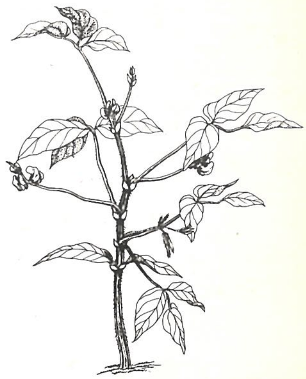
AVRDC

PROGRESS REPORT 1979



THE
ASIAN
VEGETABLE RESEARCH
AND DEVELOPMENT
CENTER

PROGRESS REPORT FOR 1979

1981
THE ASIAN VEGETABLE RESEARCH AND DEVELOPMENT CENTER
P.O. BOX 42, SHANHUA, TAINAN 741, TAIWAN, R.O.C.

About this report

AVRDC is the international research and training organization responsible for improving production and quality of selected vegetable and legume crops in the hot, humid lowland tropics.

The 1979 Progress Report summarizes research, training, and outreach activities of the Asian Vegetable Research and Development Center (AVRDC). More detailed accounts of individual studies have been published in various journals. Reprints of some of these articles can be obtained by writing the Office of Information Services at AVRDC. Please give your complete mailing address. Scientists in other countries are urged to correspond with AVRDC investigators regarding technical points and problems.

Data are presented in metric units. Monetary values are in US dollars, unless stated otherwise. "Control" means an untreated experimental plot, and "check" or "check cultivar" refers to a variety which is used for purposes of comparison, unless stated otherwise. A single asterisk (*) means significant at the 5% level, a double asterisk (**) means significant at the 1% level. Pedigrees in the AVRDC breeding program are identified by a slant bar (/). Commercial chemical names are used occasionally for identification; such use does not imply endorsement by AVRDC.

Information and conclusions in this report are solely the responsibility of AVRDC.

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Director's Foreword

The 1979 research year was a fruitful one as concerted and dedicated efforts produced a number of significant accomplishments. AVRDC tropical tomato breeding lines continued to prove superior to local varieties throughout the tropics even as plant breeders developed new lines combining heat tolerance and disease resistance. In Sierra Leone, AVRDC selections proved to be the only tomatoes that could be grown during the wet season, while in Tahiti AVRDC lines survived essentially 100% against bacterial wilt infections which killed all check plants. AVRDC tomatoes also performed well in national programs, including those of Bangladesh, the Philippines, Singapore and Mexico. In the Center's laboratories, physiologists identified 26 flood tolerant accessions and pathologists found 22 tomato lines to be resistant to rootknot nematode, a serious problem of tomatoes in the tropics.

AVRDC scientists accelerated Chinese cabbage hybrid development by incorporating cytoplasmic male sterility, a potential mechanism for hybrid production, into the genetic background of 88% of the AVRDC Chinese cabbage breeding materials. Breeders also identified the need to broaden the genetic base for heat tolerance to ensure the expression of hybrid vigor. Several encouraging reports were received on the performance of our Chinese cabbage in other countries. AVRDC hybrids did well in national trials in Malaysia, and the Seychelles national program requested seed for immediate distribution to farmers. After evaluating an AVRDC hybrid, a commercial firm in the United States expressed interest in seed production for distribution to American farmers.

Sweet potato breeders continued to make hybridization crosses to produce weevil resistant selections rich in β-carotene. More than 140 new breeding lines were selected for the breeding program, many of which are suited to the colder highlands of Indonesia, Thailand, Borneo, the Philippines, India, Nepal and Papua New Guinea.

Twenty mungbean breeding lines were distributed to 38 countries in the AVRDC-coordinated Eighth International Mungbean Nursery. Preliminary returns indicated that four of the six best entries originated from AVRDC. In Korea, the national program prepared to name and release as varieties one or two AVRDC mungbean lines, and AVRDC lines were being multiplied in Thailand for release to farmers. The Canadian national program also included AVRDC mungbean lines in preliminary yield trials.

AVRDC soybean line G-2120 was promoted to the International Soybean Variety Experiment (ISVEX) of the International Soybean Program (INTSOY) in the United States, the final step to recommendation for national programs. AVRDC soybean lines continued to outperform local varieties in trials in Honduras, Indonesia, Thailand and Taiwan. While our pathologists and entomologists have continued to identify germplasm with resistance to soybean rust and beanfly, breeders have been combining these characters with photoperiod insensitivity and early maturity, an important character for rice-based cropping systems.

The Training and Development Program again drew participants from around the world as AVRDC hosted 65 trainees from 11 countries including Ecuador and the Netherlands. The cumulative total to the end of 1979 is 229 trainees from 20 nations.

Although financial constraints persist in being our most serious problem, we expect the high quality of research and training programs to be maintained.

Paul C. Ma
Acting Director
1979

Collected pollen is used by AVRDC breeders to develop high yielding tomato lines which are heat tolerant and disease resistant.

TOMATO

Germplasm collection

Forty-eight new accessions in 1979 brought the total tomato germplasm collection to 4818 cultivars. More than 2800 crosses were made, concentrating on improving the leaf disease resistance of our heat tolerant and bacterial wilt resistant selections.

Winter yield trials

Preliminary trials were conducted in 1979 to select processing tomato varieties that can be planted as early as August and as late as mid-January. Although a September planting did not reveal any significant varietal differences in yields, differences between varieties were apparent in a mid-January planting. The most promising entries in all plantings came from the CL 1561 and CL 1591 series. These compared with check variety TK 70-4 in yield, soluble solids, titratable acidity and pH, and surpassed TK 70-4 in color and firmness.

A regional trial to select high-yielding processing tomato lines for use in Taiwan was also begun this year. Funding limitations restricted the trials to Ta-Hsi, Shui-Lin, Taipao, Hsi-Kang, An-Nan, An-Ting and AVRDC.

With the aid of a special grant, AVRDC and the Campbell Soup Company conducted six trials of Campbell material and AVRDC lines to select processing lines to grow in Taiwan. Two of the trials were conducted at Taipao and four at AVRDC. Generally, neither the Campbell materials nor new AVRDC breeding lines outyielded check variety TK 70-4. All plantings at AVRDC were affected by both TMV and early blight, while the Taipao plantings suffered from late blight and cucumber mosaic virus.

Six tomato varieties (11d-0-2-4, 122-0-1-3, 123-4-11, Divisoria 2, Nagcarlan and KL 2) were tested for their adaptability to relay cropping systems. Thirty-three days before a green corn harvest, one-month-old tomato seedlings were transplanted on the corn ridge to form the relay treatment. A monoculture of each tomato variety was established at the same time to serve as a check.

The monocultures yielded from 20% to 53% more and flowered four to nine days earlier than the relay planted tomatoes. These differences can be attributed primarily to partial shading of the tomatoes in the relay treatment. Although an identical experiment in 1978 resulted in lower yield losses (0% to 39%), Nagcarlan was still the least affected by shading as shown by its low yield loss. The flowering of 122-0-1-3 was least affected by the relay treatment, being delayed by only four days.

Hot season trials

Several trials were conducted in the hot season to screen AVRDC accessions for heat tolerance and bacterial wilt resistance. The trials confirmed both the potential of AVRDC lines for summer production and the greater risks associated with growing tomatoes under the hot conditions of a July-to-September harvest period (Table 1).

In screenings of 446 accessions for heat tolerance, two (PI 3445561 and PI 406775) showed moderate to heavy fruit setting ability. In summer screenings of segregating populations, 650 new breeding lines were selected for heat tolerance, good color, and resistance to leaf molds and bacterial wilt.

Local preference trials

AVRDC hybrids were evaluated for fruit size in order to select varieties which can satisfy consumer preferences for large fruits. Hybrid

Table 1. Performance of heat tolerant selections in hot season trials, 1979, AVRDC

AVRDC selection or acc. no.	Pedigree or variety name	Harvest period July-Sept[a]	Harvest period Oct-Dec[b]	Average
9-0-0-1	VC 11-1-2-1B/Saturn	17	30	24
143-0-10-3	VC 48-1/Tamu Chico III	16	37	26
123-2-4	ah TM-2a/VC 8-1-2-1	11	35	23
1561-6-0-22-4	UC 134-61D/TK 70-4	9	32	20
(1)	VC 48-1, check	7	24	16
(387)	(White Skin), check	0	24	12

[a]Data from July planting, means of four replications
[b]Data from average of three August plantings with four replications each

Table 2. Nitrate reductase activity (NO_2 µM/hr per gram fresh wt.) of tomato roots, 1979, AVRDC

Entries	Hours of flooding		
	0	48	96
L 1	12 ± 3	54 ± 5	107 ± 8
L 123	23 ± 5	85 ± 20	116 ± 8
L 166	25 ± 2	45 ± 12	90 ± 6

1795 produced the largest fruits (averaging 146 grams) and a marketable yield of 63 t/ha. By comparison, check variety Su Kwang had an average fruit weight of 98 grams and a marketable yield of only 26 t/ha.

Screening for moisture tolerance

In 1979, 3563 accessions were screened for tolerance to excess soil moisture. Only 26 (0.7%) showed definite degrees of tolerance to three days of flooding. The rest of the AVRDC tomato germplasm collection is still in the screening process, and flood tolerant accessions will be further evaluated in 1980.

Moisture tolerance studies

Several experiments in 1979 involved the physiological responses of tomato accession L 123 to soil flooding after it was identified in 1978 as having some degree of flood tolerance. When flooded, L 123 accumulated less free proline and maintained a higher relative water content than other less tolerant accessions. The ability of L 123 to tolerate flooding appeared due mainly to its ability to withstand low oxygen levels in the flooded soil. By transporting oxygen from the aerial parts of the plant to the roots, L 123 may be able to inhibit ethylene production and maintain relatively higher nitrate reductase activities by oxidizing a surplus of NADH (Table 2). These, in turn, enable the plant to maintain the water uptake processes of the root system.

Heat tolerance studies

In 1979, the high temperature responses of two heat tolerant entries (L 125 and CL 11d-0-1-2-0-0) and two heat sensitive entries (L 123 and L 387) were studied at 35-40/25-30^{o}C and 28-33/20-25^{o}C day/night temperatures. Fruit setting ability was evaluated with both hand and self pollinating techniques.

L 125 and CL 11d-0-1-2-0-0 suffered the least reduction in fruit set and self pollinated plants had lower fruit set than hand pollinated plants

Table 3. Fruit setting ability (%) of tomato at normal and high temperatures, 1979, AVRDC

Entries	Type of pollination[z]						Mean
	NTO X NTP	NTO X HTP	HTO X NTP	HTO X HTP	NSP	HSP	
L 123	87	48	40	34	81	0	48[b]
L 125	80	87	63	53	81	19	64[a]
L 387	90	50	60	27	75	0	50[b]
CL 11d-0-1-2-0-0	90	87	50	47	87	19	63[a]
Mean	87[a]	68[b]	53[c]	40[d]	81[a]	10[e]	

[z]NTO=Normal temp ovules, NTP=Normal temp pollen, HTO=High temp ovules, HTP=High temp pollen, NSP=Normal temp self pollination, HSP=High temp self pollination

[a-e]Means followed by the same letter are not significantly different (5% level) by Duncan's multiple range test. No interaction was found between entries and types of pollination

(Table 3). Pollen production was reduced in all cultivars, although L 125 and CL 11d-0-1-2-0-0 were less affected. L 387 had the greatest stigma exsertion and reduction of ovary weight under high temperature. These results support indications from the past three years of physiological studies that the reduction in fruiting caused by high temperatures is the result of more than just a single physiological process. The data show that although male and female gamete viability was reduced by the high temperatures, other factors such as stigma exsertion also affected fruit set.

Table 4. Bacterial wilt (*Pseudomonas solanacearum*) resistance of tomato accessions and advanced breeding lines in a screening trial, 1979, AVRDC

Disease reaction[a]	% infection	No. accessions/lines	% of total screened
R	0-20	6	5
MR	21-40	6	5
MS	41-75	51	43
S	76-100	56	47

[a]R - resistant; MR - moderately resistant; MS - moderately susceptible; and S - susceptible.

Fruit setting in a heat tolerant variety therefore demands several physiological characteristics, and none of the accessions and breeding lines tested so far possess them all to a satisfactory degree. These characteristics, then, must be enhanced in the present heat tolerant breeding lines.

Germplasm screening for wilt resistance

Eight AVRDC advanced breeding lines and 109 newly collected accessions were screened for resistance to bacterial wilt (*Pseudomonas solanacearum*). Only two advanced breeding lines (CL 1094-0-0-5-7-0 and CL 123-2-4) and four accessions (L1, L4679, L4681 and L4712) had survival rates above 80% (Table 4).

Preliminary studies on mutants of *Pseudomonas solanacearum*

Two mutants of *P. solanacearum* were isolated from purified stock cultures and designated D5S and A9S. Differing from their parent cultures in colonial size and morphology, both mutants were non-virulent in infecting tomato plants. When injected into tomato plants prior to inoculation with a virulent isolate of *P. solanacearum*, the mutants demonstrated a cross protection effect and reduced the incidence of bacterial wilt. The degree and duration of this cross protection varied with both the tomato cultivar and the mutant tested.

Field screenings for rootknot nematode resistance

A total of 301 accessions and 213 breeding lines have been screened for resistance to *Meloidogyne incognita* Chitwood, a rootknot nematode that commonly attacks tomato crops in Taiwan. The following were found resistant at each screening when screened five times: L 272, L 274, L 313, L 383; three times: L 275, L 672, L 673, L 889, L 892, L 3893; and twice: L 4109, L 4124, L 4126, L 4129, L 4104, L 885, L 890, L 97, CL 106-5-1-0, CL 129-0-1-0, CL 170-2-3-0, CL 187-4-1-0.

Host range studies of *Meloidogyne hapla* Chitwood in Taiwan

Of 139 plant species tested as hosts for *M. hapla*, 95 from 15 families were found susceptible, 15 had trace infections and 29 were immune. The Gramineae family (except coba) and the Amaryllidaceae family (except onion) demonstrated high resistance to the nematode. Other species from different plant families which also demonstrated resistance included asparagus, French marigold, taro, yellow cosmos, sun hemp, blue lupine, tobacco, garden dahlia, muskmelon (sunrose), watermelon (sugar baby), soybean (D69-9801, Bragg, Armredo) and velvet bean. These plants are potentially useful in crop rotation or multiple cropping systems.

Members of the Leguminosae family varied widely in resistance, indicating that plant response varies between species, varieties and lines. This suggests that certain failures in control programs may result if pathogens are not tested on specific strains of a given species.

Chemical control of *M. incognita*

The effects of chemicals commonly used to control rootknot nematode (*M. incognita*) were evaluated in greenhouse tomato pot trials using L 124 (TK 70) as the host plant. L-124, a popular and widely planted variety in Taiwan, is one of the tomato cultivars most susceptible to the *M. incognita* parasite.

Aldicarb was the most effective of the pesticides applied directly to the soil. Although the treatment did not eradicate the nematodes, the population and number of galls and egg masses were significantly lower than those found in the control.

Two fungicides, mancozeb and benomyl, significantly increased nematode gall formation, populations, and reproduction rates in the roots, without reducing the nematode population in the soil.

Alachlor, a herbicide, significantly reduced the number of nematodes, galls and egg masses in the roots, but failed to reduce the soil nematode population. Plant growth was also adversely affected by the herbicide.

Neither fertilizer treatments nor foliar applications of pesticides significantly reduced nematode infestations of tomato plants.

Low-dosage effects of pesticides on *M. incognita*

Although poorly documented, there are indications that low dosages of nematicides produce yield increases, are effective against nematodes, and either stimulate the growth of plants or improve their early development. This low dosage possibility was explored in greenhouse pot trials using *M. incognita* as the test pathogen, L 124 as the susceptible tomato host plant and 41 different pesticides as nematicides.

Eight insecticides (formothion, birlane, terbufos, ethiofencarp, mephosfolan, basudin, thiocyclam hydrogen exalate and galecron) significantly increased nematode root population, gall formation and reproduction rate. Despite heavy nematode infestation, plants treated with birlane, terbufos and basudin accumulated more dry matter than the control. Plants treated with phorate also grew well but were inadequately protected against nematode attack. Nematode soil population was increased by birlane and thiocyclam hydrogen oxalate, while the six remaining insecticides reduced the soil populations by 25.5% to 74.5%.

Six other insecticides (dacamox, diflubenzuron, Nem-a-tak, UC21865, etrimfos and heptenophos) consistently reduced nematode population, reproduction rate and gall formation in the roots. Soil nematode populations were reduced by 10.8% to 80.9%.

Carbendazim, a herbicide, stunted the growth of the host plant without significantly reducing nematode, gall and egg mass numbers in the roots.

There was no correlation between fecundity and nematodes in the soil, nematodes in the roots, or gall formation. The results indicate that the inherent susceptibility of the cultivar determines the extent of infection, regardless of the population density of the pathogen in the soil.

Tomato variety-nematicide combinations and *M. incognita*

Different combinations of tomato varieties and nematicides were evaluated for their control of *M. incognita* in studies conducted from February 1978 to June 1979. Two resistant varieties, L272 and L274, and one susceptible variety, L124, were planted and treated with aldicarb 10G and triazophos 5G. Both aldicarb and triazophos treatments on all three cultivars reduced nematode root populations, fecundity and gall formation. None of the treatments, however, reduced soil nematode populations.

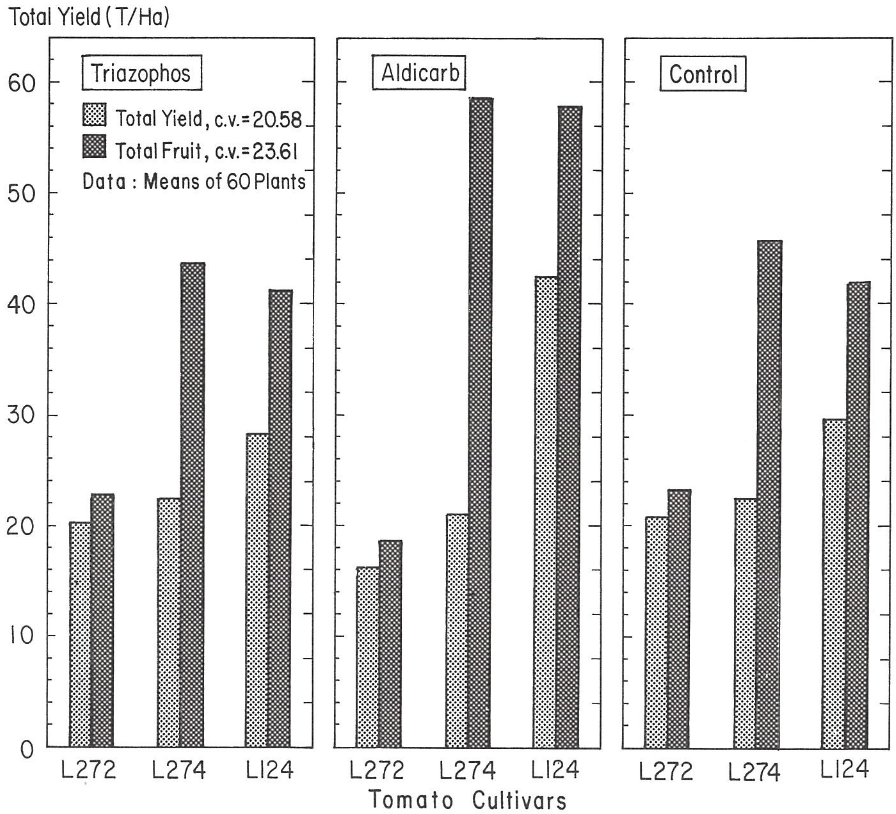


Fig. 1. Response of tomato yields to different tomato variety-nematicide combinations, 1979, AVRDC

The aldicarb-L274 combination resulted in a significant increase in the number of fruits. When yield was expressed in tons/ha, the L124-aldicarb combination significantly outyielded the resistant cultivars (Figure 1). Combinations with triazophos did not yield significantly more than the control groups.

International Cooperation

In 1979, AVRDC supplied 1576 seed packets of elite breeding lines of tomatoes to 123 scientists in 51 countries. More than 1000 seed packets of other AVRDC tomato materials were also distributed.

Bangladesh

AVRDC materials compared well with commercial hybrids and outyielded the local check by between 13% and 31% in trials conducted by cooperators at the Mennonite Central Committee. The top yielder was AVRDC accession 143-0-4B-1 at 51 t/ha.

India

Cooperators at Kerala Agricultural University screened 19 AVRDC tomato lines for bacterial wilt resistance. Only lines 143-0-10-3, 32d-0-1-19, 8d-0-7-1 and 9-0-0-1 proved resistant.

Early blight was a serious problem on five AVRDC tomato lines evaluated by the Agricultural Research and Development Foundation. Local farmers, however, praised selections 9-0-0-1 and 11d-0-1-2 for their size and keeping qualities.

In Jammu and Kashmir states, cooperators with the Department of Agriculture reported that five AVRDC lines, 8d-0-7-1, 143-0-6-9, 143-0-10-3, and accessions 1 and 38, compared favorably with the locally bred Shalimar-1. The most serious disease problems observed were early and late blights.

Indonesia

In lowland trials, accessions VC 8-1-2-7, VC 11-1 and VC 8-1-2-1 survived from 79% to 86% against bacterial wilt and yielded more than 20 t/ha. The local checks failed to produce fruit.

Philippines

Cooperators at Claveria on the island of Mindanao reported that a number of AVRDC tomato lines produced more than 40 t/ha, significantly outyielding the local check. At the same station, selections 1, 15, 20 and 40 from CL 505 with pedigree (TR/VC 11-2)-9-1 F_4/Saturn//Kewalo outperformed the local checks Improved Pope and Marikit.

The Twin Rivers Research Center in Davao has been producing and evaluating hybrids of AVRDC tomatoes and reports that combinations 143-0-6-0/Pope and 143-0-4B-1/11d-0-2-4 have outperformed all local checks and other crosses. Selections 60, 77 and 90 from CL 1094 with pedigree VC 9-1/Florida MH-1//ah TM-2a/VC 8-1-2-1 were also outstanding.

AVRDC lines are being used for commercial production by RAM Food Products in Cabuyao, Laguna because of their ability to withstand severe bacterial infestations. Although plantings beyond December usually produce low yields because of high temperatures, this year RAM Food Products planted on February 13 and reported that selections 143-0-6-9, 143-0-10-3 and 9-0-0-1 were excellent.

Singapore

The Primary Production Department of Singapore reported local farmers were enthusiastic about AVRDC tomato selection S 24-1. Yields have ranged from 30 to 48 t/ha in Singapore fields.

At the Sembawang Experiment Station, the excellent performance of 143-0-10-3 and 143-0-6-9 contrasted sharply with that of the local checks, all of which succumbed to bacterial wilt.

Thailand

Khon Kaen University selected one AVRDC tomato line for regional trials from CL 1131 with pedigree VC 48-1/Tamu Chico III//ah TM-2a/VC 11-1.

Sierra Leone

An outreach scientist of IITA reported the enthusiastic acceptance of AVRDC tomato lines in several locations of Sierra Leone because of their heat tolerance and bacterial wilt resistance.

Seychelles

The Grand Anse Experimental and Food Production Center conducted tomato trials to select tomato varieties that are wilt resistant and adapted to conditions typical of the northwest monsoon season. Of 39 varieties and breeding lines evaluated, six from AVRDC (9d-0-3-6, 114-5-5, 8d-0-7-1, 143-0-10-3, 143-0-4B-1 and VC 11-1) proved to be outstanding.

