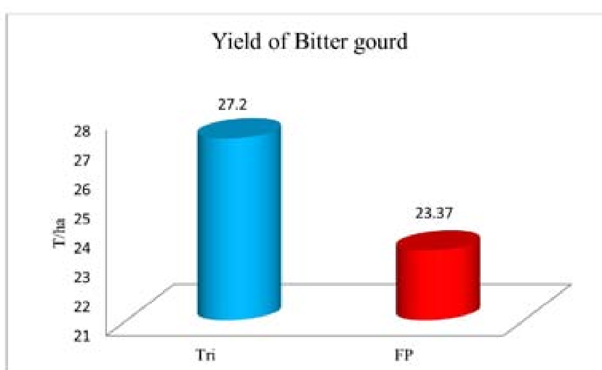

Figure 13. Bitter Gourd– Kandal

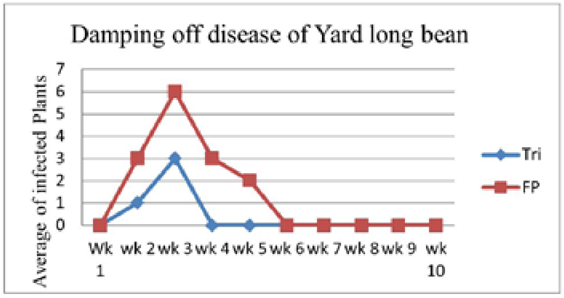

Figure 14. Yard long bean – Kandal

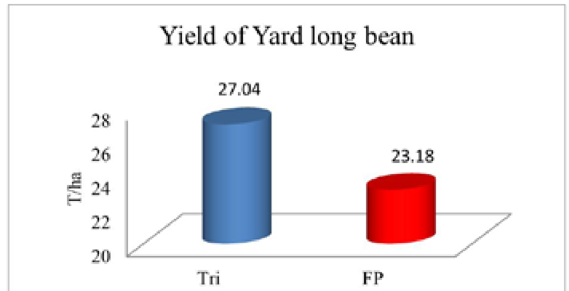

Figure 15. Yard long bean – Kandal

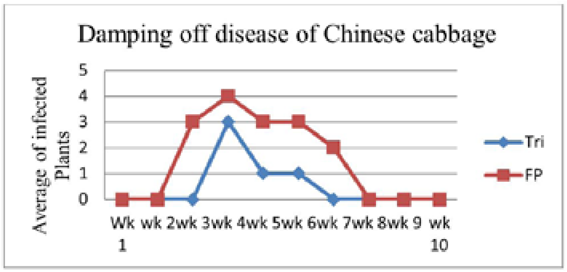

Figure 16. Chinese cabbage – Kandal

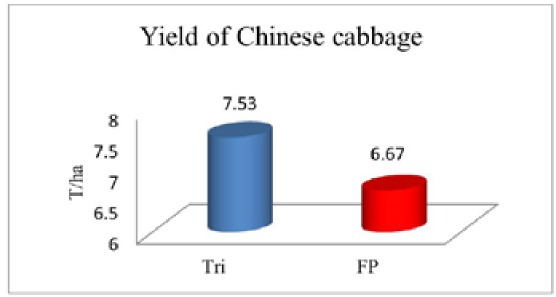

Figure 17. Chinese cabbage – Kandal

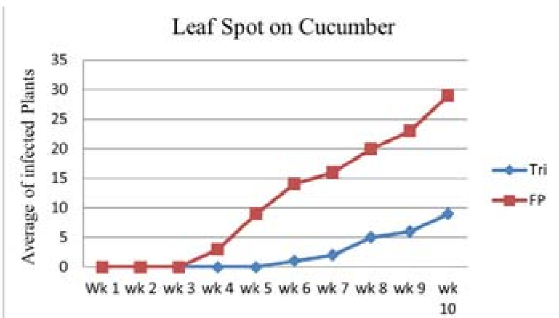

Figure 18. Cucumber – Siem Reap

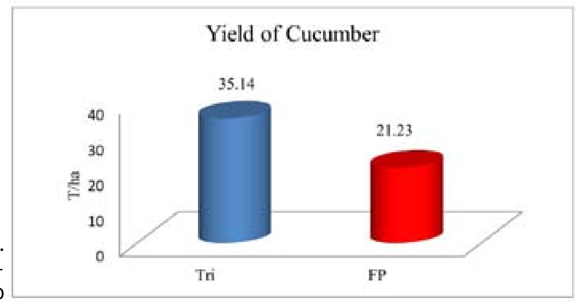

Figure 19. Cucumber – Siem Reap

experience include: that contamination may be caused by overcooking the rice mixture, resulting in too much moisture in each bag; that placing overcooked rice in bags results in bags becoming too hot and poor production of *Trichoderma*; and that large 800g bags are too big for complete spread of the *Trichoderma*.

The Minister of Agriculture, Forestry, and Fisheries visited IPM field plots to observe the benefits of the IPM approach and the potential of IPM to significantly improve Cambodian agriculture.

Figure 20. Field treated with Trichoderma

Figure 21. Farmer practice field (no Trichoderma)

Figure 22. Minister of MAFF in IPM field

INDONESIA

Chili Pepper

Thrips associated with chili pepper and other vegetables (Bogor Agricultural University)

Dewi Sartiami, Akhmad K Latip, Aunu Rauf, Ali Nurmansyah

Our previous studies of thrips-transmitted viruses have shown the presence of *Tomato spotted wilt virus* (TSWV) in tomato and chili pepper and *Peanut bud necrosis virus* (PBNV) in peanuts in Indonesia. However, thrips in Indonesia have been poorly studied. A survey of thrips was conducted on various vegetable crops during May and June 2012, mainly in the districts of Bogor and Cianjur. Thrips were collected by beating flowers or leaves over a plastic tray or by removing and placing whole leaves or flowers in plastic bags. These were later counted, cleared and mounted on slides.
Slide mounted specimens were then identified using taxonomic keys. Nine species of thrips were found: *Thrips palmi*, *T. tabaci*, *T. parvispinus*, *T. fuscipennis*, *T. nigropilosus*, *Ceratothripoides brunneus*, *Frankliniella intonsa*, *Echinothrips americanus*, and *Megalurothrips usitatus* (tab. 1). The first two thrips species are known vectors