Manila peri-urban vegetable project

Asian cities, such as Manila, face an enormous challenge to remedy micronutrient deficiencies among the poor, to recycle solid wastes, and reverse environmental degradation.

The AVRDC peri-urban vegetable project in the Philippines, sponsored by Gesellschaft für Technische Zusammenarbeit (GTZ), is designed to: stabilize the supply of safe and nutritious vegetables to metropolitan areas; and develop an approach for information acquisition, testing, and dissemination suitable to other peri-urban areas in Asia.

Socioeconomics

Technologies introduced from AVRDC to improve production of pak-choi (*Brassica rapa* L. cvg. pak-choi) proved to be profitable based on experimental and survey data from *barangay* (community) San Leonardo and Central Luzon State University (CLSU) in Nueva Ecija. Costs and returns of introduced technologies and showed significant improvement in yield and net income when compared to traditional farmer practices. For example, by sowing in rows on raised beds covered with screen tunnels and by fertilizing with composted household waste, yields increased 247% over the standard practice of broadcast seeding on flat beds with only inorganic fertilizer. The cost differential between improved and standard practices was 103%. The additional expense with improved practices is from purchase of screen, labor costs for bed preparation, seeding in rows, and harvesting/packaging more produce than obtained from standard practices.

By growing pak-choi in 18 × 18 m screen houses on the CLSU experimental site the incremental net economic benefit relative to open field over wet and dry seasons was 2778 and 10,469 PHP (pesos)/1000 m^2, respectively. Clearly, screen houses are a greater benefit during the dry season than during the wet season because insect pests are most prevalent during the dry season. When grafted tomato was grown under rain shelter (2.5 × 40.0 m) the incremental net economic benefit relative to open field was 21,588 PHP/1000m^2.

These experiences encouraged the project to expand to other provinces in southern Luzon that supply leafy vegetables to Metro Manila. An orientation–training exercise was conducted at one site in each province (Quezon, Batangas, and Laguna). In addition, a farmer field school (FFS) was conducted in Laguna after finishing a similar FFS in Mallorca, San Leonardo, Nueva Ecija. Farmers and agriculture technicians rated the training as positive.

The project used linear programming to calculate annual profit from different crop combinations within and between seasons by varying capital and variables considered to affect production (i.e., active ingredient of pesticides, levels of nitrogen fertilizer, and water supply). With an initial investment of 20,000 PHP/ha, a farmer could generate income of 487,000 PHP by planting pak-choi/mustard in the wet season and pak-choi/onion in the dry season. This is superior to the onion/eggplant sequence in San Leonardo that generated income of 285,000 PHP/ha.

Introduced technologies require more production inputs than are currently used. Survey results showed that suppliers of agricultural materials in Gapan, Nueva Ecija, could provide the inputs required if additional areas are opened to vegetable production and/or if cultivation is intensified. As well, market outlets in Manila have the means to increase the tonnage of vegetables received and distributed. Currently, in Divisoria alone, 10 brokers or *casadores* trade 66 tons daily. And there is a growing demand for quality (less pesticides and less damage) pak-choi and other leafy vegetable in Metro Manila.

Farmers' negative perceptions of introduced technologies were based on the capital needed to buy screens and on the labor needed to raise beds, sow seeds in rows, and erect screen tunnels. Farmers saw that by using the technologies, yield per unit area increased and pesticides cost was reduced, yet they were unwilling to invest the time and money required to use the new practices. Apparently farmers are most comfortable with old practices, and they lack capital.

We believe that by training farmers in the new practices and by establishing a credit program to provide access to capital for investment, farmers will adopt these new technologies.

Soil and crop nutrition

Soil and crop nutrition research consisted of four sub-activities conducted from summer 2000 to 2001. The first sub-activity was designed to determine the residual effect of six applications of inorganic fertilizer and organic amendments on the yield of kangkong (*Ipomoea reptans*). A trial was conducted at CLSU. Thirty-six plots representing nine treatments and four replications were planted to a sequence of pak-choi, radish, onion, pak-choi, pak-choi, and pak-choi. The treatments were; T1 = nil fertilizer, T2 = ½ recommended rate of fertilizer (½ RR), T3 = household waste compost (HW), T4 = chicken manure compost (CM), T5 = recommended rate of fertilizer (RR), T6 = ½ RR + ½ HW, T7 = ½ RR + ½ CM, T8 = ½ RR + HW, T9 = ½ RR + CM. The amounts of HW and CM applied in T3, T4, T6, T7, T8, and T9 plots were based on complete nitrogen substitution.

