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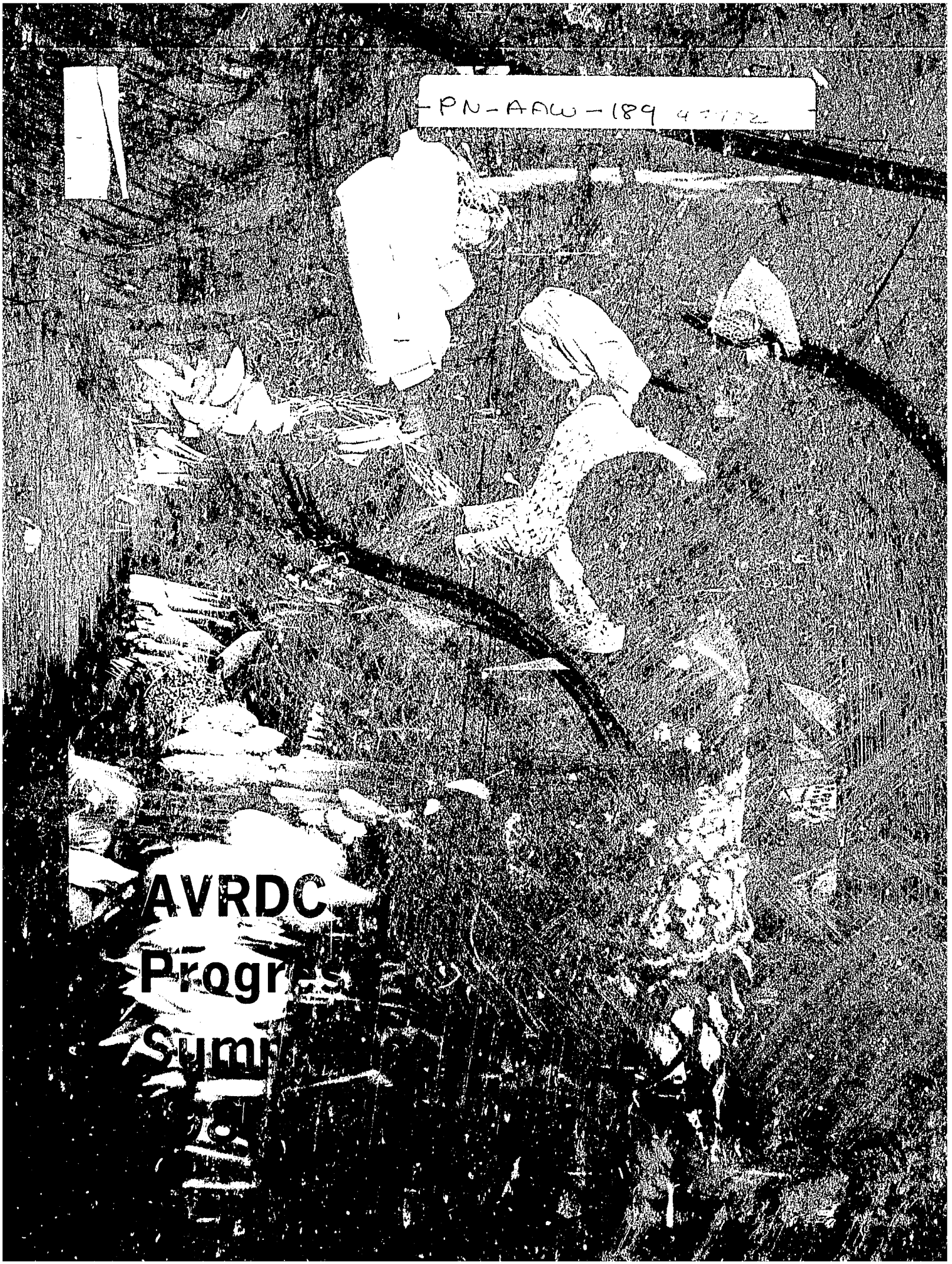

AVRDC Progr Sum

The Asian Vegetable Research and Development Center (AVRDC) is the international center with a mandate for vegetable crops' research and development 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; and training for national program personnel.

AVRDC's research and support staff consists of some 370 persons from a dozen countries. The Center's budget, which totaled US $4.9 million in 1985, 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. This Center is governed by an international board which represents the various donor nations as well as experts from collaborating organizations.

about the cover: Indonesian market photographed by Romeo T. Opeña

AVRDC Progress Report Summaries 1985

About this Report

This report provides an overview of AVRDC research in 1985. Readers who would like more detailed information are asked to consult the Center's 1985 Progress Report. The Progress Report, which will be available by the end of 1986, describes in detail all of the research conducted at AVRDC in 1985. Personal copies can be purchased for US $10.00 (see Publications Available). Complimentary reprints of up to eight sections of the report can also be requested by sending the attached postcard to AVRDC's Office of Information Services. The reprints are grouped according to crop and discipline and correspond to the summaries found on the following pages.

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Foreword

It is healthy for an institution to pause and examine itself periodically, to ask the difficult questions about target setting as well as target achieving. The AVRDC, like all international centers for agricultural research and development, exists to serve national programs. To best serve these national programs an effective system of communications both ways is required. We welcome feedback. We seek this feedback whenever our scientists visit national programs, every time we have visitors, or when correspondence is exchanged.

In order to serve national programs more effectively, AVRDC has recently reorganized into broader, multidisciplinary groups. The Center is not a large institution. It operates on a fairly limited budget and if it were not for excellent management and the strong family spirit among the international scientists and support staff we could not have accomplished what we have in our short term of existence. The reorganization is aimed at higher impact, ever-more coordinated programs based on needs signaled from national programs.

The reorganization encompasses three main groups, namely the Crop Improvement Program (CIP), the Production Systems Program (PSP) and the Development Program (DP). In the CIP group one would expect to find the breeders of the vegetables most important to the tropics. But within this group are also the plant pathologists, physiologists and entomologists who are intimately involved in the resistance, adaptability and performance characteristics of the germplasm generated.

The PSP group addresses crop management, cropping systems, soil science and on-station testing of cultivars and new technologies. The influence of cultivar and production method on human nutrition is a vital part of the PSP function. In this group the increasingly effective vegetable garden project resides.

In the DP the emphasis is on technology transfer and training. The Vegetable International Professional Service (VIPS) has a goal of listing professional workers in vegetable science available for assignments in the tropics to best serve as a scientific manpower mobilization pool from which specialists can be located readily. The Tropical Vegetable Information Service (TVIS), already deep into its program, is initially assembling as much as possible of the published information on the technology of selected vegetables in the tropics. As the publication enters the process it is cited, abstracted, and edited for computer information storage and retrieval. From this knowledge pool research and extension workers and teachers throughout the tropics should be able to locate information needed in a very short time. We also hope to link with the major computer networks on vegetable information worldwide.

This reorganization, and strengthening our information services, germplasm and seed storage facility, library, and training programs highlight the point AVRDC has reached as this volume goes to press. These functions all relate to the active outreach programs in the countries served in the Asian and Pacific region and beyond. The development and success of the outreach programs, and the national testing programs are the proving and evaluation grounds of all of the Center's activities.

This is not a contented Center. We are actively attempting to broaden and expand our resource base to improve our impact and worth to those we serve. We invite constructive suggestions as to how we may accomplish these goals.

George A. Marlowe, Jr.

George A. Marlowe, Jr.
Director General

Abbreviations and Acronyms

-ADB - Asian Development Bank
-ai - active ingredient
-ARC - Agricultural Research Corporation (Sudan)
-ARTT - advanced rust tolerance trial
-ASPEC - Asian and Pacific Council
-ASET - AVRDC soybean evaluation trial
-AVRDC - Asian Vegetable Research and Development Center (IARC)
-AYT - advanced yield trial
-AzMV - adzukibean mosaic virus
-BCMV - bean common mosaic virus
-BICMV - blackeye cowpea mosaic virus
-BLS - bacterial leafspot
-BST - botanical seed trial
-BW - bacterial wilt
-CARDI - Caribbean Agricultural Research and Development Institute
-cc - cubic centimeter
-CCC - chloroephyltrimethylammonia acid
-CIP - International Potato Center (CGIAR)
-CIPA II - Centro de Investigación y Promoción Agropecuaria (Peru)
-CIRAD - International Cooperation Center of Agricultural Research for Development (France)
-CLS - Cercospora leaf spot
-cm - centimeter
-CMS - cytoplasmic male sterile
-CPA - chlorophenoxyacetic acid
-CTA - Technical Centre for Agricultural and Rural Cooperation (EEC)
-CV - coefficient of variance
-DAE - days after emergence
-DAG - days after germination
-DAIS - District Agricultural Improvement Station (Taiwan)
-DAP - days after planting
-DBM - diamondback moth
-DNA - deoxyribonucleic acid
-EC - electro conductivity
-EEC - European Economic Community
-ELISA - enzyme-linked immunosorbent assay
-EVA - ethylene vinyl acetate
-FFTC - Food & Fertilizer Technology Center (IARC)
-g - gram
-GA - gibberellic acid
-GERDAT - Groupement d'études et de recherches pour le développement (France)
-GR - germination rate
-GTZ - German Agency for Technical Cooperation
-GYT - general yield trial
-ha - hectare
-HES - Horticultural Experiment Station (Korea)
-IAEA - International Atomic Energy Agency (UN)
-IARC - International agricultural research center
-IBPGR - International Board for Plant Genetic Resources (CGIAR)
-IDRC - International Development Research Centre (Canada)
-IITA - International Institute of Tropical Agriculture (CGIAR)
-IMN - International Mungbean Nursery (AVRDC)
-INIA - Instituto Nacional de Investigaciones Agrícolas (Mexico)
-INIPA - Instituto Nacional de Investigación y Promoción Agropecuaria (Peru)
-INRA - Institute national de la recherche agronomique (France)
-INTSOY - International Soybean Program
-IRAT - Institut de recherches agronomiques tropicales et des cultures vivrières (France)
-IRRI - International Rice Research Institute (CGIAR)
-IRTT - intermediate rust tolerance trial
-IYT - intermediate yield trial
-JICA - Japan International Cooperation Agency
-kg - kilogram
-KPS - Kamphaeng Saen (Thailand)
-m - meter
-MARDI - Malaysian Agricultural Research and Development Institute

-ml - milliliter
-mm - millimeter
-NIAR - National Institute of Agrobiological Resources (Japan)
-NIAS - National Institute of Agricultural Sciences (Japan)
-NSC - National Science Council (Taiwan)
-NUFFIC - Netherlands Universities Foundation for International Cooperation
-NVRS - National Vegetable Research Station (UK)
-OYT - observational yield trial
-OP - open-pollinated
-PCARRD - Philippine Council for Agriculture & Resources Research & Development
-PIP - Postharvest Institute of Perishables
-PM - powdery mildew
-POP - Philippine Outreach Program (AVRDC)
-ppm - parts per million
-PRTT - preliminary rust tolerance trial
-PSU - Pangasinan State University (Philippines)
-PVY - potato virus Y
-PYT - preliminary yield trial
-RH - relative humidity
-RNA - ribonuleic acid
-RYT - regional yield trial
-SMV - soybean mosaic virus
-t - metric ton
-TARI - Taiwan Agricultural Research Institute
-TLCV - tomato leafcurl virus
-ToMV - tomato mosaic virus
-TOP - Thailand Outreach Program (AVRDC)
-TuMV - turnip mosaic virus
-TYLCV - tomato yellow leafcurl virus
-UPLB - University of the Philippines at Los Baños
-USAID - United States Agency for International Development
-USDA - United States Department of Agriculture
-VISCA - Visayas State College of Agriculture (Philippines)
-WAG - weeks after germination

Horticultural Crops Program

CHINESE CABBAGE

INTERNATIONAL COOPERATION

Seed Distribution

The Chinese cabbage program distributed 1,724 packets of seed to 145 cooperators in 47 countries during 1985.

International Trials

Australia - Although plant weight was less than temperate cultivars, AVRDC hybrids constituted the earliest-maturing group with firmest heads and the least Alternaria disease in autumn trials conducted by the Gatton Redlands Horticultural Research Station, Queensland.

Costa Rica - Hybrid 59 was the highest yielder and had the best quality among the ten heading entries in trials by the Taiwan Agricultural Technical Mission. Yield was 38.7 t/ha with a 100% harvest rate and 39 days from transplanting to maturity.

El Salvador - An international Cooperator reported that trials proved AVRDC Hybrid 62 to be simply "excellent". Chinese cabbage had hitherto never been successfully harvested at the beginning of the rainy season.

India - AVRDC Hybrid 62 and two OP entries, 77M(2)-25 and 77M(3)-40, produced the highest yield, had 100% harvest rate, and no soft rot infection in this trial conducted by the Haryana Agricultural University.

Japan - AVRDC Hybrid 80-37 was the highest yielder, matured 10 days earlier than the local check, and produced firm heads 56 days after sowing in a trial by the Shizuoku Agricultural Experiment Station. It was considered good for cooking in dishes like "Sukiyaki".
The Prefecture Farmers' Cooperative, Nagasaki recommended two AVRDC OP cultivars, 77M(3)-26 and 77M(3)-35 for summer production.

Niue Island - Despite insufficient water, four AVRDC heat-tolerant OP entries grew vigorously, matured fast, and were popular in the local market.

Philippines - In extensive trials conducted by AVRDC-POP, AVRDC Hybrids 58, 62, 80-33, 80-13, and 80-32 had the most stable high yields which were attributable to high and stable harvest rates.

Zimbabwe - In a trial conducted by the Department of Research and Specialist Services, Ministry of Agriculture, AVRDC entry 77M(2/3)-46 had the highest harvest rate and head weight in a short growing period.

BREEDING

Evaluation of New Germplasm

Four entries (NL 25, NL 26, NL 27, and NL 28) proved to be heat tolerant; the former three were comparable in yield and harvest rate to the check Hybrid 62. Although the soft rot-infection rate of two other entries was as low as the resistant check, this rate seemed to be associated with the inability of either entry to form heads.

Combining Ability Trials

During the summer season, AVRDC tested 81 combinations in search of new tropical F_1 hybrids. Twenty newly developed inbred lines, topcrossed with B 129, were also tested for their general combining ability. Eleven promising combinations were selected for inclusion in advanced yield trials based on their appearance and comparable, if not superior, performance against check Hybrid 62.

Advanced Yield Trials

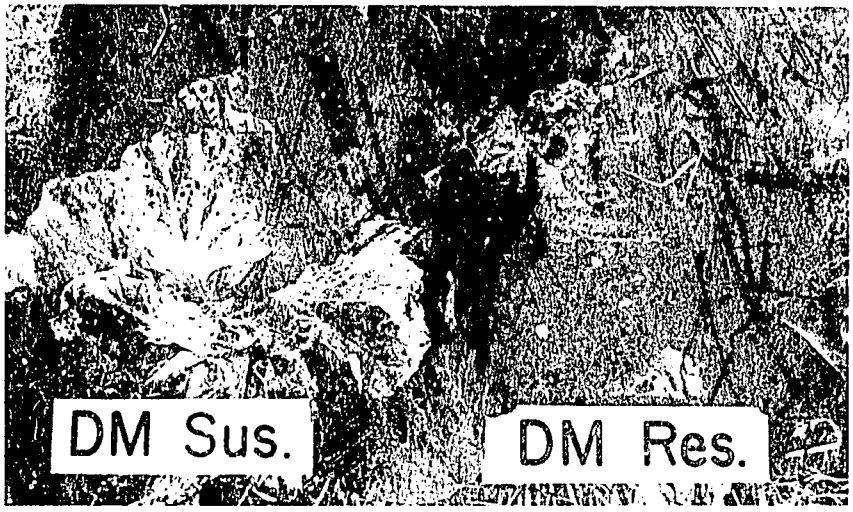
In order to select better performing and stable combinations, the 10 best combinations from the 1984 combining ability trials were tested in four advanced yield trials. Three combinations (80-2, 80-20, and 80-21) outyielded check Hybrid 62, in part or all of the three trials from which data were collected. These combinations also seemed to have more desirable consumer preference characteristics than the check.

Hakuran Backcrosses

Hakuran backcross families were exposed to heat, soft rot, and downy mildew. Although heat tolerance was satisfactory in the majority of the families, disease resistance was disappointingly lower than the donor parent in all families, except for the downy mildew reaction in two families which were still significantly more resistant than the check. Selections, therefore, were made for families and plants with good general morphology and low downy mildew infection to be utilized as parental source for the development of tropical varieties.

TuMV Resistance

The genetic purity of B 730, a known source of resistance to all five strains of turnip mosaic virus (TuMV), was studied using its progenies. Thirty-one inbred lines were also screened against each of the five TuMV strains.



Chinese cabbage cultivars susceptible (left) and resistant (right) to downy mildew after a severe epidemic

Results indicated the genetic impurity of B 730 in TuMV resistance, except in its reaction to strain C_3. Results indicated that 0-2 and two other semiheat-tolerant inbred lines were immune to all five known strains of TuMV.

Downy Mildew Resistance

To develop cylindrical heat-tolerant cultivars with downy mildew resistance, 44 F_2 families, developed from crosses between tropical and Michihli-type Chinese cabbage, were tested. The *in vitro* method was employed for downy mildew resistance in order to preselect entries for field screening. A total of 134 Michihli-like plants free from downy mildew was selected from five families.

Uniformity in OP Cultivars

A project was initiated to attain uniform maturity in two tropical open-pollinated (OP) cultivars, 77M(3)-27 and 77M(3)-35. A total of 153 downy mildew-free plants, uniform in maturity and general appearance, was selected from the former cultivar, and 85 from the latter. These selected plants will create the populations for the first cycle of maternal-line selection.

Cytosterility Backcrosses

In order to develop a simpler and more stable alternative F_1 hybrid breeding system for self-incompatibility, 17 radish-derived and 27 mustard-derived cytoplasmic male-sterile families underwent another backcross generation. Sixteen B?P/4A plants were selected for dark leaf color, lower chlorosis levels, better nectary development and/or pod and seed set from the radish-derived group to be included in the combining ability trials and/or further backcrossing. Twelve BC_2-BC_3 plants were selected from the mustard-derived groups to be used in further backcrosses.

