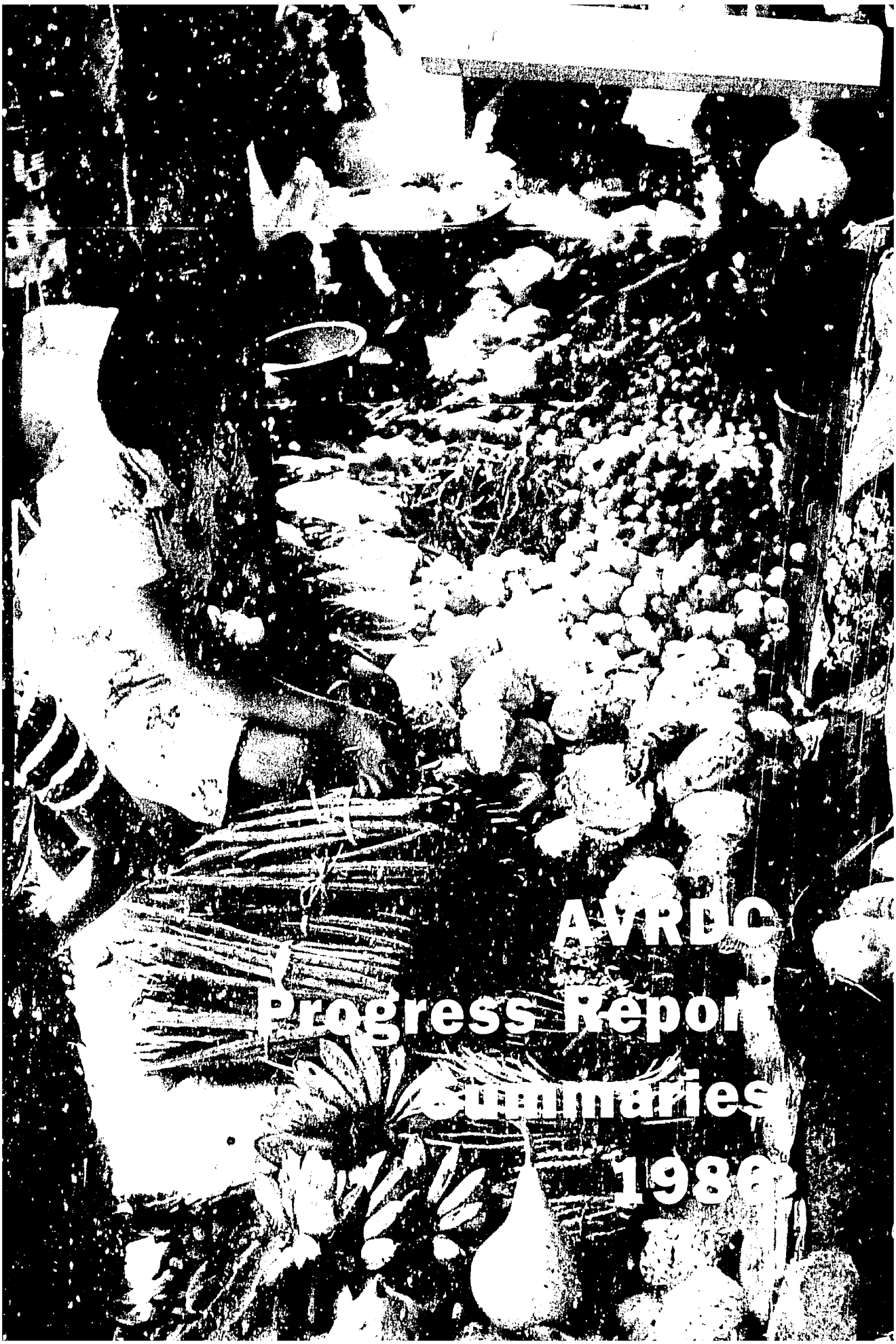

AVRDC Progress Report Summaries 1986

The Asian Vegetable Research and Development Center (AVRDC) is the international center with a mandate 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 scientific publishing.

AVRDC's research and support staff consists of some 370 persons from a dozen countries. The Center's budget, which totaled US $5.62 million in 1986, is provided by the governments of the Republic of China, the United States of America, the Republic of Korea, Japan, the Philippines, Thailand, and the Federal Republic of Germany. Special project funds are provided by a variety of international donors including the Asian Development Bank, the International Development Research Centre of Canada, and the International Board for Plant Genetic Resources.

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

about the cover: Philippine market photographed by John S. Caldwell

AVRDC
Progress Report
Summaries
1986

About this Report

This report provides an overview of AVRDC research in 1986. Readers who would like more detailed information are asked to utilize the attached request card for detailed reports of particular interest. Complimentary reprints of up to five sections of the report can be requested by sending the attached postcard to AVRDC's Office of Information Services. 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 on the following pages.

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Foreword

The AVRDC is committed to helping researchers in national programs improve their research effectiveness on tropical vegetables. The careful planning of projects and adequate review of information programs are often as important as the experimental design selected to conduct the experiment. Researchers need current and comprehensive literature available for their review and guidance. The AVRDC generates bibliographies and provides abstracting services on various subjects and crops, in addition to its research reports and technical publications, as part of this service to research workers.

Research workers at branch stations often have great difficulty in making literature searches. They may have problems to physically reach their headquarters' libraries to do this vital reading. When they arrive, many find large gaps in the publications available, even at major libraries, due to financial restrictions or other reasons. Adequate information for review is a serious problem; what can be done?

There are numerous, very comprehensive documentation services available worldwide. However, costs and mail delays are a general problem. The information is also available on tape or microfiche from many of the institutions which provide abstracting services. National programs can purchase these services, which are usually cost justified in view of improved research effectiveness.

The AVRDC documentation services cover many important topics, e.g. diseases, pests, cultural practices, etc. of AVRDC's six principal crops, and we hope to expand this knowledge pool as rapidly as our resources permit. From AVRDC's abstracting services, researchers can request photocopies of complete scientific articles.

Access to these information sources requires time and money. The development and maintenance of these services now requires an array of specialized personnel, computers, copiers and distributive facilities. Funds are needed for improvement of the research information transfer process. National programs should consider this very important activity as a research cost. Development agencies should treat this need with longer term assistance. The AVRDC will continue to contribute to this knowledge pool as an increasingly important priority.

George A. Marlowe, Jr.

George A. Marlowe, Jr.
Director General

Abbreviations and Acronyms

-ABA - abscisic acid
-ACC - 1-aminocyclopropane-1-carboxylic acid
-ARTT - advanced rust tolerance trial
-ASET - AVRDC Soybean Evaluation Trials
-AVRDC - Asian Vegetable Research and Development Center (IARC)
-AYT - advanced yield trial
-AzMV - adzukibean mosaic virus
-BICMV - blackeye cowpea mosaic virus
-BLS - bacterial leafspot
-BW - bacterial wilt
-CARDI - Caribbean Agricultural Research and Development Institute
-cc - cubic centimeter
-CCC - chloroephyltrimethylammonia acid
-CIAT - Centro Internacional de Agricultura Tropical (IARC)
-CIP - International Potato Center (IARC)
-CIPA II - Centro de Investigación y Promoción Agropecuaria (Peru)
-CIRAD - Centre de coopération internationale en recherche agronomique pour le développement (France)
-cm - centimeter
-CMS - cytoplasmic male sterile
-CMV - cucumber mosaic virus
-CSIRO - Commonwealth Scientific and Industrial Research Organization (Australia)
-CV - coefficient of variance
-DAIS - District Agricultural Improvement Station (Taiwan)
-DAS - days after sowing
-DYT - district yield trial
-EEA - Estacion Experimental Agropecuaria (Argentina)
-EC - European Community
-ELISA - enzyme-linked immunosorbent assay
-EYT - elite yield trial
-FAO - Food and Agriculture Organization of the United Nations
-FMV - feathery mottle virus
-g - gram
-GA - gibberellic acid
-GRSU - Genetic Resources and Seed Unit
-GTZ - German Agency for Technical Cooperation
-GYT - general yield trial
-ha - hectare
-HDC - highly-developed country
-IARC - international agricultural research center
-IBPGR - International Board for Plant Genetic Resources (IARC)
-IDRC - International Development Research Centre (Canada)
-IGR - insect growth regulator
-IICA - Instituto Interamericano de Cooperacion Para la Agricultura
-IITA - International Institute of Tropical Agriculture (IARC)
-IMN - International Mungbean Nursery (AVRDC)
-INTA - Instituto Nacional de Tecnologia Agropecuaria (Argentina)
-IRAT - Institut de recherches agronomiques tropicales et des cultures vivrières (France)
-IRCT - Institut de recherche du coton et des textiles exotiques (France)
-IRRI - International Rice Research Institute (IARC)
-ISABU - Institut des sciences agronomiques du Burundi
-IYT - intermediate yield trial
-kg - kilogram
-LAI - leaf area index
-LDC - less-developed country
-LEHRI - Lembang Horticulture Research Institute (Indonesia)
-LV - latent virus
-m - meter
-MARDI - Malaysian Agricultural Research and Development Institute
-ml - milliliter
-mm - millimeter
-MOA - mungbean leaf-juice oatmeal agar
-NIAR - National Institute of Agrobiological Resources (Japan)
-OP - open-pollinated
-OYT - observational yield trial
-PDA - potato-dextrose agar

-PM - powdery mildew
-PMV - peanut mottle virus
-POP - Philippine Outreach Program (AVRDC)
-ppm - parts per million
-PStV - peanut stripe virus
-PVY - potato virus Y
-PYT - preliminary yield trial
-RCB - randomized complete block
-RDA - recommended dietary allowance
-RYT - regional yield trial
-SMV - soybean mosaic virus
-SSD - single-seed descent trial
-t - metric ton
-TLCV - tomato leafcurl virus
-TMV - tobacco mosaic virus
-ToMV - tomato mosaic virus
-TOP - Thailand Outreach Program (AVRDC)
-TuMV - turnip mosaic virus
-TVIS - Tropical Vegetable Information Service (AVRDC)
-UNHCR - United Nations High Commission for Refugees
-USAID - United States Agency for International Development
-USDA - United States Department of Agriculture
-VIPS - Vegetable International Professional Service (AVRDC)
-V-V - variety-variety
-YDV - yellow dwarf virus

CROP IMPROVEMENT PROGRAM

CHINESE CABBAGE

INTERNATIONAL COOPERATION

Seed Distribution

A total of 2,014 packets of seeds was distributed to 134 cooperators in 44 countries.

International Trials

Australia - The Redlands Horticultural Research Station, Queensland reported that AVRDC open-pollinated (OP) cultivar 77 M(2/3)-41 performed best with less disease and better acceptability characteristics despite heavy rainfall and disease.

Guadeloupe (France) - The high marketable yields of AVRDC Hybrids 58 and 62 of 38.8 and 40.6 t/ha were reconfirmed over the check Tropical Pride (35.5 t/ha) at the Institute national de la recherches agronomiques des Antilles et de la Guyane.

India - AVRDC OP cultivar 77 M(2/3)-43 outyielded all other entrants with 5 .9 t/ha in a summer trial at the Haryana Agricultural University, Hissar.

Kampuchea - Although AVRDC entries did not outperform the other entries in the World Church Service trials outside Phnom Penh, important information such as the need for more compact head and uniform maturity in OPs and tipburn tolerance and earliness in both OPs and hybrids was obtained.

Malaysia - AVRDC OP cultivar 77 M(2/3)-46 with 26.1 t/ha significantly outyielded all other entries in a winter trial at the Agricultural Research Station, Sabah.

Thailand - AVRDC Hybrid 62 outyielded all other entries with 22.9 t/ha in a trial at the Faculty of Agriculture, Suracha, Chonburi. In another trial at the East-West Seed Co., Ltd. AVRDC Hybrids 58 and 80-32 outyielded all seven other F_1s from various sources.

Zimbabwe - In a trial where soft rot infection was high, primarily due to the lengthy 64 to 68 days from transplanting to harvest, AVRDC OPs 77 M(3)-33 and 77 M(2/3)-44 obtained the highest harvest rate and yield.

BREEDING

Heat Tolerance Evaluation

Twenty-seven newly collected Chinese cabbage germplasms were evaluated for heat tolerance and other horticultural characteristics in a summer trial planted on June 30. Nine entries were found to be heat tolerant. They were F_1 hybrids from Japan (1), Korea (3) and Taiwan (5), most showing minimum soft rot infection due to early maturity and the unusually dry weather conditions of the growing period. Yield was as good or better than the check, Hybrid 62, though generally poor in head solidity.

Combining Ability Trials

Ninety-nine F_1 hybrid combinations were evaluated in the early summer season and 40 entries selected therefrom were again tested later in the summer. Nine were selected to be included in the advanced yield trials next year. Four selected entries yielded significantly higher than the check, Hybrid 62, while the other five showed similar yield levels. High-yielding selections showed a more elongated head shape and matured later than the check.

Advanced Yield Trials (AYTs)

Nine previously selected F_1 hybrid combinations were further evaluated in six advanced yield trials. Combinations 85120 and 85216 were selected for their stable high yield and early maturity. Entries 85202 and 85327 were also selected in spite of the late maturity in the former and small head size in the latter, because they showed desirable preference traits for certain target areas. These selections will be included in regional and/or international yield trials.

Uniform Maturity

Open-pollinated cultivars 77 M(3)-27 and 77 M(3)-35 went through the first cycle of maternal line selection to attain more uniform maturity. Head shape and downy mildew incidence were also monitored and considered in selection. One hundred and eight plants from 77 M(3)-27 and 81 plants from 77 M(3)-35 were selected to create the second cycle. Twenty and 15 elite selections were chosen as maternal parents in the former and the latter cultivars, respectively.

Heat Tolerance Breeding for Cylindrical Head Shape

Sixty-one F_3 families from crosses between round-headed heat-tolerant parents and cylindrical-headed heat-sensitive

Selection of Chinese cabbage plants

ones were evaluated in a summer planting in order to first select families homozygous for the single recessive gene which was previously reported to confer heat tolerance. No family, however, showed heat tolerance in all or a majority of the plants, indicating a complicated inheritance mode of this trait. However, similar head shape to cylindrical parents was frequently observed in the fall planting, which included 18 families selected from the former. Seventy plants with early maturity and desirable head shape were selected from seven families in the early fall planting to be used in the backcross to restore heat tolerance.

CMS Backcross Program

Cytoplasmic male-sterile (CMS) backcrosses to tropical Chinese cabbage were observed on recovery of horticultural traits and elimination of the defects related with CMS such as chlorosis, poor nectar glands and abnormal flowers.

A considerable variation in vegetative traits was observed in both B. juncea-derived and radish-derived CMS families, although variation was less in the latter. A similar trend was observed for chlorosis at the vegetative stage.

The majority of radish-ex. CMS plants which were preselected for better traits and less defects at the vegetative stage showed no or slight chlorosis at the flowering stage, while it was still regularly observed in B. juncea-ex. CMS families with a few exceptions. Petal size was very small in B. juncea-ex. CMS plants, while it was 50% to 90% of the normal flower size of the recurrent parent in the other source. Nectar gland development scores were generally higher from mustard than radish origin. Nectar secretion was regularly observed in the selected plants of the families 85W21 (radish CMS with CT1-32 as recurrent parent) and 85W53 (mustard CMS source with CT1-56 as recurrent parent).

A total of 14 and 21 plants was selected for their superior characteristics from radish-ex. and mustard-ex.

CMS families, respectively, to be used in further backcrosses and/or developing F_1 hybrids.

CO_2 Treatment

CO_2 treatment effect on temporary breaking of self-incompatibility was studied using five tropical Chinese cabbage inbreds under AVRDC's winter-spring conditions. Results are summarized as follows:

1. CO_2 concentration of 2% was high enough to result in the number of seeds per open-flower self-pollination to be comparable to that of per bud pollination in PL-1, while 3% or higher was needed in WW and B-18. One inbred, FL-9, did not show an increase in seed number per open-flower self-pollination by CO_2 treatment.

2. Two to three hours of CO_2 treatment seemed to be long enough to break self-incompatibility of inbreds sensitive to CO_2.

3. Treatment initiated immediately after pollination showed the highest number of seeds per pollination, and thereafter gradually decreased.

4. Pollen tube number counted in the style after open-flower self-pollination was increased by CO_2 treatment.

ENTOMOLOGY

Influence of Sprinkler Irrigation on Diamondback Moth Infestation

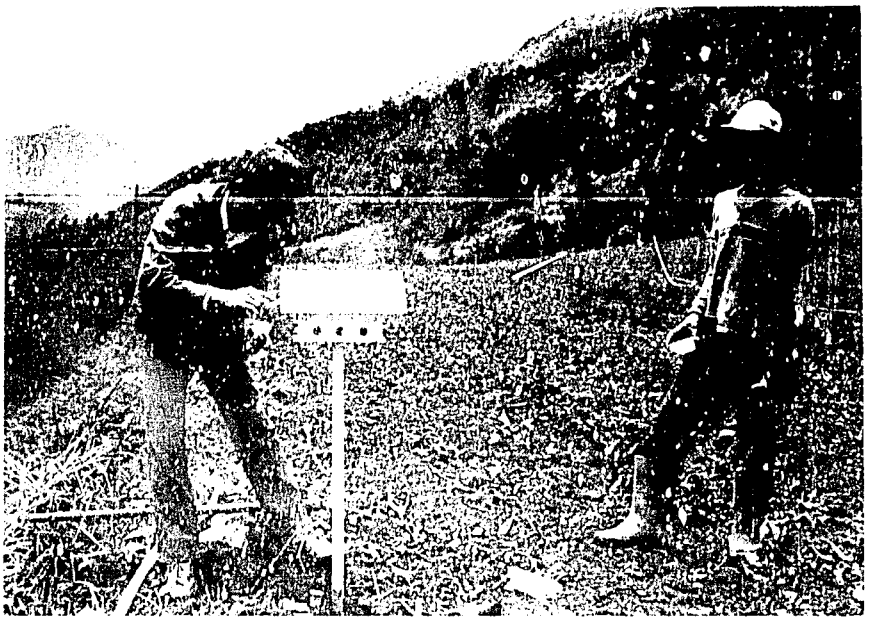
The effectiveness of two sprinkler methods in reducing diamondback moth infestation of common cabbage was compared in a field experiment. Overhead sprinkler irrigation performed at dusk reduced diamondback moth infestation. Sprinkler irrigation reduced mating and oviposition, which probably contributed to reduced infestation.

Biological Control

Attempts were made to control diamondback moth in farmers' fields in Luchu township by the use of two larval parasites: Diadegma eucerohaga and Apanteles plutellae. Diamondback moth is a serious pest of crucifers in Luchu and indiscriminate insecticide use has resulted in insects becoming resistant to all insecticides. Parasites gave satisfactory control of diamondback moth where effectiveness of synthetic organic insecticides was nil or minimum. Insecticide costs were reduced by more than 50% without any loss of yield.

Biological Control on Wuling Farm

Between May and October 1986 two diamondback moth larval parasites were released in large numbers with the



Diamondback moth parasite release house in farmer's field, Weling Farm

purpose of controlling this pest without using costly, toxic, chemical insecticides on a 17 ha area planted to cabbage. Throughout the season the diamondback moth population was maintained below damaging level. Only Bacillus thuringiensis was used to control other caterpillar pests and occasional spurts of diamondback moth. The insecticide cost was reduced by over 60% compared to the cost incurred in each of the preceeding two years.

Chemical Control

Newly discovered insect growth regulators (IGRs), B. thuringiensis formulations, and organic insecticides were screened for diamondback moth and aphid control. Among the newly introduced IGRs, CME 134, IKI 7899, PH 70-23, BAS 166801, BAS 178500 and a crystal toxin formulation of B. thuringiensis gave good control of diamondback moth. None of the IGRs controlled aphids satisfactorily. Pirimicarb, dimethoate, and prothiophos continued to give good control of aphids.