Residual effects from amendments applied previously were obtained from the first and the second cuts. Yields of kangkong at first cut were similar in plots previously treated with ½ RR + ½ HW (T6) and ½ RR + HW (T8). The yield of T8 over plots previously amended with RR (T5) was 23.96%. In the second cut of kangkong, plots previously treated with RR gave the highest yield.

The second sub-activity dealt with improvement of fertilizer management and cropping sequence in the peri-urban vegetable areas of San Leonardo. The farmer practice of growing three consecutive crops of pak-choi followed by radish and onion was compared with pak-choi alternated with kangkong then radish and onion. Likewise, the use of urea alone, a common farmer practice, was compared with NPK application with or without organic fertilizers. Three farms were used, each with a different frequency of rice hull application and burning.

Pak-choi yield from the first crop in the sequence did not differ among fertilizer treatments. However, yields from farms where rice hulls were burned every two years (3 t/ha) and every three years (3 t/ha) were much less than was yield from the farms where rice hulls were burned yearly (17–25 t/ha). The low yield was due to severe rotting associated with high rainfall. The farm to which rice hulls were applied and burned annually received 136 mm of rain, but the other farms received 413 and 537 mm.

Application of ½ RR NPK reduced the yield of the third crop in the sequence (pak-choi) on the farm where rice hulls were burned every three years.

In Maligaya clay loam soil, which is N deficient, kangkong's yield response curve was described by the linear equation $Y = 4.8882 + 0.0628X$, $R^2 = 0.97^{**}$. In relatively fertile soil, such as Quingua silty clay loam, the yield response curve was described by the quadratic equation $Y = 10.142 + 0.0473X – 0.0001X^2$, $R^2 = 0.8785^{**}$.

The equation that describes the relationship of nitrogen to radish yield differed among farms. In Maligaya clay loam soil the linear equation was $Y = 1.2224 + 0.0666X$. In Quingua silty clay loam, the relationship was given by the quadratic equation $Y = 58.759 + 0.3394X – 0.0012X^2$, whereas in Quingua silt loam a cubic equation best described the N and yield relationship given by $Y = 67.06 + 0.174X + 0.0012X^2 – 0.006X^3$. The yield response curve suggests that further study is needed to understand if there is a basis for the deviation from the expected linear or quadratic response.

Cost and return analysis indicated a profit from radish even when unfertilized in both Quiangua silty clay loam and silt loam soils, whereas growing of radish in Maligaya soil is less profitable. In fact, profit occurred only at a minimum application rate of 200 kg N/ha.

Grafted tomato to enhance off-season production

During the hot–wet months, tomatoes are grown only in a few hilly areas; production is limited and high prices make tomatoes unaffordable to many consumers. By grafting tomatoes onto eggplant rootstocks and transplanting seedlings onto raised beds protected by rain shelters, tomatoes can be grown during the hot–wet months when flooding and bacterial wilt are major constraints to production.

To develop technologies for tomato production in the hot–wet months we conducted two sets of experiments at CLSU. The first experiment tested the performance of two tomato varieties as scion (Apollo and CLN5915) grafted onto two rootstocks known to possess resistance to bacterial wilt eggplant EG203 and tomato H7996. Grafted seedlings were transplanted onto raised beds with rain shelters constructed from UV resistant plastic. The second experiment involved rootstock EG203 grafted onto scions Apollo and CLN5915. Grafted seedlings were transplanted on raised beds with and without rain shelter. The same cultural management practices were employed in both experiments.

Grafted tomato production under rain shelter

Percent survival of grafted plants was significantly higher than survival of non-grafted plants. Apollo grafted onto EG203 and H7996 had 91.7% and 75.0% survival, respectively, whereas no non-grafted Apollo plants survived the entire growing season. In contrast, CLN5915 grafted unto EG203 and H7996 had 97.2% and 91.7% survival, respectively. Non-grafted CLN5915 had 64% survival.