Brazil

In trials conducted by Jari Florestal e Agropecuaria Ltd, AVRDC lines outyielded the local checks by 382% to 663%. The highest yielder was 143-0-10-3 with a marketable yield of 73 t/ha, compared to 11 t/ha for the highest yielding local check.

Tahiti

The French Mission in Tahiti reported AVRDC tomato lines survived from 88% to 100% and yielded from 13 to 42 t/ha despite bacterial wilt infections. The check variety did not survive.

Ponape

AVRDC tomato lines outyielded the check by at least four-fold, with 143-0-6-9 yielding highest at 14 t/ha. The yield differences have been attributed to heat tolerance, since the check is reported to be resistant to bacterial wilt.

CHINESE CABBAGE

Germplasm collection and evaluation

Four new accessions were received in 1979 bringing the total collection of Chinese cabbage and allied species to 703. In summer season evaluations of 35 untested accessions, none proved to be heat tolerant. To date, we have evaluated all 540 *B. campestris* ssp *pekinensis* accessions in the AVRDC collection of which 79 (or 15% of the total screened) have exhibited heat tolerance.

Yield trials

We conducted six advanced tests planted at different dates during the 1979 summer season. Entries consisted of promising breeding materials selected from the 1978 preliminary yield test and the most promising crosses from 1978 combining-ability trials. Table 1 shows a summary of the yields of entries which performed better than the average of all cultivars at all planting dates. Hybrids #58 and #62 and two open-pollinated varieties, 76 M(3)-27 and 77 M(3)-35, yielded higher than check entries in all environments. B 189, the open-pollinated check, was a low yielder at all planting dates.

Comparative data on other important horticultural characters of selected entries expressed as averages over all planting dates are shown in Table 2. Generally, AVRDC hybrids matured earlier than other entries, except possibly the local check (B 189). Moreover, heading rates approa-

Table 1. Yield (t/ha)[1] of Chinese cabbage entries compared to checks in advanced trials, 1979, AVRDC

Entry	Advanced trial[2]					
	I	II	III-1	III-2	IV	V
AVRDC #58 F_1	7.9 de	15.8 a	17.7 a	16.4 a	14.7 a	29.9 ab
AVRDC #62 F_1	11.2 cd	14.2 ab	15.9 ab	13.8 ab	14.7 a	29.3 ab
77 M(3)-27	17.8 ab	10.4 cd	17.0 a	7.8 efg	12.2 ab	30.3 a
77 M(3)-35	13.8 bc	7.6 de	12.8 bcd	12.1 bc	11.6 bc	27.4 ab
Yuan Pao No.2 (check)	1.8 f	11.8 bc	10.8 cde	9.4 cde	12.3 ab	28.7 ab
B 189 (check)	4.1 ef	7.6 de	9.2 def	8.2 def	7.4 e	16.7 h
Environmental mean[3]	9.0	9.9	12.3	10.4	10.0	25.9

[1]Means followed by same letters are not significantly different
[2]Represented by different transplanting dates as follows:
Trial I - May 19
Trial II - May 6
Trial III-1 - July 5
Trial III-2 - July 6
Trial IV - August 10
Trial V - September 4
[3]Average of 17 entries

Table 2. Summary of horticultural characters for Chinese cabbage in advanced trials, 1979, AVRDC

Entry	Days to maturity	Heading rate	Head weight	Soft-rot[1]	Turnip mosaic virus[1]
	- DAT[2] -	- % -	- g -	- % -	- % -
AVRDC #58 F_1	40	99	583	8	10
AVRDC #62 F_1	39	99	592	7	7
77 M(3)-27	46	95	665	8	9
77 M(3)-35	46	92	628	5	5
Yuan Pao #2 F_1(check)	43	91	604	5	4
B 189 (check)	41	96	334	8	32

All data represent an average of all planting dates
[1]Natural field infection
[2]Days after transplanting

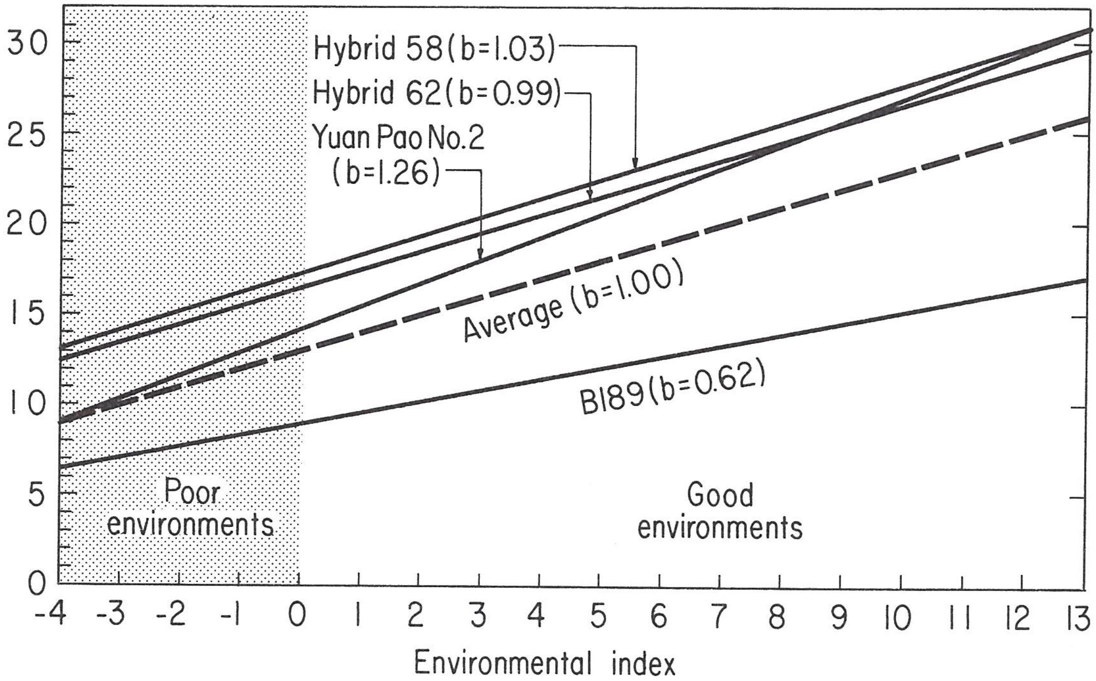


Fig. 1. Response of selected Chinese cabbage varieties to different planting dates, 1979, AVRDC

ched 100% and heads were heavier than that of the local check, although smaller than open-pollinated entries and the hybrid check, Yuan Pao No. 2.

A highly significant variety x planting date component indicated that different planting dates evoked widely different responses among entries. This was attributed to genetic differences between entries. These variations in response can be seen in Figure 1 in which both slopes (b) and positions of the regression lines vary between varieties. Hybrids #58 and #62 show regression lines above the average for all varieties and regression coefficients close to 1.0, implying that such hybrids perform better than average in all environments. On the other hand, Yuan Pao No. 2 shows a regression coefficient significantly higher than 1.0 (b = 1.26), implying that this variety performs well in good environments such as late summer, but does poorly in less ideal environments such as early and mid-summer. Although the local check (B 189) yielded consistently below average, a low regression coefficient (b = 0.62) indicates that this variety will yield higher than average in poor environments.

The deviation from regression (s_d^2) of individual varieties also measures stability. Combined with high average yield and regression slope equal to 1, the most stable variety is further defined as one with insignificant deviation from regression. Considering these three parameters, AVRDC #62 appears to be the most stable entry.

Combining-ability trials

We conducted three combining-ability trials in the summer of 1979 involving new hybrid combinations. The first trial, transplanted July 19, consisted of 14 new F_1's among AVRDC inbred lines and hybrid #58 as check. In this trial, none of the new combinations proved much better than hybrid #58 in yield or early maturity.

The second trial, planted August 9, was part of a cooperative testing program between AVRDC and the Korean Outreach Program (KOP). We tested 31 hybrid combinations from the KOP against AVRDC #59 and three other local hybrids. Four of the KOP combinations were heat tolerant, but heading rates were poor and yields were generally below 10 t/ha. By comparison, AVRDC #59 yielded an average of 18 t/ha with a 100% heading rate. Although two of the three local hybrids matured earlier than AVRDC #59, yields were 11 t/ha or less.

The third combining-ability trial involved five F_1's between AVRDC inbred lines, S-allele stocks received from KOP, and an additional five hybrids among AVRDC lines. The S-allele stocks do not carry heat tolerance, so that hybrids using them as parents were expected to be only moderately heat tolerant at best. Thus, we planted this trial in late summer (September 4). Check varieties were AVRDC #58 and Ping Luh, a popular variety grown during this period in Taiwan. Table 3 shows the yield and other horticultural characters of some hybrid entries in this trial. One combination (E 7/G6) significantly outyielded Ping Luh and matured a week earlier, but AVRDC #58 yielded as well as the new combination and also matured earlier.

Table 3. Average yields and other horticultural characters[1] of hybrid Chinese cabbage in the third combining ability trial, 1979 AVRDC

Combination	Yield (t/ha)	Head weight(g)	Days to maturity (DAT[2])	Heading rate(%)	Downy mildew
E 7/G6	27.1 a	812 a	46 c	98 a	moderate
AVRDC #58 (check)	23.7 ab	712 ab	42 d	100 a	light
Ping Luh (check)	15.1 bc	514 b	53 a	92 a	severe

[1]Means with the same letter are not significantly different
[2]Days after transplanting

Heat tolerant gene pool

Two types of experiments were conducted in summer 1979 to determine the nature of genetic diversity in the heat tolerant gene pool and to explore ways of breaking the low yield barrier in heat tolerant cultivars.

We applied Adams and Wiersema's methods to try to assess the genetic relationship among a random set of 12 heat tolerant cultivars and two new open-pollinated populations which are closely related to each other by pedigree, but only distantly related to the heat tolerant set. Variability between heat tolerant cultivars tends to be small, with closer relationship values obtained for cultivars with known related pedigrees than to those for distantly related cultivars (Table 4). This is strong evidence of a close genetic relationship.

Table 4. Comparative genetic distance among groups of Chinese cabbage cultivars, 1979, AVRDC

Cultivar groups	Trial I	Trial II	Average
Cultivars related by pedigree	0.64	0.69	0.66
Local heat tolerant cultivars	0.72	0.67	0.69
Unrelated cultivars	0.95	0.94	0.94

Genotype-environment interaction

The same 12 heat tolerant cultivars were planted at seven dates during the summer season and the results subjected to two analyses, based on statistical methods devised by Habgood (1974) and Eberhart and Russell (1966) for genotype-environment interaction. The analysis indicates an insignificant variety x planting date interaction. This result suggests the absence of genetic differences among heat tolerant varieties in their regression over environment and further lends support to the findings of correlation analysis.

Exploitation of hybrid vigor within the existing genetic resources for heat tolerance is therefore vitiated by the narrow diversity of the gene pool. Broadening the gene pool may hold the key to breaking the low yield barrier in heat tolerant cultivars. From this standpoint, our breeding methodology appears sound, based on developing inbred lines from crosses of heat tolerant cultivars with unrelated winter cultivars carrying resistance to diseases.

Self-incompatibility tests among inbred lines

We analyzed self-incompatibility among inbred lines using diallel tests to identify S-allele homozygotes essential for F_1 hybrid production. Including inbred lines that are homozygous for unknown S-alleles, we now have a total of 39 S-allele homozygous lines.

Cytosterility backcross program

In 1979, cytosterility was successfully backcrossed to selected AVRDC heat tolerant accessions and inbred lines with good combining ability but weak self-incompatibility. Cytosterility is now included in 88% (three backcrosses) of AVRDC breeding materials.

In the summer of 1979, 25 families were grown for initial selection of heat tolerant derivatives. Twenty-one selections were derived from seven families showing relatively high proportions of heading plants.

While cytosterile materials often suffer from chlorophyll deficiency, poor vigor and non-functional nectaries, their highly stable male sterility characteristic is desirable. Hence, further work will emphasize selection against undesirable characters.

Downy mildew caused by *Peronospora parasitica*

In June, 14 germplasm accessions of Chinese cabbage, B470, B503, B504, B539, B540, and B581-589, were rated as resistant to downy mildew in a screening test. Twenty-five others were partially resistant. These selected accessions plus 34 others are currently being re-screened in the field for disease resistance under cool weather conditions.

In late October, 54 entries of breeding materials, including 2686 plants of advanced inbred lines, open-pollinated populations and hybrid entries, were evaluated in the field for resistance to downy mildew. One advanced line (D-10) and four hybrid lines (#30, #58, #59 and #62) were moderately susceptible, with infected plants ranging from 63% to 74% of the total tested. Only 18% of the plants of accession B6, a resistant check, were infected.

Turnip mosaic virus

In 1979, 174 accessions and 54 breeding entries of Chinese cabbage, including 9387 individual plants, were screened in the field for resistance to TuMV using a standard inoculation method developed at AVRDC. Forty-nine germplasm accessions and 18 breeding progenies (including 11 advanced inbred lines, four open-pollinated populations and three hybrid entries) were consistently found resistant to TuMV. The elite F_1 entries were rated moderately resistant to TuMV after 24% of the plants were infected.

Softrot caused by *Erwinia carotovora*

Using the standard method to induce softrot, a total of 18,420 Chinese cabbage plants were individually inoculated with *Erwinia carotovora*, screened, and evaluated in the field for their resistance to the disease. Twenty accessions were rated resistant with accessions B157, B683, B687, and B702 entirely free of the disease.

In different screening tests, nine advanced inbred lines, three open-pollinated populations, eight inbred lines and 63 segregating breeding populations were also identified as resistant to softrot.

Other important diseases of Chinese cabbage

Clubroot disease caused by *Plasmodiophora brassicae* was discovered and positively identified by our plant pathologist, C. Y. Yang, in vegetable growers' fields along the coastal belt of Pingtung in the southern part of Taiwan. Cruciferous crops infected by clubroot are Chinese cabbage, cabbage, cauliflower, and broadleaf mustard (*Brassica juncea* var *rugosa*). The damage and spread of clubroot was greater on the mustard than on the other crucifers surveyed. In crucifer growing areas totalling 138 hectares, an estimated 15% of mustard and 1.5% of Chinese cabbage were infected by clubroot.

A *Pythium* species, possibly *P. spinosum*, was frequently found inside stunted roots of young Chinese cabbage seedlings. The possible causal relationship between this *Pythium* and the root disorder is being investigated.

Biology of cabbage webworm

In order to understand the behavior and reproductive potential of cabbage webworm (*Hellula undalis*) and the nature and extent of its damage, we continued the basic biological study that was initiated in 1978. These studies were conducted both in the field during summer and in the laboratory.

In July 1979, 300 Chinese cabbage plants grown in insecticide-free areas were surveyed to determine the extent of infestation and to learn about the feeding habits of larval instars on specific plant parts. We found as many as 11 larvae per plant. Large numbers per plant were associated with even-aged populations and vice versa. Larvae feed after emergence, but migrate at later stages, probably because of population pressures on single plants. Larvae of each of five instars could be found together indicating generation overlap.

Early instar larvae burrowed into sprouts or into the stem and veins of larger leaves, leaving feces outside the feeding area. The older larvae fed on the sprout, with some feeding on the larger leaves beneath a protective silken web. Young infested seedlings either die or produce side tillers which fail to produce heads at harvest.

Host range of webworm

The host range of webworm was assessed in field experiments using seedlings of nine cruciferous species (or subspecies) and several distinct plant types of Chinese cabbage, including early maturing and heat tolerant types. One trial was conducted in April and another during the July rainy season. Plants were allowed to become infested with natural populations of cabbage webworm. Three weeks after transplanting, we recorded the number of damaged plants, and the number of larvae and pupae per plant. Chinese cabbage and radish appeared to be the favorite hosts for this pest during the wet season. Although smaller populations of this pest were observed in the April study, all varieties of Chinese cabbage were equally infested in both studies.

Seasonal incidence of cabbage webworm

We have been monitoring the seasonal incidence of cabbage webworm since July 1977 with a view to devising appropriate control measures. Every month, Chinese cabbage (variety Feng Luh) is planted. The number of larvae on 30 plants is monitored each week for four weeks beginning one month after transplanting. During 1977 and 1978, this insect was abundant almost exclusively in the monsoon season from June through September (Figure 2). During 1979, however, insect abundance occurred much earlier, appearing in February and March and remaining high until September. Despite the earlier appearance, plant damage was at a peak only during June through September. Most of the insects found during February to April were early instar larvae feeding mainly on the older leaves, rather than burrowing into the growing points, the most common and destructive damage by this insect in the monsoon season. The reason for this shift in the nature of damage is not presently known and will be investigated next year.

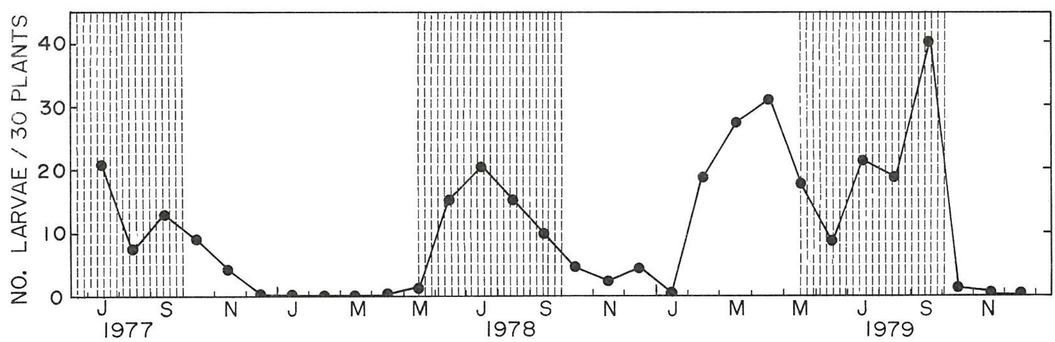


Fig. 2. Seasonal incidence of cabbage webworm at AVRDC, 1977-79

Cultural control of cabbage webworm

Various cultural practices were investigated for webworm control in Chinese cabbage during the summer of 1979. Chinese cabbage was intercropped with 22 other crops planted 10 days earlier than Chinese cabbage in 5m x 1m beds, except tomato, which was transplanted simultaneously with Chinese cabbage. Webworm incidence was lowest when Chinese cabbage was intercropped with sweet potato, mungbean and watermelon, but the rapid growth of these crops significantly reduced cabbage yields. This problem will be investigated further during 1980 with larger plots and several dates of planting.

The benefits of black plastic, clear plastic, and aluminium foil mulches, and nylon nets for seedling protection were also assessed. Seedling spacings of 50cm x 60cm, 50cm x 40cm and 50cm x 20cm were also evaluated for webworm infestation. None of the treatments was more effective than the control.

Chemical control of cabbage webworm

Weekly parathion foliar sprayings at 0.5 kg ai/ha or terbufos 10G incorporated into the soil at 2 kg ai/ha gave the best insect control with highest yields. However, parathion was the cheapest treatment. In another experiment, parathion was sprayed at various intervals in conjunction with soil incorporation of carbofuran 3G at 2 kg ai/ha. The addition of carbofuran was not an improvement over weekly or biweekly sprayings of parathion initiated three days after transplanting. Biweekly applications were as effective as any other more frequent application schedule. None of eight commercial stickers improved parathion persistence.

Of eight new insecticides screened for control of cabbage webworm, temephos, evisect and thiometon controlled cabbage webworm as effectively as parathion.

Varietal resistance to aphids and diamondback moth

During 1977 four accessions (B464, B487, B488, and B490) representative of the mustard *Brassica juncea* were found to be tolerant to aphids (*Phopalosiphum pseudobrassicae* and *Myzus persicae*). Our search for aphid resistance among Chinese cabbage relatives was continued in 1978-79. We evaluated 304 Chinese cabbage accessions in a non-replicated field experiment during late 1978 and early 1979 but none revealed any significant level of resistance. The same 304 accessions were evaluated for resistance to diamondback moth, of which 14 rated moderately resistant. Screening these 14 accessions will be continued during 1979-80 for identification of breeding stock.

Thirty promising accessions which had consistently shown low to moderate levels of resistance to diamondback moth in earlier years were screened further in three replicated field tests. Four accessions, B31, B95, B119 and B583, were rated moderately resistant to this insect. Two of these accessions, B95 and B583, being *B. campestris* ssp *chinensis* var *parachinensis*, are compatible with Chinese cabbage and may be a source of resistance to diamondback in crosses with Chinese cabbage.

Entomological studies on Chinese cabbage seed production

A study was initiated to assess damage of insect pests on Chinese cabbage seed production, and possible chemical control measures.

Aphids (*Phopalosiphum pseudobrassicae* and *Myzus persicae*), diamondback moth (*Plutella xylostella*), cabbage worm (*Pieris rapae*) and a tussock moth (*Porthesia taiwana*) were found to be the major pests. Aphids and diamondback moth infested all above-ground plant parts including stems, leaves and pods. Cabbage worm fed mainly on succulent stems and leaves and *Porthesia taiwana* fed almost exclusively on the pods. Aphids were by far the most destructive insects affecting seed yield.

In order to understand the nature of aphid damage, we conducted a greenhouse pot culture study on five varieties of Chinese cabbage to determine the effects of aphid infestation on cabbage yield and yield components.

It was clear that all yield components were seriously affected by aphid infestations. In aphid-free plants the number of pods/plant was five to six times greater, the number of seeds/pod increased at least two-fold, the weight of 1000 seeds 20 to 50% greater and seed yield six- to ten-fold higher than in aphid-infested plants. Seed germination, however, was identical in both aphid-free and aphid-infested plants.

Several insecticides were field-screened for control of insects affecting Chinese cabbage seed production. Systemic insecticides were soil-applied immediately before transplanting and foliar chemicals were applied weekly. Weekly spraying of Tokuthion 50EC at 0.25 kg ai/ha and decamethrin 2.5E at 12.5 kg ai/ha effectively controlled aphids and diamondback moth and resulted in seed yields significantly greater than any other treatment.

Control of insecticide-resistant diamondback moth

The diamondback moth has developed resistance to several common insecticides; hence preliminary experiments were conducted to discover efective techniques for chemical control. Common cabbage was used as the host plant since it can survive a severe aphid infestation. Both mixtures of common insecticides and sequential applications were tested for their effectiveness. Although applications of either methomyl or diazinon alone did not effectively control diamondback moth, a mixture of the two applied as a single spray significantly improved insect control and plant yield. Sequential sprayings of diazionin, methomyl and fenvalerate were as effective as weekly sprayings of fenvalerate. The significance of these results will be investigated in 1980.

Table 5. Correlation coefficients of Chinese cabbage yields with temperature and precipitation, 1979, AVRDC

Entries	Correlation with total days of exposure to mean temperatures above 23°C	Correlation with total days of precipitation exceeding 40 mm/day	N[1]
B-6	-0.69**	-0.43	13
B-14	-0.67**	-0.56	13
B-31	-0.44	-0.67**	13
B-33	-0.87*	-0.58	7
77 M(2/3)-45	-0.35	-0.54	7

** Significant at the 1% level
* Significant at the 5% level
[1]Sample size

Seasonal effect on growth and head yield

Studies were continued on the seasonal effects on plant growth and head yield of both heat sensitive and heat tolerant accessions of Chinese cabbage which were planted monthly throughout the year. Two heat sensitive entries and one medium heat tolerant entry indicated a negative correlation between head yield and total days of exposure to mean temperatures above 23°C (Table 5). Although B-14 was classified as heat tolerant, its yield was adversely affected by mean temperatures above 23°C. Head yields of B-14 and B-31 were also negatively correlated with total days of precipitation exceeding 40 mm between transplanting and harvest. Variable Chinese cabbage yields can thus be explained to a large extent by these seasonal weather variations.