Common Cabbage and Cauliflower Resistance

Cauliflower accessions NYIR314 and cabbage accessions NYIR116 and NYIR128 were consistently less damaged by diamondback moth. In a resistance mechanism study, two cauliflower accessions, NYIR315 and 412-1379, showed antibiosis to diamondback moth. Survival of larvae and fecundity of insects on these entries was significantly reduced. These entries represent important sources of resistance to breed other crucifers such as Chinese cabbage with resistance to diamondback moth and possibly other caterpillar pests.

Turnip mosaic virus on Chinese cabbage

PATHOLOGY

Resistance Screening Method Improvement

Past screenings of germplasm and breeding lines for TuMV resistance have noted inconsistent infectivity. Several methods to improve the screening method were tested, such

as pre-inoculation vernalization and dark treatments, different inoculation times for inoculum production and frozen storage of inoculum. Neither of the pre-inoculation methods resulted in a consistently higher infectivity. Inoculum preparation, however, affected infectivity, with inoculum produced in December and September resulting in highest infectivity. Frozen storage reduced infectivity considerably and it is not recommended to use inoculum frozen for longer than two months. Inoculum dried over $CaCl_2$ maintains good infectivity for at least six months. Leaf disks did not prove to be useful for TuMV (turnip mosaic virus) resistance screening.

Screening for Resistance

TuMV is one of the most commonly encountered viruses on Chinese cabbage in South and Southeast Asia. Five strains have been isolated from Brassica sp. in Taiwan. Some of AVRDC's new germplasm and breeding lines have been screened for resistance. Only two breeding lines were found with resistance to all five strains.

PHYSIOLOGY

Root System and Water Uptake of Chinese Cabbage

Water uptake by different sections of the root system in Hybrid No. 62 was examined. More than 70% of water consumed by Chinese cabbage plants was taken up by the top 10 cm of the root system, indicating the importance of the root system near the soil surface to ensure proper water management and cultural practices.

MUNGBEAN

INTERNATIONAL COOPERATION

Seed Distribution

A total of 2,782 seed packets was distributed to 103 cooperators in 45 countries.

Crop Releases

Indonesia - AVRDC cultivars VC 1160-C and VC 1163-A were officially released as "Gelatik" and "Walet" because of their repeated high yields, resistance to Cercospora leaf spot, moderate resistance to powdery mildew, uniform maturity and nonshattering quality.

Philippines - The Philippine Seedboard officially released AVRDC cultivar VC 2764-A, renaming it "BPI mg4", because of its high yield, early and uniform maturity, resistance to lodging and mungbean mottle virus, and moderate resistance to powdery mildew and Cercospora leaf spot.

Vietnam - The University of Cantho, Haugiang released AVRDC cultivars VC 2768-A and VC 2763-A, renaming them "DX 102a" and "DX 113", respectively, because of their high yield, resistance to local diseases and tolerance of difficult soils along the Mekong Delta.

International Trials

IMN - The 13th International Mungbean Nursery Trials (IMN) consisted of 14 AVRDC breeding lines and six selected national cultivars. A total of 41 sets was distributed to 37 cooperators in 25 countries and data was received from 20 cooperators from 17 countries. Results clearly indicated that the yield potential of the mungbean lines was mostly influenced by the environment rather than the genotype. AVRDC cultivar VC 2768-A has continuously produced the highest average yield (1,123 kg/ha) for the last three years in the IMN. The yield of AVRDC breeding lines was 24.3% higher than the selected national cultivars.

Nigeria - IITA reported that AVRDC breeding lines VC 2768-A, VC 1973-A and VC 2778-A yielded from two to three times more than the local check.

Peru - The Centro de Investigación y Promoción Agropecuaria (CIPA II) reported that seven AVRDC breeding lines performed well with large seeds, flowering between 40 and 43 days after planting, and yields over 1 t/ha.

BREEDING

Mungbean Production Survey

To elucidate the current status of world mungbean production problems, 49 cooperators from 28 countries participated in a survey. The results indicated that the Asiatic legume, mungbean, has become popular in Africa, the USA and South America. A majority of the participants indicated that diseases (Cercospora leaf spot, powdery mildew and mungbean yellow mosaic virus), multiple harvesting due to nonsynchronous maturity, insect damage (beanfly and podborer) and field weathering are the major constraints which cause severe yield losses.

Hybridization Program

To combine high yield, uniform maturity and disease resistance, 20 mungbean breeding lines and accessions were selected and crossed systematically based on factorial design II. In the second cycle, 19 F_1 hybrids were selected and crossed to maximize the recombination and to break linkage blocks. From the segregating populations, plants with desirable combinations will be selected and advanced.

Yield Trials

Promising breeding lines undergo different stages of selection in a series of yield trials every year at AVRDC. High-yielding, uniform-maturing and widely adaptable AVRDC breeding line VC 1973-A was used as the check cultivar in all the yield trials. Due to the severe typhoon damage in the summer season, there was a 40% to 50% yield reduction in all the yield trials. Many breeding lines produced a seed yield

equivalent to the check cultivar in the spring season and these high-yielding lines will be further evaluated next year.

Evaluation of Wild *Vigna* Species

The characterization of the mungbean- and black gram-type wild Vigna accessions confirmed that these two types belong to Vigna radiata subsp. sublobata, and Vigna mungo subsp. silvestris, the wild progenitors of mungbean and black gram, respectively. Significant intra-accession variability was observed in four silvestris accessions, TC 2208, TC 2209, TC 2210 and TC 2211 for free methionine content, days to maturity, plant type and PM resistance.

Genotype X Season Interaction

A significant genotype x season interaction was observed for seed yield and uniform maturity in the elite yield trial (EYT). Four genotypes, i.e. VC 3061-A, VC 1482-E, VC 2768-A and VC 2764-B outyielded the check cultivar VC 1973-A in all three seasons while genotypes VC 2771-A and VC 2755-A produced high yields during the cold spring season. The relative stability of high-yielding lines for seed yield and uniform maturity were estimated by variety-variety (V-V) regression using VC 1973-A as the check cultivar.

Photoperiod and Temperature Responses

Quadratic response surface models were developed to predict the number of days to flowering in AVRDC mungbean cultivars under a given day length and mean temperature regimes. The effect of temperature was more pronounced in influencing the days to flowering than the day length (11.6 - 14.0 h range). In the case of days to first harvest from flowering, only the mean temperature had a significant effect.

Environmental Sensitivity Analysis

To determine the degree of environmental sensitivity of genotypes evaluated in the 5-12 IMN (International Mungbean Nursery) trials, a segmented regression analysis was used. The predictability of the regression model (R^2) improved significantly and genotypes were categorized based on their environmental sensitivity index in both high- and low-yielding environments.

ENTOMOLOGY

Asiatic Cornborer Resistance

In two screenings for mungbean resistance to Asiatic cornborer (Ostrinia furnacalis), four accessions showed significantly less stem damage than susceptible checks and another set of four had significantly less pod damage than the checks. The resistance mechanisms of these accessions will be characterized in 1987 before utilizing them in resistance breeding.

Burchid on mungbean

Oviposition Characteristics of Bruchid

Studies on the oviposition of bruchid on mungbean seeds indicated that bruchids lay 1-3 eggs per seed and greater seed size accomodates a larger number of eggs. Yellow seeds are preferred over green or black for oviposition and bruchid development. Seed coat or testa play an important role in oviposition stimulation, and hexane extraction of seeds reduces oviposition presumably by removal of oviposition stimulation factors.

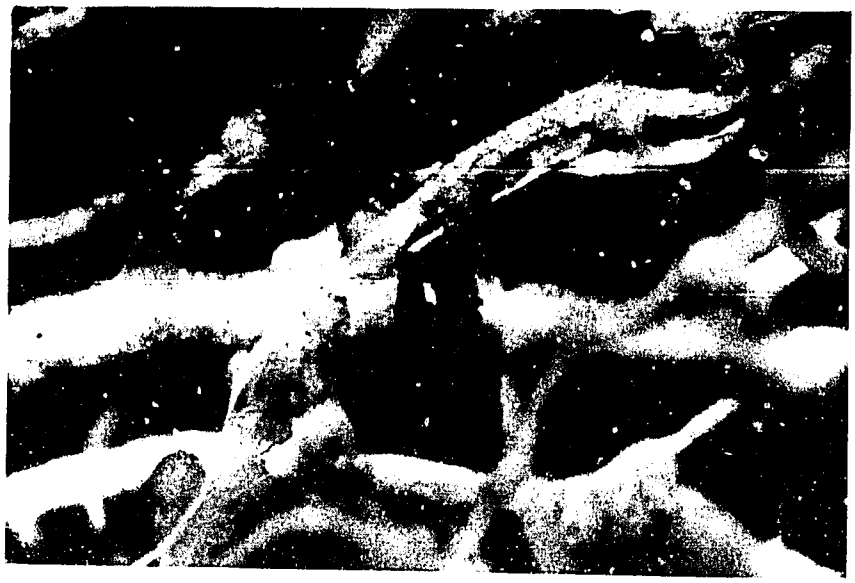
Resistance Screening

One hundred and one mungbean breeding lines developed by breeding were tested for their susceptibility to bruchid in a laboratory screening. Five breeding lines, i.e. VC 1535-11-1-B-1-3B, VC 2764-B-7-2B, VC 2764-B-7-1-B, VC 1209-3-B-1-2B and VC 1482-C-12-2B, were least damaged by bruchid. The number of first-generation adults that emerged from oviposition on the seeds of these entries was statistically at par with no adult emergence from VM 2164, the resistant check. These breeding lines have reduced bruchid susceptibility and have potential for utilization in bruchid control.

PATHOLOGY

Parasitic Nematodes

A survey for plant parasitic nematode genera and population densities associated with the principal crops and rotation crops of AVRDC was conducted over a period of seven sampling dates, from April through October 1986. A total of 243 composite field samples yielded 14 nematode genera. Rotylenchulus reniformis, the reniform nematode, was the most widely distributed nematode and occurred at very high population densities in mungbean, soybean and sweet potato. The roots of the six AVRDC principal crops allowed reproduction of the reniform and root-knot nematode, and are thus considered hosts of these two nematodes. Rice, corn and Crotalaria were considered to be nonhosts of these two pests.



Reniform nematode on mungbean

In general, growing a nonhost crop as the preceding crop reduced nematode population by greater than 50% in comparison to a preceding host plant.

Effect of Population Densities

The reniform nematode is thought to be one of the pathogens associated with the mungbean root disease complex because high populations of the nematode are found in the roots and rhizosphere of plants showing symptoms of the disease. The purpose of this study is to determine the reaction of the mungbean host, under controlled conditions, to increasing inoculum levels of the reniform nematode. In general, increasing nematode populations above 300 eggs/pot decreased the growth parameters with the greatest decrease occurring between 3,000 and 30,000 eggs/pot. However, even at the highest initial nematode population, only stunting was observed. The other symptoms of the root disease complex, i.e. root discoloration and deterioration, leaf chlorosis and necrosis, did not occur. The involvement of the reniform nematode in the mungbean root disease complex and its interaction with environment and other pathogens needs further study.

Cercospora Sporulation

Although carrot leaf-juice oatmeal agar is the best medium for sporulation of Cercospora canescens, carrot leaves are difficult to obtain during the normal season to screen for resistance to this pathogen. A number of other media were tested for their suitability to replace this standard medium. Mungbean leaf-juice oatmeal agar (MOA), although a poor medium for growth of C. canescens, was the best medium for spore production. Future studies will concentrate on improving the growth and sporulation on MOA through the incorporation of other nutrients.

Characterization of New Poty Virus

During surveys of mungbean plantings in Taiwan, cucumber mosaic virus (CMV) and a number of virus isolates were found which could not be identified. Three of these, isolates M4, M25 and M2, were further characterized by serological comparison with five common legume viruses. Isolate M4 was identified as blackeye cowpea mosaic virus (BICMV) whereas isolates M2 and M25 were found to be very closely related to peanut stripe virus (PStV) and adzuki bean mosaic virus (AzMV). It is assumed that M25 and M2 are strains of PStV.

PHYSIOLOGY

Drought Tolerance

Thirty of AVRDC's promising breeding lines and accessions were assessed for drought tolerance based on several parameters under field and greenhouse conditions. Varietal drought responses based on data obtained from the greenhouse test, in general, were consistent with the data in the field test. VC 1163-D, VC 2750-A, VC 2754-A and VC 2768-A were selected as drought tolerant by more than one selection criterion.

PEPPER

BREEDING

Pepper Varietal Improvement

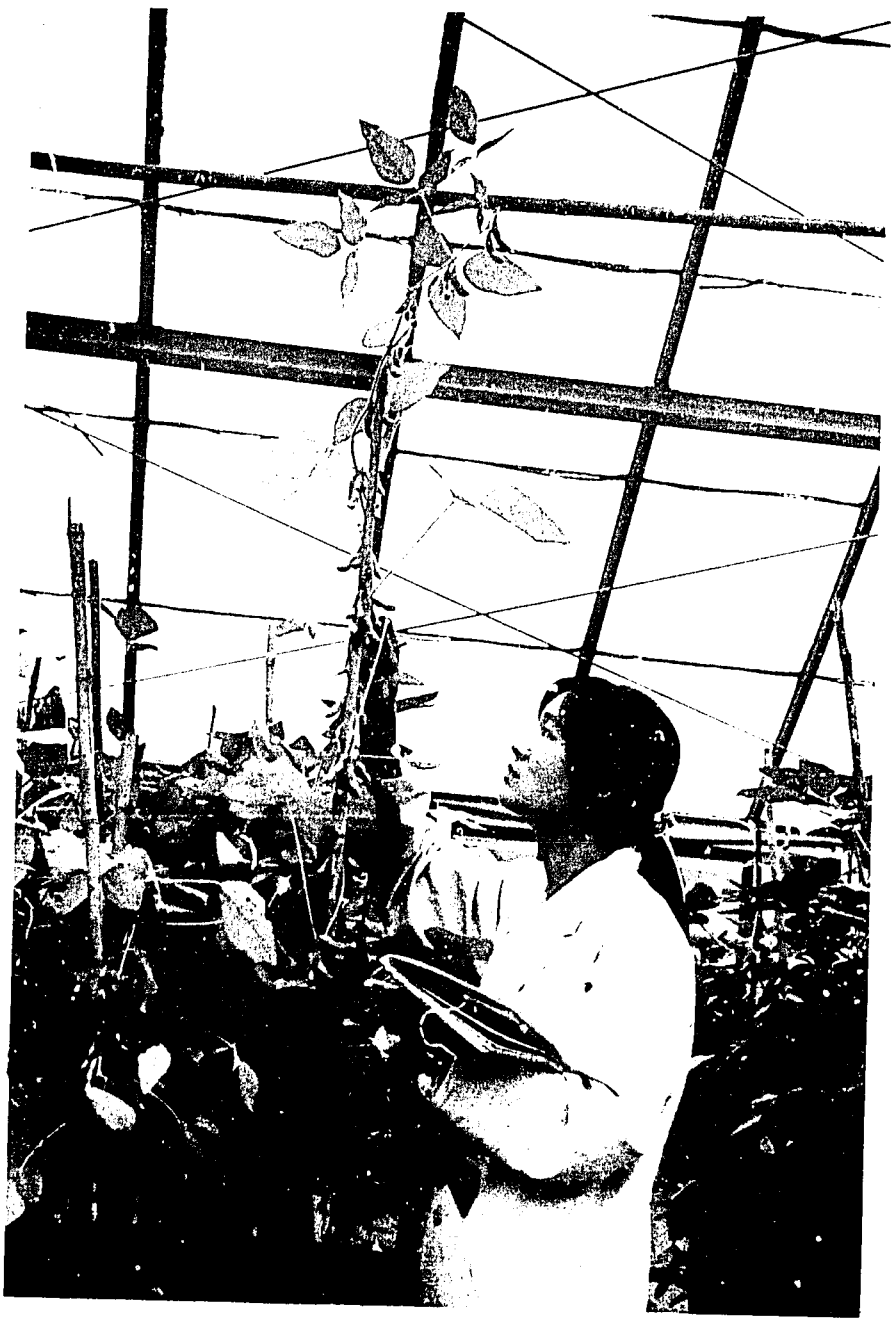
Questionnaire and literature surveys as well as monitoring trials have been started to identify or confirm the priority problem areas for pepper varietal improvement. About 1,000 accessions, including reported genetic sources of some important traits, were collected and part of them have been planted for multiplication and preliminary evaluation. Methodology development and screening for biotic and abiotic stresses will begin and identification of useful materials will be followed by initial crosses in 1987.

PATHOLOGY

Viruses

According to a preliminary field survey the three most important viruses in Taiwan appear to be CMV, potato virus Y (PVY) and tobacco mosaic virus (TMV). As a next step, the viruses and their strains will be isolated and resistance sources will be tested.

SOYBEAN



INTERNATIONAL COOPERATION

Seed Distribution

A total of 42 packets of AVRDC Soybean Evaluation Trials (ASET), 85 other packets for trials, 354 breeding lines and 642 accessions was distributed to 115 cooperators in 42 countries.

Crop Releases

Taiwan - The Tainan DAIS released AGS 66 as "Tainan No. 1" specifically for the summer season because of its high-yielding, early-maturing, nonshattering and non-lodging nature. It is also resistant to downy mildew and bacterial wilt and suitable for mechanical harvesting and for producing bean sprouts.

Thailand - The Department of Agriculture released AGS 9 as "Sukothai 1" because of its high yield, narrow leaf, resistance to bacterial pustle and moderate resistance to rust, downy mildew and purple seed stain.

International Trials

ASET - The 1986 ASET consisted of 11 AVRDC breeding lines and accessions. Results from 17 cooperators in 11 countries showed that AGS 129 often outyielded the local check.

Bangladesh - The Mennonite Central Committee is multiplying AVRDC AGS 129, AGS 160, AGS 162 and G 2120 lines because of their potential for release.

Indonesia - A mutant of AVRDC's AGS 2 (which was a parent for two soybeans previously released in Indonesia) is early-maturing with good yield potential.

Saudi Arabia - The Qassim Agricultural Research Center found AGS 164, AGS 58 and AGS 162 to be the highest yielders, with more than 4 t/ha of green pods, in this trial of grain types to be used as vegetable soybean.

BREEDING

Hybridization

Additional improvements to AVRDC soybean selections are needed. Improvements are being made in a stepwise or convergent fashion. Eighteen AVRDC selections and 14 accessions were used in the crossing program. The objectives were to incorporate selected disease or insect resistance or specific traits via straight crosses or through backcrossing. Fifty-eight crosses have been made, of which 15 were backcrosses. F_1, F_2, BC_1F_1, BC_2F_1 and BC_3F_1s have been developed for further evaluation.

Photoperiod and High Yield

Photoperiod and temperature influence the phenological development of soybean. Selection for less sensitivity to environment was given priority over other traits. Progenies in inbreeding generations from crosses involving photoperiod-sensitive and less photoperiod-sensitive parents were screened under natural light and 14 h photoperiod in the February and September seasons. Reselection of selected pedigrees was based on yield and other traits. Data suggest that high yield potential and less sensitivity to photoperiod may be combined. It is speculated that differences in flowering and maturity are likely influenced more by temperature and photoperiod x temperature interaction. It is also speculated that "disruptive seasonal selection" is probably the most cost-effective and powerful tool for identifying genotypes with both specific and wide adaptation.

Yield Evaluation

High-protein soybeans may be desirable for specific food or feed purposes. A few of the high-protein accessions and selected breeding lines were evaluated for protein and yield in three seasons. Protein content varied slightly with season. GC 40142-0-14 and AGS 313 have an average yield potential of 2.0 and 2.7 t/ha, respectively, with a protein content of 44%. If necessary, it should be possible to combine high protein with reasonably high yield.

Advanced Yield Trials

Sixteen genotypes were compared with four check cultivars. Five genotypes had significantly higher yield than the check cultivar(s). GC 60058-12-6-6-1-55 had higher yield under severe rust stress and was also resistant to downy mildew and bacterial pustule. High genetic yield potential either with or without rust should be the selection criteria. Lower yield loss due to rust (determined by fungicide treatment) does not necessarily mean higher yield potential.

