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9. ABSTRACT

Summarizes research conducted on white potatoes during 1976 at the Asian Vegetable Research and Development Center (AVRDC) in Taiwan. The introductory chapter stresses the urgent need for expansion of world food resources and reviews AVRDC's ongoing effort to develop appropriate technologies for improving the production of tropical lowland crops. The report contains research reports on recurrent selection methods to increase heat tolerance in white potatoes, the single most important attribute required for tropical adaption of this vegetable. Experimental data on the pathology, physiology, and nutritional content of white potatoes is also presented. Information on international research cooperation and AVRDC training programs, personnel, and publications concludes the report.

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AVRDC WHITE POTATO REPORT '76

Beautiful children. Healthy and strong in body and mind. Every parent's dream. Diets rich in protein, vitamins, and minerals are essential to the well-being of the growing child whether he lives in Bangladesh or Manila. Paradoxically, vegetables constitute a most important yet usually neglected source of essential nutrients in the developing countries of the tropics.

The Asian Vegetable Research and Development Center White Potato Report for 1976

About this report

The White Potato Report for 1976 summarizes research conducted at the Asian Vegetable Research and Development Center (AVRDC). This report also includes research conducted in 1975. Persons desiring additional details of the work reported may contact Dr. Romeo T. Opeña, white potato coordinator, or the research worker directly responsible.

Data are presented in metric units. Monetary values have been converted to equivalent U.S. dollars. White potato yields are calculated as fresh weight.

"Check" means an untreated experimental plot 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 (/), e.g. *S. andigena/S. tuberosum*. If the progeny is then crossed with another parent, the pedigree would be designated with a second slant bar. Beyond three crosses, however, the designations are /4/, /5/, etc. Commercial chemical names are occasionally used for identification; such use does not imply an endorsement by AVRDC.

Research reports have been published summarizing 1976 activities in tomato (*Lycopersicon esculentum*), Chinese cabbage (*Brassica pekinensis*), sweet potato (*Ipomoea batatas*), mungbean (*Vigna radiata*), and soybean (*Glycine max*). These reports and other technical papers (see page 33) may be obtained by writing the Office of Information Services at AVRDC. Please be sure to give your complete mailing address.

Information and conclusions reported herein are solely the responsibility of AVRDC.

Correct citation: Asian Vegetable Research and Development Center. 1977. White Potato Report for 1976. Shanhua, Taiwan, Republic of China.

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The Asian Vegetable Research and Development Center White Potato Report for 1976

Introduction

"Amidst the thousands of defeated, emaciated refugees, a woman lies on the station platform and gives birth. Several other women come to her aid. One finds a rusty sickle near the tracks and cuts the umbilical cord. Another, seeing the mother is too weak and shriveled to nurse, dabs the infant's lips with coarse table sugar. Burning with fever, the helpless mother watches. Bangladesh has another mouth to feed." (Steve Raymer, 1975)[a]

In every country; throughout history; regardless of class, religion, or politics, children are the hope of mankind. And, yet, this birth in a Bangladesh train station provides a harsh reminder that similar tragedies occur every day in countries around the world, and more frequently in the developing nations. The children, if they survive, very often grow up only to swell the ranks of the world's hopeless and miserable majority. Hunger will be their constant companion; disease, the silent partner in every act.

Malnutrition takes several forms and has many causes with only one known cure -- an adequate and well-balanced diet. Yet, it is not sufficient to consume an adequate quantity of food; we must also be concerned with food quality if we wish our children to progress with the ambitious goals of national development. Far too many children in the developing countries are doomed by malnutrition to lives of irreversible physical and mental damage. Even babies who receive adequate nutrition while being breastfed, often become malnourished after weaning because of the change from mother's milk to a diet of cheap, starchy, nutritionally incomplete foods such as rice gruel, cassava, and bananas. Their tiny stomachs will not hold enough of these bulky staples to provide an adequate supply of protein and other essential vitamins and minerals. Such diets during the early years of life impair the development of the brain and central nervous system, thus preventing the realization of genetic potential and permanently retarding learning capacity. The problems of nutrition are fundamental to every human activity and demand immediate and concerted attention worldwide.

The scientists at the Asian Vegetable Research and Development Center (AVRDC) have been charged with the vital task of developing appropriate technologies and improving production of six vegetable crops in the hot,

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[a] Steve Raymer, 1975. The nightmare of famine. National Geographic 148(1):34.

humid, lowland tropics. Although rice is the principal staple food in these lands, AVRDC's vegetable crops are effective nutritional supplements to a rice diet as they supply plant protein, vitamins, and minerals. Additionally, these vegetables offer Asian farmers opportunities to increase their incomes and, thereby, enhance the quality and security of their lives.

AVRDC was organized in 1971 when representatives from seven interested countries met in Taiwan to sign the Charter and Memorandum of Agreement. By January, 1972, construction of the Center was well under way. Staff members assumed their duties in late 1972 and formally initiated the research program early in 1973. AVRDC was officially dedicated October 17, 1973.

