PN-ABG-531

AVRDC Progress Report Summary 1986

The Asian Vegetable Research and Development Center (AVRDC) is an international center mandated for the research and development of vegetable crops in the humid and subhumid tropics. Established in 1971, its activities include: germplasm collection, storage, and enhancement; varietal improvement; production technology improvement; environmental and nutritional studies; technology transfer; training for national program personnel; and publication of research-based technologies.

There are approximately 350 research and support staff from 10 countries at AVRDC. The Center's budget, which totaled US$9.84 million in 1989, is provided by the governments of the Republic of China, the United States of America, Japan, the Federal Republic of Germany, the Kingdom of Thailand, the Republic of Korea, the French Republic, and the Commonwealth of Australia. Special project funds are provided by a variety of international donors including the Japan Shipbuilding Industry Foundation, the ROC Council of Agriculture (COA), the United States Agency for International Development (USAID), the Asian Development Bank (ADB), the World Bank, the International Development Research Centre (IDRC) of Canada, the OICD/U.S. Department of Agriculture, the German Ministry for Economic Cooperation (BMZ), the German Agency for Technical Cooperation (GTZ) and the Technical Centre for Agricultural and Rural Co-operation (CTA).

AVRDC is governed by an international board which represents the various donor nations as well as experts from collaborating organizations.

about the cover: A lady farmer from Taiwan proudly displaying cauliflower grown without chemical insecticides

PN-ABG-531

AVRDC
Progress Report
Summaries
1989

About this Report

This report provides an overview of AVRDC's research and development activities in 1989. Readers who would like more detailed information may send the attached postcard to AVRDC's Office of Information Services. Complimentary reprints of up to five sections of the report can be requested, however, if more than five sections are required, please include US$1.00 for each additional section. Checks, drawn on a bank in the USA, should be made out to AVRDC. The reprints are grouped according to crop and discipline and correspond to the summaries found in the following pages.

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Foreword

Our endeavors in the past are now paying off with significant hectarages of vegetables grown in Southeast Asia, China, Korea and Taiwan using AVRDC improved germplasm and technology. But more auspiciously our national partners have taken big strides in developing their capacity for vegetable research, training and extension. Thus with our colleagues in the region, our relationship has now blossomed into one of full partnership among equals.

These would not have been possible without the support of our donors, the cooperation of our partner institutions and the dedication of our professional colleagues both in the developing and developed countries. We therefore take this opportunity to express our deep appreciation to them all.

The Asian Vegetable Research and Development Center welcomes the new decade even more firm in its belief and resolute in its commitment to help improve the nutrition and raise incomes of the rural and urban poor in the developing countries through improved productivity and sustainability and more efficient marketing and distribution of vegetables. We are now being asked to play a more active role in other parts of the world where the needs are most acute. We are ready to meet the challenge but we will have to count on your continuing support.

Emil Q. Javier
Director General

Abbreviations and Acronyms

-ACIAR -Australian Centre for International Agricultural Research
-ACP-EC -African, Caribbean and Pacific-European Community
-ADB -Asian Development Bank
-ADRC -Agricultural Development Research Center (Northeast Thailand)
-a.i. -active ingredient
-AID -Agency for International Development (USA)
-AIT -American Institute in Taiwan
-AMV -alfalfa mosaic virus
-ARTT -advanced soybean rust tolerance trials
-ASET -AVRDC Soybean Evaluation Trials
-ATI -Agricultural Training Institute (Philippines)
-AVNET -Collaborative Vegetable Research Program for Southeast Asia
-AVRDC -Asian Vegetable Research and Development Center (IARC)
-AYT -advanced yield trial

-BARI -Bangladesh Agricultural Research Institute
-BAW -beet armyworm
-BePMV -bell pepper mottle virus
-BINA -Bangladesh Institute of Nuclear Agriculture
-BMZ -German Ministry for Economic Cooperation
-BP -bacterial pustule
-BSU -Benguet State University (Philippines)
-BW -bacterial wilt

-CARDI -Caribbean Agricultural Research and Development Institute
-CATIE -Centro Agronómico Tropical de Investigación y Enseñanza
-cfu -colony-forming units
-CGIAR -Consultative Group on International Agricultural Research
-CGN -Centre for Genetic Resources (the Netherlands)
-CHT -cherry tomato
-CIAPAN -Centro de Investigaciones Agricolas del Pacifico Norte (Mexico)
-CIAT -Centro Internacional de Agricultura Tropical (CGIAR)
-CIDSE -Cooperation internationale pour le developpement socioeconomique
-CIMMYT -Centro Internacional de Mejoramiento de Maiz y Trigo (CGIAR)
-CINDE -Coalicion Costarricense de Iniciativas de Desarrollo (Costa Rica)
-CIP -Centro International de la Papa (CGIAR)
-CLS -Cercospora leaf spot
-CMS -cytoplasmic male sterility
-CMV -cucumber mosaic virus
-COA -Council of Agriculture (Taiwan)
-CPA -para-chlorophenoxy acetic acid
-CSIRO -Commonwealth Scientific Industrial Research Organization (Australia)
-CTA -Technical Center for Agricultural and Rural Cooperation (EC)
-cv. -cultivar
-CVMV -chili veinal mottle virus

-DAE -days after emergence
-DAIS -District Agricultural Improvement Station (Taiwan)
-DAS -days after sowing
-DAS ELISA -double antibody sandwich
-DBM -diamondback moth
-DM -downy mildew
-DNA -deoxyribonucleic acid
-DOAE -Dept. of Agricultural Extension (Thailand)

-EC -European Community
-ELISA -enzyme-linked immunosorbent assay
-ENEA -Comitato Nazionale per la Ricerca per lo Sviluppo dell'Energia Nucleare e delle Energie Alternative (Italy)

-FAO -Food and Agriculture Organization of the United Nations
-FIRDI -Food Industry Research and Development Institute (Taiwan)
-FMTT -fresh market tropical tomato
-FMV -feathery mottle virus

-GRSU -Genetic Resources and Seed Unit (AVRDC)
-GTZ -German Agency for Technical Cooperation (Fed. Rep. of Germany)
-GYT -general yield trial

-HPLC -high performance liquid chromatography
-HS -heat sensitive
-HT -heat tolerant

-IARC -international agricultural research center
-IARI -Indian Agricultural Research Institute
-IBPGR -International Board for Plant Genetic Resources (CGIAR)
-IBSRAM -International Board for Soil Research and Management (IARC)
-ICARDA -International Center for Agricultural Research in the Dry Areas (CGIAR)
-ICIMOD -International Centre for Integrated Mountain Development (IARC)
-ICIPE -International Centre of Insect Physiology and Ecology (IARC)
-ICLARM -International Center for Living Aquatic Resources Management (IARC)
-ICRAF -International Council for Research in Agroforestry (IARC)
-ICRISAT -International Crops Research Institute for the Semi-Arid Tropics (CGIAR)
-ICW -imported cabbageworm
-IDIAP -Instituto de Investigación Agropecuaria de Panamá
-IDRC -International Development Research Centre (Canada)
-IFDC -International Fertilizer Development Center (IARC)
-IFPRI -International Food Policy Research Institute (CGIAR)
-IIMI -International Irrigation Management Institute (IARC)
-IITA -International Institute for Tropical Agriculture (CGIAR)
-ILCA -International Livestock Center for Africa (CGIAR)
-ILRAD -International Laboratory for Research on Animal Diseases (CGIAR)
-IMN -International Mungbean Nursery (AVRDC)
-INA -Instituto Nacional Agrario (Honduras)
-INIREB -Instituto Nacional de Investigaciones Sobre Recursos Bioticos (Mexico)
-INRA -Institut national de la recherche agronomique (France)
-INTHOPE -International Hot Pepper Trial Network
-IPDR -Institut pratique de developpement rural (Niger)
-IPM -integrated pest management
-IRRI -International Rice Research Institute (CGIAR)
-ISNAR -International Service for National Agricultural Research (CGIAR)
-IYT -intermediate yield trial
-LAI -leaf area index
-LEHRI -Lembang Horticulture Research Institute (Indonesia)

-MAFF -Ministry of Agriculture, Forestry and Fisheries (Japan)
-MARDI -Malaysian Agriculture Research and Development Institute
-MARIF -Malang Research Institute for Food Crops (Indonesia)
-MYMV -mungbean yellow mosaic virus

-NARS -national agricultural research systems
-NBPGR -National Board for Plant Genetic Resources (India)
-NIRS -near infrared reflectance spectroscopy

-OIS -Office of Information Services (AVRDC)

-PCARRD -Philippine Council for Agriculture, Forestry and Natural Resources Research and Development
-PDA -potato dextrose agar
-PE -polyethylene
-PeMV -pepper mottle virus
-PM -powdery mildew
-PMMV -pepper mild mottle virus
-POP -Philippines Outreach Program (AVRDC)
-ppm -parts per million
-PVMV -pepper veinal mottle virus
-PVX -potato virus X
-PVY -potato virus Y
-PYT -preliminary yield trial

-RDA -Rural Development Administration (Rep. of Korea)
-RGR -relative growth rate
-RYT -regional yield trial

-SDP -selective dissemination of publications
-SEP -standard error of prediction
-SPLCV -sweet potato leaf curl virus
-SPLV -sweet potato latent virus
-SPV II -sweet potato virus II
-SPYDV -sweet potato yellow dwarf virus

-TARC -Tropical Agricultural Research Center
-TARI -Taiwan Agricultural Research Institute
-TEV -tobacco etch virus
-TFW -tomato fruitworm
-TLCV -tobacco leaf curl virus
-TMGMV -tobacco mild green mosaic virus
-TMV -tobacco mosaic virus
-ToMV -tomato mosaic virus
-TOP -Thailand Outreach Program (AVRDC)
-TSWV -tomato spotted wilt virus
-TuMV -turnip mosaic virus
-TVDF -Tropical Vegetable Data File (AVRDC)
-TVMV -tobacco vein mosaic virus

-UNDP -United Nations Development Program
-UPLB -University of the Philippines at Los Baños
-USDA -United States Department of Agriculture

-WARDA -West Africa Rice Development Association (CGIAR)

-YDV -yellow dwarf virus

CROP IMPROVEMENT PROGRAM

CHINESE CABBAGE

INTERNATIONAL COOPERATION

Germplasm Distribution

Five hundred and eighty seed packets were distributed to 81 cooperators in 28 countries.

Crop Releases

Taiwan, China — The Taoyuan District Agricultural Improvement Station (DAIS) released AVRDC Hybrid 82-156 as Taoyuan-ASVEG No. 2. This hybrid gives high and stable yield during the hot rainy season and recovers quickly after strong winds and heavy rains. It has smooth and dark green leaves which are preferred consumer traits in Taiwan. It produces oval heads which weigh 0.6 to 1.2 kg.

International Trials

Japan — The Kumage-branch of the Kagoshima Agricultural Experiment Station conducted vinyl house and field trials. Considering yield and other characteristics such as days to maturity, head weight, solidity, and percentage of internal rot, soft rot and harvest rate, open-pollinated 77M(3)-25, Hybrid No. 58 and Hybrid No. 38 were the most promising AVRDC entries.

Swaziland — A cool season trial conducted by the Ministry of Agriculture and Cooperatives at the Malkerns Research Station using open-pollinated and hybrid cultivars from AVRDC obtained no data due to severe bolting of all plants before head formation. The trial will be repeated during the warm season.

Turkey — Most AVRDC hybrids and open-pollinated entries showed low yields because of bolting in trials conducted by the Cumhuriyet University at Toket. However, Hybrid Nos. 62 and 83-20 were relatively resistant to bolting with promising high yields of 87.1 t/ha in 63 days and 77.9 t/ha in 65 days, respectively, compared to the standard heat-sensitive check, B 40, which yielded 90.2 t/ha in 78 days.

Zimbabwe — In three-season trials conducted by the Chiredzi Research Station, all AVRDC hybrids matured in 43 to 46 days from transplanting while the heads of the heat-sensitive check, B 40, remained loose until they were harvested 60 days after transplanting.

BREEDING

Open-pollinated Cultivars for Uniform Maturity

Maternal lines of the MLS4 generations of two AVRDC-bred Chinese cabbage open-pollinated cultivars, 77M(3)-27 and 77M(3)-35, were evaluated in the late summer season. General observations of each population indicated noticeably clearer variation within maternal lines for maturity and other characters. The ML population of 77M(3)-35 was later maturing, of longer head shape and exhibited more variation than the 77M(3)-27. Lines and individual plants were selected from the 77M(3)-27 population to develop the next cycle.

Heat Tolerance and Cylindrical Head Shape

To develop heat-tolerant varieties with cylindrical head shape, a total of 46 BC_3F_2 and BC_2F_3 families, and 43 F_2's and F_1's derived from intercrosses were evaluated in the late summer season. A higher level of heat tolerance on materials with short head length was clearly noticed in the BC_3F_2 generation compared to the BC_2F_3 generation in both combinations, B61 × E-9 and B61 × R1-3. Intercrossed families appeared to be much more vigorous than other families, possibly due to heterotic effects.

Development of Heat-tolerant Composites

A total of 70 AVRDC-bred inbreds and open-pollinated families were grown in the field in the late summer of 1988 for the purpose of grouping them into distinct types. During the 1988/89 cool season, the composite was produced by hand intercrossing from components as follows: 27 of Chang Puh type, 16 of Hybrid 62 type and 19 of the semitropical type. These were grown in the 1989 late summer season. Selections from these populations will be used for further intercrosses to create the new base population of the composite.

Cytoplasmic Male Sterility Program

To develop a simpler and more stable system of hybrid seed production, two different sources of cytoplasmic male sterility (CMS) i.e. radish, *Raphanus sativus*, and mustard, *Brassica juncea*, had been repeatedly backcrossed to tropical Chinese cabbage. In general, more variation was noted among individual plants within the same family than among families. Almost every family yielded many normal green individuals and only a few variant chlorotic plants. Twenty-six selected lines in the radish-derived CMS backcross program, and 29 from mustard-originated CMS backcross families were grown in the field, and will be allowed to flower under natural conditions to produce more seeds for selection in the next generation.

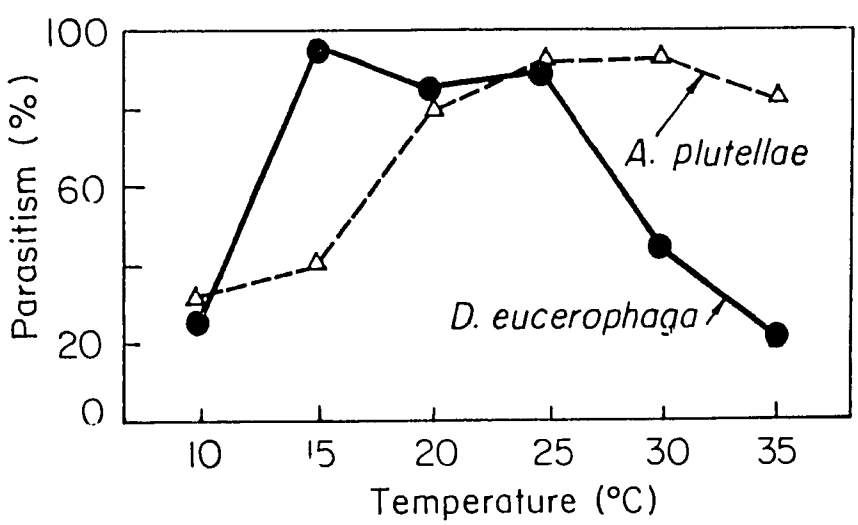
ENTOMOLOGY

Effect of Temperature on *Diadegma eucerophaga* Biology

Diadegma eucerophaga is a very effective larval parasite of the diamondback moth (DBM), *Plutella xylostella* (L.). However, despite repeated releases this parasite has not been established in the lowlands, whereas a single release has resulted in the establishment and widespread parasitism of DBM in highland areas of Taiwan. To understand this difference, the effect of temperature on various biological parameters of *D. eucerophaga* was studied. Within the range of 15° to 35°C, the duration of incubation of parasite eggs within DBM larvae decreased gradually from 2.93 days at 15°C to 1.00 day at 35°C. Hatching of eggs was not affected by temperature between 15° and 30°C, but at 35°C the rate of hatching declined from 100% to 85%. Duration of the larval stage declined from 8.65 days at 15°C to 3.52 days at 35°C and the rate of pupation from 90% at 15°C to 19.9% at 35°C. Duration of the pupal stage declined from 16.13 days at 15°C to 6.44 days at 30°C and the rate of adult emergence from 79% at 15°C to 65% at 30°C. At 35°C most of the pupae died. Higher temperatures accelerate the development of *D. eucerophaga*, but they also seem to weaken the insect. The drastic effect on pupation and adult emergence of temperatures of 30°C and above seems to limit the establishment of *D. eucerophaga* in lowland areas.

Diamondback Moth Parasitism in Crucifer Monoculture and Mixed Cropping

Past studies demonstrated that *Diadegma eucerophaga* and *Apanteles plutellae* can control the diamondback moth (DBM), *Plutella xylostella* (L.), on farmers' fields in specialized crucifer-growing areas in the highlands of Taiwan. These parasites are specific to the DBM.



Effect of temperature on two parasites of diamondback moth.

Since crucifers are often grown as mixed crops with noncrucifers and farmers use chemicals to control the pests of noncrucifer crops, the effect of mixed cropping compared to monoculture on the parasitism of DBM by *D. eucerophaga* and *A. plutellae* was investigated. Monoculture cabbage was planted in a 0.9-ha area beside a 0.9-ha area planted to four randomly selected plots (15 × 19.5 m) of cabbage and eight similar sized plots, one each to okra, eggplant, pea, soybean, garlic, tomato, sweet potato and sweet pepper. Noncrucifers were sprayed once a week with mevinphos, methamidophos or permethrin. Cabbage in either area did not receive any insecticide treatment. *D. eucerophaga* and *A. plutellae* were released periodically and the parasitism of DBM on cabbage by both parasites was monitored at established intervals. There was no significant difference in the parasitism rate whether cabbage was grown as a monocrop in which no insecticide was used, or whether it was grown surrounded by noncrucifers, all of which were sprayed frequently. The results imply that once *D. eucerophaga* and *A. plutellae* are established they can control DBM even when farmers practice mixed cropping — which is common in Asia — and use insecticides on noncrucifers.

Evaluation of *Bacillus thuringiensis* for Diamondback Moth Control

Five experimental and three commercial formulations of *Bacillus thuringiensis*, one insect growth regulator, teflubenzuron, and one fungicide, pyrazophos which has some insecticidal action, were tested in a field experiment to control diamondback moth (DBM) *Plutella xylostella* (L.) on cabbage. The insecticides were sprayed once a week

Tipburn.

starting two weeks after transplanting until 10 days before harvest. The number of DBM larvae and pupae per 20 plant samples in each plot of each treatment were recorded at established intervals. Similar observations, but only once, were made for imported cabbageworm (ICW), *Pieris rapae*. SAN415, a *B. thuringiensis* commercial formulation, gave the best control of DBM and ICW. One experimental product, Bt-4 from the National Taiwan University provided the next best control of both pests. These treatments also gave the highest cabbage yield. Both products are nontoxic to parasites and thus are ideal for integrated pest management of the DBM.

PHYSIOLOGY

Tipburn Susceptibility Under Different Nutrient Solutions

Tipburn, a nonparasitic disorder, frequently develops on Chinese cabbage grown under hot, wet conditions. The relationship between variety and tipburn-conducive conditions were tested by culturing five Chinese cabbage varieties in low Ca, high ammonium or immersion of root under hydroponic conditions. There were varietal differences in tipburn development of five Chinese cabbages grown under low calcium or high ammonium, or with roots immersed in the nutrient solution of the hydroponic system. Cultivars Shin Chiu and Bin Luh were tolerant to tipburn induced by high ammonium conditions, and AVRDC breeding line 82-15 and Shin Chiu were tolerant to that induced either by immersion of the root system or low calcium conditions. Tipburn-susceptible cvs. Summer Light No. 4 and Kang Ping No. 2 had large leaf area. The fact that ammonium suppressed Ca accumulation in the leaf was likely due to root damage and/or competitive inhibition of Ca uptake. However, the result that high ammonium or immersed roots also reduced potassium uptake does not seem to be related to tipburn development.

Involvement of Gibberellins and Calcium in Tipburn

The tipburn disorder is related to calcium deficiency and is more severe in the young, inner leaves. The incubation of detached Chinese cabbage plants for four days in solutions which contained EDTA, a chelating agent which removes calcium, caused characteristic lesions at the leaf tips. Gibberellin GA_3 alone also enhanced tipburn, but to a lesser extent. The intensity of the damage by EDTA or GA_3 was reduced by including $CaCl_2$ in the solutions. Both EDTA and GA_3 increased electrolyte leakage, but this effect was not diminished by $CaCl_2$. The results suggest that gibberellins are associated with tipburn in Chinese cabbage by interfering with the cell wall instead of the plasma membrane.

MUNGBEAN

INTERNATIONAL COOPERATION

Germplasm Distribution

In 1989, 616 breeding lines and 49 other germplasms were distributed to cooperators in 25 countries. In addition, 19 sets of International Mungbean Nurseries (IMN) were sent to 13 countries.

Crop Releases

Philippines — The Philippine Seedboard released AVRDC VC 1973-3-B-3-B as mungbean cultivar BPI Mg7. BPI Mg7 has high yield and is resistant to Cercospora leaf spot, rust and powdery mildew.

Solomon Islands — The Minister of Agriculture and Lands designated AVRDC variety VC 4080A as SIROC (1) because of the cultivar's high yield (0.8 to 1.6 t/ha), uniform maturity which permits harvesting in one or two pickings and the high resistance to Cercospora leaf spot.

Taiwan, China — The Tainan District Agricultural Improvement Station released Tainan No. 5 (AVRDC VC 3890A) because of its high yield and synchronized maturing which facilitates machine harvesting and its dull seed coat which is well accepted by local consumers and processors.

International Trials

IMN — Very limited results have been reported from previous IMN trials. VC 3004A significantly outyielded all entries in the Philippines.

Kampuchea — In a series of trials conducted at the Kbal Koh Research Station, VC 1973A was a good yielder but was more susceptible to virus diseases than other AVRDC lines. VC 3717A had the best overall field rating with 2.41 t/ha, 1000 seed weight of 70 g and days to first and last harvest which were 30 and 81 days, respectively.