May and June plantings of three AVRDC F_1 hybrids were compared for growth responses and head yield. Table 6 shows that yield, head weight, shoot growth and root weight of the May planting were significantly lower than those of the June planting. This may be due to greater precipitation in the four weeks after transplanting in May (392 mm) than in the four weeks after the June planting (160 mm). These field results indicate strongly that high precipitation, like high temperature, is a constraint to maximum yields of Chinese cabbage.

Excessive soil moisture

During the monsoon season, plants are frequently subjected to stress from excessive soil moisture. We conducted an experiment with Chinese cabbage to assess the effect of field-drainage on flooding damage. Both B-14 and B-189 produced higher yields in well-drained fields during the

Table 6. Yields and horticultural characteristics of AVRDC F_1 Chinese cabbage hybrids grown in summer, 1979, AVRDC

Entry	Planting	Yield (t/ha)	Head wt. (g)	Heading rate (%)	Shoot wt.	Heading efficiency	Root wt. (g)
Hybrid #58	May[z]	8.9	345	80	876	0.65	12
	June[y]	19.5	683	88	1391	0.97	18
Hybrid #59	May	11.2	400	86	908	0.79	14
	June	17.5	655	85	1345	0.95	17
Hybrid #62	May	10.7	412	82	885	0.89	11
	June	16.1	644	76	1288	1.00	14
LSD 5%		2.9	56		96	0.17	3

z: Sown May 1 and transplanted June 6
y: Sown June 5 and transplanted June 26

monsoon season, with B-14 in particular producing a high percentage of well-developed heads.

In order to understand the physiological responses after heavy rains, and to differentiate direct damage from rain or soil flooding, we conducted an experiment on four-week-old seedlings, subjecting them to either 50 mm/day of artificial rain or soil flooding for two days. Figure 3 shows that the root system of B-14 was completely destroyed by soil flooding, whereas B-189 suffered only partial damage. Flood damage also reduced fresh weight and relative water content four days after treatment (Table 7). Two days of artificial rain did not cause damage to the root

Table 7. Effect of flooding and artificial rain on shoot growth and water content of Chinese cabbage, 1979, AVRDC

Treatment	Entries	Fresh wt. (g/plant)	Dry wt. (g/plant)	Water content(%)
Flooding	B-14	7.2	1.51	45
	B-189	6.5	1.43	64
Rain	B-14	21.7	1.78	87
	B-189	18.3	1.41	94
Control	B-14	19.6	1.96	84
	B-189	13.1	1.33	80
LSD 5%		12.0	ns	12.8

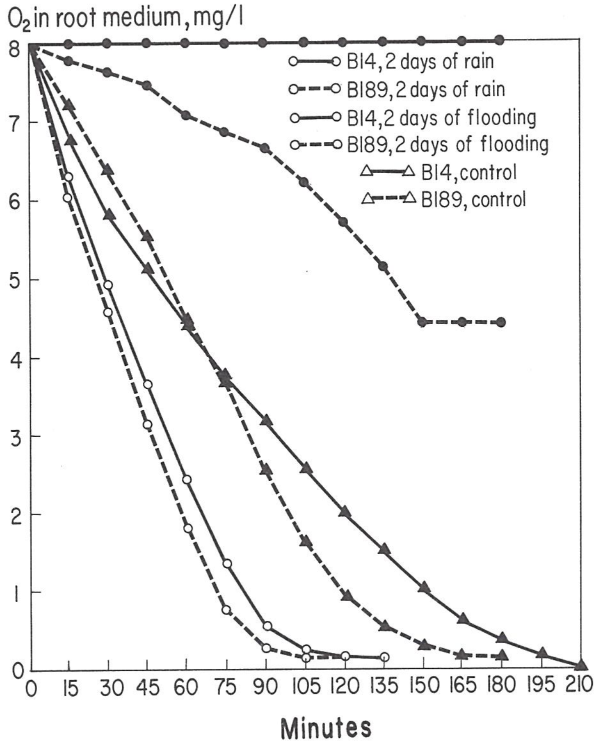


Fig. 3. Oxygen concentration in the root medium of selected Chinese cabbage varieties after artificial rain or soil flooding, 1979, AVRDC

system of either B-14 or B-189. The results suggest that flooding impedes the active processes of the root system, thus preventing soil-water uptake, and preventing flooded plants from maintaining full turgidity. This is especially important for the heading types of leafy vegetables like Chinese cabbage. Whether relative water content or turgidity can be used as an index of soil-flooding damage is still being assessed. Preliminary experiments using 16 accessions and AVRDC F_1 hybrids indicate that two days of soil flooding causes differential reductions in water and pressure potentials, while osmotic potential remains relatively unchanged. Poor growth caused by flooding is also reflected in reduced plant turgidity as expressed by turgor pressure (Table 8).

Physiology of flowering

After observing varietal differences in flowering response to low temperatures in 1978, a study was undertaken in 1979. The critical tem-

Table 8. Turgor pressure (bars) of Chinese cabbage in response to flooding, 1979, AVRDC

Entries	Tolerance to flooding[a]	Turgor pressure
B-6	1.75	4.4
B-14	2.25	2.2
B-31	1.75	3.9
B-32	2.11	3.0
B-33	2.75	3.6
B-45	2.50	2.8
58 (F_1)	1.50	3.6
61 (F_1)	2.00	4.3
62 (F_1)	2.25	2.8
B-126	2.33	2.3
B-129	2.56	2.1
B-140	2.28	1.9
B-152	3.11	1.4
B-162	3.22	3.4
B-171	2.28	-0.2
B-189	3.50	2.2
	r=-0.50*	

Data from 1-month old plants after 2 days of flooding at 30°C
*Significant at the 5% level
[a]1=high tolerance, H=low

perature for inducing flowering in easy-to-flower, heat tolerant varieties was about 14°C. While heat tolerant B-31 and 77 M(2/3)-45 tended to flower readily after 10 days at 10°C, three AVRDC heat tolerant F_1 hybrids needed more than 30 days at 10°C to initiate flowering. These results suggest that heat tolerance in Chinese cabbage is not strongly associated with vernalization sensitivity. Incompletely vernalized heat tolerant or heat sensitive accessions were brought to flower by three sprays of gibberellin at 250 ppm, while flowering of easy-to-flower accessions induced by low temperatures was delayed by three sprays of alar or CCC at 1000 ppm.

International Cooperation

In 1979, we obtained 147 accessions of Chinese cabbage and distributed 947 seed packets of new breeding lines to scientists and cooperators in 35 countries.

New Hebrides

Eleven AVRDC entries were compared with check variety Yuan Pao No. 2. Entry 77 M(3)-40 yielded 64 t/ha in 49 days after transplanting and four other AVRDC entries yielded 50 t/ha or more, compared with 22 t/ha in 43 days for Yuan Pao No. 2. Seeds of the top three entries were sent to the New Hebrides for multiplication and distribution to farmers.

Seychelles

Two hot season trials were conducted to compare AVRDC materials with Japanese hybrids. Only one hybrid (Sakata Hybrid Tropical Delight) produced heads, while nine AVRDC entries were selected particularly for their good head production. Five kg seed were requested for each of entries 77 M(2/3)-43, 77 M(2/3)-41, AVRDC #59, AVRDC #62 and B 129 C_1 for immediate distribution to farmers.

Hawaii

The University of Hawaii tested 14 AVRDC materials at Waimanalo in March 1979 at temperatures of 20-25^{o}C and daylengths of 11 hours. The university reported excellent performance of AVRDC entries under these conditions, reporting the development of respectable heads for the first time in this environment. Entries 77 M(3)-38 and 77 M(3)-40 averaged more than 1 kg/head with early to medium maturity. Seeds of these entries and B 189 C_1 were supplied for additional trials and multiplication.

California

The W. Atlee Burpee Company tried AVRDC hybrids #58 and #62 during the 1979 early summer and fall seasons. They reported that both hybrids were extremely late in bolting (a very important attribute for Californian conditions) and produced medium heads with a crispy texture and mild taste. The company predicts that these hybrids (especially #62) will be very popular among American farmers and has already expressed an interest in producing seeds of this hybrid.

Indonesia

Our cooperators in Indonesia conducted four trials at three different locations in 1979. At Pasarminggu, three entries, 76 M(1)-6, 76 M(1)-4 and 76 M(2)-20, outyielded check varieties B 189 C_1 and B 129 C_1, producing almost 30 t/ha in 55-60 days after transplanting. At Cipanas, a highland location 1100 m above sea level, three entries yielded as well as Granat (the local check) in 59-61 days after transplanting. Yields of these entries including that of Granat ranged from 34.7 to 41 t/ha. By comparison, the heat tolerant check B 189 C_1 yielded only 11.1 t/ha. Heads harvested from all AVRDC entries were more compact than those of Granat, but cool temperatures induced premature bolting in the majority of AVRDC entries. The highest bolting rate (45%) occurred with B 189 C_1.

In the first of two trials at Kediri, 12 entries yielded from 25-41 t/ha compared with no yield for Yamato-Noen, the heat sensitive check. The five best entries, which included AVRDC #59, yielded 32 t/ha or more. Entry 77 M(2)-25 was the highest yielder with 41 t/ha in 38 days after transplanting.

The second trial at Kediri also consisted of 12 AVRDC entries. The five best entries, which again included AVRDC #59 and 77 M(2)-25, yielded 45 to 54 t/ha in 38-40 days after transplanting. AVRDC #62 yielded 54 t/ha in contrast to 24 t/ha in 42 days for the heat tolerant check B 189 C_1.

Philippines

Three trials were conducted by cooperators at three locations in the Philippines. At the Los Baños Economic Garden, 15 new entries were tested against check cultivars B 189 C_1 and Yuan Pao No. 2. Yields ranged from 15 to 24 t/ha but significant differences were not detected between entries.

At the Twin Rivers Research Center in Davao, 14 of 15 entries yielded 30 t/ha or more. Entry 77 M(2/3)-29 yielded highest at 52 t/ha in 52 days after transplanting versus check cultivar B 189 C_1 with 33 t/ha in 49 days. Seeds of the seven top yielders were provided to cooperators for experimental seed multiplication at their medium-elevation farm.

A former AVRDC trainee conducted a trial of 10 entries at Mindanao State University, Marawi City. Two entries, 76 M(2)-17 and 76 M(1)-4, produced 27 and 24 t/ha respectively, significantly outyielding check B 189 C_1. The check matured from three to five days earlier, but yielded only 14 t/ha.

Malaysia

In a late 1978 trial of six Chinese cabbage entries, cooperators at MARDI found two entries which significantly outyielded the check cultivar B 129 C_1, although neither proved better than B 189 C_1. The highest yield of 15 t/ha in 42 days was given by 76 M(2)-20. Yamato-Noen, the heat sensitive check, did not produce heads.

In a 1979 trial involving 15 new AVRDC entries, hybrid #59 produced the highest yields, averaging 16 t/ha, and according to our cooperator, an unavoidable delay in harvesting adversely affected yields. Experimental seed multiplication of the best entries in the Cameron Highlands is now being considered.

Papua New Guinea

Cooperators at the University of Papua New Guinea found five AVRDC heat tolerant Chinese cabbage accessions to be suitable to their climatic conditions and well within the range of consumer acceptability. Accession B 177 yielded 42 t/ha at a density of 40,000 plants/ha and appeared to be less susceptible to softrot than other entries. B 177 also displayed relative resistance to bolting and produced reasonably-sized solid heads.

Taiwan

Fengshan Tropical Horticultural Experiment Station reported a trial involving 15 AVRDC entries. AVRDC #59 yielded 19.4 t/ha in 39 days after transplanting, compared with 7.6 t/ha for local check B 189 C_1. In the same period, AVRDC #58, #62 and #30 LV yielded from 12.8 to 14 t/ha.

An Indonesian trainee prepares a plot for sweet potato plantings.

SWEET POTATO

Germplasm collection and distribution

Thirty-three accessions were received in 1979, bringing the total collection of sweet potato to 422. More than 300 breeding line samples were distributed to 42 scientists in 19 countries.

Hybridization

Crossing efforts in 1979 focused on incorporating weevil-resistance into promising sweet potato selections. Grafting parentals to free-flowering stocks boosted the number of crosses made to 169, and those showing weevil-resistance were selected for further evaluation in 1980 observation trials.

A hybridization program using low-sugar lines was also initiated to improve staple-type varieties.

Winter yield trials

To select sweet potato lines that are high-yielding during the winter months, a series of observational, preliminary and advanced trials was planted from September 20 to October 25, 1978. Breeding lines in the preliminary trials yielded from 1 to 25 t/ha in 105 to 119 days. About 16% of the varieties yielded at least 10 t/ha, a respectable harvest since a 270 to 300-day crop yields even less in many highland areas of Asia.

In the advanced trials, AVRDC breeding lines outyielded check cultivars when harvested after only 103 days. Although yields were lower in later plantings, many breeding lines still produced between four and seven-fold more than the check varieties (Table 1).

In observational trials, new materials yielded from 0 to 41 t/ha. The top 12% (140 lines) yielded 20 t/ha or more and were selected for further evaluation. Many of these lines are potentially useful in the colder

Table 1. Yield and vine/root ratio of sweet potato lines in winter advanced trials, 1978-79, AVRDC

AVRDC selection	pedigree or variety	Marketable yield (t/ha)	Vine/root ratio
591-14	Poly Tainung 57 (2)[a]	38	0.4
438-3	Taiwan 2/B 6708 (OP)[a]	30	0.4
590-2	Poly Tainung 57 (1)[a]	29	0.5
590-13	Poly Tainung 57 (1)[a]	27	0.5
590-33	Poly Tainung 57 (1)[a]	27	0.6
431-12	Daja 380/B 6708 (OP)[a]	27	0.7
482-2	PI 344129/PI 315342[b]	22	0.5
557-1	Red Tuber Tail/OK 6-3-106// PI 344129[b]	21	0.6
478-9	PI 344129/Tainung 31[b]	20	0.6
489-1	PI 344129/B 6708[b]	20	0.6
478-7	PI 344129/Tainung 31[b]	19	0.4
297-47	Poly 171[b]	18	0.5
(171)	(Tainung 63) (check)[a]	8	0.5
35-1	HDK 6/B 6708 (check)[a]	10	0.4
(57)	(Tainung 57) (check)[b]	6	0.6
015-6	HKD 6 (OP) (check)[b]	3	0.7

Data represent means of four replications
[a]Orange-fleshed lines planted September 27, 1978, and harvested January 8, 1979 (103 days)
[b]White- or yellow-fleshed lines planted October 24/25, 1978, and harvested February 25/26, 1979 (124 days)

highlands of Indonesia, Thailand, Borneo, Philippines, India, Nepal and Papua New Guinea where sweet potato is considered a staple crop.

The adaptability of several sweet potato lines to relay-cropping systems was also assessed. Thirty days before harvesting a green corn crop, sweet potato was planted on the corn ridge to form a relay treatment. Yields were lower, due mainly to reduced root production. Although a low yielder, AIS 272-2 adapted best to the relay treatment, showing only slight root reduction, an increase in average root weight and the least gain in vine weight.

Summer yield trials

In preliminary trials conducted during the 1979 summer season, the top 10 AVRDC lines yielded from 13 to 21 t/ha, compared with 4 to 7 t/ha from check entries. Selection 693-9 yielded highest at 21 t/ha, with 818-33 and 822-21 yielding 19 and 18 t/ha respectively.

Two groups of advanced trials were planted in the summer of 1979. The first group tested consistently high-yielding lines carried over from 1978. Although the best yielder in 1978 did less well in 1979, overall the yields were consistent (Table 2). An orange-fleshed selection (590-13) had the highest two-year average yield of 19 t/ha, compared with averages of 4 to 9 t/ha for the check entries. The second group of advanced trials compared crop durations of four months vs five months for sweet potato yields. Although selections 551-1 and 540-7 had higher four-month yields than check entries, none proved better than check 0122-2 over a five-month period (Table 3).

Varietal screening for sweet potato weevil resistance

During 1979, we conducted two screening tests to select sweet potato germplasm resistant to sweet potato weevil (*Cylas formicarius*). The first experiment evaluated 105 accessions and 15 breeding lines planted at AVRDC on October 15, 1978, and harvested May 10-11, 1979. Using a field ex-

Table 2. Yield, vine/root ratio and flesh color of sweet potato lines in summer advanced trials, 1979, AVRDC

AVRDC selection acc. no.	Pedigree or variety	Marketable yield		Mean	Vine/root ratio (1979)[a]	Flesh color
		(1979)[a]	(1978)[b]			
489-6	PI 344129/B 6708 (OP)	19	15	17	1.2	yellow
431-12	Daja 380/B 6708 (OP)	17	16	16	0.7	orange
431-22	Daja 380/B 6708 (OP)	14	11	12	0.5	orange
551-3	B 6708 (OP)//Tainung 27/HDK 8	14	20	17	0.9	orange
479-1	PI 344129/Taiwan 2	14	8	11	2.6	white
590-13	Poly Tainung 57 (1)	13	25	19	1.3	orange
(57)	(Tainung 57), check	3	5	4	3.5	yellow
35-2	HDK 6/B 6708, check	6	11	9	1.4	orange
0122-2	B 6708 (OP), check	6	7	6	2.2	orange

[a] 55 breeding lines from 5 advanced trials planted July 11 and 12, harvested Nov 15-17, 1979, means of 4 replications.
[b] 80 breeding lines from 8 advanced trials planted July 4-5, 1978, harvested November 6-14, 1978, means of 4 replications.

Table 3. Comparison of sweet potato yields after crop durations of four vs five months in summer advanced trials[a], 1979, AVRDC

AVRDC selection or acc. no.	Pedigree or variety	Marketable yields (t/ha) when harvested after 4 months	5 months	Flesh color
0122-2-76	AIS 0122-2 (OP)	10	17	yellow
551-1	B 6708 (OP)//Tainung 27/ HDK 8	15	17	orange
540-7	B 6708 (OP)/PI 308201	15	17	yellow
580-1	Tainung 27/HDK 8// PI 318548	14	17	yellow-orange
551-2	B 6708 (OP)//Tainung 27/ HDK 8	9	16	yellow-orange
595-51	Poly PI 318859	11	16	orange
35-2	HDK 6/B 6708	6	10	orange
0122-2	B 6708 (OP)	10	18	orange
(57)	Tainung 57	7	8	yellow

[a]70 breeding lines from 7 advanced trials planted July 10-12, 1979; harvested November 13-14, 1979 and December 10, 1979, means of 4 replications

periment technique developed in 1974 (AVRDC Annual Report 1974), test lines were planted between heavily-infested rows of a susceptible variety. Only 55 entries surpassed yields of 0.5 kg roots/plot (5m x 1m) in two of three replications. Twenty-four of these rated moderately resistant to weevil according to statistical analyses of 1) the percentage of damaged root and 2) the standard deviation of the mean number of insects per kg root. The second experiment was conducted on Penghu Island in the Taiwan Strait using the 120 entries tested at AVRDC plus 18 accessions acquired during 1978-79. The sweet potato was planted on April 22, 1979, and weevils were released in the experimental area two months later. Of the 138 entries, only 30 yielded enough roots (1 kg per 5m x 1m plot) to give a reliable resistance rating. Eleven entries showed moderate resistance, but only one accession, I 384, was resistant at both Penghu and AVRDC test sites. All of the moderately resistant accessions will be evaluated again in 1980.

Over the past five years, only two AVRDC accessions, I 123 and I 152, have consistently shown moderate resistance at different locations. Both are being used in our breeding program.

Integrated control of sweet potato weevil

An experiment involving crop rotation, resistant varieties, intercropping and insecticides was begun in 1977 in order to evaluate integrated control methods for the sweet potato weevil. In November 1979, a 1 ha field was planted to susceptible accession AIS 35-2 and subsequently inoculated with sweet potato weevils raised in the laboratory. At harvest, the field was entirely infested. In June 1978, the field was divided into six sub-plots, with three planted to AIS 35-2 and the remaining three planted to rice. Although weevils were not introduced, the natural infestation at harvest was even greater than that of the first planting.

The sub-plots were further divided in November 1978 for six sub-treatments consisting of:

1. susceptible variety AIS 35-2
2. moderately resistant variety I 123
3. corn and AIS 35-2 intercropped
4. sugarcane intercrop, planted three weeks prior to sweet potato
5. AIS 35-2 sprayed with methomyl 85 WP at 0.5 kg ai/ha biweekly beginning two weeks after planting
6. AIS 35-2 sprayed with triazophos 40EC at 0.5 kg ai/ha biweekly beginning two weeks after planting

At harvest in April 1979, sweet potato roots in each treatment were evaluated for root damage and yield, and weevil counts in roots and stems.

Crop sequence had no significant effect on root damage or yield, but the weevil population was significantly higher in roots and stems when sweet potato was planted after rice than when planted after sweet potato. There were significant differences between sub-treatments, however, as shown in Table 4. Insecticide spraying greatly reduced weevil damage. These results indicate that if weevils are present, neither rice rotation nor the other treatments in this experiment will prevent infestation.

Varietal screening for sweet potato stemborer

The entire sweet potato germplasm collection was screened on Penghu Island in 1979 for resistance to sweet potato stemborer (*Omphisa illisalis*). Each accession was planted and managed by standard cultural practices, but without the use of insecticides. Twenty-three accessions were highly resistant, 44 moderately resistant, 85 had low resistance and 231 were susceptible. The 23 highly resistant entries will be re-evaluated in a multireplicate test in 1980.

Table 4. Effects of various subtreatments on weevil damage and root yield of sweet potato[1]

Subtreatment	% damaged roots	Root yield t/ha
Susceptible variety (AIS 35-2)	25.4 a	3.5 cd
Resistant variety (I 123)	22.4 ab	6.2 bc
Corn intercropping	21.8 ab	3.8 bcd
Sugarcane intercropping	22.5 ab	2.8 d
Methomyl spraying	13.7 bc	6.8 b
Triazophos spraying	10.2 c	10.0 a

[1]Planted November 9-10, 1978, harvested April 25, 1979. % damage is based on weight of damaged slices (2.5mm thick). Data are means of 6 replications. Means followed by the same letters are not significantly different at 5% level

Chemical control of sweet potato weevil and stemborer

Several insecticides were screened for weevil and stemborer control. Both carbofuran 3G at 2 kg ai/ha applied biweekly, and decamethrin 2.5EC biweekly at 25 g ai/ha, effectively controlled stemborer. Decamethrin, however, caused moderate defoliation, especially during long periods of dry weather. Carbofuran 3G was also effective against the weevil and resulted in the highest yield.

Carbofuran residues in sweet potato stems and roots were analyzed at harvest using gas liquid chromatography. While only 0.06 ppm carbofuran was found in the roots, 1.32 ppm remained in the stems. The high residue of this insecticide in the stems may account for the effective control of stemborer.

Dry matter production and distribution in sweet potato

The seasonal patterns of dry matter production and distribution in sweet potato were studied in 1979. AVRDC selections 0122-2 and 35-2 were grown from March to July (dry season to wet season) and from June to October (wet season to dry season). Although both entries produced more total dry matter in the March planting, both were more efficient at accumulating dry matter in storage roots in the June planting.

Since leaves and stems compete with storage roots for dry matter, the distribution of dry matter appears to be more important for root development than total dry matter contents. By selecting the appropriate planting date and controlling soil temperature and moisture content, it might be possible to influence dry matter production in the roots. It seems more reasonable to study these factors rather than factors which promote maximum dry matter production.

International Cooperation

Tahiti

AVRDC sweet potato entries yielded from 40 to 72 t/ha compared to 19 t/ha from the best local variety. The top three entries were 591-14, 590-13, and 431-12, with yields of 72, 62 and 60 t/ha, respectively. In addition to higher yields, the majority of AVRDC entries are orange-fleshed, a character preferred to the yellow flesh of the local variety.