ENTOMOLOGY

DBM and Host Plants

In this study of the development and food consumption habits of the diamondback moth (DBM) on different crucifers, Brassica juncea, B. campestris var. sarson, B. campestris subsp. rapifera and subsp. pekinensis were the most preferred hosts. The larvae consumed more foliage of these crucifers, completed larval stage in less time, and had heavier pupae. On the other hand, B. oleracea var. gongylodes and B. oleracea var. alboglobra were the least accepted hosts.

Oviposition Behavior of DBM

The periodicity of oviposition of the diamondback moth (DBM) was studied in a laboratory test with fresh Chinese cabbage plants. The DBM females laid most of their eggs between 1900 and 2100 hours. Sixty percent of the eggs were laid on the upper leaf surface; 37% on the lower leaf surface; and 3% on the stems. In order to disrupt reproduction of the largest number of insects, sprinkler irrigation must be applied between these times.

DBM and Parasitism

In a large enclosed area in the field, Diadegma eucerophaga successfully parasitized diamondback moth (DBM) larvae. The parasites increased cabbage yield significantly above the control plot where an equal number of DBM cocoons were released.

DBM and Biological Control

Attempts are being made to control diamondback moth (DBM) by mass-release of two of its parasites, Diadegma eucerophaga and Apanteles plutellae, together with the application of a bacterial pesticide, Bacillus thuringiensis, on farmers' fields in Luchu township, southern Taiwan. Since this combined approach gave effective control of DBM without the use of chemical insecticides, the project will be expanded to other areas in 1986.

Parasite of diamondback moth laying its eggs in the moth's larva

DBM and Trichome Density

The results of this study indicate that trichomes on the leaf surface are a factor in the adult female's choice of leaf surface for oviposition. The trichomes probably act as a hook or support for the insect and the eggs. Further studies are needed in order to understand better the role of trichomes in the oviposition of the diamondback moth (DBM). Although the results of this study suggest that the cultivation of glabrous Chinese cabbage cultivars may help to reduce the DBM insect population, this character's effectiveness to control the insect is uncertain.

DBM and Intercropping

Garlic, as an intercrop, controlled diamondback moth (DBM) infestation in common cabbage more effectively than tomato. However, the fact that it reduced cabbage yield considerably when planted four months earlier, needs to be investigated further. Spacing or pattern of garlic planting should be able to be modified to achieve insect control without influencing cabbage yield. Such planting can be used in conjunction with other control measures, such as the use of the bacterial pesticide Bacillus thuringiensis and insect growth regulators.

Other Control Measures of DBM

In an insecticide screening test, two insect growth regulators (CME-134 and IKI-7899) provided excellent control of DBM and significantly increased cabbage yield. Two strains (H7 and H3a3b) of the bacterial pesticide Bacillus thuringiensis also gave satisfactory control of DBM and significantly increased cabbage yields.

Cabbage Webworm Resistance

Twenty selected Chinese cabbage accessions were screened in the field for resistance to cabbage webworm (Hellula undalis) during the summer. Accession B 197 was the least damaged in two evaluations of webworm infestation.

Cabbage Webworm and Sex Pheromone

Preliminary studies on the sex pheromone of cabbage webworm were undertaken using virgin female moths as the pheromone source. Based on the results a sticky paper trap positioned 0.5 m above the ground will be used to study cabbage webworm control with the use of synthetic sex pheromone. For comparison with naturally produced pheromone, 10 three- to four-day-old virgin females per trap will be used.

Insecticide Screening for Cabbage Webworm

Based on the results of this insecticide screening, IKI-7899, MK-936, and CME-134 were superior in the control of cabbage webworm. Since these growth-regulator insecticides affect the hormonal balance, they have a mode of action different from that of the traditionally used

organophosphorus, carbamates, or synthetic pyrethroids. These compounds are also known to control other cruciferous insect pests.

PATHOLOGY

Downy Mildew Resistance I

Hybrid Chinese cabbage lines developed by AVRDC have partial resistance to downy mildew under field conditions. As in the open-pollinated (OP) lines 77M(3)-27 and 77M(3)-35, these hybrids displayed resistance in the form of reduced lesion size and lesion number and a reduced rate of disease increase when compared to the susceptible check. Although levels of resistance varied in the hybrids, some had levels approaching that of the OP lines. Lesion size appeared to be the best disease parameter if only a single disease assessment is used, and percent of area infected was the best measure if the resistance is being measured on an epidemiological basis.

Downy Mildew Resistance II

Past studies confirmed the ability to measure downy mildew resistance on young cotyledons *in vitro*. This year four additional hybrids and their parental lines were tested using the *in vitro* method. All of the hybrids displayed levels of resistance significantly different from their parental averages, which indicates possible non-additive gene action. The rate of spore production is a useful means of estimating downy mildew resistance in young, vigorous material, however, its use on inbreds, which lack the vigor of hybrids, requires further refinement.

PHYSIOLOGY

Water Usage Studies

Heat-tolerant Hybrid Nos. 58 and 62, which produced heads at high temperature, utilized more water at leaf erection and head posture stages. This may be necessary to maintain leaf turgidity during these periods. On the other hand, heat-sensitive Chinese cabbage used more water than heat-tolerant ones at the later stage, which probably accounted for more transpiration occurring in the nonheaded leaf area of the heat-sensitive ones. The heat-tolerant hybrids also contained more potassium in the cell sap of the leaf petiole; this may be related to water retention for leaf erection.

Water usage study

SWEET POTATO

INTERNATIONAL COOPERATION

Distribution

Upon perfection of AVRDC's pathogen-testing system of planting material from tissue-cultured meristems, the sweet potato program distributed 264 packages of planting material to 43 cooperators in 31 countries.

Crop Releases

Bangladesh - The National Seed Board officially released AVRDC cultivar AIS 0122-2 as "Kamala Sundari" ("orange beauty") to be grown by farmers because of its high carotene content, attractive root shape, good yield and overall performance.

Philippines - The AVRDC-POP announced that the Philippine Seed Board officially released AVRDC cultivar CI 693-9 under the local name of BPI-Sp2.

International Trials

Australia - AVRDC entry LO 323 was the highest yielder in a trial of seven introduced cultivars conducted by the Department of Primary Production, Northern Territory. The roots were large with very attractive color, bright copper skin and slightly brighter flesh.

Bangladesh - The Mennonite Christian Committee reported that BNAS-white (AVRDC) and Tinirining (AVRDC-POP) were the highest yielders in trials and that recently released AIS 0122-2 (AVRDC) was also performing well.

Philippines - The Bureau of Plant Industry, Baguio reported that AVRDC entry CN 1280-3 was the highest yielder with 96 t/ha in a trial of 39 AVRDC clones.

After comparison of nine clones from AVRDC with three clones developed by themselves, Visayas State College of Agriculture (ViSCA) Leyte began using some of the promising AVRDC material as parental stocks in their polycross breeding nursery.

Singapore - The Sembawang Field Experiment Station, Primary Production Department assessed AVRDC leaf-tip-type CN 1367-2 as being well received in terms of taste and texture, although the color (yellowish green) of the leaves was not particularly appealing.

Taiwan - The Agricultural Experiment Station, Kinmen identified AVRDC clones CN 1028-15 and CN 1058-10 as being potentially good for feed purposes.

BREEDING

Hybridization Program

Since sweet potato is a vegetatively-propagated crop and all multistage evaluations attempt to identify only elite genotypes without further genetic recombination, the crossing program emphasizes the use of deliberately chosen parental clones according to specific breeding objectives. Moreover, we always attempt to produce large amounts of seeds to maximize the chances of finding the best, but infrequent, genotypes in this highly heterozygous polyploid crop.

In the 1984-85 crossing project, priority was given to the improvement of dry matter yield and eating quality, and resistance to stem borer and scab disease.

Botanical Seed Trials

A total of 56,626 seeds was included in two botanical seed trials. Of this number 2,426 entries were selected for the observational yield trials (OYTs) based on: the ability to form storage roots; freedom from undesirable flesh pigmentation; and high specific gravity of the root.

Observational Yield Trials

A total of 7,035 clones was included in three OYTs. Selections were made primarily on the basis of flesh color, appearance, uniformity, and specific gravity of the roots and secondarily on dry matter content and occasionally on a few other recorded characters. Ninety-three clones were selected to be entered in the preliminary yield trials (PTYs).

Rapid Screening Techniques

To develop mass-screening techniques to apply to the botanical seed stage and the first clonal generation, investigations were made on the reliability of rapid assessment methods and the consistency over different vegetative generations of multistage evaluation systems in a few traits.

Selection for dry matter content by specific gravity in the botanical yield trial (BST) and OYT proved reliable, with excellent consistency and a highly significant correlation between specific gravity and actual dry matter content. Selection for root skin and flesh color, as well as for ability to form storage root in BST, was also satisfactory. Yield and protein content, however, showed poor consistency over different vegetative generations.

Preliminary Yield Trials

A total of 352 selections from the 1983 OYTs was entered in the 26 preliminary yield trial (PYT) groups in the 1984 summer and fall seasons. Of these, 26 were further selected

and subsequently entered in the 1985 advanced yield trials (AYT). In general, the best selections had stable high yields in both summer and fall season PYTs and were also characterized by consistently high dry matter content and yield relative to the check cultivars and breeding lines.

Advanced Yield Trials

A number of selections outperformed the check cultivars in a series of AYTs of clones derived from the previous year's PYTs and AYTs. In the spring, entry CN 1525-22 showed potential as a dessert/staple type and CN 1510-116 outyielded the check. Generally, performance of all clones were low in the summer trials because of adverse hot-wet conditions. A severe weevil infestation in the spring and summer trials underlined the necessity that in a year-round cropping, such as in the sweet potato breeding field, pest management will have to be given more attention in the future.

High Starch Clone Stability

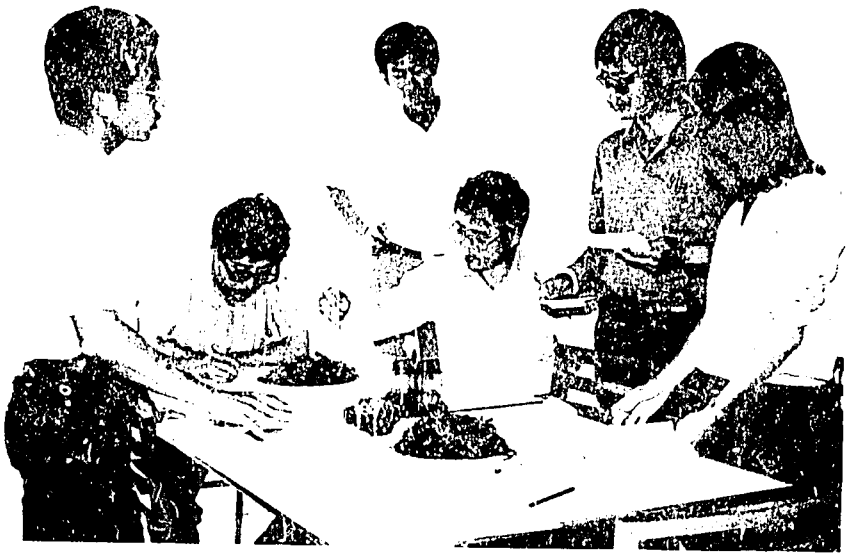
Four high-starch breeding lines were compared with four local cultivars in a series of advanced trials during the fall and summer seasons of 1984-85. In terms of yield stability, three (and possibly four) can be considered stable high-yielders. However, the best performer, CN 1028-15, had a generally low starch content. Local check cultivars tended to have only average or below-average yields. Lowest yields were generally obtained in the adverse summer season when local cultivars did relatively poorly compared to the breeding lines.

Protein Content Stability

Twelve clones were analyzed for stability of protein content across environments in multilocational trials in Taiwan. Clones CN 1229-14 and CN 1216-10 demonstrated high, stable protein content. CN 1028-15, a high protein clone, had consistent protein content across locations, but the deviation of values from its regression line was substantial. Although TN 57 also had stable protein content, its average was generally below the mean. Results indicated that variation in protein content among environments was more substantial than variation between clones.

Early Maturity

Eight cultivars in the regional yield trial were assessed for early productivity through harvest at three different growth periods (120, 150, and 180 DAP). Three clones, CN 941-32, CN 1108-13, and CN 1219-1, produced the highest early yields and did not show any substantial increase in yield when allowed to grow longer. Of these early-maturing clones, CN 941-32 achieved high early yield by rapid bulking of relatively few roots, whereas the other early-maturing clones obtained high yield by producing more roots of smaller size. The early-maturing clones also tended to achieve maximum vine growth in 120 days.



Organoleptic test of leaf tips

Leaf Tip Selection

Twelve leaf-tip-type clones were tested for yield and acceptability in 1984. Neither of the highest yielder, one clone and one check, were rated as tender after cooking. In terms of acceptability, all clones were rated at least good, although tip tenderness after cooking varied. This evaluation of acceptability after cooking was not sufficiently exhaustive and should be expanded in the future.

ENTOMOLOGY

Sweetpotato Vineborer

Screening of eight selected sweet potato accessions at Penghu Island resulted in the identification of one additional resistant accession, 1789.

Sweetpotato Weevil Resistance

Two sets of sweet potato accessions were screened for resistance to sweetpotato weevil. Entries (eight in the first test and four in the second) that were least damaged will be evaluated further in 1986. Despite intensive screening, no accession has yet been identified with a consistent level of resistance.

Sweetpotato Weevil and Mulching

When sweet potato plots were covered with black plastic or rice straw mulch, weevil infestation was less than in the unmulched check plots.

Sweetpotato weevil

Sweetpotato Weevil and Root Characteristics

Sweet potato accessions with a wide range of characteristics were subjected to sweetpotato weevil infestation. There was no statistically significant correlation between weevil infestation and dry matter, sugar, and protein contents of roots, but a significant positive correlation was observed between infestation and beta carotene content. Since wide variation in yield and weevil infestation is common from season to season, this experiment will be repeated over three seasons.

PATHOLOGY

Sweet Potato Scab

Because of the importance of sweet potato scab in tropical countries, AVRDC initiated a scab-resistance project and an *in vitro* screening and evaluation methodology was developed. This methodology, combined with field trials, identified several cultivars with apparent high levels of resistance to scab. The resistance levels of these cultivars will be confirmed and the *in vitro* screening methodology verified in 1986.

PHYSIOLOGY

Leaf Cuttings and Leaf Age

Leaf cuttings are used to conduct physiological studies, as well as to produce disease-tested storage roots for international distribution. The best time to make leaf cuttings for use as planting material was investigated.

Leaves, two to three days after unfolding, grew properly and formed storage roots.

Source-Sink of Leaf Cuttings by Reciprocal Grafting

Experiments on grafted leaf cuttings showed that although both source potential and sink strength are important in determining yield, the latter seems to be paramount. Results of this experiment indicate that the AVRDC high-yielding clone, CN 1028-15, had both good source potential and sink strength; whereas CN 1367-2 showed both poor source potential and sink strength. This may explain why yield potential differs among four clones tested under field conditions.

Although CN 1367-2 and CN 1028-25 had comparable leaf size, the former always contributed to low total dry matter yield when used as a scion. It, therefore, seems unlikely that leaf size could determine the capacity of source potential. On the other hand, the sink strength of high yielders, i.e. CN 1038-16 and CN 1028-15 used as stocks, were able to overcome the poor source potential of CN 1367-2 and maintained the latter's high storage root yield potential.

From these results, it is suggested that genotypes with large source potential and sink strength, with emphasis on the latter, should be initially selected in breeding work and subsequently improved by incorporating other desirable characteristics. The findings also indicate that the evaluation of source potential and sink strength could be conducted by using leaf cuttings as grafts, thus, facilitating the evaluation of a large number of entries.

Growth and Nutrients of Leaf Cuttings

Leaf cuttings of both high-yielding CN 1028-15 and low-yielding AIS 35-2 produced equal amounts of total dry matter during the 10-week growing period. The accumulation in the petiole base of high potassium and soluble sugar content in CN 1028-15, and high starch content in AIS 35-2, supports the hypothesis that the yield difference was apparently due to the difference in the efficiency of accomodating translocated photosynthates in the developing storage root.

Drought Tolerance

The AVRDC tissue-cultured collection of improved and selected clones was evaluated for drought tolerance by introducing polyethylene glycol-6000 to the medium. This technique identified CN 1038-16 as having drought tolerance comparable to a drought-tolerant accession, I 444. Tests to confirm the tolerance levels of these clones will be conducted in 1986.

In Vitro Storage Root Formation

Formation of small storage roots was induced under in vitro conditions. About 35% of the leaf cuttings of AIS 35-2 cultured in a modified Murashige-Skoog medium with 0.5 mg/l of naphthalene acidic acid, 5.0 mg/l of GA_3, 37.6 mM of potassium, and 8% sucrose; with perlite as the supporting medium. This appears to be the first investigation that successfully induced storage root formation of sweet potato under in vitro conditions and work is underway to increase the percentage of storage root formation.

In vitro storage root formation

TOMATO

INTERNATIONAL COOPERATION

Seed Distribution

The tomato program distributed 3,574 seed packets to 254 cooperators in 76 countries during 1985.

International Trials

Brunei - In trials conducted during 1984 and 1985 by the Sinaut Agricultural Training Center, AVRDC entries CL 5915-93-1-0 and CL 143-10-3 were the highest yielders and the former also showed improved fruit size compared to other lines. These varieties will enter large-scale demonstration trials in 1986 in preparation for release to growers.

Cook Island - AVRDC entry CL 5915-206-2-1 outyielded all commercial cultivars and produced the largest fruits in this 37-entry trial. This entry was considered excellent for local use but inadequate for export because of insufficient pericarp.

Haiti - In adverse conditions (check obtained zero yield), AVRDC entry PT 1461 yielded highest and had the largest fruit in a trial conducted by the Taiwan Agricultural Technical Mission.

Kampuchea - Of the 20 entries in a trial conducted by Church World Service, AVRDC CL 1131-0-0-65-13-0-1 substantially outyielded the commercial cultivars but had fruit sizes three to four times smaller. In terms of fruit size, two other AVRDC entries, however, compared favorably with the local cultivar.