Intermediate Yield Trials (IYTs)

Pedigrees selected from different inbreeding generations undergo evaluation for days to maturity, yield, disease resistance, adaptability and other desirable agronomic traits. Intermediate and preliminary yield trials are conducted in three seasons. A "disruptive seasonal selection" procedure is used in making selections. Appropriate check varieties are used for comparison. A number of high-yielding selections with resistance to one, two or all of the following diseases have been identified: soybean rust, bacterial pustule and downy mildew.

In most of the trials the yield differences between treatments with and without fungicide were insignificant. However, the differences in percent soybean rust infection were significant. The correlation between percent soybean rust and yield in all cases were insignificant. Despite heavy rust infection high yields were obtained with selected genotypes. Results suggest that selection should be based on high yield potential regardless of soybean rust. Research is needed to determine the threshold level of percent rust infection beyond which yield reduction would occur. The critical phenological stage and number of fungicide sprays required to obtain maximum economic yield need to be identified.

Preliminary Yield Trial (PYT)

Initial screening and evaluation of pedigrees from various crosses are conducted through PYTs. Early-maturing and late-maturing selections were evaluated in two separate trials. Out of 113 entries evaluated in PYTs 1 and 2, 36 outyielded AGS 181, which had a low level of rust in the February planting. GC 81078-12 produced a significantly higher yield than the high-yielding check AGS 129.

In the July planting, three selections had significantly higher yield than AGS 129. Two among them were resistant to both downy mildew and bacterial pustule; one of which is also one week earlier maturing than AGS 129.

About 80% and 83% of the 113 entries were classified as resistant to downy mildew and bacterial pustule, respectively. Based on seed appearance in the July planting, selections were made for seed quality.

Vegetable Soybean Trials

Vegetable soybeans for the tropics are presently not available. A number of vegetable soybean varieties adapted to temperate countries and a few identified in the Philippines were evaluated at AVRDC. Selections from crosses made at AVRDC were also evaluated at AVRDC in different seasons. AGS 190 and 191, introductions from the Philippines, appear to be promising for pod yield and quality characteristics. Among AVRDC selections, pedigrees from GC 83006 and GC 83011 have either significantly higher yield or larger seed size, which are desirable for vegetable soybeans. In some pedigrees, resistance to downy mildew and bacterial pustule, which are lacking in check varieties, have been combined.

Seasonal Growth Data Variations

A critical evaluation of PYT and IYT data from 1983, 1984 and 1985 trials was done. Grain yield was highest in the February planting, decreased in July and was lower in the September-planted crop. With few exceptions, time to flowering and time to maturity followed a similar pattern. Variation in yield between years for the July-planted crop is likely attributable to typhoons and heavy rainfall.

Depending upon the maturity duration desired, the yield varied. To have an early-maturity genotype a penalty has to be paid in yield. However, the data also suggest that there is no yield advantage by increasing the maturity duration beyond a specific level within a season. The optimum maturity duration for maximum yield differed with seasons. It is necessary to evaluate the regression of yield on various yield determinants within each maturity class for specific seasons so they can serve as a selection criteria or characteristic for further improvement of yield.

ENTOMOLOGY

Beanfly Tolerance

In a preliminary beanfly tolerance screening involving 120 entries, 14 showed less than 5% yield loss despite heavy beanfly infestation. In a second trial, accessions G 2320 and G 8586 showed the least yield reduction of 0.9% and 6.3%, respectively. G 8586 showed similar tolerance levels in two previous tests and represents a source of beanfly tolerance.

Chemical Control

In an insecticide screening test, the efficacy of nine insecticide treatments in controlling beanflies was compared. Neither of the two insect growth regulators, CME 134 and IKI 7899, gave satisfactory control of beanflies. Similarly, thiodicarb seed treatment was also not effective. Carbofuran granules, band applied at sowing, protected soybean for only the first three weeks. Omethoate gave the best control of beanflies.

Stink bug on soybean

Yield Loss Due to Stink Bug

Soybean plants were exposed to infestation by Riptortus clavatus at various reproductive stages for a one week period each. Insect infestation reduced yield, which was due to the reduction in pod weight. Germination of infested seeds was significantly decreased. There was no significant effect on oil content except when the insect infestation was initiated in R6. When insect infestation was maintained throughout the reproductive stage, plants failed to bear pods and, hence, no seed yield was possible.

Antibiosis in Soybean

First instar larvae of Spodoptera litura or Orgyia sp. were fed on foliage of PI 171444, PI 171451, PI 227687, PI 229358, and TK 5 and observations were recorded on larval development, pupation, adult emergence, and foliage consumption. Both insects fed on various PI accessions had varying levels of abnormal development compared to insects fed on the susceptible entry, TK 5. In general, larvae fed on PI 171444 had a higher level of mortality, lighter pupae, and a lower rate of adult emergence. This indicates a generally high level of antibiosis in PI 171444 to these polyphagous defoliators.

Defoliator Resistance

Several crosses between three defoliator-resistant PI accessions and agronomic breeding lines or accessions were screened for resistance to Spodoptera exigua and two species of stink bugs, Nezara viridula and Riptortus clavatus, in the F_2 generation. Certain crosses showed antibiosis to S. exigua and N. viridula but not to R. clavatus. All F_2s were advanced to F_3 at which stage individual plants were screened for resistance to S. litura. Susceptible checks had considerable foliage loss. Foliage damage to crossed material was not so high. The plants showing 0% to 25% leaflet damage have been saved and will be processed further in consultation with the soybean breeder.

Sex Pheromone Studies

Preliminary studies were carried out to detect the presence of female sex pheromone activity in Orgyia sp., a polyphagous pest of several economically important crops, including soybean. One-day-old females release greater amounts of pheromone. The ideal trap height for catching males was 0.5 m above the soil surface; the greater number of males was attracted between 0400 and 0500. Pheromone effectiveness extended to 3 m from the source.

Insecticide Screening

The six insect growth regulators (IGRs) CME 134, IKI 7899, PH 70-23, PH 6051, BAS 166801 and BAS 178500, two synthetic pyrethroids (alpha-cypermethrin and deltamethrin), and one Bacillus thuringiensis formulation (SAN-415) were tested for control of certain lepidopterous caterpillars, i.e. Spodoptera exigua, S. litura, Porthesia taiwana and Orgyia spp., and coleopterous adult beetles Anomala cupripes and A. expansa on soybean. All chemicals gave significant reduction in defoliator damage but B. thuringiensis failed to do so. Synthetic pyrethroids gave superior reduction in defoliator damage compared to IGRs but they caused a resurgence in mite infestation. Resulting yields were significantly lower than in the control and certain other insecticide treatments.

Limabean Podborer Resistance

In a preliminary single replicate test, 1000 soybean accessions were screened for resistance to limabean podborer (Etiella zinckenella) by planting the entries once each in September and October 1985. Several accessions with the lowest podborer damage were observed in both screenings. In replicated tests, 24 soybean accessions were sowed four times, once each in July, August, September and October, respectively, and screened to confirm their podborer resistance observed in the previous tests. No accession was found to be consistently less damaged by the podborer. Soybean accessions with larger numbers of pods per plant tend to be less damaged than those with fewer pods per plant. No accession with consistently less podborer damage has yet been found.

PATHOLOGY

Advanced Soybean Rust Tolerance Trials (ARTTs)

Twenty-five cultivars were planted in the ARTT for fall 1985 and eight cultivars were selected for further evaluation. A combined yield stability analysis was conducted on these eight cultivars, AGS 302, and three check cultivars (G 38, AGS 129, and AGS 181). Each of the test cultivars was evaluated in 6-12 of the 24 environments (each tolerance trial was considered as having two environments, one fungicide-protected and the other unprotected) between fall 1983 and

fall 1985. The checks were evaluated in all the environments. The estimated mean yield across environments of eight of the nine test cultivars was higher than the highest check cultivar. Six cultivars have a regression coefficient, and, therefore, potential tolerance lower than G 38; and in three of these it was similar to or lower than AGS 181, the tolerant check. The relative yield of all test cultivars in the unprotected environments was superior to AGS 181, with yield increases ranging from 6% to 42%. The relative yield of the best test cultivar in the fungicide-protected treatment was 26% above G 38. Five cultivars were selected, and because of their superior performance, are recommended for use in further testing outside of AVRDC.

Precipitation and Rust Development

Prior studies on the effect of environment on the epidemiology of soybean rust have indicated that precipitation is one of the factors that determine the timing of epidemic development. The purpose of this experiment was to establish the role of precipitation in the development of the rust epidemic and to evaluate the relationship between the development and intensity of the rust epidemic and the associated yield loss. Three experiments were conducted from October 1984 through December 1985. Soybeans were grown under plastic rain shelters, with overhead irrigation simulating precipitation. The data indicate that precipitation (as simulated by overhead irrigation) is necessary for the development of a severe epidemic, and that precipitation during the middle period of soybean growth is most important for epidemic development. The data also show that significant yield loss occurs if the rust epidemic reaches 30% affected foliage by the R6 growth stage and negligible loss occurs if the epidemic fails to reach 20% affected foliage by the R6 growth stage. The relationship between development and intensity of the rust epidemic and the associated yield loss needs to be further delineated in order to determine the relative benefits of resistance and tolerance. Emphasis in the future will be on establishing this relationship.

Physiological Reactions to Rust

The purpose of this experiment was to compare the effect of infection and epidemic development on the physiological parameters of a rust-tolerant and susceptible soybean cultivar. The experiment was conducted under fungicide-protected and unprotected conditions in spring 1986. The epidemic developed later in the season than normal and at a slower rate on the tolerant cultivar than on the susceptible one. At least part of the yield loss in both cultivars can be explained by the direct effect of rust on the reduction of the leaf area index (LAI), principally through increased defoliation, and on the reduction of chlorophyll content. However, the threefold difference in yield loss when SRE-B-15A is compared to TK 5 apparently cannot be explained solely on the basis of these two parameters. A possible explanation for this difference in yield loss is related to the pod and seed dry weight accumulation. SRE-B-15A accumulates seed dry matter at a relatively constant rate, whereas,

TK 5 accumulates seed dry matter at a rapid rate between the R6 and R7 growth stages, a time when the severely rusted leaves are least able to mobilize and translocate the assimilates necessary for seed fill. Another explanation, and possibly interrelated with the first, is the different growth habits of the two cultivars. The indeterminate habit in SRE-B-15A is possibly reflected in progressive seed dry weight accumulation from the bottom of the plant; therefore, assimilates are more readily accumulated and translocated to the seed before the rust effect reaches its zenith.

Intermediate Soybean Rust Tolerance Trial, Fall 1985

Previous research indicated that considerable variation in levels of tolerance to soybean rust exists among soybean cultivars. The utilization of tolerance is currently the most practical method for controlling rust in developing countries of S.E. Asia, where rust is a serious disease. The trial contained 14 lines previously selected for tolerance, planted in replicated 2 x 2 m plots in a split-plot design with and without fungicide protection. The level of tolerance was based on the rust-induced yield loss in the plots without fungicide protection in comparison to the yield under fungicide protection. Thirteen lines were selected for further evaluation in the advanced rust tolerance trials in the spring season 1986.

Intermediate Rust Tolerance Trial, Spring 1986

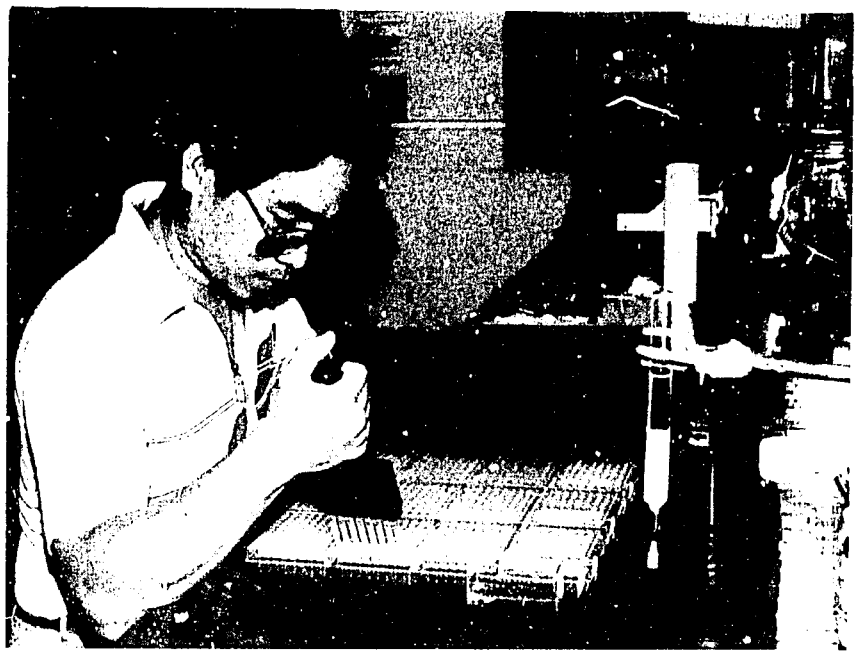
This trial, containing 13 soybean lines/cultivars, was planted in replicated 2 x 2.5 m plots in a split-plot design with and without fungicide protection. AGS lines 128, 139, 141 and 153 met the minimum requirements for selection. Two lines 82285-F5(5)-2-BK and AGS 153 had tolerance levels similar to AGS 181. The maturity of all lines, except for AGS 181, was affected by the rust, with effect ranging from 3 to 8 days.

Wild Soybean Resistance

Soybean rust is a disease of classical economic importance in S.E. Asia. To identify additional sources of resistance, a total of 100 lines of wild perennial soybeans was tested outside the greenhouse with artificial inoculation. Thirty-six lines were rated as resistant. These lines will be tested again in the fall season to confirm the resistance.

Bacterial Pustule Resistance

Bacterial pustule is one of the most important diseases of soybean in S.E. Asia during the rainy season. For the confirmation of bacterial pustule resistance in breeding lines, a total of 135 lines from the AYT, IYT_1, PYT_1, PYT_2, and F_6 generations in spring 1986 were tested in the field with artificial inoculation during the summer season. Twenty-three cultivars/breeding lines including two AYT lines, one IYT_1 line, three PYT lines, eight PYT_2 lines and nine F_6 generations were rated highly resistant to bacterial pustule. The apparent source of resistance for 22 of the 23 cultivars/lines was SRF 400.



Application of ELISA test

Peanut Stripe Virus (PStV)

The new poty virus, which was frequently found in soybean plantings and which was previously found to be related to AzMV and BICMV, was further investigated by host range, serology and electron microscopy. The virus was found to infect peanut systemically, which neither AzMV nor BICMV do. However, in comparative enzyme-linked immunosorbent assay (ELISA) tests it reacted strongly with antiserum to PStV, AzMV and only weakly with BICMV. This, and the presence of curved laminar aggregates in thin sections of tissues infected with either PStV or the new poty virus, offers indication that the new poty virus is probably a soybean strain of PStV.

Because of its severe symptoms and frequent occurrence on soybean, its ability to infect other economically important legume crops, and its transmission by seed, this virus is considered important enough to be included in the soybean improvement program.

Another New Poty Virus

In past surveys of the soybean production areas, three viruses were commonly found: soybean mosaic virus (SMV strains 1, 3, 4 and 5), peanut mottle virus (PMV), and the soybean strain of PStV. Recently another virus was found. Further characterization indicates that the new virus is also a poty virus, but is serologically not related to PStV, SMV, BICMV, cowpea aphid-borne mosaic virus, or bean common mosaic virus (NL-5 and NY 15). Resistance to this new virus is available in AGS lines, most of which are also resistant to SMV G1 and G4.

Peanut Mottle Virus (PMV)

PMV is one of the three most important viruses of soybeans. In Taiwan, the virus has been found recently both on peanut and soybean. Three isolates were strain typed. Their reactions on the differentials, however, did not fit any previously recorded strains and they probably represent a new strain.

SMV Straintyping and Resistance Screening

For any efficient virus resistance screening program, the presence of strain-specific resistance has to be recognized and the various strains used for virus resistance screening if possible. Strains 1, 4 and 5 of SMV have been isolated from soybean in Taiwan. Recently, another strain, SMV C3, has been identified. Most AGS lines, found to be resistant to strains 1 and 4, and to the new poty virus believed to be PStV, were also found resistant to strain C3. In the future this strain will be routinely used in the SMV resistance screening program.

Virus Detection in Seeds

Two important viruses of soybean, SMV and PStV, are known to be seed transmitted. Several methods of testing the seed transmission rate of two important soybean viruses, SMV and the soybean isolate of PStV (isolate PN) have been investigated. Testing individual seeds by ELISA resulted in very high percentages of seed transmission, which did not correspond to the seed transmission rates found by the growing-out test. For practical purposes the actual rate of seed transmission should be tested after germination.

Screening of Korean Soybean Materials

For the identification and collection of germplasm with high levels of resistance to bacterial pustule, a total of 95

soybean lines from Korea were tested in the field with artificial inoculation during the summer season. Three lines were rated as highly resistant and seven additional lines were rated as near highly resistant. These lines will be retested next year to confirm their resistance to bacterial pustule.

Sources of Resistance to Seed-Borne Diseases

Seed-borne diseases are very important to soybean production in the lowland tropics of S.E. Asia. Significant differences in varietal reaction to the disease were found in previous studies. This trial was designed to identify the sources of resistance to seed-borne diseases from 323 AGS lines and 130 soybean cultivars/lines. There are 108 cultivars, including 100 AGS lines, that had over 30% germination in soil; and 172 cultivars, including 161 AGS lines, that had over 80% germination on potato-dextrose agar (PDA) plates. Sixty lines had over 30% germination on the flat and also over 80% germination on PDA plates. These are the best lines. The major pathogens, i.e. Rhizoctonia solani, Macrophomina spp., Colletotrichum spp., Phomopsis spp. and Cercospora spp., were frequently isolated.

PHYSIOLOGY

Narrow Leaf-Type Soybean

Growth and yield of a narrow leaf-type breeding line, GC 83005-14-14, was evaluated along with its normal leaf-type parents, AGS 188 and KS 8. The low net assimilation rate in this narrow leaf type did not match up the gain in large leaf area and possible benefit in the narrow leaf for better light penetration, thus resulting in low crop growth rate, total dry matter production and seed yield in this particular breeding line.

SWEET POTATO

INTERNATIONAL COOPERATION

Safe Germplasm Exchange

All distribution of AVRDC sweet potato germplasm has been halted since mid-1985 while improvements of the virus indexing scheme were developed and implemented. AVRDC developed a virus elimination method which utilizes thermotherapy and meristem tip culture, followed by two subsequent stem tip cultures. As the first sweet potato materials clear the virus indexing procedures by October 1987, they will become available for distribution to AVRDC's international network of cooperators.

International Trials

Kampuchea - Church World Service reported that of five advanced AVRDC clones, CN 1028-15 was selected as being the best adapted. This clone has assumed an important role in the Phnom Penh area because it produced a crop during the rainy season, whereas the local varieties could not.

Philippines - PI 344129 from AVRDC was the highest yielder, excelling over 11 other locally developed lines, in experiments by the College of Agriculture, Catanduanes State College. This variety was provided by AVRDC-POP in 1978 and is quite well known as "Siminit" by the local farmers.

Saudi Arabia - Of the nine AVRDC sweet potato clones in the trial conducted by the Qassim Agricultural Research Centre, AIS 0122-2, CN 1028-15, CN 1232-9 and CN 941-32 were excellent yielders compared to the local check. AIS 0122-2 was identified to be particularly promising for human consumption because of its high carotene content, 25.2 t/ha yield, good taste and attractive appearance.

BREEDING

Hybridization Program

A total of 286,983 seeds was produced from the five 1985-86 crossing blocks. Improvement of dry matter content was especially emphasized in all crosses.

Seedling Screening and Observational Yield Trials (OYTs)

A total of 70,276 seeds was sown in 1986. Out of the entries, 4,423 clones were entered into the OYT and different selection procedures were applied depending on the objectives of each population: high dry matter content, scab resistance, vineborer resistance, etc.