Bangladesh

In a trial of five AVRDC lines, orange-fleshed selection 0122-2 yielded highest at 21 t/ha, followed by cream-fleshed selections 243-2 at 19 t/ha and 272-9 at 18 t/ha. The red-fleshed local variety yielded only 10 t/ha.

The seasonal response of AVRDC lines was also studied. Most performed well when planted in November or January. In the March planting, only 0122-2 produced a respectable yield of 8 t/ha.

In an evaluation of consumer preferences, AVRDC lines were generally preferred to the local variety. Selection 230 was ranked by 75% of the panel as the best of all entries.

Philippines

A former AVRDC trainee conducted a trial of 10 AVRDC lines and a local check (Dilaw). Selections 551-1 and 548-3 yielded 14.5 and 14.4 t/ha, respectively, while the check yielded only 0.9 t/ha. Selection 548-3 also had the highest vine yield of 27.6 t/ha.

Taiwan

The Taiwan Sugar Research Institute tested nine AVRDC selections in a 124-day crop duration. The top two entries were 243-2-1 at 22.6 t/ha, and 057-4 at 21 t/ha.

Nigeria

A Sweet Potato International Collaborators' Group (SPICG) has been established at the International Institute of Tropical Agriculture in Ibadan. A liaison officer has been appointed for Asia and the Pacific Islands, and AVRDC will be examining ways of improved cooperation with SPICG.

MUNGBEAN

A trainee from Korea conducts powdery mildew resistance screenings

Germplasm collection

The mungbean germplasm collection increased by 59 samples to 4986 in 1979. Seed packets representing 1186 accessions and 1937 breeding lines were distributed. Many went to regular cooperators in Asia, but this year for the first time African scientists in Zambia, Somalia, Uganda, Tanzania and Upper Volta requested mungbean seeds for field trials.

AVRDC scientists made 223 crosses, mostly with AVRDC advanced breeding lines, in which many desirable genes have now been assembled.

Mungbean yields in spring, summer and fall plantings

Scientists assessed the results of a three-year trial which evaluated 10 cultivars from five countries for spring, summer and fall yields (Figure 1). Mean yields of all cultivars over the three years were 1.81, 1.23 and 1.07 t/ha for summer, spring and fall respectively. In summer, mungbean produced more pods per plant and more seeds per pod, but

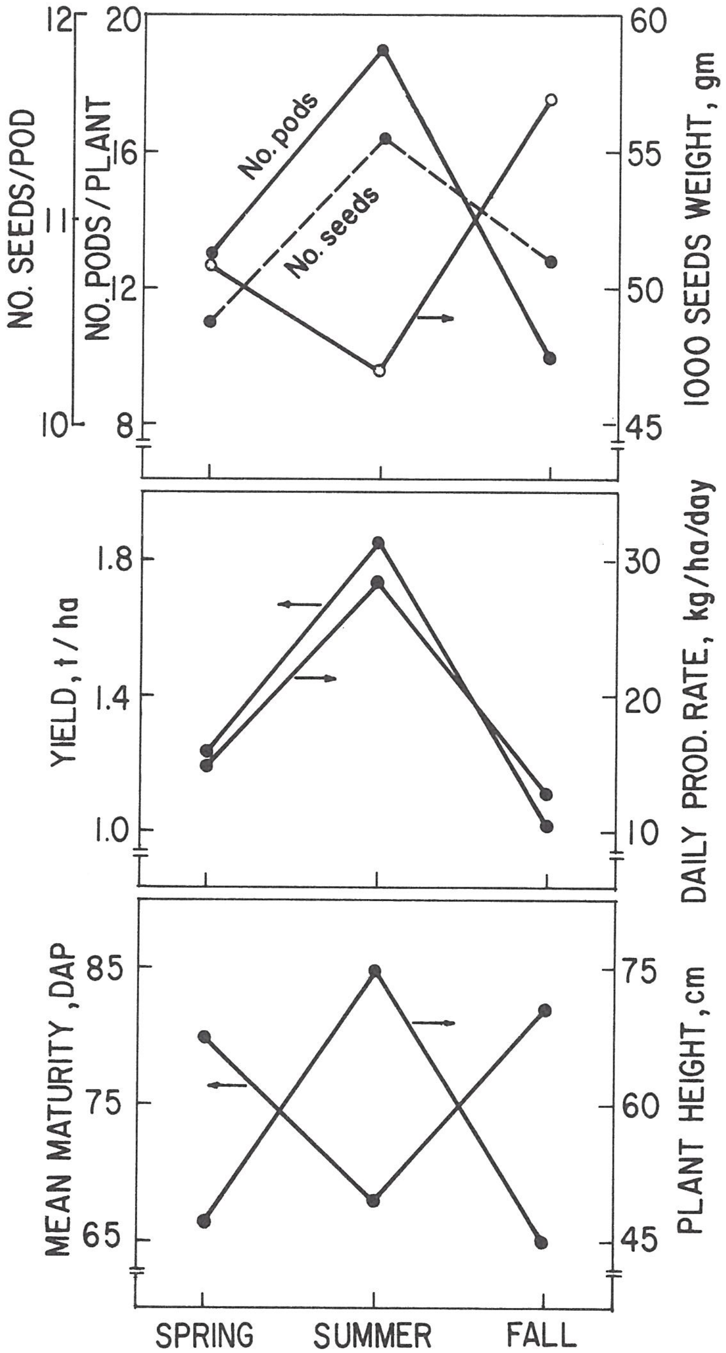


Fig. 1. Average plant and yield characters of 10 mungbean cultivars evaluated over spring, summer and fall, 1976-78, AVRDC

Table 1. Mungbean yield, disease susceptibility, photoperiod sensitivity, and lodging of five selected breeding lines in elite yield trials over three seasons, 1979, AVRDC

AVRDC acc cross #	Pedigree or cultivar name	Yield[a] (t/ha)				Disease[b]		Photoperiod sensitive[c]	Lodging[d] (1-5)
		spring	summer	fall	mean	PM	CLS		
VC1210 Sel A	ML-3/CES 87-17	1.2	2.2	1.3	1.6	R	R	no	2.0
VC1177 Sel A	MG 50-10A(Y)/ML-5	1.3	1.9	1.4	1.5	S	MR	no	2.0
VC1131 Sel A	EG-MG-16/ML-3// EG-MG-16	1.2	2.0	1.4	1.5	MR	R	yes	3.5
VC1168 Sel B	CES 59/ML-5	1.5	1.8	1.2	1.5	S	MS	no	2.0
V 3476 (check)	CES 1D-21	0.9	2.2	1.1	1.4	S	S	no	1.5
	Grand mean	1.0	1.8	1.1					
	LSD (0.05)	0.5	0.2	0.3					
	CV (%)	34	8	20					

[a] Sown February 21, July 13, and September 7. 6-row plots, 6m x 2.4m, 4 replications
[b] Powdery mildew (PM) ratings were taken in spring during a light infestation. *Cercospora* leaf spot (CLS) ratings were taken in summer during a severe infestation. Ratings are means of 2 replications
[c] 16-hour days
[d] Lodging data taken in summer when lodging is normally prevalent. 1=highly resistant to lodging. 5=highly susceptible

seed size was smaller. The study showed that environmental factors caused considerable variation of almost all plant and yield characters. Correlation studies indicated that breeders may not be able to use such characters as selection criteria for high yields.

Performance of 20 elite lines

For the first time AVRDC tested its mungbean breeding lines in disease nurseries to confirm resistance to powdery mildew (*Erysiphe polygoni*) in spring and fall, and to *Cercospora* leafspot (*Cercospora canescens*) in summer. All advanced breeding lines were also tested for sensitivity to photoperiod.

The best 16 advanced lines were evaluated over three seasons against four check cultivars (CES 1D-21, ML-3, M 304 and M 317). Crops on average yielded about 80% more in summer (1.8 t/ha) than in spring (1.0 t/ha) or in fall (1.1 t/ha). Table 1 summarizes yield, reactions to diseases, photoperiod and lodging, of the five best lines. Only check cultivar CES 1D-21 performed relatively well against AVRDC lines. All checks were susceptible to both powdery mildew and *Cercospora* leafspot. Five breeding lines proved highly resistant to one or both diseases. AVRDC uses these lines in the breeding program as a source for disease resistance.

There were clear varietal differences in seasonal adaptation. VC 1177 Sel B and VC 1168 Sel B performed relatively better in the cool season, whereas cultivar CES 1D-21 from the Philippines and breeding line VC 1627 Sel A performed much better under hot summer conditions. VC 1210 Sel A ranked high in all three seasons.

Resistance to rootknot nematode

Over four seasons in 1978 and 1979, 287 accessions and 89 breeding lines were tested for resistance to the rootknot nematode *Meloidogyne incognita*. Accessions V 1133, V 2744 and V 2179 proved to be resistant in two screening trials.

Outcrossing variations

A trial in 1979 showed a much lower rate of mungbean outcrossing (from 0 to 0.75%) than in an identical trial held in 1975 and described in AVRDC's 1975 Mungbean Report (p 15-16). In the earlier trial a 13% rate of outcrossing was reported for one variety (Table 2).

Dominant gene for *Cercospora* resistance

In spite of high levels of *Cercospora* leafspot infection during the summer, accession V 4718 remained highly resistant to the disease. Resistance appears to be controlled by a single dominant gene.

Table 2. Outcrossing incidence of eight mungbean cultivars in 1975 and 1979, AVRDC

AVRDC acc.#	Variety	1975 No. of out-crosses	1975 rate %	1979 No. of out-crosses	1979 rate %
V1387	CES 55	77/596	13	6/797	0.75
V1946	Yellow mungo	16/553	3	0/876	0.00
V2007	M 304	26/927	3	1/819	0.12
V1948	CES 87-17	17/670	3	5/876	0.57
V1944	MG 50-10A(Y)	9/517	2	0/594	0.00
V1327	CY-B-6	23/796	3	NA	
VC1525 Sel A		NA		4/826	0.49

Inheritance of powdery mildew resistance and photoperiod sensitivity

The resistance mechanism in mungbean against powdery mildew is affected by daylength. The disease is more serious under short-day conditions. Under 16-hour days, resistance is controlled by a single dominant factor. The proportion of susceptible F_2 plants increased under 12-hour conditions. A monogenic mechanism was thus ruled out (Table 3). It is not yet known whether daylength affected the resistance mechanism in the host plant, or the pathogenic mechanism in the pathogen, or whether there was interaction between both factors.

Table 3. Inheritance of photoperiod sensitivity and powdery mildew resistance in mungbean during 16-hour days, 1979, AVRDC

Genotype	PM[a] rating: / PP[a] rating:	Resistant / Sensitive	Resistant / Insensitive	Susceptible / Sensitive	Susceptible / Insensitive
V 1400 (P_1)		-	-	-	36
V 4718 (P_2)		28	-	-	-
F_2		277	78	99	38
Expected ratio		9 :	3 :	3 :	1
Chi-square				4.40	
P			0.25	0.01	

[a]PM=powdery mildew, PP=photoperiod
Sown October 4, 1979

In photoperiod tests, all plants of accession V 1400 flowered at about the same time under both 12-hour and 16-hour light exposures, demonstrating that the accession is day-neutral. Under 12-hour light, V 4718 flowered in the same number of days after planting as V 1400, but did not flower under 16-hour exposures. All 645 F_2 plants flowered between 29 and 60 days after planting when exposed to 12 hours of light, while only one-third of 492 F_2 plants flowered (between 40 and 64 days after planting) under 16-hour conditions. This suggests that photoperiod sensitivity is controlled by a single dominant factor. The genetic factors for disease resistance and photoperiod sensitivity are independently inherited. It will not be difficult to combine both characters into one line.

The Korean trainee who undertook the above work later examined 16,382 F_2 plants from 36 different crosses for resistance to powdery mildew under very epiphytotic conditions. The genetic mechanism for powdery mildew resistance proved to be far more complex, and varied with different crosses. VC 1560 A has the most resistant gene(s) followed by VC 1647 A, CES 1D-21 and PHLV 18 in that order. PHLV 18 seemed to have a single dominant susceptible gene.

Inheritance study on leaflet number

Most mungbeans have a trifoliate leaf, but a mutant line (V 5926) from the Philippines Atomic Energy Research Institute has a multifoliate leaf with nine leaflets. AVRDC studies showed that this character is controlled by a single complete recessive gene.

Inheritance study of four characters

The inheritance of various plant characters was studied in a two-year survey. Purple hypocotyl color proved to be dominant over green, lobed leaf-shape over entire, black pod color over tan, and green seedcoat color over yellow. All characters are independently inherited except hypocotyl color and mature pod color, the genes for which are located within 16 crossing-over units on the same chromosome (Table 4).

Intercropping for beanfly control

Accession V 2184 was intercropped with each of 59 different crops in fall trials to test the influence of intercropping on beanfly infestation. Infestations were assessed by counting larvae and pupae. Intercropping significantly reduced infestations when mungbean was grown with muskmelon, soybean, blackgram, pearl millet, watermelon, cantaloupe, ginger, tomato, or a local grass in Taiwan. Intercropping with soybean and watermelon, however, did not significantly reduce plant damage. Further tests are planned using only effective combinations on larger plots and different time intervals for intercropping.

Table 4. Inheritance study of hypocotyl color, leaf shape, ripe-pod color and seed-coat color in mungbean, 1978-79, AVRDC

Genotype	Hypocotyl color		Leaf shape		Ripe-pod color		Seed-coat color	
	Purple	green	lobed	entired	black	tan	green	yellow
	no. of plants							
V 1329 (P_1)	90	0	90	0	90	0	90	0
VC 1525 A (P_2)	0	80	0	80	0	80	0	80
F_1	85	0	85	0	85	0	85	0
F_2	972	378	1054	296	989	361	1022	328
BC ($P_2 x F_1$)	70	62	71	61	69	63	59	73
	P value							
F_2 (3:1)	0.02-0.01		0.01-0.001		0.21-0.10		0.70-0.50	
BC (1:1)	0.50-0.30		0.50-0.30		0.70-0.50		0.30-0.20	

Sown September 18, 1978

Podborer resistance screening

Ninety-nine accessions which had suffered the least damage in 1978 trials were tested again in spring in replicated trials at AVRDC and Pingtung for resistance to podborer, mainly *Maruca testulalis*. The 11 most promising varieties were screened further at AVRDC and four of these (V 2109, V 4270, V 2106 and V 2135) emerged with significantly less damage. V 2135 appears especially promising.

Chemical control of beanfly

The best beanfly control and highest yields were obtained by spraying omethoate at 0.5 kg ai/ha at 3, 10, 17, 24 and 31 days after emergence. Omethoate 50EC was shown in 1978 to be as effective for beanfly control as monocrotophos 60EC, the standard compound used at AVRDC.

Repeated legume cropping and mungbean yields

A dry season trial showed that yield and pod numbers are significantly reduced in a second crop of mungbean. Total dry matter also tends to be lower. Compared with planting mungbean after fallow, seed yield reduction can be as high as 60% (Table 5), but is less pronounced in the wet season. However, a soybean crop in the wet season appears to be particularly detrimental to a succeeding mungbean planting (Table 6).

Table 5. Effect of previous mungbean crop (V 2184) on growth, yield and yield components of mungbean, 1979, AVRDC

Entries	Previous crop[z]	Dry weight (g/plant)	Yield (t/ha)	No. pods /m^2	No. seeds /pod	100-seed wt. (g)
VC 1000-45-0-10	F	11.6 ± 2.3	1.11 ± 0.31	250	10.6 ± 0.4	5.0
	M	8.4 ± 2.6	0.45 ± 0.19	130	10.1 ± 0.3	4.7
V 1381	F	12.1 ± 2.4	1.08 ± 0.06	260	10.3 ± 0.4	4.4
	M	8.2 ± 2	0.61 ± 0.27	160	11.2 ± 0.1	4.6
V 2013	F	10.7 ± 1.3	0.92 ± 0.13	200	13.7 ± 0.8	5.4
	M	10.8 ± 2.0	0.67 ± 0.10	160	12.0 ± 0.7	4.6
V 2184	F	9.1 ± 0.3	0.74 ± 0.12	200	11.7 ± 0.2	6.0
	M	8.9 ± 2.1	0.53 ± 0.04	120	11.0 ± 0.3	5.7
V 2272	F	9.0 ± 0.4	1.29 ± 0.27	300	11.3 ± 0.3	4.2
	M	8.3 ± 2.4	0.55 ± 0.09	150	10.7 ± 0.5	4.0
V 3096	F	5.5 ± 0.7	0.68 ± 0.13	210	10.9 ± 0.2	4.0
	M	6.6 ± 0.4	0.75 ± 0.11	180	12.3 ± 0.3	4.4

[z]F = fallow, M = mungbean

Table 6. Effect of previous crops on growth, yield and yield components of mungbean, 1979,AVRDC

Entries	Previous crop[z]	Dry weight (g/plant)	Yield (t/ha)	No. pods /m^2	No. seeds /pod	100-seed wt. (g)
	F	14.3 ± 1.5	0.99 ± 0.07	240	14	4.1
V 2013	M	12.8 ± 2.5	0.99 ± 0.15	260	13	4.2
	S	9.0 ± 0.2	0.71 ± 0.07	140	14	4.0
	F	14.3 ± 1.5	0.99 ± 0.07	210	13	5.9
V 2184	M	12.7 ± 0.6	1.03 ± 0.01	210	11	5.7
	S	9.5 ± 0.3	0.73 ± 0.03	150	11	5.9
	F	10.8 ± 0.5	0.63 ± 0.08	150	13	3.5
V 3069	M	9.9 ± 1.1	0.60 ± 0.06	170	13	3.3
	S	8.8 ± 1.4	0.69 ± 0.12	180	12	3.0

[z]F = fallow, M = mungbean, S = soybean

There is a 30% reduction in seed yield under these circumstances, compared to yields obtained from mungbean grown on fallow. These effects are subject to varietal differences, however. Low yielding V 3096 tended to be less affected. The causes of the phenomenon are as yet unclear, but successive mungbean crops should be avoided in intensive rotations.

International mungbean nursery

AVRDC received data from 35 trials of mungbean materials tested in the 7th International Mungbean Nursery (IMN), an 80% return. Varietal differences in yield were highly significant at most locations. Entries from the IMN outyielded local checks everywhere except in Bangladesh, where mungbean yellow mosaic virus (MYMV) virtually wiped out all genotypes from areas where the disease is not endemic.

Significant varietal differences are apparent when yields are averaged from all locations. The average yield of all 20 cultivars taken together differed significantly from location to location. Three out of the five highest yielding genotypes were AVRDC breeding lines, indicating their wide adaptability (Table 7). Despite this, it appears that average mungbean yield is decreased by 210 kg/ha for every 10° latitude from the Equator (Figure 2). Mungbean thrives in hot weather, but even under tropical conditions, yield potential can be severely limited by factors such as drought and disease.

The highest yield of mungbean recorded was 2369 kg/ha by PHLV 18 (V 2184) in Thirunelvely, Sri Lanka. The average yield of 22 entries at that station (including two local checks) was 2060 kg/ha.

Table 7. Average yield of five cultivars at 34 locations in the 7th International Mungbean Nursery, 1978-79

AVRDC acc. or cross #	Variety or pedigree	Origin	Yield (t/ha)	Rank	Frequency[a] 1st	2nd
VC1089 Sel A	ML-3 x Ph. Coll 1	Taiwan(AVRDC)	0.87	1	3	4
V 3476	CES 1D-21	Phil	0.87	2	3	4
VC1163 Sel A	EG-MG-4 x ML-6	Taiwan(AVRDC)	0.83	3	2	2
VC1209 Sel A	ML-3 x CES 55	Taiwan(AVRDC)	0.82	4	1	2
V 2773	ML-3	India	0.80	5	3	4

4-row plot, 6m x 1.6m or 2.4m, 3 replications
[a]Number of times the cultivar ranked 1st or 2nd in yield over 34 locations

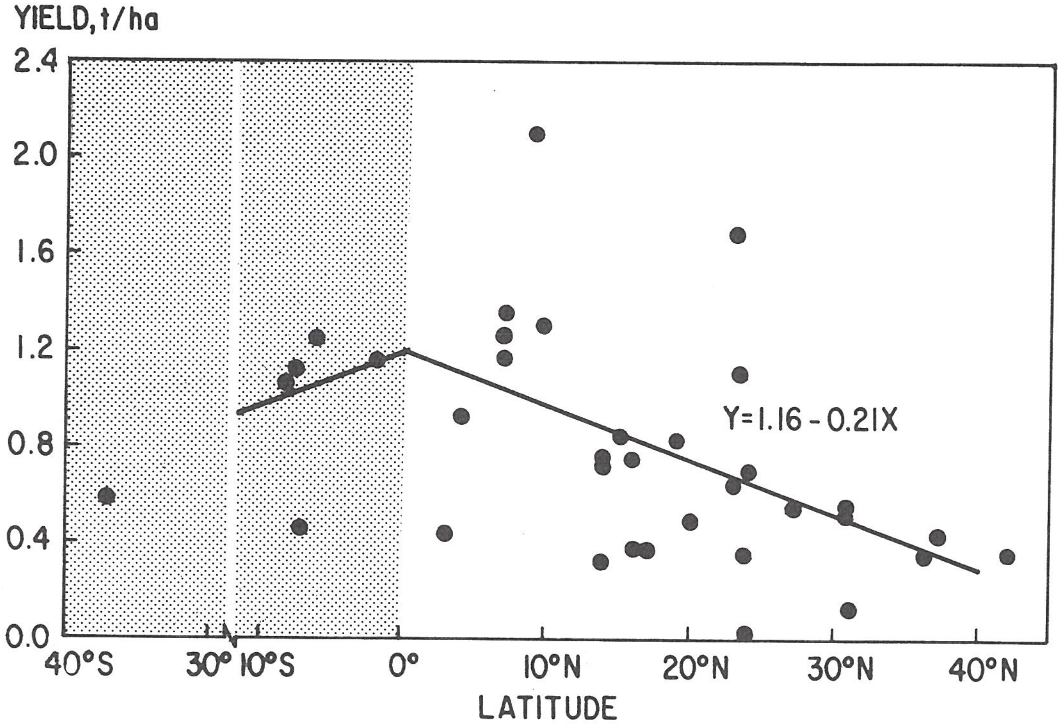


Fig. 2. Correlation of mungbean yields with latitudes of 35 locations in the 7th International Mungbean Nursery, 1978

Daylength and temperature had a strong influence on the number of days to flowering. In near-tropical lowland, varietal differences in this character were very small and most genotypes flowered within 30 to 40 days. Days to flowering increased with distance from the Equator, and was highest in Canada and New Zealand. Low temperatures during the first five weeks of plant growth also delayed flowering. Long-day conditions and/or low temperature usually accentuated varietal differences.

AVRDC coordinated the 8th IMN in 1979, distributing 38 sets of entries. Data were returned from nine trials by the end of the year. Four of the six best yielding entries are AVRDC breeding lines. However, drought and a severe infestation of MYMV caused low yields in Bangladesh, and low temperatures had the same effect in Nepal and Canada.

New mungbean lines were collected from national yield trials in the Philippines, Thailand, India, Korea and ROC and assessed at AVRDC for a minimum of two seasons. The best entries will be included in future IMNs.

International Cooperation

A total of 223 AVRDC advanced mungbean lines complete with breeding records were sent to enrich breeding programs in Korea, the Philippines, Indonesia, Thailand and Canada.