Malaysia - In a trial conducted by the Agriculture Research Center, AVRDC entry CL 143-10-3-1 gave the highest yield and had the least cracking problem. However, its fruit is too small for the prevailing market standard.

Martinique (France) - Of the 22 entries in this IRAT trial, AVRDC lines CL 5915-93D4-1-0 and CL 1219-0-8 showed better crack resistance and firmness, respectively, over the local check Caraibe.

Mexico - INIA confirmed the superiority for heat tolerance of most AVRDC lines over local checks. Although the fruit size is generally small, these AVRDC heat-tolerant lines are outstanding parental stock for the breeding program to develop processing tomatoes for Sinaloa.

Philippines - In promissing trial conducted by AVRDC-POP, PT 1599 substantially outyielded the check cultivars under favorable conditions.

TROPICAL TOMATO BREEDING

Crosses and Segregating Populations

New crosses to incorporate nematode and bacterial leafspot (BLS) resistance were made using sources of nematode resistance that bear medium-to-large fruit and BLS resistance from cv. Hawaii 7998.

Nematode screening using the electrophoresis method was carried out on 32 BC1F3 and double cross F_2 families. Good fit to the expected ratios of homozygous resistant, heterozygous resistant, and homozygous susceptible progenies were obtained from 23 families. The abnormally segregating families will be reexamined in 1986 to determine the possible sources of discordant ratios.

BW Resistance in New Tropical Breeding Lines

Two sets of new tropical breeding lines already carrying heat tolerance, resistance to tomato mosaic virus, and good horticultural characteristics, were evaluated for resistance to bacterial wilt (BW) under field conditions. The field screening technique in use was found to be inadequate. The problems of heterogeneity in the inoculum density and low infection rates among entries, as well as in the susceptible check, need to be resolved. In the present experiments, only the highly susceptible lines were discarded. The remaining lines will be reevaluated in 1986 either with the seedling screening method previously used or with an improved field screening technique.

Corroboration of Gene Action for Heat Tolerance

A cursory analysis of probable gene action among 33 F_1 hybrid combinations of advanced tropical lines and temperate-bred fresh-market cultivars, corroborated our 1984 report that both additive and nonadditive gene action underlie the expression of heat tolerance. When combinations were between heat-tolerant stocks, more hybrids outperformed the tropical parent lines although their fruit sizes, in general, were smaller than those of the hybrids between temperate and tropical stock. Some F_1 combination from the latter crosses compared well with their tropical parents.

Performance of New Breeding Lines

Thirty-three F_1 hybrid combinations among advanced tropical lines and temperate-bred fresh-market cultivars were evaluated in two summer trials to isolate promising combinations. Three hybrids performed better than the commercial hybrid checks but did not differ statistically from the best performing tropical parent line, CL 5915-206D4-2-5.

Thirty new lines were tested in a summer observational trial to select promising tropical lines for further tests. Three entries outperformed the tropical check lines. The

best of these were CLN 65-349-2-1-0 and CLN 65-349-2-2-0, which showed lower BLS damage, resistance to fruit cracking and firm fruits of larger size.

Twenty-one lines selected from 1984 observational trials were tested twice in preliminary trials conducted in the summer. Although none of these new lines outperformed the tropical check line CL 1131-13-0-6, those belonging to the CLN 65 series bore larger, firmer fruits without cracking problems.

Four sets of advanced trials were performed on 10 entries selected from preliminary and advanced summer yield trials in 1984. Based on overall average marketable yields, three lines obtained the highest rating: CL 5915-93-1-0, CL 5915-223-2-1-0, and CLN 65-349-2-0. A further stability analysis identified the latter as having stable performance for all characters analyzed except plant stand. Other advantages of CLN 65-349-2-0 include lower BLS infection, improved fruit size and firmness, and absence of fruit cracking.

New Germplasm for Heat Tolerance

Twelve new lines which originated from the selection program for heat tolerance of Campbell Soup Company were evaluated for fruit setting ability during the summer season under shade house and field conditions. None of the new lines performed as well as the AVRDC tropical lines CL 11-31-13-0-6 and CL 5915-153-3-3 in the shade house. In the field, CX 8207 compared favorably in overall performance with CL 5915-153-3-3.

It appears that heat-tolerant genotypes selected under the hot, dry conditions of California may not necessarily perform as well as AVRDC tropical lines selected under hot, humid conditions.

AVRDC tropical tomato line CL 5915-153-3-3

Weighing yield in processing tomato trial

PROCESSING TOMATO BREEDING

Performance of New Breeding Lines

Eight processing tomato hybrids were tested against two checks in a trial planted one month earlier than the regular planting date in Taiwan's commercial fields. One hybrid, PT 1017, strikingly outperformed both check cultivars. The main advantage of this hybrid was its better fruit setting ability during the hot period.

New F1 Hybrid Combinations

A total of 166 new hybrid combinations was made in the processing tomato program to develop cultivars with heat and bacterial wilt resistance, resistance to mosaic virus and rootknot nematode, and good fruit characteristics such as firmness and improved size. Since several of these desired traits are already present among advanced tropical lines, they were used considerably in the above hybrid development.

ENTOMOLOGY

Fruitworm Resistance

Eight accessions with excessive pubescence on the foliage and stems were screened along with a susceptible and resistant check for resistance to tomato fruitworm (*Heliothis ormigera*). The excessively hairy entries suffered substantial fruitworm damage compared to the susceptible check and enormous damage in relation to the resistant check.

Tomato Fruitworm Studies

AVRDC joined an interdisciplinary team of entomologists and chemists to utilize sex pheromone for tomato fruitworm control. Data obtained in studies on trap design, trap height, pheromone concentration, and ages of active reproduction for both sexes will be used in the 1986 studies on synthetic sex pheromones.

PATHOLOGY

Late Blight

Line L 1197, which in a study conducted the previous year did not develop any disease during on artificial late blight (Phytophthora infestans) epedemic (despite the presence of the inoculated plants and overhead sprinkler irrigation), was repeated with the same results in 1985. Apparently L 1197 has a very good level of resistance to late blight.

Infectivity Titrations for BW Resistance Testing

Accurate assessment of relative resistance or susceptibility to bacterial wilt (BW) has been a primary goal. The infectivity titration method used by Lum was adopted and has generally given satisfactory results. In this study thirteen lines were inoculated with BW and kept in a heated greenhouse. All lines showed an intermediate level of resistance between the susceptible and resistant checks. The most resistant breeding line was CLN 65-349-2-0.

Initial step in application of the infectivity titration method to assess bacterial wilt resistance

PVY Resistance Screening

Because the incidence of Potato Virus Y (PVY) in tropical and subtropical areas is high and commercial cultivars do not possess resistance to PVY, AVRDC began screening its germplasm for possible sources of resistance employing a method which provides clear symptom expression. Of the 84 randomly selected accessions (comprising mainly wild types, 20 lines with reported resistance to PVY and 20 commercial cultivars) screened, only accession 3683 and line VL 111 were found to be resistant.

Hairy Tomatoes for CMV Resistance

In a follow-up study to corroborate the resistance of two very hairy lines to cucumber mosaic virus (CMV), a second field test under high disease and vector pressure was conducted. CMV incidence and infection rates were not significantly different between the very hairy and average hairy lines. Hairyness may not be very useful in controlling CMV because the significantly lower aphid levels on the very hairy tomatoes which were observed in a separate study apparently do not result in significantly lower incidences or rates of CMV infection.

Further Characterization—New Poty Virus

An aphid transmitted Poty virus (isolate T697) has been recovered from tomato in Taiwan. Host range studies and comparative serological tests by immunosorbent electron microscopy have indicated that this is a new, previously unreported virus. However, since the virus produces only mild symptoms, does not occur frequently, and is not seed transmitted in tomato, it is currently unjustified to include this virus into our disease resistance breeding effort.

ToMV Survival in Agricultural Soils

The results of a soil survey conducted during 1981-85 strongly indicate that tomato mosaic virus (ToMV) does not normally survive longer than five months in agricultural soils of southern Taiwan.

Tomato Leafcurl Virus

The whitefly-transmitted tomato leafcurl virus (TLCV) is the most important yield limiting factor of tomato production in the Near East and certain regions of Africa and Asia. Commercial cultivars with resistance to this virus are not available. Virologists at AVRDC have detected this virus for the first time in Taiwan.

Since natural incidence of TLCV in Taiwan is too low for field screening, AVRDC began screening in the greenhouse by grafting material with reported resistance to leafcurl-infected plants and subsequent testing by back grafting to healthy tobacco plants. Lycopersicon peruvianum INRA SEL. (VL115) performed best producing fewer than 20% infected plants. This selection and two other lines, which produced fewer than 50% infected plants, will be tested in

other Asian countries where the disease is reported to be endemic.

PHYSIOLOGY

Pollination under High Temperature

Emasculation with artificial pollination increased fruit-set rate, but not seed number and fruit size, at high temperature. This promotive effect of emasculation with artificial pollination on fruit-set rate, implies that the pollination itself may have a triggering effect in the initiation of fruit development. The results also demonstrate that AVRDC's improved breeding lines possess the characteristic of parthenocarpy in addition to their natural pollination ability at high temperature. This makes them superior, in terms of increased fruit-set rate and yield, to facultative parthenocarpic tomato.

Pedicel Retention *In Vitro*

Accessions and breeding lines demonstrated varietal difference in pedicel retention rate when their pedicels, with their reproductive organs removed, were cultured under in vitro. Pedicels of heat-tolerant breeding line CL 5915-153 did not form any abscission layer after six days of in vitro culturing, whereas pedicels of all other entries abscised. Abscission layer formation in the pedicel seems to play a role in determining the heat tolerance/sensitivity of tomato fruit-setting.

Pedicel retention in vitro

Growth Regulators

Treating the new indeterminate tropical line CL 5915-206 with CPA and/or Alar and CCC regulators enhanced yield potential during the humid summer season; the highest recorded yield was 22 t/ha. CPA more than doubled fruit size of CL 5915-206 over the control. Although the yield increment of CPA growth regulator on L 387 was less than CL 5915-206, the extent of increment was greater in L 387 than CL 5915-206. The results seem to indicate that heat-tolerant CL 5915-206 contains more promoting hormones than heat-sensitive L 387.

Growth Regulators and Fruit Set

Artificial pollination, and GA_3 with artificial or natural pollination, improved fruit set of both L 124 and CL 5915-153 at high temperature, without increasing seed number. It seems that pollination which triggers fruit set has a hormonal nature.

Proline Content and Germination

Pollen germination depends upon proline content of the pollen. Both pollen germination and pollen proline content are reduced during the hot season. AVRDC breeding line CL 5915-153 had the highest pollen proline content in the hot season. High proline content may confer resistance to the pollen at unfavorably high temperatures.

Nucleic Acids in Flowers

The high temperature during the hot season retarded anther and pistil development of both heat-tolerant and heat-sensitive tomatoes. It also tended to decrease DNA content of anther and pistil from 6 to 0 days before anthesis. High temperature also reduced the formation of RNA during the

development of anther and pistil. The significance of DNA and RNA reduction, and the retarded growth of flowers at high temperature in relation to heat tolerance require substantial further investigation.

Leaf Character and Fruit Set/Size

An inventory of 12 entries was made for genetic variation in fruit set and size in relation to physiological characteristics. AVRDC breeding line CL 5915-153 was the most heat-tolerant in terms of fruit set. However, another AVRDC breeding line, PT 1461, and accession L 208 were heat sensitive but had the largest fruit. Both PT 1461 and L 208 maintained high starch content in the leaf. Since it has been previously demonstrated that L 208 possesses a high photosynthetic potential, the results reported here suggest that fruit size may be strongly related to the supply of photosynthates of the nearby leaf.

Leaf/Flower Removal and Fruit Set/Growth

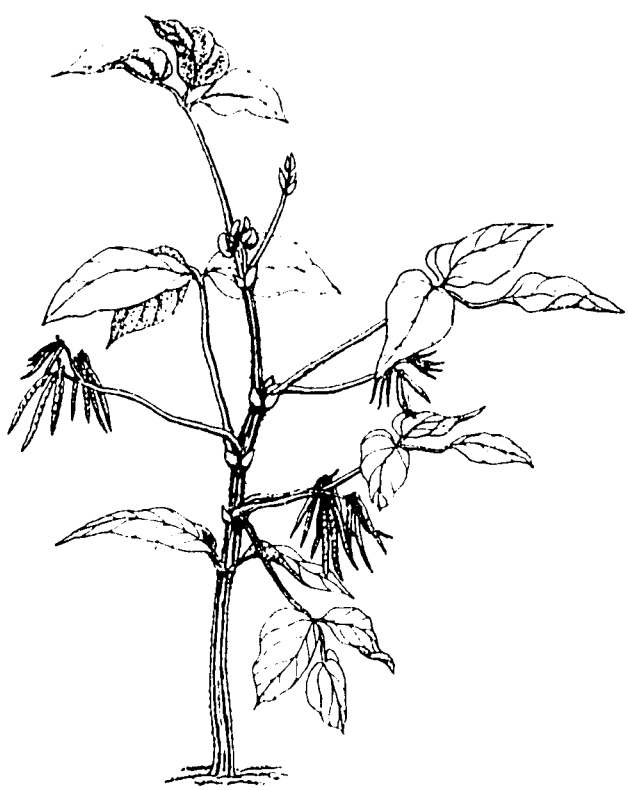
Flower and/or leaf removal did not influence fruit set and yield of either L 387 or CL 5915-206. However, removal apparently increased fruit size of CL 5915-153. The results seem to imply that growth competition may not play a role in fruit-set rate at high temperature; however, it certainly controls fruit size.

Water Consumption in Cool Season

CL 1131-43 and CL 5915-153 consumed more than 40 l/plant of water during the 113-day growth period in the cool season. Although CL 5915-153 transpired more water per unit leaf area, it was more effective in dry matter production. Maximum water uptake occurred in the middle of the flowering and fruiting period.

Legume Crops Program

MUNGBEAN



INTERNATIONAL COOPERATION

Seed Distribution

During 1985, 824 breeding lines and 428 accessions were distributed to 67 cooperators in 23 countries.

Crop Releases

China - After three years of testing by the Regional Agricultural Research Institute, Jiang-su Province, AVRDC cultivar VC 1973-A provided a one-quarter average yield higher than the local check. It was named "Yu yin No. 1" and officially released.

Ecuador - AVRDC line VC 1163-A was released for official use by farmers and named "Boliche 451".

Thailand - After extensive trials by AVRDC's TOP, and several national institutes, AVRDC cultivars VC 1973-A and VC 2778-A were renamed "KPS No. 1" and "KPS No. 2" and released by the Thai authorities.

International Trials

IMN - The 12th International Mungbean Nursery (IMN) consisted of 14 AVRDC breeding lines and six selected national cultivars. A total of 67 sets were distributed to 31 countries and data was received in time for this report from trials of 24 cooperators in 14 nations. The mean yield of the 20 entries over 21 locations was 1.09 t/ha. VC 2768-A produced the highest average yield of 1.19 t/ha and was also the highest yielder in the preceding IMN.

Peru - CIPA II/INIPA reported that AVRDC entries VC 1974-A and VC 1089-A produced yields of 2.21 t/ha and 1.99 t/ha respectively in trials and that the latter is under consideration for release because of its early maturity, big seed size and resistance to powdery mildew and viruses.

Thailand - A series of yield trials with AVRDC lines were conducted by AVRDC-TOP against the national cultivar "U-thong 1". Five AVRDC breeding lines substantially outyielded the check, providing more than 3 t/ha in the intermediate trial.

Vietnam - According to the University of Cantho, after outyielding other varieties consistently for four consecutive cropping seasons, VC 2768-A is under cultivation in approximately 80 ha.

BREEDING

Hybridization

A total of 159 crosses were made in the spring and summer and segregating populations derived from these crosses will be screened for high yield, uniform maturity, and disease resistance.

Leaflet Type and Hypocotyl Color

Before initiating a breeding program to reduce the shading of the relatively closed canopy of mungbean by modification of leaf type, the inheritance of this character requires examination. This study, in which two lines with different leaflet type and hypocotyl color were crossed, indicated that leaflet type probably has a direct influence on seed yield components. To verify this hypothesis, production of mungbean isolines with different leaflet types and a long-term evaluation in the field are necessary.

Interspecific Hybridization

The methionine level of mungbean cultivars can be successfully increased by crossing, especially with Vigna radiata subsp. sublobata genotypes. The results of these interspecific crosses indicated that the inheritance of methionine content appeared to be controlled by polygenes. Therefore, selfed seeds of each heterozygous genotype should be screened for higher methionine content before backcrossing with mungbean.

Wild Vigna radiata subsp. sublobata genotype

Yield Trials

The average yield of 20 entries in the elite yield trials was 1.21 t/ha in the spring and 1.78 t/ha in the summer. Although 9 breeding lines significantly outyielded the check cultivar in summer, only VC 3012-A repeated its performance in the spring. With the exception of VC 3012-B, which was highly resistant to Cercospora leaf spot (CLS) and VC 2917-A, which was moderately susceptible to powdery mildew (PM), all other lines demonstrated moderate resistance to these diseases. VC 2917-A appeared to be photoperiod insensitive.

Average summer yield in the advanced yield trial of 16 entries was 1.87 t/ha. Twelve breeding lines outyielded the check, had larger seed and were less photoperiod sensitive.

In intermediate yield trials in the summer, 24 breeding lines significantly outyielded the check cultivar and the top five lines produced an average yield over 1.70 t/ha. These high performers had larger seed and were less photoperiod sensitive. Lines VC 3543-B-2-1-1-B and VC 3732-B-3-B-1-B demonstrated high resistance to CLS and PM.

In preliminary yield trials of 81 entries, seven lines significantly outyielded the check in both spring and summer. However, none of these lines showed a better synchronized maturity than the check.

Of the 16 mungbean cultivars which have been officially released for farmers' use in 12 different countries, 10 were reevaluated in a yield trial against V 3476. Seven of the released cultivars outyielded the check in the spring and in the summer trials.