Evaluation of Screening Methods

Rapid-screening techniques and the consistency of dry matter and protein were examined over three different screening stages. The specific gravity method was identified as a useful preselection method to eliminate the progenies with low dry matter content in the field. The rapid screening for protein using the tetrabromophenol blue indicator paper was not proper for large-scale selection, although the actual protein content appeared to be relatively consistent between the OYT and the PYT.

Preliminary and Advanced Yield Trials

PYTs with 76 entries and AYTs with 21 entries were conducted in summer 1985 and fall 1986. No outstanding selections were recovered. However, marketable yield and dry matter content of all selections tended to be stable in both seasons.

Evaluation of the Breeding Value of 5x Interspecific Hybrids

With respect to the utilization of wild relatives in breeding, 5x hybrids from crosses between sweet potato varieties and Ipomoea trifida (4x) were evaluated in a preliminary test. The hybrids showed good potential for sweetpotato weevil resistance, high dry matter content and high protein content. However, they are still not immediately useful as cultivars. A sequence of backcrossing and further selections among derived progenies would be necessary.

Wild sweet potato species

ENTOMOLOGY

Sweetpotato Vineborer (*Omphisa anastomasalis*)

In a field test on Penghu island, breeding materials derived from open-pair crosses between a sweetpotato vineborer-resistant accession, 155, and three agronomic breeding lines were tested for vineborer resistance. Progeny, derived from seeds harvested from 155 as a maternal parent, had reduced insect damage and a greater frequency of plants falling in no damage or minimal damage categories as against progeny derived from susceptible but agronomic parents. Based on low vineborer damage, 125 promising entries were selected for further evaluation and testing for vineborer resistance and agronomic characteristics.

Sweetpotato Weevil (*Cylas formicarius*) Resistance

Two sets of sweet potato accessions were screened for resistance to sweetpotato weevil. Several accessions in the first test were weevil free and three accessions in the second were the least damaged. These accessions will be screened again to confirm the stability of their low preference by the weevil. Considerable variations in weevil infestation from season to season have been observed. Despite continuing intensive screening, no accession has yet shown a consistent level of resistance to the weevil.

A total of 1,131 progenies from Ipomoea trifida x I. batatas was screened for resistance to sweetpotato weevil. Several progenies gave satisfactory yields and had no or very low sweet potato weevil infestations. Further tests are

Sweetpotato vineborer

underway to confirm the yield response and weevil infestation of these progenies to judge the resistance stability.

Sweetpotato Weevil and Root Characteristics

There was no significant correlation between sweetpotato weevil infestation and dry matter, sugar and protein contents of roots in both 1984-85 and 1985-86 seasons. A significant positive correlation was observed between root carotene content and weevil number in the 1984-85 season but no such correlation was evident in the 1985-86 test. Since wide seasonal variations in yield and weevil infestation are common in sweet potato, this experiment will be repeated one more season to draw definite conclusions.

Intercropping and Weevil Control

Among 68 crops tested, intercropping sweet potato with chickpea, coriander, pumpkin, radish, fennel, black gram, and yardlong bean reduced weevil infestation of sweet potato roots to less than five weevils/kg roots. Since some of these intercrops adversely affect the sweet potato yield, it is not certain whether the reduction in weevil infestation was due to intercropping. Therefore, certain of these intercrops will be studied again in the 1986-87 season to confirm these results.

Sweetpotato Weevil and Mulching

Utility of two commonly used mulches, plastic film and rice straw, in reduction of sweetpotato weevil infestation of sweet potato roots was studied in a field experiment. When the soil around sweet potato plots was covered with plastic or rice straw mulches soon after transplanting until harvest, sweetpotato weevil infestation in these plots was significantly reduced compared to the uncovered check plots.

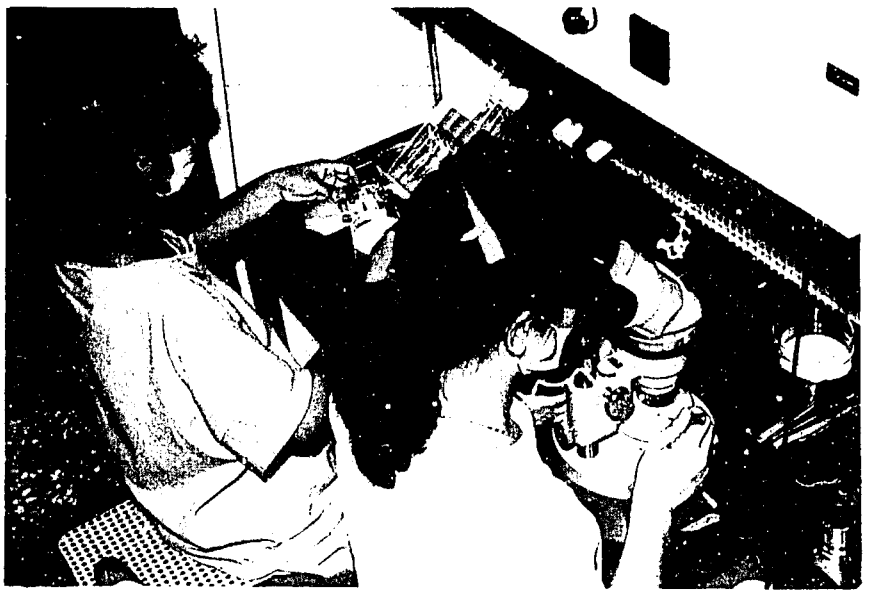
Eradication Program

In an effort to initially reduce sweetpotato weevil infestation and eventually eradicate the insect, a combination of cultural practices, sanitation and insecticide application was tried on an island where sweetpotato weevil is endemic. Dipping the plant material in insecticide solution followed by destruction of Ipomoea weeds, occasional earthing up of plants, and monthly use of carbofuran 3 G at the rate of 2 kg ai/ha reduced infestation of sweet potato plants from 100% in 1985 to 50% in 1986 and reduced damaged roots from 75% to 30% during the same period.

PATHOLOGY

Scab Resistance

The experiments this year were designed to evaluate the resistance of lines derived from crosses involving a resistant parent or parents, to determine the differences in virulence and aggressiveness among E. batatas isolates, and to deter-



Sweet potato virus indexing

mine the feasibility of reducing the complexity of the susceptibility rating system. A total of 158 sweet potato lines were screened and 104 were identified as having a level of resistance not significantly different from the resistant check, V2-30. There were no indications of physiological specialization among three scab isolates; however, there were differences in aggressiveness. Disease indices were highly correlated with the respective disease incidence of each sweet potato clone, indicating that it is feasible to simplify the scab resistance evaluation methodology.

Virus Indexing

A virus indexing method has been adopted by AVRDC which utilizes meristem tip culture, followed by an ELISA test of young plantlets and two subsequent graftings of mature plants to susceptible indicator plants. The best-performing breeding lines of the 1985 AYT were the first to be subjected to this scheme. Meristem culture could not completely eradicate virus from infected plants. Feathery mottle virus (FMV) was eradicated more easily than the latent virus (LV) and the yellow dwarf virus (YDV). By the ELISA test it was, however, possible to eliminate virus-infected plants prior to the graft indexing. Ipomoea setosa proved to be a more reliable virus indicator for grafting than I. nil.

Chemical Treatments for Viruses

Meristem culture alone has been shown to be inefficient in eliminating viruses from infected tissues. The use of virazole at a concentration of 20 mg/l in the tissue culture medium eliminated SPLV in some but not all tobacco plantlets infected with the virus. Higher concentrations will be tested for efficiency in eliminating virus and checked for phytotoxicity on sweet potato tissue.

Grafted sweet potato

PHYSIOLOGY

Evaluation of Leaf-Cutting Method

Thirty-five diverse genotypes of sweet potato clones with no prior selections for agronomic characteristics were assessed for total dry matter production and storage root dry weight on a per plant basis in the field, and by a self-grafted leaf-cutting basis under greenhouse conditions. Similar tests were performed with 20 of AVRDC's improved clones between field planting and leaf-cutting without grafting. Significant correlations were established for total dry matter production and storage root yield between field trial and greenhouse tests regardless of whether the clones were improved or not improved.

There was a significant correlation between total dry matter production in the field and root-penetrating ability of leaf cuttings of improved sweet potato clones observed in the greenhouse. Two of AVRDC's improved clones, CN 1510-25 and CN 151/-139, were the highest yielders and had the highest root-penetrating abilities.

Source-Sink Relationships

The source-sink relationship of two sweet potato clones, CN 1028-15 (high yielding) and CN 1367-2 (low yielding), was investigated by means of reciprocal and self graftings of individual plants grown in the field, and of leaf cuttings grown in the greenhouse. An analysis of soluble sugars and starch content in the leaf blade, upper petiole from the scion, lower petiole from the stock, the swelling portion of the

petiole base, fibrous roots and storage roots of grafted leaf cuttings was also conducted.

Varietal differences in the potential of total dry matter accumulation and storage root dry weight yield were similar between grafted plants in the field and grafted leaf cuttings in the greenhouse. Grafted plants and leaf cuttings of CN 1028/CN 1028 had the highest total dry matter production and storage root dry weight, and CN 1367/CN 1367 the least. Two reciprocal grafted plants and leaf cuttings had intermediate levels of total dry matter production and storage root dry weight.

CN 1028-15 had higher chlorophyll and starch contents in the leaf blade in the early stages of grafted leaf cuttings, indicating high photosynthetic potential and resulting in high dry matter production. When CN 1367-2 was used as a stock, more starch contents accumulated in the leaf blade, upper and lower petioles, petiole base and fibrous roots in both grafted leaf cuttings of CN 1028/CN1367 and CN 1367/CN 1367, indicating weak ability to develop storage roots in CN 1367-2 to import assimilates synthesized in the blade. When CN 1028-15 was used as a stock, more soluble sugars accumulated in the petiole base, and fibrous and storage roots, indicating the regulatory function in the developing storage root, as a sink, to import more translocatable forms of carbohydrates.

Results show that there were marked differences in the sink capacity and source potential of these two clones. Both source potential and sink capacity are important in determining the storage root yield of grafted plants or leaf cuttings. However, the contribution of sink capacity seems to be more so.

Effect of Growth Regulators on Leaf Cuttings

Several growth regulators and an un-coupler of oxidative phosphorylation (2,4-dinitrophenol) were examined to investigate their effects on growth and storage root yield of sweet potato leaf cuttings. Kinetin, CCC, BAS 106 and 2,4-dinitrophenol, applied as a soil drench, increased total dry matter production and storage root yield of CN 1028-15 leaf cuttings. CCC applied as a foliar spray also increased total dry matter production and storage root yield of grafted leaf cuttings of CN 1367-2/CN 1028-15, and CN 1028-15/CN 1367-2. Brassinolide, applied as a foliar spray, increased total dry matter production and storage root yield of CN 1028-15 leaf cuttings, and grafted leaf cuttings of CN 1028-15/CN 1367-2, but not grafted leaf cuttings of CN 1367-2/CN 1028-15, which had low source potential. It may be possible that sink capacity depends on certain growth substances, and that fibrous root respiration may have some role in storage root formation.

TOMATO

INTERNATIONAL COOPERATION

Seed Distribution

A total of 2,012 packets of seed was distributed to 146 cooperators in 61 countries.

Crop Releases

Gabon - the Centre pour le developpement de l'horticulture selected AVRDC cultivar CL 949 for release under the local name of "Tropiva" especially because of its good resistance to bacterial wilt.

Reunion (France) - MST 21-23, a line selected in Mauritius from AVRDC breeding materials, was released as "Bourbonna" for farmers use.

Senegal - AVRDC line CL 143-0-13-3 UG was crossed with a local line to develop "Xina". It has acceptable heat tolerance, resistances to nematode, Fusarium wilt (Races 0 and 1) and Stemphylium, and firm fruit.

Taiwan - AVRDC hybrid PT 3027 was released as "Tainan No. 3" because of its desirable qualities of early maturity, heat tolerance, and resistance to tomato mosaic virus, nematode and bacterial wilt.

International Trials

Cook Island - In a trial conducted at the Tokoitoku Experiment Station AVRDC line CL 5915-206-2-5-0 obtained the highest marketable yield of 48 t/ha and largest fruit size of 119 g/fruit.

Egypt - AVRDC line CL 5915-206-2-5-0 outyielded all other entries with 53 t/ha in the spring trial conducted by the Horticulture Dept. of the Agriculture Faculty at Kafr El-Sheik.

Nepal - In a hot-humid season trial of the Institute of Agriculture and Animal Science, four AVRDC cultivars gave marketable yields of from 22 to 25 t/ha and demonstrated a high level of field resistance to bacterial wilt as well as some level of tolerance to water-saturated field conditions.

Philippines - AVRDC line CL 5915-153-3-3-0, at 68 t/ha, significantly outyielded all other entries in a dry-season processing tomato trial at Mariano Marcos State University in Ilocos. Other reported favorable characteristics were moderate fruit firmness, thick flesh, uniform to deep red color, excellent external fruit quality and no puffiness.

BREEDING

Crosses and Segregating Populations

Development of new tropical lines carrying nematode resistance continued. An additional 54 new crosses were made in 1986; the majority of which were aimed at incorporating resistance to potato virus Y (PVY) from Lycopersicon hirsutum to cultivated tomato. A range of breeding populations was screened for resistance to tomato mosaic virus (ToMV), nematode, bacterial leafspot (BLS) and fruitworm. Selection intensity in various populations ranged from 1% to 9%.

Heat Tolerance in New Introductions

Fifteen new introductions were evaluated for fruit-setting ability during 1986. Three lines performed better than TK 70, the heat- sensitive check, but none compared favorably with the heat-tolerant check, CL 5915-153-3-3-0. The new materials tended to produce larger fruits than the check but were more prone to crack.

Only one entry showed a moderate fruit-setting ability among 101 introductions tested in the field. All others either had no or very little fruit-set.

BW Resistance in New Tropical Breeding Lines

A new system of field screening for bacterial wilt (BW) resistance was developed and used in testing new tropical tomato lines. The method was found to be reliable as indicated by reasonably low coefficients of variance (CVs) in most of the trials, apparently homogeneous inoculum distribution in the experiments, and high infection levels on the susceptible check, L 390. These problem areas were the major drawbacks of field screening tests carried out previously.

Levels of resistance in lines varied considerably. In some trials, the best new lines compared well with L 285, the highly resistant check, and CLN 65-349-2-0, currently the most resistant breeding line in the program. In others, the best lines were either equal to or somewhat lower in resistance level than CLN 65-349-2-0. Some of the most promising BW-resistant materials already carry nematode resistance in a homozygous condition such as lines derived from the following crosses: CLN 337, CLN 236 and CLN 229. The BW resistance of some lines derived from CLN 337 was further confirmed in an independent seedling inoculation trial.

Genetics of Heat Tolerance

Genetic analysis of high temperature fruit-set in one cross, CL 5915-223-2-1-0/L 345, showed a pronounced bimodality of fruit-set distribution in the F_2 and BC_1F_2 generations. This tendency was also evident in the F_1 and BC_1F_1 families. It appears, therefore, that the number of genes for heat

tolerance differentiating the parents in this particular cross may be few, possibly comprised of a limited number of genetic factors with major effects on the trait and an unknown number of minor genes.

An attempt to score the segregants into a discrete fruit-set category led to a similar conclusion. It was conclusively shown that a single backcross is adequate to obtain a large number of individuals with fruit-setting ability equal to or better than the recurrent heat-tolerant parent.

Performance of Determinate and Indeterminate Tropical Breeding Lines

Most trials conducted in the 1986 summer season were adversely affected by typhoons and by an epidemic of bacterial leafspot. Selection of entries in several trials was, therefore, restricted to evaluating their apparent potential for further tests in the 1987 summer season.

None of the new determinate tropical lines or selections from the best lines out of the CL 5915 series outperformed CL 5915-153-3-3-0, the most heat-tolerant line among the current materials. Some lines with comparable yield but with better fruit firmness, crack resistance and larger fruit size were noted for retesting in 1987.

Although true yield potentials were not attained, a number of processing hybrids in the summer trial showed dramatic advantages over check cultivars TK 70 and Tainan No. 2 because of their heat tolerance. They exhibited good crack resistance and firmness.

Small-fruited, indeterminate tropical lines also outyielded the local cherry cultivars because of their heat tolerance. However, the local checks had better flavor and fruit firmness.

Among the large-fruited, indeterminate fresh-market entries, most revealed dramatic advantages in productivity over the local checks in the fall and summer seasons. Although most of the new materials had smaller fruit size than the checks, the best entries produced larger fruits even in the summer trials.

Performance of New Processing Tomato Hybrids

The best new hybrids behaved similarly to the current best check, PT 3027, in terms of total and marketable yields. However, a number gave better once-over harvest potential than PT 3027, indicating improved concentration of fruit-set. Better fruit firmness among these hybrids could have enabled the fruit to hold longer on the vine, thus imparting higher once-over yield.

Some of the new hybrids in certain trials showed better processing traits, such as higher brix content, than PT 3027. A number of the elite combinations had better fruit firmness and crack resistance compared to the checks. While the

majority of the new combinations had good seed-yield potential, there were instances in which certain hybrids did no better or even worse than PT 3027, a hybrid check with very poor seed yield. Some of these seed-yield data will need to be reconfirmed since they were reckoned from a small-scale hybrid seed increase.

Compared to checks TK 70 and Tainan No. 2, many of the new combinations were more productive. However, few outperformed TK 70 in brix content. As the yield of TK 70 in several trials was low, its high brix content was likely related to its poor yield.

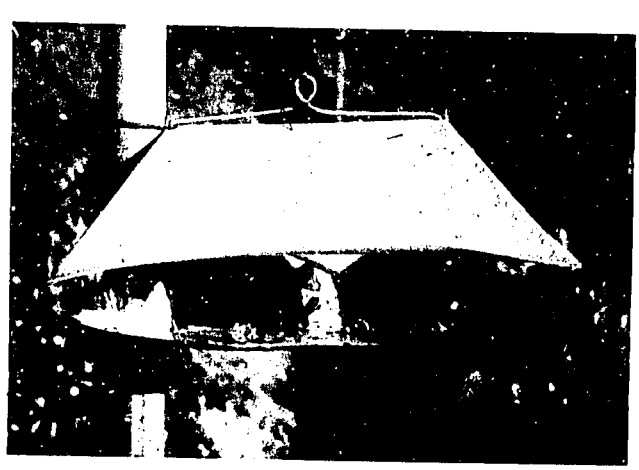
ENTOMOLOGY

Fruitworm Resistance

A total of 1,877 plants derived from BC_3F_3 families were screened for fruitworm (Heliothis armigera) resistance in the field. Two hundred and twenty-seven plants were free of insect damage. Twenty-seven of these plants having bigger fruit size and desirable horticultural characteristics have been selected for further observation and backcrossing.

Pheromone Studies

Three sex pheromone components, (Z)-11-hexadecenal (Z-11-16 Ald), (Z)-11-tetradecenal (Z-11-14 Ald), and (Z)-9-hexadecenal) (Z-9-16 Ald) were used in various field trials. A combination of Z-11-16 Ald and Z-9-16 Ald at a 9:1 ratio resulted in a larger number of male moths captured followed by an 8:1:1 combination of Z-11-16 Ald, Z-11-14 Ald and Z-9-16 Ald. Pheromone mixture concentrations of 2-4 mg Z-11-16 Ald and Z-9-16 Ald (9:1) captured a greater number of males than virgin female-baited traps (7 females/trap). A pheromone concentration of from 0.5 to 20 mg/trap captured an increasing number of males with increasing pheromone concentration; however, at 40 mg/trap, the number of males captured decreased considerably. Based on these findings, pheromone sources placed at the intersections of 10-m grids in tomato fields reduced fruitworm damage.