Taiwan

Six R.O.C. District Agricultural Improvement Stations (DAIS) and AVRDC participated in regional mungbean yield trials. Eight trials returned data by the end of the year, and the top four entries represented AVRDC breeding lines. AVRDC recommends that mungbean be planted in the warmer months. Hsinchu DAIS and Hwalien DAIS took this advice and their average yields were the first and second highest of all seven trials.

Korea

Nine Korean institutes representing the country participated in mungbean regional trials coordinated by AVRDC. Korean authorities have since released one line in 1980, and have requested seed multiplication of CES 1D-21 (V 3467) at AVRDC.

Philippines

The Economic Garden at Los Baños selected 249 individual plants and 43 lines from AVRDC advanced mungbean breeding lines, which were adapted to local climatic conditions.

AVRDC lines ML-3, VC 1209 Sel A, VC 1000 Sel A and ML-5 outyielded local check CES ID-21 by about 80% at Central Luzon State University. These successful lines will be tested in the barrios around CLSU in 1980.

Thailand

Thai scientists have identified promising new mungbean varieties selected from AVRDC breeding materials. This follows a rigorous single plant selection by the Department of Agriculture, in which selected lines were compared with local cultivars first at chosen locations in both wet and dry seasons, and later in regional yield trials.

At Chiang Mai, the Thai-Australia Land Development Program found that three AVRDC breeding lines from the 7th IMN (VC 1163-2-2-6-2B, VC 1168-2B-7-2B and VC 1209-3-B-1-2B) performed well. These will be evaluated further.

Sri Lanka

Three AVRDC mungbean accessions (V 3484, V 3476 and V 3404) and two AVRDC lines (VC 1168-2B-7-2B and VC 1209-3-B-1-2B) appeared resistant to charcoal rot caused by *Macrophomina phascolina* when tested at Thirunelvely during a particularly serious outbreak in May and June.

New Zealand

Two lines from the AVRDC-coordinated 7th IMN are to be evaluated further after yielding 1.90 t/ha (Kyunggi Jaerae 5 from Korea) and 1.75 t/ha (Oklahoma 12 from the USA). Most of the other entries performed poorly because of low temperatures, with an average yield of only 0.58 t/ha from the 20 entries.

Bangladesh

An unprecedented drought in April and May resulted in extremely low average mungbean yields from the 8th IMN when tested by the Institute of Nuclear Agriculture at Mymensingh. Twenty-two entries and two local checks yielded an average of only 0.22 t/ha. However cultivar V 3484 from Pakistan where it is known as 6601 proved highly tolerant to drought and yielded 1.09 t/ha. The Bangladesh trials, and others in India and Pakistan, show it to be resistant to MYMV.

Tanzania

Five mungbean cultivars sent by AVRDC produced more than 2 t/ha. Reports indicate that mungbean scab caused by *Elsinoe* ssp is serious in Tanzania. Of eighteen lines supplied by AVRDC, Utong 1 and PHLV 18 slightly outyielded the best of seven local checks in trials at four Tanzanian locations.

Canada

Canadian scientists are to test five AVRDC lines selected from a total of 223 in 1980 preliminary yield trials conducted by the King Grain Seed Company in Chatham, Ontario. AVRDC has been asked to advance generations of two breeding lines (AVRDC's 3092 and Canadian cultivar King Mung 1, a possible selection from Tainan 1) which have performed well under cool Canadian conditions.

India

Two AVRDC lines from the 7th IMN outyielded the best local check at Orissa, India and will be evaluated further. One other cultivar from the 7th IMN (V 3484 from Pakistan) outyielded all local checks and appeared to be resistant to MYMV in trials at the Indian Agricultural Research Institute in New Delhi. Its plant type is ideal for Indian conditions, and it will be included in the All-India Coordinated Varietal Trial. AVRDC's ML-5 also performed well. Indian scientists noted that the plant appears quite different from the original ML-5 from Punjab Agricultural University.

Table 8. Screening results of 2028 mungbean germplasm against mungbean yellow mosaic virus (MYMV), leaf crinkle virus (LCV) and *Cercospora* leaf spot (CLS) at Punjab Agricultural University, India, 1978

Disease[a]	MYMV		LCV		CLS	
rating	# of lines	%	# of lines	%	# of lines	%
0	0	0	3	0.2	0	0
1	0	0	20	1.0	3	0.2
2	3	0.2	23	1.1	14	0.7
3	8	0.4	35	1.7	42	2.1
4	12	0.6	168	8.3	58	2.9
5	25	1.2	163	8.0	125	6.2
6	49	2.4	322	15.9	326	16.1
7	206	10.2	339	16.7	538	26.5
8	537	26.5	257	12.7	541	26.7
9	779	38.4	269	13.3	312	15.4
10	409	20.2	429	21.2	69	3.4
Total	2028	100	2028	100	2028	100

Sown July, 1978. The incidences of diseases, particularly MYMV, were very heavy.
[a]0 = resistant, 10 = susceptible

Accessions V3417 and V4483 proved to be resistant to mungbean yellow mosaic virus (MYMV), *Cercospora* leafspot (CLS) and leaf crinkle virus (LCV) under very heavy epiphytotic conditions. The Punjab Agricultural University screened 2030 AVRDC mungbean accessions in the tests (Table 8).

AVRDC mungbean breeder Dr H. Park stands with cooperators from Punjab Agricultural University, participants in the 7th IMN. These scientists also evaluate AVRDC mungbean germplasm for resistance to mungbean yellow mosaic virus, a destructive disease throughout South Asia.

A trainee from the Netherlands works on a soybean project.

SOYBEAN

Germplasm collection

The addition of 31 new accessions from the USA, Zimbabwe (Rhodesia), Indonesia and the FAO brought the total soybean germplasm collection to 9147. The Korean Atomic Energy Research Institute (KAERI) sent a repeat shipment of 299 cultivars which failed to germinate last year. Only 35 of the new shipment failed to germinate. Nearly 200 cultivars showed severe virus symptoms and these were discarded.

The University of Illinois supplied five wild *Glycine* species and these were evaluated in greenhouse tests at AVRDC. One of them, *G. falcata* (PI 233139) produced pods both above ground and in the soil. Such underground pods contained single seeds. A similar phenomenon is also reported from Japan in the genus *Amphicarpaea*, known as 'yabumame' in Japanese.

AVRDC scientists made 230 crosses from 45 parents to combine a wide variety of agronomic characters. Specific backcrosses to incorporate photoperiod insensitivity and soybean rust resistance have also been made.

Early maturity and high yield combined

Forty-one F_8 and F_9 breeding lines were evaluated for yield, disease resistance and adaptability in the spring, summer and autumn. AVRDC selection AGS 66 gave the highest yield of 3246 kg/ha in just 98 days in spring and also proved resistant to bacterial pustule (*Xanthomonas phaseoli* var *sojensis* (Hedges) Starv and Burkh). Seed quality was as good as local check Shih Shih which gave 2845 kg/ha in 98 days. AGS 62 was also outstanding, yielding 2948 kg/ha in 97 days, thus confirming the promise it showed in the previous year's preliminary yield trials. It also yielded highest (2610 kg/ha) and matured earliest (94 days) in the summer trial. It yielded 75% more than Shih Shih in this trial, and AGS 71, AGS 59 and AGS 66 also easily outyielded the check, by 74%, 70% and 57% respectively.

As observed in previous years, autumn yields were lower than those of spring and summer. The highest yielding selection was AGS 108 with 2089 kg/ha in 88 days. AGS 116, AGS 105, and AGS 110 all yielded over 2000 kg/ha.

Early-maturing selections for spring and summer

Broad-leafed selection AGS 66 and narrow-leafed AGS 62 matured on average at 96 days and gave the highest mean yield of about 2800 kg/ha when spring and summer seasons were taken together (Table 1). These yields are 29% higher than early maturing local cultivar Shih Shih and 23% higher than late maturing improved cultivar Kaohsiung No. 3. AGS 66 and AGS 62 have both been accepted into INTSOY's SIEVE trial in the United States, and into the R.O.C.'s national soybean program for regional trials. Multilocational trials will be held with both varieties in the Chianan area in 1980.

Table 1. Early-maturing and high-yielding selections of soybean for spring and summer seasons from advanced yield trials, 1979, AVRDC

Selection no.	Parents	Yield (kg/ha)	Index	Yield/day (kg/ha)	Days to maturity
AGS 66	Forrest x Shih Shih	2792	129	29	96
AGS 62[1]	SRF 400 x PI 297550	2779	128	29	96
	Shih Shih	2167	100	22	98
	Kaohsiung No. 3	2289	106	23	101
	Mean	2434	112	24	102

[1]Narrow-leaved line

Table 2. Promising breeding lines from spring preliminary yield trials[a], 1979, AVRDC

Cross no.	Parents	DF[b]	DM[c]	Yield (kg/ha)	Index	Yield/day (kg/ha)	SQ[d]
GC 50232-2-19	PI 153262/PI 200492	50	108	4385	145	41	3.0
GC 40359-1-104-8	SRF 400/PI 297550	44	102	4136	137	41	3.0
GC 30229-8-7	SRF 400/Shih Shih	44	107	4062	135	38	4.0
GC 50268-1-13	Shih Shih/PI 194647// Shih Shih	50	105	3967	131	38	2.5
GC 40359-1-110-8	SRF 400/PI 297550	44	100	3745	124	37	2.0
GC 50106-4-33	PI 194647/G 2120	44	97	3270	108	34	3.0
Shih Shih (check)		44	95	3020	100	32	1.5
Kaohsiung No. 3 (check)		46	104	3277	109	31	4.0
Mean		48	105	3072	102	29	3.2
C.V.		3	4	11	-	11	30
LSD .05		2.8	8.8	695	-	6.7	1.9

[a] 174 lines sown February 20, 1979
[b] Days to flowering
[c] Days to maturity
[d] Seed quality, 1=good, 5=poor

Preliminary and intermediate yield trials

Three preliminary yield trial entries yielded more than 4000 kg/ha in the spring season (Table 2). These entries yielded from 7% to 45% higher than check Shih Shih. In the summer, three narrow-leaved lines far outyielded check cultivar Kaohsiung No. 3 by 46% or more with yields of more than 2700 kg/ha. The same three were also high yielders in the spring.

Three entries in the spring intermediate yield trial produced 4000 kg/ha or more compared with 2835 kg/ha from check cultivar Shih Shih (Table 3). The highest yield in the summer trial was 3600 kg/ha from GC 30243-10-38, followed by 3023 kg/ha from GC 40359-1-51 and 2964 kg/ha from GC 40359-1-103. The latter two are narrow-leaved lines which consistently yielded higher than broad-leaved lines. Almost all the selected lines were resistant to bacterial pustule.

A total of 8707 bulk populations, pedigrees and germplasms were evaluated for yield, disease resistance, early maturity, seed quality, adaptablity and other desirable agronomic characters.

Table 3. Promising breeding lines from spring intermediate yield trials[a], 1979, AVRDC

Cross no.	Parent	DF[b]	DM[c]	Yield (kg/ha)	Index	Yield/day (kg/ha)	SQ[d]
GC 30104-2-56	Tainung No.4/Yagi I	48	107	4361	153	41	2.5
GC 30104-2-66	Tainung No.4/Yagi I	47	107	4038	142	38	1.5
GC 30251-10-43	Clark 63/64-4	50	107	4017	142	38	1.5
GC 40142-0-94	CH #3/PI 297550	49	99	3192	113	32	2.0
GC 40142-0-57	CH #3/PI 297550	42	96	3049	108	32	1.0
Shih Shih (check)		45	101	2835	100	28	1.2
Kaohsiung No. 3 (check)		46	103	3050	108	29	2.7
Mean		46	103	3100	109	30	2.4
CV		4	4	10	-	10	34
LSD .05		4	7	598	-	6	1.6

[a] 179 lines sown February 16, 1979
[b] Days to flowering
[c] Days to maturity
[d] Seed quality, 1=good, 5=poor

Day-neutral soybean flowering

Tests with day-neutral accession G 215 and photoperiod-sensitive accession G2120 showed that the day-neutral accessions flowered when stripped of all but cotyledonary and unifoliolate leaves. This is the first time this phenomenon has been recorded. The photoperiod-sensitive soybean required trifoliolates to reach flowering. If this phenomenon is unique to day-neutral soybeans, it could be used as an indicator of photoperiodic response, and time-consuming screening under different photoperiod regimes could be avoided.

Beanfly resistance inheritance

A new technique developed at AVRDC now allows researchers to dissect a plant part affected by beanfly without killing the plant. The plant is stimulated to produce two lateral branches by cutting off the growing point. One of these branches can then be dissected for beanfly studies, and the plant, if not too badly damaged, will normally survive to seed harvest. An F_3 bulked population of a cross between G 2120 and G 3080 (a source of moderate resistance to beanfly) was screened with this technique. Of 351 seedlings planted in spring (normally a period of low beanfly infestation), 261 escaped damage. But when seeds of these 261 plants were grown in the fall (when beanfly is more common), only 22 plants escaped damage.

Soybean stem diameter and beanfly infestation

There appears to be no significant correlation between soybean stem diameter and beanfly infestation, according to AVRDC fall trials.

Intercropping soybean for beanfly control

Soybean intercropped with ricebean, jute, okra, pearl millet, cowpea or tomato had significantly fewer beanflies (at the 5% level) than the non-intercropped control. Smaller infestations were also achieved by planting soybean between two rows of four-week-old mungbean plants. Tomato intercropping gave the best results. Based on the percentage of damaged plants, however, there was no significant difference between the treatments. This percentage ranged from 92 to 100%.

Varietal resistance to podborer

Five AVRDC accessions of 3298 tested were significantly less damaged than others when screened for the third time for podborer resistance. Previous screenings against podborer (mainly *Etiella zinckenella*) were in replicated trials at AVRDC and at Kaohsiung DAIS, Pingtung. The five most resistant accessions were G 3473, G 2102, G 3818, G 3517 and G 2105.

In spring, another 1687 accessions previously untested for podborer resistance were screened in a non-replicated mass trial. Seventy-nine of the most resistant were re-screened in a fall replicated trial, from which 13 moderately resistant accessions were selected.

Greenbeetle infestation

AVRDC experiments suggest that greenbeetle (*Anomala* sp) is not a serious threat to soybean. Greenbeetles appear to prefer the adult plant, and since soybean develops more foliage than it needs in early growth stages, it is tolerant to quite heavy infestations at maturity. Experiments in greenhouse and field suggest that the reason greenbeetles prefer older soybean is their need for shade. The pest is less important during the fall season.

Carbofuran in acidic and alkaline soil

AVRDC tests show that carbofuran is less effective on beanfly in alkaline soil. This was established in a pot culture experiment with mungbean and soybean using laterite soil (pH 4.3) from Taichung and alluvial alkaline soil (pH 8.1) from AVRDC (Table 4). Carbofuran probably breaks down more quickly in AVRDC soil, since organophosphorus and carbamate insecticides (like carbofuran) are known to be unstable under alkaline conditions.

Seed treatment with carbofuran 30ST proved to be less effective for beanfly control on mungbean for the first six weeks after planting in al-

Table 4. Effectiveness of carbofuran in acidic and alkaline soil for beanfly control on soybean and mungbean, 1979, AVRDC[1]

Soil type	No. beanfly maggots and pupae /10 plants		% damaged plants	
	10/22	11/5	10/22	11/5
		Soybean		
Laterite acidic	0	1.0	5.0	10.0
Alluvial alkaline	0.3	1.3	7.5	55.0**
		Mungbean		
Laterite acidic	0	0	0	7.5
Alluvial alkaline	0	1.0*	2.5	37.5*

[1]Sown September 25, 1979. Data are means of 3 replications
*Significant at 5% level
**Significant at 1% level

kaline soil than in acidic soil. In soybean, no such soil difference was evident, although plant damage in alkaline soils over the first six weeks' observation was slightly higher than in acidic soils.

Taken together these results indicate that in acidic soil, carbofuran and other systemic organophosphorus or carbamate insecticides are likely to be more effective against beanfly than in alkaline soil.

In a related study, the effects of carbofuran seed treatment on nodulation in soybean were investigated. In all treatments the nodule dry weight of plants grown from treated seeds was greater than in the control. This may have been because carbofuran controlled the beanflies and allowed the plants to grow vigorously, thus stimulating nodule growth.

Chemical control of beanflies

Omethoate sprayed twice a week for the first three weeks after planting gave the best beanfly control and improved yields in an insecticide application timing experiment. Carbofuran seed treatment was also tested in related experiments. Tests confirmed earlier findings that carbofuran provided protection for three weeks, but reduced seed germination and thus plant stand and yield. AVRDC tested other insecticides as replacements for omethoate and azodrin, in the event of developing beanfly resistance. Chlorpyrifos 40EC sprayed at 5 kg ai/ha at 3, 7, 14, 21 and 28 days after germination was as effective as omethoate, but reduced yields.

Characterization of resistance to soybean rust

Dr K. R. Bromfield and colleagues at the Plant Disease Research Laboratory of the USDA at Maryland have described two different kinds of lesion caused by soybean rust as RB and Tan. Infection of the moderately resistant accessions G 8586 (PI 230970) and G 8587 (PI 230971) by *Phakopsora pachyrhizi* results in the RB type of lesion, which is reddish brown and characterized by rapid necrosis and a small number of uredia. Tan type lesions occur on more susceptible cultivars and are characterized by slow necrosis, abundant uredia, and a tan color, especially two to three weeks after infection. Results from inoculation tests at AVRDC of progeny from crosses between parentals G 8586 and G 8587 and susceptible parents show that the RB lesion character is dominant and appears to occur in a 3:1 ratio to the Tan lesion character. The RB character is apparently the result of a single dominant gene. The appearance of Tan lesions on G 8586, G 8587 and progeny involving these parents indicates the appearance of a new race of *P. pachyrhizi* to which G 8586 and G 8587 are more susceptible. Frequency of Tan lesions on the previously moderately resistant accessions has increased rapidly with time. The appearance of this new race of the pathogen means that the RB character is of questionable value for determining resistance to *P. pachyrhizi*. This had previously been considered a useful indicator.

Table 5. Soybean rust progress and soybean yields of 10 moderately resistant accessions, spring 1979, AVRDC

Acc. No.	Percent affected foliage			Harvested	Yield (kg/ha)	100-seed weight(g)
	5/18	5/25	6/1			
G4919	2	10	M[a]	5/29	1413	26.4
G5095	0.001	1	M	5/29	1171	44.1
G6154	0.001	2	M	5/29	440	18.8
G5524	0.01	2	M	5/29	1424	22.8
G5525	0.1	3	M	5/25	1449	19.0
G5554	0.1	2	M	5/25	950	16.5
G5422	0.001	5	M	6/6	2272	26.3
G5497	1	5	M	5/29	720	19.7
G8586[b]	0.001	0.01	25	6/29	2039	16.7
G8587[b]	0.001	0.01	25	6/29	2251	21.4
TK-5[c]	60	98	M	5/29	1718	14.7

[a]Mature [b]Moderately resistant in previous screenings
[c]Taita Kaohsiung No. 5, susceptible check

Resistance to soybean rust

A total of 674 soybean accessions were evaluated in spring and another 230 in fall for resistance to soybean rust (*Phakopsora pachyrizi*) under epiphytotic conditions. Cultivars Taita Kaohsiung No. 5 and Shih Shih were the susceptible checks, and rust reactions were evaluated according to the IWGSR rating system. Twenty accessions, most of them wild relatives of soybean, rated resistant in the spring trial when flowering was delayed. Nine of the most resistant were retested in the fall, but all rated susceptible this time. Similar results have been observed in other wild soybean relatives and collateral hosts of soybean rust. It appears that such plants are either immune to rust or allow it only very limited development before flowering and seed production, but become susceptible thereafter.

Twenty accessions and 10 breeding lines identified as moderately resistant in earlier evaluations were selected for an advanced rust resistance test. Seven progeny of two breeding lines, GC 60037 (UPSL-85/G 8587) and GC 60005 (Shih Shih/G 8586), were more resistant than parent material, while eight accessions (Table 5) were more resistant to rust and matured earlier than accessions G 8586 and G 8587, previously identified as moderately resistant.

Host range of soybean rust

Eleven new collateral hosts of rust from nine different genera were tentatively identified in AVRDC trials which tested 122 legume species from 45 genera. Several of the species are cultivated in either Asia or North America. Tests will continue in order to confirm the presence of rust, and further host range studies are planned. Worldwide research efforts have so far identified 50 collateral hosts of rust which could serve as sources of primary inoculum for soybean.

Soybean rust epidemiology

Three susceptible cultivars (Taita Kaohsiung No. 5, Tainung No. 4 and Shih Shih (G-38)) and one moderately resistant cultivar (PI 230971(G-8587)) were used in these experiments. The experiments were conducted at AVRDC and four other locations in Taiwan over spring, summer and fall to determine disease progress under different environmental conditions.

Disease progress curves for the experiments at AVRDC indicate that rust development is similar in the susceptible cultivars, but is delayed three to four weeks in G 8587. This delay could be associated with the later maturity of G 8587 (two to four weeks after that of the susceptible cultivars) but is most likely an expression of its resistance. Several progeny of crosses between G 8586 or G 8587 (late maturity, moderate resistance) and UPSL-85 or Shih Shih (early maturity, susceptible) confirm this resistance, showing levels of resistance higher than either parent and earlier maturity than G 8586 or G 8587. The apparent delay in rust development in G 8587 is probably the result of a reduction in the rate of disease development, a characteristic of general disease resistance.

Disease development varied with cultivar environment and treatment (with or without fungicide) and interactions between these variables are implicated. At AVRDC, fungicide protection reduced final disease severity in all cultivars; however, the effectiveness of the fungicide treatment varied with the season and variety. Generally, fungicide protection reduced the rate of rust development in the spring and fall seasons. During the summer, however, the rate was only appreciably reduced early in the season when light precipitation allowed greater fungicide persistence.

Rust development in the three susceptible cultivars was similar within each of the three plantings with the exception of Tainung No. 4 in the summer planting when rust development was slow on this cultivar. However, rust development varied between plantings. The most rapid development in all cultivars occurred in the fall planting, but during the spring and summer plantings, an environment x variety interaction was observed. Rust development in Taita Kaohsiung No. 5 and Shih Shih is similar, more rapid in summer than spring; however, rust development in Tainung No. 4 and G 8587 is more rapid in spring than summer. The greatest variation in the rate of rust development occurred in G 8587 with the highest level of resistance occurring during the summer when fungicide effectiveness is lowest.

Variations in total yield, 100-seed weight and days to maturity were observed with cultivars, treatments and environments. The maturity of cultivars varied the least within the fall planting, maturing earlier than the other seasons. Among the cultivars, the maturity of Shih Shih was least affected by either environment or soybean rust infection. Yield reduction due to rust was least in the fall planting even though disease development was most severe, and greatest in the summer planting, indicating an environment x disease development interaction with respect to yield loss. In Tainung No. 4 and G 8587 during the summer, rust development was slowest and yet yield reductions were greatest. The prediction of yield loss from disease severity data should be avoided until sufficient data for each season and cultivar have been compiled.

Screening for resistance to rootknot nematode

Five accessions and seven breeding lines were consistently resistant or highly resistant to rootknot nematode (*Meloidogyne hapla*) after three screenings in various seasons between spring 1978 and fall 1979. A total of 78 accessions and 151 breeding lines were tested.

Fungicide evaluation for soybean rust control

In spring fungicide trials, BASF 42100F provided the best rust control on Taita Kaohsiung No. 5 plants, followed by Baycor 25 WP. Significantly less disease developed in these treatments compared with Dithane M-45, but the differences in yield were not significant. Seed weight was also highest in the BASF 42100F-treated plot.