Selections with high yield potential, combined with high levels of resistance to CLS and PM with bigger seed, with less photoperiod-sensitivity and different seed coat luster have been identified. However, improvement is needed for synchronized maturity. The highly significant positive correlations between number of pods per plant and yield indicate that traits influencing more pods per plant must be emphasized in breeding programs to improve seed yield.

Disease Resistance

Improved levels of resistance to CLS and/or PM have been incorporated in more new breeding lines. A breeding program to incorporate both disease resistance and photoperiod-insensitivity will be emphasized in the future.

ENTOMOLOGY

Asiatic Cornborer Resistance

Since Asiatic cornborer, Ostrinia furnacalis (Lepidoptera: Pyralidae) is increasingly becoming a serious pest in Southeast Asia, 2,159 mungbean accessions were screened for resistance to this pest. Based on insect damage to stems and pods, 19 entries were least damaged. These entries will be evaluated further in 1986 before judging their suitability for inclusion in the resistance breeding program.

Asiatic cornborer

Asiatic Cornborer Damage

The biology and nature of damage of the Asiatic cornborer to mungbean was examined. The insect lays its eggs on the underside of the leaves of the upper part of older plants, and the larvae bore inside stems and pods. Plants damaged in the stems are weakened and at times die of infestation.

Beanfly Resistance

Beanflies are the most destructive pests of mungbean in the seedling stage throughout tropical and subtropical Asia. Five breeding lines with moderate beanfly resistance and, based on single-plant characters, a higher yield potential than the resistant parents were selected in 1985. These selections will be planted in a series of yield trials before release to national programs.

Mechanism of Beanfly Resistance

In 1980 three mungbean accessions resistant to beanflies were found. A detailed investigation of insect development and the nature of plant damage in resistant and susceptible accessions indicated that certain biochemical elements in resistant plants adversely affect the development of beanflies infesting these plants.

PATHOLOGY

New Poty Virus from Mungbean

A virus has been isolated from mungbean which has not been previously reported on this host in Taiwan. The virus is serologically very closely related to blackeye cowpea mosaic virus. (BICMV), adzukibean mosaic virus (AzMV) and the

NY-15 strain of bean common mosaic virus (BCMV). The virus was found to be transmitted by aphids in a nonpersistent manner. The virus is seed transmitted at a low rate in mungbean and yardlong bean. Host range was mainly confined to the legume family.

Although a significant yield reduction occurred in mungbean when plants were infected at the early growth stages (up to 14 days after sowing), the 100-seed weight and germination was not affected. Good levels of resistance were not detected in elite breeding lines, but immunity was found to both isolates of the virus (M25 and M4) in several accessions.

This virus is not considered very important in terms of absolute yield loss. However, on the basis of the wide host range, seed transmissibility and absence of resistance to this virus of the advanced breeding lines, it should be included into AVRDC's disease resistance breeding program.

Cucumber Mosaic Virus

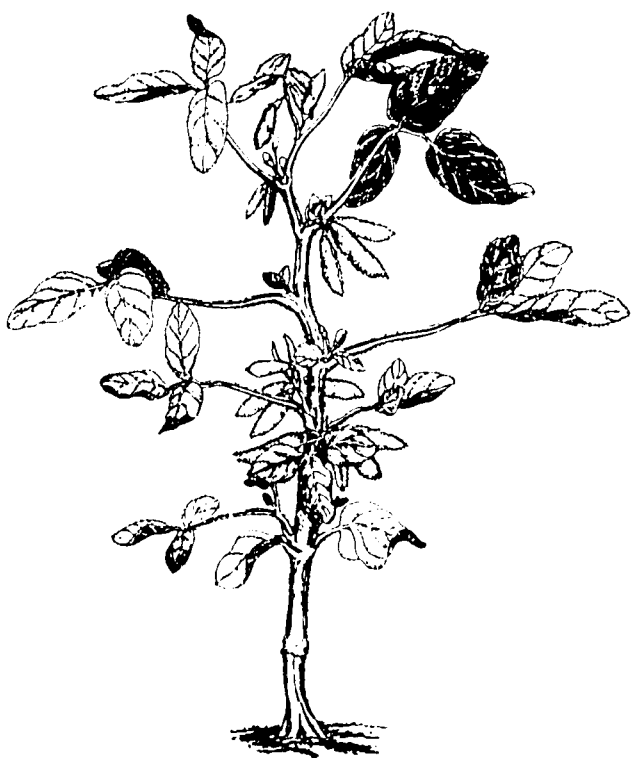
Cucumber mosaic virus (CMV) affects mungbean wherever it is grown and the virus has been found for the first time on this crop in Taiwan. The host range was found to be largely confined to the legume family. Although soybean generally was not infected, Chenopodium quinoa and Chenopodium amaranticolor were the only non-legume hosts that could be infected, the latter with systemic local lesions.

The virus was found to be seed transmitted in mungbean and cowpea. Several resistant elite breeding lines have been found and sources of resistance have been identified among the parental lines. In mungbean, resistance seems to be associated with the appearance of necrotic local lesions on the inoculated leaves. The inheritance of resistance will be investigated in the future.

Root Disease Complex

The mungbean root disease complex has become a serious problem at AVRDC, particularly, when mungbean is grown in the cool season. Although previous experiments have indicated that soil fumigation with chloropicrin provides effective control, this method is impractical for AVRDC. Therefore, three treatments, deep plowing, application of compost, and soil application of fungicides were compared in an experiment. Although deep plowing was the best treatment for promoting plant growth in a field infested with suspected pathogens associated with the root disease complex, only partial control of the root disease complex was obtained. Additional studies are necessary.

SOYBEAN



INTERNATIONAL COOPERATION

Seed Distribution

The soybean program distributed 343 breeding lines, 303 accessions and 46 sets of AVRDC Soybean Evaluation Trial (ASET) packages to 116 cooperators in 38 countries.

Crop Releases

Indonesia - A new variety, Kerinci, released by the Bogor Research Institute for Food Crops has AVRDC's G 2120 as one parent.

Philippines - AVRDC soybean variety AGS 73 was officially released by the Philippine Seed Board as BPI-Sy'4 because of its high yield potential and long seed viability under ambient conditions.

Taiwan - After three years of multilocational trials, AVRDC line AGS 129 was officially released as Kaohsiung No. 10.

International Trials

ASET - The 1984-85 ASET consisted of eleven AVRDC breeding lines and accessions. AVRDC entries AGS 58, AGS 133, and AGS 129 often outyielded the local checks.

Costa Rica - In trials of 130 AVRDC AGS lines conducted by the Taiwan Agricultural Technical Mission, nine AGS lines were found to mature earlier than the check.

Indonesia - 34 mutant lines (of G 2120) were entered together with three high-yielding checks by the Central Research Institute for Food Crops. With the exception of mutant line 20-4, mutant yields were not substantially higher. However, the mutants matured 18 days earlier than the parent and 12 days earlier than the checks.

Philippines - A large number of AVRDC and IITA entries were grown in yield trials at the University of the Philippines at Los Baños (UPLB) and Pangasinan State University (PSU). At UPLB and PSU, the AVRDC material significantly outyielded all other entries.

Taiwan - Farmers continue to expand the area grown to AGS 66, although not yet officially released.

Thailand - A selection from AVRDC breeding materials, 16-4, is becoming a popular variety. It has been named by Thai farmers 'Pakboon' because of its narrow leaflet.

BREEDING

Hybridization

A total of 360 crosses were made to combine high yield with disease and/or insect resistance. These hybrids will be used in a selection program. Further intermating or hybridization will be done to enable recurrent selection or incorporation of additional traits.

Photoperiodic Response

Twenty-eight new accessions and two checks were screened for photoperiodic response. One accession was identified as photoperiod insensitive. The yield potential of the photoperiod-insensitive accession will be evaluated in 1986.

Nonbeany Flavor

Assuming that lipoxygenase is one of the factors causing the beany flavor which is objectionable in a number of countries, crosses were made to eliminate lipoxygenase. From preliminary results it appears that selecting genotypes null for lipoxygenase from a segregating population, can be a routine process. The selections made thus far will be evaluated for yield and other desirable characteristics.

Preliminary Yield Trials

Lines GC 90004-13 and GC 50265-2-9-6-8-75 yielded higher than the checks in the spring PYT without fungicide. These two lines also were more tolerant to rust than the highest yielding check, AGS 129.

Intermediate Yield Trials

Line GC 60058-12-6-6-1-39 yielded higher than the check lines without fungicide in the spring IYT. Four of the breeding lines have levels of tolerance to soybean rust that are higher than AGS 181, the highly tolerant check. In the summer IYT, there were five breeding lines which had yields from 3.2 t/ha to 3.6 t/ha compared to the check (AGS 181), which had 2.2 t/ha.

Advanced Yield Trials

Of the 50 AGS lines evaluated in autumn 1984 AYTs, AGS 239, 261, and 265 yielded significantly higher than the checks. In spring and summer 1985 AYTs, although all lines were significantly lower than the high yielding check cultivar (AGS 129), they all matured significantly earlier than AGS 129.

ENTOMOLOGY

Beanfly Tolerance

Seven (of 102) entries in the unreplicated preliminary test showed yield reduction of 5% or less and 4 (of 14) entries in the three-replicate secondary test had reduction of less than 10%. These entries will be evaluated in 1986 for stability under various levels of beanfly population.

Insecticide Control for Beanfly

In an insecticide screening test in which synthetic pyrethroids were tested, along with standard organophosphorus compounds, none of the pyrethroids provided as good control of beanflies as omethoate or monocrotophos, the standard insecticides.

Defoliator Resistance

All defoliators feeding on PI 171444 foliage died before the pupal stage; whereas those on the susceptible check, TK 5, had mortality of only 62%. Green stink bug nymphs fed on green PI 171444 pods also had a considerably prolonged nymphal stage. Each nymphal stage suffered greater mortality. Accession PI 171444, thus, represents an important source of resistance to defoliators.

Leaf Folder Resistance

Among 833 soybean accessions screened for resistance to leaf folder, Hedylepta indicata Fabricius (Lepidoptera: Pyralidae), average plant damage was over 90%. Six accessions had less than 25% plants damaged by this pest. These accessions will be evaluated further in autumn 1986.

Limabean podborer

Limabean Podborer Resistance I

Among the 1,000 soybean accessions screened, 19 showed moderate to high levels of resistance to limabean podborer, Etiella zinckenella (Lepidoptera: Pyralidae), in two plantings in a preliminary nonreplicated screening. These accessions are being evaluated further to confirm their resistance.

Limabean Podborer Resistance II

Three accessions were consistently least damaged by limabean podborer in three monthly screenings. Less damage was associated with greater number of pods per plant rather than with true resistance. It is necessary to continue the search for podborer resistance in the future.

Limabean Podborer Oviposition Behavior

A survey of a large number of plants for oviposition characteristics indicated that the limabean podborer prefers to lay eggs on the pods in the upper one-third of the plant. Among the plants at R_5 to R_8 reproductive growth stages, the insects preferred to lay eggs on R_5 to R_7 stage plants. Pods of R_6 plants had the most eggs.

PATHOLOGY

Advanced Soybean Rust Tolerance Trials (ARTTs)

Seven lines were planted in fall 1984 and 26 lines in two spring 1985 ARTTs. Previous yield data were also compared

with the data in these two trials. In a combined analysis of the four lines in six trials, GC 60087-7-9-6-11-46 showed superiority in yield stability and mean yield across the 12 environments. Among the 19 lines of the other spring ARTT, three had tolerance levels higher than check AGS 181 and yield similar to or better than G 38 with fungicide protection. Two other lines had tolerance levels intermediate between AGS 181 and G 38 and yielded far better than G 38 with fungicide protection and AGS 181 without fungicide protection.

Intermediate Soybean Rust Tolerance Trials

Three trials containing 38 lines previously selected for tolerance were conducted 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 that with protection. Nineteen lines were selected for further evaluation in 1985 ARTTs.

Downy Mildew Resistance

A resistance-screening trial for downy mildew, caused by the fungus Peronospora manshurica (Naum.) Syd. ex Guam., with 360 test cultivars and three checks (which represented the expected levels of resistance or susceptibility) was planted in spring 1985. The majority of the AGS lines tested were rated as modertely to highly resistant to downy mildew.

Bacterial Pustule Resistance

AGS lines and accessions previously tested for resistance to bacterial pustule, which is caused by Xanthomonas campestris pv. glycines, were retested this year. A total of 104 AGS lines, accessions, and breeding lines were tested in the field with artificial inoculation. All AGS lines and accessions that were rated highly resistant in 1984 again achieved the same rating in 1985.

Lines susceptible (lower) and resistant (upper) to bacterial pustule

Bacterial Pustule Screening

Plants of eight different ages, from V_1 (vegetative) to R_4 (reproductive), were inoculated with a bacterial suspension of Xanthomonas campestris pv. glycines and lesion densities were determined at 8 and 13 days after inoculation. The infectivity of X. campestris pv. glycines was significantly affected by the age of susceptible soybean plants at the time of inoculation. The data indicated that it was not possible to develop a resistance screening test for bacterial pustule on seedlings because of the very low infectivity of X. campestris pv. glycines during the early vegetative stages of a susceptible cultivar.

Harvest Period Effects

The effect of early and later harvesting on soybean yield, seed quality, and germinability was studied. Seed harvested in the fall (dry) season was not affected by harvest date. However, significant variation occurred when seed was harvested during the rainy season. Highest germination across cultivars occurred when the seeds were harvested at the R_7 and R_8 growth stage. Germinability also varied considerably among cultivars, with TK 5 having the highest germination (80-87%) across harvest stages. If soybean must be harvested in the rainy season, the best time is during the R_7 growth stage. This minimizes the percentage of diseased and small seed, thereby, maximizing the percentage of good quality seed and germinability.

Germination

The relationship between seed size, storage environment, and the germinability of soybean seed was examined. Three cultivars with a range of seed sizes were stored in both a cold room and in an office at room temperature over a period of one year. There was no indication that seed size was related to germinability under these storage conditions. In general, poorest seed germinability after storage was associated with intermediate seed size. The germinability of seed stored in the cold room remained very high even after nearly one year of storage (94-97%) and even for the seed stored at room temperature, germinability remained moderately high (81-86%) after seven months of storage.

Seed Quality

This study examined whether the reduced postharvest germinability of soybean seed harvested during the rainy season is due to rust, and to determine the effect of preharvest fungicides on postharvest seed germinability. Dithane M-45, either alone or in combination with benomyl, provided nearly complete control of soybean rust; however, neither fungicide alone nor their combinations improved germination. Apparently rust did not affect seed germinability, nor did the fungicides reduce the other constraints that caused the poor seed germinability.

Mycorrhizal Fungi Population Dynamics

This study further examined the spore population dynamics of mycorrhizal fungi in the rice-rice-soybean cropping system and the relationship of spore populations to phosphorus levels. Phosphorus concentrations did not seem to be correlated with spore populations of mycorrhizal fungi under field conditions. Peak spore populations at most locations occurred during one or both of the rice crops.

Soybean Mosaic Virus

The use of strains of soybean mosaic virus (SMV) in a resistance breeding program is important because of the presence of strain specific resistance genes. Since 1981 soybean fields in Taiwan have been surveyed, using ELISA to detect SMV, and the Cho-Goodman differential system to characterize the SMV strains. Thus far only SMV strains G1, G4, and G5 have been identified and have been actively incorporated into AVRDC's SMV resistance screening program. Several isolates of SMV have also been recovered which do not fit into the seven SMV strain categories proposed by Cho and Goodman. They may represent new strains.

Resistance Screening

With the recent isolation of SMV-G4 and SMV-G5 strains and an unknown virus, all AGS lines and their parents, as well as some other SMV-resistant accessions, were screened for resistance by artificial inoculation. Twenty-four of the 290 AGS lines were found to be immune to SMV-G1 and SMV-G4 and to the unknown virus. Only three of these lines are also resistant to SMV-G5. These three lines either have an additonal gene for resistance, or a different resistance mechanism may be in operation which confers resistance to all three SMV strains and the unknown virus. The source(s) of resistance to SMV-G1 and SMV-G4 and to the unknown virus, but not to SMV-G5, have been identified among the AGS parents. Several AVRDC accessions were identified with immunity to SMV-G5 and/or SMV-G1 and SMV-G4 and/or the unknown virus. Two lines were found with immunity to SMV-G1, SMV-G4, SMV-G5, as well as to the unknown virus.

Further Characterization of New Poty Virus

A virus, previously not reported on soybean in Taiwan, has been recovered and studies initiated to characterize it by host range, serology, and protein coat molecular weight. The virus has been purified and high titer antiserum was produced. Host range did not prove to be very useful for the identification of the virus. However, the virus was shown to be biologically very closely related to both azukibean mosaic virus, blackeye cowpea mosaic virus, and the NY-15 strain of bean common mosaic virus. The molecular weights of these viruses were also shown to be nearly identical. Exact identification will be attempted in 1986.

Necrotic symtom of the new poty virus in soybean

Seriousness of New Poty Virus

The effect of the new poty virus (using isolate PN) on soybean yield was assessed. Significant decreases in yield and 100-seed weight can be attributed to infection with isolate PN at all growth stages. Virus-infected plants were also found to produce a high percentage of mottled seed. Neither high percentage nor high intensity of seed coat color mottling, however, appeared to be associated with presence of this virus in emerging seedlings. Seed transmission of virus isolates 74 and PM was examined by direct testing of seeds, and of germinated seed and was found to be extremely low (0.5% or less). Seed coat color, associated with virus infection of the plant, does not necessarily imply presence of the virus in the seed, since virus is detectable also in non-mottled seeds. This virus is considered important enough to be included in AVRDC's soybean disease resistance breeding program.

Production Systems Program

45

AGRICULTURAL ECONOMICS

Postharvest Losses and Marketing Cost of Cabbage

Although outer leaves did not protect cabbage effectively from weight loss, they did protect from mechanical injury during transportation. Cabbage with wrapper leaves incurred higher freight and container costs.

EVA film reduced water loss significantly; however, its enhancement of decay on the butts raises questions concerning its usefulness.