When Apollo was grafted onto EG203 and to H7996, yields were not significantly different (12.2 and 9.1 t/ha, respectively). In contrast, yield of non-grafted Apollo was only 0.02 t/ha. Similarly, when CLN5915 was grafted onto EG203 and H7996, yields were 28.1 and 22.2 t/ha, respectively, whereas yield of non-grafted was 6.5 t/ha. Grafted CLN5915 out yielded grafted Apollo by a factor of 2.5.

Grafted tomato with and without rain shelters

Percent survival was unaffected by scion, rootstock, and shelter. Survival of Apollo and CLN5915 was 76.5% and 72.5%, respectively, whereas 79.5% and 69.5% of plants survived through the season when grafted onto EG203 and non-grafted, respectively. Survival under shelter was 79% across scions and rootstocks and 70% in open field. In contrast to percent survival, yield was affected by graft and by shelter. There was no yield difference between scions. Single degree of freedom F tests showed that yield from grafted plants (6.7 t/ha) was significantly ($P = 0.027$) greater than yield from non-grafted (4.5 t/ha), and yield under rain shelter (8.1 t/ha) was greater than yield in open field (3.1 t/ha). It is important to note that yields are low because plants were destroyed by a hurricane after only eight harvests, which is about half the standard number of harvests.

In an experiment conducted by the Bureau of Plant Industry, Los Baños, three fresh market tomato cultivars, FMTT-586, CLN 1466A, and BPI Tm 9, were grafted onto rootstock of EG203 and transplanted 11 August 2000 onto beds raised 25–30 cm and covered by a screen shelter, 10.0 × 20.0 × 2.4 m, constructed from 32-mesh screen. Grafted and non-grafted plants of each variety were arranged in a split-plot design with two factors, variety and graft level, and three blocks. Distance between beds and blocks was 0.5 m. Compost at 10 t/ha was applied to beds prior to transplanting, whereas NPK at 168–164–324 kg/ha was applied at the time of transplanting, and at 7 and 30 days after transplanting. Flower clusters were treated with the fruit-set regulator, Tomatotone, on six occasions. Yield was calculated from the fruit weights of eight harvests made from 4 October to 6 November.

There was no interaction between graft level and variety. Yields of BPI-Tm 9 (12.5 t/ha) and FMTT-586 (10.1 t/ha) were not significantly different across graft level, but both cultivars yielded more than CLN 1466A. There was no significant yield difference between graft levels across varieties. All plants were affected with virus and bacterial wilt.

Leafy vegetable cultivars for year-round production in the tropics

Leafy vegetables, such as cabbage, pak-choi, and mustard, are grown year-round in Baguio, a highland area. But supplies from highland areas cannot meet consumer demand, so leafy vegetables are also grown in the lowlands, where they are exposed to severe insect and disease pressures. Therefore, the search for resistant or tolerant accessions is a major part of efforts to promote lowland production. The objectives are to: 1) identify new leafy vegetable crops adapted to Nueva Ecija; 2) construct a database of leafy vegetable varieties identified for year-round production; and 3) come up with ways to reduce crop damage by diamondback moth (*Plutella xylostella*) (DBM), cabbage webworm (*Hellula undalis*) (CWW), and flea beetle (*Phyllotreta striolata*).

Two field designs were used to evaluate the performance of leafy cultivars (except kangkong) at CLSU. Fifty-five accessions were direct seeded into raised beds 1 × 3 m (four rows/bed and 20 cm between rows) inside a screenhouse (32-mesh) and in the open field. Fertilization included a basal application of 10 t/ha organic fertilizer and 60–60–60 NPK followed by side dressing of 30 kg N/ha two weeks after sowing. Insecticides was sprayed in the screenhouse as needed. The two middle rows from each plot were harvested 30–40 days after sowing.

*Pak-choi (*Brassica campestris *L. cvg. pak-choi)*

Sixteen accessions were evaluated in screen houses and in open field over two crops. In the screen house, yields ranged from 24.8 (Bp 39) to 53.1 (Bp 04) t/ha for the first crop and from 31.5 (Bp 39) to 57.8 (Bp 21) t/ha for the second crop, but yield differences were not significant.