In the fall test, BASF 42100F did not perform well because it was not applied until after rust symptoms had appeared. Disease incidence varied significantly in this trial (from 0.1% to 95%) but the number of pods or seeds per plant did not. There were no significant differences between yield and final disease severity when testing Baycor 25 WP, Dithane M-45 or RH-2161, a fungicide tested at AVRDC for the first time.

International Cooperation

Seventy scientists from 28 countries received 580 accessions and 1179 breeding lines from AVRDC for evaluation and direct use in their programs.

Bangladesh

In an observation trial at Noakhali, two breeding lines from AVRDC proved superior to check cultivar Bragg in seed quality, disease resistance and yield. In a late season observation trial, two other AVRDC lines matured earlier than Bragg, yielded 39% higher (1550 kg/ha vs 1250 kg/ha) and were virtually free of disease.

In another trial, AVRDC lines outyielded Bragg by between 40% and 121%, and seed quality and virus resistance ratings were excellent. GC 30255-1-4 and GC 40545-0-6 were outstanding, with yields of 2640 kg/ha and 2210 kg/ha respectively. Bragg yielded 1190 kg/ha.

Honduras

AVRDC line GC 30251-1-1 was selected for inclusion in regional yield trials after an outstanding performance in trials which evaluated 84 breeding lines for high yield, seed size, and resistance to shattering and bacterial pustule. It yielded 2741 kg/ha while the local check Siasta 194 gave 2406 kg/ha. Another AVRDC line, GC 50136-8-8, gave 3062 kg/ha.

Indonesia

The Republic of China's Agricultural Technical Mission to Indonesia evaluated AVRDC's pure line selection G 2120 and found that as a monoculture it yielded 58% higher and matured four days earlier than the local cultivar (Table 6). It is a small-seeded cultivar, and the local people prefer this character. It is also comparatively tolerant of stem miner attack. The variety also proved highly successful in intercropping trials with sugarcane at Desa Menang, in Pagu Kediri, East Java. G 2120 is currently being evaluated in replicated trials at several sites in East Java, and the Mission is to multiply G 2120 seeds on three hectares.

Table 6. Assessment of two promising soybean cultivars, 1979, Desa Bulupasar, Indonesia

Cultivar	DM[1]	Yield (kg/ha)	Index	Yield/day (kg/ha)	100 SW[2] (g)
G 2120	91	2321	158	26	9.5
No. 1340	94	2160	147	23	15.1
Local check	95	1465	100	15	11.2

Planted March 16, 1979 in 20 m^2 plots with 35cm x 20cm spacings and 2 seeds/hill; 3 replications

[1]Days to maturity

[2]Seed weight

International soybean program (INTSOY), USA

G 2120 performed well in INTSOY trials in Puerto Rico, and in subsequent selected pedigree observational trials (SPOT). It was then promoted to the 1979 International Soybean Variety Experiment which has cooperators in 107 countries. G 2120 has been included in both the tropical and subtropical sets.

Two AVRDC entries were selected for the 1979 SPOT after performing successfully in the preceding Soybean International Experimental Variety Evaluation (SIEVE). They will now be tested at 12 sites. Another three entries were sent to the 1979 SIEVE.

Korea

In March, AVRDC airfreighted 50 kg multiplied seed to Korea. Another 230 kg seed from pedigree lines and bulked populations were airfreighted in June, in time for sowing in Korea after the barley harvest. Suweon 97, a Korean variety multiplied at AVRDC, did particularly well in regional yield trials. Korean authorities are planning to release it as a new cultivar.

Malaysia

Evaluation of AVRDC material is in progress at the Universiti Malaya. GC 30238-3-22 is a stable genotype and looks promising in trials at six locations. Of 52 lines evaluated at the Universiti Pertanian Malaysia, five AVRDC entries yielded 3 t/ha or more. AVRDC is also helping the Joint Malaysian Soybean Breeding Project.

Philippines

Ten AVRDC breeding lines were evaluated at Central Luzon State University, with Taita Kaohsiung No. 5 as check. G 2120 gave the highest yield of 0.93 t/ha in 130 days, as against 0.26 t/ha for the check in 94 days. Insect infestation kept yields low despite control measures.

In dry season trials at IRRI, AGS 7 outperformed five other AVRDC lines and three checks to give 2010 kg/ha compared with 1300 kg/ha from the best check.

GC 30193-7-6 gave the highest yield of 2.55 t/ha in tests of 100 early maturing breeding lines at the Philippines Outreach Program in which 71 AVRDC entries outyielded the check cultivar L-114. In an advanced trial, AGS 17 gave a yield of 1060 kg/ha compared to 790 kg/ha for Taita Kaohsiung No. 5. In different dry season trials, four high-yielding lines from AVRDC yielded 2711, 2230, 2200 and 1917 kg/ha.

At the La Granja experiment station, AGS 17 was again the highest yielder at 1198 kg/ha in a dry season trial. The highest yielding check produced only 671 kg/ha.

Taiwan

AGS 17 yielded on average 12% higher than KS 691, its nearest rival, in a four location summer trial run by Kaohsiung DAIS in which six cultivars were evaluated (Table 7). It was the top yielder in two locations, and second highest in the other two. The Kaohsiung DAIS is planning to recommend AGS 17 to the Release Committee.

GC 30295-6-6 proved the highest yielder of five AVRDC lines in both spring and summer regional yield trials conducted by Tainan DAIS. It was top yielder in all three spring trial locations and all four summer locations, significantly outyielding local varieties Shih Shih and H 15.

Six cooperators in Taiwan received 1003 accessions and 181 breeding lines.

Table 7. Yield (kg/ha) of six cultivars at four locations in summer trials, 1979, Taiwan

Cultivar	Location			
	Kaohsiung DAIS	Lein Mein I	Lein Mein II	Lein Mein III
KS 535	1583 (77)	1270 (67)	2160 (100)	2533 (96)
KS 691	2334 (114)	2100 (111)	2860 (132)	2933 (112)
AGS 17	2084 (101)	3130 (165)	3400 (157)	2840 (108)
Tai-lien Tou	1417 (69)	1030 (54)	1430 (66)	1533 (58)
Kaohsiung No.3	1545 (75)	1260 (66)	2860 (132)	2240 (85)
Palmetto	2056 (100)	1900 (100)	2160 (100)	2620 (100)

Values in parentheses are calculated using Palmetto yield = 100.

Thailand

AVRDC line GC 30229-9 is being multiplied for farmers' field demonstration trials. It has proved to be high yielding and resistant to bacterial pustule in past evaluations. However, in the first regional yield trial with 17 entries at four locations in the dry season and five in the wet season, there was no significant difference between entries for all locations taken together. In the second regional yield trial, AVRDC line GC 30229-8 was the top yielder at 2573 kg/ha at three locations in the wet season.

Information from food consumption surveys is used by the Agricultural Economics staff to help determine research strategies aimed at improving nutrition levels.

Nutrition, Environment and Management

A large number of environmental and socio-economic factors intervene between the time a farmer decides what crops to plant and the time a consumer eats the fresh or processed product. It is the task of the Nutrition, Environment and Management Program (NEM) of AVRDC to identify and study these factors. Using an inter-disciplinary approach, the program's scientists work to enhance the nutritional quality of vegetable crops and increase crop production by adapting and developing appropriate crop management techniques and technologies, with the aim of improving the quality of life for the tropical farmer and the people he feeds.

In vitro digestibility of mungbean and blackgram protein

A pepsin-trypsin digestion system confirmed findings of a rat-feeding experiment which indicated that crude extract of mungbean protein was more digestible than blackgram protein, but less digestible than casein.

Cooking time of mungbean

Different methods of mungbean preparation were studied to reduce cooking time, one of the factors limiting the use of dry mungbean as a food. Cooking times of 14 mungbean cultivars ranged from 17.4 to 25 minutes with a mean of 21.6 minutes. Storage for one year at 10% moisture did not affect cooking times.

Blanching the beans followed by soaking in a salt solution for eight hours reduced the cooking time to 5.5 minutes. Eating quality was also slightly improved. This method is potentially useful in locations where domestic fuels are expensive.

Processing quality of tomato breeding lines

The processing qualities of AVRDC's tomato breeding lines approach local industry standards when evaluated according to pH, soluble solids, titratable acidity, and color. Within these parameters, the following lines are of especially high quality: CL1591-5-0-1-4-1, CL1591-5-0-1-3-1, CL1591-5-0-1-2-0, CL1591-5-0-1-7-6, CL1591-5-0-2-2-0, CL1591-5-0-1-1-4, and CL1591-6-0-7-1-3.

Sugar content of sweet potato

As part of AVRDC's efforts to develop a low sugar, high protein staple food, the entire sweet potato germplasm collection was screened twice in 1979 for sugar content. Sugar contents ranged from 4% to 22% (6% to 36% on a dry weight basis). Further correlation studies indicated that sugar content is genetically stable.

A very high negative correlation was found between sugar concentrations and dry matter content. Since high dry matter content is another desirable characteristic of a staple type sweet potato, it may be possible to select for these two characters simultaneously.

Carbohydrates of Chinese cabbage

Dietary fiber components affect both the eating and nutritional qualities of Chinese cabbage, and thus are important factors in selecting palatable and nutritious varieties.

More than half of the solids in Chinese cabbage represent carbohydrates. About 50% consists of free sugar, and the remainder unavailable carbohydrate and trace quantities of starch. Petioles were found to have a higher sugar content than leaves on a dry-weight basis. Leaves, however, had higher levels of hot water-soluble carbohydrates. Other carbohydrate components were found to be distributed equally between leaves and petioles. Younger, inner leaves were higher in hot water-soluble carbohydrates than the outer leaves. Starch content was distributed equally between inner and outer leaves.

SOIL SCIENCE

Boron response of the tomato

The beneficial effects of boron on the growth of tomato plants are achieved within a very narrow range of boron concentrations in the soil. To determine the upper limit of this range, the effects of boron concentrations on tomato plants were assessed using AVRDC farm soils and tomato cultivar CL143-0-10-3-0. Plants showed toxicity symptoms when boron concentrations exceeded 4 ppm. Boron at 16 ppm caused serious damage, and 32 ppm led to the death of the plant within weeks after transplanting. Untreated checks were not affected.

A highly significant correlation was found between fruit yields and boron content of leaves collected three and five weeks after transplanting. Correlation analysis showed the most suitable boron content in the leaves to be 85 ppm, a concentration resulting from soil boron concentrations of 2 ppm.

Compost and manure decomposition

The decomposition pattern of compost and manure was studied to determine better application methods for organic materials. A marked increase in the decomposition rates of organic carbon and nitrogen occurred four months after subsurface laying. Furthermore, organic carbon decomposed rapidly when compost and manure were mixed with soil before application. The results suggest that organic materials applied to the field should be mixed with soil before their application for better plant growth.

Soil chemical properties and legume yields

An experiment using 54 different soils was conducted to assess the relationship between soil chemical properties and yields of soybean and mungbean. Soybean yields were positively correlated with the soil's electrical conductivity, sand content, and available P_2O_5 and K_2O. When soil was treated with nitrogen, phosphorus and potassium, yields were positively correlated with the soil content of acid extractable iron, P_2O_5 and K_2O. A regression equation showed that soil containing 86 ppm available P_2O_5 would result in the best yield on unfertilized soil.

Mungbean yields were positively correlated with the electrical conductivity of unfertilized soil without fertilizer applications.

Mycorrhizal study

A 1979 study examined the incidence of vesicular-arbuscular (VA) mycorrhizal infection of mungbean, soybean, Chinese cabbage, sweet potato and tomato grown on the AVRDC experimental farm. Bulked soil samples (0-10 cm deep) from each crop were cleared, stained and scored for mycorrhizal infections. Mungbean, soybean, sweet potato and tomato were generally infected to a significant extent (>25% infection intensity), while Chinese cabbage was not infected at all.

A total of six species of VA mycorrhizal fungi were found and identified. Spores were found in large numbers in soil samples from fields previously planted to mungbean and soybean. *Gigaspora magarita* was the most abundant. In a pot experiment, the effects of inoculating soybean with VA mycorrhizal fungus (*Acaulospora scrobiculata* at 50 spores per pot) were investigated both with fertilizer (N:P:K:Mg = 15:15:6:4 at 2 g/pot) and without fertilizer applications. At 48 days, the soybean plants showed significant responses to both inoculation and fertilizer applications (Table 1). While plants treated with only fertilizer or mycorrhizal inoculations showed good growth, inoculation together with fertilization produced by far the best growth response.

Table 1. Effect of mycorrhizal inoculation on soybean (GC 30120-2-10) growth[z]

Treatments	Plant height (cm)	Dry weight (g/plant)	Leaf P concentration (mg/g)
Control	16.5	2.2	1.0
Fertilizer	21.8	4.6	1.7
Inoculation	24.1	4.4	3.8
Fertilizer + inoculation	26.8	6.6	3.2
LSD 5%	2.9	1.2	0.8

[z]Emerged November 21, 1979; sampled January 8, 1980

CROP MANAGEMENT

Planting methods of summer Chinese cabbage

The effects of direct seeding and transplanting methods on Chinese cabbage yields were compared in three experiments conducted from May to August 1979. Direct seeded plants had significantly higher heading rates, higher yield, and matured between 2.7 and 4.5 days earlier than transplanted Chinese cabbage. Softrot incidence was the same in both treatments.

Mulching rates and Chinese cabbage yields

The effects of three mulching rates (0, 5 and 10 t/ha) on Chinese cabbage yields were studied. Although the differences in yield were not significant, mulching decreased the incidence of softrot. As the mulching rate increased from 0 to 10 t/ha, the softrot levels decreased from 15.11% to 9% in the first planting, and from 16.26% to 10.95% in the second planting. Mulching also prevented soil contact with the non-wrapper leaves, protecting them from rotting.

Effects of different mulching materials on summer tomato

Rice straw mulch and a black paper mulch produced by the Tsunefugi Export Company were compared in summer tomato production. Total yields of tomato plants with mulches were significantly higher than that of the non-mulched control (Table 2). Although the black paper mulch treatment resulted in larger average fruit size, the rice straw mulch treatment produced more fruit per plant and a higher percentage of it marketable.

Effects of bed height on tomato growth

A bed management trial was conducted to determine if heavy rainfall damage could be reduced in summer tomatoes. Plants on a 30 cm-high bed had significantly greater total and marketable yields than those planted on a 15 cm-high bed (Table 3). Although there were no significant differences between the two treatments in the percentage of marketable fruits, the plants on the higher beds produced larger fruit. Higher beds also reduced plant wilting during prolonged flooding.

Drip irrigation for tomatoes

There were no significant differences in the yield of tomatoes between drip and furrow irrigation treatments studied in 1979. Drip irrigation appears to increase yields only when the soil is very dry and when furrow irrigation schedules cannot be kept. Drip irrigation, however, is

Table 2. Effect of mulching materials on yields of summer tomato[a], 1979, AVRDC

Mulching materials	Total yield (t/ha)	Marketable yield (t/ha)	% of non-marketable fruits[b]	Fruit weight (g)	No. of fruit /plot
No mulch	1.5	0.7	40.1	34.8	105.3
Rice straw	2.3	1.6	33.5	28.7	181.4
Black paper	2.1	1.1	42.0	30.1	143.1
C.V. %	22	34	24	37	16
LSD .05	ns	1	ns	ns	80

[a] AVRDC tomato selection CL1591-5-0-1-6 transplanted April 11, 1979, and harvested on June 12, 19 and 29, 1979

[b] Due mainly to rot. Other causes were wilt, insects, sun-burn and cracking

Table 3. Tomato yields and sizes as affected by bed height and compost application[a]

		Total yield t/ha		Marketable yield t/ha		% of non-marketable fruits		Fruit size g/fruit	
		high bed	low bed	high bed	low bed	high bed	low bed	high bed	low bed
Field with underground drainage	With compost	25.4	5.3	24.8	5.2	2.9	2.0	60.6	35.6
	No compost	17.7	6.5	16.9	6.2	5.4	7.3	46.3	43.0
	Main plot means	21.6*	5.9*	20.9*	5.7*	4.2 NS	4.7 NS	53.5 NS	39.3 NS
Field without underground drainage	With compost	26.5	6.2	25.9	6.0	3.9	6.0	34.6	14.1
	no compost	35.3	12.4	34.3	12.3	4.5	0.7	41.5	24.1
	Main plot means	30.9*	9.3*	30.1*	9.2*	4.2 NS	3.4 NS	38.1*	19.1*

[a] AVRDC tomato selection CL 1591-5-0-1-6 transplanted July 23, 1979; harvested October 2 to November 7, 1979
*Difference between means significant at 5% level
NS = not significant

much more economical on water. Although drip irrigation requires more labor in the initial construction of the system, manpower requirements for subsequent maintenance are reduced. The necessarily large investment required for installation of drip irrigation, however, is the primary constraint to wider application in Asia.

Mungbean and soybean herbicide trials

Butralin, alachlor, oxyfluorfen and Hoe 23408 were evaluated in February 1979, for weed control in mungbean. Alachlor and oxyfluorfen substantially reduced mungbean stand and yields while Hoe 23408 failed to control broadleaf weeds. Only butralin was selective, resulting in highest mungbean yields.

In 1979 soybean herbicide trials, oxyfluorfen and acifluorfen-Na produced moderate to serious phytotoxicity. Although butralin gave better weed control, alachlor resulted in highest soybean yields.

Herbicide application timing

In an experiment to assess the importance of timing herbicide applications, soybean and mungbean plants were treated with alachlor or butralin at the following growth stages: preplant, preemergence, early postemergence, and postemergence. Butralin was selective when applied preemergence, but caused leaf distortion, death of the growth point, and/or general growth reduction when applied postemergence. Alachlor applied postemergence was only mildly phytotoxic to the crop, but failed to control emerged weeds. These results suggest that while alachlor and butralin can be applied preemergence to the crop, alachlor must be applied preemergence to weeds.

Weed growth with no-tillage rice stubble soybean

In a no-tillage field experiment of soybean planted after rice, weed fresh-weight increased sharply after 30 days' growth (Table 4). These results suggest that one weeding 30 days after planting is sufficient to prevent yield loss.

Soybean broadcasting after paddy rice

To evaluate four soybean seeding methods, dibbling on no-tilled soil, drilling on tilled soil, broadcasting on no-tilled soil, and broadcasting on tilled soil were compared in a paddy field one week after harvesting rice. Yields from broadcast plots were equivalent or higher than dibbled or drilled plots.

Tilled vs no-till soybeans following paddy rice

The effects of tillage on soybean yields were studied on no-till, rice-stubble soybean (Table 5). Yields from broadcast seedlings were higher when tilled after planting, but with 22.5 x 22.5 cm spacings, dibbled plants yielded more on no-till plots.

Table 4. Crop yields of no-tillage rice-stubble soybean with and without weeds, September to December, 1979, AVRDC

Treatment	Days after planting	Bean yield (kg/ha)	Weed[a] fresh-weight ($kg/10m^2$)			
			Grass	Broadleaf	Rice	Total
Weed-free	15	1100	5.1	1.9	-	7.0
Weed-free	30	1110	3.7	2.2	-	5.9
Weed-free	45	1160	0.3	0.6	-	0.9
Weed-free	60	1300	0.1	0.1	-	0.1
Weed-free	75	1170	0.1	0.1	-	0.1
Weedy	15	1290	0.6	0.3	0.2	1.1
Weedy	30	1260	0.8	0.7	0.3	1.8
Weedy	45	1050	3.1	1.8	0.4	5.3
Weedy	60	750	6.9	1.7	0.3	8.9
Weedy	75	690	8.2	2.0	0.2	10.4

[a]Major grass weeds: *Echinochloa crusgalli, colonum,* and *Paspalum distichum*. Major broadleaf weeds: *Edipta prostrata, Lindernia pyxidaria,* and *Chenopodium album*

Table 5. The effect of planting and tillage methods on soybean yields, March 1979, AVRDC[a]

Planting method[b]	Bean yield (kg/ha)		Mean
	With tillage	Without tillage	
Broadcasting	2380	620	1500
Dibbling with 22.5 x 22.5 cm spacing	2580	3020	2800
Dibbling, with 45 x 11.25 cm spacing	2490	2400	2445
Dibbling, with 45 x 22.5 cm spacing	2540	2080	2310
Mean	2500	2030	

LSD 5% Between planting methods: 309

Between tillage methods: 176

Between tillage methods on the same planting: 352

Between tillage methods on different plantings: 341

[a]Planted after no-tillage rice-stubble soybean
[b]Seed rate: 40 seeds/m^2

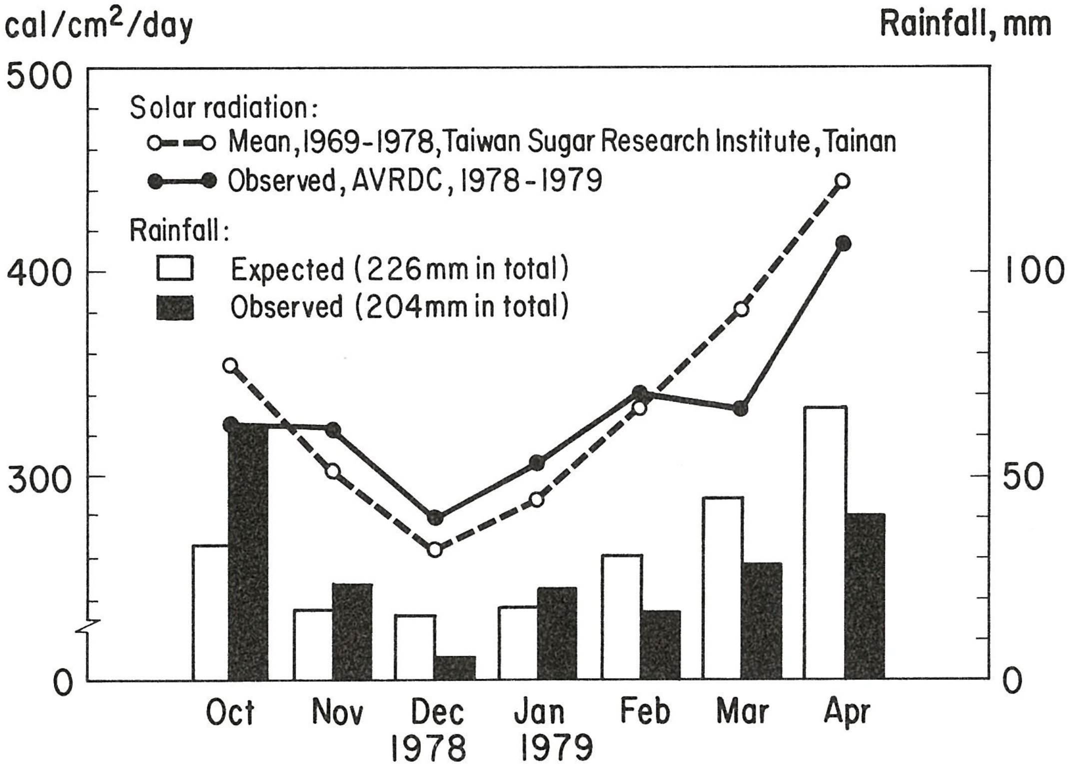


Fig. 1. Precipitation and solar radiation during the 1978-79 dry season at AVRDC

ENVIRONMENT

Weather

The 1978-79 dry season deviated only slightly from the normal patterns of precipitation and solar radiation (Figure 1). Although the 1979 wet season was drier than normal (Figure 2), many summer crops which demonstrated good growth in June and July were severely damaged by the year's heaviest one-day rainfall (17.0 cm) on August 17, 1979.