Vietnam — In a trial at the University of Cantho, only VC 3012A, VC 3737A and VC 1560D had resistance to the local race of Cercospora leaf spot. AVRDC lines VC 3541A (704 kg/ha) and VC 3528A (690 kg/ha) significantly outyielded the local checks.

BREEDING

New Germplasm Evaluation

Eight mungbean mutants from the Bhabha Atomic Energy Research Centre, Bombay, India were introduced and evaluated. As reported, all mutants were found to be highly resistant to powdery mildew (PM). However, they are susceptible to Cercospora leaf spot (CLS). Four introductions which are resistant to mungbean yellow mosaic virus (MYMV) were multiplied for testing in the Indian subcontinent.

Hybridization

To combine high yield, uniform maturity and disease resistance, 8 mungbean breeding lines were chosen and a diallel cross was made to produce 56 hybrids. The F_1s will be intermated and used for a recurrent selection program. Thirty single-cross hybrids were made to transfer bruchid resistance from *V. radiata* var. *sublobata* and *V. radiata*. Eight single cross hybrids were made to transfer beanfly resistance plants with desirable traits selected from the inbred populations using appropriate screening techniques.

Evaluation of an Interspecific Hybrid Between *Vigna radiata* and *V. glabrescens*

Seventeen BCS_1 plants of *V. radiata* (VC 1973A) x F_1 (*V. glabrescens* (V 1160) x VC 1973A) were selfed in the greenhouse. Each of them produced normal and shriveled seeds (BCS_2) which were large (100 seed weight varied from 6.1 to 8.9 g). They were evaluated for resistance to beanflies, bruchids, CLS and PM. All were susceptible to bruchids, PM and cucumber mosaic virus (CMV) (needs to be verified). Four progenies appear to have moderate levels of resistance to beanflies and will be further evaluated.

Evaluation of Intermated Populations

Intermated populations from different cycles were evaluated and compared during the spring and summer seasons. The increased amount of intermating tended to improve 1,000 seed weight in the spring and yield during the summer season. When selections were made for PM and evaluated for CLS within Cycle 4 populations, it appears that high levels of resistance to CLS and PM could be combined. However, in cases in which resistance to PM was greater than that of VC 3890A, the yield decreased significantly. Therefore, selection will emphasize resistance to PM and high yield.

Evaluation of V and VC Lines

Twenty V lines and 173 improved VC lines which have been developed over the past 15 years were compared for their performance in three seasons. As reported in 1988, considerable progress in yield

improvement and resistance to CLS has been accomplished. The seed size also has been increased. Future research should focus on the percent of first harvest, and PM and insect pest resistance.

Yield Trials

In the 1988 autumn season, the 16th IMN and advanced yield trials (AYT) were conducted. The results of these trials suggest that PM is more severe in autumn than in the spring. However, there is good correlation between spring and autumn season disease ratings. Powdery mildew disease severity is not related to yield. The 17th IMN and intermediate yield trial (IYT) were conducted in the 1989 spring and summer seasons. In summer, selected beanfly-resistant entries were evaluated with and without insecticide and 32 introduced varieties were evaluated for yield and other traits. VC 4059A was identified from the 17th IMN, as higher yielding in the spring season. VC 4152A, VC 4066A, VC 2768A, VC 3746A, VC 3890A, VC 4111A, VC 3902A and VC 4080A had a low incidence of PM disease in the spring. VC 3945A had a high protein in the same season. Compared to the 292 kg/ha protein yield of VC 2768A, VC 4059A gave 355 kg/ha protein yield. A pooled analysis of spring and summer seasons revealed that most of the variation in yield is due to season and that variation due to genotype is rather small. In the IYT, VC 4443-3B was a high yielder in both seasons. Nine entries had a 90% or higher percent first harvest. Preliminary results indicated that the yield potential of beanfly-resistant breeding lines was lower than other improved selections. Of the 32 newly introduced varieties, four have been selected for further evaluation.

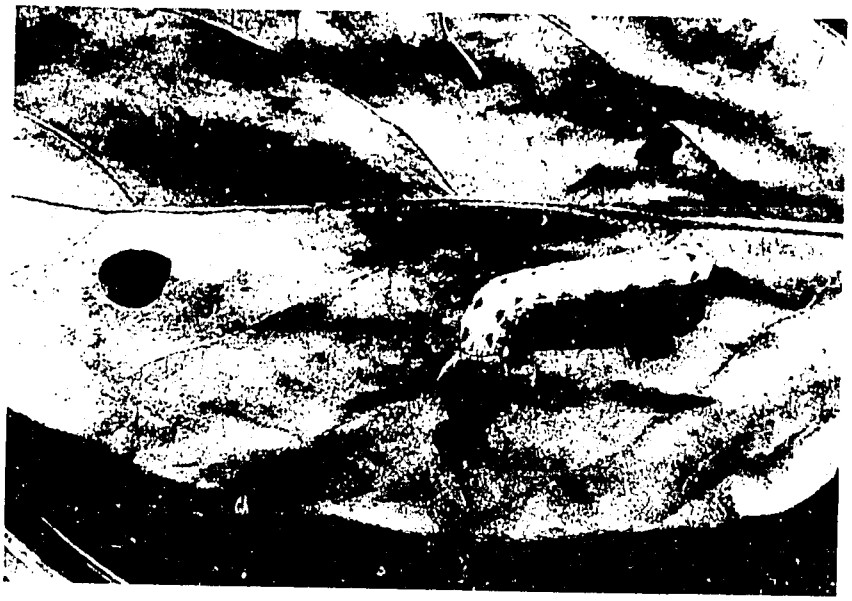
ENTOMOLOGY

Beanfly Resistance

Twenty-seven backcross progenies from a cross between beanfly-resistant *Vigna glabrescens* and beanfly-susceptible *V. radiata* were screened for resistance to beanfly [mainly *Ophiomyia phaseoli* (Tryon)] in the field. Only four entries showed moderate levels of resistance. These entries will be used for further improvement and evaluation of yield and agronomic characters.

Defoliator Resistance in *Vigna glabrescens*

Various studies on plant morphological and insect feeding characteristics have been conducted to understand the mechanism of defoliator resistance in a *Vigna glabrescens* accession V 1160. A polyphagous insect, beet armyworm (BAW), *Spodoptera exigua*, was used in this study. V 1160 had significantly less trichome density on both upper and lower leaf surfaces compared to VC 1973A, a susceptible check. The BAW laid significantly less eggs on V 1160 than on VC 1973A and there was significant positive correlation between trichome density and the number of eggs laid. This resulted in less insect



Beet armyworm larva.

larvae feeding on V 1160 than on VC 1973A. Foliage of V 1160 was as suitable for growth and development of BAW as that of VC 1973A. The low trichome density or glabrous nature of foliage of V 1160 seems to be the only characteristic that reduces oviposition and attack by BAW.

Bruchid Resistance Mechanism

The mechanism of resistance to *Callosobruchus chinensis* in the seeds of three *Vigna* sp. accessions, i.e., V 2709, V 2802, and VM 2164, was studied. The bruchids laid significantly fewer eggs on the seeds and pods of the three resistant accessions than on those of the susceptible check, VC 1973A. The seeds of resistant accession were small. However, seed size was not associated with resistance. When artificial seeds, made from the susceptible accession, were fortified with seeds from the resistant accession, the number of bruchid adults which emerged from the seeds decreased with increasing proportion of seeds of the resistant accession. The bruchid adults which developed from the artificial seeds which had been fortified with seeds of the resistant accession were significantly lighter than those developed from seeds of the susceptible accession. This antibiosis effect was the strongest with VM 2164, a highly resistant black gram accession. The resistant factor from seeds of all three resistant accessions could not be extracted with cold acetone.

Bruchid Resistance

The backcross progeny of a cross between *Vigna glabrescens* accession V 1160 which is resistant to *Callosobruchus chinensis* and a high yielding agronomic breeding line of mungbean, VC 1973A, were screened for resistance to *C. chinensis*. Bruchid adults laid eggs on all seeds and one to three adults emerged from each seed, indicating that all progenies are susceptible.

PEPPER

Sweet

Hot

BREEDING

New Crosses

There was a lag in making new crosses during 1989. More varieties with good horticultural traits and donors of resistance to specific diseases need to be confirmed, screened and multiplied before new crosses are made. Parental stocks for new crosses with donors which are resistant to cucumber mosaic virus (CMV), potato virus Y (PVY), pepper veinal mottle virus (PVMV), chili veinal mottle virus (CVMV) and *Phytophthora capsici*, were planted. Horticultural traits of donors will be observed and seeds will be multiplied at the same time.

Advanced Germplasm Evaluation

The varieties selected from previous observational trials and the cultivar exhibition trial held during the international pepper and tomato symposium in 1988 were planted in 1988/1989 cool season and in 1989 summer. The yield of sweet pepper was generally lower in summer, while that of hot pepper did not appear to be drastically reduced. In general, the best sweet pepper entries in all trials significantly outperformed Blue Star (check), in both total and marketable yields. Often, the yield advantage is expressed in terms of greater number of fruits per plant but this was compensated by a concomitant reduction in mean fruit weight, except in the hot season trial. The outstanding hot pepper cultivars in all trials significantly outyielded Szechwan (check). In contrast to sweet pepper, however, the yield advantage over the check of the leading entries was expressed in terms of greater fruit number per plant and heavier fruit weight. Of the sweet pepper varieties tested, Key Largo appears to be the most adapted to the hot season as evidenced by its absolutely high yield rank in the spring-summer trial combined with a high heat tolerance index. On a similar basis, the best-adapted hot pepper genotypes are 88P40, One Thousand, and possibly Red Horn. The pungency of hot peppers measured in these trials ranged from 1.5 to 7.6 mg capsaicin/g dry matter. Further studies on the cultivars which have been identified as "heat-tolerant" in the above trials and the various important factors which depress yield in the hot and humid season are needed.

International Hot Pepper Trial Network Entries

Selfed seeds of 21 varieties from nine countries were collected for further multiplication and evaluation at AVRDC prior to their distribution to the collaborators in the International Hot Pepper Trial Network (INTHOPE). General information on maturity and survival rate during the monsoon season (especially after typhoon) was obtained. The pungency of INTHOPE entries appeared to be relatively higher than Szechwan (check), ranging from 2.1 to 5.9 mg capsaicin/g dry matter versus 1.9 mg capsaicin/g dry matter for the check. Only a few varieties produced a limited amount of selfed fruits in the 1989 summer planting.

Most entries did not produce sufficient flowers following the typhoon which damaged the planting.

ENTOMOLOGY

Insecticides to Control Flower Thrips

Nine insecticides which had given some control of thrips on various crops were screened for their efficacy in controlling thrips on sweet pepper. The chemicals were sprayed on crops once a week starting 10 days after transplanting or applied to the roots soon after transplanting and 5 weeks later. Observations on the number of thrips in the flowers and aphids on the entire plant were recorded. Two synthetic pyrethroids, deltamethrin and karate, gave the best control of both thrips and aphids and the protected plants produced the highest yields. Oxamyl also gave satisfactory control and permitted a similar yield as the two synthetic pyrethroids.

PATHOLOGY

Bacterial Spot in Taiwan

Bacterial spot, caused by *Xanthomonas campestris* pv. *vesicatoria*, is a major disease of pepper in the tropics. Three races of *X. campestris* pv. *vesicatoria* were found to occur in Taiwan. Race 1 predominated in those strains isolated from pepper, while race 3 predominated in those strains isolated from tomato. Race 1 was widely distributed throughout the island.

Inoculation Procedures for Evaluating Resistance to Bacterial Spot

The objectives of this experiment were to confirm the best method for inoculation based on methods tested in 1988 and to determine what screening procedure is most effective to detect plants with dominant resistance. The disease index for plants rated for bacterial spot using four inoculum concentrations was greatest at 10^8 and 5×10^8 cfu/ml on susceptible plants. Plants with a major dominant gene for resistance became slightly infected at 5×10^8 cfu/ml, but not at 10^8 cfu/ml. The range of the disease index varied depending upon inoculation pressure with less variation at 1.5 kg/cm^2. Older inoculated plants were less susceptible to bacterial spot, while young plants were highly susceptible. Thirty to forty days were the best age for evaluating the resistance of plants.

Disease Survey of Anthracnose and Identification of Species

The fungi that cause anthracnose are *Colletotrichum capsici* and *C. gloeosporioides*. This study was conducted to determine the occurrence of anthracnose and to identify the causal species. Anthracnose on pepper fruit at a wholesale market occurred on 20% to 30% of the fruit sampled. The causal fungus from sampled infected fruit was *Colletotrichum gloeosporioides*. Fruits from surveys of pepper fields in highland production areas of Taiwan had from 1% to 20% anthracnose infection. Most of these fruits were infected with *C. capsici*.

Colletotrichum spp. on Symptom and Symptomless Fruit

Since *Colletotrichum* spp. often cause latent infection, symptom and symptomless ripe fruits were evaluated to determine the incidence of fruit infection and to identify the species of *Colletotrichum*. The incidence of *Colletotrichum capsici* and *C. gloeosporioides* on pepper fruit with symptoms was 18% and 20%, respectively. The lines C 00015A and C 00679-1 had no infection while the highest incidence was 80% on C 00004. When symptomless fruits were incubated, the occurrence of *C. gloeosporioides* was 10 times greater than *C. capsici*. Most of the symptomless fruits had some latent infection caused by *Colletotrichum* spp.: an average of 41% of the fruit was infected.

Bacterial spot.

Colletotrichum and *Phomopsis* spp. on Fruit and Plant Parts

The incidence of species of *Colletotrichum* and *Phomopsis* was examined on fruit, fruit stalks and petioles of four pepper varieties. *Colletotrichum* spp. occurred on 96% of the lower petioles and 55% of the upper petioles of pepper. More *Colletotrichum* spp. were found from samples on Big Star and New Star than on Blue Star and Szechwan. *Colletotrichum capsici* and *Colletotrichum gloeosporioides* were recorded on 51% and 30% of all samples assayed, respectively. Regardless of variety, *C. capsici* was more prevalent than *C. gloeosporioides*. New Star had the most infection followed by Big Star, Blue Star and Szechwan. *Phomopsis* spp. were found most frequently on upper petioles (40%). Blue Star had 35% of its fruit infected with *Phomopsis* spp., while the other varieties had no infection.

Initial Infection of *Colletotrichum* spp. from Field-grown Plants

There is little information on the epidemiology of anthracnose. Therefore, an experiment was conducted to estimate the infection of anthracnose on young plants and to determine if early infection of vegetative plant parts relates to later infection of the fruit. Petioles of two hot peppers (Szechwan and C 00104-2) had lower incidence and severity of *Colletotrichum* spp. than two sweet peppers (C 00161-3 and C 00157-4). Older plants had 15% to 20% of petioles infected compared to <5% infection for younger plants. Disease severity was as high as 70% on C 00161-3 compared to 17% on Szechwan at 102 days after planting.

Colletotrichum and *Phomopsis* spp. on Diseased Fruit and Relationship to Seed Germination

The objective of this study was to investigate the occurrence of species causing fruit infection and to determine what effect fruit infection has on seed viability and infection. *Colletotrichum* spp. occurred on 93% of diseased fruits of pepper while 9% of the fruits were infected by *Phomopsis* spp. The lesions on the fruit were most developed on the distal position. *C. gloeosporioides* occurred more frequently than *C. capsici*. Seed germination averaged 26% from infected fruit and was 38% from fruit that had <20% severity.

Inoculation Time and Species of *Colletotrichum* on Seed Germination and Infection

This study examined the effect of *Colletotrichum* on seed germination and infection. Seed germination without inoculation was 83% and was reduced to 70% when seeds were inoculated for 1 minute in a conidial suspension of *Colletotrichum* spp. Only 45% of the seed germinated when soaked for 30 minutes in a conidial suspension of *C. capsici*. Inoculated seed had over 99% infection, regardless of soaking time, fungal species used for inoculation or variety.

Latent Infection of *Colletotrichum capsici* and *C. gloeosporioides*

The objective of this test was to determine the effect of inoculating seedlings on infection and whether this technique has any application to screening for resistance. Symptoms of anthracnose were not detected on seedlings up to 20 days after inoculation. However, all vegetative tissue sampled were latently infected with *Colletotrichum* spp. The severity of infection on sampled tissues of four varieties was higher for *C. capsici* than for *C. gloeosporioides*. The incidence of *C. capsici* was highest on petioles (86%) and lowest on shoot tips (63%). The incidence of *C. gloeosporioides* was greatest on leaves (43%) and lowest on shoot tips (22%).

Resistance to Anthracnose

A total of 1,084 accessions of pepper were evaluated for resistance to anthracnose. Six accessions, C 00104-3, C 00105-2, C 00376, C 00532, C 00533 and C 00755 had no lesions after inoculation. Eighty-one accessions had lesion diameters of less than 0.5 cm and were rated as highly resistant. More than 68% of the accessions were susceptible.

Resistance to Phytophthora Blight

A total of 300 pepper accessions were screened for resistance to Phytophthora blight. No highly resistant materials were identified in the trials, but 10 accessions (C 00352, C 00082, C 00071, C 01176, C 00588, C 00226-1A, C 00226-1B, C 00536, PBC 93A and PBC 93B) were rated as moderately resistant.

Virus-resistant Germplasm

Four viruses, i.e., CMV, PVY, CVMV and tobacco mosaic virus (TMV) are commonly found on pepper in Southeast Asia. Germplasm with reported resistance to some of these viruses have been collected. Thirty-seven lines were screened for resistance to CMV, 15 lines for PVMV and 17 lines for CVMV resistance. One line (VC 35a) was identified with PVMV resistance and two lines with CVMV resistance (VC 58a, VC 86). Line VC 58a was resistant to both the Malaysian and the Taiwan CVMV isolates. Resistance to CMV was not found.

Improvement in Screening and Rating Method for CMV and CVMV

Previously, resistance screening was conducted by inoculation of the plants at the fourth leaf stage followed by an enzyme-linked immunosorbent assay (ELISA) two to three weeks later. An experiment was conducted to study whether the screening time might be shortened without losing effectiveness, and whether inoculation by power sprayer might be possible. For both viruses, inoculation by power sprayer at 40 kg/cm^2, using 0.3 ml sap/plant, proved less efficient than manual inoculation using a Q-tip. Inoculation of CMV at the cotyledon stage gave 100% infectivity. Rating as early as one week after the inoculation with

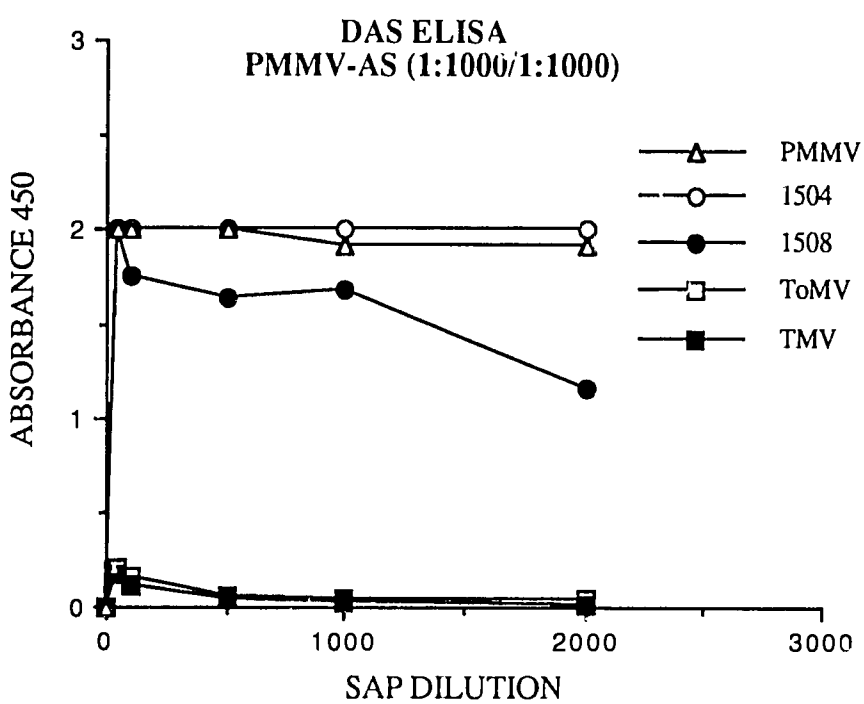
CMV detected 100% of the infected plants. For CVMV, inoculation at the third leaf stage was more efficient than at earlier and later stages. However, detection of 100% infected plants was achieved only when the ELISA test was conducted at 3-4 weeks after inoculation. This indicates that CVMV takes longer than CMV to become established, to translocate and to multiply in inoculated plants.

Detection of PVY Pathotypes

Pathotypes 0 and 1 of potato virus Y (PVY) are reported to be most common in temperate countries. Pathotype 1.2 has only occasionally been detected. Twenty-four isolates collected in Taiwan in 1988 were found to belong to pathotype 0; 10 additional isolates collected in 1989 also were identified as pathotype 0, following inoculation of a set of five *Capsicum* spp. differentials. It is unclear why pathotype 1 has not yet been found in Taiwan.

Identification of Tobamoviruses

Five tobamoviruses are known to infect *Capsicum* spp.: tobacco mosaic virus (TMV), tomato mosaic virus (ToMV), bell pepper mottle virus (BePMV), pepper mild mottle virus (PMMV) and tobacco mild green mosaic virus (TMGMV). The 22 tobamoviruses isolated from pepper during 1988 were ToMV. Additional samples were collected in 1989. Of these, two isolates were characterized as PMMV by differential hosts, agar gel immunodiffusion and ELISA. These two isolates reacted strongly in DAS ELISA tests using PMMV antiserum whereas ToMV and TMV controls reacted only weakly.



Detection of the PMMV tobamovirus by ELISA.

Further Studies on CVMV

As a result of past surveys, chili veinal mottle virus (CVMV), which was originally reported only in Malaysia, is now also known to occur in Taiwan and other Southeast Asian countries. The virus isolates from Taiwan were further characterized. The isolates from Malaysia and Taiwan infect the same hosts. However, five plant species, reported to be non-hosts of CVMV, were found to be infected with both isolates. Strains of the virus seem to exist as evidenced by one isolate (1062) which was able to infect *Capsicum* line VC 35a, which was not infected by the other 35 Taiwan isolates. In DAS ELISA serological tests, both CVMV isolates reacted positively only with the homologous antiserum. Other viruses, such as pepper mottle virus (PeMV), PVY, PVMV, tobacco etch virus (TEV), tobacco vein mosaic virus (TVMV) and isolate 697 did not react with CVMV antiserum. Necrosis can be produced in several *Capsicum* lines by CVMV.