Cartons were effective in reducing mechanical damage to overmature and totally trimmed cabbage. Cartons also resulted in less weight loss. Therefore, properly designed cartons might be able to increase marketing efficiency in some cases. In this study, however, trimming and packing in baskets was more cost-effective.

Postharvest Losses: Thailand, Indonesia, Philippines

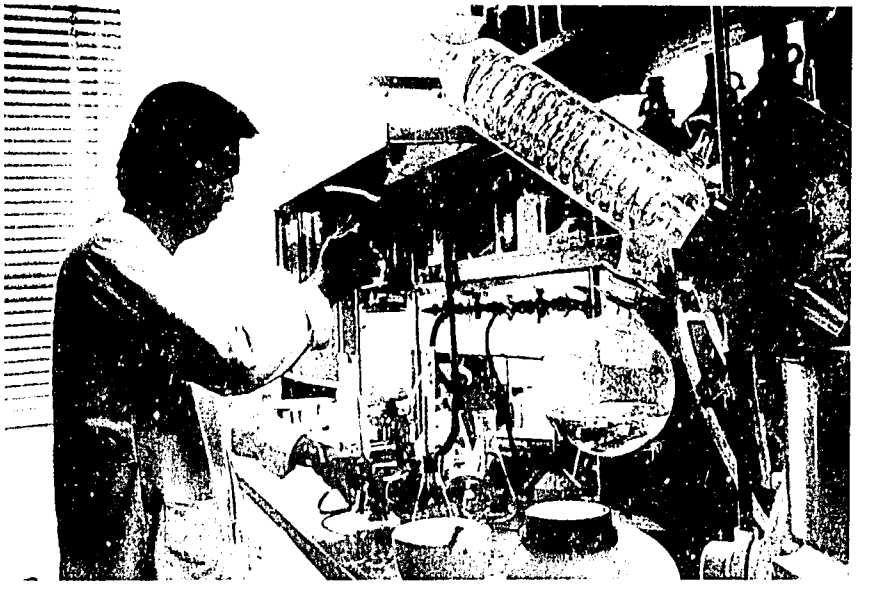
Observation reports on postharvest losses of perishable crops in Southeast Asian were written by four specialists. Their reports were condensed into one volume titled Postharvest Loss Investigations in Thailand, Indonesia and the Philippines, ed. Harvey C. Neese, by the Postharvest Institute for Perishables (PIP).

All three countries have common characteristics: they are in the hot, humid tropics with relatively large land areas; roads, other than main arterials, are generally poor; and all are suspected of having large postharvest losses in perishable crops with limited personnel and financial commitments to reduce these losses. The handling of technology, type of containers, refrigeration and storage conditions, extension of postharvest technology, and lack of accurate data on postharvest losses were the five problem areas identified. Some of the recommendations of the group were to initiate an information exchange between PIP and AVRDC, the development of a training course and field manual, support of postharvest organizations, the development of a regional or international postharvest loss center in Asia for vegetables, and the need for research on traditional bamboo containers.

CHEMISTRY

Provitamin A in Sweet Potato

Provitamin A, although abundant in vegetables and fruits, has a rather low absorbability by humans. An experiment using laboratory rats demonstrated that the availability of provitamin A in sweet potato is higher than in other vegetables. Boiling and baking, however, reduced vitamin A availability, whereas, frying did not.



Sweetpotato Weevil Damage and Sweet Potato Palatability

Sweetpotato weevil damage reduces the market quality of sweet potato. Since experimental animals were found to be very sensitive to terpene content, it was used as an index to determine what is an acceptable damage level of sweet potato for animal feed. Although it was suggested that terpene is the principle compound affecting the palatability of weevil-damaged sweet potato, this experimental design did not exclude the possibility of other contributing factors also being involved and, therefore, additional investigation will be needed for clarification.

Sweet Potato Tip Edible Fiber Composition

Tenderness in sweet potato tips hinders its full acceptance as a green leafy vegetable by consumers. Regarding edible fiber content, the new AVRDC breeding line CN 1508-93 showed long petioles with high pectic content which may suggest a better eating quality than the check cultivars. Organoleptic evaluation indicated that it is, however, less acceptable than water convolvulus.

Mungbean Cooking Quality

A long cooking time length is undesirable for dry beans. It was found that the required cooking time for mungbean seed is affected by crop season and storage period. AVRDC breeding line VC 11688 proved to be better than the local check V 2010 regarding the cooking time requirement.

Quality Constitutents of AGS Soybean Lines

Many of AVRDC's 290 AGS soybean lines have been released by national programs for commercial production.

These lines have been analyzed over a period of years for certain qualities. A wide variability in combination of contents was noted. Certain lines were high in both protein and fat, whereas others were very high in protein with slightly lower fat content. High protein lines are good for traditional oriental foods such as tofu and beancurd skin. Lipoxygenase activity of AGS lines varied from 85 to 170 units/mg. Flavor patterns, determined by gas chromatography on lines high and low in enzyme activity, suggest that lipoxygenase enzyme activity can be a potential indicator of the beany flavor in soybean milk. Lines identified with special qualities will be planted in the field with replications for reconfirmation and quantitative comparison.

Beany Flavor of Processed Soybean Products

The undesirable green-beany and grassy flavor of tofu and beancurd skin is often a deterrent to consumer acceptability. Flavor patterns of these traditional soybean products were analyzed by gas chromatography and showed that their major volatiles were similar to those in soybean milk. Beancurd skin, however, has very low carbonyl compounds, which suggests that is has a better chance of being accepted by consumers.

CROP MANAGEMENT

Seedling Medium

Tests indicated that the AVRDC standard seedling medium should be improved. Media mixtures with 1:2 sand:crotellaria compost, with or without 7-14% burnt/rice hulls, are recommended for further study. The addition of sand should not exceed one-third of the mixture by volume.

Chinese Cabbage Seedling Media

The final salable yield of Chinese cabbage originating from seedlings grown in the 5:1:1 ratio of soil, sugarcane compost, and burnt rice hulls medium was nearly double that produced from seedlings grown in the standard AVRDC medium when both treatments were transplanted and harvested on the same day.

Emergence Rate of Direct-Seeded Mungbean and Soybean

Germination of soybean and mungbean is affected by soil moisture conditions. Very wet soil conditions at seeding time (wetter than a soil moisture tension of -0.07 bar) caused slower initial, and less total, germination of soybean and mungbean. Optimum initial and total germination occurred when seeds were planted at a soil-moisture tension level of -0.23 bar which occurred seven days after furrow irrigation.

Vegetable Soybean—Nitrogen Fertilization and Plant Population

Yield and quality of vegetable soybeans are greatly affected by planting density. The optimum density for two cultivars was 18-19 plants/m^2, but G 9053 also yielded well at a density of 10 plants/m^2 with greater pod size and number of pods per plant.

Total pod yield increased 18% in one of two experiments at a population of 10 plants/m^2 when preplant plus sidedressed total nitrogen application was increased from 60 to 120 kg/ha. For higher populations, 30 kg preplant N/ha plus 30 kg sidedressed N/ha appeared adequate.

Vegetable Soybean—Furrow Irrigation in Dry Weather

Irrigation of vegetable soybeans during dry weather resulted in higher pod yields. The most effective single furrow irrigation treatment was given at 20 days after emergence in the first experiment and at the beginning of pod formation and filling in the second experiment. Two irrigation treatments provided better results than one and proved to be nearly as effective as three or four treatments when one irrigation was given early and the other at the beginning of pod filling.

Bag Culture/Rainshelters for Summer Tomatoes

Diseases greatly reduce tomato yields during the hot, rainy season. Yields and quality of two tomato cultivars were improved with a 0.8-m-wide plastic-covered rainshelter over the rows during this season. Although yields with bag culture were significantly lower than those of plants in the soil, the method could have many practical applications and, therefore, merits additional research.

Tomato Field Establishment

Tomato stands may be field-established by either transplanting seedlings or direct-seeding. Direct-seeded tomatoes had a lower germination rate than those in flats and pots. There were no significant yield differences among transplanted and normal direct-seeded treatments. Yields were not affected by the addition of igetagel, a water absorbing material, to the container media, but decreased when 2.5 g of the compound was added to the planting hole of direct-seeded tomatoes.

Processing Tomato—Plant Spacing

Yield responses of processing tomato cultivars to plant and row spacings may vary with cultivars. No clear response pattern of fruit size was observed to the spacings ranging from 1.0 m x 0.3 m to 1.5 m x 0.5 m. Fruit number and weight per plant increased more with wider plant spacings than with wider row spacings, but the yield increases were less than proportional to the additional space required.

Processing Tomato-Banking and Staking

Tomato growers are interested in the consequences of banking and staking operations on processing tomatoes. Banking increased southern blight incidence on two cultivars in one experiment. Banking did not increase yields; in fact, banking too late (44 days after transplanting) resulted in lower yields for CL 5915-153-D_4-3-3. Staking resulted in higher yields, either with or without banking, in all but one case.

Sweet Potato-Field Establishment and Yield

Field establishment and yield of sweet potatoes were affected by the condition of the cuttings which were transplanted. Removal of leaves from cuttings reduced early root growth and resulted in lower marketable yields. More consistent results were obtained with 30-cm than with 20-cm cuttings. Cuttings which were immersed in water for one day performed equal to or better than fresh cuttings or those immersed in water for three days.

Sweet Potato-Bed Height and Nitrogen Fertilization

Bed height and nitrogen application rates are important considerations for the production of sweet potatoes during the rainy season. In a rainy season where no flooding occurred, marketable yields of sweet potatoes growing on 30- and 45-cm beds were similar. Marketable yields of CN 1309-18 responded to increasing N rates but CN 1108-13 did not.

GARDEN PROGRAM

Home Gardens

In selected countries AVRDC has developed small, easy-to-grow, nutrition-related home gardens for the rural poor to grow their own vegetables. Over a four-year period these gardens have produced significant amounts of the RDA for protein, calcium, iron and vitamins A and C of a family of five.

The home gardens are 4 x 4.5 m, containing three raised beds (25 cm high) and grow, with simple inputs, a culturally acceptable intercrop of nutritious vegetables. Crop

management procedures appropriate for mainly women gardeners in developing countries are practiced (e.g., rice-straw mulch, composting, hand-removal of insects and weeds). Women are generally responsible for obtaining food for the family in rural areas of the developing world. Eighty percent of the gardeners involved in the AVRDC program in Indonesia, the Philippines and Thailand are women.

Yield and nutritional outputs for 1984-85 reflect the value of a small home garden to a family of five in a developing country. An impressive amount of selected nutrients were consistantly produced by these gardens throughout the year.

School Garden

AVRDC has researched a school garden, 10 m x 18 m x 25 cm (high), with a culturally acceptable intercrop of nutritious, easy-to-grow garden vegetables. The garden uses crop management practices appropriate to developing countries. They are designed to be grown and maintained by school children and yields are expected to be high enough on a daily basis to provide 100 school children each with one-half cup (113 g) of nutritious vegetables.

In the 1984-85 season the AVRDC school garden produced an average daily yield of over 11 kg of vegetables, enough daily half-cup portions for 99 school children during a 260-day school year. This type of technology is suitable for transfer to developing countries where children from low-income families can provide themselves with nutritious vegetables to augment their rice-box lunches at school.

Urban Garden

As demand for perishables goes up in urban markets, so does the price, with the result often being that such items as nutritious vegetables are not affordable by the people who

may need them most: the urban poor. An urban garden was studied in which nutritious vegetables are grown in eight wooden boxes which total an area of 3.2 m^2. Yields and nutritional outputs were recorded and results indicate that this type of garden yielded an average of 0.22 kg per harvest of nutritious vegetables, 244 times throughout the year.

Market Garden

A market garden was developed on a 10 x 20 m plot which grows a variety of vegetables in demand in urban areas. The objective of the market garden is to increase the income by 30% of small-farm families who live near urban areas.

The market garden produced 2,012 kg of market-quality vegetables during the year. Deducting cash costs, the garden produced a wholesale profit of US $423, a figure that could readily increase the income of peri-urban families in developing countries who may only produce a yearly household income of around US $1,000.

Dryland Garden

Gardens usually require considerable daily watering which is a constraint to growing gardens in dryland or rainfed areas of the developing world. Therefore, an AVRDC microbiologist investigated the use of permanent composting beds in order to grow gardens that have the potential of retaining large amounts of water.

A three-month trial was undertaken at AVRDC, in which a controlled environment garden that contained permanent composting beds, and the traditional sunken beds as a check, were grown. A variety of seven garden vegetables was planted in both types of beds. Sunken beds were given small amounts of water on a daily basis which is the usual garden watering practice in the tropics, while composting beds were watered once after being built and thereafter only when plants showed a need.

The composting beds produced greater yields with less than half the amount of water used in the sunken beds. The experiment will be continued for a full year's agricultural cycle as a result of these encouraging results.

Thai Pilot Garden

The transfer of nutrition-related gardening technologies to developing countries is an interdisciplinary task, requiring the talents of horticulturalists, nutritionists, economists, and extensionists. A joint effort was undertaken by AVRDC and Kasetsart University to transfer gardening technologies from AVRDC to a rural area in Thailand.

A Thailand home garden was developed at AVRDC to provide a family of five with significant amounts of its needs for protein, calcium, iron and vitamins A and C. The 4 x 4.5 m AVRDC home garden grows a culturally acceptable intercrop of nutritious vegetables using inputs appropriate to the rural poor. The gardens were established among 30 small-family farming systems and compared to 15 non-gardening families. The value and impact of these gardens on Thai

small-family farming systems is assessed using Farming/Family Living Systems and Relative Nutrient Cost methodologies.

Backyard gardening was accepted by farm families, resulting in an increase in vegetable consumption and a decrease in food expenditures. The gardening technologies are now being transferred to five other provinces in the northeast of Thailand where a serious vitamin A deficiency exists.

NEW VEGETABLE PROJECT

Of the 400 vegetables consumed in Southeast Asia, only about 115 are routinely cultivated. Fewer than 40 of these are suitable for commercial production. Most modern cultivars of these vegetables were developed in temperate countries and can only be produced in the limited highland areas or during the cool-dry months in Southeast Asia.

AVRDC's new vegetable project was established in 1981 with the objectives of (1) screening commercial varieties of selected vegetables prior to their use by national programs and (2) identifying crops that might warrant future research at AVRDC.

Based on the results of the series of trials from 1982 to 1984 and the availability of seed supplies, 20 cultivars (out of 646 initially collected) were selected of five vegetables: cauliflower, sweet and hot pepper (Capsicum annuum), mustard (Brassica juncea), radish (Raphunus sativus), and snap bean (Phaseolus vulgaris). These final selections were prepared as a recommended set and a total of 381 sets of the five vegetables was sent to 91 cooperators in 35 different countries for international trials.

Sweet Pepper Evaluation Trial

Ten cultivars were entered in a summer trial for sweet pepper. Two F_1's, Gypsy (high number of fruit per plant) and Blue Star (large fruit size), were the highest yielders. The original F_1 seed of Gypsy showed a longer harvest period and, consequently, a larger number of fruit per plant and higher yield than the seed advanced from it at AVRDC. The difference between the two seed sources, however, was not significant in unit fruit size. Cultivars Avelor and Cubanelle produced thin-walled fruit.

Sweet pepper trial

SOIL SCIENCE

Improved Cropping Systems

After tests of seven successive cultivations of various crops since 1983, 10 cropping systems with rice, corn, Chinese cabbage, mungbean, soybean, sweet potato, and tomato during the spring, summer and autumn seasons are recommended. In addition to the yields and total dry mass, input-output balance for such nutrients as N, P, K, Ca, Mg, and C were obtained for each cropping system over the period of autumn 1984 to autumn 1985.

Nitrogen Fertilization for Soybean

Nitrogen topdressing at 4 weeks after germination (WAG) greatly increased pod number, and its topdressing at 8 WAG increased 100-seed weight. For high yield, however, it is more important to obtain the greatest number of pods than heavy seeds. Since N fixation, suppressed at the pod-filling stage by high nitrogen rates at 4 to 8 WAG, was easily remedied by avoiding topdressing at 8 WAG, a relatively high N rate at basal and topdressing applications at 4 or 6 WAG, or a slightly high basal application with low N topdressing at 4 and 8 WAG is strongly recommended to obtain a high economic soybean yield.

Soybean Continuous Cropping

Although deep plowing, rice straw mulching, and even fertilization initially did not increase soybean yield significantly, it gradually increased over two years and finally reached more than 4 t/ha with continuous soybean cropping. Spring soybean followed by no summer cropping (but with a rice straw mulch) and by autumn soybean was an adequate crop rotation method that sustained a relatively high yield and minimized cropping hazards.

Seedling Media for Tomato and Chinese Cabbage

Recommended seedling media, using locally available materials such as sugarcane compost (SCC), smoked rice hulls (SRH), crotellaria (CLC), etc., are: in a soil basis (1) soil:SCC:SRH = 5:1:1 or 3:1:1, and (2) soil:SCC:sand:RH = 3:1:1:1; in a porous material basis (1) soil:SCC:CLC:sand = 1:2:2:1, (2) soil:SCC:sand:RH = 1:1:2:1, (3) SCC:sand = 1:3, and (4) sand:CLC = 1:2; and in high pots (1) soil:SCC:CLC:sand = 1:2:2:1, (2) soil:SCC:sand:RH = 1:1:2:2, and (3) SCC:sand = 1:3. The germination rate was mainly governed by inorganic N and the electro conductivity (EC) of the medium. The inorganic N concentration in the media should not exceed 140 ppm and 1.0 mmhos/cm for EC. Since the seedling media greatly affected the yield of tomato and Chinese cabbage, there is a good chance of avoiding soil-borne diseases through use of better seedling media.

Tipburn and Internal Rot in Chinese Cabbage

A series of experiments were conducted which focused on the cultural practices which minimize tipburn and internal rot in Chinese cabbage. The initial growth rate should be suppressed by covering and N split application to minimize internal rot. Nitrogen and water application at the desired time can control the growth rate to eliminate tipburn and internal rot without a great decrease in yield. Irrigation through pipes buried 10 and/or 20 cm deep effectively decreased tipburn and internal rot.

Checking the Chinese cabbage root system for its ability to overcome tipburn and internal rot.