of tospoviruses. However, the most prevalence species was *T. parvispinus,* comprising 85.8% of the total individual thrips collected. *Thrips parvispinus* is a polyphagous species found on 16 different vegetable crops (tab. 1). *T. parvispinus* was mostly found on flowers of tomato and chili pepper. Further studies were conducted to determine the preference of *T. parvispinus* to traps with different colors in chili fields. We found that *T. parvispinus* was significantly more attracted to white and blue than yellow traps (fig. 1). This suggested that white and blue traps can be used for monitoring *T. parvispinus* populations.

Location Dates	Host plants	Species	Adults		Nymphs
			Female	Male	
Cipanas 29-05-2012	Chili pepper (flower)	*Thrips parvispinus*	22	13	3
Cipanas 29-05-2012	Snap bean (leaf)	*Thrips parvispinus*	44	9	27
Cipanas 29-05-2012	Tomatoes (flower)	*Thrips parvispinus*	2	1	0
Cipanas 29-05-2012	Zucchini (flower)	*Thrips parvispinus*	15	3	0
Cipanas 29-05-2012	Cucumber (flower)	*Thrips parvispinus*	16	28	9
		Thrips palmi	1	0	0
		Megalurothrips usitatus	1	0	0
Cipanas 01-06-2012	Chili pepper (flower)	*Thrips parvispinus*	63	14	103
Cipanas 12-06-2012	Cucumber (leaf)	*Thrips parvispinus*	12	0	6
		Thrips palmi	8	0	0
Cipanas 12-06-2012	Cucumber (flower)	*Thrips parvispinus*	10	2	2
		Thrips palmi	2	0	0
Cipanas 12-06-2012	Chili pepper (leaf)	*Thrips tabaci*	6	0	5
Cipanas 12-06-2012	Green onion (leaf)	*Thrips parvispinus*	2	0	87
		Thrips tabaci	3	0	0
Cipanas 12-06-2012	Zuchini (flower)	*Thrips parvispinus*	25	1	2
		Ceratothripoides brunneus	1	0	0
		Frankliniella intonsa	1	0	0
Cipanas 12-06-2012	Potato (leaf)	*Thrips parvispinus*	23	1	2
Cipanas 12-06-2012	Corn	*Thrips fuscipenis*	15	0	0
Cipanas 12-06-2012	Tomatoes (flower)	*Thrips parvispinus*	5	3	0
Cisarua 18-06-2012	Carrot	*Thrips parvispinus*	68	1	2
		Thrips nigropilosus	3	0	0
Cisarua 18-06-2012	Lettuce	*Thrips parvispinus*	17	0	0
		Echinothrips americanus	2	0	0
Cisarua 18-06-2012	Carrot	*Thrips parvispinus*	9	0	2
Cisarua 18-06-2012	Chili pepper (flower)	*Thrips parvispinus*	10	4	1
Cisarua 18-06-2012	Chili pepper (flower)	*Thrips parvispinus*	12	4	7
Cisarua 18-06-2012	Chili pepper (leaf)	*Thrips parvispinus*	1	0	2
Rancabungur 21-06-2012	Egg plant (flower)	*Thrips parvispinus*	41	25	3
		Thrips palmi	24	0	0