Seed Transmission of CVMV

Seed transmission had not been reported for CVMV until an initial experiment at AVRDC in 1988 detected seed transmission in certain pepper cultivars. Investigations were conducted to verify these preliminary findings on seed transmission. No seed transmission was found in plants grown from seeds of 10 original AVRDC accessions from Malaysia where the virus is endemic. Fifteen accessions, in which seed transmission was detected in 1988, revealed no CVMV in the plants grown from seeds of infected plants, although a high percentage of virus-positive seeds were obtained when individual ground up seeds were tested by ELISA. However, with a few exceptions, the virus was not detected in seed coats, hypocotyls or rootlets of moist paper-germinated seedlings of lines in which a high percentage of ELISA positives had been obtained by grinding up whole seeds. One possible explanation is that although the virus may be detectable in whole, ground up seeds, it becomes inactivated by enzymatic activity as the seed germinates. However, the 1988 finding of seed transmission in plants grown from seeds of CVMV-infected plants is not clearly understood. Temperature during plant growth and seed drying may have played a role.

Resistance to Most Important Pepper Viruses

The resistance of nine *Capsicum* sp. lines to CVMV, CMV, PVY and ToMV was tested. Plants were mechanically inoculated at the second leaf stage with the individual virus and an ELISA test was conducted on the inoculated plants on the second, sixth and eighth leaf above the inoculated leaf and on the top leaves. All lines were found to be susceptible to ToMV and the virus was detected by ELISA in all leaves above the inoculated leaf. In lines previously found to be resistant to CVMV, all leaves above the inoculated leaf tested negatively, compared to the susceptible check plants in which all leaves had high ELISA absorbance values. Most of the lines were also resistant to PVY with no virus being detected at any of the leaf positions tested. All lines were found to be susceptible to CMV. However, with some exceptions, the

ELISA absorbance values of these nine lines were generally significantly lower in the sixth, eighth and top leaves than in the susceptible checks. This study confirms that the CVMV-resistant genotypes previously identified are highly resistant and also shows that several lines which are resistant to CVMV also offer resistance to PVY and some tolerance to CMV.

Pepper Viruses in the Philippines

Fifty-nine samples were collected from the major production areas on the island of Luzon in the Philippines and tested by ELISA for the presence of viruses. Alfalfa mosaic virus (AMV), ToMV, CMV, CVMV and tomato spotted wilt virus (TSWV) were found. Two samples reacted with antiserum to virus isolate 697, previously isolated from tomato in Taiwan and characterized as tobacco veinbanding mosaic virus.

Virus Purification and Antiserum Production

Antisera to CMV (3 isolates), CVMV and ToMV were made for the cooperators of the Germplasm Improvement Subnetwork in the Collaborative Vegetable Research Program for Southeast Asia (AVNET). The virus purification methods were those previously described.

PHYSIOLOGY

Growth and Partitioning of Dry Matter

Hot and sweet peppers were grown in the hot and cool seasons to evaluate the effect of spacings on growth and yield. Total dry matter production, marketable fruit yield and fruit size of sweet pepper were significantly higher in the cool season than in the flooded. hot season. Sweet pepper in the cool season diverted more dry matter to the fruit than in the hot season. However, the flower and fruit number, and thereby fruit set, of sweet pepper in both seasons were comparable. Therefore, the yield difference of sweet pepper in both seasons could be attributed to the difference in the potential production and translocation efficiency of the dry matter. Total dry matter production and marketable fruit yield of hot pepper were similar in both seasons. However, hot pepper produced more but smaller fruits in the hot season than in the cool one. Apparently hot pepper set more fruits in the hot season than in the cool season. Close intrarow spacing at 30 cm appeared the most suitable for the fruit yield of the hot and sweet peppers in both seasons.

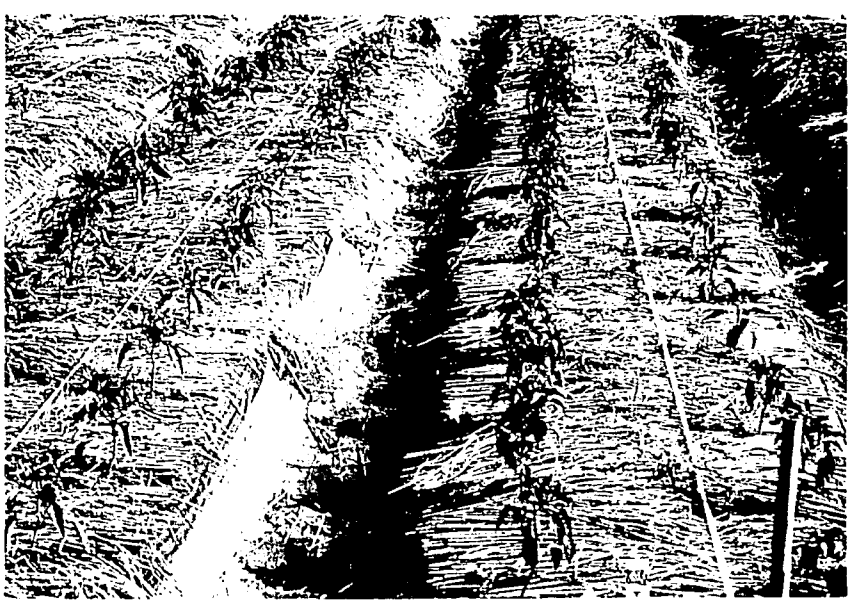
Generative and Growth Characteristics

Twenty sweet and 28 hot peppers were investigated for growth and generative characteristics in three distinct seasons to relate these characteristics to yield formation in both types of peppers from a

wide range of genetic backgrounds. Results refute the contention that fruit set in most *Capsicum* plants is sensitive to high temperature. On the contrary, there was an increasing trend in fruit number of both types of peppers at high temperatures without excess rainfall. However, the ovary size and fruit size of both peppers were significantly reduced at high temperature; fruit size was positively related to ovary size. There was a negative correlation between fruit number and fruit size. The overall fruit yield was higher in the hot season than in the cool season. The seed number per fruit was less in fruits obtained during the hot season than the cool season; it is possible that seed formation is related to fruit development. The fruits from the hot season contained high sugar levels. The overall growth of both hot and sweet *Capsicum* plants was sensitive to soil temperatures exceeding 30°C.

Row Direction and Growth of Sweet Pepper

This experiment was conducted to ascertain the reason for the great difference in growth response previously noted between east and west rows of pepper plants of the NS-oriented row bed that was mulched with silver-colored polyethylene (PE) film. Mulching with silver-colored PE film increased soil temperatures of east-side and west-side rows at 3°C and 2°C, respectively, of the NS-oriented row bed, and south-side and north-side rows at 1.5°C and 1.0°C, respectively, of the EW-oriented row bed with sweet pepper (Blue Star) plants transplanted in June 1989. There were no differences in soil temperature between rows and bed directions of the NS- or EW-oriented row bed without mulching. Sweet pepper plants of the EW-oriented bed without mulching produced more dry matter than those of the NS-oriented bed; while under PE mulching, plants of the east side produced less dry matter than the west side of the NS-oriented bed, and the south side less than the north side of the EW-oriented bed.



Difference in pepper plant growth because of row position and direction.

Electrolyte Leakage Changes

To assess the degree to which permeability of infected tissues is altered by the pathogen, (*Xanthomonas campestris* pv. *vesicatoria*), conductometric measurements of leaf leakage of various pepper cultivars containing different resistant genes were made. Conductance measurements indicated an increase in the leakage of electrolytes in leaves of a sweet pepper cultivar inoculated with a race of *Xanthomonas campestris* pv. *vesicatoria* to which it is susceptible, whereas leakage remained low after inoculation with a race to which it is resistant. The results suggest that increased cell permeability is associated with host response to the pathogen, and the magnitude of increase is least in hypersensitive host-pathogen combinations.

Bacterial Leaf Spot Resistance Expressed in Tissue Cultures

A tissue culture system was set up to study the interaction of race 1 of *Xanthomonas campestris* pv. *vesicatoria* and three cultivars of its host sweet pepper plants, resistant Early Calwonder-30R (ECW-30R), partially resistant PBC 163 (Redland Sweet Sue) and susceptible Early Calwonder. Results indicate that resistance to the pathogen can be expressed under *in vitro* conditions. By inoculating the calli of pepper plants with bacterial cells at 10^5 cfu/ml of race 1, resistant and partially resistant reactions could be detected.

SOYBEAN

INTERNATIONAL COOPERATION

Germplasm Distribution

In 1989, 1,471 seed packets of grain soybean were distributed to 74 cooperators in 35 countries and 167 packets of vegetable soybean seeds to 41 persons in 22 countries. A total of 8 sets of AVRDC Soybean Evaluation Trials (ASETs) were sent to scientists in 7 countries.

International Trials

ASET — Six cooperators from five countries returned the trial data.

Ecuador — The Programa de Oleaginosas de Ciclo Corto, Instituto Nacional de Investigaciones Agropecuarias reported that AGS 269 significantly outyielded all entries with 2.87 t/ha.

Mexico — In trials conducted by the Sede (CIAPAN) Campo Agricola Experimental del Valle de Culiacán, the local check, Tomazula S-80, outperformed all AVRDC entries in all agronomic parameters.

Pakistan — The Agricultural Research Station reported that AGS 147 significantly outyielded all other entries with 3.37 t/ha in a summer trial.

Philippines — In a wet season trial at Isabela State University in northeastern Luzon, AGS 268 obtained 1.32 t/ha, significantly outyielding all other entries.

In another wet season trial at the Central Mindanao University, three AVRDC entries, AGS 269, AGS 304 and AGS 147, had the highest yields at 1.47 t/ha, 1.42 t/ha and 1.34 t/ha, respectively.

Saudi Arabia — The Tabuk Agricultural Development Co. reported that AGS 268 significantly outyielded all other entries at 2.57 t/ha in a summer trial.

BREEDING

Hybridization

A total of 77 crosses were made, of which 48 were for vegetable soybeans and 29 for grain soybeans. Utilizing some promising newly introduced vegetable soybeans from Japan, modified backcrossing was used to develop productive, good consumer-quality vegetable soybean. Specific crosses were made to combine multiple disease resistance to a promising Thailand variety, Nakhon Sawan 1 and to improve the seed size of two Indian varieties, Co 1 and Monetta.

Yield Trials

The results of 1988 spring, summer and autumn season advanced yield trials (AYTs) were subjected to pooled analysis. Genotypic variation accounted for more than 80% of the total sum of squares for 100 seed weight. However, most of the source of variation for yield is attributed to season. Genotypes GC 81090-48 and OCB (Nakhon Sawan 1) appeared to have adaptability to all seasons. The yield potential of soybeans has been improved to more than 5 t/ha. In addition, such lines carry resistance to both bacterial pustule (BP) and downy mildew (DM). Yield during summer was drastically reduced due to typhoon. However, selections with BP resistance and yields equal to or better than the check, Kaohsiung No. 10, have been identified.

Vegetable Soybeans

Many tropical and subtropical countries are interested in producing vegetable soybeans either for domestic consumption or for export. However, suitable varieties are unavailable. In 1988 the yield potential of the graded pod was shown to be 5.9 and 5.5 t/ha for the spring and autumn seasons, respectively. In the 1989 AYT, the yield potential was 9.5 and 7.8 t/ha for the spring and autumn seasons, respectively. Of the nine vegetable soybean varieties newly introduced from Japan, Blue side, Shirofumi and Kahori appear to be promising. Four selections each from the preliminary yield trial (PYT) and intermediate yield trial (IYT) have excellent yield potential (graded pod yield) and good horticultural characteristics. Consumer acceptance of some of the promising vegetable soybeans will be evaluated in 1990. Depending upon season and genotype, the harvest index (for total pod yield) varied from 30% to 65% and the harvest index (for graded pod yield) from 26% to 50%. One of the selections, GC 84136-P-4-1-8, gave a biological yield of 33.2 t/ha on a fresh weight basis.

Soybean Rust Tolerance

A combined analysis of the AYT data from the 1987 and 1988 spring and autumn seasons suggested that of the total variation for yield, 49% was attributable to the fungicide treatment. It showed that soybean rust had a dominant role in determining yield compared to genotypic or seasonal effect. Similarly, 45% of the total variation in the percent rust infection was influenced by fungicide treatment. However, variation due to genotype was predominant for 100 seed weight, although the treatment had some effects. In the 1989 yield trials, new genotypes such as GC 81118-8-4, GC 82345-20-2 and GC 82349-6-1, have combined high rust tolerance index and yields similar to or higher than the checks. Among the 268 pedigrees evaluated, 4 were identified with lowest percent rust infection; five percent of the entries were selected for further evaluation.

Bacterial Pustule Resistance

Of the 51 IYT, 21 AYT and 5 check entries evaluated, 48% were either highly or moderately resistant to bacterial pustule. Among the 121 additional breeding lines evaluated, 97% were either highly or moderately resistant, indicating that the selection pressure exerted in the past season was quite effective. The summer yield was low due to either continuous rain or typhoon during harvest.

Traces of soybean rust infection.

ENTOMOLOGY

Beanfly Control

An insecticide screening trial, using *Ophiomyia phaseoli* (Tryon), *O. centrosematis* (de Meijere) and *Melanagromyza sojae* (Zehntner) was conducted to control beanflies on soybean, mungbean and snap bean. Pyrazophos, an organophosphorus fungicide, BAS15246, an insect growth regulator, and two organophosphorus insecticides, omethoate and dimethoate, were tested for control of mainly *M. sojae* on soybean. The insecticides were sprayed at 3, 7, 10, 14, 21, 28 and 36 days after emergence (DAE) and their efficacy was evaluated at 21 and 35 DAE. Pyrazophos at 0.4 and 0.5 kg a.i./ha gave the best control of agromyzids on soybean. There was significant negative correlation between the dosages of pyrazophos from 0.1 to 0.5 kg a.i./ha and the number of beanfly larvae found in soybean or the percentage of soybean plants damaged by the pest. Pyrazophos gave superior pest control over omethoate, the standard insecticide. This fungicide also provided excellent control of agromyzids in mungbean which harbor all three species and in snap bean where *O. phaseoli* is the major species.

Limabean Podborer Resistance

Soybean germplasm was screened in three different field tests for resistance to limabean podborer (*Etiella zinckenella* [Treitschke]). The germplasm was planted in the field in July, August or September and exposed to the ambient population of the pest, supplemented by the occasional release of laboratory-reared insects. At harvest the healthy pods and those damaged by insects were recorded and the percentage of damaged pods was analyzed by statistical methods to judge their resistance reaction. In a preliminary single replicate, single planting screening of the 815 accessions, 11 were classified as highly resistant. The average pod damage in these accessions was 0.74% versus 12.88% for three highly susceptible checks. In a second test, all three accessions (G 6359, G 7180, G 6497) which were least damaged in 1987 tests were significantly less damaged in each of the three plantings. Similarly, in an advanced test all three accessions (G 3469, G 3543, G 3574) which were least damaged in two previous tests in 1986 and 1987, were also significantly less damaged in this test. All six resistant accessions included in the latter two tests have smaller pods (and thereby seeds). In all past tests, smaller seeded accessions were invariably less damaged than the large seeded ones. The utility of these accessions in breeding podborer-resistant cultivars is, therefore, limited.

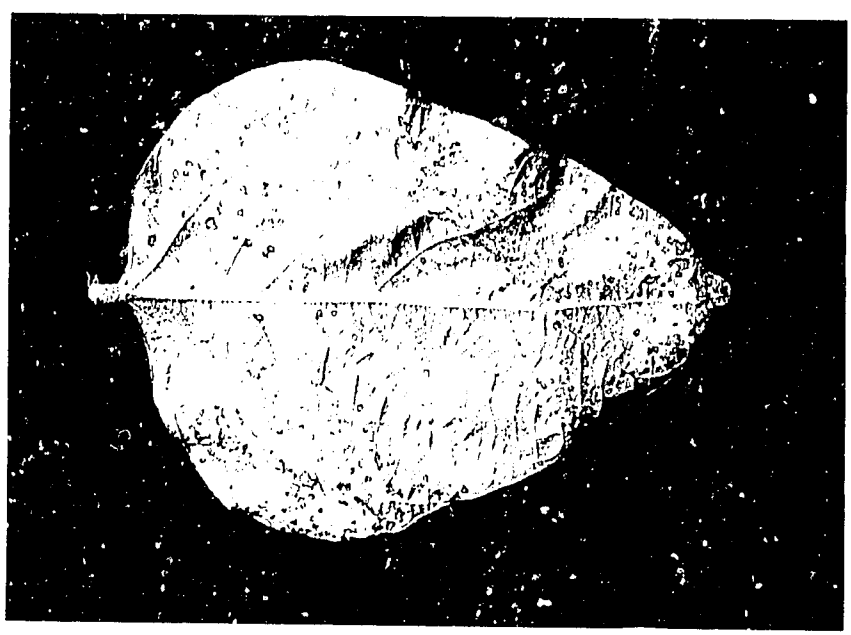
PATHOLOGY

Bacterial Pustule Resistance

Twelve of the 116 soybean breeding lines evaluated were confirmed as highly resistant to bacterial pustule under field conditions. Most of the remaining 104 lines were classified as resistant to moderately resistant with only one line identified as moderately susceptible. Of the 12 highly resistant lines, 10 had AGS 269 as one of the parents while the other two had AGS 129 as one of the parents.

Incidence of Pathogens on Stems

There were more pathogens on stems of soybeans in the AYT1 than the AYT2. Plots treated with a fungicide had consistently less fungi on stems compared to nontreated plots (57%). *Macrophomina phaseolina* occurred on 70% of the stems examined in the AYT1 plots without fungicide.



Spots of bacterial pustule on soybean leaf.

SWEET POTATO

INTERNATIONAL COOPERATION

Safe Germplasm Exchange

International exchange for testing improved sweet potato breeding material has always been hampered by the possibility of the transmission of diseases. Therefore, strict quarantine regulations have generally been established to ensure safe exchange. A virus-indexing scheme has been developed at AVRDC to test that virus diseases are not present before international exchange. Since 1987, 39 AVRDC-improved lines have successfully passed through the virus-indexing scheme and are available for international exchange.

Germplasm Distribution

A total of 1,201 tubes of 39 clones of virus-indexed materials have been distributed to 40 cooperators in 25 countries since 1987. In addition, a total of 11,000 true seeds were sent to the International Potato Center (CIP) in Peru and the Ministry of Agriculture and Water Development, Zambia in 1989.

International Trials

Vietnam — In a preliminary nonreplicated trial by the Mekong Delta Farming Systems Research and Development Center, most entries outyielded Duong ngoc, the local check, especially CN 1028-15, CN 1108-13 and CN 1489-89 from AVRDC and Xushu No. 18 from China. AVRDC entry CI 608-652 and Xushu No. 18 showed vigorous vegetative growth with large leaves which is preferred for hog feed.

BREEDING

Hybridization Program

In the hybridization program 1988/89, four polycrosses and two series of hand crosses were conducted. Priority was continuously given to the improvement of dry matter, eating quality, resistance to leaf scab and vine borer, and root performance under hot humid conditions.

Spring and Summer Yield Trials

The AVRDC sweet potato breeding program to select clones with good adaptability to a range of environments in the lowland tropics continues. Trials in different yielding environments (spring and summer) are routine screening procedures. These trials investigate the nature of genotype × season interaction on yield and chemical components and to confirm the varied responses of the clones under different seasons.

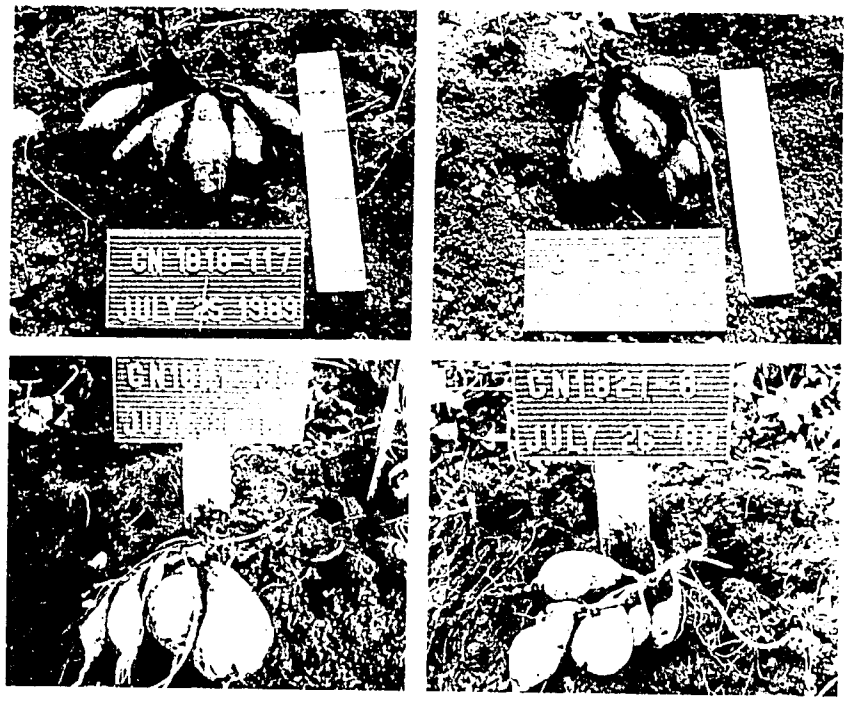
A significant genotype × season interaction was observed for marketable yield and its components. Of the high yielding clones evaluated, CN 1489-89 had stable yield and Tainung 66, one of the best yields under favorable conditions, appeared to be most sensitive to the adverse hot-humid condition. Based on these results, planting during different seasons, appears to be an effective means of identifying genotypes with contrasting responses to environmental changes.

Advanced Yield Trials

After passing through the different stages of selections, the final set of promising clones are evaluated in the advanced yield trial (AYT). Selections are made in the AYTs on the basis of combined performance over season and year. A total of 12 clones were selected for further evaluation; CN 1818-117 and CN 1790-42 for human consumption, and CN 1821-39 and CN 1821-8 for feed types are especially promising.

Preliminary Yield Trials

Thousands of new genotypes undergo rigorous selections in the seedling screening and observational yield trials. Only a limited number of clones are entered into the preliminary yield trials (PYT) to be evaluated for yield, adaptability to wider environments and overall performance, including morphological and chemical factors. A total of 20 clones were selected from the PYT2, and 18 from the PYT1 for further evaluation.