Advanced Cultural Practices for Summer Tomato

Drip irrigation, combined with a high seedling pot, is a very promising technique for summer tomato cultivation and easily yielded 5 kg of tomatoes per plant. The combined treatment of $CaCN_2$, incorporation of rice straw, submergence, and increased soil temperature proved to be very effective in suppressing root knot nematode damage in the tomato-Chinese cabbage-tomato crop rotation.

Tomato Cultural Practices

The high seedling pot is a promising technique for summer tomato cultivation if a good seedling medium and staking are provided on a 40-cm raised bed. Rice in a cropping sequence is effective against nematodes and soil-borne diseases, but upsets soil physical properties which results in a great decrease in yield.

Bilateral Programs

AVRDC-INDONESIA BILATERAL PROJECT

Breeding Scab Resistance into AVRDC Sweet Potato Cultivars

Although AVRDC sweet potato lines generally produce good plant type, tuber form and have high carbohydrate content, no cultivar has thus far been released in Indonesia because of susceptibility to scab (Elsinoe batatas). To minimize susceptibility to scab, crosses have been made at AVRDC with Indonesian clones Daya, Prambanan, Borobudur, and Tumpuk. Evaluation of the crosses is underway.

Evaluation of AVRDC Tomato Cultivars

Twenty AVRDC varieties were planted and compared to the local cultivar Intan. Three lines outyielded the check: PT 858 (877 g/plant), PT 862 (1099 g/plant), and Tainan No. 2 (968 g/plant). All lines were susceptible to Phytophthora infestans but not to bacterial wilt. These three lines showed good characteristics for processing tomatoes.

Evaluation of AVRDC Chinese Cabbage Varieties

Twelve AVRDC varieties were planted and compared to the local check Granat. AVRDC varieties 80-32 (44.6% head formation, 287.5 g/head), 80-37 (22.6% head formation, 146 g/head), and Hybrid 62 (21.4% head formation, 387.5 g/head) were promising.

AVRDC-KOREA BILATERAL PROGRAM

Cytoplasmic Male Sterility in Chinese Cabbage

Three Raphanus originated cytoplasmic male sterile (CMS) parents were backcrossed with recurrent lines of two varieties. In 1985 these CMS lines and the F_1 hybrids developed therefrom were compared to the recurrent parents and the corresponding F_1 hybrids, respectively. The results with the Raphanus CMS material suggested that many genetic traits of the recurrent parent were not fully recovered even after six generations of backcross although their appearance was similar. The combining ability of CMS lines should be studied again after further backcrosses.

Although the average seed-setting ability of B. juncea CMS lines was tremendously improved, they were so different

from their recurrent parents that they bore low rates of seed per pollination and each CMS line grown in the field still showed severe chlorosis regardless of its seed-setting ability. This source will continue to be used for backcrossing.

Breeding for Heat-Tolerant Chinese Cabbage

Sixteen combinations between two Horticultural Experiment Station (HES) lines and eight AVRDC lines were tested in summer 1985 trials. Generally the results were more satisfactory than in former trials. Most plants showed the desired characteristics from the parents. Selected crosses will be tested again in 1986.

Nonstaking Processing Tomato Hybrids

The performance test in 1985 concentrated on four cross combinations, in which AVRDC CL 1561 was used as pollen parents in two cross combinations, which had provided constantly acceptable yields and high fruit quality over two years. Unfortunately unusual weather conditions affected yields and further studies with additional entries are required.

Improving Staking Tomato Hybrids

A total of 53 advanced lines ranging from F_3 to F_4 generations were screened and 18 lines and 26 individual plants were selected. These materials will be screened again and some cross combinations made in 1986.

Regional Adaptability for Processing Tomato Varieties

Fourteen processing tomato varieties developed by HES or AVRDC were tested for their regional adaptability at six locations. Unfortunately inclement weather ruined the tomato harvests and the trial will be repeated next year.

AVRDC-MALAYSIA VEGETABLE RESEARCH PROGAM

Soybean Observational Trial

Of the 10 advanced AVRDC lines, AGS 58, AGS 129, AGS 130, and AGS 154 compared favorably with the local check and will be included in a future replicated yield trials.

Mungbean Observational Trial

Two promissing AVRDC lines (VC 1768-A and BV 1628-A) outyielded the check and will be included in a future yield trial.

Tomato Evaluation Trial

Twenty-three AVRDC tomato lines were evaluated in two trials. Four determinate lines (CL 5915-93D4-1-0), CL 5915-223D4-2-1, CL 5915-223D4-2-2, and CLN 65-349D5-1-0), and an indeterminate line (CL 5915-206D4-2-5) were selected. They were all highly resistant to bacterial wilt.

Virus Resistance in Hot Pepper

Several viruses are suspected of creating the serious problem in hot pepper cultivation in Malaysia. Three lines with reported resistance to several viruses were obtained from the Texas Agricultural Experiment Station. However, in field trials all three lines were susceptible to viruses and not adapted to the local conditions.

Assessing Tomato Reaction to Black Leaf Mold

Black leaf mold (Cercospora fuligena) is one of the most serious fungal diseases in tomato. A total of 27 AVRDC tomato lines previously evaluated, and an additional nine accessions from USDA with reported resistance to early blight, were included in the trial. Four lines were only moderately susceptible to leaf mold: CL 5915-39D4-1-0, CL 5915-223D4-2-2, PI 105267, and PI 255 829. In view of the seriousness of this pathogen and the scarcity of information about its biology, further investigations are recommended.

Other Vegetable Trials

Germplasm for a large number of other vegetables has been ordered from various sources, particularly international seed companies, in preparation for observational trials. Until now a total of 333 cultivars have been received: asparagus (45), broccoli (11), cabbage (25), carrot (19), cauliflower (29), cucumber (24), eggplant (20), garlic (5), lettuce (18), onion (14), pea (7), sweet potato (31), hot pepper (36), radish (9), spinach (17), tomato (22), and turnip (1).

AVRDC-PHILIPPINE OUTREACH PROGRAM (POP)

Mungbean Trials

The criteria for selection in this project are yield potential, early and uniform maturity, resistance to common pests and diseases, tolerance to lodging, and good seed quality. Six lines (VC 3668-2B-1, BC 3830-B-3-1, VC 3865-B-4-1, VC 3791-B-1-1, VC 3881-B-11-1, and VC 3897-B-3-1) were highly resistant to Cercospora leaf spot and entry VC 3881-B-11-1 was resistant to virus infection.

Since these varieties had undergone preliminary yield trials (PYT) over four seasons, the two most outstanding lines were elevated to the regional yield trial (RYT). Other promissing lines will be included in the general yield trial (GYT) next season.

Seventeen AVRDC entries were evaluated during the dry and wet seasons in GYTs. Due to their outstanding performances, lines EG 2755 and EG 2764 (VC 2764-B) will be recommended to the Philippine Seed Board for release as commercial varieties.

AVRDC Soybean Breeding Lines

This study was conducted to determine high bean yield potential, resistance to major foliar diseases, and adaptability to agro-climatic conditions of AVRDC soybean lines/accessions. Although a total of 58 AVRDC lines/accessions were planted, no yield was computed because of poor germination and typhoons.

Soybean Trials

A total of 56 soybean entries were evaluated during the dry and wet seasons. In the dry season trial, one-half of the entries significantly outyielded the best performing check regarding yield as well as in most other parameters. The most stable yielder in both seasons was G 90089.

After three consecutive years of testing in soybean regional performance tests, AGS 73 was found to be a consistently high yielder with the highest seed-germination rate. It was recommended and approved for commercial release as BPI Sy4 by the Philippine Seed Board.

Chinese Cabbage Trials

Eleven entries were evaluated for stable high yields in both wet and dry season PYTs. CAT 80-32, CAT 80-33, and CAT 80-37 significantly outyielded the check in the wet season.

Five promising AVRDC entries were evaluated in dry and wet season GYTs. The overall performance of all entries was comparable to the check.

Chinese Cabbage Seed Production

After release of AVRDC Hybrid 62 (Reyna Elena) in the Philippines, a study was initiated to determine the feasibility of producing hybrid seeds using AVRDC-developed techniques. This preliminary study showed that the seed-production technology developed at AVRDC can easily be adapted under Philippine conditions. The study is being held again in farmers' fields to determine its economic feasibility before extending the technology to prospective seed growers.

Tomato Single Seed Descent Trial

Single seed descent entries were seed-increased at POP in unreplicated rows. Of the 65 lines in the trial, 44 lines were advanced to the PYT based on high marketable yield, good fruit set and other ideal fruit characters.

Tomato Trials

After two seasons of PYTs, 8 promising fresh market tomatoes have been identified. These entries will be evaluated for two more seasons before they are entered in the GYT. Processing tomato F_1 hybrids PT 1017, PT 3027, and PT-1599 were selected. Seeds of these hybrids have been requested from AVRDC for further field trials.

After four seasons in GYTs, fresh market tomatoes CL 1094-88, CL 1344-48, and CL 1344-78 were selected for inclusion in the 1986 RYT because of their yield, heat tolerance, and resistance to pests and diseases during both wet and dry seasons.

Of the eight AVRDC processing tomato entries evaluated in the RYT during the wet season, four were the highest yielders.

Sweet Potato Trials

Of the 49 new entries in PYTs, 7 had highly significant yields over the check.

Four promising entries showed significant tuber yields in the GYT.

AVRDC entry CI 693-9 was selected from this regional performance test and officially released as BPI Sp2 for commercial production by the Philippine Seed Board.

Sweetpotato Weevil Resistance Study

Sweetpotato weevil is a serious problem in the tropics. Some AVRDC varieties tested in Taiwan have shown resistance to weevil damage and were, therefore, further evaluated under Philippine conditions. Although ten entries had highly significant yields, they were found to be susceptible to sweetpotato weevil.

Chinese cabbage at Taichung DAIS being inspected by AVRDC Chinese cabbage breeder

AVRDC-ROC BILATERAL PROGRAM

Chinese Cabbage Trials

In 1985 summer RYTs in eight locations in Taiwan, AVRDC 82-46 and Hybrid 62 gave the highest average yields at 38.58 t/ha and 38.49 t/ha, respectively, which were 16% higher than the local check.

Mungbean Trials

In 1985 spring and summer RYTs at four locations in Taiwan, VC 2768-A and VC 1168-B outyielded the check by 6% and 4% with average yields of 2.20 t/ha and 2.18 t/ha, respectively.

Soybean Trials

In the three season RYTs in 1984 in eight locations in Taiwan, TARI 14 (2.80 t/ha), KS 8 (2.73 t/ha) and AGS 129 (2.67 t/ha) were the best yielders. In district trials in eight locations throughout Taiwan over three seasons during 1984, AGS 129, KS 8, and KS 955 all yielded 2.0 t/ha. In view of the excellent results from the 1982 and 1983 RYTs and 1984 district trials, AGS 129 was officially released for commercial use as Kaohsiung selection No. 10 on 4 October 1985.

In 1985 spring and summer vegetable soybean RYTs in six locations, AGS 292 provided the best pod yield at 6.2 t/ha, with the smallest regression coefficient which indicates the line's stability. In a different Kaohsiung DAIS testing and grading trial, the quality of AGS 292 was found to be similar to the check.

Sweet Potato Trials

During 1985 spring and summer RYTs in four locations throughout Taiwan, CN 1232-9 outyielded the check by 14% with 22.7 t/ha. Results from 1984 and 1985 trials also indicate that CN 1232-9 had the smallest regression coefficient and largest possible determination coefficient which indicates line stability.

Fresh Market Tomato

In 1985 summer RYTs at six locations around Taiwan, PT 774 yielded 49.6 t/ha, however; the line's fruit shoulder color was not acceptable in the Taiwan fresh market and bacterial wilt, susceptibility was high at 48%.

Processing Tomato Trials

In all three season RYTs during 1984 at three locations in Taiwan, TM 103 was the top yielder. Based mainly on yield and fruit appearance, TM 103 was included again in 1985 RYTs.

AVRDC-THAILAND OUTREACH PROGRAM (TOP)

Chinese Cabbage Trials

Twelve successive varietal trials were conducted from 1982 to 1985 on 16 hybrids and 15 OP Chinese cabbage lines from AVRDC. Five heat-tolerant AVRDC varieties gave higher yields than the commercial cultivar, especially in the summer season. However, the horticultural characters of these varieties need to be further improved to meet local preferences.

Insecticide Control of Cruciferous Pests

In a study to determine insecticides that effectively control the diamondback moth (Plutella xylostella) and cabbage webworm (Hellula undalis), which are the most serious cruciferous insect pests in Thailand, Teflubenzuron at 0.005%, Bacillus thuringiensis at 20 cc/20l l and Triflumuron at 0.0375% for the diamondback moth and Teflubenzuron at 0.005%, Triflumuron at 0.0375% and KIC at 0.1% for cabbage webworm were found to provide adequate control.

Soybean Trial

Although the local check cultivar gave the highest yield of 1.9 t/ha in this grain soybean trial, it was infected by downy mildew, whereas AGS 154, AGS 129, and AGS 58 were resistant to downy mildew.

Dr. Charles Yang, Director and Resident Scientist, TOP-AVRDC

Mungbean Trials

Seventeen trials with 9 cultivars and 11 breeding lines from AVRDC were conducted from 1982 to 1984 to determine mungbean yield and other horticultural characters. AVRDC varieties VC 1973-A and VC 1778-A were the most stable and high-yielding lines with some better agronomic characters than the Thai national cultivar Uthong No. 1 and were released for commercial use in 1985 by the Thai authorities as Kamphaeng Saen 1 and Kamphaeng Saen 2, respectively.

Sweet Potato Germplasm Collection

TOP-AVRDC maintains a field collection of 48 (40 from AVRDC, 6 from Thailand and 2 from China) sweet potato lines at the Kamphaeng Saen (KPS) campus. Duplicates have been apportioned to other research institutes to ensure the collection's survival.

Sweet Potato Trials

In the sweet potato trials conducted at TOP's KPS from 1982 to 1984, AVRDC cultivars outyielded the local checks.

Plant Density and Sweet Potato Yield

A 75 x 30 cm plant density gave AVRDC sweet potato variety AIS 0122-2 maximum root yield (17.2 t/ha) and an acceptable root size (70 g).

Market Evaluation of AVRDC Tropical Tomatoes

Thai consumers have a preference for noncracking tomatoes with small pink fruit which are ovate to pear shaped and not very firm. AVRDC tropical tomato lines were found to lack these desired horticultural characters.

Tomato Trials

Five new AVRDC tropical breeding lines with some degree of heat tolerance and bigger fruit size were tested while the maximum and minimum temperatures at fruit-setting period was 33.0°C and 23.7°C, respectively. Fruit weight of AVRDC varieties ranged between 31 and 78 g/fruit (checks were 22 and 23 g/fruit) and yield, except CL 5915-206F4-2-4-0, between 17.2 and 14.2 t/ha (check was 7 t/ha).

During 1984 PT lines and F_1 hybrid processing tomatoes were tested at TOP's KPS station. Seven lines produced higher yields in all seasons than the most widely grown commercial cultivar.

Tomato-Weed Control and Fertilizer

Metribuzin at 0.5 kg (ai)/ha continued to be the best pre- and post-emergence herbicide for tomato against Thianthema portulacastrum, Amaranthus spinosus, and Echinochloa colonum. Optimum rate and time of fertilizer applications were determined for KPS where the soil is sandy and silty loam with poor organic matter.

Tomato Yield and Cultural Practices

Yields gradually increased with closer spacings and were highest at spacing between plants of 100 x 30 cm. Mulching, staking, and shorter harvest intervals resulted in better tomato yield.

Home Garden

A home garden in which less than one hour a day is required to provide daily a family with fresh vegetables such as amaranths, bitter gourd, Chinese cabbage, celery, coriander, green onion, kale, kang kong, leaf mustard, lettuce, pakchoi, spinach, and yardlong bean was continuously grown during the year at KPS.

Regional Training

Nine trainees from China and Thailand successfully participated in the five-month fall/winter 1985-86 course at TOP-AVRDC.

INFORMATION SERVICES

The Office of Information Services (OIS) assists to increase the level of communication between AVRDC researches and their colleagues working in national programs; prepares and disseminates the Center's finished research products; and serves as a link between the Center, its donors, and other audiences interested in AVRDC's activities. OIS consists of editorial, photographic, artistic, printing and distributive staff who provide a wide range of publishing/informational services for the Center. During 1985 OIS undertook the following activities, among others:

- Published 45,650 copies of 23 formal documents for a total of 2,193 pages; each page required the full use of OIS specialized skills to prepare for publication.
- Distributed publications upon request to 1,590 different readers from throughout the world.
- Prepared the 1984 Highlights leaflet in English, German, Indonesian, Korean, and Thai.
- Initiated a copublication project with the Technical Centre for Agricultural and Rural Cooperation (CTA) for the translation and publication of AVRDC's Sweet Potato Proceedings in French.
- Merged the separate TVIS News and Soybean Rust Newsletter mailing lists with the central AVRDC mailing list and began to update this 7,000-entry computerized list.
- Aided AVRDC scientists to obtain publication of 8 journal papers, prepared 5 additional papers for future publication, and assisted in the preparation of 17 symposium presentations.
- Exhibited at the Frankfurt International Bookfair, the Zimbabwe International Bookfair and the Hunan Exposition.

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Newsletters/Bulletins

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Soybean rust newsletter - This annual newsletter is published by the International Working Group on Soybean Rust through TVIS.

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TRAINING

AVRDC provided an articulated training program in 1985 for 94 scholars who were trained at Headquarters and 9 trained through the TOP-AVRDC program in Thailand.

At AVRDC headquarters trainees from Indonesia, Korea, Malaysia, the Philippines, Taiwan, and Thailand, as well as Bangladesh, the Federal Republic of Germany, Japan, Liberia, Papua New Guinea, Reunion (France), Tonga, and the USA underwent training in two five-month courses and one two-month summer course. Table 1 provides a breakdown of the training scholars by subject/discipline and period of training.