Table 1. Thrips species collected from various host plants and localities

Broccoli

Farmer Participatory Research (Bogor Agricultural University)

Jaenudin, Wahyu Haidir, Dedih Ruhyatna, Aunu Rauf

The objectives of this research were to compare IPM strategies and existing farmers' practices for managing pests and diseases. Broccoli was grown using the IPM package compared with the standard grower practice. The IPM treatments consisted of: (a) use of plastic mulch, (b) mixing *Trichoderma* with bokashi (locally-produced compost), (c) dipping seedlings in *B. subtilis* and *P. fluorescens,* (d) lower rate of synthetic fertilizers, and (e) hand-picking and botanical insecticide for control of lepidopteran pests. Even though not as impressive as on tomatoes and chili pepper trials, results on broccoli showed that IPM treatments still gave a higher yield and income and were more profitable than farmers' practices as indicated by B/C ratio (tab. 2).

Table 2. Budget, yield, and cost-benefit analysis of IPM and farmer practice on broccoli

Items	IPM	Farmer Practice
Yield (kg)	512	460
Gross revenue (Rp)	4,096,000	3,680,00
Cost (Rp)	2,263,500	1,885,000
Net revenue (Rp)	1,832,500	1,795,00
B/C ratio	1.8	1.5

Green Onion

Farmer participatory research (Bogor Agricultural University)

Ujang Dayat, Wahyu Haidir, Dedih Ruhyatna, Aunu Rauf

A study was conducted with the objective to compare IPM strategies and existing farmers' practices for managing pests and diseases. Green onion crops grown under an IPM package were compared to those produced using standard grower practices. The IPM package included: (a) use of plastic mulch, (b) pouring bokashi mixed with *Trichoderma* into planting holes, (c) dipping seedlings

Table 3. Budget analysis of IPM and farmer practice on green onion

Items	IPM	Farmer Practice
Yield (kg)	2,700	2,400
Gross revenue (Rp)	8,100,000	7,200,000
Cost (Rp)	5,552,000	5,620,000
Net revenue (Rp)	2,548,000	1,580,000
B/C ratio	1.5	1.3

in *B. subtilis* and *P. fluorescens* 12 hours before transplanting, (d) lower rate of synthetic fertilizers, (e) hand picking of caterpillars from infested plants, and (h) need-based pesticide applications. As with broccoli trials, even though not so impressive, results showed that IPM treatments still gave a higher yield and income, and were more profitable than farmers' practices as indicated by B/C ratio (tab. 3).

Sweet potato

Dissemination of field studies result to wide-scale area for controlling the sweet potato weevil, *Cylas formicarius* (FIELD)

The Sajati Farmer Group trained other farmer groups (Tunas Muda, Srikandi Saiyo, and Murni Sakato Farmer Groups) in controlling sweet potato weevil, *Cylas formicarius,* with biopesticides. The training was followed up by an evaluation meeting. In it they found that the farmers in the surrounding area are starting to implement IPM technologies for managing the weevil, such as:

- Sanitation (collecting leftover tubers from the field after harversting) to prevent becoming a source of infestation of the new crop. The collected tubers were composted and used as organic fertilizer.
- Use of healthy planting material.
- Use of bioagents (*Beauveria* and *Metarhizium*).