Some promising clones selected by the sweet potato breeding program.

Utilization of Interspecific Hybrids

Since 1985, the possibility of utilizing 5 × -hybrids, obtained from the cross between 4 × *Ipomoea trifida* and sweet potato, has been explored. To improve the yield of the hybrids, the first backcross and selection of their progenies (BCF_1) was made. Eleven BCF_1 lines selected last year were entered into the PYT2 and evaluated in three seasons. Compared to the 5 × -hybrids, the yield of these lines was recovered after the first backcross and was comparable to sweet potatoes. No special defect was identified in morphological and chemical characters, such as dry matter, starch, protein, sugar, etc. and the lines can be utilized in the breeding program as ordinary sweet potato varieties.

Evaluation of Germplasm Collection

Germplasm selected from the early yield trial in 1988 were evaluated again in 1989. The 26 entries include 11 AVRDC elite clones, 24 germplasm accessions from 10 countries and Tainung 66 as a check. Yield, other horticultural characters and dry matter content were evaluated. The 16 promising clones will be further evaluated for other traits, such as resistance to leaf scab and vine borer, chemical component, etc.

ENTOMOLOGY

Search for Sweetpotato Weevil Resistance among Interspecific Backcross Progeny

Seventy-six breeding progenies from a cross between *Ipomoea trifida* × *I. batatas*, which was backcrossed to *I. batatas*, were screened for resistance to sweetpotato weevil, *Cylas formicarius*. The entries were planted between weevil-infested rows of sweet potato to provide uniform infestation and roots were evaluated for weevil infestation at harvest. The two highest yielding entries with moderate damage and five high yielding ones with least damage appeared to be promising and will be further investigated.

Search for Sweetpotato Weevil Resistance in Vines

AVRDC's entire sweet potato germplasm collection consisting of 1,189 available accessions and 54 elite clones from its breeding program were screened for sweetpotato weevil (*Cylas formicarius*) resistance in vines in two batches in nonreplicated tests. The accessions were planted in the field and laboratory-bred weevils were released to initiate infestation. Ten weeks after planting, each plant was cut open to check for the presence of weevil and signs of damage in the crown. Seven accessions in the first batch, and 12 in the second had the least weevil infestation. In a second multireplicate test, accessions I 13, I 98 and I 123 — which had showed varying levels of resistance to weevil in roots — had the least infested vines. These accessions are currently under investigation to judge their suitability for the sweetpotato weevil resistance breeding program.

Effect of Plant Age on Sweetpotato Weevil Infestation of Crown

The preference of sweetpotato weevils to infest the crowns of sweet potato plants of various ages starting from 1 week to 8 weeks after planting was studied in a field test. The older the plants, the greater were the number of weevils found inside the crowns. There was highly significant positive correlation between plant age and the number of insects found in the crown.

Epidemiology of Sweetpotato Weevil

The infestation by sweetpotato weevil on sweet potatoes planted in an open field and weevil-protected enclosed plots was monitored from planting to harvest. Weevil infestation becomes visible 8-10 weeks after planting, a period that coincided with initiation of root formation. In the open field, the infestation increases exponentially from the 12th week when root enlargement begins and cracks in the soil begin to appear. Infestation in the open field is far greater than in the weevil-protected enclosed field, obviously due to emigration of the weevils from the surroundings. If the external host of weevil infestation is reduced significantly, it should be possible to grow a relatively weevil-free crop.

Role of Cuttings Age in Carryover of Sweetpotato Weevil Infestation

The role of fresh and old (growth) cuttings on the carryover of sweetpotato weevil infestation from weevil-infested field to the new planting was studied in a field experiment. In an open field, the crop planted with fresh cuttings was damaged as much as the one planted with old cuttings. However, in weevil-protected enclosed plots, sweet potato planted with old cuttings was seriously damaged while the crop planted with fresh cuttings was practically weevil-free. To obtain weevil-free roots when planting a new sweet potato crop, it is, therefore, advisable to use as tender growth cutting as practicable and plant the crop away from other hosts of the weevil.

Sweetpotato Weevil Control by Sex Pheromone

An experiment was conducted in three seasons (1987, 1988 and 1989) to study the utility of a synthetic sex pheromone for the control of sweetpotato weevil in the field. In each of three widely spaced, 0.1-ha parcels of land, sweet potato was planted utilizing weevil-free cuttings. Starting soon after planting, and throughout the season, traps baited with 100 μg of sex pheromone were placed 10 m apart in one parcel. This was done to trap male weevils. In the second field, rubber septa, each baited with 1 mg of pheromone, were placed 0.5 m above the crop canopy at 5-m-grid junctions. This was done to inundate the field with pheromone so that males would not be able to locate the females for mating. The third parcel was maintained as a check. The male weevil population was monitored once a week in all three plots. Although the male weevil population in the pheromone-treated plots was considerably lower than in the check plot in two out of three years, this low population

Sex pheromone trap for weevils in a sweet potato field.

was not reflected in less weevil damage to the sweet potato roots. Only in one year was there less weevil damage in the pheromone-treated field. To obtain satisfactory control, therefore, it is essential to observe clean cultivation practices. Pheromone use under such cultivation practices, however, may be redundant.

Control of Sweetpotato Weevil in Planting Material

Twenty-one organic insecticides were screened for their suitability for dipping in a preplant sweet potato cutting treatment to control the sweetpotato weevil. Sweet potato (cv. Tainung 57) cuttings were dipped for 1 or 3 hours in 0.05% or 0.1% active ingredient of each insecticide. Chlorfluazuron, DDVP, diazinon, dimethoate, fenitrothion, methyl parathion, mevinphos, permethrin, and prothiophos showed severe phytotoxicity. Carbosulfan, methomyl, monocrotophos and omethoate showed mild phototoxicity. Carbaryl, carbofuran, cartap, diflubenzuron, malathion, methamidophos, profenofos and teflubenzuron were not phytotoxic. Diflubenzuron and teflubenzuron are less water soluble and relatively costly. Carbaryl, carbofuran, cartap, malathion, methamidophos and profenofos can be used for the cutting dip treatment. Dipping of sweet potato cuttings in carbofuran solution prior to planting delayed the infestation of treated plants by the weevil compared with untreated cuttings. The weevil infestation was always lower for up to 16 weeks after planting in treated than in untreated plants.

Sweetpotato Vine Borer Resistance

Two hundred and sixty-five newly received accessions in AVRDC's sweet potato germplasm collection and 45 improved breeding lines were screened for resistance to sweetpotato vine borer, *Omphisa anastomosalis* (Guenée), in a field test on Penghu island, Taiwan. All entries, along with two known resistant and one susceptible checks, were planted in single row 5-m-long, 1-m-wide nonreplicated plots and were exposed to the ambient population of vine borer. At harvest each plant was observed for vine borer damage. Fifty-four entries were considered moderately resistant. These included six breeding lines, of which two were crosses between *Ipomoea trifida* and *I. batatas*.

Sweetpotato Vine Borer Resistance/Tolerance

Progenies from crosses between sweetpotato vine borer (*Omphisa anastomosalis*) resistant accessions and agronomic clones and locally adopted commercial cultivars were screened for resistance/tolerance to the vine borer. Clone CN 1756-163 proved to be tolerant as it gave a high yield of 15.4 t/ha under high insect damage. Although insecticide application reduced vine borer damage, it did not increase the yield of this clone. A commercial cultivar, Tainung 66, also showed similar tolerance. Four clones with a moderate level of resistance to the vine borer in the past were also moderately resistant in this test.

PATHOLOGY

Resistance to Scab

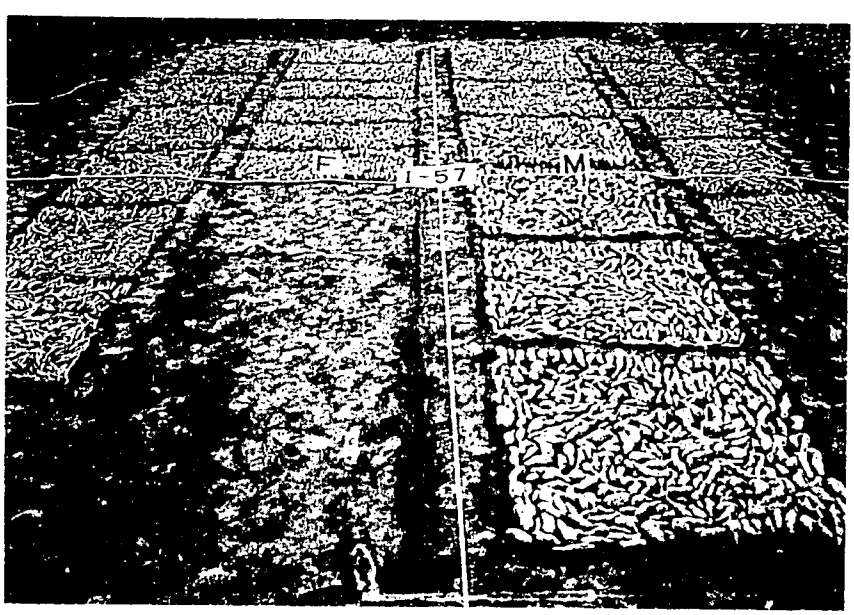
Abundant conidia of *Sphaceloma batatas* were produced at 5.3-5.5 pH on potato dextrose agar. Young, actively growing tissue of sweet potato was more susceptible than older tissue. The method of inoculation for resistance screening was changed to use 7- to 10-day-old cuttings or seedlings. A new rating scale was established to simplify the procedure for evaluating resistance.

Yield and Quality of Meristem-derived Plants

It is well known that vegetatively propagated plants are prone to contamination by viruses. A replicated field trial was conducted to compare yield and quality parameters in six meristem-derived and field-propagated sweet potato lines. Although virus reinfection of meristem-derived plants took place in some plants within the first growing season, yields of meristem-derived plants were significantly higher in all but one line. The increase in yield ranged from 5% to 65%. Root quality of meristem-derived plants was similar to field propagated plants.

Virus Elimination and Indexing

The virus elimination and indexing method described previously has been used to obtain the following virus free lines: seven AVRDC breeding lines (set 3), seven AVRDC accessions, 10 lines from



Yield of meristem-derived plants was significantly higher than field (F) propagated sweet potatoes.

Thailand, 5 from China, 8 from Puerto Rico, 6 from Peru, 8 from Nigeria, 7 from Tonga, 12 from Papua New Guinea, 20 from the Solomon Islands and 65 from the USA. Together with lines previously freed of virus, a total of 238 virus-free lines are now available for international distribution. An ELISA test conducted before the growing out of the tissue-cultured plantlets effectively reduced the number of plants containing virus in the two consecutive graft indexing steps. The collections from Thailand and the Solomon Islands were heavily infected with virus. About 80 virus isolates, which do not react by ELISA with antisera to any of the known viruses, have been recovered. They may be infected with viruses which have not been characterized previously.

Improvement of the Virus Indexing Method

The problems encountered previously in the virus indexing scheme were lack of sufficient *Ipomoea setosa* indicator plant seeds and the high background in the ELISA test of some of the antisera giving rise to false positives. New sweet potato yellow dwarf virus (SPYDV) antiserum, using a different propagation host (*I. nil* instead of *Sesamum indicum*) was produced and gave a positive/negative threshold of 2 × = 0.144 which is higher than the highest absorbance of healthy plants and a 0.37 absorbance value less than the lowest value of diseased plants. Healthy plants can now be clearly distinguished from SPYDV-infected plants by DAS ELISA. Sufficient quantities of *I. setosa* seeds were produced in the field in the spring season. Although all field-grown *I. setosa* plants were found to harbor feathery mottle virus (FMV), SPYDV and sweet potato latent virus (SPLV), none of the seeds originating from these plants was found to carry the virus when plants were grown from these seeds.

Effect of Viruses on Yield and Quality

Although it is generally assumed that infection of sweet potato leads to a general yield decline, very little information exists on the effect of specific viruses on yield and the quality of sweet potato. The effect of five viruses, FMV, sweet potato virus II (SPV II), SPLV, sweet potato leaf curl virus (SPLCV) and SPYDV, on sweet potato lines TN 66 and CN 1108-13 was studied in a replicated field trial. All viruses caused significant yield reduction. In line TN 66, the greatest reduction was caused by FMV, followed by SPLCV, SPLV, SPV II and yellow dwarf virus (YDV), whereas in line CN 1108-13 yield reduction was greatest with SPV II followed by SPLCV, FMV, YDV and SPLV. Infection with some viruses also affected quality parameters such as sugar level and fiber content of the root.

Identification of Unknown Viruses

The etiology of the sweet potato leaf curl disease is unknown. Electron microscopic examinations have revealed the presence of gemini-type particles in adsorption preparations of leaf curl-diseased plants but not in healthy ones. Nuclear inclusion bodies typical of gemini viruses were visualized in the light microscope after staining with Azure A. These findings and the isolation of single-stranded DNA strongly

suggest that the causal agent of the sweet potato leaf curl disease is a gemini virus.

Effect of Virazole on Elimination of Viruses

Antiviral chemicals, such as ribavirin, have shown promise in eliminating sweet potato viruses from infected tissue. The effect of different concentrations of ribavirin on the elimination of FMV and YDV in stem tips was also investigated. The efficiency of virus elimination was also compared in plantlets derived from meristems placed on regular medium and in plantlets derived from meristems placed on medium containing virazole. With increasing concentrations of virazole, the efficiency of virus elimination in stem tips was increased. At 100 mg/l, virazole eliminated FMV in 57.6% and SPYDV in 79.1% of the stem tips. This was, however, not higher than the virus elimination achieved by meristem culture alone. Placing meristems on medium containing 50 mg/l virazole did not result in higher virus elimination efficiency than when meristems were placed on regular medium.

PHYSIOLOGY

Growth and Partitioning of Dry Matter

Differences in dry matter production, partition of assimilates, and formation and growth of storage root were investigated for ten improved sweet potato clones under five distinct seasons to examine the effect of environmental conditions on the expression of yield. Harvest indices and dry matter accumulation of storage roots increased throughout the growing season, but at a slower rate under conditions with increasing temperatures and excess rainfall. The relative importance of source, sink, and partitioning effects change during the growing season and differ among clones. Two major determinants were total dry matter production and the partition of assimilates to the storage root. However, the partition seemed to play a decisive role despite the season of planting. The inclined diversion of dry matter to the storage root was related to sink strength; this trend was subjected to change with environmental conditions such as high temperature and soil flooding. Maintaining a balance between top growth and storage roots is probably a factor in obtaining maximum yield.

Variations of Starch Contents in Cultured Cells

Cells derived from meristem cultures of 18 sweet potato clones which were grown in MS media containing sucrose, exhibited appreciable differences in relative growth rate (RGR) during five weeks of *in vitro* culture at 25°-30°C. Both CN 1489-89 and Tainung 31 have comparable RGR, which were the highest among 18 clones, whereas AIS 35-2 had the lowest RGR. Under normal cell growth, starch formation also exhibited clonal difference in the cultured cells. CN 1661-15 had the highest starch content, 8.9% on a dry weight basis, highest percentage of cells (82%) with starch grains, and highest

number of starch grains per cell (16% of cells with more than 50 starch grains per cell). Cells of I 1192, CN 71-4 and CN 1517-139 had less than 3% starch contents on a dry weight basis. Levels of amylase, an enzyme responsible for starch degradation, inside the cells also exhibited a three-fold difference among 18 clones examined. CN 1108-13 had the least amylase activity in the cultured cells. GA_3 in the media decreased starch formation in the cultured sweet potato cells.

Evaluation of Tolerance to Excess Soil Moisture

Flooding imposed at three or seven weeks after planting affected leaf growth and storage root formation of leaf cuttings. Flooding imposed at three weeks after planting was more crucial than at seven weeks after planting in accelerating leaf senescence and inhibiting storage root initiation, but flooding imposed at seven weeks after planting was more effective in impeding storage root enlargement. There were clonal differences in leaf senescence and survival of leaf cuttings after flooding treatments. CN 1489-89 had the slowest rate of leaf chlorosis and the highest survival rate, more than 80%, during the 63-day growth duration with flooding at three or seven weeks after planting. Other clones, I 392, I 444, TN 66 and TN 67, also had more than 50% survival rates after flooding. In general, TN 66, CN 1108-13 and CN 1489-89 produced more storage root yield than other clones under flooding conditions. In a screening of 214 nonimproved clones, I 100, I 358, I 381, I 405, and I 932 were found to produce reasonable storage roots when the leaf cuttings were exposed to excess soil moisture at three weeks after planting.

Flood tolerance screening of sweet potato.

TOMATO

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INTERNATIONAL COOPERATION

Germplasm Distribution

A total of 2,907 seed packets were distributed to 141 cooperators in 47 countries.

Crop Releases

Cape Verde Islands — The Food and Agriculture Organization (FAO) reported that Xina (AVRDC CL 143-0-13-3 UG x local line) and Tropiva 3 (AVRDC CLN 236 BC_1F_2-26-3-3-15) were released to farmers in the hot season. Xina has firm fruit, is heat-tolerant and is resistant to bacterial wilt, Fusarium wilt (0, 1) and gray leaf spot. Tropiva 3 is a fresh market determinate line with heat tolerance, resistance to bacterial wilt, tomato mosaic virus and nematode, 60 g average fruit size and 20 t/ha yield.

Taiwan, China — The Taichung District Agricultural Improvement Station released AVRDC FMTT 22 as Taichung ASVEG No. 4 because of its resistance to bacterial wilt, tomato mosaic virus and fruit cracking. This fresh market variety has moderately firm and large fruit and its moderate level of heat tolerance achieves high productivity at elevations of 500 m during the hot and humid season.

International Trials

Kampuchea — The World Church Service reported that AVRDC PT 870 and PT 3027 outyielded the local check, 19 t/ha vs. 12 t/ha and 14 t/ha vs. 7 t/ha, respectively, in dry season trials. The AVRDC materials had relative resistance to yellow leaf curl virus which is very serious in the area.

Philippines — The East-West Seed Company reported the outstanding performance of a series of AVRDC cherry hybrids in which the best entry CHT 104, yielded 69 t/ha, with very uniform fruit size averaging 31 g per fruit and minimal foliage and fruit diseases.

Somalia — The Food and Agriculture Organization (FAO) reported that VC 13-2-2P, an introduction from the Philippines, was the highest yielder in two successive seasons although with slight leaf curl virus infection and has now been recommended for on-farm trials.

Tanzania — Sokoine University of Agriculture reported that AVRDC's CL 143 outyielded Roma VF, the most widely grown cultivar in the country.

Turkey — Kagome Company, Ltd. selected two AVRDC fresh market hybrids (FMTT 114 and FMTT 22) for their high adaptability. The dark shoulder, however, is a hindrance to consumer acceptance.

BREEDING

Hybridization Program

To further enhance the fruit setting ability of tropical breeding lines, new crosses were made with parthenocarpic stocks (gene *pat-2*) to complement the heat tolerance genes. Crosses to incorporate resistance to black leafmold, potato virus Y (PVY) and insects were also developed.

Bacterial Wilt Resistance

As in previous years, all new breeding materials were rigorously tested for bacterial wilt (BW) resistance because BW is, by far, the **most serious disease** limiting tomato production in the tropics. New materials were selected for their high BW resistance in addition to heat tolerance, resistance to tomato mosaic virus (ToMV) and rootknot nematode, and other desirable horticultural traits. Three new single seed descent-derived heat tolerant lines, three large-fruited fresh market hybrids, and two determinate and one indeterminate advanced breeding lines were selected. As in the past the advanced cherry tomato breeding lines showed, at best, only moderate to low levels of BW resistance, thus indicating the need to undertake further breeding for this trait among cherry genotypes.

Tropical Breeding Lines

In recent years, the tomato improvement program emphasized the stepwise combination into tropical lines of **heat tolerance** and **resistance to two major diseases and a pest**, i.e. bacterial wilt, tomato mosaic virus and rootknot nematode. In addition, improvements in fruit size, firmness and resistance to fruit cracking were also sought.

In a general trial of determinate lines bred at different stages of the improvement program, the best yielders were those developed in Groups III-IV (1980-88). Breeding lines from these groups significantly outyielded all lines bred prior to 1980 and TK 70, the heat sensitive check. Their marketable yield during the hot season ranged from 30 to 49 t/ha compared to only 3 t/ha for TK 70; they are also resistant to ToMV and carry varying levels of BW resistance. Group IV lines also benefit from new attributes such as resistance to rootknot nematode, improved fruit size and better fruit firmness.

The best entries from the general trial of indeterminate tropical lines ranged in yield from 28 to 36 t/ha, significantly outyielding the heat-sensitive check cultivars, KY 301 and L 387, which yielded 3-5 t/ha. These lines also produced moderately firm to firm fruits, with none or slight concentric or radial cracking, and carry resistance to both ToMV and BW. Three of the best lines also carry, in addition, resistance to rootknot nematode and apparent "resistance" to bacterial leaf spot.

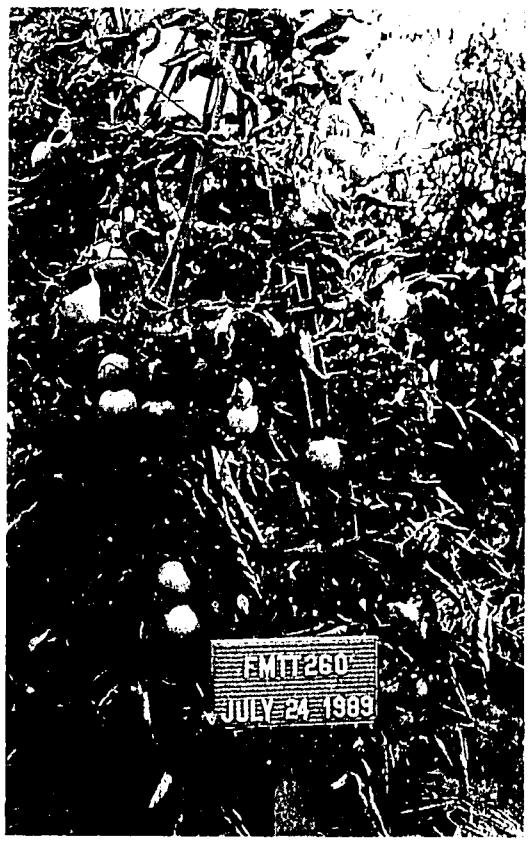
The largest gains in hot season yield and fruit size were recorded among the latest batch of nematode-resistant genotypes even though there was an appreciable reduction in fruit setting ability. It appears that the sizable increase in fruit size in this group was more than adequate to offset the loss in fruit set.