Pheromone trap

A comparison of the effectiveness of pheromone dispensed on a rubber septum; Biolure, a commercially available product; and virgin females showed that Biolure attracted a far greater number of males than the rubber septum-dispensed product and virgin females. Utilizing Biolure, the periodicity study indicated that males are attracted to pheromone traps daily from midnight to 0300 hours. In an effective range study 40% of the marked males were recaptured from 10 m and 21.5% from 20 m along wind direction. Far fewer moths were captured from against wind direction. In a similar test in which males were placed at 5 and 10 m from pheromone traps, 40% of the moths recaptured came from 5 m and 23% from 10 m along wind direction. These data are being utilized in field studies devising communication disruption.

Growth Regulators and *Bacillus thuringiensis*

Four insect growth regulators, and three B. thuringiensis formulations were screened along with one standard synthetic pyrethroid, deltamethrin, to control tomato fruitworm on tomato. Deltamethrin gave superior control and greater marketable yield than other chemicals. Two insect growth regulators, IKI7899 and PH60-51, also gave satisfactory control of this pest. Marketable yield was high and discarded fruits were minimum in these three treatments.

PATHOLOGY

PVY — Screening for Resistance

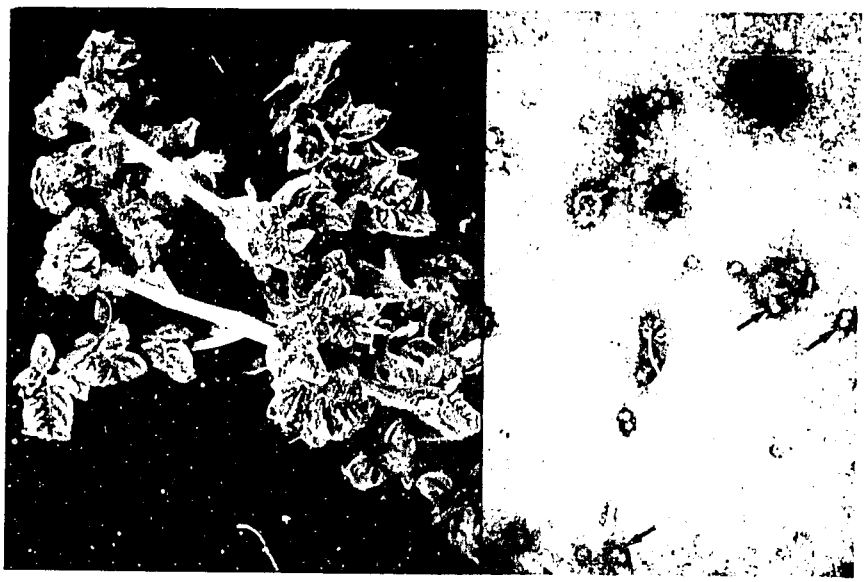
In 1986, PVY was included in the tomato improvement program at AVRDC. In last year's screening, two lines, L. hirsutum PI 247087 and PI 1365903 were found to carry resistance. Twenty new lines with reported resistance to PVY, crosses of PI 247087 with PVY-susceptible breeding lines, were screened this year. All F_1 combinations and all of the 20 new lines except one (LA 1295), were susceptible. This suggests that resistance in PI 247087 is recessive. It also appears that resistance is available in other L. hirsutum lines.

PVY Strain Classification

PVY is known to occur as several pathotypes, which have to be considered in any program aiming at developing resistance to this virus. The 22 PVY isolates collected in the past were all found to be pathotype 0 by straintyping on six Capsicum annuum species.

Effect of T697 on Tomato Yield

A poty virus (Isolate T697) was previously isolated from tomato in Taiwan, which was serologically not related to other poty viruses commonly known to affect tomato. It was transmitted by aphids but not by seeds and its host range was found to be confined to the Solanaceae, where it mainly



Tomato leafcurl virus (left) and leafdip from leafveins of leaf-curl-infected tomato (right, arrows indicate gemini particles)

infected tomato and tobacco. The effect of this virus on tomato yield was examined in the field. Loss of marketable yield ranged from 43% to 47% when plants were inoculated at 22 DAS (days after sowing), and from 33% to 43% when plants were inoculated at 29 DAS.

Screening for Resistance to TLCV

Screening for resistance to tomato leafcurl virus (TLCV) at AVRDC has become possible since discovery of the virus in Taiwan. Screening is done by grafting to virus-infected plants. To verify presence of TLCV in the grafted scions, they are backgrafted to healthy N. benthamiana in which clear symptoms appear quickly. The resistance of L. peruvianum VL 215 has been confirmed and two additional L. hirsutum lines (VL 257 and VL 258) with resistance have been found.

CMV — Screening for Resistance

The screening of wild-type germplasm was continued, using 36 L. pennellii lines with reported resistance to CMV. All lines were found susceptible except two, which produced only 50% infected plants.

PHYSIOLOGY

Hormonal Control of Abscission

Floral pedicel abscission of different tomato varieties as affected by growth regulators was studied under in vitro conditions. Floral pedicels from heat tolerant CL 5915-153,

Floral pedicel abscission *in vitro*

L 3957, and L 3958 abscised little under *in vitro* conditions. Both abscisic acid (ABA) and 1-aminocyclopropane-1-carboxylic acid (ACC) applied acropetally promoted abscission of cultured pedicels. Indoleacetic acid (IAA), applied acropetally or basipetally, prevented the abscission caused naturally or by ABA or ACC. Heat tolerance in terms of fruit-setting may rely on the balance of endogenous plant hormones, which is subject to fluctuate with ambient temperature, to control the abscission of floral pedicels.

Water Uptake and Dry Matter Production

Heat tolerant CL 5915-153 and heat sensitive L 124 were investigated for water use, dry matter production and fruit yield under cool and hot season conditions. No difference in total dry matter production within the same entry was noticed in two seasons. At high temperatures, more assimilates were accumulated in the stem of heat-sensitive L 124 than heat-tolerant CL 5915-153. This suggests that heat tolerance in tomato is not limited by carbon fixation but by the capacity of the sink to accumulate reserve materials.

More than 90 liters of water per plant were consumed throughout 120 days of growing period in both the cool and hot seasons. More water was used in the hot season than the cool season, due to high transpiration rates. Water use efficiency in terms of dry matter production during early growth was more effective in the cool season than the hot season. There was no apparent relation between heat tolerance of tomatoes and the use of water.

Varietal Carbohydrate Content Differences

Seven tomato genotypes were grown during the hot season and the soluble sugar and starch contents in the leaves and pistils were determined from the pre-anthesis to post-anthesis period. The soluble sugar/starch ratios of

heat-tolerant tomatoes were high at pre-anthesis and anthesis stages. It appears that carbohydrate availability at high temperature could play an important role in the fruit-setting process, and deserves further attention.

Pollen Germination Control Factors from Pistils and Anthers

Tomato pollen germinates in a solution containing only sucrose and boric acid, but with a low germination rate. Aqueous stigma exudate from CL 5915-153 incorporated in the germination medium promoted the pollen germination rate of L 387; however, antherial extracts of all four entries inhibited pollen germination. Results suggest that there are two distinct mechanisms controlling pollen germination. An active endogenous inhibitory system in the anther appears to prevent precocious pollen germination, and promotive factors established in the stigma seem to be necessary for normal pollen germination.

Novel Growth Regulators

Several novel growth regulators involved in the inhibition of synthesis or activities of GA, ABA and ethylene, and a new plant hormone, brassinolide, were tested on tomatoes during hot season conditions. BAS 106, BAS 111 and CCC, inhibitors of GA biosynthesis, and norflurazon, an inhibitor of ABA, improved fruit-set and yield of high-order clusters of heat-tolerant CL 5915-153.

PRODUCTION SYSTEMS PROGRAM

.H9-

CHEMISTRY

Weevil Damage in Sweet Potatoes

The effect of weevil damage on quality of sweet potatoes as animal feed was further studied in 1986. Palatability of sweet potato flours prepared from healthy and weevil-infested roots were evaluated against corn starch by a free-selection preference test. Flour from healthy roots was found better in palatability than the cornstarch check. The palatability of sweet potato flour was drastically reduced due to weevil infestion. Weevil damage thus deserves primary concern when produced for feed purposes.

Quality of Tropical Tomatoes

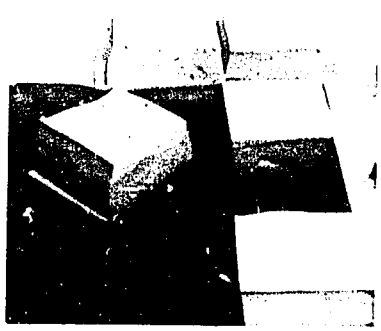
Quality of selected tropical tomato lines was assessed for color, firmness and quality-related chemical composition. When the stage of fruit softness reached about 2 mm (deformation distance under pressure of 500 g/cm^2) the fruit color of tested varieties ranged from 0.38 to 0.79 (Hunter a/b value). All the lines tested show a certain degree of blotchy ripening under field conditions. The solid content of the tropical tomato is comparable to the winter tomato. How to maintain a desired partition of solids among yield, alcohol-soluble and alcohol-insoluble solids could be an important task for better quality of tropical tomatoes in the future.

Compositional Changes of Vegetable Soybeans after Harvest

Preliminary experiments were conducted on compositional changes of the vegetable soybean after harvest. Nutritional values, such as B_2 and C contents were found dependent on maturity. Sugar and starch are major carbohydrates in the vegetable soybean. Development of yellow spots on green pods was found to be a major post-harvest problem and is associated with prolonged storage after harvest. This problem does not affect the appearance of beans and thus is not a serious problem for the local market.

Tofu-Making Properties of Soybeans

The effect of storage on tofu-making properties of soybean was studied. Changes in acid values, solids content in soaking water, milk pH and milk solids content were noted. Water activity may explain the storage effects. Poor processing properties of AGS 2 were observed, indicating that varieties good for sprouting may not necessarily be suitable for tofu.



Tofu

Provitamin A in Vegetables and Fruits

The biological provitamin A availability of selected vegetables and fruits was determined by an animal - feeding experiment. Significant variations in provitamin A utilization were observed among commodities tested. Vegetables rich in chlorophylls and nonprovitamin A carotenoids were found to be lower in provitamin A availability. The inhibitory effect of chlorophylls and carotenoids on provitamin A availability was confirmed by experiments using purified pigments. The inhibitory effect of fiber on bioavailability of provitamin A was also observed. Feeding experiments using purified provitamin A reveal that the actual provitamin A activity of commodities rich in α-carotene or β-cryptoxanthin may be higher than the values estimated by chemical analysis.

CROP MANAGEMENT

Sweet Potato Evaluation Trial

A field experiment was conducted to screen sweet potatoes for the use of its tips as a vegetable. Seven varieties including two local checks were evaluated. Tip yields of most of AVRDC's varieties were higher than the local checks. Based on yield performance and taste acceptability, it appeared that only D 66-L 37, CN 1397-3 and CN 1367-2 warranted further evaluation.

Vegetable Soybean Management

Yield and pod characteristics of vegetable soybeans were significantly affected by population density and spacing. Yield from population density of 400,000 plants/ha (10 x 25 cm spacing with 1 plant/hill) was higher than those from 200,000 and 300,000 plants/ha and as high as that of 800,000 plants/ha (10 x 25 cm spacing with 2 plants/hill). Wider spacing gave more pods/plant and had more unfilled pods, especially with increased inter-row spacing.

Screening for Seedling Media

Seedling vigor is one of many factors that affect crop yield significantly. With vigorous and healthy seedlings, higher yields may be expected. An experiment was carried out to determine if an improved seedling medium could be developed by blending locally available materials. Seven combinations of simple and easy-to-prepare media were compared with the standard medium. Based on seedling height and weight, there were three which gave better seedlings than the standard. These media were 1:3:1, 1:1:1 and 1:2:2 (soil:sand:compost).

Animal Manure as Soil Mix

Animal manure is widely used by farmers in the developing countries as a soil mix for seedling production. A trial was conducted to determine the effect of different media,

developed by blending chicken and cow manure with soil in various ratios, on seedling growth and yield of Chinese cabbage. Height and weight of seedlings were reduced when the concentration of animal manure in the media was too high. The result showed that chicken manure concentration should not be higher than 10% whereas that of cow manure could be as high as 25%. Yields from animal manure treatment tended to be higher than those of AVRDC soil mix and smoked rice hull treatments.

CROPPING SYSTEMS

Fertilizer and Previous Crop Factors for Chinese Cabbage

Suitable rotations and application of organic fertilizers are important to increase yields of vegetable crops and to maintain soil fertility. Chinese cabbage was grown after rice, tomato, Chinese cabbage and soybean, and five different organic fertilizers were applied. It was found that oilseed cake is the most effective organic fertilizer among those tested. Chinese cabbage is beneficial to grow after soybeans but harmful after tomatoes. Cropping systems, including rotation with paddy rice, seem important to intensive vegetable production and warrant further stucies.

Collecting and Testing 'New Vegetables'

The purpose is to gather more information on tropical vegetables for use in AVRDC's garden nutrition project, bilateral programs, and Center cooperators. The second set of 15 new vegetables was selected in 1986. A total of 533 varieties of these crops have been collected from 38 seed companies in 14 countries. Observational trials of some of

Malabar spinach

these crops were conducted during summer 1986. Results show that various entries of amaranth (8), big-fruit cucumber (2), small-fruit cucumber (2), malabar spinach (4), yardlong bean (7), cherry tomato (6), and water convolvulus (16), outperformed other entries. These entries will be included in advanced yield trials for further confirmation and nutritional studies.

Regional Yield Trials (RYTs)

Promising AVRDC lines are being tested in different environments in Taiwan through regional yield trials. This project is attempting to identify and gather useful information for testing methodologies for "environment-oriented research" which are being developed in the Production Systems Program. Comparing results of RYTs in 1985 and 1986, the following information might be useful in production systems: a) the integrated management techniques developed at AVRDC for soybean are reliable and quantitative analysis of the key factors contributing to yield gaps is needed; b) soybean spring cropping in Taiwan should be sown as early as possible, and forming beds is necessary; c) the relationship of tomato yields and temperature could be developed by using data from the RYT; and d) tomato yields might be reduced significantly if there is drought stress during early growth stages.

Seasonal Effects on Improved Soybean Varieties

It is important to understand crop-environment relationships in order to identify suitable production areas and also to fit suitable crop varieties into the existing cropping systems. Particularly in developing countries where strong national programs are not available, this kind of information can improve the efficiency of adaptation research of national programs. This project is, therefore, attempting to develop these crop-environment relationships for improved soybeans by using available data.

Results show that improved soybean lines AGS 66 and AGS 129 were less sensitive to day length during three cropping seasons at AVRDC. Sowing to flowering time was mainly related to mean daily maximum temperature. The yield components are dynamic and yields of soybean were clearly affected by seasons. Pod number per plant, a key yield component of soybean yield, was not significantly influenced by season.

CROSS-COMMODITIES PHYSIOLOGY

Evaluation of Heat Tolerance

Fifty-seven entries of different species and varieties of vegetables were assessed for heat tolerance of leaf tissues. The test involved controlled heating of excised leaf tissues to damage cell membranes and measurements of the leakage of electrolytes by the conductivity method. The degree of heat

tolerance could be expressed by the percentage of leaf tissue injury. In general, tested species which belong to Monocotyledoneae, and Convolvulaceae of Dicotyledoneae were more heat tolerant than other species. Tested species which belong to Cruciferae were heat sensitive. As a whole, test results agreed with what were expected for the field performance under high temperatures of any specific species.

Water-Use Efficiency

Water requirement and water-use efficiency of amaranth, cucumber, mungbean, soybean, sweet pepper, and water convolvulus were assessed during the early growth period under field capacity and high temperature conditions. Amaranth, a C4 species, appeared to be the most efficient in water use and required the least water during early growth. The PVF system seemed able to assess the water requirement and water-use efficiency of different vegetable species.

GARDEN PROGRAM

Home Gardens

Nutritional deficiencies among low-income groups in developing countries can be alleviated by people growing their own home vegetable gardens that contain nutrients deficient in their diets.

Over the last five years AVRDC has developed small, efficient home gardens that produce significant amounts of a family of five's RDA for protein, calcium, iron, and vitamins A and C. Gardens have been developed for Indonesia,

High-bed semi-arid vegetable garden

Thailand and the Philippines. A vitamin A garden was also developed to show that home food production of this nutrient can be a long-term alternative to vitamin A capsule distribution and inoculations. Results this year show that these gardens can contribute significantly to a family's needs for the mentioned nutrients.

School Garden

A school garden can be a way to introduce a variety of vegetables to children early in life, as well as provide supplementary nutrients to their school lunches. During the year, the AVRDC school gardens grew 24 different vegetables which provided, on a daily basis, more than one hundred 1/2-cup (113 g) portions of nutritious vegetables to add to ricebox lunches children bring to school. Each 1/2 cup portion can provide significant amounts of a 10-year-old's RDA for iron and vitamins A and C.

Urban Gardens

Growing nutritious crops in boxes or pots can be a way for urban families in developing countries to provide needed nutrients for their growing children. In two types of city gardens a small selection of crops was planted in containers. Data were collected on yield and nutritional outputs, and the gardens were evaluated in terms of their contribution to the RDA of two preschool children. Yields of the urban garden and 45-pot garden averaged 0.3 kg per day. The nutritional contribution to the RDA of two preschoolers was good for protein and calcium and excellent for iron and vitamins A and C. The 45-pot garden also gave excellent contributions of vitamins A and C. Both gardens produced a high number of daily harvests throughout the year.

Training

This year two of the AVRDC training scholars specialized in gardening. One, a nutritionist from Thailand, has returned to initiate a garden activity in the Northeast. The other, a community development specialist from Bophuthatswana, is now director of a vitamin A gardening project in her country.

Extension

Projects are being continued, planned or initiated in two Asian developing countries and in Africa. In Thailand an AVRDC gardening pilot project ended and the technologies are being transferred to provinces in the Northeast where vitamin A deficiency is a problem. In Indonesia AVRDC is assisting the Ministry of Health to initiate a garden project to alleviate iron and vitamin A deficiencies among families on tea plantations. In Africa, AVRDC is going to initiate an USAID-founded vitamin A gardening project for the Sahel region, developing semi-arid gardens, conducting training and workshops, and assisting graduates of the training program to initiate gardening activities in their home countries.

ON-STATION TESTING

Cooperative Projects

Promising AVRDC lines were tested in Taiwan through regional yield trials. Soybean variety AGS 66 and tomato hybrid PT 3027 were released during 1986 because of their outstanding performances. Entries which outperformed check entries in RYT and district yield trials (DYT) during 1985 and 1986 are: vegetable soybean - AGS 190 and AGS 292; Mungbean - VC 3738-A, VC 3678-A and VC 3116-A; processing tomato - PT 3027, PT 1600 and TM 103; fresh-market tomato - FMTT 3, FMTT 13, FMTT 14, FMTT 22 and FMTT 23; Chinese cabbage - (AVRDC) 82-46 and 83-20; sweet potato - CN 941-32, CN 1232-9 and CN 1345-8.

SOIL SCIENCE

Advanced Chinese Cabbage Culture

High seedling pot greatly increased both the head and total yields in the summer Chinese cabbage cultivation. It also protected the plants from such serious diseases as soft rot and turnip mosaic virus. When Chinese cabbage is cultivated in summer under high population density, the combination of high pot and polyethylene (PE) pot is highly recommended in order to avoid mutual shading and minimize disease infection.

Netting caused a significant yield loss; however, it eased rain damage and resisted even a strong typhoon. To produce summer vegetables with high quality, installation of some devices to avoid rain damage is strongly recommended.

Hybrid 82-156 was very sensitive to such unfavorable environments as low light intensity and cold weather and resulted in nonheading and bolting. No superiority over Hybrid No. 62 was observed.

Developing Improved Cropping Systems

All the cropping sequences tested were accepted to utilize all the information available from the related systems efficiently and effectively. A new data management system was proposed. The system is composed of three software programs, i.e. spread sheet, database and statistics which can run on the IBM PC. Fertilizer application rates to each crop in the different cropping sequences; nutrient accumulation in each plant part; nutrient balance under different crop combinations; soil nutrient variation; yield fluctuation; and factors affecting the yields are nicely predicted.