Although an associate member of the Consultative Group for International Agricultural Research (CGIAR), AVRDC receives no funds through the CGIAR framework as do the other international agricultural research centers. Instead, the governments of the Republic of China, the Republic of the Philippines, Japan, the Republic of Korea, and the United States (AID) provide principal funding. Additional donations, often earmarked for specific research, come from the Rockefeller Foundation, the Asia Foundation, International Minerals and Chemicals Corp., the Asian Development Bank, USI(Far East) Corp. and others.

Located near Shanhua on the rich coastal plain of southwestern Taiwan, AVRDC lies 19 km north of Tainan City. Land provided by the Republic of China, contains a 14 ha campus and a 102 ha irrigated experimental farm. The campus facilities include an administration building, a laboratory complex, a domitory/cafeteria, a service building containing shops and germplasm storage, six greenhouses, and residences for the international staff. The experimental farm, formerly planted to sugarcane and now organized for field experiments, is level with silt loam soil and an average elevation of 8 m above sea level.

Completing our fourth research year with the 1976 fall season, AVRDC is working in cooperation with governments, private groups, and individuals to improve breeding lines, develop new crop technology, and distribute information. AVRDC's scientists maintain contact with the international agricultural community through travel and participation in conferences, workshops, and seminars. Through visits to national researchers, cooperative trials on local farms, and involvement in agriculture-related activities, the scientists familiarize themselves with production practices and constraints. Additionally, researchers and production specialists from many countries are trained at AVRDC in an effort to directly improve the capabilities of national vegetable programs.

In the white potato report, we at AVRDC would like to acquaint you not only with some of our accomplishments during the past year, but also with the challenge we face along with our many colleagues in the effort to produce more and better food for a healthier world.

Crop environment

Weather. The amount of precipitation in 1976 (1357 mm) at AVRDC was 42% less than that occuring in 1975 (2380 mm) and 23% below the 73-year mean of 1771 mm/yr (1897-1970)[1]. There were 75 rainy days (normal is 107) and most of the rainfall occured in July and August (Fig 1). In addition, available solar energy for 1976 was 1.3% above the 5-year average for Tainan City (Fig. 2).

Daytime temperatures were high from May through October (above 30°C), and minimum temperatures were above 21°C (Fig. 3). During the winter months (Dec, Jan, Feb), temperatures often dropped below 14°C, and daytime maximum temperatures ranged from 22°C to 25°C. Soil temperatures (10 cm depth) were slightly cooler than the mean daytime temperatures.

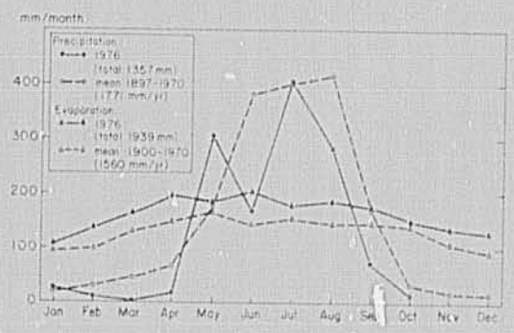

Fig. 1. Monthly precipitation and evaporation data for 1976 at AVRDC compared with means from 1897 to 1970, respectively, for Tainan City. (Reference: Central Weather Bureau, 1974, Summary of meteorological data -- Taiwan, Vol. III).

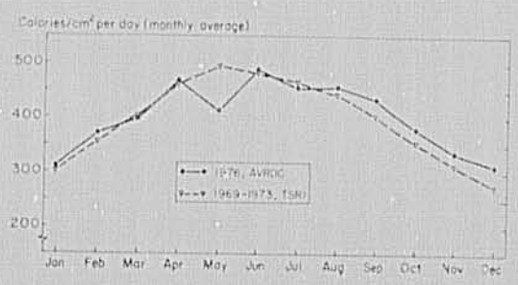

Fig. 2. Solar radiation during 1976 at AVRDC compared with 5-year average at Taiwan Sugar Research Institute.

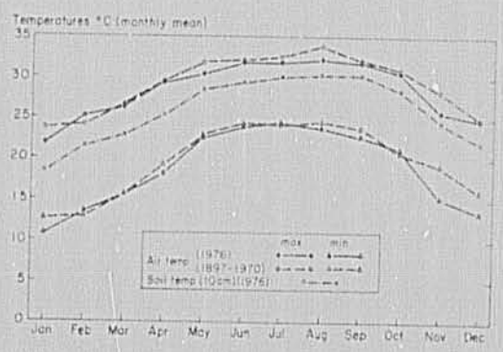

Fig. 3. Temperature ranges for 1976 compared with the means for Tainan City (1897-1970). Soil temperatures (10 cm depth) for 1975 are also included.