Training sponsors in 1984 included: the Asian Development Bank (ADB), AVRDC-TOP, World Bank Assisted Seed Project - Indonesia, Rural Development Administration - Korea, National Science Council (NSC) - Taiwan, Japan International Cooperation Agency (JICA), German Agency for Technical Cooperation (GTZ), German Academic Exchange Service, Netherlands Universities Foundation for International Cooperation (NUFFIC)/UNIBRAW, USAID Garden Program, University of Illinois, Canho Enterprise Co., Ltd., Adams International, Ltd., and the Board of Global Ministries United Methodist Church - USA.

At the TOP-AVRDC regional training program 9 trainees from China and Thailand attended the 5-month course 1985-86.

AVRDC training specialist (left) conducting a field class

Table 1. Trainees by subject/discipline and period of training in 1985.

Subject/Discipline	RI	RS	RF	PT	SPT	VS	SST	Total	Man-months
Plant Breeding	2	1	-	-	-	2	4	9	35.0
Plant Pathology	3	-	-	-	2	2	2	9	24.5
Plant Physiology	1	-	-	-	-	-	4	5	13.0
Entomology	1	-	-	-	-	2	5	8	17.0
Seed Technology	1	-	-	-	-	-	2	3	9.0
Chemistry	-	-	-	-	1	-	9	10	25.0
Crop Management	-	-	-	-	-	4	-	4	4.0
Economics	-	1	-	-	-	-	-	1	7.0
Garden/Nutrition	-	-	-	-	2	-	-	2	1.5
Soil Science	2	-	1	-	2	-	-	5	22.0
Production	-	-	-	26	1	-	-	27	124.5
Information	-	-	1	-	-	-	-	1	12.0
Research Management	-	-	-	-	-	6	-	6	4.0
Training Management	-	-	-	-	1	-	-	1	3.0
General	-	-	-	-	3	-	-	3	1.5
Total	10	2	2	26	12	16	26	94	303.0

RI : Research Intern
RS : Research Scholar
RF : Research Fellow
PT : Production Trainee
SPT : Special Purpose Trainee
VS : Visiting Scientist
SST : Summer Student Trainee

GENETIC CONSERVATION

Germplasm Collections

AVRDC houses the world's base collection for mungbean and the Asian and the Pacific regional collection for sweet potato in the IBPGR's international conservation network. Table 2 provides specific information of the holdings on a crop basis.

Germplasm Distribution

A total of 22,367 seed samples was distributed to cooperators in 86 countries/territories during 1985 (see Table 2 and the following listing of "Germplasm Recipients").

Germplasm Characterization

Table 3 provides the current status on characterization of the principal crops in AVRDC's genebank.

Seed Distribution Survey

Germplasm recipients were queried in order to determine possible bottlenecks to rapid exchange. Respondents indicated that a seed packet may take from 5 to 150 days to reach its destination and it may remain another 150 days under poor storage conditions before it is planted. Various steps have been taken to resolve some of the problems identified by the survey.

Duplication of Chinese Cabbage Collection

In a joint AVRDC/IBPGR project, AVRDC is multiplying and characterizing all OP materials in its germplasm collection

and depositing them in the IBPGR-designated base collections at the National Vegetable Research Station (NVRS), Wellesbourne, United Kingdom, and the National Institute of Agrobiological Resources (NIAR), Tsukuba, Japan. During the year 50 accessions were sent to both NVRS and NIAR. The accessions will continue to be multiplied and as sufficient quantities become available they will be deposited at NVRS and NIAR.

Preparation of Chinese Cabbage Descriptor List

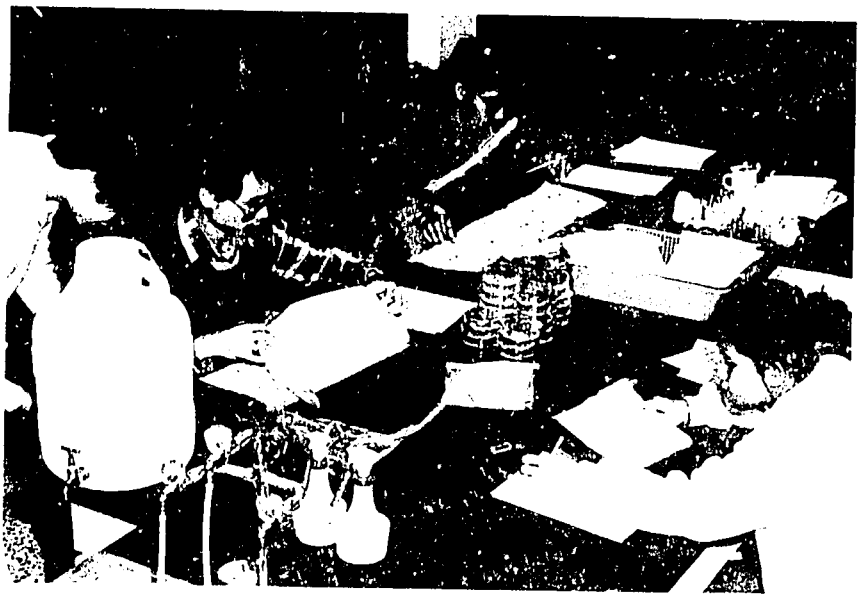
Another activity in the joint AVRDC/IBPGR project is the development of a comprehensive descriptor list of Brassica campestris, and to test the proposed list and study the relationship between characters. A proposed list containing 122 descriptors has been developed following the IBPGR standard format. Preliminary analysis was conducted to examine the nature of the data and to determine how the different characters related to each other. A full examination using multivariate analysis will be done when the data are complete.

Table 2. AVRDC germplasm collection and distribution in 1985.

Crop	Total no. accessions	New accession (1985)	Total no. samples distributed
Chinese cabbage	846	45	2,762
Mungbean	5,282	23	5,146
Soybean	12,244	390	7,770
Sweet potato	1,200	-	548
Tomato	5,366	560	4,330
Subtotal	24,938	1,018	20,556
Other vegetables	441		1,811
Total	25,379	1,018	22,367

Table 3. Status of germplasm characterization in 1985.

Crop	Status
Chinese cabbage	Out of the 376 OP and suspected OP accessions, 315 have been characterized on vegetative characters and 121 on flower and fruit characters.
Mungbean	Entire collection completed for 35 characters and partially done on four characters.
Soybean	Non-USDA accessions (2,672) completed.
Sweet potato	Above-ground vegetative and root characters completed; flower characters completed for those that flowered; will confirm again in the coming season.
Tomato	4,708 accessions completed with 9 characters; other accessions and characters to be added.



Studies on seed viability

Polymorphism in Mungbean Collection

In a study to determine whether out-pollination contributes to the presence of different seed morphotypes in mungbean accessions, segregation patterns for seed types were similar for both inside and outside pollination which suggests that segregation may be due to both past cross-pollination and/or expressivity of genes.

Competition between Different Mungbean Genotypes

Competition between morphoecotypes is a common phenomenon in which dominant types will slowly become predominant. Only one of 14 mixtures remained stable when grown out; all others lost or significantly reduced one of their mixture's characteristics. The number of regenerations of an accession should be kept to a minimum by maintaining seeds in base collections.

Analysis of Seed in Mungbean Collection

Chemical analysis of the mungbean collection indicated that protein content can be as high as 30% and may be associated with a dull, yellow seed coat. Starch can reach 54% and may be associated with a green, shiny seed coat. Fiber content can reach only slightly over 5% and is higher in black gram than in mungbean. Correlation between protein and starch content is negative at -0.43, between protein and fiber is low and negative at -0.21, and between starch and fiber is -0.497.

Flower Induction on V 1160

The breeding potential of accession V 1160 Vigna glabrescens, against pests, diseases, and weeds has been

under examination since 1984. However, it is highly photoperiod sensitive, responding to short-day and normally nonflowering when planted in the spring at AVRDC. V 1160 can be induced to flower both by using decreasing daylength from 13 daylength down or by using control of short daylength of less than 13. The former approach appeared preferable.

Viability of Accessions in Cold Store

The stored seed viability pattern is essentially sigmoid. There is a gradual decrease in the beginning, followed by a more abrupt decrease after which a plateau or flattening out period develops. It is necessary to monitor this level of deterioration to ascertain the time for regeneration of the seed lot.

Chinese Cabbage in Medium-term Store — Chinese cabbage seeds can be stored in medium-term store for more than 10 years without any critical loss in germination.

Soybean in Medium-term Store — Seed viability of soybean can be maintained for at least eight years if kept in medium-term store at 2-5°C and 40-45% RH. An ordinary window-type air conditioned (20-25°C, 55-65 RH) room is not suitable for storing soybean.

Seed Research

Pod Development Stage and Chinese Cabbage Seed Storability — From a practical point of view, harvesting when pods are dried on the plant may result in losses due to shattering. It is recommended to harvest at the greenish yellow stage with removal of the smaller poor seed by a suitable screen.

Crop Management Practices on Tomato Seed Yield — Cultivars or lines are the most important determinant of seed yield. Since a cultivar is released without considering its seed yield and the seed producer may have difficulties, it is important to understand the different seed yield components in order to improve seed yield.

Germplasm Recipients 1985

Anguilla, British

INTA Agricultural Experiment Station, Sunni Isle Gardens

Antigua

Caribbean Agricultural Research & Development Institute

Argentina

La Cousulta Experiment Station
Museo Argentino De Ciencias Naturales
Universidad Nacional de Rio Cuarto
Universidad Nacional de Tucuman

Australia

Department of Agriculture, Perth
Redlands Horticultural Research Station
South Australian Department of Agriculture
South Australian Seedgrowers Co.

Austria

Deko-Datenservice, GmbH
FAO/IAEA Agricultural Biotechnology Unit

Bangladesh

Bangladesh Agricultural Research Institute
Christian Service Society
Citrus and Vegetable Seed Research Center
Institute of Nuclear Agriculture
University of Chittagong

Belgium

Faculté des Sciences Agronomiques de l'Etat

Belize

Carribean Agricultural Research & Development Institute

Bhutan

District Administration

Bolivia

Estacion Experimental Gran Chaco

Botswana

Department of Agricultural Research

Brazil

Centro Nacional de Recursos Genéticos
Empresa Maranhense De Pesquisa Agro Pemaria
Lab. Fitopatologia/EMCAPA

Brunei

Pusat Latihan Pertanian Sinaut

Burkina Fasso

Canadian Project
IRAT/CIRAD

Burma

IRRI - Burma Project
FAO Representative in Burma

Canada

Horticultural Experiment Station
International Development Research Center (IDRC)
King Grain, Ltd.
Ridgetown College of Agricultural Technology

Chile

Universidad De Tarapaca

Colombia

Centro Internacional de Agricultura Tropical

Cook Islands

Ministry of Agriculture and Fisheries
Rarotonga Exports, Ltd.
Tokoitoku Research Station

Costa Rica

Fertilizantes de Centro America (Costa Rica), S. A.
Proyecto Agroforestal
Taiwan Technical Mission

Cuba

Instituto Nacional De Ciencias Agricolas

Dominican Republic

Semillas Surenas, S. A.

Ecuador

Leguminosas Costa, Officina Central

Egypt

University of Assiut

El Salvador

Industrials Alimenticias "EL PANDA"
Vivero Merliot

Ethiopia

Institute of Agricultural Research
Institute of Agricultural Centre

Fiji

Fulton College
The Fiji Sugar Corporation, Ltd.
Legalega Research Station
Sigatoka Research Station
Sugarcane Research Center

France

Centro De Recherches Agronomiques

French Guiana

Centre de Polyculture

Gambia

Yundum Agricultural Station

Ghana

Agricultural Experiment Station
Bremens, Ltd.
Crops Research Institute
Dodowa Cooperative Multi-Purpose Society, Ltd.
The Dryland Farming Research and Development Project
Nyankpala Agricultural College
Plant Introduction and Exploration
Rural Farmers Resources and Appropriate Technology

Guadeloupe (France)

Institut national de la recherche agronomique (INRA)

Guyana

Agrico, S. A.
Guyana Sugar Experiment Station

Haiti

Convention Baptiste D'Haiti
Faculté d'Agronomie et de Medecine Veterinaire
Mennonite Central Committee
Taiwan Technical Mission

Honduras

Escuela Agricula Panamericana
Universidad Nacional Autonoma de Honduras

Hong Kong

Wu Di Christian Center

Hungary

Research Center for Agrobotany

India

Agricultural Research Unit
Andhra Pradesh Agricultural University
Ankur Agricultural Research Laboratory
Central Agricultural Research Institute
Cotton and Millets Experimental Station
Desai Agricultural Farm at Sakhare
Fertilizers Co., Ltd.
G. B. Pant University of Agriculture and Technology
Ganeshkhind Fruit Experimental Station
Haryana Agricultural University
Himachal Pradesh Agricultural University
India Institute of Horticultural Research
Indian Agricultural Research Institute
Khedut SahaKari Jin, Ltd.
Kitchen Gardening Society, Ltd.
Nagpur University
National Bureau of Plant Genetic Resources
National Research Centre for Groundnut
Punjab Agricultural University
Punjab Young Farmers Training Centre
Regional Agricultural Research Staton
Sakthi Sugars Limited
Tamil Nadu Agricultural University
The University of Agricultural Sciences
Wimco Seedlings, Ltd.

Indonesia

Agricultural Training Center
Balai Benih Induk Sukamenanti
Bogor Agricultural University
Bogor Central Research Institute for Food Crops
Central Research Institute for Food Crops
Cirelon Tedeng Pertanian
Dinas Pertanian Pangan
General Soedirman University
Horticultural Research Institute
Indonesia-Australia NTT Livestock

Development Project
The Irian Jlaya Joint Development Foundation
Lembang Research Institute
MARIF
Maros Research Institute for Food Crops
Sub Balai Penelitian Hortikultura
Sukamandi Research Institute for Food Crops
Technical Cooperation for Area Development
Universitas Sriwijaya
West Java at Service

Iran

Seed & Plant Improvement Institute

Israel

Consultant and Engineering Office
The Hebrew University of Jerusalem

Italy

Centre Ricerche
Sementi Hunhems

Jamaica

Plenty Canada
University of the West Indies

Japan

Kagome Research Institute
Kaneko Seed Company
Kikko Food Co.
Kirin Brewery Co., Ltd.
National Institute of Agrobiological Resources
Plantech Research Institute
Shizuoka Agricultural Experimental Station
Takii and Company, Ltd.
Tokita Seed Company, Ltd.
Tohoku Seed Company
Vegetable and Ornamental Crops Research Station

Jordan

USAID - American Embassy

Kenya

Coast Workshop for the Handicapped
Egerton College
nya Seed Company
Institute for Rural Development
The Dryland Farming Research and Development Project

Korea, Republic. of

Horticultural Experiment Station
Hung Nong Seed Company
Kang Won Provincial Office of Rural Development Administration
Kongwwon Provincial Office of Rural Development
Korean Advanced Energy Research Institute
Office of Rural Development

Liberia

Central Agricultural Research Institute
Nimba County Rural Development Project

Malawi

Bumbwe Research Station
Lilongwe Agricultural Development Division
Makoka Agricultural Research Station
Smallholder Sugar Authority
Sugar Corporation of Malawi Limited

Malaysia

Agriculture Research Centre
Bayer (Malaysia) Sdn. Bhd.
Malaysian Agriculture Research and Development Institute (MARDI)
Magain Enterprise Sdn. Bhd.
Tropical Industries Sdn. Bhd.
Universiti Pertanian Malaysia

Maldives

Ministry of Agriculture

Mauritius

Ministry of Agriculture, Natural Resources and the Environment Agricultural Services

Mexico

Alimentos del Fuerte

Nepal

Grain Legume Improvement Program
Integrated Cereals Project
Ministry of Agriculture

Netherlands

Enza Zaden de Enkhuizer Zaadhandel, B. V.

Nicaragua

Finca La Esperanzita

Nigeria

Ahmadu Bello University
Arbot Farms

Ekiti-Akoko Agricultural Development Project
Lake Chade Research Institute
International Institute of Tropical Agriculture (IITA)
National Horticultural Research Institute
University of Calabar
University of Ibadan
University of Jos

Pakistan

Agricultural Development Bank of Pakistan
Nuclear Institute for Agriculture and Biology
Pakistan Agricultural Research Council

Paraguay

Taiwan Technical Mission

Peru

INIPA - CIPA II
Inter-American Institute for Cooperation on Agriculture
National Food Legume Program
Pyramid Research Center

Philippines

Ateneo de Davao University
AVRDC Philippine Outreach Project (POP)
Betinan Research Station
Botanique Philippines, Inc.
Bureau of Plant Industry
Cagayan Electric Power and Light Co., Inc.
Don Mariano Marcos Memorial State University
Eden Fruits and Vegetables Co., Inc.
Farm System Development Corporation
Infanta Community Development Administration, Inc.
Institute of Plant Breeding, UPLB
International Potato Center (CIP)
International Rice Research Institute (IRRI)
International Institute of Rural Reconstruction
Isabela State University
Mountain State Agricultural College
National Food and Agricultural Council
Philippine Council for Agriculture and Resources Research and Development (PCARRD)
The Philippine-German Seed Potato Program
Philippine Packing Corporation
Philippines Sugar Commission
Sarangani Agricultural Co., Inc.
Second Laguma de Bay Irrigation Project - Vegetable Component
University of Southern Mindanao
Victorias Milling Co., Inc.
Visayas State College of Agriculture
Western Luzon Agricultural College

Reunion (France)

IRAT - Reunion
Institut de recherches agronomiques tropicales et des cultures vivrières

Samoa, West

American Samoa Government
Pacific Agricultural Consultancy Service Limited
Peace Corps
Rural Development Section

Saudi Arabia

Ministry of Agriculture and Water
Taiwan Technical Mission

Seychelles

Grand'Anse Experimental Centre

Sierra Leone

Rokupr Rice Research Station
Njala University

Solomon Islands

Ministry of Agriculture and Lands
Taiwan Technical Mission

South Africa

Grain Crops Research Institute

Spain

Hispareco, S. A.