Training on propagation of bioagents to control the sweet potato weevil, *Cylas formicarius* (FIELD)

As part of their effort to control the weevil in a wider area, the Sajati farmer group in Agam conducted a training on propagation of bioagents with trainers from Bukit Tinggi Laboratory. Around 60 farmers from 24 nagaries (villages) and 5 districts (Agam, Padang Pariaman, Solok Selatan, Padang and Pesisir Selatan) attended the training.

This training was a serial part of the previous bioagents training conducted in North Sumatera. Thus, the "pictorial guide" on propagation of bioagents produced from North Sumatera was used in this training.

As a result of this training, 12 nagaries (villages) of FIELD Bumi Ceria program in Padang Pariaman district started bioagent propagation. Around 300 farmers in these villages carried out the propagation of *Trichoderma, Beauveria,* and *Metarhizium* in their own villages to support the farming program.

Vegetable crops

IPM for vegetable crops in North Sulawesi, Indonesia (Sam Ratulangi University)

Dantje T. Sembel, Ir. Merlyn Meray and Ir Max Ratulangi

Vegetables such as tomato, chili, cabbage, potato, and spring onion are important cash crops in North Sulawesi. Most vegetable farmers still use a mixture of pesticides (insecticides and fungicides) on crops to control vegetable pests and diseases. Two recently introduced pests of tomato, namely, *Liriomyza sativae* and *Nesidiocoris tenuis,* together cause serious damage to tomato crops, particularly in the sub-district Tompaso. Other major pests of tomato are *Bactocera papayae* and *Bemisia tabaci.* The fruit fly, *B. papaya,* often causes damage to tomato fruits, and *B. tabaci* damages tomato by direct feeding and vectoring viral diseases. Four parasitoids, *Hemiptarsenus varicornis, Gronothoma* sp., *Neochrysocharis* sp. and *Opius* sp. were recorded and the most dominant one was *H. varicornis*.

The main pests of cabbage are *Plutella xylostella* and *Crocidolomia pavonana*. A parasitoid, *Diadegma semiclausum,* has established in N. Sulawesi and has been able to control *P. xylostella* with parasitism of up to 90%. Entomopathogenic fungi, *Metarhizium anisopliae* and *Nomuraea rileyi,* have been isolated from lepidopteran larvae, and their pathogenicity is being studied under laboratory and field conditions.

Tomato and chili are affected by wilt and viral diseases. Local strains of *Trichoderma koningii* are being tested in the field to reduce the incidence of wilt disease. Varieties of chili and tomato from AVRDC are being tested for resistance to viral and fungal diseases in North Sulawesi.

Figure 23. Bioagent training

Figure 24. Bioagent training

Development of IPM knowledge with smallholder farmers producing vegetables in North Sumatera (FIELD)

Activities in North Sumatera were focused on training the trainers about propagation and use of bioagents *Trichoderma harzianum, Beauveria bassiana, Metarhizium anisopliae, Pseudomonas fluorescens,* and VAM (*Vesicular Arbuscular Mycorrhizae*). It involved farmers from villages of Puang Aja and Batu Layang (Sibolangit sub-district, Deli Serdang district), Doulu village (Berastagi sub-district, Karo district), and Tangkidik village (Barus Jahe sub-district, Karo).

Training was conducted on February 2012 and facilitated by partners from Food Crop and Horticulture Protection Center of Bukit Tinggi, West Sumatera. For training on *Trichoderma, Beauveria, Metarhizium,* and *Pseudomonas fluorescens*, a manual was provided by a trainer from Bukit Tinggi Laboratory. For training on VAM, PhilRice (Ms. Hermie Rapusas) supplied manuals. On September 2012, the trainers conducted a workshop to share their experience in working with the bioagents and also planned for field studies on theapplication of bioagents. During the workshop, the farmers evaluated the bioagent propagation techniques, discussed improvements, and practiced propagation techniques of bioagents.