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[1] Central Weather Bureau. 1974. Summary of Metrorological Data-Taiwan, Vol. III. Taipei, Taiwan, R.O.C.

The day length at AVRDC ranges between 13 hr and 33 min on Jun 21 to 10 hr and 43 min on December 21. If civil twilight is considered, an additional hour and 20 minutes should be included.

During 1976, three weak tropical storms occured; however, damage to experimental crops in the field was minimal (Table 1).

Table 1. Tropical storms which influenced AVRDC, 1976.

Dates	Max. wind speed knots[1]	Max. wind speed meter/sec	Rain fall mm	Names
May 27 - 30	27.8	14.2	296.16	Olga
Jun 26 - 27	14.8	7.5	67.31	Ruby
Aug 9 - 10	26.9	13.9	131.83	Billie
Total			495.30	

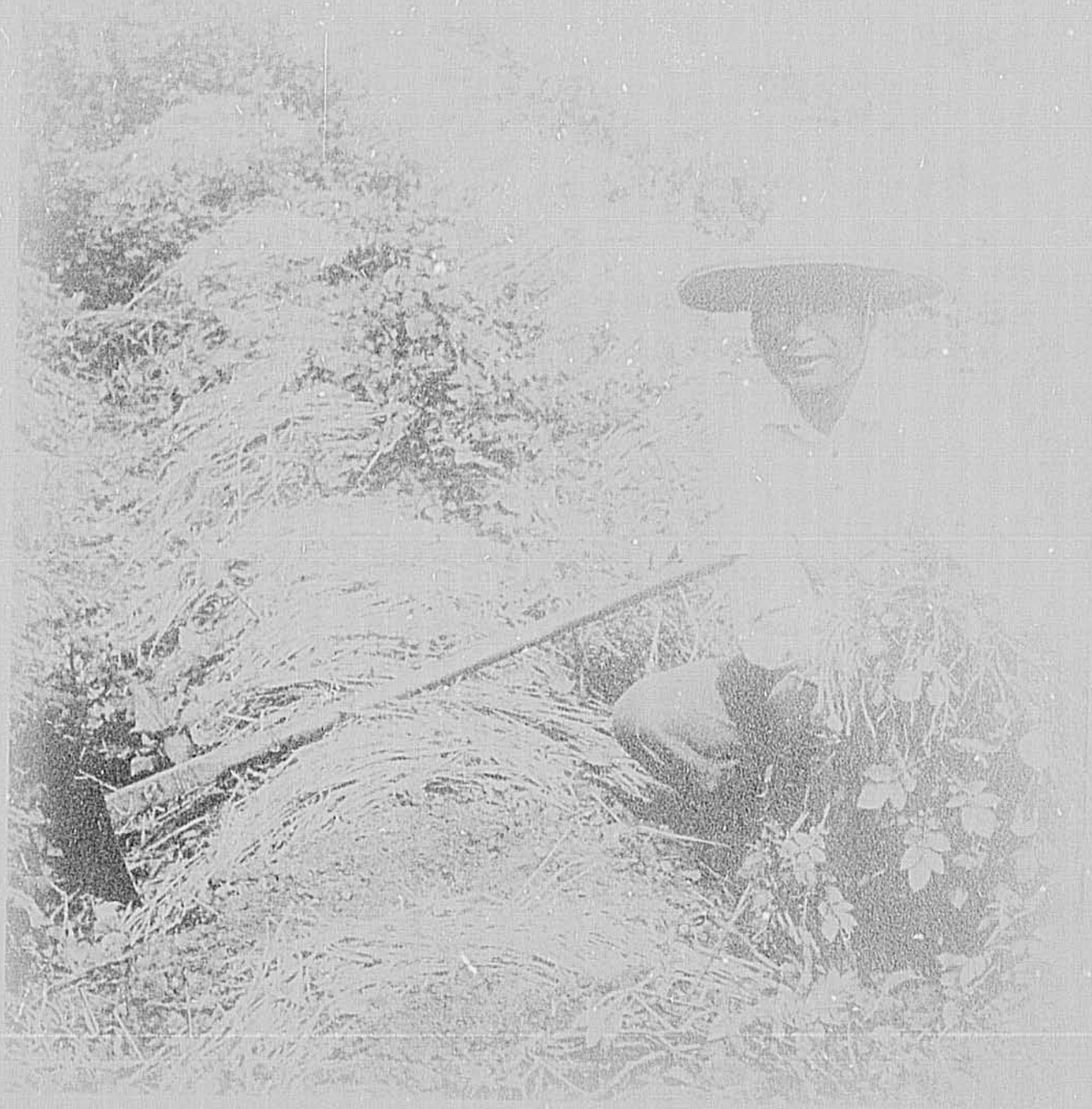
[1] knot = 1.51 mph

Soil. Although four soil series are present in the Experimental Farm, 80% of the area consists of the Take series. In general, the soil is moderately well drained and is derived from a calcareous alluvial parent material. The soil type is a silt loam with approximately 1.4% organic matter (Table 2).