As expected, lower yields were obtained in the open field than in the screen house. The lowest open field yield was from Bp 21 (8.2 t/ha) and the highest from Bp 03 (33.6 t/ha). Yields obtained in the second trial were higher, ranging from 13.6 t/hs (Bp 11) to 74.5 t/ha (Bp 21).

*Indian mustard (*Brassica juncea *Coss.)*

Significant yield differences were noted among accessions in screenhouse and in open field. Highest yields were obtained in the screenhouse. There, yields ranged from 24.8 (Bj 01) to 66.2 t/ha (Bj 14). Interestingly, yields in the open field ranged from 7.2 to 65.9 t/ha. And, as in the screen house, Bj 01 gave the lowest yield, whereas there was no significant difference in yield among accessions Bj 03,11, 14, and 15, though yields ranged from 31.1 to 65.9 t/ha.

*Non-heading Chinese cabbage (*Brassica rapa *L. cvg. Chinese cabbage)*

Ten accessions were evaluated. No yield differences were noted. The highest yield was from Bcc 10 with mean yields of 100.4 t/ha from the screenhouse and 44.0 t/ha from the open field.

*Chinese kale (*Brassica oleraceae *L. cvg. alboglabra)*

Yield among accessions varied significantly in the second trial in both screenhouse and open field. In the screenhouse, Ba 08 yielded significantly more (45.9 t/ha) than Ba 05 (14.5 t/ha). Ba 17 might be a promising accession as yields across trials in the screen house (40.9 and 45.7 t/ha in trials 1 and 2, respectively) were less variable than were yields from other accessions. In the open field, however, yields of Ba 17 across trials showed about the same variation as yields of other accessions.

*Choysum (*Brassica rapa *L. cvg. Caisin)*

There were no yield differences among accessions over trials within environments (screenhouse and open field). However, yields from trial 2 were greater than yields from trial 1 in both screen house and open field. In trial 2, yields ranged from 25 to 62 t/ha in the screen house and from 32.6 to 54.3 t/ha in the open field. Bc 02 showed less yield variability across trials in the screenhouse (60 and 61 t/ha) than did other accessions, but in the open field its performance was similar to that of others.

*Kangkong (*Ipomoea reptans *Poir)*

Again, there were no yield differences among accessions. Average yields taken from trials 1 and 2 were 57.34 and 35.8 t/ha, respectively.

Leafy vegetable yield trials in Los Baños

Eight cultivars of leafy vegetables were tested for yield by the BPI–Los Baños in January, February, July, and October 2000. Accessions were seeded in rows 15 cm apart on 1 × 3 m beds. Beds were raised 10 cm and covered with screen tunnels to protect plants from insect damage. Accessions were arranged in random complete block design (RCBD) with three blocks. Compost was applied to beds at 10 t/ha prior to seeding, and NPK at 90–20–20 kg/ha was applied basally. At 10 and 20 days after seeding plants were treated with a foliar fertilizer, Crop Giant, (NPK, 19–19–19 + ME), at 2.5 ml/l.

Most species performed best when seeded in December–February and worst when seeded in August–October. High rainfall during October (809 mm) likely contributed to low yields. Mean yields ranged from a low of 5.6 t/ha for Chinese kale to a high of 13.6 t/ha for pak-choi.

Leafminer infestation was observed across planting dates and vegetable species. Mean ratings (scale 0 to 5) were 1.87, 1.83, and 1.23, respectively, for the three planting periods. Flea beetle infestations were also noted, but severity estimates were not made. Clearly, 32-mesh screen tunnels did not prevent infestation by leafminer and flea beetles. Sixty-mesh screen would prevent insect entry, but would restrict air movement resulting in heat buildup and poor crop growth.

Building partnerships

The project works to develop partnerships with local government units (LGUs), nongovernmental organizations (NGOs), other stakeholders, and farmers to accelerate adoption of peri-urban vegetable production technologies. The project promotes technologies that: 1) enhance productivity and reduce use of pesticides and inorganic fertilizers; 2) reduce health risk related to pesticide exposure; and 3) foster off-season production with reduced risk of economic failure.