Sri Lanka

Regional Agricultural Research Centre
Janatha States Development Board

St. Kitts & Nevis

Taiwan Technical Mission

St. Lucia

Caribbean Agricultural Research and Development Institute (CARDI)
St. Jude Hospital

Sudan

Agricultural Research Station

Genetic Conservation

Agricultural Research Project (World Bank and USAID)
ARC/Western Sudan
Ministry of Agriculture and Natural Resources
Regional Ministry of Agriculture and Animal Production
Seed Production and Improvement Station
Univeristy of Khartoum

Sweden

Swedish University of Agricultural Sciences

Tahiti (France)

GERDAT - IRAT

Taiwan

Ace Seed Company
Asian Exchange Center, Inc.
Corn Research Center
FFTC/ASPAC
Formosa Seed Company
Fu Jen University
Hualien District Agricultural Improvement Station
Kaohsiung District Agricultural Improvement Station
Known You Seed Company
National Chiayi Institute of Agriculture
Tainan District Agricultural Improvement Station
Taiwan Agricultural Development Co., Ltd.
Taiwan Agricultural Research Institute
Taiwan Seed Improvement Station
Taiwan Sugar Research Institute

Tanzania

Ilonga Agricultural Research Institute
Livestock Production Research Institute
Ministry of Agriculture Zanzibar
Office of the Prime Minister

Thailand

Adams International
AVRDC Thailand Outreach Program (TOP)
Chainat Field Crop Research Center
Charoen Seeds Co., Ltd.
Chiang Mai Field Crops Research Center
Church World Service
Department of Agriculture
East West Seed Co., Ltd.
Kasetsart University
Khon Kaen University
Mae Joe Institute of Agricultural Technology
Nakorusawan Field Crop Research Center
Prince Songkhla University

Togo

Ecole Superieure d'Agronomie

Tonga

Department of Agriculture
Hango Agricultural College

Trinidad and Tobago

Caribbean Chemicals and Agencies, Ltd.
Orange Grove National Co., Ltd.
The University of the West Indies

Turkey

University of Cukurova

United Kingdom

Glasshouse Crops Research Institute
L. W. Lambourn & Co., Ltd.
National Vegetable Research Station
Royal Botanical Garden
University of Birmingham
University of Nottingham
University of Reading

USA

The Alabama Cooperative Extension Service
Alf. Christianson Seed. Co.
BHN Research
Campbell Institute for Research and Technology
Coastal Plain Experiment Station
Coffey Seed Company
Cornell University
Dairyland Research International
Del Monte Corporation - Agricultural Research
Extension Research Center
Iowa State University
Land O'Lakes, Inc.
Michigan State University
Neumon Seed Company
Northrup King Company
Peto Seed Co., Inc.
Plant Germplasm Quarantine Center
Positive Thinkers
Rangoon ID State Department
The University of Arizona
University of Florida
University of Hawaii, Manoa
University of Illinois
Warner Southern College
Water Island
Zeenat Rahman

Seminars

The following seminars were presented in 1985 by Center staff and guest speakers. Please note that seminar papers are not available for distribution.

January 17 - The Heat Shock Response in Soybean Seedlings: Physiological Considerations, Dr. Chu-yung Lin, Professor, National Taiwan University.

January 23 - Farming Systems Research and Development, Dr. John S. Caldwell, Virginia Polytechnic Institute & State Universty, USA.

January 31 - AVRDC Computer System, Dr. Jonathan E. Yuen, AVRDC.

February 6 - The Economics of Post Harvest Losses and/or U.S./Taiwan Trade Relations, Dr. James R. Jones, University of Idaho, USA.

February 14 - The Situation of Processing Tomato Cultivation and its Future Prospect in Korea, Mr. K. K. Lee, Korean Research Intern.

February 14 - Identification of Root Knot Nematode Resistance in Processing Tomatoes by Starch-Gel Electrophoresis and Egg Inoculation Techniques, Mr. H. D. Kim, Korean Research Intern.

February 27 - The Extrafloral Nectaries of Cowpea (Vigna unguiculata (L.) Walp.); Structure, Nector Composition and Nectary Functioning, Dr. John Kuo, University of Western Australia.

March 21 - Hormonal Factors in the Fruit Set of Tomato, Dr. George C. Kuo, Plant Physiologist, AVRDC.

March 28 - Plant Regeneration via Embryogenesis in Tissue Culture of Loquat, Dr. Wai-jane Ho, Head of Research Department, Taiwan Seed Improvement and Propagation Station, Taiwan.

April 2 - The Sweet Potato Virus Diseases in Nigeria, Dr. H. W. Rossel, Virologist, IITA, Ibadan, Nigeria, visiting scientist at AVRDC.

April 11 - Studies of the Application of Microbial Nitrogen-fixation in the Local Agriculture, Dr. C. J. Lin, Microbiologist, TARI, Taiwan.

April 25 - Plant Genetic Resources in Ethiopia, Dr. Jan Engels, Project Coordinator & Documentalist, Plant Genetic Resources Center, Ethiopia.

May 3 - Agricultural Systems Analysis and Simulation for Agrotechnology Transfer, Dr. Goro Uehara, Professor, University of Hawaii, USA.

May 9 - Air Pollution Injury to Vegetation in Taiwan, Dr. En-jang Sun, Acting Chief, Bureau of Environmental Protection, DOH, Taiwan.

May 10 - Adaptation of an AVRDC improved Chinese cabbage variety from the farmer's perspective in Taiwan, Miss Shu-yu Huang, Principal Research Assistant, AVRDC.

May 16 - Major Constraints in Vegetable Production in the Humid Tropics - with Special Reference to Soil and Crop Management, Dr. Hideo Imai, Soil Scientist, AVRDC.

May 20 - Genetic Resources Among the Wild Tomato Species, Dr. Charles M. Rick, Professor, University of California, Davis, USA.

May 30 - The Low Germinability of Sorghum Seed, the Taichung No. 5, Dr. Wang-ching Ho, Associate Research Fellow, Taiwan Seed Improvement and Propagation Station, Taiwan.

June 6 - Control of Papaya Ringspot Virus by Cross Protection, Dr. Shui-dong Yeh, Associate Professor, National Chung Hsing Univeristy, Taiwan.

June 13 - Cloning and Expression in E. coli of the whole nif genes of Klebsiella oxytoca, a nitrogen fixer in the rhizosphere of rice, Dr. Pei-Ting Wang, Associate Professor, National Chung Hsing University, Taiwan.

June 20 - Crop Nematode Diseases in Taiwan, Mr. Tung-tsuan Tsay, Teaching Assistant, National Chung Hsing University, Taiwan.

June 27 - Physiology of Short-rooted Mungbean Sprout Cultivation, Dr. Doris C. N. Chang, Professor, National Taiwan University, Taiwan.

June 28 - Vegetable Post Harvest Problems in Asia, Dr. James R. Hicks, Professor, Cornell University, Visiting Scientist at AVRDC.

August 28 - The Caribbean and Agriculture. Dr. Adisak Sajjapongse, Associate Crop Management Specialist, AVRDC.

September 5 - Seedlings and Shelters, Dr. Bernie Kratky, Professor, University of Hawaii, Visiting Scientist at AVRDC.

September 12 - Malathion Detoxication of Diamondback Moth, Phetella xylostella L., Dr. William C. J. Maa, Research Fellow, Academia Sinica, Taiwan.

September 19 - Chinese Cabbage Germplasm at AVRDC, Dr. Chong-seng Tay, Seed Technologist, AVRDC.

September 26 - Residue and Toxicity Problems Associated with Pesticide Use in Taiwan, Dr. Gwo-chen Li, Director, Taiwan Agricultural Chemicals & Toxic Substances Research Institute, Taiwan.

September 26 - My Vegetable Research Experience, Prof. D. H. Dabbs, Department of Horticultural Science, University of Saskatchewan, Canada.

September 26 - The Louisiana Foundation Seed Production for Sweet Potatoes, Dr. Ron Robbins, Resident Director, Sweet Potato Research Station, Louisiana State University, USA.

September 26 - Production of Vegetable Seeds in the United States, Dr. Charles W. Reynolds, Professor, Department of Horticulture, University of Maryland, College Park, USA.

September 26 - Variety Trials of Vegetable Crops in the Tropical Lowlands of Honduras, Central America. Dr. Le Da Ton, Horticulturist, United Fruit Company, Port Newark, New Jersey, USA.

October 3 - Breeding for Rice Blast Resistance in Taiwan. Mr. Hsin-kan Wu, Research Fellow, Academia Sinica, Taiwan.

October 16 - Major Diseases of Asparagus and their Control in Taiwan, Dr. Yung-hsiung Cheng, Chief, Division of Crops Environment, District Agricultural Improvement Station, Taiwan.

October 24 - Application of Monoclonal Antibodies to Research on Plant Virus and Virus-like Diseases, Dr. Hong-ji Su, Professor, National Taiwan University.

October 28 - Application of Protein Electrophoresis for Evaluation of Cultivated Plants, Dr. H. Stegemann, Institute for Biochemistry, Federal Institute of Biology, Federal Republic of Germany.

November 7 - Under-exploited Vegetable Crop - Edible Amaranth, Dr. Huang Han, Professor, National Taiwan University.

November 14 - Potato Breeding by Ploid Manipulations Using Haploids and 2n Gametes, Dr. Masaru Iwanaga, Cytogeneticist, CIP, Visiting Scientist at AVRDC.

November 28 - The Potential of Plant Virus Control by Genetic Engineering, Dr. Yau-heiu Hsu, Associate Professor, National Chung Hsing University, Taiwan.

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Korea

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German Agency for Technical Cooperation
Federal Republic of Germany

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France

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Philippines

Dr. R. V. Valmayor
Philippine Council for Agriculture and Resources Research
and Development
Philippines

ex officio Member

Dr. G. W. Selleck
Asian Vegetable Research and Development Center
(Until September)

Dr. Paul M. H. Sun
Asian Vegetable Research & Development Center
(After September)

Observers

Mr. F. T. Chang
Council of Agriculture
Taiwan, ROC

Ms. Deborah R. Schwartz
American Institute in Taiwan
USA

Dr. John S. Robins
Agency for International Development
USA

Mr. D. F. Panganiban
Ministry of Agriculture, Philippines
(Representing Minister Escudero)

Mr. Takasuke Yamaguchi
Interchange Association
Japan

Senior Personnel

Administration

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George W. 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, C.A., C.P.A., Comptroller
Chen Jeng-hua, B.S., Superintendent, Buildings and Maintenance**
Ann Hwa, Manager, Food and Dormitory Services

Tomato Breeding

Romeo T. Opena, Ph.D., Program Leader (horticulture) and Plant Breeder (tomato)

Jen-tzu Chen, Assistant Specialist

Chinese Cabbage Breeding

Jin Young Yoon, Ph.D., Associate Plant Breeder**

Lien-chung Chang, B.S., Assistant Specialist

Mungbean Breeding

George C. J. Fernandez, Ph.D., Research Associate°

Ren-cheih Jin, B.S., Research Assistant
Miao-miao Hsu, M.S., Principal Research Assistant*
Chen Hao-koan, M.S., Principal Research Assistant***

Soybean Breeding

S. Shanmugasundaram, Ph.D., Program Leader (legumes) and Plant Breeder (soybean)+

Kun-te Lee, Senior Research Assistant
Li-fen Chen, M.S., Principal Research Assistant

Sweet Potato Breeding

Steve S. M. Lin, Ph.D., Associate Plant Breeder (sweet potato and processing tomato breeder)++
Masaru Iwanaga, Ph.D., Visiting Scientist from CIP**
Hiroko Takagi, Ph.D., Research Associate°

Ching-hsiung Hung, M.S., Principal Research Assistant*
Chei-shan Cheng, B.S., Senior Research Assistant*

Plant Pathology

Arnold T. Tschanz, Ph.D., Associate Plant Pathologist (legumes), Head, Plant Pathology

Tien-cheng Wang, B.S., Associate Specialist
Min-chu Tsai, M.S., Principal Research Assistant*
Yao-hua Cheng, B.S., Research Assistant
Ming-ming Chao, M.S., Principal Research Assistant

Sylvia K. Green, Ph.D., Associate Plant Pathologist (virology)

Dar-ren Lee, M.S., Principal Research Assistant
Yen-jen Kuo, M.S., Principal Research Assistant

Jonathan E. Yuen, Ph.D., Associate Plant Pathologist (horticulture)/computer specialist*

Hsiou-chen Huang, M.S., Principal Research Assistant*
Hao-jan Lin, B.S., Research Assistant

Hendrick W. Rossel, Ph.D., Visiting Scientist from IITA**,*

Entomology

N. S. Talekar, Ph.D., Entomologist

Hui-chin Yang, B.S., Research Assistant*
Song-tay Lee, B.S., Research Assistant°°
Chih-pin Lin, B.S., Research Assistant
Su-chong Kuo, B.S., Research Assistant*
Shang-wen Hwang, B.S., Research Assistant
Min-yi Liu, M.S., Principal Research Assistant**
Jen-wang Hou, B.S., Research Assistant**
Ying-huey Lee, 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

Chemistry

Samson C. S. Tsou, Ph.D., Program Leader, Production Systems Program (PSP) and Biochemist

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

Garden Programs

Jack Gershon, Ph.D., Nutritionist

Yen-chin Chen, M.S., Principal Research Assistant*
Lee-ju Chen, M.S., Principal Research Assistant

Soil Science

Hideo Imai, Ph.D., Soil Scientist

Chin-hua Ma, B.S., Research Assistant
Chi-hsin Lu, M.S., Principal Research Assistant

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°

Agricultural Economics

James R. Hicks, Ph.D., Visiting Scientist from Cornell University**,*

Hsu-yu Huang, M.S., Principal Research Assistant*

Soil Microbiology

William C. Stearn, Ph.D., Soil Microbiologist*

Lee-ju Chen, M.S., Principal Research Assistant+++

Training and Development

Diosdado V. Castro, M.S., Training Specialist

Sen-hsiung Lai, B.S., Assistant Development Officer***
Yuan-chin Yang, B.S., Training Assistant
Jia-chi Cheng, B.S., Training Assistant

Information Services

E. W. Sulzberger, M.A., Information Specialist*
Bruce T. McLean, B.A., Associate Information Specialist**

Lastimosa, Pura V., M.A., Assistant Information Specialist**

Library

Teng-hui Hwang, B.A., Senior Librarian
Chen Nein-ming, M.S., Documentalist**,*

Experimental Farm

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

Genetic Resources and Seed Unit (GRSU)

Chong Seng Tay, Ph.D., Research Associate

Yung-kuang Huang, B.S., Research Assistant
Wen-hsiu Kuo, B.S., Research Assistant
Jin-huei Lu, M.S., Principal Research Assistant**

Statistical Services

Makoto Nagai, B.S., Scientist in Biometry and Head of Statistical Services*

Hsien-yang Tien, B.S., Senior Computer Assistant+
Ming-zen Chang, B.S., Statistical Assistant*

Computer Services

Jonathan E. Yuen, Ph.D., Associate Plant Pathologist (horticulture)/computer specialist*

Hsien-yang Tien, B.S., Computer Assistant+
Yuh-ling, Chen, B.S., Computer Assistant**

Bilateral Regional/Programs

°Thongchai Tonguthaisri, Ph.D., Resident Scientist, Indonesia/AVRDC Bilateral Project, Lembang Horticultural Research Institute, Jalan Tangkuban Peruhu 517, Lembang, Bandung-West Java, Indonesia
Jung Ho Kim, Ph.D., Director, The Korean Sub-Center Affiliated with AVRDC, Horticultural Experiment Station, Rural Development Administration, Suweon, Korea
El Mostafa Saadaoui, Ph.D., Resident Scientist, Malaysia/AVRDC Vegetable Research Program, MARDI, Jalan Kebun, Kelang, Selangor, West Malaysia
Benjamin P. Legaspi, Affiliate Horticulturalist, AVRDC/Philippine Outreach Program, Bureau of Plant Industry, Economic Garden, Los Baños, Laguna, Philippines
ROC-AVRDC Outreach Program, Council of Agriculture, 37 Nan-Hai Road, Taipei, Taiwan, ROC
Charles Y. Yang, Ph.D., Director and Resident Scientist Thailand Outreach Program/AVRDC, P. O. Box 9-1010, Kasetsart, Bangkok 10903, Thailand

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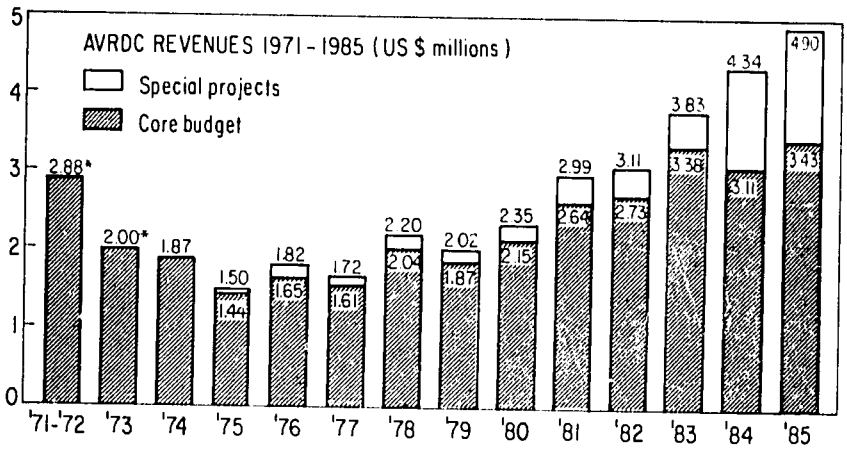
* Left during 1985
** Arrived during 1985
*** Reinstatement
\+ Sabbatical
++ Termination upon death
+++ Transferred
° Arrived in 1986
°° Advanced study leave
°°° Reassignment to CARDI, St. Lucia, West Indies

Finances

AVRDC's projected budget for 1985 was US$ 4,950,000, compared with an actual income of US$ 4,905,901 and expenditures of US$ 5,126,024. Core funding was provided by the governments of the Republic of China, the United States, the Philippines, the Republic of Korea, Japan, Thailand and 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)
- International Soybean Program (INTSOY)
- Land O'Lakes, Inc.
- Taiwan Kagome Co.
- Campbell Soup Company
- Nagasaki Farmers Cooperative
- Potash and Phosphate Institute of Canada



*US $ 3.4 million for capital expenditures 1971-73