Table 2. Physical and chemical characteristics of a typical soil profile from the AVRDC Experimental Farm, 1976.

Depth (cm)	pH	Texture: sand	Texture: silt	Texture: clay	Organic matter content	Cation exchange capacity	Available nutrients: P	K	Ca	Mg	Mn	Fe	B
		(%)				(me/100g)	(ppm)						
0 to 15	8.6	22	54	24	1.4	9.2	5	27	1990	199	127	223	2
16 to 29	8.2	24	52	24	1.4	9.5	6	19	1890	189	142	243	1
30 to 64	8.4	24	48	28	0.7	8.8	2	17	2090	331	122	268	2
65 to 77	8.6	16	54	30	0.7	10.7	4	24	1900	375	143	356	2

The mean bulk density of the soil is 1.67 g/cm^3. The water available to plants ranges from 23% (field capacity) to 8% (wilting point). The experimental fields are irrigated, when necessary, from wells ranging in depth from 20 to 50 m.



White Potato Research Program 1976

Objectives

Greater formation and expansion of tubers under conditions prevalent in the humid lowland tropics.

Varietal resistance to yield-reducing tropical diseases.

Improved mineral nutrition and cultural methods for higher yields.

Breeding

In AVRDC's brief experience with screening breeding lines, established cultivars, and segregating populations, genotypes with exceptionally high levels of heat tolerance were not encountered. However, a few selected clones appear to be near if not at the threshold of adaptation. It is likely, therefore, that the development of a truly tropical potato may require a gradual stepwise approach in breeding.

Recurrent selection is the most logical breeding procedure to adopt in increasing the present level of heat tolerance among the initial selections. Within the limits of genetic variability, the method should enable the stepwise improvement of populations through a gradual increase in the frequencies of favorable genes. Such an improvement program (Figure 4) forms the core of AVRDC's program to develop cultivars that are physiologically adapted to humid lowland tropics.

The AVRDC collection of tuber-bearing *Solanum* germplasm during 1976 was limited to true seeds, which are considered segregating populations. Six new populations of *tuberosum/vernii* combinations backcrossed several times to *tuberosum* were received from the Max Planck Institute in Germany.

AVRDC developed second cycle populations in the 1975 spring season from intercrosses of 1974 summer selections. Parental components of these crosses were chosen on the basis of single-hill yield data. These populations are listed with their pedigrees in Table 3. Seed samples from five populations were taken to the highlands near Taichung forconversion into first generation clones in the 1975 summer season. Clones harvested from these populations were planted for heat tolerance evaluation at the Twin Rivers Research Center in Davao, Philippines on January 3, 1976. The yield advance of selections from the five cycle 2 populations tested ranged from 67 to 226% of the cycle 1 parents (Table 4). The best cycle 2 clone produced 1500 g of marketable tubers in 88 days. This segregant was isolated from population 9, the most genetically diverse material