Recently released PT 3027

Noncirculating Hydroponics

AVRDC soil science is investigating a noncirculating hydroponic system which requires neither aeration nor checks of pH, electro conductivity (EC), temperature or nutrients. The only input required, once the facility is set up, is the addition of nutrients once every three weeks. The composition of nutrient solution need not change according to kind of crop. Soybean, sweet pepper, large fruited tomato, melon and cucumber were grown in the summer. Yields with the latter three were 3.3 kg (average fruit wt = 150 g), 2.34 kg and 4.72 kg/plant, respectively.

Advanced Tomato Culture

Fruit size of large-fruited tomato was greatly affected by different cultural practices and easily decreased under such undesirable environments as low light intensity, flooding and nutrient deficiency, while that of small-fruited tomato did not.

To select an adequate sticking method for summer tomato production was very important, and "training" not only increased the fruit size of EMTT 3 greatly, but also protected the large fruited tomato from lodging.

Three seedling pots tested, namely, high pot, soft high pot and long pot, were all promising to increase the yield of large-fruited tomato in a summer cultivation.

FMTT 4 and PT 4032, large-fruited tomato when protected from rain damage and provided both water and nutrient properly by drip irrigation, produced nearly 2 kg of fruits per plant within two months after transplanting, while both cultivars produced only 0.4 to 0.85 kg/plant in the field during the same period. Average fruit size of FMTT 4 and PT 4032 exceeded 135 g and 120 g, respectively, whereas, those in the field were, at most, 60 to 70 g.

On-time irrigation, successive application of nutrients and cultural practices to keep roots active throughout the growth period are very important in the summer cultivation of large-fruited tomato.

Soybean Continuous Cropping

Since the autumn of 1983, soybean has been cultivated twice a year, in the spring and autumn, on the same land. Soybean yield increased gradually year by year, and reached 4.5 t/ha in the spring planting of 1986. No continuous cropping hazard has been observed.

To utilize the data accumulated efficiently and effectively, a new data management system was proposed. This system can run on the IBM PC or a compatible machine. Once raw data is keyed into a spread sheet of this system, it is easily transferred to other programs such as database and statistical analysis. Soil science has already completed several subdata files regarding nutrient uptake, fertilizer application, soil nutrient distribution and cultural practices. Next year, more data files will be produced and made available to other disciplines. It is highly recommended to use the same format for data management, making possible data transfer within and between each program.

DEVELOPMENT PROGRAM

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TRAINING

Sixty-two participants from nine countries were trained at AVRDC in 1986. The trainees were enrolled in 13 subjects/disciplines within the three major programs for periods ranging from two weeks to 12 months and were supported by 11 sponsors, including AVRDC.

TROPICAL VEGETABLE INFORMATION SERVICE

The Tropical Vegetable Information Service (TVIS) is a multidisciplinary, multicomponent activity in which the role of the Development Program is one of coordination. The main activity of TVIS is the administration and coordination of the International Development Research Centre (IDRC) TVIS project. The TVIS-related bibliographic data bases contain over 912 completely processed records and will continue to be expanded. Approximately one-third of the expected TVIS project output has been completed. A total of 15 new publications are expected to be completed between January 1987 and the end of the project in May 1988. The 2nd International Symposium on Mungbean will be held in Bangkok, Thailand, 16-21 November 1987.

VEGETABLE INTERNATIONAL PROFESSIONAL SERVICE

The Vegetable International Professional Service (VIPS) was established within the Development Program in 1986 to: 1)

develop a multinational computer data base registry of vegetable experts in research and development which will serve as a pool of resource persons for AVRDC, donor agencies, national programs and private organizations; 2) conduct workshops, in cooperation with Training, on the importance of vegetables for various interest groups including national planners and policy makers; and 3) develop special projects and provide technical assistance for non-AVRDC - administered projects.

AVRDC-CARIBBEAN COOPERATIVE PROGRAM

The objective of research was to identify the variety of vegetables that are suitable for growing during the hot-wet season and/or year-round under eastern Caribbean conditions. Most of the experiments were conducted at the field station and only one was in a farmer's field. Different varieties of tomatoes, vegetable soybean, cauliflower, broccoli and snap bean were evaluated. The following varieties were found to be the best yielders for each crop: CL 5915-229D_4-1-5-0 and CL 5915-222D_4-0-4-0 for tomatoes; AGS 190 for vegetable soybean; Chia Tai No. 1, F 451 and Fengshan Extra Early for cauliflower; Early Value and Prize Head for broccoli; and Pai Chia and Black Cresback for snap bean.

AVRDC-INDONESIA BILATERAL PROGRAM

Highland Chinese Cabbage Variety Trial

Twelve entries of six OP breeding lines, six AVRDC hybrids, one Japanese F_1 hybrid variety (Nagaoka) and two locally released varieties were used for the highland trial at Lembang Horticultural Research Institute (LEHRI) in August 1986. An RCB design with three replicates was employed. The growth after 2-3 weeks of field transplanting looked normal. After that the growth was slow due to severe infection by club root (Plasmodiophora brassicae Woroniu). Hybrid 82-46 and OP 77 M(2/3)-43 had a tendency of giving a high number of heading plants. Hybrid 82-46 gave the highest number of bolting plants. The trial was terminated 36 days after transplanting.

Lowland Chinese Cabbage Variety Trial

Fourteen entries of six OP breeding lines, eight AVRDC hybrids and two locally released varieties were tested for lowland adaptation in Subang (elev. 200 m). Four AVRDC hybrids, AVRDC #1, HB 82-157, HB 82-46 and HB 83-2, gave high head yields and showed promise under lowland conditions. The head yields of the four hybrids were 13.5, 12.3, 11.8 and 10.5 t/ha, respectively, compared to 3.0 and

Lowland Chinese cabbage variety trial, Indonesia

1.4 t/ha of the two local check varieties, TALAUD and SANGIHE. Head- shape variation was also found in the two local varieties.

Lowland Tomato Variety Trial

Thirty-seven entries were used for the lowland trial at Subang in June 1986. Thirty-one entries thrived under lowland conditions and fruits were harvested for yield determination. Eighteen entries were segregrated for fruit-shape characteristics. The four AVRDC breeding lines which also gave fruit-shape variation were grown and selected for the third generation at LEHRI. Since no crossing was done among the AVRDC breeding lines or among the locally selected lines, the variation in fruit shape is thought to be due to the seed mixture among different lines during the postharvest process of seed drying and cleaning. It is recommended that careful selection and proper seed processing be employed among those breeding lines which were uniform in fruit shape and showed potential for the lowland growing conditions.

AVRDC-KOREA BILATERAL PROGRAM

Breeding for Heat-Tolerant Chinese Cabbage

Six inbreds were diallel-crossed and the hybrids tested together with their parents in 1986. Four combinations among 21 were selected for desired characteristics. The selected crosses will be tested again in 1987.

CMS in Chinese Cabbage

The morphology of Raphanus - originated CMS cultivars 60 Days and Cheongbang was very similar to their recurrent

parents. However, their hybrid vigor was not observed in some of the previous year's crosses. This year one more backcross was carried out. The results indicated that CMS lines in the BC_6F_1 and BC_7F_1 generations need more backcrosses to be isogenic to their recurring parents. Favorable plants of the CMS lines were selected for the female parent in the backcross program.

Three recurrent parents of Brassica juncea - originated CMS lines were crossed to their identical lines in the BC_2F_1 generation. The seed-setting ability, which had increased 10 times each year until 1985, unexpectedly worsened in 1986 for an unknown reason. Each CMS line in the field still showed severe chlorosis. Plants showing least chlorosis were selected for further backcrossing.

Four male sterile plants were found in a pedigree population of Korean native turnips, B. Campestris, in 1986. After identification of the genetic background, the plants will be backcrossed to Chinese cabbage inbreds in 1987.

Breeding of Nonstaking Processing Tomatoes

In addition to two previously tested cross combinations, two selected lines from selfed commercial F_1 hybrids from the USA and Japan were tested. The cross combinations performed similarly to last year, but the two selected lines showed low fruit-set per plant, meaning larger fruit size. These lines will be used as parents for larger and higher quality fruit.

Regional Adaptability for Processing Tomatoes

Five selected lines for nonstaking culture and four lines for staking were used at four test locations this year. Major horticultural traits, yield and field resistance were used as criteria. No promising lines or varieties surpassed the check variety, Jinhong. On Jeju Island, one more seeding date was added to investigate the possibility of fall growing and winter marketing of tomato.

Improving Staking Tomato Hybrids

The tomato hybrids released to commercial seed companies last year still require improvement in fruit size and quality. A Japanese F_1 hybrid will be used in several cross combinations for this purpose in 1987.

AVRDC-MALAYSIA VEGETABLE RESEARCH PROGRAM

Research activities were carried out at the main lowland vegetable research station and consisted mainly of variety trials involving both AVRDC crops and vegetables from other sources.

Tomato Evaluation Trial

Twenty-three advanced AVRDC tomato lines were evaluated in replicated yield trials and three lines were selected: CL 5915-93D4-1-0, CL 5915-223D4-2-1 and CL 5915-206D4-2-5. They had the same level of bacterial wilt resistance and yielding ability as the best check, but were superior with respect to fruit firmness, fruit size and resistance to leaf spot fungi.

Chinese Cabbage Evaluation

Nineteen advanced AVRDC Chinese cabbage lines were evaluated and these three lines selected: 77 M(2/3)-43, Hybrid 82-156 and 77 M(3)-40.

Sweet Potato Trial

A sweet potato observational trial involving 24 AVRDC elite selections was carried out, with the main objective of propagating the lines to provide enough planting material for yield trials. The lines were evaluated for reaction to scab.

Mungbean and Soybean Trials

Ten advanced mungbean and soybean lines each were evaluated in preliminary observational trials. Two mungbean and four soybean lines were identified as promising.

New Vegetable Program

Cauliflower, hot pepper and sweet pepper cultivars pretested at AVRDC were evaluated. Cauliflower cultivars Chia Tai No. 1 and F1 451 were found very promising, whereas Feng Shan Extra Early performed poorly. All three sweet pepper and five hot pepper cultivars performed very poorly.

A number of cultivars of various vegetable species, mainly commercial cultivars obtained from international seed companies, were evaluated in preliminary observational trials. Promising cultivars were identified among the following species; broccoli (4), cabbage (6), cauliflower (4), lettuce (3), hot pepper (4), and onion (4). No promising sweet pepper or garlic cultivars were identified.

Hot Pepper Viruses

A survey of virus diseases of hot pepper throughout Malaysia was carried out. Virus identification was done at AVRDC using ELISA. The survey revealed the following viruses: cucumber mosaic virus, tobacco etch virus, tobacco mosaic virus and tomato spotted wilt virus. Alfalfa mosaic virus and pepper mottle virus gave only weak reactions.

Asparagus Screening for Cercospora Blight

Forty-three asparagus cultivars were screened for resistance to Cercospora blight, the main asparagus disease

AVRDC Director General discussing cooperative program activities with Malaysian cooperators

observed so far in Malaysia. All were found susceptible to the disease.

Consultancy Visits

Consultancy visits to Malaysia were undertaken by an AVRDC breeder, the crop management specialist and the entomologist.

AVRDC-PHILIPPINE OUTREACH PROGRAM (POP)

Chinese Cabbage Trials

Twenty entries were evaluated for stable high yields in both wet and dry season PYTs. Only Hybrid 58 outyielded the check Reyna Elena (Hybrid 62) during the dry season, but the difference was not significant. Five promising AVRDC entries were evaluated in dry and wet season general yield trials (GYTs). No entry outperformed Reyna Elena in either season.

Mungbean Trials

Adaptability to local agroclimatic conditions with high bean yield potential, early and uniform maturity, resistance to common pests and diseases, and tolerance to lodging with acceptable eating and processing qualities are the criteria for selection in this project. Six lines (VC 3560-B-3-2, VC 3544-B-1-2, VC 3572-B-1-2, UC 3995-B-B, VC 3963-B-3 and VC 3971-B-2) produced an initial yield of more than 1.2 t/ha. Entry VC 3553-B-1-1 was highly resistant to Cercospora leaf spot and lines VC 3525-B-2-1, VC 3510-B-6-4, VC 3553-B-1-1 and VC 3525-B-1-2 were resistant to virus infection.

Adverse weather conditions in both seasons affected yields of this year's PYT. From the previous PYT 16 AVRDC lines were selected for inclusion in the GYT. From set E of the PYT, which has undergone four seasonal trials, two promising lines (VC 2307 and VC 2768) were selected for inclusion in the RYT.

Five AVRDC lines included in the RYT performed well in eight test locations. In the dry season, EG 2764 ranked first and EG 1131 ranked third among the 15 entries evaluated. In the wet season, EG 1973 and EG 1131 ranked second and third, repectively, showing adaptability in both seasons.

After six seasonal trials, EG 2764 was officially released by the Philippine Seedboard in June 1986 as BPI Mg5 for commercial production.

Seed Production Study

A study on seed production of variety Reyna Elena was conducted in cooperation with the Baguio Experiment Station. The purpose was to test the seed production technology developed by AVRDC under Philippine conditions and to determine the economic feasibility and identify the restraints relative to hybrid seed production. The study showed that seed production of hybrid Reyna Elena is feasible at Baguio using AVRDC technology and that the ideal month for seed production is November. Major constraints were Alternaria leaf spot, diamondback moth and cabbage flea beetle.

Soybean Trials

Twenty-seven stable lines/accessions were evaluated in a PYT during the wet and dry seasons. During the dry season trial, only G 90074 significantly outyielded the check. All entries were rated moderately susceptible to very susceptible to soybean rust. The low mean yield was attributed to low precipitation and early infection of soybean rust. Although no entry outyielded the check during the wet season trial, the yields of 15 entries did not differ significantly from it.

Sweet Potato Trials

Two plantings in a PYT to evaluate 24 AVRDC lines showed that entries CN 1423-438, CN 941-3 and CN 942-47 outyielded the check, BNAS. Entries CN 1345-8 and CN 1219-1 significantly outyielded the check in the second planting.

Eighteen lines/accessions were evaluated in the GYT during the wet and dry seasons of 1985-86. Five entries significantly outyielded the check. CI 1088-11, CI 1122, CI 1077-9, CI 980-16 and CI 1124-4 showed relatively stable marketable tuber yields.

Sweetpotato Weevil Resistance Study

Sweet potato accessions least damaged by potato weevil in the screening test at AVRDC were further screened at

POP. Twenty entries were evaluated without insecticide. All 20 entries were severely damaged by the weevil.

Tomato Single-Seed Descent Trial (SSD)

Nine AVRDC fresh-market tomato entries were included in a trial. Local check Marikit outyielded all entries. AVRDC lines CL 5915-206(G)D4-2 and CL 1131-0-0-43 had yields not significantly different from the check.

Tomato Trials

Two sets of plantings involving 27 AVRDC entries of fresh-market tomatoes under PYT showed that six lines significantly outyielded the check, Marikit. During the wet season, three lines (CL 1131-0-0-65-1-13-0-1, CL 5915-156 D_4-1 and CL 1131-0-0-38-4-0) also outyielded Marikit. Selections from the SSD showing potential characteristics for off-season production were used. Processing tomatoes were likewise screened for high yields and processing qualities.

After four seasons of GYTs, three lines from the first set (CL 1344-48, CL 1344-78 and CL 1094-88) were selected for the 1986 wet-season regional yield trial (RYT). In the second set (two wet-season plantings) entries CL 1131-0-0-34-4-12 and CL 5915-362 (G)-1 outyielded the check, Marikit.

Three AVRDC entries (CL 2784-1-2-5-2, CL 2815-1-1-7 and PT 1017 F_1) outyielded the check in the 1985-86 RYT. Results for the wet-season fresh-market tomatoes were not yet compiled.

AVRDC-THAILAND OUTREACH PROGRAM (TOP)

Chinese Cabbage

At four successive varietal trials at the TOP experimental site, the best yielder was an AVRDC OP line (77 M(2/3)-43) with 12.2 t/ha. Two new F_1 hybrids (82-156 and 82-157) yielded much lower than the older AVRDC lines (Hybrids 58,59 and 62). Although four AVRDC lines yielded more than the check, Elephant Brand, this long-headed variety was preferred at local markets.

Mungbean

Extensive experiments resulted in the official release of two AVRDC mungbean lines (VC 1973-A and VC 2778-A) for commercial production. They are named Kamphaeng Saen (KPS) 1 and 2, respectively, in honor of the new campus where the TOP station is located. Seed industry sources note that the area planted to these new mungbean varieties could reach 5,000 ha in the rainy season of 1987.

Agronomic Studies

Several experiments have been conducted to formulate suitable cultural practices for the new mungbean varieties. The recommendations thus far are broad and more studies are needed.

Soybean

Although some AVRDC lines performed better than the locally recommended cultivars, no soybean line has been released as a new cultivar yet. AGS 190 is used as a genetic source for large seed size.

Sweet Potato

Five cultivars were grown at the TOP KPS station using two cultivation methods — flat and ridged plots. Only cull root weight showed a significant difference between the two treatments. The different cultivation methods did not affect yield.

Tomato

Four tomato yield evaluation trials were conducted at the TOP KPS station. Eleven F_1 hybrids from AVRDC gave higher yields than VC 134-1-2, the commercial cultivar. In the rainy season experiment, PT 3027, PT 1599 and TM 103 gave the highest yields of 31-33 t/ha. Average fruit weight was small, about 30-50 g/fruit.

The new AVRDC determinate tomato line with a heat-tolerant gene had better fruit-setting ability than the commercial variety. However, fruit size, color and soluble solids of this line need improvement. The new AVRDC indeterminate breeding lines gave higher yields and fruit size over cultivar Seeda, a fresh- market tomato used in Thailand.

Fresh Tomato Improvement Program

The improvement program at the TOP KPS station is aiming to improve for 1) pink color at ripening stage, 2) year-round heat tolerance and high yield, 3) moderate firmness, 4) small but more than 25 g fruit size and 5) oval shape.

Home Garden

The home garden trials and their cultivation practices such as seed selection, fertilizer application and care of insect-disease-weed inputs were examined in preparation for training classes for agricultural extension officials from different regions in 1987.

REGIONAL PROGRAM

Thailand/AVRDC Regional Training Program

Fourteen trainees from China, Indonesia, the Philippines, Sri Lanka, Thailand and Vietnam successfully participated in the five-month fall/winter 1986-87 Regional Training Course for Vegetable Production and Research at TOP-AVRDC. Since 1983 a total of 64 scientists from 11 countries have attended TOP's Regional Training Program.

Trainees at TOP Regional Training Course

INFORMATION SERVICES

During 1986 the Office of Information Services (OIS) undertook, among others, the following activities:

Publication Activities

- Published 44,650 copies of 24 different publications which contained 1,942 camera-ready pages;
- Edited 11 major documents and 26 informal papers, authored one issue of Centerpoint, and compiled the 1985 Highlights brochure and Progress Report Summaries;
- Printed 650,000 pages required by 3,300 internal print requests;
- Prepared the color 1985 Highlights brochure and issued editions in Chinese, English, French, German, Indonesian, Italian, Japanese and Korean;
- Initiated discussions for copublication in Chinese of Soybean in Tropical and Subtropical Cropping Systems (Revised Edition) and the Diamondback Moth Management proceedings;
- Exhibited at the Tianjin and Frankfurt International Book Fairs; and
- Aided AVRDC scientists to: obtain publication of three journal papers, prepare five papers for future publications and prepare seven symposium presentations.

Public Relations Activities

- Issued two press releases; scheduled the international BBC radio program interview; directed the GTZ-sponsored film crew operation; scheduled the filming of Korean and Chinese film crews; and prepared a 3½ minute color video about AVRDC.

Data Bases

- Completed an update of the mailing list in which one-third of previous addresses were removed, thereby providing the Center with a tight and accurate communication data base.