Linkages were established with LGUs to facilitate delivery of agricultural extension services to farming communities in provinces identified by the project's socioeconomics group as major contributors of leafy vegetables to markets in Manila. Memoranda of Agreement (MOA) were signed between the project and LGUs. This led to three training activities attended by 78 farmer leaders, 62 agricultural technicians, and 16 researchers from eight municipalities. Later, two farmer field schools (FFS) were held, the first in Mallorca, San Leonardo, Nueva Ecija and the second at Hornalan, Calamba, Laguna. Thirty-one farmers and eight LGU technicians were trained in integrated crop management of pak-choi. The field schools provided hands-on instruction in the use of raised beds during the rainy season as an effective means to reduce flooding and rotting of plants, and in the use of screen tunnels to exclude insect pests, reduce pesticide use, and improve crop quality. Farmers learned that application of urea in excess of the recommended rate does not increase pak-choi yield.

Components of the project, particularly grafted tomato for off-season production, solid waste management for peri-urban production, and integrated crop management for pak-choi , were showcased in technology fairs conducted by LGUs, state colleges and universities, and other scientific organizations. The project was also featured in local and national newspapers, radio, and television. Land Bank of the Philippines (LBP), through its Technology Promotion Center, has pledged money to validate the cost and return from grafted tomato seedling production and use of screen tunnels for pak-choi production. If the technologies are found to be feasible, LBP will provide loans to interested farmers and other clients.

The project's research outputs in socioeconomics, integrated pest management, integrated nutrient management, and partnership building were presented at six scientific conferences. A socioeconomics report was judged best paper while one on building partnerships was judged best poster.

Integrated pest management

Vegetable production in San Leonardo usually suffers from severe insect and disease problems. Pest infestation is high because environmental conditions are conducive to growth and development of hosts and pests year-round. Generally, farmers spray prior to the appearance of any insects (or disease), which results in: 1) excessive cost of crop protection due to unwarranted use of pesticides; 2) decreased efficacy of pesticides because insects develop resistance; and 3) potential human health problems from insecticide residues.

The project develops and promotes integrated pest management (IPM) strategies as a means to reduce pesticide inputs and pesticide residues.

Improved profitability and safety of pak-choi

Three consecutive trials were conducted on one farm to compare farmer and researcher-managed plots for yield and pest development. Farmers used broadcast seeding, flat beds, inorganic fertilizer at 78–37–37 kg NPK/ha (split application), and applied pesticides without regard to pest intensity and crop growth stage. Researchers used raised beds, sowing in rows, inorganic fertilizer at 35–10–10 kg NPK/ha plus 3.5 t/ha chicken manure applied basally, and pesticides based on 'action thresholds' established previously.

Plant and pest numbers, incidence of pest-damaged plants, incidence of diseases, and crop yield were subjected to analysis of variance (ANOVA) to determine treatment effects. Researcher-managed plots yielded significantly more than farmer-managed plots in trials 2 and 3, but not in trial 1 (Table 120). Incidences of DBM and CWW were the same for farmer- and researcher-managed plots across trials. However, the incidence of web blight was less in researcher-managed plots, maybe due to the fungicide (benomyl) applied to the researcher-managed plots in trials 1 and 2. Researcher-managed plots did not receive fungicide in trial 3, but the incidence of web blight in researcher-managed plots was less than in farmer-managed plots that received the fungicide. Generally, farmers applied more insecticide and less fungicide than did researchers. Trial 3 remains an anomaly. Although there were significant treatment effects in trials 1 and 2, yields were low, attributed to DBM, CWW, and web blight. Interestingly, when CWW was absent, but DBM and

Table 120. *Yield, number of cabbage webworm and diamondback moth larvae, percent plants with insect feeding damage and symptoms of web blight and number of insecticide and fungicide treatments applied over three trials of pak-choi at San Leonardo in farmer- managed (FM) and researcher- managed (RM) plots*

Trial	Yield (kg/m²)		Plants harvested (no./m²)		CWW (no./m²)		DBM (no./m²)		Incidence feeding damage (%)		Incidence web blight (%)		Insecticide treatments (no.)		Fungicide treatments (no.)	
	FM	RM	FM	RM	FM	RM	FM	RM	FM	RM	FM	RM	FM	RM	FM	RM
1	1.4	1.4	10	30	0.3	0.1	6.8	7.4	11	3	75	17	5	3	0	1
2	0.3	0.8	7	36	0.6	0.4	3.2	5.2	10	2	50	9	3	5	0	2
3	2.7	3.1	65	62	0.0	0.0	4.4	5.2	1	1	10	5	4	2	1	0

web blight present (trial 3), yields were markedly greater than when the three pests were present (trials 1 and 2). Other factors might have contributed to the high yields noted in trial 3, but it is tempting to speculate that the absence of CWW was the major factor because the number of plants harvested in trial 3 was 46% and 87% greater than the mean number of plants harvested from the farmer- and researcher-managed plots, respectively, in trials 1 and 2.