Farm drainage improvement study

To improve subsurface drainage, 3-inch (7.5 cm) diameter perforated polyetheline pipes were placed 80 cm below the soil surface on six hectares of the experimental farm. Water table measurements indicated that the pipes markedly improved drainage.

Insecticide persistence in the soil

Two experiments were conducted over a two-year period to study the persistence of frequently-used insecticides when applied alone and in

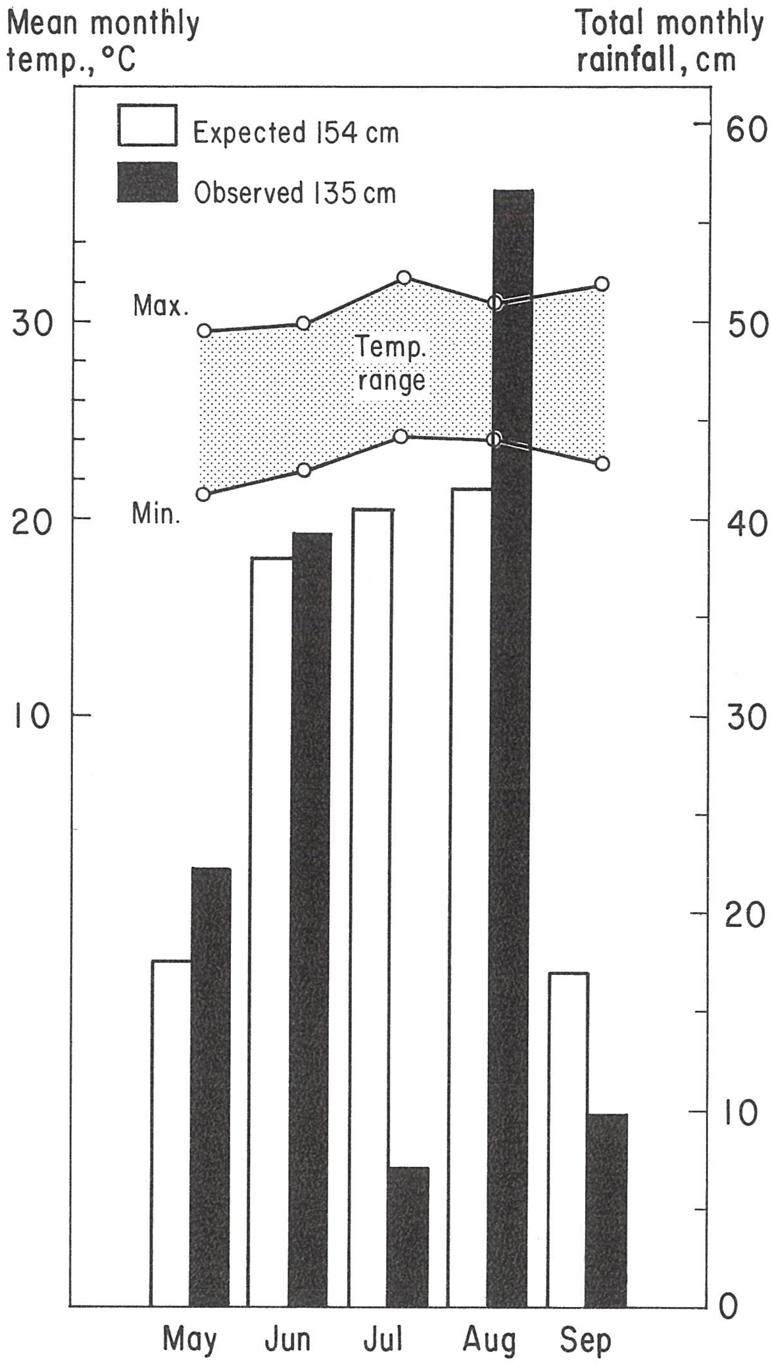


Fig. 2. Rainfall and temperatures during the 1979 wet season at AVRDC

mixtures. In the first experiment, insecticides were applied biweekly to soil in the field. In the second, the insecticides were applied to three soils of different pH in wooden cartons placed in the field adjacent to the field experiment.

The pattern of pesticide persistence in both experiments was identical. Insecticides degraded quickly during the hot and humid part of the year from May to October, but accumulated during the cooler and drier period from November to April. In both cases, however, only a tiny fraction of the chemicals applied over the two-year period could be recovered at the end of 27 months.

AGRICULTURAL ECONOMICS

Food consumption survey

In 1979, the agricultural economics staff commenced analysis of data from a one-year consumption survey, a follow-up of the 1978 baseline food consumption survey. The survey recorded the daily food purchases of 100 Kaohsiung households over a one-year period. More than 200,000 records have been stored on computer tape for further economic analysis.

Maximum input yield budgets

The current prices of inputs used in maximum input yield trials were computed into an estimated budget for sweet potato or soybean farmers. For both sweet potato and soybean, weeding and harvesting required the largest expenditures. Sweet potato required a large expenditure for animal power relative to soybean, while soybean required larger expenditures for mechanical power. Since the data used were for maximum inputs, expenses exceeded income for both crops.

Tomato farm trials

Nine farmers in Ta-pao planted a total of 1.5 hectares of AVRDC tomato and recorded their cultural practices. Yields were much lower than those obtained in AVRDC trials. The major production problems listed by the farmers were:

- early blight during development and fruit-setting stages
- untimely rains which caused fruit loss and lower quality.

After examining their practices, a number of problems were apparent:

- the continuous rain delayed pesticide applications, thereby reducing effectiveness
- beds were not mulched with rice straw
- P_2O_5 applications were 69 kg/ha vs the AVRDC recommendation of 80 to 150 kg/ha

-poor field drainage was often a problem.

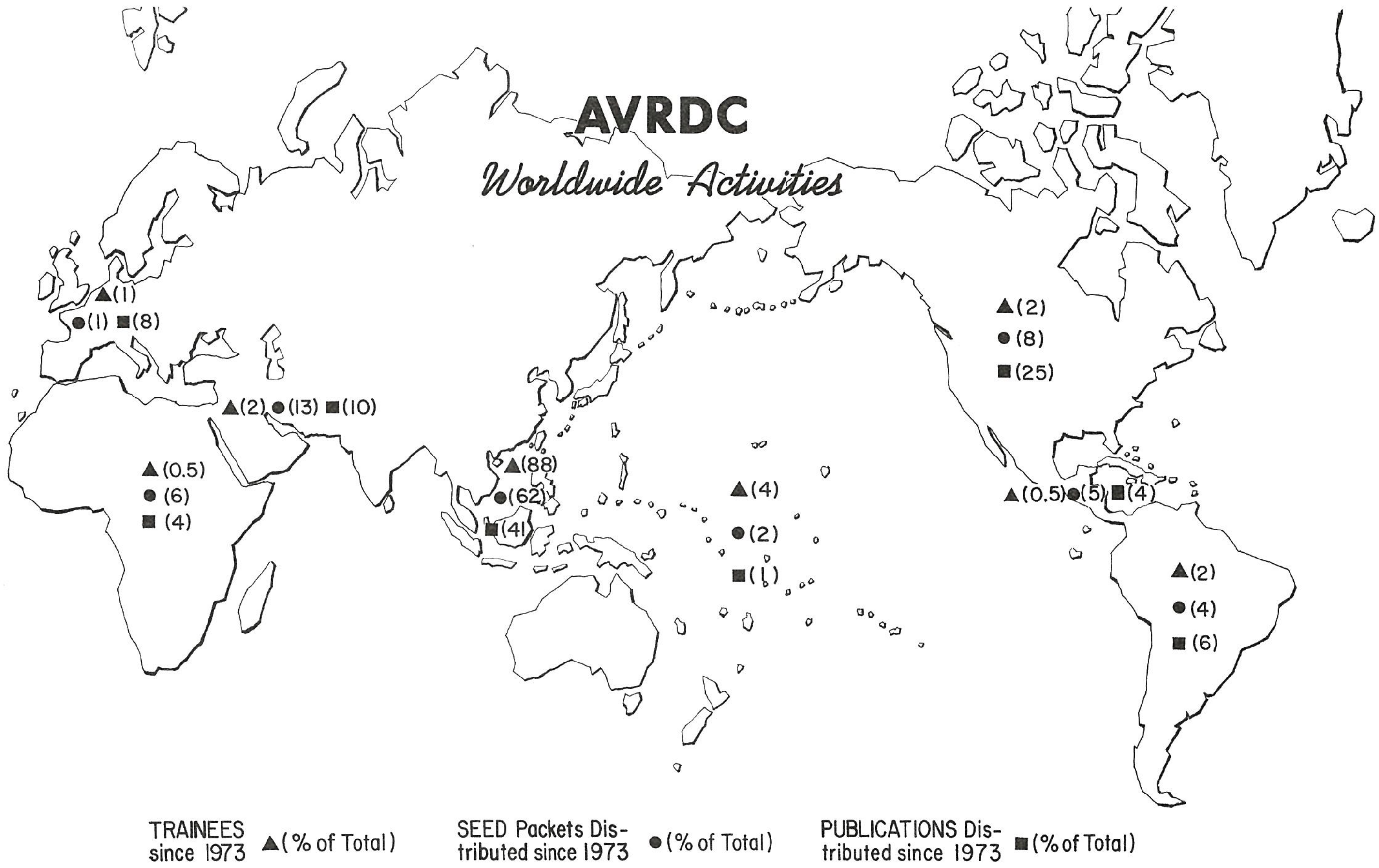
Summer Chinese cabbage production in lowland central Taiwan

Data from a 1978 survey of 53 Chinese cabbage farmers in central Taiwan were subjected to a four-independent-variable model. Preliminary results showed that pesticide-use reduced yields, suggesting a misuse of pesticides. The analysis indicated also that farmers may be using insufficient nitrogen fertilizer.

Vegetable system monitoring

During 1979, the Agricultural Economics Department began to monitor vegetable marketing systems of AVRDC client or potential-client countries. In Taiwan, wholesale price and volume data are being gathered for small and large Chinese cabbage and tomato. Retail price data are being gathered for mungbean, soybean and sweet potato. Price data from Sri Lanka are also being compiled for mungbean and soybean.

Trainees from Ecuador and the Republic of China plant sweet potato.


AVRDC
Worldwide Activities
▲(1) ●(1) ■(8)
▲(2) ●(13) ■(10)
▲(0.5) ●(6) ■(4)
▲(88) ●(62) ■(41)
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▲(2) ●(8) ■(25)
▲(0.5) ●(5) ■(4)
▲(2) ●(4) ■(6)
TRAINEES since 1973 ▲(% of Total)
SEED Packets Distributed since 1973 ●(% of Total)
PUBLICATIONS Distributed since 1973 ■(% of Total)

Outreach Programs

Outreach is an integral part of AVRDC's research program, facilitating germplasm exchange, research coordination, and the testing and development of breeding lines and management practices under the widest possible variety of agroclimatic conditions. Extensive international contacts have thus far resulted in two formal outreach programs. The AVRDC Philippines Outreach Program (POP), based at the Economic Garden Experiment Station in Los Baños, has been fully incorporated with the Philippines national agricultural research program since 1977. In Korea, the AVRDC Korean Outreach Program (KOP) operates from the Horticultural Experiment Station of the Office of Rural Development near Suweon.

PHILIPPINES

Soybean

Seven out of 160 breeding lines yielded more than 3.0 t/ha in wet season evaluations. GC 50243-7-6 yielded highest at 3.97 t/ha compared with 1.25 t/ha for check cultivar L-114. In a preliminary yield trial sown in June, breeding line GC 50217-3-6-10 yielded 2.42 t/ha and was relatively free from disease. L-114 yielded 1.29 t/ha by comparison. In wet season screenings for soybean rust resistance, GC 60061-8-9 was rated resistant and seven other lines were moderately resistant.

In a dry season advanced yield trial conducted at the La Granja Experiment Station, selection GC 30050-2-17 yielded significantly more (1.2 t/ha in 86 days) than all other lines and check varieties. In another dry season trial, four AVRDC lines were the top yielders at 1.9 to 2.7 t/ha. The highest yielder, GC 50062-5-20, had excellent seed quality and was resistant to bacterial pustule and lodging.

Mungbean

Mungbean breeders at the Economic Garden selected 462 plants and

108 lines from 488 early segregating populations (F_2 and F_3) sent by AVRDC. These materials were used in replicated trials at the Los Baños, Bicol and La Granja experiment stations.

At Los Baños, dry season plantings of mungbean outyielded wet season plantings by about 50%. AVRDC breeding line VC 1241-2B-22-B (Phl Coll. 31/ML-3) yielded 1.74 t/ha, compared with 1.12 t/ha from Pag-asa (V3476), the best local cultivar.

At the La Granja station, the average yield of 30 mungbean breeding lines was 1.00 t/ha in the wet season, but only 0.36 t/ha in the dry season. The highest wet season yield of 1.71 t/ha was given by AVRDC breeding line VC 1186-81-E (BPI Glabrous 3/LM 115) while Pag-asa yielded 1.06 t/ha.

Blackgram

Blackgram varieties were also evaluated in trials at the Los Baños, Bicol and La Granja experiment stations. In follow-up trials of two varieties found promising in earlier trials, VM 3171 and VM 3115 yielded 1.32 and 0.91 t/ha, respectively, in wet season plantings at Los Baños.

Blackgram yields were significantly affected by both location and season. Blackgram planted at Bicol yielded 1.16 t/ha in the wet season and 1.76 t/ha in the dry season. Wet season plantings at La Granja, however, yielded only 0.67 t/ha (Table 1). Five varieties (VM 3153, VM 3148, VM 3081, VM 3053 and VM 3146) yielded more than 2.0 tons dry bean/ha at Bicol in the dry season, but only 0.5 t/ha at La Granja. Only two varieties, VM 3139 and VM 3115, performed consistently well, with yields of 0.9 t/ha at La Granja and up to 1.9 t/ha at Bicol.

Blackgram flowered between 33 and 39 days after sowing and matured within 73 to 79 days. Plant height ranged from 55 cm to 77 cm. Blackgram produced six or seven seeds per pod compared with 10 to 15 for mungbean. Seed size was comparable to mungbean, ranging from 48 to 62 g/1000 seeds.

Sweet potato

The outreach staff maintained 131 accessions, distributing sweet potato cuttings to students, farmers, stations and institutions for research and food production programs. The Mennonite Central Committee of the Philippines requested one ton of AIS 35-2 sweet potato cuttings to be sent to Bangladesh in anticipation of a possible food shortage in that country due to prolonged drought.

Several AVRDC accessions performed as well as local check BNAS in preliminary trials at Los Baños, yielding from 22 to 39 t/ha. In other trials, Tainung New 10 and PI 315345 appeared to have some resistance to scab, a serious sweet potato disease in the Philippines and Indonesia.

Table 1. Summary of yield, yield components, plant height and maturity of 20 blackgram varieties in two seasons at Bicol Rice and Corn Experiment Station and one season at La Granja Experiment Station, the Philippines, 1979

Location	Season	Yield mean	Yield range	1000 seed wt	Seeds/ pod	Pods/ plant	Plant height	Days to flower	Maturity
		------t/ha-----		---gr--			--cm--		
Bicol[a]	Dry	1.76	0.89-2.26	NA	7.3	36	55	33	73
Bicol[a]	Wet	1.16	0.55-1.46	53	6.9	23	77	NA	NA
La Granja[b]	Wet	0.67	0.40-0.94	61	6.2	17	66	39	79

NA:Data not available
[a]RCBD with 3 replications, 4-row plots, 5m x 3.75m
[b]RCBD with 3 replications, 4-row plots, 5m x 2.4m, sown May 9, 1979

Tomato

At the Los Baños Economic Garden, AVRDC selection CL 505-5 yielded 17% more than the local variety (Pope) during the dry season. Further, CL 143-0-6-9-0-0-0 outyielded Pope by 83% in a wet season planting. In a late-dry/early-wet season trial evaluating bacterial wilt resistance, over 50% of the lines from crosses CL 1084 and CL 1131 reached maturity and bore fruit.

At the Bicol Rice and Corn Experiment Station, four AVRDC single seed descent lines gave the highest dry season yields of between 16 and 22 t/ha. In wet season trials, three AVRDC lines outyielded Pope by be-165% to 193%. Three other AVRDC lines outyielded Pope and another local variety, TK3-4, by at least 34% in dry season plantings.

One AVRDC line outyielded Improved Pope in wet season trials at the Mizamis Oriental Horticultural Research Center. Seven other AVRDC lines also outyielded Improved Pope in dry season plantings with mean yields ranging from 31.4 to 39.4 t/ha. Five of these lines were free from bacterial wilt infection.

Chinese cabbage

Seventeen AVRDC Chinese cabbage entries were evaluated in a January transplanting. Marketable head yield ranged from 14.7 t/ha for 77 M(3/4)-42 to 24.0 t/ha for 77 M(2)-46.

In wet season trials, adverse weather conditions resulted in poor stand and low yields ranging from 4.4 to 14.8 t/ha. Diamondback moth also caused serious damage.

KOREA

Soybean

Suweon 97, a high yielding Korean variety resistant to soybean mosaic virus (SMV), was recommended for the north-central areas of Korea. The Korean breeding line SS 74185 was rated highly resistant to necrotic or common SMV.

More than 90 different varieties were used in 114 crosses in 1979 to combine lodging resistance, good seed quality, SMV resistance and high yields. Five advanced breeding lines from Korea were multiplied at AVRDC to be used in Korean multi-location summer trials.

Delayed harvesting was observed to increase the incidence of stem-blight (*Diaporthe phaseolorum*), but did not affect the incidence of purple stain disease (*Cercospora kikuchii*).

Beanfly infestations could be avoided for the first four weeks of growth if soybean was planted before mid-June. Later planting dates resulted in progressively higher beanfly infestations.

Mungbean

After two years of testing, V 3476 (Pag-asa) was recognized as a high yielding variety suitable for the southern part of Korea. Three other AVRDC varieties outyielded the local variety in 1979 yield trials over seven locations (Table 2).

Table 2. Average yields (kg/ha) from six selected varieties over two areas, Korea, 1979

Variety	Central-northern areas[a]	Southern areas[b]
V3476	1080	1440
VC1163 Sel A	930	1080
VC1168 Sel B	718	1310
VC1627 Sel A	1100	1470
V2984 (Kyungkijaerae)	1318	1200
Local variety	728	480

[a]Includes Suweon, Chuncheon, Cheongju
[b]Includes Chinan, Mokpo, Chilgok, Chinju

Chinese cabbage

Crosses between three AVRDC breeding lines and 60-Days or Cheongbang breeding lines produced promising yields and head types for lowland summer cultivation.

Three combinations, Ta Feng Feng hu x 60-Days, Ta Feng Feng hu x Cheongbang, and Yung Ching 30-Days x Cheongbang, performed well in combining-ability trials and will be evaluated in farmers' fields in the 1980 summer season. This will be a preparatory step to the release of a new variety.

Studies revealed that Chinese cabbage tipburn infection increased as the plant's water potential dropped.

Summer trials of commercial hybrid varieties were conducted at six locations to evaluate the effects of planting date and elevation on plant

Table 3. Maximum yields at six locations in Korea, 1979

	Place	Elevation (m, sea level)	Date sown 4/30	5/20	6/10	6/30	7/20
	Seoshin	seacoast	47.8	0	0	0	0
	Suweon	lowland	35.9	0	0	0	0
Maximum yield (t/ha)	Miwon	400	45.6	0	0	0	0
	Daehwa[a]	500	71.9	24.8	0	0	38.7
	Jinbu	650	-	86.5	52.7	66.9	-
	Daekwan-ryung	800	-	52.2	54.8	82.3	-

[a]Field soil was strongly acidic (pH 4.5)

performance. Only the earliest of five plantings (April 30) produced marketable yields in the lower-elevation locations. In two later plantings, the two highest locations (Jinbu and Daekwanryung) returned respectable yields, and planting could be recommended there (Table 3). Bolting was the major problem of the early plantings, while softrot damaged the later plantings. Virus disease was also serious at the lower elevations.

Tomato

Twenty-five F_1 combinations were made during the spring of 1978 and evaluated for yield and processing quality at AVRDC and the Horticultural Experiment Station. The selected hybrids (Karlik/Heinz 1370, Karlik/Kurikoma, Karlik/Tamu Chico III, VC 11-1/Tamu Chico III) outyielded check Wase Daruma. The fruits of the hybrids, however, did not compare with those of the check for firmness, an important processing characteristic.

Five crosses selected in 1978 for fresh market production were evaluated again in 1979 with Market No. 2 from Japan as a check. Only L 166-1/Tatura Dwarf Glove yielded higher than the check. Combination L 142-TM/L 166-1 was the only one rated resistant to a number of leaf diseases.

White potato

A liquid medium containing cytokinin and GA was successfully developed at the Suweon Horticultural Experiment Station for use as the initial and sub-culture for meristem explants. With the addition of 1.0 ppm IAA, the medium gave the best results for the rooting of multiplied shoots. Two important varieties, Dejima and Shimabara, are being increased with this technique.

Reasonable protection against aphids and virus infections was given by a treatment of Temik, mineral oil and pirimor during seed potato production.

Cooperators from the Philippines Outreach Program at Los Baños conduct a trial of AVRDC soybean.

Trainees discuss tomato virus diseases with the Center's plant pathologist and director.

Training and Development

The AVRDC staff has trained 229 people from 20 countries in vegetable research and production techniques since the international training program was started in 1974. The program offers six kinds of training to students, scientists, extension workers and production specialists who are engaged in increasing vegetable production in their countries. The program also provides opportunities and resources for individually tailored projects. All participants conduct their work under the guidance of an AVRDC scientist. Classroom lectures in the basic sciences involved are provided by the Training and Development Office.

In 1979, a total of 65 people completed the training program. Seventeen conducted projects in the legume crops, 47 worked with the horticultural crops, and one Special Purpose Trainee studied the methodology of pesticide residue analysis. An associate professor from Fu Jen University in Taiwan participated in the program as a Research Fellow, studying various aspects of the rootknot nematode problem in Taiwan.

Development is another integral part of the AVRDC mandate. The task of the Development Program is to evaluate promising AVRDC breeding lines under both AVRDC and local conditions in cooperation with the national program, concerned institutions, or local farmers. The program also examines the cultural practices of AVRDC and local farmers for possible improvement and adoption.

In 1979, the assistant development specialist conducted field trials and demonstrations of Center materials and methods for farmers and farmers' associations. A detailed record was kept of all costs and marketing returns. Results of the tests show that, using the Center's recommended practices, AVRDC Chinese cabbage can be a profitable summer crop in Taiwan. Another test with AVRDC heat tolerant tomato lines indicated that two of the lines were profitable for summer production, while the local variety was not. Mulching was determined to be the most effective method of protecting plants from heavy rains.

A number of accessions from all five vegetable crops were included in regional trials conducted by the national program throughout Taiwan.

Crop Commodity Training Program

SOYBEAN

SUPARYONO; Research Intern; Research Assistant, Central Research Institute for Agriculture (CRIA) Sukamandi, Subang, West Java, Indonesia.

Major project: Study of the development of *Cercospora* leaf spot (CLS) at different growth stages of mungbean

HUTAMI, Sri; Production Trainee; Staff member, Legume Production, Central Research Institute for Agriculture (CRIA), Bogor, Indonesia.

Major project: Effects of compost and fertilizer applications on soybean yields

RUDIMAN; Production Trainee; Lecturer, Agriculture Faculty of Padjajaran University, Bandung, Indonesia.

Major project: Effect of compost and fertilizer applications on soybean yields

CRUZ, Marshal; Production Trainee; Extension Services Adviser; Planters Products, Inc.; Makati, Metro Manila, Philippines.