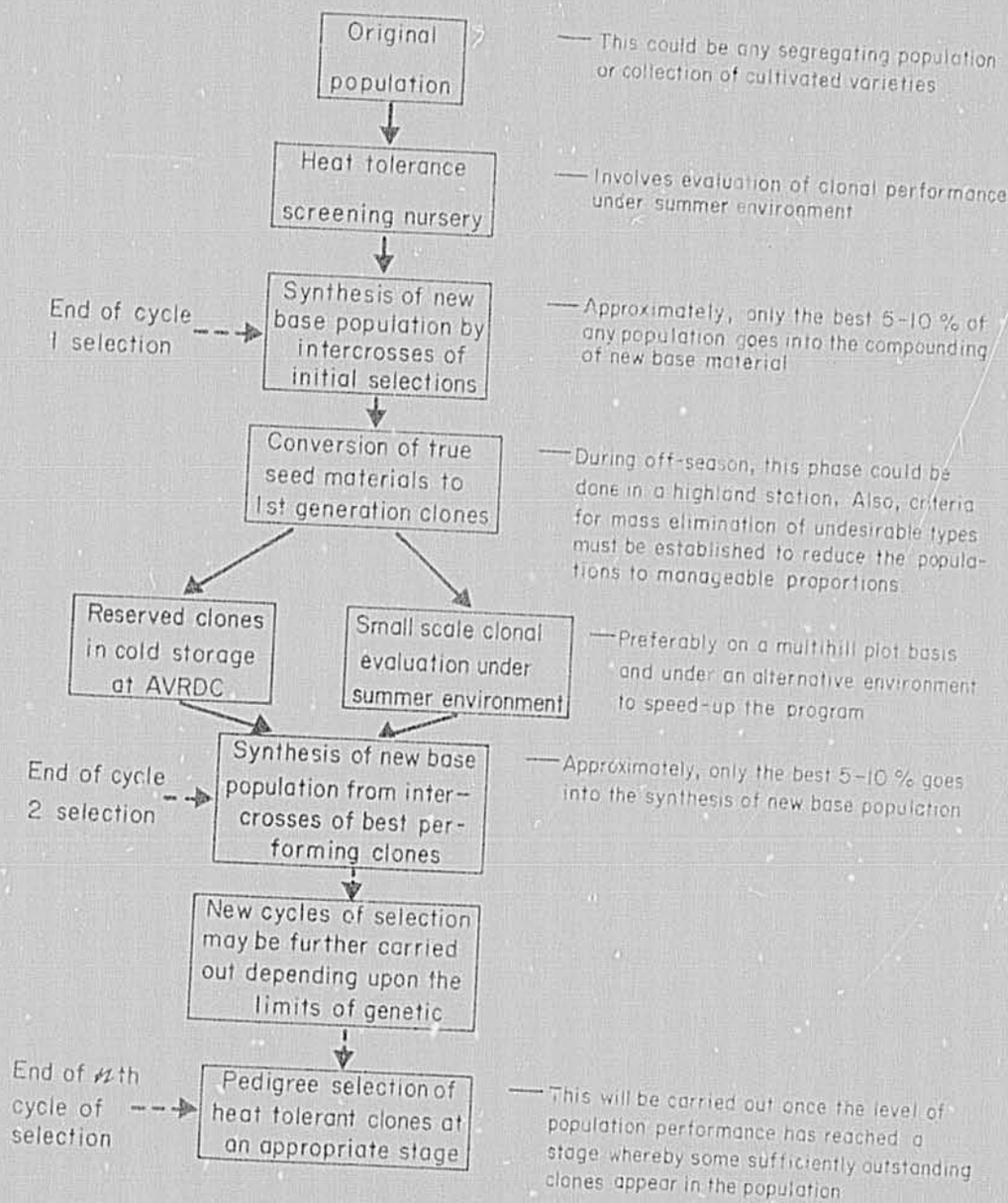


Fig. 4. Flow-chart showing program for increasing the level of heat tolerance in white potatoes; 1976, AVRDC.

developed. On the other hand, the lowest advance was recorded on population 8 which originated strictly from intra-*tuberosum* crosses. Relative to the other populations, it did not possess comparable genetic diversity. In general, performance of materials appeared to be much better in Davao

than at AVRDC due perhaps to its less stringent soil and climatic conditions. The best second cycle clones from the above populations have already been selected as parental components for an additional cycle of recurrent selection.

Table 3. New second cycle populations developed at AVRDC from intercrosses of 1974 summer selections.

AVRDC population no.	Pedigree
8	Bulked pollinations of four selected accessions from Mexican collection.
9	Bulked pollinations of four best selections from University of Guelph (UG) populations, Mexican collection, and intervarietal crosses with Katahdin.
21	Bulked pollinations of the three best clones from UG population 1282.
23	Bulked pollinations of five best clones among UG populations.
33	Bulked pollinations of all selections from UG population 1282.
39	Bulked pollinations of all selections from UG population 1284.

Table 4. Results of two cycles of recurrent selection to improve white potato performance under hot, humid tropical conditions; 1974-76, AVRDC and the Philippines.

Population no.	Mean marketable yield				Approx. yield advance[d]
	cycle 1 selection		cycle 2 selections[c]	best cycle 2 clone	
	AVRDC[a]	TRRC[b]			
	(g/plant)				(%)
8	244		412	525	69
9	372	368	1200	1500	226
21	352	462	880	1148	90
23	351	469	813	950	67
33	310	405	857	1300	112

[a]Screened in summer of 1974 at AVRDC. [b]1975 trial at TRRC near Davao City, Philippines. [c]1976 planting at TRRC. [d]Mean yield of cycle 2 selections divided by mean yield of cycle 1 selections at TRRC except for population 8.

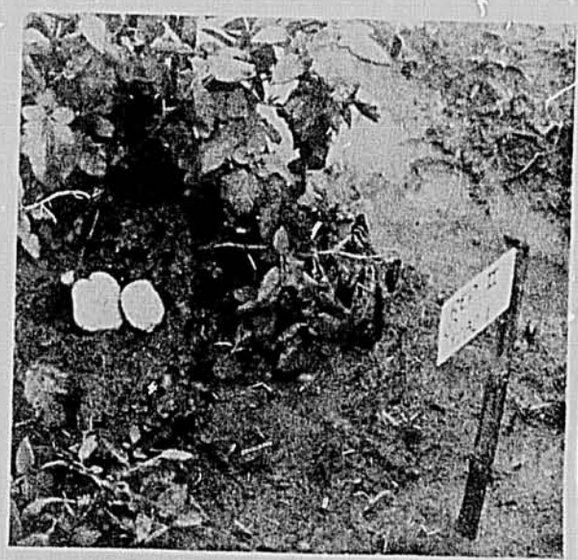
AVRDC breeders also distributed promising cycle 1 selections for heat tolerance trials in Davao City and La Granja, Philippines in 1975. Additional trials were conducted in Malaysia and on the AVRDC Experimental Farm. Only the Philippine trials produced meaningful results.