Pesticide residues

Pak-choi from farmer- and researcher-managed plots in San Leonardo were collected in July and September 2000 and submitted to the Philippine National Analytical Laboratory— BPI for pesticide residue analysis. Residues of chlorpyrifos, methamidophos, profenofos, deltamethrin, fenvalerate, and cypermethrin were detected, but levels were generally less than the maximum residue level (MRL) set by the Association of Southeast Asian Nations. Chlorpyrifos on pak-choi collected in July from farmer-managed plots was the only exception — 0.19 ppm, 3.8-times the MRL for cabbage. In contrast, pak-choi collected from researcher-managed plots in July contained 0.01 ppm chlorpyrifos. The project did not have access to MRL values for leafy vegetables.

Cropping sequence

Farmers in San Leonardo plant three consecutive crops of pak-choi, beginning in the hot–wet season, and thus provide a host for DBM and CWW from June to October. Kangkong, a non-host, was introduced to break the cycle of infestation.

The sequence kangkong, kangkong, pak-choi returned a net income equivalent to 96,397 PHP/ha, compared to 66,818 PHP/ha from three consecutive crops of pak-choi. Calculations are based on yields of 1.086 and 0.804 kg/m² for the two crops of kangkong and 0.66 kg/m² for pak-choi in the kangkong, kangkong, pak-choi sequence, and a sale price of 5 PHP/kg for kangkong and 10 PHP/kg for pak-choi. Yields from the three consecutive crops of pak-choi were 0, 0.52, and 0.60 kg/m². The first crop of pak-choi was destroyed by flood, whereas kangkong survived. Labor costs and materials were 45,781 PHP for the three crops of pak-choi, and 64,503 PHP for the mixed sequence. The difference in cost was primarily due to seed and harvest labor cost, both of which were higher when kangkong was grown.

Screenhouses to limit insect damage

Fifty-five accessions pak-choi, choysum, non-heading cabbage, Chinese kale, and Indian mustard were seeded in four rows on raised beds 1 × 2 m in two screenhouses, each 18 × 18 m. In screenhouse A, two repetitions of 15 accessions each of pak-choi and choysum were seeded. The same pak-choi accessions were planted in open field to compare insect incidence in screen house to incidence in open field. In screenhouse B, 10 accessions each of non-heading cabbage and Chinese kale and five accessions of Indian mustard were planted with two replications. The same accessions were seeded in open field. One insecticide treatment was applied in the screenhouses, whereas accessions in the open field were treated twice weekly regardless of insect incidence. Insect numbers, plant damage from insect feeding, and disease incidence were noted weekly. Two trials were conducted.

Some accessions in screenhouses were infested with DBM and CWW. Infestations of DBM, CWW, flea beetle, and armyworm were observed on all accessions in the open field. Clearly, insecticide treatments in the open field did not prevent infestation and damage. Values for insect feeding damage (scale 0 to 9) were <1 in the screen houses and from 1 to 3 in the open field across accessions and trials. As expected, yield among species in the screenhouses was greater than yield in the open field (Table 121). The trials were not designed to test accession performance between environments so it is not known whether the differences were significant. Rather, the intent was to test accession performance within environments. In screenhouses and in open field, there were yield differences among accessions within some species (see above). (Because insect infestations are not random, we did not test for accession responses using ANOVA.)