Distribution Activities

- Distributed publications upon request to 1,000 readers worldwide;
- Prepared an AVRDC Distributive Agreement and obtained new commercial distributors in India, Japan, Malaysia and Thailand;
- Substantially increased the number of publications which will be distributed by sales, instead of on a complementary basis; and
- Presented "Towards a Cost-Effective Publication Policy" for consideration.

Publications Available

How to Order

All of the publications listed below can be ordered from the Office of Information Services (OIS), AVRDC. 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.

HDC Distributors

TRIOPS: Tropical Scientific Books
Raiffeisenstr. 24
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Notice to Librarians

AVRDC has had a long-standing policy of depositing one copy of its publications free of charge to all of the bona fide libraries on its mailing list. In order to maintain this policy AVRDC has established a Publication Distribution Fund which solicits donor contributions in order to cover the mounting costs of distribution. If this Fund is successful, it is hoped that besides continuing library distribution, AVRDC will also be able to continue to add new libraries to its complimentary mailing list.

Annual Progress Reports

1983 Report. 444 p.
1984 Report. 480 p.
1985 Report. 500 p.
(All issues of Progress Reports cost HDC $20.00; LDC $15.00)

Progress Report Summaries

1985 Summaries. 96 p.
1986 Summaries. 94 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)

Cowell, Robert (ed.). 1978. Tropical tomato: Proceedings of the first international symposium. 290 p. (HDC $18.00; LDC $10.00)

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., Edward Sulzberger and Bruce 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)

Lastimosa, Pura J. and Norma V. Llemit (eds.). 1987. Gardening Nutritious Vegetables; Proceedings of the Vegetable Improvement Gardening Workshop. (HDC $8.50; LDC $4.50)

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)

TB 2 Menegay, M. R. 1976. Farm management research on cropping systems. 19 p. (HDC $4.00; LDC $3.00)

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. 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)

TB 8 Calkins, P. H. 1978. Why farmers plant what they do: A study of vegetable Production technology in Taiwan. 92 p. (HDC $7.50; LDC $4.00)

TB 9 Calkins, P. H. and H. M. Wang. 1978. Improving the marketing of perishable commodities: A case study of selected vegetables in Taiwan. 65 p. (HDC $6.00; LDC $3.50)

TB 10 Calkins, P. H. and S. H. Tu. 1978. White potato production in Taiwan: A farm survey. 29 p. (HDC $4.00; LDC $3.00)

TB 11 Calkins, P. H. 1978. Soybean production in Taiwan: A farm survey. 28 p. (HDC $4.00; LDC $3.00)

TB 12 Riley, James J. 1978. Evaluation of environmental parameters in the humid tropics for crop scheduling purposes. 31 p. (HDC $4.00, LDC $3.00)

TB 13 Shanmugasundaram, S. 1979. Varietal development and germplasm utilization in soybeans. 36 p. (HDC $5.00; LDC $3.50)

TB 14 Caldwell, John S. and Donald W. Newsom. 1984. Vegetable consumption and production in two municipalities in Ilocos Norte, Philippines. 24 p. (HDC $4.00; LDC 3.00)

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)

Bibliographies

Talekar, N. S., H. C. Yang, S. T. Lee, B. S. Chen and L. Y. Sun (comps.). 1985. Annotated bibliography of diamondback moth. 469 p. (Gratis, limited stock distributed selectively)

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

Monographs

Bressani, Ricardo. 1982. World needs for nutrition and the role of vegetables and legumes. 22 p. (HDC $4.00; LDC $3.00)

Chandler, Robert F. 1983. The potential for breeding heat tolerant vegetables for the tropics. 10 p. (HDC $3.00; LDC $2.00)

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)

Liu, M. S. and Paul C. Ma. 1983. Postharvest problems of vegetables and fruits in the tropics and subtropics. 14 p. (HDC $3.00; LDC 2.00)

Wittwer, Sylvan H. 1983. Frontiers for science and technology in vegetable production. 19 p. (HDC $4.00; LDC $3.00)

Miscellaneous

AVRDC. 1987. Accomplishments, Goals and Structure. 23 p. (Gratis)

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

Franssen, C. J. H. 1934 [translated 1987]. Insect Pests of Sweet Potato Crop in Java. 24 p. (HDC $4.00; LDC $3.00)

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

Ahn, Chang-Soon, Jin-Hu Chen and Hao-koan Chen. 1985. International Mungbean Nursery (IMN) 1981 & 1983. 86 p. (Gratis, limited stock distributed selectively)

International Guide Sheets

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, Ruben L. and S. H. Lai. 1978. Pollen Collector. 2 p. (Gratis)

78-66 Riley, James J. 1978. AVRDC crop environment. 2 p. (Gratis)

78-101 Villareal, Ruben L. and S. H. Lai. 1978. Procedures for tomato evaluation trials. 4 p. (Gratis)

79-112 Shanmugasundaram, S. 1979. Suggested cultural practices for soybean. 2 p. (Gratis)

79-121 Hubbell, John N. 1979. Suggested cultural practices for sweet potato experiments. 2 p. (Gratis)

79-125 Shanmugasundaram, S. 1979. Evaluating AVRDC soybeans. 4 p. (Gratis)

79-127 Kuo, C. G. and S. H. Lai. 1979. Suggested cultural practices for tomato. 3 p. (Gratis)

80-134 Villareal, Ruben L. 1980. Procedures for sweet potato evaluation trials. 4 p. (Gratis)

80-144 Opena, Romeo T. and S. H. Lo. 1980. Procedures for Chinese cabbage evaluation trials. 6 p. (Gratis)

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

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

87-272 Yoon Jin-Young, Romeo T. Opena and Lien-chung Chang. 1987. Cultural practices for Chinese cabbage at AVRDC. 6 p. (Gratis)

Newsletters

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

TVIS News - This journal is prepared by the Tropical Vegetable Information Service (TVIS) through AVRDC and published twice a year. It provides a platform of exchange of information for scientists working with mungbean, soybean and Chinese cabbage. (HDC $4.00/issue; LDC $2.00/issue)

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

Journal Paper Reprints

JP 1 Mackenzie, D. R., L. Ho, T. D. Liu, Henry B. F. Wu and E. B. Oyer. 1975. Photoperiodism of mung bean and four related species. HortScience 10(5):486-487.

JP 3 Wu, Henry B. F., T. T. Yu and T. D. Liou. 1974. Physiological and biochemical comparisons of sweet potato varieties sensitive (Tai-Lung 57) and insensitive (Red-Tuber-Tail) to chilling temperatures. Bull. 12, Roy. Soc. of New Zealand, p. 483-486.

JP 5 Mew, I-pin C., T. C. Wang, and T. W. Mew. 1975. Inoculum production and evaluation of mungbean varieties for resistance to *Cercospora canescens*. Plant Dis. Reptr. 59:397-401.

JP 6 Mew, T. W. and W. C. Ho. 1976. Varietal resistance to bacterial wilt in tomato. Plant Dis. Reptr. 60:264-268.

JP 7 Mew, T. W., W. C. Ho and L. Chu. 1976. Infectivity and survival of soft-rot bacteria in Chinese cabbage. Phytopathology 66:1325-1327.

JP 9 Mew, T. W. and W. C. Ho. 1977. Effect of soil temperature on resistance of tomato cultivars to bacterial wilt. Phytopathology 67:909-911.

JP 13 Opena, R. T. and S. H. Lo. 1978. Derivation of matroclinal diploids in Chinese cabbage and evaluation of their significance in breeding. J. Amer. Soc. Hort. Sci. 103(6):820-823.

JP 15 Shanmugasundaram, S. and Samson C. S. Tsou. 1978. Photoperiod and critical duration for flower induction in soybean. Crop Sci. 18: 598-601.

JP 17 Kuo, C. G. and J. S. Tsay. 1977. Propagating Chinese cabbage by axillary bud culture. HortScience 12(5):456-457.

JP 20 Talekar, N. S., L. T. Sun, E. M. Lee, J. S. Chen, T. M. Lee and L. Lu. 1977. Residual behavior of several insecticides on Chinese cabbage. J. Econ. Entom. 70(6):689-692.

JP 27 Kuo, C. G., M. C. H. Jung and S. C. S. Tsou. 1978. Translocation of ^{14}C-photosynthate in mungbean during the reproductive period. HortScience 13:(5):580-581.

JP 29 Lim, W. L., S. H. Wang and O. C. Ng. 1978. Resistance in Chinese cabbage to turnip mosaic virus. Plant Dis. Reptr. 62:660-662.

JP 31 Villareal, R. L. 1979. Use of sweet potato (*Ipomoea batatas*) leaf tips as vegetables. Expl. Agric., 15(2):113-127.

JP 33 Villareal, R. L. Observations on multiple cropping in Taiwan. Philipp. J. Crop Sci. 1(3):129-136.

JP 34 Villareal, R. L. 1976. The philosophy in the tomato and sweet potato breeding programs of the Asian Vegetable Research and Development Center. Philipp. J. Crop Sci. Jan. - March 1976:32-35.

JP 36 Cowell, Robert C. 1976. Vegetable Research in Southeast Asia: The Asian Vegetable Research and Development Center. Entwicklung + Landlicher. Vols. 5 & 6.

JP 38 Ho, Leonard. 1976. Some aspects of seed production and distribution in Asia. Seed Technology in the Tropics. p. 179-205.

JP 39 Villareal R. L., S. K. Lin and S. H. Lai. 1979. Variations in the yielding ability of sweet potato under drought stress and minimum input conditions. HortScience 14(1):31-32.

JP 40 R. L. Villareal, S. C. Tsou, S. H. Lai and S. L. Chiu. 1979. Selection criteria for eating quality in steamed sweet potato roots. J. Amer. Soc. Hort. Sci. 104(1):31-33.

JP 41 Yang, C. Y. 1977. Past and present studies of soybean rust incited by *Phakopsora pachyrhizi* Syd. Bull. Inst. Trop. Agr. Kyushu Univ., Japan. 2:78-94.

JP 42 Cowell, R. L. and C. L. Luh. 1978. International research in agriculture. Span 21(3):104-106.

JP 45 Opeña, R. T. and S. H. Lo. 1979. Genetics of heat tolerance in heading Chinese cabbage. HortScience 14(1):33-34.

JP 46 Shanmugasundaram, S. 1979.Variation in the photoperiodic response of several characters in soybean, *Glycine max* (L.) Merrill. Euphytica 28:495-507.

JP 47 Talekar, N. S. 1980. Search for host plant resistance to major insect pests in Chinese cabbage. In: Proceedings of the Symposium on the Production and Insect Control of Cruciferous Vegetable in Taiwan. April 17-18, 1980. Plt. Prot. Center, Taichung, Taiwan.

JP 48 Riley, James J. and Merle R. Menegay. 1978. Intensive agricultural practices in Asia. J. Food Proc. and Pres. 2:197-203.

JP 49 Villareal, R. L., S. K. Lin, L. S. Chang and S. H. Lai. 1979. Use of sweet potato (*Ipomoea batatas*) leaf tips as vegetables. Expl. Agric. 15:113-116.

JP 50 Hubbell, John N., Jr. 1980. The germplasm accession information system at the Asian Vegetable Research and Development Center (AVRDC). HortScience, 15(1):17-21.

JP 51 Tschanz, A. T. and T. C. Wang. 1980. Soybean rust development and apparent infection rates at five locations in Taiwan. Prot. Ecol., 2:247-250.

JP 52 Shanmugasundaram, S. and M. S. Lee. 1980. Influences of night temperature on the flowering of the photoperiod sensitive and day-neutral soybeans. In: Proceedings of legume in the tropics. Faculty of Agriculture. Universiti Pertanian Malaysia, Serdang, Selangor, Malaysia. p. 53-66.

JP 54 Kuo, C. G., J. S. Tsay, C. L. Tsai and R. J. Chen. 1981. Tipburn of Chinese cabbage in relation to calcium nutrition and distribution. Scientia Hortic. 14:131-138.

JP 55 Shanmugasundaram, S. and M. S. Lee. 1981. Flower-inducing potency of different kinds of leaves in soybean, *Glycine max* (L.) Merr. Bot. Gaz. 142(1):36-39.

JP 56 Chin, Michael. 1980. Administration of a research center under constraints – some ways of cutting costs. Entwicklung + Landlicher raum 5:5-9.

JP 57 Riley, J. J. and J. C. Moomaw. 1979. Vegetable production in tropical Asia. The Conference on Tropical Foods: Chemistry and Nutrition. Honolulu, Hawaii, March 28-30, 1979.

JP 58 Kuo, C. G., F. H. Hsu, J. S. Tsay and H. G. Park. 1980. Variation in specific leaf weight and RuDPCase activity in mungbean. Can. J. Plant Sci. 60:1059-1062.

JP 59 Chiang, H. S. and N. S. Talekar. 1980. Identification of sources of resistance to the beanfly and two other agromyzid flies in soybean and mungbean. J. Econ. Entom. 73(2):197-199.

JP 60 Kuo, C. G., J. S. Peng and J. S. Tsay. 1981. Effect of high temperature on pollen grain germination, pollen tube growth, and seed yield of Chinese cabbage. HortScience 16(1):67-68.

JP 61 Inouye J. and C. G. Kuo. 1981. Flower initiation of *Brassica* species under total darkness. HortScience 16(2):192-193.

JP 62 Villareal, R. L. and S. H. Lai. 1981. Cultivar responses of tomatoes to relay cropping. HortScience 16(4):552-553.

JP 63 Kuo, C. G., M. H. Chou and H. G. Park. 1981. Effect of Chinese cabbage residue on mungbean. Plt. and soil 61:473-477.

JP 64 Talekar, N. S. and Yuo Hwa Lin. 1981. Two sources with differing modes of resistance to *Calloso bruchusci chinensisci* in mungbean. J. Econ. Entom. 74(5):639-642.

JP 65 Shanmugasundaram. S. 1981. Varietal differences and genetic behavior for the photoperiodic responses in soybeans. Bull. Inst.Trop. Agr. Kyushu Univ. 4:1-61.

JP 66 Kuo, C. G., J. S. Tsay, B. W. Chen and P. Y. Lin. 1982. Screening for flooding tolerance in the genus *Lycopersicon*. HortScience 17(1):76-78.

JP 67 Shanmugasundaram, S., C. R. Yen and T. S. Toung. 1982. Genotypic

response to maximum and minimum input in soybean. In: Proc. of the plt. breeding symp., ROC Reg. Soc. of SABRAO and the Agric. Assoc. of China.

JP 68 Kuo, C. G. and R. S. Huang. 1982. Effect of vesicular-arbuscular mycorrhizae on the growth and yield of rice-stubble cultured soybeans. Plt. and Soil 64:325-330.

JP 69 Talekar, N. S. 1982. Effects of sweet potato weevil (Coleoptera: Curculionidae) infestation on sweet potato root yields. J. Econ. Entom. 75(6):1042-1044.

JP 70 Talekar, N. S. 1983. Infestation of sweet potato weevil (Coleoptera: Curculionidae) as influenced by pest management techniques. J. Econ. Entom. 76(2):342-344.

JP 71 Tsay, J. S., W. L. Kuo and C. G. Kuo. 1983. Enzymes involved in starch synthesis in the developing mungbean seed. Phytochemistry 22(7):1573-1576

JP 72 Talekar, N. S., J. S. Chen and H. T. Kao. 1983. Long-term persistence of selected insecticides in subtropical soil: Their absorption by crop plants. J. Econ. Entom. 76:207-214.

JP 73 Talekar, N. S. J. S. Chen and H. T. Kao. 1983. Persistence of fenvalerate in subtropical soil after repeated biweekly applications over two years. J. Econ. Entom. 76:711-716.

JP 74 Talekar, N. S., H. T. Kao and J. S. Chen. 1983. Persistence of selected insecticides in subtropical soil after repeated biweekly applications over two years. J. Econ. Entom. 75:711-716.

JP 75 Sajjapongse, A. and Y. C. Roan. 1983. Effect of shading and leaf-tying on summer Chinese cabbage. HortScience 18(4):464-465.

JP 76 Talekar, N. S. and B. S. Chen. 1983. Seasonality of insect pests of soybean and mungbean in Taiwan. J. Econ. Entom. 76:34-37.

JP 77 Talekar, N. S. and B. S. Chen. 1983. Identification of sources of resistance to limabean podborer (Lepidoptera:Pyralidae) in soybean. J. Econ. Entom. 76:38-39.

JP 78 Ruelo, J. S. 1983. Integrated control of *Meloidogyne incognita* on tomato using organic amendments, marigolds, and a nematicide. Plt. Dis. 67:671-673.

JP 80 Kuo, C. G. and C. T. Tsai. 1984. Alternation by high temperature of auxin and gibberellin concentrations in the floral buds, flowers, and young fruit of tomato. HortScience 19(6):870-872.

JP 82 Talekar, N. S. and K. W. Cheng. 1987. Nature of damage and sources of resistance to sweetpotato vine borer (Lepidoptera:Pyralidae) in sweet potato. Journal of Economic Entomology 80:788-791.

JP 84 Green, S. K. 1985. Turnip mosaic virus strains in cruciferous hosts in Taiwan. Plt. Dis. 69(1):28-31.

JP 87 Kuo, C. G., H. M. Chen and L. H. Ma. 1985. Effect of high temperature on proline content in tomato floral buds and leaves. J. Amer. Soc. Hort. Sci. 111(5):746-750.

JP 88 Selleck, G. W. and R. T. Opeña. 1985. National Programs: the need for increased emphasis on the development of vegetables and legumes. FFTC Book Series No. 30, p. 54-66.

JP 89 Talekar N. S. 1987. Host plant resistance to insects attacking soybean and mungbean in the tropics. Insect Science and its Application.

JP 90 Talekar, N. S. 1987. Influence of cultural pest management techniques on the infestation of sweetpotato weevil. Insect Science and its Application.

JP 91 Talekar, N. S. 1987. Resistance in sweet potato to sweetpotato weevil. Insect Science and its Application.

JP 92 Talekar, N. S. 1987. Talekar, N. S. 1987. Feasibility of the use of resistant cultivar in sweetpotato weevil control. Insect Science and its Application.

JP 93 Green, S. K. and D. R. Lee. 1986. Occurrence of an unidentified potyvirus of soybean in Taiwan. In: Tropical Agriculture Research Series No. 19.

JP 94 Green, S. K. 1986. Virus diseases of tomato and Chinese cabbage in Taiwan and sources of resistance. In: Plant Virus Diseases of Horticultural Crops in the Tropics and Subtropics, FFTC Book Series No. 33.

JP 95 Kuo, C. G., B. J. Shen, H. M. Chen, H. C. Chen and R. T. Opeña. 1987. Associations between heat tolerance, water consumption, and morphological characters in Chinese cabbage. Euphytica.

JP 96 Green, S. K. 1987. Two poty viruses in sweet potato. Tropical Pest Management.

JP 97 Green, S. K., L. L. Hwang and Y. J. Kuo. 1986. Epidemiology of tomato mosaic virus in Taiwan and identification of strains. Journal of Plant Diseases and Protection.

JP 98 Kratky, B.A. and Y.C. Roan. 1987. A steel reinforced, concrete filled PVC pipe shelter for vegetable seedlings. p. 140-145. In: Hemphill, D.D.,Jr. and N.S. Mansour, eds. Proceedings of the Twentieth National Agricultural Plastics Congress.

GENETIC CONSERVATION

Germplasm Acquisition

A total of 3,471 accessions of the six principal crops was introduced in 1986. The USDA soybean lines contributed about 50% of the total germplasm introduction. The Genetic Resources and Seed Unit (GRSU) has been actively engaged in a world-wide acquisition of pepper germplasm resulting in 942 new introductions. Recently, 29 Brassica juncea, 5 B. campestris Korean landraces, and 100 sweet potato clones from Thailand were introduced.

Germplasm Conservation

Currently, a germplasm collection of about 22,297 accessions of AVRDC principal crops is maintained as base (long-term storage) and active (medium-term storage) collections. In addition to the 1,219 sweet potato clones that are maintained in the field gene bank, about 600 clones are also conserved in an in vitro active collection to ensure against the loss of valuable genetic materials due to environmental hazards.