However, based on the above replicated performance tests, 6 clones were chosen as parents for a new cycle of recurrent selection (Table 5).

Table 5. Marketable yields in 2 trials of the best 6 white potato selections chosen as parental components for recurrent selection; 1975, Philippines.[a]

AVRDC selection no.[b]	Mean yield	Yield	
		Davao City	La Granja
	(t/ha)		
1282-1	16	22	11
1284-18	15	18	12
1282-5	14	16	12
1284-5	13	20	7
1282-4	13	17	9
1284-15	13	16	10

[a]Planted Sep 20 and harvested Dec (1975) at Twin Rivers Research Center (TRRC) near Davao City, Mindanao, Philippines (min temp >20°C); and Oct 27 to Jan 27 (1975) at the UP La Granja Research & Training Center near La Carlota City, Negros Occidental, Philippines. [b]Genetic material selected from populations obtained from the Univ. of Guelph in Canada.



Selection 1282-1 before harvest showing good-size marketable tubers, 1975, TRRC Davao Trial.

Harvest results from 2 replication of selection 1284-12, 1975 TRRC Davao Trial.

Diallel crosses (excluding reciprocals) were made among the above component clones in the 1976 spring season. Out of the possible 15 combinations from the six-parent diallel, sufficient seeds were obtained from only 11 matings. Seeds from these crosses were converted into first generation clones in the 1976 winter season. These crosses will be evaluated for heat tolerance during the 1977 summer season.

All remnant seeds from AVRDC crosses immediately developed in the 1975 spring planting were converted into clones in the 1975 winter season. During the same period, populations received from different sources were also multiplied and/or converted into clones. AVRDC breeders screened these populations for heat tolerance during the 1976 summer season. Table 6 shows a summary of the results. A total of 16,428 seedlings representing 254 families were evaluated.

Table 6. List of white potato segregating populations screened for heat tolerance during the summer; 1976, AVRDC.[a]

Population	Families	Clones	Emergence	Survival	Selections
	(no.)	(no.)	(%)	(%)	(no.)
AVRDC crosses[b]	52	4,339	83	45	42
CIP crosses[c]	35	2,169	86	37	0
Andigena	49	609	71	32	0
Andigena/tuberosum	21	3,365	86	25	0
Phureja-stenotomum	97	5,948	65	3	0
Totals	254	16,428			42

[a]Planted Jun 20 and harvested Oct 3. [b]Progeny of intercrosses of selections from populations with wild species background obtained from Univ. of Guelph. [c]Populations obtained from the International Potato Center (CIP), includes 6 received in 1975.

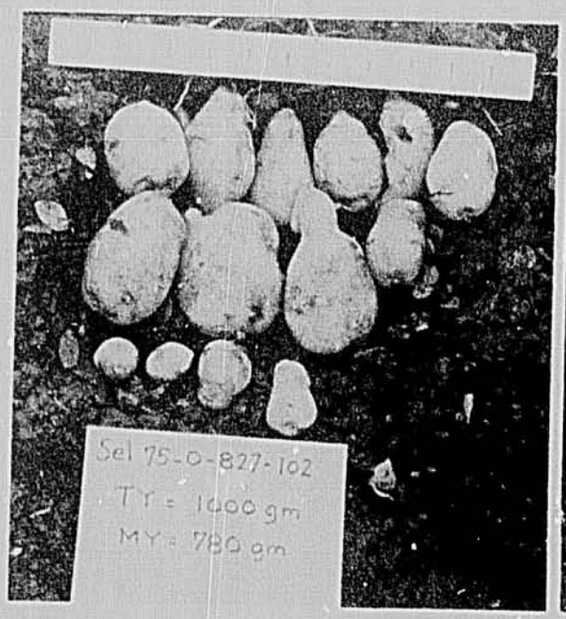
Heat tolerance screening nursery, 1976, AVRDC.

Forty-two selections were initially made from AVRDC crosses. The AVRDC nutrition laboratory performed a total glycoalkaloid analysis on these selections following a report from Davao that some clones from segregating populations had a bitter taste. The number was then reduced to eleven selections with fairly low solanine contents, all of which outyielded the original parents (Table 7). Some clones with solanine contents greater than 20 mg/100 g sample were retained as parental stocks for an additional selection cycle. These outstanding 1976 summer selections are currently being multiplied massively through stem cuttings for yield tests and disease resistance evaluations under lowland tropics conditions.