Table 121. *Mean yield of Brassica species across two trials in screen house and in open field*

Vegetable species	Yield (t/ha)	
	Screen house	Open field
Pak-choi	32	19
Choysum	34	31
Non-heading Chinese cabbage	56	13
Chinese kale	24	10
Indian mustard	35	28

Natural enemies of diamondback moth and cabbage webworm in Luzon

A survey of insect pests and beneficial insects on crucifers was conducted in the provinces Nueva Ecija, Batangas, Quezon, Laguna, Pangasinan, La Union, and Benguet. Highlands of Baguio, La Trinidad, and Atok are major vegetable producing areas. Larvae of DBM and CWW were collected and transferred onto 14-day-old pak-choi plants in the laboratory. *Diadegma semiclausum*, a parasitoid of DBM, was found to be established in all highland areas. The parasitism of DBM larvae collected on cabbage was 11.1% in La Trinidad and 20% in Atok. In Calamba (lowlands) 22.5% of DBM larvae collected were infested by a *Cotesia* species. We assume that this is *Cotesia plutellae*, because *C. plutellae* was last released in October 1999 by the Asian Vegetable Network (AVNET) in the neighboring town of Cabuyao. Based on our data, the parasitoid *Oomyzus sokolowskii* could supplement *C. plutellae* in controlling DBM populations in Calamba.

In Nueva Ecija, percent infection of CWW by a *Microsporidium* was determined by collecting 100 first and second instar larvae of CWW and transferring them into 100 ml plastic containers where they were reared on an artificial diet. Larvae were checked daily for mortality until adults emerged. Dead larvae were examined under a compound microscope to confirm the presence of Microsporidia. Microsporidia infected a total of 16 percent of CWW larvae.

Biological control of podborer on yardlong bean

Four parasitoids emerged from podborer (*Maruca vitrata*) eggs and larvae were collected in unsprayed fields of yardlong bean (*Vigna sesquipedalis*). The only egg parasitoid was *Trichogramma evanescens*. *T. evanescens* hatched from a single collection in the second crop of 1999. Because of experiments with natural enemies of vegetable insect pests in surrounding fields we suspect that *T. evanescens* was introduced. The other parasitoids were *Exorista xanthaspis, Peribaea orbata*, and *Bassus asper*. *B. asper* was the most prevalent species. Parasitism in unsprayed fields of yardlong bean on the CLSU campus was lowest (1.4%) in the wet season, 2000, and highest (19.9%) in the wet season, 1999. Mean parasitism was higher in untreated plots than in plots treated with insecticides. Total mortality of all larval stages of podborer was 42.2%, of which 9.9% was caused by parasitoids and 32.3% by unknown factors. Mortality was greatest among fifth instar larvae and pupae, and least among third and fourth instar larvae. We were unable to differentiate between first and second instars, but mortality for the two stages combined was 18.1%. Unknown factors caused mortality in all stages, whereas parasites killed only eggs, fifth instars, and pupae. Data suggest that parasitoids in general, and *B. asper* in particular, can contribute to the control of podborer on yardlong bean.

We tested the following materials in y-tube (olfactometer) bioassays for their ability to attract *B. asper*: 1) intact yardlong bean pods; 2) pods previously infested with podborer; 3) pods infested with pod borer larvae; 4) excrements of podborer; and 5) air as control. The olfactometer was made from 59-cm-long glass tubing 4.5 cm in diameter. Test substances were placed in two 500 ml flasks attached to the distal ends of the tube. A pump on the longitudinal end sucked in air at 6.6 liters/hour. One adult *B.asper* per experiment was placed at the longitudinal end of the olfactometer. Experiments were finished after 1 hour or when the parasitoid made a choice for one of the substances in the distal ends. Each experiment was repeated 20 times. *B. asper* was attracted to pods without larvae but previously infested by podborer and to pods with larvae. Pure excrement of podborer attracted *B. asper* adults. The results suggest that *B.asper* uses cairomones emitted by excrement from pod borer larva to locate host plants.

Different concentrations of the commercial insecticides chlorpyrofos, deltametrin, methomyl, and carbaryl were diluted in water and tested for their toxicity to third instar larvae of podborer in pod dip bioassays. Usually six concentrations were used, including the control and the recommended field concentration. Mortality was determined after 48 hours exposure to insecticides. Larvae were considered dead if they were unable to respond visibly to a blunt probe. Results showed that calculated LC_{50} values were greater than concentrations recommended for control of podborer for all four insecticides. This implies that *M. vitrata* has developed resistance to the insecticides tested. Carbaryl had the lowest LC_{50} value of all insecticides tested. With methomyl we tested second, third, and fourth instar larvae of podborer to identify concentration – development stage dependency and found that LC_{50} values increased with larval stage.

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