Characterization

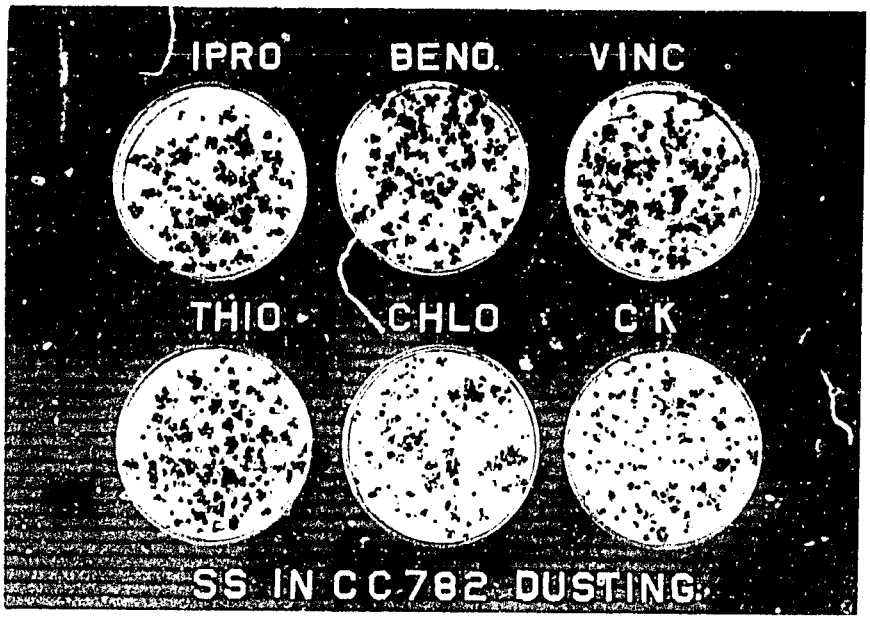
Characterization and evaluation for morphological and biochemical traits are emphasized at GRSU. The IBPGR descriptor lists are closely followed in characterizing the six principal crops. Characterization of the entire mungbean and Asian soybean collections, and 376 open-pollinated Chinese cabbage accessions has been completed. Soybean, mungbean and sweet potato were also evaluated for nutritional characteristics.

Documentation

A computerized central data base consisting of passport, characterization, germplasm catalogs and seed inventory data bases is underway on the HP 3000 microcomputer using the software package "MINISIS". Passport data and the important characteristics will be compiled from the central data bases, and the germplasm catalogs of AVRDC principal crops will be released.

Germplasm Utilization

The majority of AVRDC germplasm collections are evaluated by both the AVRDC and international scientists. A total of 17,747 seed packets was distributed to 99 countries or territories in 1986. Thailand, the USA, the Philippines, Japan, and India received more than 1,000 seed packets of AVRDC principal crops. This year, 4,004 seed packets were internally distributed to scientists.



Experimental seed treatments against seed-borne pathogen (Sclerothinia sclerotiorum)

Seed Treatment for *Sclerotinia sclerotiorum*

Seed treatment with iprodione, benomyl and vinclozolin reduced the losses caused by seed-borne pathogen S. sclerotiorum in B. campestris accessions B 472 and B 782. Thiophanate-methyl and chlorothalonil treatments were effective only in B 782.

Control Measures Against Black Mold

Treatment of Brassica campestris seeds with a soaking or dusting of iprodione gave outstanding control against seed-borne Alternaria brassicicola and A. alternata diseases. Treatment with sodium hypochlorite or hot water failed to control black mold. Captan, Thiram and Dithane M-45 treatments gave partial control in the 70-day vernalization period.

Breaking Seed Dormancy in Chinese Cabbage

A solution of potassium nitrate (1000 ppm), gibberellin (10-50 ppm) or the combination of thiourea and gibberellin can break seed dormancy of Chinese cabbage breeding line 83-20-D.

Training

Fourteen trainees from six countries participated in the second mini-workshop on seed production technology from June 2 to 6, 1986. The topics covered were seed and seed production, cleaning, drying, packing, storing, viability, seed health and seed quality control.

Germplasm Recipients 1986

Anguilla (UK)

Sunni Isle Gardens

Antilles (Netherlands)

Department of Agriculture, Husbandry and Fishery

Argentina

Agencia de Extension Piloto Metán, Instituto Nacional de Tecnologia Agropecuaria (INTA)-SEAA
Compania Continental S. A.
Estacion Experimental Agro-Industrial
Estacion Experimental Agropecuaria (EEA) San Pedro
Federacion Argentina de Cooperativas Agrarias Coop. Ltda.

Australia

Commonwealth Scientific and Industrial Research Organization (CSIRO)
Plant Quarantine Service
Redlands Horticultural Research Station
Vegetable and Allied Crops Branch, Department of Agriculture

Bahamas

Department of Agriculture

Bangladesh

Commission Agent, Indentor and Importer
Institute of Postgraduate Studies in Agriculture
MCC
Mennonite Central Committee
Nural Islam Siddique

Belize

United States Agency for International Development (USAID)

Bhutan

Department of Agriculture, EC

Bolivia

'PEROTO' Expt. Station
Proyecto Oleaginosas - IBTA

Botswana

The Botswana Development Corporation, Ltd.
Department of Agricultural Research

Brazil

Bioplanta Tecnologia de Plantes Ltda.
Coordinator of Plant Introduction Exchange and Quarantine, EMBRAPA/ CENARGEN
Instituto Agronomico

Brunei

Sinat Agricultural Training Centre

Burma

Burma-IRRI Farming System Project, Agricultural Research Institute

Burundi

Institut des sciences agronomiques du Burundi (ISABU)

Cambodia

Church World Services

Cameroon

Comite diocesain de développement

Canada

Agriculture Canada Research Station
Harrow Research Station
Stokes Seeds, Ltd.
University of Guelph

Chad

Institut de recherche du coton des textiles exotiques (ICRT)

Chile

Oficina Regional de la FAO Para America Latina y el Caribe

Colombia

Centro Internacional de Agricultura Tropical (CIAT)

Federacion Nacional de Cafeteros de Columbia
Instituto Linguistico de Verano

Cook Island

Tokoitoku Research Station

Costa Rica

Chinese Agricultural Technical Mission
Ministerio de Agricultura y Ganaderia

Egypt

Field Crop Research Institute, ARC
Minufiya University

El Salvador

Vivero Merliot

Ethiopia

Awasa Agricultural Research Station
FAO
Institute of Agricultural Research

Fiji

Food Processors (Fiji), Ltd.
Plant Protection Project/UNDP
Sigatoka Research Station

French Polynesia

Centre de coopération internationale en recherche agronomique pour le développement (CIRAD)

France

Station d'amélioration des plantes maraichères
PROLEA, G.I.E. de recherches agricoles et agroalimentaires spécialisées

Germany, Federal Republic of

Bayer AG

Ghana

Irrigation Development Authority

Grenada

Agriculture Development Co., Ltd.

Instituto Interamericano de Cooperacion Para la Agricultura (IICA)

Guadeloupe (France)

Centre de recherches agronomiques des Antilles et de la Guyana

Guatemala

Science and Agricultural Technology Institute

Guinea-Bissau

Mission française de coopération

Guyana

Institut de recherches agronomiques tropicales et des cultures vivrières (IRAT)
National Agricultural Research Inst.

Haiti

Ferme Tonton Ben
Le centre de développement de patte large

Honduras

Encargado Regional de Hortalizas Recursos Naturales
Universidad Nacional Autonoma de Honduras

Hungary

Research Center for Agrobotany

India

Allahabad Agricultural Institute
Andeman and Nicobar Group of Islands
Central Agricultural Research Institute
The Chandigarh Co-op. Kitchen Gardening Society, Ltd.
Farmers Forum and Small Scale Industries Consultant
Fredrick Institute of Plant Protection and Toxicology
Haryana Agricultural University
Himachal Pradesh Agricultural University
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S. K. University of Agricultural Sciences and Technology
The University of Agricultural Sciences
Wimco Seedlings, Ltd.

Indonesia

Akademi Farming Semarang
Central Research Institute for Horticulture
Chinese Agricultural Technical Mission
Gadjah Mada University
Indonesia-Australia N.T.T. Livestock Development Project
Lembang Horticulture Research Institute
Malang Research Institute for Food
Padjadjaran University
Sub Balai Penelitian Tahaman
Segunung Sub Research Institute for Horticulture

Israel

Ministry of Agriculture

Italy

First Biosintesi Vesetali
FAO
International Board for Plant Genetic Resources (IBPGR)
Nunhems Seed Company
Sementi Nunhems S. R. L.

Jamaica

Ministry of Agriculture
Plenty Canada

Japan

Nagasaki Agricultural Association
National Institute of Agrobiological Resources (NIAR)
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Vegetables and Ornamental Crops Research Station

Jordan

University of Jordan

Kenya

A. D. C. Potato Project
Horti Seed Kenya, Ltd.

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Han Nong Seed Company
Institute of Agricultural Sciences
International Technical Cooperation Bureau
Jeonnan National University
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Malaysia

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Malaysian Agricultural Research and Development Institute (MARDI)
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University Kebansaan
University of Malaya

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CIPEA
Institut d'économie rurale

Martinique Islands (France)

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Ministry of Agriculture, Fisheries and Natural Resources
University of Mauritius

Micronesia

Department of Economic Development
Ponape Agriculture and Trade School

Nepal

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Institute of Agriculture and Animal Science
Vegetable Seed Production Project

Netherlands

Bruinsma B. V.
Royal Sluis
Samen Grains Seeds

New Zealand

DSIR
Marlborough Research Centre
Massey University

Nicaragua

Finca la Esperanzita

Nigeria

Eson Farms, Ltd.
International Institute of Tropical Agriculture (IITA)
Omoregie & Sons Farms, Ltd.

Norway

Landvik Agricultural Research Station

Pakistan

Agricultural Research Institute
National Agricultural Research Centre
Pakistan Agricultural Research Station
STM International

Panama

Chinese Agricultural Technical Mission
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International Potato Center (CIP)

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Pioneer Overseas Corporation
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Regional Crop Protection Center
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Sarmiento Research and Development Corporation
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Qassim Agriculture Research Center

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Agricultural Research Station
Coconut Research Institute
Diversified Agricultural Project
Faculty of Agriculture, Peradeniya
IIMI
Tea Research Institute
University of Ruhuna
USAID/SL

St. Kitts

Chinese Agricultural Technical Mission

St. Lucia

Caribbean Agricultural Research and Development Institute (CARDI)

Surinam

Ministerie van Landbouw, Veeteelt en Visserij

Swaziland

Malkerns [illegible]arch Station
Ministry of [illegible]ulture and Cooperatives

Sweden

Nordic Genebank for Agricultural and Horticultural Plants

Syria

Ministry of Agriculture and Agrarian Reform

Tahiti

Centre de coop. internationale en recherche agronomique pour le développement

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Kaohsiung DAIS
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Chiang Mai Field Crop Research Center
Chiang Mai University
Chia Tai Company, Ltd.
East-West Seed Company
FAO, RAPA
Kasetsart University
Maejo Institute of Agricultural Technology
Mahidol University
Phitsanulok Field Crop Experiment Station
Thai Farm Tech. Co., Ltd.

Tonga

Department of Agriculture
Hango Agricultural College

Trinidad

The University of the West Indies

Tunisia

Institut national de la recherche

Turkey

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United Arab Emirates

University of United Arab Emirates

United Kingdom

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Uruguay

Estacion Experimental Agropecuaria del Este
Estacion Experimental del Norte

USA

Alf. Christianson Seed Company
Asgrow Seed Company
Auburn University
BHN Research
Campbell Institute for Research and Technology
C. F. Kettering Res. Laboratory
ECHO, Inc.
Harris Moran Seed Company
Heinz, USA
Iowa State University
Irrigated Desert Research Station
Israel Trade Center
Joseph Harris Co., Inc.
The Land, Epcot Center
Land O'Lakes, Inc.
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Senior Scientific Personnel

Administration

George A. Marlowe, Jr., Ph.D., Director General
Paul M. H. Sun, Ph.D., Deputy Director General
Michael Chin, B.S., Director of Administration
David I. K. Chi, G.A., C.P.A., Comptroller

Crop Improvement Program

Program Director: Romeo T. Opeña

Breeding, Chinese Cabbage

Jin-Young Yoon, Ph.D., Associate Plant Breeder
Lien-chung Chang, B.S., Assistant Specialist

Breeding, Mungbean

George C. J. Fernandez, Ph.D., Research Associate
Ren-cheih Jin, B.S., Research Assistant[1]
Hao-koan Chen, M.S., Principal Research Assistant

Breeding, Pepper

Jin-Young Yoon, Ph.D., Associate Plant Breeder
Lien-chung Chang, B.S., Assistant Specialist

Breeding, Soybean

S. Shanmugasundaram, Ph.D., Plant Breeder[1]
Kun-te Lee, Senior Research Assistant
Li-fen Chen, M.S., Principal Research Assistant

Breeding, Sweet Potato

Hiroko Takagi, Ph.D., Research Associate
Takao Ando, M.S., Visiting Senior Sweet Potato Breeder
Liang-yu Chien, B.S., Research Assistant
Masaru Iwanaga, Ph.D., Visiting Scientist from CIP[1]

Breeding, Tomato

Romeo T. Opeña, Ph.D., Plant Breeder
Jen-tzu Chen, Assistant Specialist

Entomology

N. S. Talekar, Ph.D., Entomologist
Chih-pin Lin, B.S., Senior Research Assistant
Jer-chyuan Yang, M.S., Principal Research Assistant
Min-yi Liu, M.S., Principal Research Assistant‡
Yin-huey Lee, M.S., Principal Research Assistant
Song-tay Lee, B.S., Senior Research Assistant‡‡
Shang-wen Hwang, B.S., Research Assistant‡
Jen-wang Hou, B.S., Research Assistant

Plant Pathology

Arnold T. Tschanz, Ph.D., Plant Pathologist, Head, Plant Pathology
Tien-cheng Wang, B.S., Associate Specialist
Hao-jan Lin, B.S., Research Assistant
Yao-hua Cheng, B.S., Research Assistant
Chao-feng Wang, M.S., Principal Research Assistant
Ming-ming Chao, M.S., Principal Research Assistant‡

Sylvia K. Green, Ph.D., Associate Plant Pathologist (Virology)
Dar-zen Lee, M.S., Principal Research Assistant
Yen-jen Kuo, M.S., Principal Research Assistant

Plant Physiology

George C. Kuo, Ph.D., Plant Physiologist
Huei-mei Chen, M.S., Principal Research Assistant
Hsiu-chu Chen, M.S., Principal Research Assistant

Production Systems Program

Program Director: Samson C.S. Tsou

Crop Management

Adisak Sajjapongse, Ph.D., Associate Crop Management Specialist*
Bernard A. Kratky, Ph.D., Visiting Scientist from University of Hawaii, Hilo‡
Yu-chi Roan, B.S., Assistant Specialist
Mei-huey Wu, B.S., Senior Research Assistant

Cropping Systems

James J. S. Tsay, Ph.D., Research Associate

Nutrition/Vegetable Gardens

Jack Gershon, Ph.D., Nutritionist
Shoai-tzy Yang, M.S., Principal Research Assistant
Lee-ju Chen, M.S., Principal Research Assistant‡

On-Station Testing

Sen-hsiung Lai, B.S., Associate Development Officer

Soil Science

Hideo Imai, Ph.D., Soil Scientist
Chin-hua Ma, B.S., Research Specialist
Chi-hsin Lu, M.S., Principal Research Assistant‡
Ching-liu Wu, B.S., Research Assistant

Development Program

Program Director: Arnold T. Tschanz

Cooperative Programs

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Jung-Ho Kim, Ph.D., Director, The Korean Sub-Center Affiliated with AVRDC, Horticultural Experiment Station, Rural Development Administration, Suweon, Republic of Korea

El Mostafa Saadaoui, Ph.D., Resident Scientist, Malaysia/AVRDC Vegetable Research Program, MARDI, Jalan Kebun, Kelang, Selangor, West Malaysia

Benjamin P. Legaspi, Affiliate Horticulturist, AVRDC/Philippine Outreach Program, Bureau of Plant Industry, Economic Garden, Los Baños, Laguna, Philippines

Charles Y. Yang, Ph.D., Director and Resident Scientist, Thailand Outreach Program/AVRDC, P.O. Box 9-1010, Kasetsart, Bangkok 10903, Thailand

Training

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Jia-chi Cheng, B.S., Training Assistant‡
Yuan-chin Yang, B.S., Training Assistant
Su-jenn Wen, B.S., Training Assistant

Regional Programs

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Jack Gershon, Ph.D., Chief of Party, Sahelian/AVRDC Vitamin A Project, B.P. 12820, Niamey, Niger

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Chemistry

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Kuang-kung Kan, M.S., Assistant Specialist
Shu-jen Wang, M.S., Principal Research Assistant
Shyun-shyun Lee, M.S., Principal Research Assistant‡

Computer and Statistical Services

Hsien-yang Tien, B.S., Principal Computer Assistant
Yuh-ling Chen, B.S., Computer Assistant
Ke-lung Shih, B.S., Statistical Assistant

Experimental Farm

Teng-sheng Tu, B.S., Farm Superintendent

Genetic Resources and Seed Unit (GRSU)

Chong-seng Tay, Ph.D., Associate Seed Technologist (on leave Oct. '86-July '87)
George C.J. Fernandez, Ph.D., Acting Head, GRSU, (Oct. '86-July '87)
Jin-huei Lu, M.S., Principal Research Assistant
Yung-kuang Huang, B.S., Research Assistant
Chew-ann Chen, B.S., Research Assistant
Wen-hsiu Kuo, B.S., Research Assistant

Information Services

Bruce T. McLean, B.A., Associate Information Specialist
Pura J. Lastimosa, M.A., Assistant Information Specialist‡

Library

Teng-hui Hwang, B.A., Senior Librarian
Pei-ling Hwang, M.S., Documentalist

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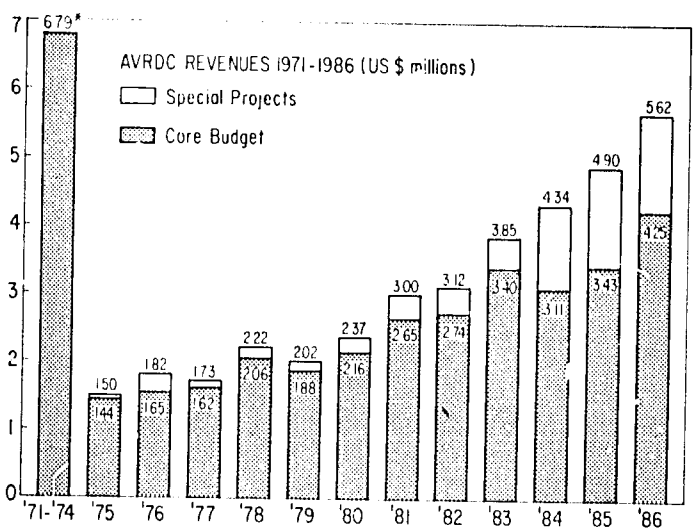
‡ Left during 1986.
‡‡ Advanced study leave.
† Returned from sabbatical (August 1986).
* Returned from assignment at CARDI, St. Lucia, West Indies.

Finances

AVRDC's projected budget for 1986 was US $5,524,900 compared with an actual income of US $5,616,455 and expenditures of US $5,596,283. Core funding was provided by the governments of the Republic of China, the United States, the Philippines, the Republic of Korea, Japan, and Thailand and restricted core by the Federal Republic of Germany.

Grants and other forms of assistance were also received from:

- Asian Development Bank
- International Development Research Centre (Canada)
- International Board for Plant Genetic Resources
- Council of Agriculture (ROC)
- National Science Council (ROC)
- Land O'Lakes, Inc.
- Taiwan Kagome Co.



*US $ 4.2 million for capital expenditures 1971-74