Large-fruited Fresh Market Genotypes

The search for fresh market tomato hybrids with the following characteristics continued: heat tolerance, disease resistance (BW, ToMV and rootknot nematode), firm fruits, dark green shoulder and good fresh market flavor.

In the early summer observational trial, the best new hybrids outyielded the heat tolerant check, FMTT 22. The marketable yield of the new hybrids ranged from 41 to 54 t/ha compared to 27 t/ha for the check, and the former enjoyed larger or comparable fruit size, generally firmer fruits, with none or only slight fruit cracks, and relatively lower virus infection.

In the summer advanced trial, the best large-fruited hybrids outyielded the heat tolerant check, FMTT 22, with a yield range of 42-51 t/ha compared to 29 t/ha for the check. Fruits of the new hybrids were also crack resistant.



One of the new, large-fruited fresh market hybrid tomatoes.

New Cherry Breeding Lines and Hybrids

The breeding program continued the development of cherry genotypes with the following features: heat tolerance, disease resistance (BW, ToMV and nematode), firmness, tough skin, crack resistance and acceptable cherry-type qualities (especially high soluble solids — Brix range above 6°).

In the summer observational trial, the yields of selected cherry hybrids ranged from 11 to 16 t/ha, outyielding the checks, Girl's Sweet and Sugar Pearl, which yielded 8-9 t/ha. These hybrids also produced moderately firm to firm fruits, with slight to no fruit cracking and also carry resistance to ToMV and apparent "tolerance" to flooding.

Four hybrids clearly exhibited good heat tolerance and yielded well (39-44 t/ha), with less fruit cracking and good vine cover in the early summer preliminary yield trial. Hybrids such as CHT 104 and CHT 105 also possess some levels of BW resistance.

New Processing Tomato Hybrids

The search continued for processing tomato genotypes with the following characteristics: heat tolerance (for late summer and spring season planting), disease resistance (BW, ToMV and nematode), high concentrated yield of firm fruits (for mechanical harvesting) and acceptable processing quality.

From various observational and preliminary trials, four hybrids, i.e. PT 4225, PT 4287, PT 4289 and PT 4300, performed consistently well in late summer, fall and spring cropping seasons. These hybrids were high yielding. produced firm fruits and had good vine cover. However, their soluble solids content were at best only comparable to the high solids checks.

Among hybrids in the advanced testing stages, PT 4121 and PT 4165, were outstanding in the 1988 late summer advanced yield trial, outyielding the heat tolerant check TN-3. These hybrids, particularly PT 4121, are also notable for their firm and large fruits, and good vine cover.

ENTOMOLOGY

Resistance to Tomato Fruitworm

Eleven families derived from a cross between *Lycopersicon hirsutum* f. *glabratum* which is resistant to tomato fruitworm (TFW) (*Heliothis armigera*) and a *L. esculentum* which is susceptible to TFW but has high yield and desirable characters were screened in the BC_3F_5 progeny for resistance to TFW in the field. In addition to TFW damage the progeny were also examined for larger fruit size and higher yields. Five least damaged breeding lines with yields from 68 to 74 t/ha and fruit size ranging between 36 and 59 g/fruit were selected for distribution to national programs and further improvement.

Tomato with severe bacterial wilt infection (left row) and resistant tomato variety (right row).

PATHOLOGY

Control of *Pseudomonas solanacearum* by Soil Amendment

Pseudomonas solanacearum is the causal agent of bacterial wilt, which is one of the most serious diseases of tomato in the tropics. A soil amendment consisting of mineral ash and urea was utilized to reduce populations of *P. solanacearum*. Reduction of the population to obtain 50% mortality occurred 21 days after incubation with the 1% soil amendment. Survival of L 390, a highly susceptible check, was 50% in nonamended soil compared to 100% survival in amended soil at 35 days after transplanting under pot culture in the greenhouse. The bacterial population was reduced to less than 10% of the initial population in amended plots versus nonamended plots under field conditions. Plant survival increased in soil treated with amendment over nontreated soil in a bacterial wilt nursery.

Effect of *Pseudomonas solanacearum* on Inoculated Seeds

The effect of *Pseudomonas solanacearum* on inoculated tomato seeds was studied. Seed germination was not affected by inoculum concentration of *P. solanacearum* for resistant L 285, moderately resistant CL 143-0-10-3-0-10, and susceptible L 390. Increased inoculum reduced root and stem lengths, the number of upright stems, and the appearance of normal seedling growth. Seed soaked in inoculum had less clear-cut differences when comparing L 390 to CL 143-0-10-

3-0-1-10, but seed placed on top of cheesecloth soaked with inoculum had greater differences between these two lines. Total length of seedling was one of the variables measured that had consistent differences among the three lines tested.

Cercospora Leaf Mold

Cercospora leaf mold, caused by *Cercospora fuligena*, is an important disease of tomato grown in some warm, humid locations. Two tomato accessions, L 1352 and L 1558, had consistently and comparatively low levels of Cercospora leaf mold infection in three separate experiments compared to 37 other accessions that had been reported highly resistant to Cercospora leaf mold in a previous AVRDC report. The fungus failed to sporulate on accession L 1558 in one of the trials.

Resistance to *Sclerotium rolfsii*

Sclerotium blight, caused by *Sclerotium rolfsii*, is a serious disease under hot and wet conditions. The objective of this experiment was to evaluate *Lycopersicon* spp. for resistance to *S. rolfsii*. Most accessions and breeding lines of tomato had a very low percentage of plants surviving inoculation with *S. rolfsii*. In general, accessions of *L. peruvianum* had more surviving plants (20%) than other *Lycopersicon* spp.

Virus Survey in the Philippines

In 1983 an initial survey was conducted in the Philippines and the following viruses were detected: CMV, PVY, ToMV and tobacco leaf curl virus (TLCV). To gain additional information on the presence of viruses, 60 samples were collected from 3 locations and tested for the presence of 10 viruses. Seventy-eight percent of the samples were found to be infected with virus: CMV (72%), ToMV (58%), TSWV (33%), PVY (17%) and potato virus X (PVX - 3%). Other viruses were not detected. The high incidence of ToMV and CMV reflects the virus situation of this crop in other Southeast Asian countries as found in AVRDC surveys.

Tobacco Vein Banding Mosaic Virus: A New Natural Host

Additional electron microscopy and serological tests were conducted to exactly characterize several potyvirus isolates previously recovered from tomato. Ultrathin sectioning of infected cells revealed virus particles in tightly packed aggregates which were associated with cylindrical inclusions of the pinwheel, scroll and laminated aggregate type. Immunosorbent electron microscopy and decoration tests using antisera to 32 potyviruses revealed a close relationship only with groundnut eyespot virus. In DAS ELISA tests, antiserum to the unknown tomato isolates was found to react positively only with tobacco vein banding mosaic virus, recently obtained from the Taiwan Tobacco Research Institute. However, the physical properties (thermal inactivation point, longevity *in vitro* and dilution end point) of the tomato

virus differ somewhat from those of tobacco vein banding virus. The mild symptom expression on tomato and the types of cytoplasmic inclusion bodies are also almost identical to tobacco vein mosaic virus (TVMV) reported only from the USA on tobacco. The relationship of TVMV with the tobacco vein banding mosaic virus of Taiwan has not been previously studied and needs to be determined.

PHYSIOLOGY

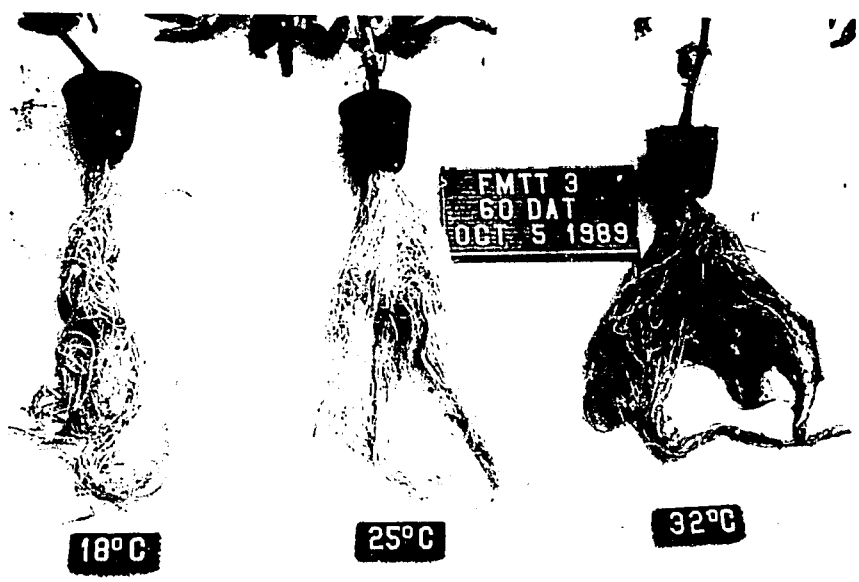
It is imperative to determine the temperature causing direct heat injury to root systems so that cultural practices aimed at reducing daily maximum soil or container medium temperatures can be evaluated. Root systems attached to shoots of Chinese cabbage, soybean, mungbean, sweet potato, sweet pepper, hot pepper and tomato plants were measured for membrane thermostability after incubation at 25°, 35°, 40°, 45°, 50° and 60°C for 30 minutes. Membrane leakiness increased with increasing temperature. About 50% of heat injury occurred at 47.7° ± 0.5°, 48.7° ± 0.5°, 49.0° ± 0.5°, 50.0° ± 0.5°, 50.5° ± 0.5°, 51.2° ± 0.5° and 54.7° ± 0.5°C for the roots of tomato, Chinese cabbage, soybean, mungbean, sweet pepper, hot pepper and sweet potato, respectively. The intact roots of sweet potato appeared most effective to withstand direct heat injury, the roots of soybean displayed an intermediate response, while the roots of tomato and Chinese cabbage were most sensitive.

Growth Analysis of Tomatoes Applied with Growth Regulator

High temperature possibly disturbs the endogenous hormonal balance between the vegetative and generative parts of tomato plants, thereby causing a reduced diversion of assimilates to the plant's generative parts. This study examined the effect of para-chlorophenoxy acetic acid (CPA) on dry matter distribution of tomatoes in relation to fruit size under hot and cool growing conditions. CPA application at anthesis decreased the flower and fruit number of CL 5915-206 and FMTT 3 but increased fruit size in both hot and cool seasons. FMTT 3 had greater fruit size and fruit yield than CL 5915-206 under the corresponding treatment in the same season. CPA application at anthesis or two weeks after anthesis increased fruit yield in the hot season, but not in the cool season. There was a balanced effect of the fruit number and fruit size due to different timings of CPA application in the hot season. Plants with CPA application at anthesis produced less, but larger fruits without seeds, whereas plants with CPA application at two weeks after anthesis produced smaller fruits with some seeds. Under high temperature conditions, CL 5915-206 had high rates of natural parthenocarpy without CPA. CPA application increased harvest index in the hot season but not in the cool season. The high sugar/starch ratio in the peduncle of tomatoes under high temperature conditions might be related to early ripening.

Solution Temperature of Hydroponically Grown Tomatoes

To survive under flooding, or grow under hydroponic conditions, plants will have to depend on gross structural and metabolic adaptations to flooding. This experiment investigated the effect of solution temperature on the root system and growth of tomato plants. FMTT 3 tomato plants were grown hydroponically for 60 days under three solution temperatures. Plants grown under 18°C solution temperature had the highest total dry matter production and dry matter accumulation in the fruit. More fruits, but with smaller size, were formed at 18°C. The root system of the 32°C solution temperature had the least membrane thermostability (as determined by electrolyte leakage) and oxidizing activity (as determined by the oxidation of α-naphthylamine) at later stages of growth; high membrane thermostability and oxidizing activity may facilitate water and nutrient uptake. In this connection, the solution-immersed root system had higher membrane thermostability and oxidizing activity than the root system exposed to the air. Apparently the solution may serve as buffer against the extreme temperature fluctuation imposed on the root system. Furthermore, the peduncle of the 18°C solution had higher phosphorus and potassium contents in the later stages of growth; high phosphorus and potassium contents in the peduncle may be conducive to dry matter partition in the fruit.



Response of root development to different solution temperatures.

PRODUCTION SYSTEMS PROGRAM

CHEMISTRY

Determination of Pepper Fruit Capsaicin Content by Near Infrared Reflectance Spectroscopy

The possibility of using near infrared reflectance spectroscopy (NIRS) as a rapid screening technique for the determination of the capsaicin content of pepper fruit was studied. Prediction statistics show that NIRS is accurate enough to estimate the capsaicin content of pepper fruit. The correlation coefficient (R^2) and standard error of prediction (SEP) between the NIRS method and the high performance liquid chromatograph (HPLC) method was 0.91 and 0.85, respectively. A good linear relationship was also observed between the routine colorimetric procedure and NIRS. However, the NIRS approach, calibrated by the colorimetric procedure, may overestimate the capsaicin content in pepper fruit due to the lack of specificity of the colorimetric method used.

Effect of Methionine on Mungbean Sprout Properties

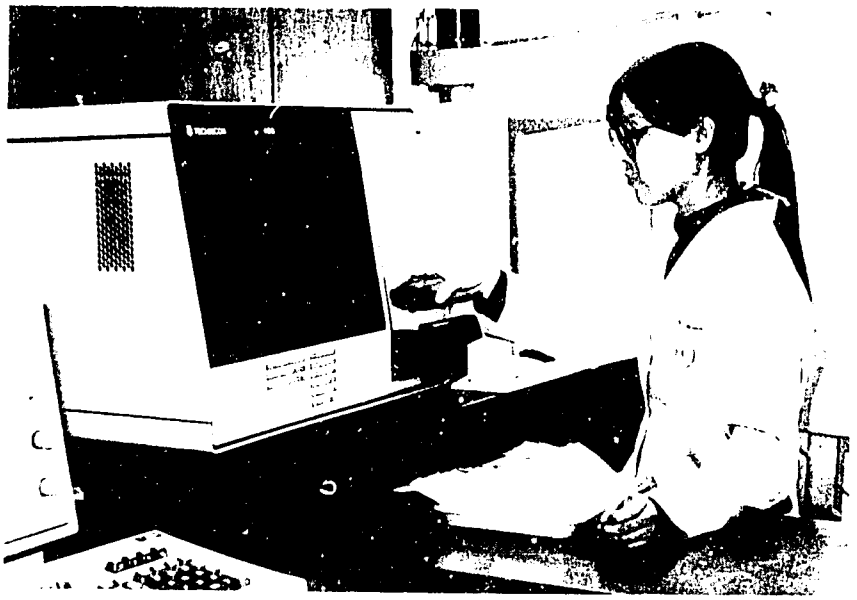
The effect of applying methionine in the soaking water solution during mungbean sprout production was studied. The methionine treatment enhanced the length of hypocotyls but not the diameter and root length. Treatments under different concentrations indicate that the effect of methionine leveled off above 1,250 ppm.

Compositional Analysis of Vegetable Soybean

Near infrared reflectance spectroscopy (NIRS) was found to be a reliable technique to determine moisture, protein, fat, fiber, starch, sugar and ash content in vegetable soybean. Gas chromatographic analysis suggested that most of the volatiles in vegetable soybean are so called 'beany flavor' compounds. The major volatiles identified are n-hexanal, 1-octen-3-ol furfural and trans-2-cis4-decandienal. The free amino acid content in vegetable soybean seeds was found to be much higher than in mature seeds. Glutamic acid is the dominant free amino acid and it contributes 0.38% of the total fresh weight. It is suggested that, in addition to sugars, this amino acid may make a significant contribution to the eating quality of vegetable soybean.

Estimation of Vegetable Soybean Hardness

Texture is an important attribute of the sensory quality of food and considerable research has been undertaken to develop methods for measurement of food texture by instruments. The texture of vegetable soybean can be expressed by the seed hardness at the first bite. Regression studies demonstrate that physical properties can be predicted by near infrared reflectance spectroscopy (NIRS). The R^2 and SEP between hardness of cooked beans and predicted values by NIRS using uncooked beans was 0.91 and 0.24, respectively. This result indicated that the hardness of vegetable soybean can be estimated simultaneously with determination of the chemical composition by NIRS using the same sample.



Near infrared reflectance spectroscopy is proving to be a useful analytical tool.

CROP MANAGEMENT

Improvement of Harvest Efficiency of Processing Tomato

Previous trials have shown that ethrel was the most effective growth regulator for enhancing the ripening of tomato. This experiment utilized two processing tomato varieties (UC 82 and PT 4121) of uniform maturity and three different cultural management practices (spacing, plant population and rate of fertilizer application) and concentration of ethrel to study their harvest efficiency by hand and machine. The ethrel treatments showed a 20% to 30% higher rate of uniform maturity than the traditional management check and; ethrel plus mechanical harvester saved the most amount of labor.

Vegetable Soybean Plant Density

Plant density influenced the growth of vegetable soybean by reducing plant height, increasing branch number, plant dry weight and leaf area with wider spacing. The optimum density for AGS 292, G 9053 and G 10134 was around 26-27 plants/m^2 (15 x 50 cm) in both spring and fall seasons. Pod quality, such as percent of graded pods, pod color, sugar content, etc. was not affected by plant density. G 10134 yielded less than AGS 292 because of the poor pod quality (percent of graded pod) obtained by the former in fall and the greater number of pods produced by the latter in spring.

CROPPING SYSTEMS

New Vegetables

This continuing project gathers information on tropical vegetables for AVRDC's nutrition garden project, cooperative programs and for the Center's international cooperators. The second set of 15 new vegetables was selected in 1986. A total of 606 varieties of these crops had been collected through December 1989. Observational trials of broccoli, eggplant, onion and spinach and advanced yield trials of broccoli and eggplant were conducted during 1989. Fifteen entries each of broccoli, eggplant and spinach and 18 of onion were selected based on their yield potential and other horticultural characteristics. They will be included in advanced yield trials for further confirmation and nutritional studies. Two broccoli entries, BR No. 13 and No. 441, and two eggplants, F 100 and Nite King, performed consistently well in these trials. The major production constraints observed were diamondback moth (*Plutella xylostella*) and black rot (*Xanthomonas campestris* pv. *campestris*) on broccoli, bacterial wilt (*Pseudomonas solanacearum*) on eggplant, purple leaf spot (*Alternaria porri*) and bolting on onion, and downy mildew (*Peronospora spinaciae*), Sclerotinia rot (*Sclerotinia sclerotiorum*) and flowering on spinach.

Garden Program

AVRDC is developing an '**expert system**' for crop selection by utilizing information from the garden research on individual crops and the possible interactions between crops. The characteristics from 102 varieties of 42 vegetables which might be used in the garden design have been recorded from the school and home gardens and placed in the computerized Tropical Vegetable Data File (TVDF) during 1989. The nutrient contents of the varieties were analyzed and the nutrient production on a garden basis was calculated. Similar data were also collected from 89 varieties of 32 vegetables under the noncirculating hydroponic system to evaluate their adaptability for this urban garden system in 1989. These data were compiled in an application form used for choosing a crop (or variety) for a particular cropping pattern, locality or purpose. Results from the urban garden system (hydroponic) indicated that the low yield of vegetables under this system during summer might be partially attributed to poor root development.

Intercropping of Sweet Potato and Legumes

This study evaluated leguminous crops and their relative planting times to sweet potato to increase the productivity of sweet potato-based intercrop plantings. Two soybean varieties (AGS 66 and AGS 129), one vegetable soybean (AGS 292), and one mungbean (VC 3890A) were intercropped with sweet potato (TN 67) on two relative planting dates in late spring. The results indicated that genotype and relative planting date of legumes have significant effects on sweet

potato and combined yield. Planting legumes nine days after transplanting sweet potato substantially reduced the competition from legumes to sweet potato. Mungbean was the only legume dominated by sweet potato among the entries due to its slow initial growth. On the other hand, mungbean was more suitable to be intercropped with sweet potato than the other legumes because the sweet potato yield was less affected by mungbean. However, results of the combined yield indicated that this late spring season planting, which starts in cool, dry and ends in hot, humid conditions, is less suitable for the sweet potato-legume intercropping compared to other season plantings. To maximize the yield advantage of intercrops, suitable genotypes and the appropriate relative planting time need to be identified. However, the total growing duration of this 'relay' intercropping (in which the two component crops are not planted on the same day) should be considered from the cropping systems' point of view.

Relationships Between Soybean Yield and Environmental Factors

It is important to understand crop-environment relationships to identify suitable production areas and seasons, and also to fit suitable crop varieties into existing cropping systems. This kind of information can improve the efficiency of adaptation research by the national agricultural research systems (NARS). This project, therefore, established a working model for collecting this type of information to overcome the difficulties in studying location-specific problems at an international agricultural research center (IARC). A network was set up in cooperation with the Hualien, Kaohsiung, Tainan, Taitung and Taoyuan District Agricultural Improvement Stations (DAIS), and the Taiwan Agricultural Research Institute (TARI) to identify the main

Harvesting of vegetable soybean which was intercropped with sweet potato.

limiting factors in soybean production in the different regions in Taiwan. The results indicated that a high plant population density of soybean should be maintained in the spring season planting. Increasing the seed number per pod is not an effective manner of genetic improvement of soybean for the spring season planting in Taiwan. In summer, the vigorous-type soybean produced an excessive number of pods which resulted in unfit seeds. The yield of soybean can be improved in summer by lengthening the period from sowing to the setting of first pod. In the autumn season planting, low pod number per plant is a limiting factor of soybean yield. Overall, there is room to improve soybean yield by improving its growth; soybean lines adapted for high population planting is needed. The measurement of light interception was found to be a convenient method to estimate the leaf area index (LAI) as well as plant growth and is suitable for this kind of multilocation and multiseason trial. Soybean quality, in terms of protein and oil contents, was significantly affected by location and season.

Storage, System Analysis and Application of Data Obtained from Cropping Systems Research

This project aimed to develop system analysis methods and a data base for the results from cropping systems studies to assist the development of productive and sustainable cropping systems and was carried out in cooperation with the local national programs. The results from field trials from 1986 to 1988 have been keyed into the computer and analyzed. The performance of soybean in different cropping patterns, seasons and locations was utilized as an example for consideration of incorporating a vegetable component into the existing cropping systems.