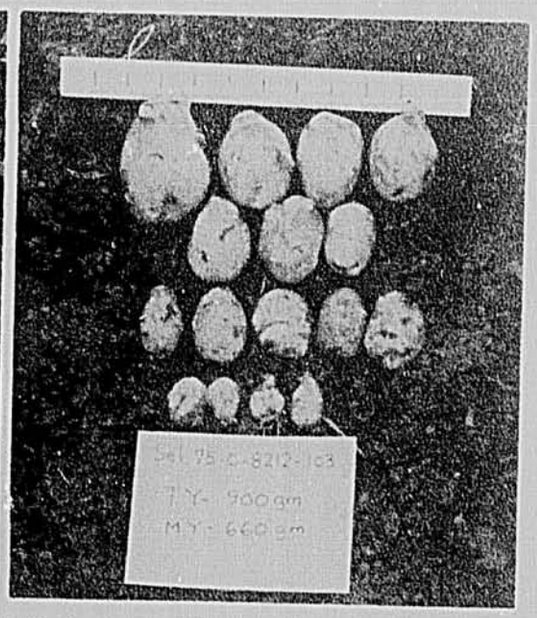
Table 7. Yield and solanine content of the best 5 white potato selections from AVRDC crosses, 1976, AVRDC.[a]

AVRDC selection no.	Yield		Tuber		Solanine content
	total	marketable	total	marketable	
	(g/clone)		(no.)		(mg/100g)
75-0-827-102	1000	780	14	7	29
39-1-106	760	710	12	7	32
75-0-893-237	660	660	6	6	12
75-0-8212-103	900	660	16	7	12
33-15-140	830	640	33	12	31

[a]Planted Jun 20 and harvested Oct 3.



Outstanding selection 75-0-827-102 which yielded 780 g marketable tubers, 1976, AVRDC heat tolerance nursery.



Selection 75-0-8212-103 which yielded 660 g marketable tubers, 1976, AVRDC heat tolerance nursery.

The minimization of potato seedpiece breakdown under high soil temperature conditions was examined in a 1975 summer field trial involving mulching and cutting time. Table 8 shows the summary of the analyses of variance for all characters measured in the experiment. Treatment comparisons showed that planting whole tubers or seedpieces cut one day before planting effectively improved emergence and stand at harvest but did not significantly increase yield. On the other hand, mulching accelerated the rate of emergence, reduced tuber greening, and also promoted haulm growth. The above methods were actively employed during 1976 breeding experiments.

Table 8. Summary of analyses of variance for horticultural characters[a] measured from cutting time × mulching experiment, 1975, AVRDC.

Source of variation	d.f.	Emergence (10 days)	Emergence (20 days)	Emergence (30 days)	Stand at harvest	Haulm growth	Tuber greening	Marketable yield
						(gm)	(%)	(kg/plot)
Treatment	7	23.11	6.58	5.92	5.36	4.01	14.60	2.53
Mulching	1	134.13	ns	ns	ns	10.77	16.56	ns
Cutting time	1	9.48	13.79	12.20	10.51	ns	ns	ns
Mulching × cutting time	1	ns	ns	ns	ns	3.36	ns	3.09

[a] characters such as tuber/haulm ratio, [illegible] infection, total yield, and marketable/total yield ratio were insignificant and therefore omitted. ns = not significant.

Because heat tolerance is the single most important attribute required for tropical adaptation, AVRDC oriented the white potato breeding program towards this characteristic. Breeders conducted an experiment to confirm the possible relationship between heat tolerance and daylength insensitivity. Three hundred accessions from the Mexican collection of cultivated tetraploids were planted on November 7, 1975 under two photoperiods: natural short days (ND) and continuous photoperiod (CLD) using supplemental light. Comparisons showed that 97 accessions did not vary in time to tuber initiation between the two photoperiods.

The experiment was repeated on February 4, 1976. Modification in the design was made to achieve higher light intensity in the experiment. Out of the 97 accessions which appeared to be day-neutral in the first experiment, only 17 were found to be consistent. Long daylength significantly increased plant height and internode length, and reduced haulm growth and the width and length of terminal leaflets. These observations strongly indicate that long days and high temperatures have remarkably similar effects on vegetative growth. Although photoperiod insensitive clones generally performed better than sensitive clones when they were evaluated under hot, humid conditions in summer, 1976, the relationship between photoperiod insensitivity and heat tolerance was not close enough to be a useful screening criterion by itself.

Phenotypic correlation analyses between morphological characters and heat tolerance were carried out using two types of materials. The first involved a sample of 40 selections derived originally from the 1974 heat tolerance nursery. Multiplied during the 1975-76 winter season, observations were made on plant height, haulm growth, tuberization efficiency, leaf length, length and width of terminal leaflet, and total and market-

able yield. The second type of material involved two seedling populations from the recurrent selection program converted into clones during the 1975-76 winter season. Similar data to those above were recorded. Both types of materials were grown in the 1976 summer season for heat tolerance evaluation. Only characters which indicated significant correlations are reported here.