Technology transfer

Support by local government (Bogor Agricultural University)

IPM CRSP sites in Cianjur have been selected by the local government for agricultural training. Sixteen students (6 males and 10 females) of SMK Pertanian (Agriculture Vocational High School) Kuningan conducted an internship for three months (June-August 2012) at farmer group Multitani Jayagiri. The internship was part of the school curriculum. At the location, they learned various vegetable cultivation techniques, including compost production and IPM technologies.

Networking and dissemination (Bogor Agricultural University)

Networking was accomplished through institutional collaboration with the Agricultural Extension Agency of District of Cianjur, Food and Horticultural Crop Protection Center of West Java (BPTPH), Directorate of Horticultural Crop Protection and Directorate of Food Crop Protection of the Ministry of Agriculture. Dr. Aunu Rauf was invited by the Ministry of Agriculture to present a talk on impact of climate changes on insect pests. The meeting was organized by Plant and Animal Protection Society of Indonesia (MPTHI) and conducted in Palembang (South Sumatera), October 5-7, 2011, with more than 600 participants. They were pest observers, extension agents, researchers, and some farmers coming from various places throughout Indonesia. With the outbreaks of rove beetle (*Paederus fuscipes*) in Surabaya in late March 2012, Dr. Aunu Rauf became a main resource person and was interviewed by various national newspaper and televisions.

For more dissemination of IPM, we collaborate with Edelweiss Radio, located in the highland of Ciputri. This community radio (107.6 FM) was launched on October 24, 2009, and supported by Green Radio in Jakarta, which advocates for environmental issues. Though Edelweis' signals are not strong, the favorable location allows broadcasts to reach the urban areas of Jakarta and Bandung, the capitol of West Java Province. Management of the radio is by local farmers who are members of an organic farming group, and the radio has become a medium for spread of information about agriculture and IPM. The success of the organic farming group is partially attributable to the radio which has attracted consumers from Jakarta and elsewhere to come to Ciputri to purchase vegetables directly from local farmers. They get twice the price for their organic produce than for conventional produce. Also, the success of the organic producers and the spread of the message has brought an individual from Jakarta who had purchased land next to the organic farm and established his own organic farm.

Leverage funds (Bogor Agricultural University)

Over the course of the past year, The United States Agency for International Development Mission to Indonesia (USAID/Indonesia) sought applications from institutions of higher education to support USAID/Indonesia's development strategy through partnership activities between institutions of higher education in Indonesia and the United States. With the objective of leveraging funds to enhance our effort in IPM supporting research, IPM CRSP Southeast Asia Co-PI Aunu Rauf, Bogor Agricultural University, and Prema Arasu and Naidu Rayapati, Washington State University, submitted a successful proposal to the USAID/Indonesia. The proposal entitled "A Smart Strategic Coalition for Sustainable Agricultural and Economic Development in Indonesia" have two broad goals: (1) to strengthen human and institutional capacities in agricultural research and science based education and training through biotechnology for improvement and management of high value crops; and (2) to create a dynamic and sustainable network of partners engaged in the spectrum of knowledge discovery and transfer, and effective implementation through technology commercialization. During the project period (2012-2015), the funds requested will ensure the training of six PhD students, three through IPB and three through WSU. PhD research projects will emphasize the proposed modern biotechnology, DNA barcoding, and crop protection and management issues relevant to the needs of Indonesia. Student training will involve the guidance of both WSU and IPB collaborators.

IPM communication and education leading to widespread adaptation, adoption, and impact (FIELD)

Activities in West Sumatera were carried out in Sungai Sariak village (Baso wub-district, Agam district) in collaboration with Food Crop and Horticulture Protection Center – Bukit Tinggi Laboratory and Agricultural Service Office of West Sumatera Province. The program also involved farmers' groups in several villages in Padang Pariaman district, in integration with the other USAID-funded FIELD program in the area (FIELD Bumi Ceria – Building Disaster and Climate Change Resilience in Padang Pariaman Farming Communities, West Sumatera).

- Field study on the use of *Beauveria bassiana* and *Metarhizium anisopliae* for controlling *Cylas formicarius* on sweet potato
- Dissemination of information on controlling *Cylas formicarius* on sweet potato
- Training on propagation of bioagents