ON-STATION TESTING

Cooperative Projects with Local Institutes

Promising AVRDC material and the selected snap bean varieties of new vegetables were tested under different environments in Taiwan in cooperation with the local national program through Regional Yield Trials (RYT). In 1989, AVRDC Chinese cabbage Hybrid 82-156, mungbean VC 3890A and fresh market tomato FMTT 22 were released as Taoyuan ASVEG No. 2, Tainan No. 5, and Taichung ASVEG No. 4, respectively, through this process. AVRDC vegetable soybean AGS 292, which was released as Kaohsiung Selection No. 1 in 1987, occupied 71.9% (2,321 ha) and 65.1% (2,620 ha) of total vegetable soybean acreage in Taiwan in the 1989 spring and autumn season plantings, respectively. Entries which outperformed the checks in the RYT and observational trials during 1988 and 1989 were: vegetable soybean — GC 83008-16 (yield) and GC 83007-7 (quality); mungbean — VC 3738A, VC 3751A, VC 3907A, VC 3901A, VC 3888A and VC

3737A; processing tomatoes — PT 4121, PT 4225 and PT 4287; fresh market tomatoes — FMTT 22, FMTT 33 and FMTT 3; cherry tomatoes — CHT 172, CHT 103 and CHT 105; Chinese cabbage — Hybrid 86-187, Hybrid 86-181 and Hybrid 86-182; snap beans — Wisa and Taichung No. 1; snap peas — Snappy and Taichung Sugar 3B; crisp head lettuce — Summer Gold, Mikado Great 3204, Lagomor INTA and Martha; butter head lettuce — Lattuga Toria S'..; cos lettuce — Corsica, Gallega INTA and Seme Nero; and curled lettuce — Grand Rapid, FM 1559 and Green Wave.

SOIL SCIENCE

Organic Materials for Vegetable Production

To determine the effective utilization of organic matter for vegetable production in tropical countries, information was obtained on the decomposition of organic matter in upland soils in the summer season. The following organic materials — sugarcane compost, cattle dropping compost and organic fertilizers Nos. 1 and 3 — were put in separate net bags together with top soil from an AVRDC upland field, buried in the same field and sampled at intervals. Organic fertilizer No. 1 differed remarkably in contents of total carbon; total and available nitrogen; available phosphorus, potassium, calcium and magnesium; and the electric conductivity in the soil throughout the experimental period. However, further studies on the behavior of both total and available nitrogen — including nitrate nitrogen — using the same materials are required to analyze their decomposition or rates of release in the soil with and without irrigation in both summer and winter.

Organic materials being buried in the experimental field.

Organic Fertilizers, Vegetable Soybean Yield and Quality

Quality considerations are vital aspects of the vegetable soybean crop. This study was conducted in autumn, spring and summer to increase yield with high quality — particularly taste — by utilizing organic fertilizers or compost. Fertilizers had seasonal effects upon soil fertility. Organic fertilizer TF No. 1 seemed to contribute to seed production. However, reverse effects on protein and sugar contents in seed were observed in spring and summer croppings in 1989. The effects on the other items of seed quality require further study.

Effect of Nutrient Compositions on Distribution of Minerals in Chinese Cabbage

A preliminary study was conducted to examine the effects of different nutrient composition ratios upon their distribution in Chinese cabbage plants as well as their relationship to the occurrence of tipburn or internal rot. Chinese cabbage Hybrids 85-216 and 82-46 were cultivated for 35 days after transplanting, using solution culture techniques with potassium, calcium and magnesium at different concentration ratios, together with nitrogen and phosphorus at conventional rates. The growth and yield of both hybrids were affected by the nutrient concentration ratio. The distribution of Ca, even in the midrib of the innermost leaves, was greatly affected by adequate supply of the nutrients, while Ca concentration in the outer blade of unwrapped leaves appeared to be regulated by application of nutrients with suitable composition ratios. However, Hybrid 85-216 was better than Hybrid 82-46 in resistance to tipburn or internal rot. It may therefore be concluded in this experiment that the nutrient supply in proper ratio and variety of Chinese cabbage greatly affect the occurrence of tipburn.

Pepper Tolerance to Varying Soil Moisture Levels

To survey the yield potential and tolerance of crops to varying soil moisture levels, two large-scale sloping beds were constructed in 1988. The yield and tolerance to moisture of 112 pepper accessions were preliminarily examined from August 1988 to January 1989 using these fields. Nine accessions without yield reduction and 7 with 10% yield reduction under higher soil moisture conditions were tentatively considered as or potentially tolerant materials, respectively. However, in terms of yield level, 10 accessions seemed to be acceptable. Further experiments are needed to elucidate further on crop tolerance to varying soil moisture levels.

Soybean Tolerance to Varying Soil Moisture Levels

In another experiment using two large-scale sloping beds, 111 soybean varieties were preliminarily tested for yield and tolerance to varying levels of soil moisture. Ten varieties without reduction in yield and 22 with 10% yield reduction under higher soil moisture condition were tentatively selected as tolerant and potentially tolerant materials,

respectively. However, from the standpoint of yield level 21 varieties seemed to be acceptable. In addition to seed weight, other growth parameters such as the number of pods, number of seeds and total dry matter weight, were considered to be very useful for the evaluation of tolerance to higher soil moisture levels. However, to evaluate more thoroughly the tolerance of vegetables to soil stress due to flooding and drought, further experiments are required, particularly from the standpoint of water and fertilizer management.

Evaluation of Sloping Field Cultivation as a Screening Method

This project surveyed the uniformity in distribution of moisture and nutrients in the sloping bed field to evaluate its applicability as a screening method for flood and drought tolerance. Three Chinese cabbage cultivars were examined for their crop responses under various soil moisture conditions. The distribution of soil moisture was mainly governed by the irrigation piping system and bed height. Moisture fluctuations between pipes were much greater than above pipe. Water had difficulty arriving between pipes at bed heights above 75 cm. To obtain equal moisture distribution, it is suggested that water be supplied directly from the base of the bed, rather than through a piping system. Soil nutrients followed soil water movement. At high bed positions, nutrients accumulated on top soils due to plant uptake and evapotranspiration. At low bed positions, nutrients moved down with water movement and accumulated in subsoils. Judging from yield responses of Chinese cabbage to the moisture gradient in the sloping beds, most moisture regions lay within optimum to adequate ranges for crop growth. Only areas 1 m from the lower bed and 3 m at upper bed were flood and dry moisture regions. It is recommended that terraced beds be utilized for screening crops under soil moisture stress.

Chinese cabbage growing in the sloping bed field.

Distribution of Soil Moisture and Nutrients in Large Sloping Bed Fields

Two sloping bed fields were constructed in 1988 to evaluate the production potential and tolerance of crops to soil stress due to flooding and drought in the tropics. This survey examined the distribution of soil moisture and nutrients in these fields after cultivation of soybean because there seemed to be non-uniform amounts of soil moisture and some nutrients along the contour lines. Preliminary results indicate that the lower sites appeared to fall in the wet soil moisture region, but the higher sites were not dry enough to be under drought conditions.

Continuous Soybean Cropping

Soybean has been cultivated twice or three times a year in spring, summer and autumn on the same land since 1983. Total yield per year of AGS 129 and KS 8 reached 10.6 and 9.0 t/ha, respectively, in 1987. But in the 1988 spring cropping, due to the severe charcoal rot infection in all experimental plots, yields were considerably decreased to 4.3 and 3.3 t/ha for AGS 129 and KS 8, compared with those of 1987 spring, i.e. 4.7 and 4.6 t/ha for AGS 129 and KS 8, respectively. Yield of the spring cropping in 1989, compared with that in 1988, was almost the same for AGS 129, but was slightly increased to 3.7 t/ha for KS 8, which was again infected partly with charcoal rot.

Effect of Different Nitrogen Concentrations on Growth of Tomato Using Kyowa Hydroponic System

The Kyowa nutrient circulation hydroponic system was utilized to examine the effects of continuous application of nitrogen on the growth and fruit production of a tomato plant. Tomato plants of a Japanese cultivar, Bestom, were grown with nutrient solutions containing nitrate-nitrogen at 60, 90 and 120 ppm levels in winter 1988/89 and were measured for their growth, fruit yield and nutrient contents. The total fruit yield per plant was 5,570 g, 6,235 g and 6,363 g at the nitrogen levels of 60, 90 and 120 ppm, respectively. The N-60 ppm treatment showed no nitrogen deficient symptoms, but the N-90 ppm treatment was found to be most suitable for tomato cultivation by statistical analysis of growth performance and yield production and from the standpoint of resource utilization.

INTERNATIONAL COOPERATION PROGRAM

63

A trainee working on his field plot.

TRAINING

In 1989, 113 training participants were enrolled at AVRDC under six categories of training. These trainees constituted an aggregate training time of 419 man months or 35 man years. When the participants are grouped into the three major AVRDC programs, the International Cooperation Program registered the highest enrollment (38%), followed by the Crop Improvement Program (35%) and the Production Systems Program (20%), with the rest going to the support units. Twelve training sponsors, including AVRDC, provided financial support to the 113 training participants. The Japan Shipbuilding Industry Foundation was the biggest sponsor.

The Asian Development Bank, through AVNET, provided financial support for 27 network researchers to participate in short courses in plant protection held at AVRDC headquarters and in participating network centers in Indonesia and Thailand.

With financial assistance from the Japan Shipbuilding Industry Foundation, the Training Office developed training materials; published IMPACT, the trainee newsletter; and evaluated the training activities.

The development of training materials was mainly in the following areas: (1) video tape production, (2) *Vegetable Production Training Manual* (3) slide sets and accompanying booklets. These were all basically new activities in 1989. During the year, video equipment was purchased, a production facility constructed, a video technician hired,

and two instructional video tapes produced. These tapes are: (1) Integrated Pest Management of the Sweet Potato Weevil, and (2) Growing Vegetables Using the AVRDC Hydroponic Method. Another major activity involving almost all AVRDC staff members is the preparation of the *Vegetable Production Training Manual*. The Manual will be ready for distribution in April 1990. To complement the other instructional media used at AVRDC, several slide sets were developed. Their purpose is two-fold: some were developed primarily for use in the Vegetable Production Training Course while others were developed as self-contained instructional packages. All sets will be mass reproduced for wide distribution.

Late in 1989 it was decided to produce small, low-cost, simply worded, generously illustrated booklets dealing with basic concepts in vegetable production. Ten topics had been developed, and presently under preparation. The printing of these booklets is expected in early 1990.

A newsletter, IMPACT, was designed and produced for the former trainees of AVRDC. The newsletter contains mainly short items dealing with simple topics related to vegetable production. An attempt was made in each issue to motivate trainees to respond to the newsletter, thereby reestablishing a linkage with the AVRDC training program. Approximately 50 former trainees responded to each of the first two editions.

A simple evaluation was undertaken daily to monitor the perceptions of the trainees regarding the value of the training lecture(s) given. The information had been useful to the Training Office to quickly learn of what training activities need closer monitoring and attention. This evaluation seems useful for informing the Training Office which lectures are perceived as most useful and most effective. In general trainees in the production course indicated that they found lectures dealing with the various topics of plant protection to be the most useful in their jobs.

AVNET PROJECT

A technical assistance agreement to establish a Collaborative Vegetable Research Program for Southeast Asia (AVNET) was signed in May between the Asian Development Bank (ADB) and AVRDC. AVRDC appointed an AVNET coordinator and each of the four participating countries, Indonesia, Malaysia, the Philippines and Thailand, designated a policy and technical coordinator. The AVNET coordinator and the technical coordinators formed the Program Coordinating Committee. A memorandum of understanding between AVRDC and each of the four participating countries was prepared to implement AVNET.

During 1989 a planning meeting was held for Sub-network 1, Germplasm Improvement of Selected Vegetables. The participants discussed in detail the action work plans, respective responsibilities, training needs and all other relevant aspects required to successfully implement AVNET. Specific training was organized for network participants in pepper viruses and on the anthracnose disease of pepper

The planning meeting of the Sub-network for Germplasm Improvement of Selected Vegetables.

at AVRDC and for bacterial wilt of tomato and pepper at Kasetsart University, Bangkok, Thailand. Other network activities include: Thailand and Malaysia contributed their share of germplasm to the network partners; Philippine collaborators confirmed the presence of the PVY virus with antiserum provided from AVRDC; and a pepper virus literature data base was provided to network participants by AVRDC.

A planning meeting was also held for Sub-network 2, Integrated Pest Management. The participants discussed the work plans, facilities needed, responsibilities of the collaborating network partners, the establishment of benchmark information at the commencement of the project, training and all other matters of common interest to the success of the project and developed action plans and recommendations for follow up. A training program was organized at AVRDC for network participants. Construction of parasite-rearing facilities began in each of the countries. Rearing of some parasites appears to be easy while rearing of others appears to be difficult in the Philippines and Thailand; however, in both countries field release of parasitoids were planned soon. The AVNET coordinator visited both the Philippines and Thailand during 1989.

AVRDC-INDONESIA VEGETABLE RESEARCH PROGRAM

AVNET Activities

Indonesia is one of the four participating countries in the Collaborative Vegetable Research Program for Southeast Asia (AVNET). Initial

activities in the germplasm improvement component consisted in multiplying seeds of four yardlong beans for Malaysia, four cucumbers for Thailand, four tomatoes for AVRDC, and two shallots and three garlics for the Philippines. Three cultivars were received from Malaysia and are being multiplied.

Another activity in the germplasm improvement component is the detection and identification of resistance to diseases caused by fungi and viruses. In initial screening trials some pepper entries which were resistant or moderately resistant to the causal agents of anthracnose, *Colletotrichum capsici* and *C. gloeosporioides* were identified. No pepper accessions showed resistance to *Cercospora capsici*, the causal organism of Cercospora leaf spot. A scientist from Indonesia attended a training course at AVRDC for anthracnose (pepper) and another in Thailand for bacterial wilt (tomato). Forty-seven samples of healthy-looking pepper plants were tested with antisera of CMV, PVY, CVMV and ToMV by ELISA and only 50% were found to be free of virus. In two other tests, the 155 samples from Subang had AMV (103), TEV (58), PVY (44) and TMV (5), and the 94 samples from Brebes showed infection with CMV (65), PVY (35) and TMV (8). In visual tests for symptoms of 16 pepper accessions, none were resistant to CMV or CMV + TEV but three accessions appeared to be immune to TEV, five accessions resistant and three moderately resistant. During the year two Indonesian scientists attended a training course on pepper viruses at AVRDC.

The other major element of the AVNET project is integrated pest management of the diamondback moth (DBM). A larval parasitoid of DBM, *Apanteles plutellae*, and an egg parasitoid, *Trichogrammatoidea bactrae*, were introduced to the Lembang Horticulture Research Institute (LEHRI) where they were successfully mass reared. A preliminary study was begun with *A. plutellae* and *Diadegma eucerophaga* and the results

Participants of the bacterial wilt training course held at the Thailand Outreach Program.

should be useful in setting up a biological control program of DBM in the lowlands. An Indonesian entomologist served as a resource person at the IPM DBM training course at AVRDC and two staff members from LEHRI attended the same course.

AVRDC-KOREA BILATERAL PROGRAM

Chinese Cabbage

To investigate the distribution of turnip mosaic virus (TuMV) strains in Korea, 270 samples from 130 locations were collected and sent to AVRDC for assistance in identifying the virus strain(s). As the first step in the breeding program for TuMV resistance, 11 crosses were made between Korean inbreds and the 0-2 cultivar which had been found resistant to all five known strains of the virus by AVRDC virologists. The backcross method will be employed for further manipulation of the materials.

Mungbean

In 1989 the Crop Experiment Station introduced 50 breeding lines from AVRDC for a preliminary yield trial (PYT) and 20 lines from the IMN. In the PYT, all lines tested showed low yield, compared to the check variety, Seonhwanogdu. Six breeding lines yielded more than 80% over Seonhwanogdu and had comparatively good seed coat quality. Considering several important characteristics, VC 4530-C and VC 4169 were the best entries. In the IMN, 7 breeding lines yielded 15% more than Seonhwanogdu. In this trial the yield of the check was unusually low because of excessive soil moisture. Considering several characteristics, VC 2768-A, VC 2991-A and VC 3902-A were comparatively desirable. However, almost all AVRDC breeding lines were late maturing, sensitive to lodging and large seeded, whereas, Korea needs mungbeans which have early maturity, a short flowering period, disease and lodging resistance, and small and lusterless seed.

Pepper

A total of 489 anthracnose isolates were collected from 213 areas throughout the country for identification of the pathogen species. Results showed that 485 isolates were *Colletotrichum gloeosporioides* and the remaining 4 isolates were *C. dematium*. This confirmed that anthracnose of pepper in Korea is caused mainly by *C. gloeosporioides*.

Some 500 accessions of pepper were introduced from AVRDC. About 200 of the accessions were multiplied in 1989 and a part of the multiplied seed will be sent back to AVRDC when processing is finished. Most of the multiplied accessions were screened for resistance to two isolates of *Phytophthora capsici*, two races of *Xanthomonas campestris* pv. *vesicatoria* (Races 1 and 3), *C. gloeosporioides* and TMV-T. Three accessions were found resistant to both isolates of *Phytophthora capsici* and one accession was resistant to both races of bacterial leaf spot, while 10 and 3 accessions were resistant to TMV-T and anthracnose, respectively.

Tomato

Two processing tomato cultivars, TN3 and TM103, were evaluated in three different locations: Suwon, Taegu and Chunchon. TN3 performed very well in 1988, but the yield level of both entries was disappointingly low in 1989, compared to the check variety, Jinhong.

A total of 50 cherry tomatoes were grown for preliminary evaluation. Some promising lines showed a yield potential of 60 - 80 t/ha and fruiting ability of 250 or more fruits per plant. They showed a wide range of variation in fruit size, sweetness and acidity. Some lines selected will be further evaluated in replicated trials in 1990.

AVRDC-MALAYSIA MARDI VEGETABLE RESEARCH PROGRAM

Chinese Cabbage

A yield trial was conducted at four locations representing different soil types. Great Sun had the highest yields at 19.9 t/ha, 17.8 t/ha and 16.2 t/ha in coastal sand, peat and alluvial soil, respectively. AVRDC Hybrid 82-156 performed better in peat soil (17.3 t/ha) than in alluvial soil (15.6 t/ha) and coastal sand.

Control of Diamondback Moth on Cabbage

Studies on population dynamics of the diamondback moth (DBM) indicated that the population is high during the drier months than the wet months. DBM mortality in the wet months is mainly due to diseases of the larvae caused by fungi, bacteria and virus and the larval parasites, *Apanteles plutellae* and *Diadegma eucerophaga*.

Other studies showed that the DBM has already acquired resistance to insect growth regulators (teflubenzuron, chlorfluazuron and diflubenzuron), synthetic pyrethroid (cypermethrin) and an organophosphorous compound.

The IPM trial showed that insecticide application on a prophylactic basis is not necessary when the DBM population is low. However, an IPM approach is required when the population is high.

Processing Tomato Yield Trial

Fifteen processing tomato varieties were tested against local check, MT 1, at the Jalan Kebun Peat Research Station. Two AVRDC lines, PT 4098 and PT 4026, were the highest yielders, although their yields were not significantly different from the check.

This AVRDC fresh market tropical tomato significantly outyielded the check.

Fresh Market Tomato Yield Trial

Eighteen fresh market tomato varieties were tested for yield against local check, MT11, at the Jalan Kebun Peat Station. Four AVRDC lines, viz. FMTT 94, FMTT 104, CLN 5915-206D4-2-1 and CL 5915-209D4-2-2, showed potential although only FMTT 94 significantly outyielded the check.

Soybean Varietal Evaluation

An advanced yield trial was conducted at Serdang to evaluate the performance of nine promising soybean varieties against the local check, Palmetto. Duocrop (3,219 kg/ha) and 7507-38-4 (3,089 kg/ha) significantly outyielded the check (2,118 kg/ha).

Soybean Under Saturated Soil Condition

Varietal evaluation under saturated soil conditions was conducted during two seasons. The results indicated that 7521-26-1, Guntur, Duocrop and Palmetto have the potential of producing very high yields. Of these, 7521-26-1 was the most stable in yield performance and had better seed quality. A mechanized trial was conducted as a follow-up and variety 7521-26-1 produced an estimated yield of 2.03 t/ha.

Vegetable Soybean Varietal Evaluation

The performance of two vegetable soybean lines was evaluated for another season at the Jalan Kebun Peat Station. GC 81083-63 produced a higher green seed yield (6.8 t/ha) compared to AGS 190 (4.7 t/ha). However, the seed size of GC 81083-63 was smaller than that of AGS 190. Both varieties were found acceptable in terms of taste.

Mungbean in Rotation with Corn

Data from four seasons indicated that mungbean is suitable for rotation with grain corn. Mungbean yields of 2-3 t/ha were obtained without the yield of grain corn being adversely affected.

Hot Pepper Yield Trial

A total of 25 accessions of chili from AVRDC were tested against local check varieties, MC 4 and MC 5, at the Jalan Kebun Peat Station. Only accession C 00551 produced a significantly higher yield than the two check varieties. This accession also has the desired fruit type and other agronomic traits popular among consumers in Malaysia.

Anthracnose-Resistant Hot Pepper

Previously conducted studies indicated that all 'cili padi' varieties (not necessarily *Capsicum frutescens*) were resistant to anthracnose caused by *Colletotrichum capsici* and that fruits with smaller size and high capsaicin content had higher tolerance to anthracnose. The resistant factors from 'cili padi' and also from a Mexican source have been successfully incorporated into susceptible cultivars. Currently, 68 resistant breeding lines are being screened at Jalan Kebun Peat Station to identify lines that are acceptable to commercial growers.

Viruses of Hot Pepper

Rigid screening of germplasm collection had identified 34 genotypes that are resistant to chili veinal mottle virus (CVMV) and another 27 genotypes that are resistant to cucumber mosaic virus (CMV).

Two different CVMV-resistant genes, one from local 'cili padi' and the other from Mexico, had been successfully incorporated into susceptible cultivars. The resistant breeding lines are now being tested at the F_7 generation to identify superior lines for further crossing to incorporate the CVMV-resistant gene.

Preliminary studies on the effects of CVMV and CMV on chili MC 4 and MC 5 revealed that MC 4 is more tolerant than MC 5 to CMV infection. When both cultivars were infected a month after sowing, yield reductions were 11% and 40% for MC 4 and MC 5, respectively. However, the two cultivars did not differ significantly in their tolerance to CVMV. When infected with CVMV, the yield of both cultivars were reduced by about 30%. Generally, a mixed infection by both viruses resulted in greater yield loss than by a single infection.