Major project: Comparisons between yields of pure and blend varieties of soybean

CHENG, Chien Sheng; Production Trainee; Junior Specialist, Hualien District Agricultural Improvement Station (DAIS), Hualien, Taiwan, Republic of China.

Major project: Evaluation of advanced soybean breeding lines for yield and yield components

VIRTUCIO, Roberto H.; Production Trainee; Supervising Agronomist, Bureau of Plant Industry (BPI), Economic Garden, Philippines.

Major project: The influence of soybean seed size on yield and yield components

SEREEPRASERT, Vinich; Special Purpose Trainee; Research Assistant, Multiple Cropping Research Project Faculty of Agriculture, Kasetsart University, Bangkhen, Bangkok, Thailand.

Major project: Orientation to the breeding programs and crop management practices for legumes at AVRDC

SOEMARDHI; Special Purpose Trainee; Head of Agricultural Extension Service, Sub-Province Kedu, Magelang, Indonesia.

Major project: Seed production and marketing, legume program

RUNGSARDTHONG, Sukont; Special Purpose Trainee; Assistant Technical Manager, Agrochemicals Division, Bayer Thai Co., Bangkok, Thailand.

Major project: Legume production with emphasis on insect pests and diseases

LEE, Song Tsay; Summer Student Trainee; National Chung Hsing University, Taichung, Taiwan, Republic of China.

Major project: Biology of greenbeetle (*Anomala cupripes* and *A. expansa*)

WANG, Hsing Ping; Summer Student Trainee; National Chung Hsing University, Taichung, Taiwan, Republic of China.

Major project: Correlations between soybean stem diameter and beanfly infestation

MUNGBEAN

CHIANG, Yeong Jene; Research Scholar; MS candidate, Research Institute of Food Crops, National Chung Hsing University, Taichung, Taiwan, Republic of China.

Major project: Effects of water stress on mungbean growth and yield

CHEN, Chao Yi; Research Scholar; PhD candidate, Research Institute of Agricultural Chemistry, National Taiwan University, Taiwan, Republic of China.

Major project: Differences in starch granules and protein bodies among mungbean varieties and maturity levels

HAKIM, Lukman; Production Trainee; Staff, Legume Breeding, Central Research Institute for Agriculture, Bogor, Indonesia.

Major project: Effects of fungicide sprays on yields of six mungbean varieties at two population densities

LEE, Yong Beom; Production Trainee; Junior Researcher, Horticultural Experiment Station, Office of Rural Development, Suweon, Korea.

Major project: Inheritance study for powdery mildew and photoperiod sensitivity of mungbean

CHENG, Miaw Ling; Summer Student Trainee; National Taiwan University, Taipei, Taiwan, Republic of China.

Major project: Cooking time requirement of mungbean

YANG, Meng Huey; Summer Student Trainee; National Taiwan University, Taipei, Taiwan, Republic of China.

Major project: Nutrition value of protein fractions isolated from mungbean and blackgram

SWEET POTATO

TRIA, Ignacio S.; Production Trainee; Plant Pest Control Technologist, Bureau of Plant Industry, Region 4, Manila, Philippines

Major project: Sweet potato breeding line yield trials

CHEN, Junz Hsien; Summer Student Trainee; Fu Jen University, Taipei, Taiwan, Republic of China.

Major project: Contact toxicity of various insecticides on sweet potato weevil and greenbeetle

WONG, Shu Wang; Summer Student Trainee; National Taiwan University, Taipei, Taiwan, Republic of China.

Major project: Methionine content of sweet potato protease inhibitors

CHINESE CABBAGE

KIM, Kwang Soo; Research Intern; Research Assistant, College of Agriculture, Chonnam National University, Kwang Ju, Korea.

Major project: Effects of rain and flooding on Chinese cabbage growth and yield

VERSNEL, Aletta; Research Scholar; Ir. Student, Agricultural University, Wageningen, The Netherlands.

Major project: Effects of flooding on Chinese cabbage growth and development

Bunyi, Alfredo B.: Production Trainee; Horticulturist III, Tanay Vegetable Farm, BPI, Region 4, Philippines.

Major project: Seed production for open-pollinated Chinese cabbage varieties

HOU, Feng Wu; Production Trainee; Junior Specialist, Taiwan Seed Service, PDAF, Shinshieh, Taichung, Taiwan, Republic of China.

Major project: Effects of nitrogen levels and timing on Chinese cabbage bolting and seed yield

Hsu, Jia Yan; Production Trainee; Junior Specialist, Hsin-Chu District Agricultural Improvement Station, Hsin-Chu, Taiwan, Republic of China.

Major project: Bolting behavior of artifically and naturally vernalized Chinese cabbage lines

GAMILA, Erlindo B.; Production Trainee; Crop Protection Specialist, Agricultural Service Center, Pangantukan, Bukidnon, Philippines.

Major project: Effects of mulching on Chinese cabbage growth and yield

LAZARO, Gonzalo A.; Production Trainee; Agricultural Extension Technician, Instituto Boliviano de Tecnologia Agropecuaria, Bolivia.

Major project: Effect of compost, chemical fertilizers, and chicken and cattle manures on Chinese cabbage yields

SUVANNUS, Santi; Production Trainee; Horticulturist, Bangkhen, Bangkok, Thailand.

Major project: Synchronization of bolting and flowering in an open-pollinated Chinese cabbage seed production scheme

LORENZANA, Orlando J.; Production Trainee; Plant Pest Control Officer, Bureau of Plant Industry, Nueva, Vizcaya, Philippines.

Major project: Varietal evaluation for fall season production

CHEN, Lung Mu; Production Trainee; Technician, Known-You Seed Company, Kaohsiung, Taiwan, Republic of China

Major project: Seed multiplication through bud pollination of selected inbred lines and monitoring self-incompatibility

KANG, Goon Jung; Production Trainee; Assistant, Jinju Agricultural and Forestry Technical College, Jinju, Korea

Major project: Cultural control of Chinese cabbage insect pests

TU, Wu Chun; Summer Student Trainee; National Chung Hsing University, Taichung, Taiwan, Republic of China.

Major project: Cultural control of cabbage webworm

LIU, Mei Ann; Summer Student Trainee; National Taiwan University, Taipei Taiwan, Republic of China.

Major project: a. Biology of cabbage webworm (*Hellula undalis*)
b. Host plant survey of (*H. undalis*)

TOMATO

TSAI, Eric C. T.; Research Scholar; PhD candidate, Department of Botany, Chinese Culture College, Yang Ming Shan, Taipei, Taiwan, Republic of China.

Major project: Effect of high temperature on tomato fruit setting

PERELLO, Felicidad A.; Production Trainee; Agronomist III, Bicol Rice & Corn Experiment Station, Pili, Camarines Sur, Philippines

Major project: Effects of pruning and fruit load on tomato seed yield and maturity

MANUEL, Eduardo G.; Production Trainee; Farm Management Technologist II Bureau of Agricultural Extension, Bagabay, Nueva Vizcaya, Philippines.

Major project: Yield and spacing trials of two tomato varieties

CASTILLO, Doroteo G.; Production Trainee; Senior Farm Management Technologist, Bureau of Agricultural Extension, Calapan, Or. Mindoro, Philippines.

Major project: Yield and spacing trials of two tomato varieties

BARRIENTOS, Victor H.; Production Trainee; Research Technician, Moxos Experimental Station, Instituto Boliviano de Tecnologia Agropecuaria, Trinidad, Beni-Bolivia.

Major project: Effects of nitrogen fertilization on tomato yields

PALACIOS, Alejo A.; Production Trainee; Tomato Breeder, Campo Agricola Experimental Zac-tepec, Instituto Nacional de Investigaciones Agricolas, Zacatepec, Mor. Mexico.

Major project: Ethrel applications for tomato ripening

ALVAREZ, Antonio E.; Production Trainee; Agricultural Engineer 1, Comision de Estudios para el Desarrollo de la Cuenca del Rio Guayas, Guayaquil, Ecuador.

Major project: Tomato seed production studies

PALAJE, Manuel B.; Production Trainee; Extension Service Advisor, Planters Products Incorporated, Makati, Metro Manila, Philippines

Major project: Tomato seed production studies

POPPE, Cornelis K.; Production Trainee; Agriculturalist, Christian Reformed World Relief Committee's Agricultural Development Project, Bogra District, Bangladesh.

Major project: Phosphorous and potassium fertilizer applications and tomato yields

Sr. RUELO, Julita S.; Research Fellow; Associate Professor, Biology Department, Fu Jen University, Taipei, Taiwan, Republic of China.

Major projects:
a. Tomato, soybean, mungbean screenings for resistance to root-knot nematodes
b. Survey of the root-knot problem of Taiwan and AVRDC
c. Host range studies of *Meloidogyne hapla*
d. Integrated control of root-knot nematodes for tomato, soybean and mungbean

HORTICULTURAL CROPS

CHIANG, Kao Shan; Special Purpose Trainee; Priest, Howchia Village, Wu Tai Town, Pingtung, Taiwan, Republic of China.

Major project: Cultural practices for AVRDC's horticultural crops

YAU AKUI, Robert; Special Purpose Trainee; Technical Agent, GERDAT-IRAT Polynesie, Papeete-Tahiti, Polynesie Francaise.

Major project: Plant pathology, entomology and plant breeding; horticultural crops program

SALMON, Yves; Special Purpose Trainee; Technical Agent, GERDAT-IRAT Polynesie, Papeete-Tahiti, Polynesie Francaise.

Major project: Plant pathology, entomology and plant breeding; horticultural crops program

OTHERS

CHENG, Jui Hsiung; Special Purpose Trainee; Quality Control Supervisor, Yeong Mei Foods, Co., Ltd., Shan Shang, Tainan Hsien, Taiwan, Republic of China.

Major project: Pesticide residue analysis methodology

AVRDC scientists and staff meet with a farmer to discuss his field which is planted with AVRDC mungbean.

Seed Technologist Leonard Ho monitors mungbean seed production.

Communications and Research Services

SEED TECHNOLOGY

During 1979, AVRDC seed technologists multiplied the seed of 5201 soybean, 1394 mungbean, 853 sweet potato, 187 Chinese cabbage and 466 tomato accessions. The Seed Laboratory distributed 14,688 samples of these accessions to scientists in 81 countries and territories.

The entire AVRDC white potato germplasm collection was multiplied by the Seed Laboratory in the winter of 1978. After a February harvest, a total of 966 accessions was transferred to the Taiwan Agricultural Research Institute (TARI) in Taichung, thus concluding the Seed Laboratory's work with white potato. Our AVRDC scientists had succeeded in breeding highly productive heat tolerant white potato lines for the summer tropics. This promising germplasm is being maintained in tissue culture form at the Center for distribution to interested scientists.

Experiments conducted in the seed laboratory established that tomato seeds hardened with KNO_3 have improved germination vigor without adverse effects on percentage germination.

At the end of 1979, AVRDC's germplasm storage included 9933 soybean accessions, 3860 mungbean accessions, 702 Chinese cabbage accessions, 4701 tomato accessions and 422 sweet potato accessions (duplicates included).

STATISTICAL SERVICES AND COMPUTING CENTER

A total of twelve research groups used the statistical services at AVRDC in 1979, making more than 150 computer runs for 28 programming requests. Through the IBM/AVRDC partnership program, AVRDC scientists are given access to the IBM System/370 Model 158 located at the IBM Data Center in Taipei, greatly reducing turn-around time for data analyses.

In cooperation with IBM, AVRDC staff members gained access in 1979 to the IBM series of computer courses. The three basic courses are made available at AVRDC every month while more advanced training can be undertaken in Taipei.

THE OFFICE OF INFORMATION SERVICES

Publications

In 1979, the Office of Information Services produced 20 publications of various kinds and assisted in the publication of seven journal papers. More than 30,000 publications of all kinds were mailed to persons in 130 countries.

A mailing list of 5000 names was recently reduced to 2800 and is growing at a rate of about five names per day.

Photographic Services

The photographic unit processed or handled 4006 black and white prints, 1118 color prints, 8853 color slides and 3733 blue slides in 1979.

Press releases

OIS mailed 20 press releases during 1979.

In addition, two television programs were produced at the Center. One was produced for Taiwan, and the other was by a team from Chicago, USA, for distribution to more than 100 participating television stations.

Board of Directors

Dr Paul C. Ma, Chairman
Director, Food Industry Research & Development Institute
Taiwan, ROC

Dr Dong Soo Kim, Vice-Chairman
Director, Research Bureau
Office of Rural Development
Korea

Dr Yoshiaki Ishizuka
Professor Emeritus
Hokkaido University
Japan

Mr H. E. Arturo Tanco, Jr.
Minister
Ministry of Agriculture
Philippines

Dr Norio Kondo
Professor, Director
The Institute for Breeding Research
Tokyo University of Agriculture
Japan

Dr J. D. Drilon, Jr.
Director, Southeast Asian Regional
Center for Graduate Study & Research in Agriculture
Philippines

Dr T. C. Tso
Chief, Tobacco Laboratory
Plant Genetics and Germplasm Institute
US Department of Agriculture
USA

Dr J. C. Moomaw
Director
Asian Vegetable Research and Development Center
Taiwan

Personnel

Administration

James C. Moomaw, Ph.D., *director**
C.L. Luh, M.S., *associate director (administration)*
James J. Riley, Ph.D., *associate director (research)*
Michael Chin, B.S., *executive officer*
David I.K. Chi, B.S., C.P.A., *comptroller*
J.H. Chen, B.S., *superintendent, buildings and grounds**
C.C. Wang, B.S., *superintendent, buildings and maintenance@*
H.L. Chang, *manager, food and dormitory services**
Flora Chuang, *assistant manager, food and dormitory services@*

Horticultural Crops Program

Romeo T. Opeña, Ph.D., *program leader & associate plant breeder*
San-ho Lo, *research assistant*

Ruben L. Villareal, Ph.D., *plant breeder#*
Sen-hsiung Lai, B.S., *assistant scientist**
Jen-tzu Chen, *research assistant@*
Yu-mei Hsu, M.S., *research assistant*

Charles Y. Yang, Ph.D., *plant pathologist*
Fu-hsiung Lin, B.S., *research assistant**

James J.S. Tsai, M.S., *assistant scientist (plant physiology)*
Bih-wu C. Chung, M.S., *research assistant**

N.S. Talekar, Ph.D., *associate entomologist (Chinese cabbage coordinator)*
Yuo-hua Lin, M.S., *research assistant*
Nan-hsing Lee, B.S., *research assistant@*

Legume Program

S. Shanmugasundaram, M.S., *program leader & associate plant breeder (soybean coordinator)*
Tong-shroung Toung, B.S., *assistant scientist**
Jean-jar Dzou, B.S., *research assistant@**
Kun-te Li, *research assistant@*
Maw-sheng Lee, M.S., *research assistant**

Hyo-Guen Park, Ph.D., *associate plant breeder (mungbean coordinator)*
Tai-Yung Chyau, B.S., *research assistant**
Jou-ruey Juang, B.S., *research assistant**
Meng-Jiau Tserng, M.S., *research assistant@*

Arnold T. Tschanz, Ph.D., *associate plant pathologist (soybean rust)*
Tien-chen Wang, B.S., *assistant scientist*
Li-fen Hu, B.S., *research assistant*
Morgan H. M. Ueng, B.S., *research assistant**

George C.G. Kuo, Ph.D., *associate plant physiologist (tomato coordinator)*
Min-ho Chou, B.S., *research assistant**
Ruey-shyang Huang, M.S., *research assistant@*

Shih-hsin Chiang, M.S., *assistant scientist**
Ben-huai Lye, M.S., *research assistant@*
Bor-shyan Chen, B.S., *research assistant*
Wen-feng Shiao, M.S., *research assistant**

Nutrition, Environment & Management Program

Samson C. Tsou, Dr., *program leader & biochemist*
Su-chin L. Chiu, B.S., *chemical analyst*
Ming-seh H. Lee, B.S., *chemical analyst*
Shieh-te Tan, B.S., *assistant scientist**
Jiang-hsiung Huang, B.S., *research assistant@**

John N. Hubbell, Ph.D., *associate crop management specialist (sweet potato coordinator)**
Mou-yen Chiang, B.S., *assistant scientist**
Yu-chi Roan, B.S., *research assistant*
Hai-an Hsu, M.S., *research assistant*

Hu-mei Wang, M.S., *research assistant*
Su-hua Tu, B.S., *research assistant**
Chiung-pih L. Huang, B.S., *research assistant*

Takayuki Yoshizawa, Ph.D., *soil scientist*
Chih-ping Chu, B.S., *research assistant*
Chin-hua Ma, B.S., *research assistant*
Li-jen Sun, B.S., *research assistant*

Training, Communication & Research Services

Diosdado V. Castro, M.S., *associate training specialist*
Wei-jong Chung, M.S., *training assistant*
Sui-ting Chen, B.S., *training assistant**
Jen-loun Kao, B.S., *training assistant@*
Yi-sung Chen, B.S., *assistant development officer*

Grant I. Johnson, B.A., *associate information specialist*
Robert L. Cowell, M.S., *information associate**

Teng-hui Hwang, B.S., *librarian*

Yung Liang, *farm superintendent*

Leonard Y.L. Ho, M.S., *seed technologist*

Su-may J. Wang, B.S., *computer services assistant**
Rouh-yun Yu, B.S., *statistical assistant**
Shwe-yu Yeh, B.S., *statistical assistant@*

Outreach

Alfredo Palo, Ph.D., *affiliate horticulturalist, Philippines Outreach Program*

**Left during 1979*
@Arrived during 1979
#Sabbatical leave 1979

Since 1979, there have been several staff changes and new appointments. The major changes are listed below:

Administration

G.W. Selleck, Ph.D., *director*
Paul M.H. Sun, Ph.D., *associate director for administration and research*

Horticultural Crops Program

Romeo T. Opeña, Ph.D., *associate plant breeder on sabbatical leave*
Charles Y. Yang, Ph.D., *plant pathologist on sabbatical leave*
Sylvia K. Green, Ph.D., *associate plant pathologist (virology)*

Nutrition, Environment and Management Program

Jack Gershon, Ph.D., *consulting nutritionist*
Creighton Peet, Ph.D., *social anthropologist*
Dennis W. Pervis, Ph.D., *associate agricultural economist*
Adisak Sajjapongse, Ph.D., *associate crop management specialist*
Ichiro Tanabe, Ph.D., *soil scientist*

Training, Communication and Research Services

Tim Griggs, M.A., *head, Office of Information Services*

Finances

Total income designated for AVRDC's 1979 core budget was US$2,025,857 compared with a program budget calling for US$2,023,000. The Republic of China contributed US$999,949, and the United States Agency for International Development contributed US$660,000. The Republic of Korea and the Republic of the Philippines each contributed US$82,500, while Japan contributed US$75,000 and the services of a Soil Scientist. Interest, farm sales, overhead recovery and other income (including miscellaneous grants for general purposes received from President Enterprises Corporation and the Yung-mei Food Industry Corporation) totalled US$125,908.

Additional contributions to the Center for special projects, training scholarships, conferences and symposia totalled US$142,929. Special purpose projects were supported by the Asian Development Bank, the ROC Council for Agriculture Planning and Development, the United States Department of Agriculture, the USI Far East Corporation, and others.

Publications Available

Journal Papers

JP 1 Mackenzie, Photoperiodism of mungbean and four related species

JP 7 Mew, Infectivity and survival of soft-rot in Chinese cabbage*

JP 8 Talekar, Persistence of some insecticides in subtropical soil*

JP 9 Mew, Effect of soil temperature on resistance of tomato cultivars to bacterial wilt

JP 11 Menegay, Crop intensity index: a research method of measuring land use in multiple cropping*

JP 13 Opeña, Derivation of maternals through pseudogamy and evaluation of their potential importance in Chinese cabbage breeding*

JP 24 Villareal, Heat tolerance in the genus *Lycopersicon**

JP 27 Kuo, Translocation of 14-C-photosynthate in *Vigna radiata* during the reproductive period*

JP 29 Lim, Resistance in Chinese cabbage to TuMV*

JP 32 Villareal, The wild vegetables of southeast Asia*

JP 35 Calkins, Labor and input variability in determining vegetable Production technology in Asia*

JP 39 Villareal, Variations in the yielding ability of sweet potato under water stress and minimum input conditions*

JP 40 Villareal, Selection criteria for eating quality in steamed sweet potato roots*

JP 44 Shanmugasundaram, Photoperiodic response of flowering in decapitated soybean plants*

JP 45 Opeña, Genetic control of heat tolerance in heading Chinese cabbage*

JP 48 Riley, Intensive agricultural practices in Asia

JP 50 Hubbell, The Germplasm Accession Information System at the Asian Vegetable Research and Development Center

JP 51 Tschanz, Soybean rust development and apparent infection rates at five locations in Taiwan

JP 53 Kuo, Physiological responses of different tomato cultivars to flooding

JP 54 Kuo, Tipburn of Chinese cabbage in relation to calcium nutrition and distribution

JP 55 Shanmugasundaram, Flower inducing 'potency' of different kinds of leaves in soybean

JP 58 Kuo, Variation in specific leaf weight and RuDPCase activity in mungbean

JP 59 Chiang and Talekar, Identification of sources of resistance to agromyzid beanflies in soybean and mungbean

JP 60 Kuo, Effect of high temperature on pollen grain germination, pollen tube growth and seed yield of Chinese cabbage

JP 61 Kuo, Flower initiation of *Brassica* species under total darkness

Technical Bulletins

TB 1 Menegay, Taiwan's specialized vegetable production areas

TB 2 Menegay, Farm management research on cropping systems

TB 3 Calkins, Four approaches to risk and uncertainty for use in farm management extension

TB 4 Calkins, Farmer's viewpoint on sweet potato production

TB 5 Calkins, Vegetable consumption in five Taiwan cities

TB 6 Huang, Summer tomato production in Taiwan

TB 7 Huang, Vegetable production in Taiwan: A survey of 300 farmers

TB 9 Calkins, Improving the marketing of perishable commodities: a case study of selected vegetables in Taiwan

TB 10 Calkins, White potato production in Taiwan: a farm survey

TB 11 Calkins, Soybean production in Taiwan: a farm survey*

TB 12 Riley, Evaluation of environmental parameters in the humid tropics for crop scheduling purposes

International Guide Sheets

78-63 Park, Suggested cultural practices for mungbean

78-64 Park, Procedures for mungbean evaluation trials

78-65 Villareal, Pollen collector

78-66 Riley, AVRDC crop environment

78-101 Villareal, Procedures to coordinate tomato evaluation trials

78-112 Shanmugasundaram, Suggested cultural practices for soybean

79-121 Hubbell, Suggested cultural practices for sweet potato
79-125 Shanmugasundaram, Procedures for soybean evaluation trials
79-127 Kuo, Suggested cultural practices for tomato
79-134 Villareal, Procedures for sweet potato evaluation trials
80-144 Opeña, Procedures for Chinese cabbage evaluation trials

Annual Progress Reports

1972-73 Report*
1976 Report
1977 Report

Crop Reports

1976 Sweet Potato
1975 Chinese Cabbage

Miscellaneous

Proceedings of the First International Symposium on Tropical Tomato
Proceedings of the First International Mungbean Symposium**

About AVRDC #1, #2, #3, 1979
CENTERPOINT, Spring, Summer, Fall

Weed Control: Herbicide Evaluation Tests

*limited copies only

**may be reprinted

These publications can be ordered from:

The Office of Information Services
AVRDC
P O Box 42, Shanhua, Tainan 741
Taiwan, ROC

Please type or print clearly your name and complete address.