AVRDC-PHILIPPINE OUTREACH PROGRAM (POP)

Chinese Cabbage Preliminary Yield Trial

During a dry season PYT trial of seven AVRDC entries and checks Reyna Elena (HT) and B-40 (HS), comparable yields of 19.2 to 24.8 mt/ha were obtained for five entries compared to the highest yielding check, Reyna Elena (25.03 t/ha). During a wet season trial there was no significant difference in marketable yields among entries and Reyna Elena which obtained the highest yield of 17.43 t/ha.

Chinese Cabbage General Yield Trials

Further evaluation trials were conducted on three promising selections during the dry and wet seasons to reconfirm their yield potentials over the check. Hybrid 85-216 obtained the highest yields of 23.9 t/ha and 16.05 t/ha during the dry and wet seasons, respectively. No significant difference was observed during the dry season. However, during the wet season, all test entries significantly outyielded the check Reyna Elena (10.94 t/ha).

AVRDC Mungbean Breeding Lines

Promising selections identified in previous years were planted for further selection and evaluation under local agroclimatic conditions. Of the 33 selected lines, only VC 4140-B-5, VC 4140-B-4 and VC 4140-B-1 — with yields ranging from 1,196 to 1,243 kg/ha -- outyielded the check, BPI-Mg7 (1,192 kg/ha). Twenty-two lines were selected for inclusion in the PYT next season.

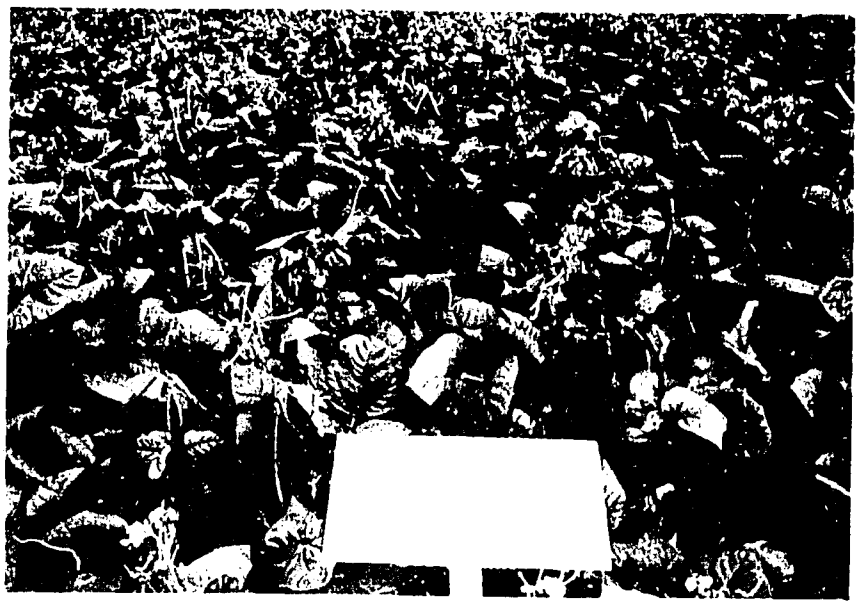
Mungbean Preliminary Yield Trials

The study was conducted to identify mungbean lines with high bean yield potential, desirable agronomic characters and disease resistance, particularly Cercospora leaf spot (CLS) and powdery mildew (PM). Among the 20 entries of Set I, although VC 3530-B-1-1 (1,250 kg/ha) and VC 3560-B-4-4 (1,171 kg/ha) surpassed the yield of the check Pag-asa 5 (1,159 kg/ha), the difference was not significant. The average yield for all entries was 1,006 kg/ha.

The average yield was only 672 kg/ha for the 18 entries in Set II. Although 10 entries outyielded the check, the differences were not statistically significant. Slight infection of CLS was observed during the maturity stage of the crop.

Mungbean General Yield Trial

This study was designed to further screen and select PYT lines for yield potential, adaptability to local agroclimatic conditions and reactions to common pests and diseases. In 1988-89, 40 entries were evaluated



AVRDC mungbean recently released as BPI-Mg9 in the Philippines for famers' use.

in two sets of trials. In Set I, six promising lines produced higher yields than Pag-asa 5 (check). The top yielder was line VC 3982-2B-2-1-1-B. In Set II, eight lines gave higher mean yields than BPI-Mg7 (check). However, only VC 3901-B-4-1-1-1-B, with 1,326 kg/ha, significantly outyielded BPI-Mg7 (1,118 kg/ha). Entry VC 3751-1-B-2-2-B was least infected with CLS.

Mungbean Regional Yield Trial

The RYT is a component of the National Crop Improvement Program and is conducted to determine seasonal and regional adaptability of new strains/varieties of crops. The results from the RYT form the basis for the release of new varieties by the Philippine Seedboard for commercial use. Due to its outstanding performance in the RYT conducted in nine locations throughout the country, AVRDC line VC 2768 (or POP EGM 2768) was released as BPI-Mg9 (commonly known as Taiwan Green) by the Philippine Seedboard for commercial production in May 1989.

Four AVRDC lines were included in the 1988-89 RYT trials. EGM 2768 and EG 2307 performed better during the wet season and EGM 2762 during the dry season than the check, BPI-Mg5.

International Mungbean Nursery

Twenty entries were tested in the field for their performance under Philippine conditions. Results showed that only two lines produced average yields of more than one ton per hectare: VC 3890A yielded 1,098 kg/ha and VC 3737A 1,031 kg/ha. Several lines showed high resistance to CLS.

Soybean Preliminary Yield Trial

The study aimed to evaluate and identify soybean lines with high bean yield potential, resistance to common pests and diseases and other desirable attributes. Nineteen promising accessions/lines from AVRDC and other sources were evaluated during the dry and wet seasons of 1988-89. Line GC 90086 with 1.63 t/ha outyielded the check UPL-Sy4 (1.53 t/ha) during the dry season, but the difference was not significant. During the wet season, PI 7395, with 3.24 t/ha, significantly outyielded the check (2.54 t/ha).

Soybean General Yield Trial

The lines selected from the PYT were elevated to the general yield trial (GYT) to further verify their yield potential, resistance to common pests and diseases and desirable agronomic characters. One of the 18 test entries evaluated during the dry season (AGS 225 with 1.61 t/ha) outyielded the highest yielding check, UPL-Sy4 (1.57 t/ha) but the difference was not significant. During the wet season trial, AGS 147 with 3.45 t/ha significantly outyielded the check, UPL-Sy4 (2.44 t/ha) against two standard checks during the dry and wet seasons. The study was designed to verify bean yield potentials and reactions to major pests and diseases of the promising strains/varieties in the different regions of the Philippines.

Results from the Economic Garden showed that during the wet season, AGS 129 with 3.16 t/ha and LGSY 1-13 with 2.83 t/ha significantly outyielded the highest yielding check, UPL-Sy4 (2.29 t/ha). During the dry season, none of the entries outyielded the check variety.

Sweet Potato Germplasm Collection

A total of 110 sweet potato lines/accessions from local and foreign sources (mostly from AVRDC) are maintained in the station. This collection serves as a source of materials for yield trial studies by POP and other government and private researchers

Sweet Potato Preliminary Yield Trial

Twenty-four AVRDC sweet potato accessions/lines were evaluated in the PYT to identify those with high root yield potentials and other desirable agronomic characters. The check, BPI-Sp2, was a high yielder in both dry and wet season trials.

Sweet Potato General Yield Trial

The GYT is designed to confirm the results of materials selected from the PYT. Results indicated that the check, BPI-Sp2, was still the highest yielder with 61.04 t/ha during the dry season. However, CI 946-25 was also promising with 43.29 t/ha. Both varieties produced sweet potatoes with desirable wide root diameters.

Sweetpotato Weevil Control

This study was conducted to evaluate the effectiveness of using sex pheromone in controlling sweetpotato weevil under local conditions. The use of sex pheromone to reduce weevil population showed great promise. The initial number of male weevils trapped during the third and fourth weeks of the first and second plantings, respectively, was very high and tapered off towards the end of the study. Weevil damage to the tubers at the end of the trial was 18%.

Tomato Single Seed Descent Trial

Seventy lines of determinate and indeterminate fresh market tomatoes were tested during the 1988-89 dry and 1989 wet seasons. The CLN and CHT series produced high average yields of 45 t/ha during the dry season. The unfavorable conditions of the wet season resulted in very low yields of the fresh market tropical tomatoes. A high incidence of bacterial wilt totally destroyed the set of CHT indeterminate types planted in August 1989.

Tomato Preliminary Yield Trial

Among the 66 lines evaluated during the 1988-89 dry season, the CLN series planted in mid-January gave better yields (35.7 t/ha average) than those planted in December. The wet season evaluation of 58 test lines resulted in very low yields due to severe infection of TMV and BW.

Tomato General Yield Trial

Fourteen AVRDC fresh market lines and six processing tomatoes were evaluated during the 1988-89 dry season and eight fresh market lines during the 1989 wet season. Lines CL 5915-197 (G) D4-1 and CL 5915-455 (G) D4-2 significantly outyielded the check, Marikit. Five out of six F_1 processing tomatoes gave yields comparable to the check, Mapula. During the wet season, five fresh market lines significantly outyielded the two checks. Because of their high yield potentials and desirable agronomic characters, lines CL 5915-206 (G) D4-2 and CL 5915-222 (G) D4-0 were included in the 1989-90 RYT for table-type tomatoes.

REGIONAL PROGRAMS

AVRDC-TOP REGIONAL TRAINING AND RESEARCH PROGRAMS

The main objective of the current phase of the Thailand Outreach Program (TOP) is to consolidate and expand training facilities in vegetable production and research. The specific objectives are:

- to develop mobile technology teams through well programmed in-country training workshops in response to the needs of vegetable production and research for countries in the region such as Pakistan, Thailand, Indonesia and/or China;
- to develop and promote home garden/nutrition concepts, their appropriate techniques and training through close cooperation with Thailand's Department of Agricultural Extension.
- to release superior varieties of AVRDC's principal crops to Thai farmers through the Thai national agricultural extension programs; and,
- to continue the AVRDC crop yield trials, cultural practice trials, screening for diseases, insect pests and physiological stresses and garden programs at the Kamphaeng Saen facilities and at selected sites in other regions of Thailand.

Chinese Cabbage

Seed production of Hybrid 62 is promising in the highlands of Chiang Mai. With good management, seeds could also be produced in lowland areas such as the Pakchong Research Station and the AVRDC-TOP field at Kamphaeng Saen. Yields are, however, quite low compared to seed produced in the highlands.

Seeds of Hybrid 62 produced in three different locations in Thailand produced smaller seedlings than the ones from AVRDC seeds. However, there were no differences based on source in the performance of seedlings after transplanting.

Self-incompatibility of parental lines used was broken with the spraying of a 2% NaCl solution during flowering. The use of NaCl solution was found to be more practical than manual pollination which requires highly skilled labor.

Tomato

The acceptance rating of the newly released AVRDC-TOP varieties Seedathip 1 and 2 is quite high; they currently occupy one-third of the area formerly grown to the old Seeda variety. A new variety named Seedathip 3 will be released soon. Results of the experiments and trials conducted show that this variety has the same yield level as Seedathip 1 and also the same pink fruit color preferred by Thais as Seeda and Seedathip 2.

AVRDC processing tomato line PT 3027 has shown promise and was multiplied for further testing.

Sweet Potato

The varietal trial conducted in 1988-89 indicated that CN 2129-1, CN 1058-10 and AIS 0122-2 have the same yield level as Xushu No. 18 (China's premier variety) and significantly higher yield than the local Thai variety Ungbuay.

Fertilizer studies on sweet potatoes indicated that the optimum nitrogen requirement for CN 1028-15, CN 1489-89 and Ungbuay is 80 kg/ha when grown in Kamphaeng Saen.

A total of 84 sweet potato cultivars are being maintained at the AVRDC-TOP sweet potato genebank.

Pepper

Activities on pepper, being a new principal crop, are mainly on germplasm collection and preliminary yield trials.

Mungbean

The compiled data on studies of different planting dates indicated that the yielding ability and stability of the mungbean crop are high when the crop was sown from September to November and also during the months of February to March if irrigation is available.

AVRDC-TOP, in cooperation with the Chainat Field Crops Research Center of the Department of Agriculture, is testing AVRDC mungbean line VC 1628A in different environments for possible future release.

Soybean

Sixteen selected soybean lines of the KUSL series were evaluated at the TOP field. KUSL 20014, a cross between William and SJ_4, was the highest yielder at 2,533 kg/ha (in 98 days). Other good yielders were KUSL 20010, 20040, 20034 and 20018. All these lines gave higher yields than SJ_4 and NW_1. Furthermore, the KUSL lines were also more resistant to downy mildew than all of the check cultivars.

AGS 129 is now being tried on a commercial scale in the production field by the CP group of companies.

Home Gardens

The data gathered from the home garden trial indicated that the yield of vegetables grown under nets was much lower than those grown in the open, meaning, that fruit-bearing vegetables are not suited for growing under shade.

Seed production for the vegetables commonly grown in home gardens under lowland conditions in the northeast of Thailand was attempted at the AVRDC-TOP field and results are quite promising.

Classroom instruction during the regional training course, TOP.

Seventh and Eighth Regional Training Course

A total of 27 training scholars, 8 Chinese, 3 Nepalese, 1 Filipino, 4 Sri Lankans, 4 Thais and 7 Vietnamese, graduated from the Seventh Regional Training Course on 17 March 1989. The Eighth Regional Training Course (October 1989 to March 1990) comprised of 20 training scholars from China (9), Laos (2), Malaysia (1), the Philippines (1), Thailand (1) and Vietnam (6). This course marked the first participation of trainees from the Lao People's Democratic Republic. They were sponsored by the Government of Switzerland.

Publications

In addition to the Seventh Regional Training Course training report, four technical bulletins and a manual on major diseases of crucifers were published by the program during 1989.

Infrastructure Improvement/Equipment Procurement

The ADB-financed laboratory/storage building complex which houses two laboratories, one technical staff office, one lecture hall and four cold storage rooms was formally dedicated in April 1989. It is presently used by both AVRDC-TOP and the Thai counterparts for their research and training programs. Since initiation of the Thailand Outreach Programs, through ADB assistance, over US$210,000 worth of equipment has been purchased for the program's use.

Germplasm Collection and Distribution

Different planting materials are being collected from countries such as China, Vietnam and Lao PDR and a total of more than 200 kg of seeds have also been distributed to more than 30 institutions in the region through this program.

Other Activities

Assistance is also extended by AVRDC-TOP to the coordination and implementation of different AVRDC programs such as AVNET and the Japan Shipbuilding Industry Foundation training program with Southeast Asian countries.

AVRDC COLLABORATIVE GARDEN/VITAMIN A PROJECT

AVRDC's Vitamin A Gardening Project in Africa completed its first training program in 1989. Sixteen African trainees from Burkina Faso, Mali, Mauritania and Niger attended the training course. The 50-day program covered training in vegetable gardening and nutrition, carried out in both classroom and in hands-on fieldwork. The training was conducted at the project's host institution, the Institut Pratique de Developpement Rural (IPDR) in Kollo, Niger. In written and personal contacts subsequent to the completion of the training program, both training graduates and their employers expressed considerable enthusiasm for the program.

A participant of the training course in vegetable gardening and nutrition held in Niger.

GENETIC RESOURCES AND INFORMATION SERVICES

GENETIC RESOURCES AND SEED UNIT

Germplasm Introduction

A total of 861 new accessions were introduced in 1989. The base collection of 379 accessions of peppers at the Centre for Genetic Resources, the Netherlands (CGN) was transferred to AVRDC. New sweet potato germplasm continued to be introduced into the Asian and the Pacific sweet potato repository at AVRDC, especially from the Pacific island nations. An interesting set of local leafy Chinese cabbage accessions (38), mostly of *Brassica* subsp. *parachinensis*, was donated by the Lembang Horticulture Research Institute (LEHRI), Indonesia. A set of mungbean germplasm was received from the National Board for Plant Genetic Resources (NBPGR), India but most were duplicates of AVRDC's existing mungbean collection.

Conservation

In 1989, 31,617 germplasm accessions were maintained in the Genetic Resources and Seed Unit (GRSU). The base collections in long-term storage totaled 10,258. All mungbean tomato and pepper accessions which have been multiplied were finally packed and put into storage. The original germination test was conducted for all mungbean and Chinese cabbage accessions in long-term storage. The set of 42 Thai sweet potato accessions released from the virus indexing scheme is now stored in both the *in vitro* and field genebank at AVRDC. The *in vitro* sweet potato genebank currently has 979 accessions; only 165 accessions remain to be cultured *in vitro*.

Characterization and Evaluation

A total of 13,158 accessions of AVRDC's six principal crops have been evaluated for morphological and physiological characters. Work was concentrated on pepper and tomato in 1989. Cooperation is on-going with the Pathology Department to screen for anthracnose resistance in pepper.

Documentation

A computerized data management system has been established and is in operation. However, there is a lack of sufficient support for the actual computerization and staff to input data. The *Germplasm Catalog of Mungbean [Vigna radiata (L.) Wilczek] and Other Vigna Species* was published. The characterization method, variation in the collection, passport and description information for the 5,274 mungbean accessions in the AVRDC collection are listed in the catalog. A soybean germplasm catalog for non-USDA accessions is under preparation and is expected to be published in 1990. A sweet potato germplasm catalog will be prepared when the root characteristics are reconfirmed in 1990.

Distribution

A total of 8,959 seed samples of both unimproved germplasm and breeding lines were distributed to collaborators in 77 countries/ territories from throughout the world. Of this total, 8,260 samples were of AVRDC's six principal crops. A total of 2,913 samples were distributed for internal use at AVRDC, mainly for screening for insect and disease resistance.

Improved Distribution Method of Sweet Potato Meristem Culture

The international distribution of sweet potato germplasm is usually hindered by strict national quarantine regulations. AVRDC has adopted the policy to distribute only virus-indexed tissue culture plantlets and botanical seeds to avoid dissemination of sweet potato diseases. The objective of these studies were to improve the transportability of the cultures and to transfer plantlets from tubes to pots. It was found that media with an agar concentration of 0.95% in grooved tubes were the best conserved because the grooves stop the harder media from sliding to the mouth of the tube during transport. The experiment indicated that sweet potato shoot culture grew well in 0.95% agar, and that plantlets were stouter and survived well during transplanting. A new distribution method was formulated for sweet potato tissue culture.

Ability to Store Vegetable Soybean Seed at Different Temperature and Moisture Conditions

The ability to store three vegetable soybean lines, 205, AGS 292 and 305 was studied with AGS 129 as the check. Various storage conditions under three temperatures, i.e. 10°, 20° and 30°C, and three seed moisture contents, i.e. 8%, 10% and 12% were utilized. The objective of this study was to find a commercial storage condition for vegetable soybean seed to be kept between plantings (about a 10-month period). It was found that large-seeded vegetable soybean could be stored equally well for 8 months from 10° to 20°C and at 8% to 12% moisture content as the good storing grain soybean, AGS 129.

Germplasm Recipients 1989

Argentina

AER-Piloto Metan
Universidad de Buenos Aires

Australia

Commonwealth Scientific and Industrial Research Organization (CSIRO)
Department of Agriculture
Pacific Seeds

Bahamas

Ministry of Agriculture, Fisheries and Local Government

Bangladesh

Bangladesh Agricultural Research Institute (BARI)
Bangladesh Institute of Nuclear Agriculture (BINA)
Regional Agricultural Research Station
Seed Multiplication Project

Barbados

Caribbean Agricultural Research and Development Institute (CARDI)

Belgium

Faculte des Sciences Agronomiques de L'Etat

Belize

Belize College of Agriculture
Caribbean Agricultural Research and Development Institute (CARDI)

Bhutan

Applied Research Centre, Yusipang (BNPP)

Botswana

Department of Agricultural Research

Brazil

Estaçao Experimental de Anapolis

Brunei

Sinaut Agricultural Training Centre

Burma

Agricultural Research Institute

Cameroon

Antenne du C.U. Ds a Ebolowa
USAID/UF

Canada

Agriculture Canada

China

Beijing Municipal Academy of Agriculture and Forestry Science
Jiangxi Academy of Agricultural Science

Colombia

Centro Internacional de Agricultura Tropical (CIAT)
Compania Envasadora del Atlantico Ltda.

Costa Rica

Centro Agronómico Tropical de Investigación y Enseñanza (CATIE)
Coalicion Costarricense de Iniciativas de Desarrollo (CINDE)

Denmark

The Royal Veterinary and Agricultural University

Egypt

Aswan Governorate
Faculty of Agriculture

Ethiopia

Agricultural Research Centre
ETH/87/001, FAO
Institute of Agricultural Research
Ministry of State Farms Development

Fiji Islands

Delanoa Nursery
Sigatoka Research Station
Teidamu Central Nursery
Vuda Garden Ltd.

France

Andre Blondeau Selectionneur-Obtenteur
Institut national de la recherche agronomique (INRA)
Verneull recherche

Gambia

Catholic Relief Services/The Gambia Program
Momodou A. Sey
Yundum Experimental Station

Germany, Federal Rep. of

Bayer AG
Biologische Bundesanstalt für Land und Forstwirtschaft
Institut für Angewandte Genetik der Universität Hannover
Lehrstuhl für Gemusebau

Honduras

Instituto Nacional Agrario (INA)

India

Annamalai University
Assam Agricultural University
Bihar Agricultural College, Sabour
Central Agricultural Research Institute
Desai Agricultural Farm
Food Specialties Ltd.
Himachal Pradesh Agriculture University
Horticultural Research Station
Indian Agricultural Research Institute (IARI)
National Bureau of Plant Genetic Resources (NBPGR)
National Research Centre for Soyabean
Navalakha Seed Pvt. Ltd.
Nimbkar Seeds Private Ltd.
Nu Tech Farm
Punjab Agricultural University
Punjab Agricultural University, Regional Research Station
Sakthi Soyas Limited
Sri Venkateswara Hybrid Seeds Co.
Tamil Nadu Agricultural University

Indonesia

Bantul Agricultural Secondary School
Central Research Institute for Horticulture
Directorate of Food Crops Extension
Directorate of Horticultural Production
ESCAP CGPRT Centre
Fakultas Pertanian, Universitas Lampung
Food Crops Extension
Jeff and Ruth Gucker
Kepala Badan Penelitian dan Pengembangan Pertanian
Lembang Horticultural Research Institute (LEHRI)
Malang Research Institute for Food Crops (MARIF)
Metro Agricultural Secondary School
Nabire Junior Technical School
Nganjuk Agricultural Secondary School

P.T. Taninuo Subur Prima
Pematang Raya Agricultural Secondary School
PT Summa Surya
Rantau Agricultural Secondary School
Salatiga Agricultural Secondary School
Sawit Agricultural Secondary School
Sekolah Menengah Teknologi Pertanian Sidenreng Rappang
Sidrap Agricultural Secondary School
Sitiung Agricultural Secondary School
SMT Pertanian Sidrap
Takengon Agricultural Secondary School
Vocational Education Development Center for Agriculture
WUAE Project-UNILA

Iraq

FAO

Ireland

University College

Italy

ENEA
FAO
Sementi Nunhems S.R.L.

Japan

Chiba University
Japan Tobacco Inc.
Kagome Co., Ltd.
Mikado Seed Growers Co., Ltd.
Ministry of Agriculture, Forestry and Fisheries (MAFF)
Nihon Horticultural Production Institute
Snow Brand Seed Co., Ltd.
Sumito Chemical Company
TARC, MAFF
Tokita Seed Co., Ltd.
Tokyo University of Agriculture

Kenya

Egerton University
National Agricultural Laboratories

Korea

CES/RDA
Chungbuk Office of Rural Development Administration
Horticultural Experiment Station
Korea Seed Association
Rural Development Administration (RDA)
Seoul National University

Laos

Project of Integrated Rural Development Sekong/Dakchung, UNDP

Lesotho

PLENTY

Malawi

Bvumbwe Research Station

Malaysia

Agricultural Chemicals (M) Sdn. Bhd.
Agricultural Research Centre, Semongok
Agriculture Research Station
Cawangan Pembangunan Komoditi
Department of Agriculture, Malaysia
Harrisons Malaysian Plantations Berhad
Malaysian Agriculture Research and Development Institute (MARDI)
Stesen MARDI Jalan Kebun

Mali

Section de recherches sur les cultures vivrieres et oleagineuses

Mauritius

Mauritius Sugar Industry Research Institute

Mexico

Centro de Investigaciones Agricolas del Pacifico Norte (CIPAN)
Instituto Nacional de Investigaciones Sobre Recursos Bioticos (INIREB)

Nepal

Khumaltar Agricultural Farm/ NARSC
PVBP Project

Netherlands

Bruinsma Seeds B.V.
Deruiter Zonen B.V.
Zoadunie B.V.

Niger

Faculty of Agronomy
Projet horticole vitamine A en Afrique
USAID/Niger

Nigeria

Ahmadu Bello University
Ministry of Agriculture and Natural Resources
Obafemi Awolowo University

Pakistan

M/S Zaidis International
N.W.F.P. Agricultural University
National Agricultural Research Centre
Nuclear Institute for Agriculture and Biology

Panama

Instituto de Investigación Agropecuaria de Panamá (IDIAP)
Nestlé Panama, S.A.

Peru

Agronomy Department — UNAS
Autoridad Autónoma de Majes
Estacion Experimental Agropecuaria "EL Porvenir"
International Potato Center (CIP)
Programa de Investigación en Oleaginosas
Universidad Nacional de Educacion

Philippines

Agricultural Training Institute (ATI)
AVRDC/POP
Benguet State University (BSU)
Don Severino Agricultural College
Farms Training Center
Hortanova Farm
Institute of Plant Breeding, UPLB
Mariano Marcos State University
National Training Center, BSU
PCARRD
Regional Training Center, Isabela State University
University of the Philippines at Los Baños (UPLB)

Romania

Agricultural Research Station Suceava

Saudi Arabia

Aba-Husayn Development Co., Ltd.
King Faisal University
Ministry of Agriculture and Water

Seychelles

Ministry of Agriculture

Sierra Leone

Rice Research Station, Rokupr

Singapore

Eastreco (Pte.) Ltd.
Sembwang Field Expt. Station
West District Agrotechnology Division

Solomon Islands

Lagoon Farm Enterprises
Chinese Agricultural Technical Mission

Somalia

UNDP/FAO Project SOM/86/018

South Africa

Starke Ayres (PTY) Limited

Spain

Intersemillas, S.A.

Sri Lanka

C.A.R.I.
Department of Agriculture
Development Alternatives, Inc.
Diversified Agricultural Research Project
Eastern University

St. Kitts

Chinese Agricultural Technical Mission

Suriname

Ministry of Agriculture, Animal Husbandry and Fishery

Swaziland

Malkerns Research Station
Ministry of Agriculture and Cooperatives

Taiwan, China

Ace Seed Company
Chiayi Branch, TARI
Evergrow Seed Company
First Seed Company
Fu Jen University
Harvest Farm Magazine
Hualien DAIS
Kaohsiung DAIS
Taichung DAIS
Taiwan Agricultural Research Institute (TARI)
Taiwan Seed Improvement and Propagation Service
Taiwan Seed Improvement and Propagation Station
Taoyuan DAIS

Tanzania

Same District Council
Sokoine University of Agriculture

Thailand

Agricultural Development Research Center in Northeast Thailand (ADRC)
Chiang Mai Field Crop Research Center
Church World Service
Cooperation internationale pour le developpement socioeconomique (CISDSE-PNH)
Department of Agricultural Extension (DOAE)
Department of Agriculture
Field Crops Research Institute
IMC Project Development and Management (Thailand) Ltd.
Indo Swiss Ltd.
Institute of Technology and Vocational Education
Kasetsart University
Mu Ban Suan Nuansri
Nakhon Sawan Field Crops Research Center
Provincial Agricultural Extension Office
Seed Center No. 7
Southern Agricultural Extension Office
Provincial Agricultural Office
TOP/AVRDC
Vegetable Seed Production Section, Seed Center No. 7
Western Regional Agricultural Extension Office

Trinidad and Tobago

Caroni (1975) Limited

Turkey

Tokat Ziraat Fakultesi

United Kingdom

Nottingham University
University of Bath
University of Reading

USA

BHN Research
Cornell University
Dairyland Seed Co., Inc.
DNA Plant Technology Corporation
Harvard University
Heinz USA
Land O'Lakes, Inc.
Mississippi Agricultural and Forestry Experiment Station
Oklahoma State University
Oregon State University
Peto Seed Co., Inc.
Plant Germplasm Quarantine Center, USDA
Rodale Research Center
Texas A & M University
The Ohio State University
University of Hawaii at Manoa
University of Illinois
University of Minnesota
University of Nevada-Reno
USDA
Washington State University

Uganda

USAID

Uruguay

Centro de Investigaciones Agricolas

Vietnam

Hung Loc Agricultural Research Center
University of Cantho

Western Samoa

Office for Tokelau Affairs

Yemen

El-Kod Agr. Res. Center

Zambia

Ministry of Agriculture and Water Development

Zimbabwe

Chiredzi Research Station
FAO
Horticultural Research Centre
University of Zimbabwe

OFFICE OF INFORMATION SERVICES

The Office of Information Services (OIS) reports the following communication activities undertaken for the Center in 1989.

Publication Activities

- Published 19,050 copies of 12 formal publications and prepared 1,959 pages to the camera-ready stage;
- Authored an issue of *Centerpoint* and the *1990 AVRDC Publication Catalog*, compiled the *1988 Progress Report Summaries*, and edited, among others, 6 major documents, 4 issues of periodicals, 10 journal papers, 24 symposium presentations and 20 informal documents;
- Facilitated the publication of nine journal papers of AVRDC scientists and prepared an additional paper for future publication;
- Surveyed the commitments and resources of the other IARC communication units in conjunction with the strategic planning exercise;
- Reviewed the typescript of the *Beanflies of Food Legumes in the Tropics* copublication of Wiley Eastern, Ltd.; and
- Printed 450,000 pages required by 248 internal print requests.

Public Awareness Activities

- Issued four press releases and distributed two others for the CGIAR Secretariat;
- Coordinated press tours by a journalist and a film crew and arranged for a staff member to be interviewed on radio;
- Identified a dozen times that AVRDC appeared in the mass media;
- Represented AVRDC at the second "Public Awareness Association for International Agricultural Research" and served as the channel to provide AVRDC's inputs to the on-going activities of the Association.

Data Bases

- Began to include occupational background and communication information of new mailing list entries and code former trainees and AVNET cooperators to facilitate distribution of special-interest newsletters.

Photographic/Art Services/Composition

- The photographic unit took 21,000 photographic records of the scientific work in progress in over 1,000 separate photographic sessions in the fields, laboratories, greenhouses and studio;
- The art unit drew nearly 350 figures, tables, book and publication cover designs, etc. from 103 requests and assisted in checking the text at all stages of the printing process; and
- In three years since purchase of the typesetting equipment, the composition unit has completed sufficient work to repay the purchase cost of the equipment.

Workshop/Meeting Support Services

- Edited and typeset the *Tomato and Pepper Production in the Tropics* proceedings;
- Prepared the announcement for the Second International Workshop on The Management of Diamondback Moth and Other Crucifer Pests; and
- Provided 120 complimentary copies of publications to AVNET cooperators who attended meetings at AVRDC.

Distribution Activities

- Continued implementation of the program outlined in the 1986 proposal "Towards a Cost-effective Publication Distribution Policy";
- Distributed nearly US$18,000 of complimentary publications to ACP-EC nations and increased substantially the number of publications sent to Africa through the first contribution to the "Publication Distribution Fund";
- Continued to obtain subsidization of the cost of automatic complimentary distribution through a second contribution to the "Publication Distribution Fund";
- Continued to benefit from the reduction of the number of libraries participating in the complimentary repository scheme and the selective dissemination of publications (SDP) to the libraries based on their expressed needs;
- Continued to fully utilize tariffs through publication design techniques to reduce weight, and consolidated mailings; and
- Continued to increase publication sales through the commercial distribution network and promotional activities including prepublication offers, discounts to selected groups, and systematic requests for book reviews. Annual book sales have increased six-fold since 1986 and nearly equaled postal expenditures for publication distribution in 1989.

Publications Available

How to Order

All publications listed below can be ordered from the Office of Information Services (OIS), AVRDC, P.O. Box 205, Taipei 10099. The following list of distributors in the highly developed countries (HDC) and less developed countries (LDC) have many of these publications available for sale in local currency.

The prices quoted below include surface postage. If airmail delivery is required the additional postal charges will be added to the invoice. All charges should be paid with a US dollar check (**payable by a bank in the USA**) made out to AVRDC, or with Unesco coupons.

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Annual Progress Reports

1983 Progress Report. 444 p.
1984 Progress Report. 480 p.
1985 Progress Report. 471 p.
1986 Progress Report. 541 p.
(All issues of Progress Reports cost HDC $20.00; LDC $15.00)

Progress Report Summaries

1985 Progress Report Summaries. 96 p.
1986 Progress Report Summaries. 94 p.
1987 Progress Report Summaries. 98 p.
1988 Progress Report Summaries. 100 p.
1989 Progress Report Summaries. 108 p.
(All issues of Progress Report Summaries cost HDC $7.50; LDC $4.00)

Symposium Proceedings

AVRDC. 1977. Vegetable Technology in Asia. Proceedings of the Workshop on Pre- and Post-harvest. 156 p. (HDC $12.00; LDC $8.00)

Talekar, N.S. and T.D. Griggs (eds.). 1981. Chinese cabbage: Proceedings of the First International Symposium. 489 p. (HDC $25.00; LDC $15.00)

Villareal, R.L. and T.D. Griggs (eds.). 1982. Sweet potato: Proceedings of the First International Symposium. 481 p. (HDC $28.00; LDC $15.00)

Shanmugasundaram, S., E.W. Sulzberger and B.T. McLean (eds.). 1986. Soybean in Tropical and Subtropical Cropping Systems, Revised ed. 485 p. (HDC $25.00; LDC $18.00)

Talekar, N.S. and T.D. Griggs (eds.). 1986. Diamondback Moth Management: Proceedings. 483 p. (HDC $25.00; LDC $18.00)

Shanmugasundaram, S., P. Lastimosa and N. Llemit (eds.). 1987. Soybean Varietal Improvement: Proceedings of the International Workshop. 93 p. (HDC $7.50; LDC $4.00)

Llemit, N.V. and P.J. Lastimosa. (eds.). 1987. Gardening Nutritious Vegetables; Proceedings of the Vegetable Improvement Gardening Workshop. 136 p. (HDC $10.00; LDC $6.00).

Sapin and Grange (trans.). 1988. La Patate Douce: Actes du premier symposium international. CTA, ACCT and AVRDC, Belgium. p. 483. (From the original Sweet Potato: Proceedings of the First International Symposium. R.L. Villareal and T.D. Griggs (eds.) AVRDC, 451 p. (HDC $28.00; LDC $15.00).

McLean, Bruce T. (ed.). 1988. Vegetable Research in Southeast Asia. 242 p. (HDC $17.50; LDC $10.00)

Shanmugasundaram, S. and B.T. McLean (eds.). 1988. Mungbean: Proceedings of the Second International Symposium. 750 p. (HDC $40.00; LDC $25.00)

Green, S.K., T.D. Griggs and B.T. McLean (eds.). 1989. Tomato and Pepper Production in the Tropics. 619 p. (HDC $35.00; LDC $22.50)

Technical Bulletins

TB 1 Menegay, M.R. 1975. Taiwan's specialized vegetable production areas: An integrated approach. 17 p. (HDC $4.00; LDC $3.00)

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TB 3 Calkins, P.H. 1976. Four approaches to risk and uncertainty for use in farm management extension 18 p. (HDC $4.00; LDC $3.00)

TB 4 Calkins, P.H., S.Y. Huang and J.F. Hong. 1977. Farmers' viewpoint of sweet potato production in Taiwan. 44 p. (HDC $5.00; LDC $3.50)

TB 5 Calkins, P.H. 1978. Vegetable consumption in five cities of Taiwan. 24 p. (HDC $4.00; LDC $3.00)

TB 6 Huang, S.Y. and P.H. Calkins. 1978. Summer tomato production in Taiwan. 29 p. (HDC $5.00; LDC $3.50)

TB 7 Huang, K.R. and P.H. Calkins. 1978. Vegetable production in Taiwan; A survey of 300 farmers. 36 p. (HDC $5.00; LDC $3.50)

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TB 15 Green, S. K. 1984. Guidelines for diagnostic work in plant virology. 43 p. (HDC $5.00; LDC $3.50)

TB 16 Caldwell, John S. 1987. Assessing rainy season vegetable production alternatives: A case study in 'upstream' farming systems research. 50 p. (HDC $5.00; LDC $3.50)

TB 17 Opeña, R.T., C.G. Kuo and J.Y. Yoon. 1988. Breeding and seed production of Chinese cabbage in the tropics and subtropics. 92 p. (HDC $7.50; LDC $4.00)

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Hwang, P.L., F.C. Chen and C.C. Wei (compilers.); Saadaoui, M., A.T. Tschanz and J.W. Soderlund (eds.). 1987. Bibliography of Soybean Rust:1895-1986. 103 p. (HDC $7.50; LDC $5.00)

AVRDC. 1988. Disease and Insect Pests of Mungbean and Black Gram: A Bibliography. 254 p. (HDC $17.50; LDC $10.00)

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Choudury, B. 1984. Vegetables and the quality of life in the year 2000. 7 p. (HDC $3.00; LDC $2.00)

Innes, N. L. 1983. Breeding field vegetables. 34 p. (HDC $5.00; LDC $3.50)

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Van der Goot, P. 1930 [translated 1984]. Agromyzid Flies of Some Native Legume Crops in Java. 102 p. (HDC $7.50; LDC $4.50)

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Shanmugasundaram, S., T. S. Toung and L. F. Chen. 1985. AVRDC Soybean Evaluation Trial (ASET) 1980 & 1981. 62 p. (Gratis, limited stock distributed selectively.)

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Tay, D.C.S., Y.K. Huang and Y.L. Chen. 1989. Germplasm Catalog of Mungbean [*Vigna radiata* (L.) Wilczek] and Other *Vigna* Species. 316 p. (Gratis to mungbean researchers and genebank curators.)

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78-63 Park, H.G. 1978. Suggested cultural practices for mungbean. 2 p. (Gratis)

78-64 Park, H.G. 1978. Procedures for mungbean evaluation trials. 4 p. (Gratis)

78-65 Villareal, R.L. and S.H. Lai. 1978. Pollen Collector. 2 p. (Gratis)

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85-234 Kuo, G.C. 1985. Handling of sweet potato germplasm. 2 p. (Gratis)

85-238 Kuo, G.C., S. Lin and S. Green. 1985. Sweet potato germplasm for international cooperators. 3 p. (Gratis)

87-272 Yoon, J.Y., R.T. Opeña and L.C. Chang. 1987. Cultural practices for Chinese cabbage at AVRDC. 6 p. (Gratis)

88-292 Talekar, N.S. 1988. How to Control Sweetpotato Weevil: A practical IPM approach. 6 p. (Gratis) — Chinese edition also available.

Newsletters

Centerpoint — This newsletter of AVRDC provides up-to-date information on research, training, publications, etc. (Gratis)

TVIS News — This journal was prepared by the Tropical Vegetable Information Service (TVIS) through AVRDC. It provided a platform for exchange of

for scientists working with mungbean, soybean and Chinese cabbage. (HDC $4.00/issue; LDC $2.00/issue)

Vol. 1, Nos. 1, 2; Vol. 2, No. 1; Vol. 3, Nos. 1, 2

Soybean rust newsletter — This annual newsletter is published by the International Working Group on Soybean Rust through AVRDC. (HDC US$5.00/issue; LDC US$2.00/issue)

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Program Director: S. Shanmugasundaram***

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Fidel S. Borja, M.S., Research Fellow†

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Elhadj Amadou Cisse, Assistant Scientist‡

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Yung-kuang Huang, M.S., Principal Research Assistant
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Jia-chain Shieh, B.S., Research Assistant†

Information Services

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Norma V. Llemit, M.A., Assistant Information Specialist‡
Cecilia M. Lantican, M.A., Assistant Information Specialist†

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Teng-hui Hwang, B.A., Senior Librarian

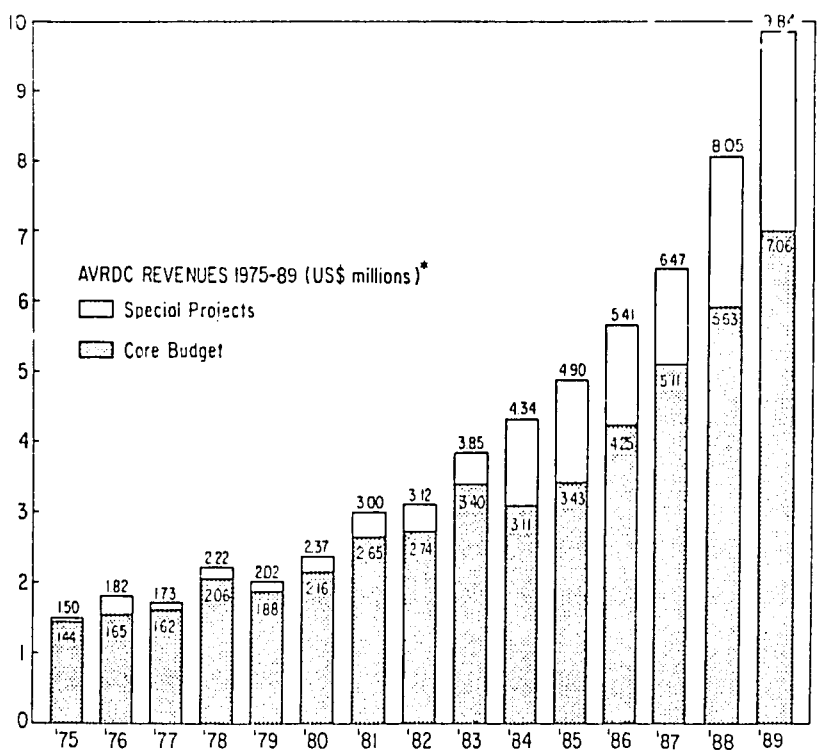
† Arrived during 1989.
‡ Left during 1989.
‡† Reinstated after advanced study leave.
** Promoted in 1989.
*** Acting personnel.

Finances

AVRDC's projected budget for 1989 was US$7,730,000 compared with an actual income of US$9,841,492 and total expenditures of US$9,121,027. In 1989 AVRDC received support from the following:

- the Republic of China
- the United States of America
- Japan
- the Federal Republic of Germany
- the Kingdom of Thailand
- the Republic of Korea
- the French Republic
- the Commonwealth of Australia
- the World Bank

Grants and other forms of assistance were also received from (among others): the Japan Shipbuilding Industry Foundation, the ROC Council of Agriculture (COA), the United States Agency for International Development (USAID), the Asian Development Bank (ADB), the International Development Research Centre (IDRC) of Canada, the OICD/U.S. Department of Agriculture, the German Ministry for Economic Cooperation (BMZ), the German Agency for Technical Cooperation (GTZ) and the Technical Centre for Agricultural and Rural Co-operation (CTA).



* A total of US$ 6.79 million was received for 1971-74 of which US$ 4.2 million was for capital expenditure.

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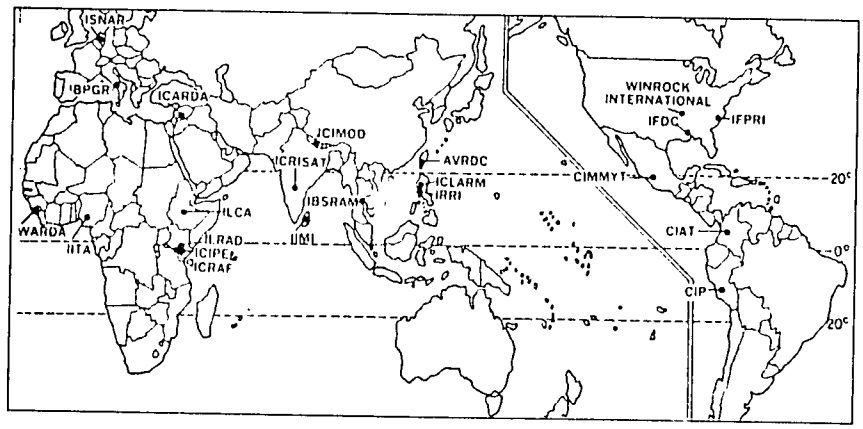
AVRDC is one of the institutions which comprise the informal network of international agricultural research centers (IARC). These IARCs have all been established by international funding agencies and governments to assist agriculture in developing countries.



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