Table 9 shows the simple correlation matrix for measurements made during the two seasons on the original selections. Total and marketable yield during the winter provided the significant correlation with summer performance. Multiple correlation analyses among these traits did not show any substantial improvement in the coefficient of determination. Significant, although rather low, correlations were noted between marketable yield in the summer and tuberization efficiency of seedlings during the winter. Table 10 summerizes the results from the seedling populations.

Table 9. Simple phenotypic correlations (r) between winter and summer data on yield and other characters among white potato selections; 1976, AVRDC.[a]

Winter data	Summer data			
	total yield	marketable yield	tuberization efficiency	haulm growth
Total yield	0.33*	0.39*	0.37*	ns
Marketable yield	0.37*	0.44*	0.36*	ns
Tuberization efficiency	ns	ns	0.58**	-0.56**
Haulm growth	ns	ns	-0.41*	0.45**

[a]* and ** indicate significant correlations at 5 and 1 levels, respectively. ns = not significant.

Although the relationships of summer yield data with a number of winter plant characters do not appear to be close, the technique may be applied to a limited extent in reducing initial seedling populations to manageable size.

Photoperiod sensitivity experiment, 1976, AVRDC.

Table 10. Simple phenotypic correlations between winter and summer data on yield and other characters among white potato seedling populations; 1976, AVRDC.

Winter data	Summer data: population 23 (n=53) marketable yield	population 23 (n=53) total yield	population 33 (n=121) marketable yield	population 33 (n=121) total yield
Total yield	-0.09	-0.21	-0.09	-0.24*
Tuberization efficiency	0.28*	-0.08	0.27**	-0.22*
Haulm growth	-0.15	-0.20	-0.13	-0.22*

Following a preliminary yield trial conducted at AVRDC during the 1975-76 winter season, nine high yielding clones having resistance to late blight (*Phytophthora infestans*) were selected. A second winter trial involving ten breeding lines was conducted on farmer's fields in Fengyuan, Central Taiwan. All cultural and management practices followed the farmer's techniques. None of the selections outyielded the local check, Norin 1, and the four best selections showed comparable horticultural characters to the check. In a spring trial again involving ten breeding lines on farmer's fields in Fengyuan, two AVRDC selections significantly outyielded the local cultivar, Norin 1 (Table 11).

Table 11. Yield data of the best white potato selections compared to Nohrin 1 in a spring yield trial; 1976, Central Taiwan.[a]

AVRDC selection no. (or cultivar name)	Yield: marketable	Yield: total	Marketable to total yield ratio	Marketable tuber
	(t/ha)		(%)	(no./plant)
1491-4	17	26	66	3
1282-14	17	23	73	2
1513-1	15	25	59	3
1511-3	14	23	62	2
1491-3	14	24	56	2
1282-7	12	30	42	2
1522-1	12	18	71	2
(Nohrin 1)	11	19	54	2
LSD 5%	5	4		

[a]Planted Dec 30 (1975) in a farmer's field in Fengyuan in central Taiwan with 2 replications. Harvested early on Mar 24 (84 days after planting). Experiment in cooperation with Fengyuan Farmers' Associations.

In an observational trial, conducted during the 1976 summer season 107 breeding lines selected from the 1974 summer screening nursery and cycle 2 populations grown in the Philippines were planted in farmer's field in Tashe, Taiwan (near AVRDC). Five selections averaged more than

400 g of marketable yield per plant (Table 12). Among these selections, only 1282-15 had been included in the lowland tropics trials conducted in the Philippines. The results suggest that these selections may have better yield potential for lowland tropics than selections previously tested.

Table 12. Mean yields and other horticultural traits for the best 5 white potato selections compared to values for Nohrin 1 in a summer trial; 1976, Tashe near AVRDC.[1]

AVRDC selection no. (or cultivar name)	Hills harvested	Yield marketable	Yield total	Tubers marketable	Tubers total	Haulm growth	Tuberization efficiency[2]
	(no.)	---(g/plant)---		(no./plant)		(g/plant)	
1282-17	5	600	840	5	[illegible]	700	1.2
11R-10	10	511	911	5	18	860	1.1
11R-2	15	409	672	4	14	761	0.9
1282-19	15	409	716	4	14	788	0.9
1282-15	10	401	666	3	12	800	0.8
(Nohrin 1)[3]	12	80	203	1	5	262	0.8

[1]Planted Jun 25 in 3-m single row plots with 2 replication and harvested Oct 20 (120 days).
[2]Total yield divided by haulm growth. [3]Heat-sensitive check.

Harvest on farmer's field in Fengyuan, 1976.

Pathology

Twenty-eight accessions and 88 selections were screened for late blight (*Phytophthora infestans*) at the Taiwan Seed Service during early 1976. Under natural epiphytotic conditions and following artificial innoculation, 8 accessions and 9 selections were found resistant.

Two screening trials for Southern blight (*Sclerotium rolfsii*) were conducted during 1976. In the Spring, two selections out of 61 screened showed resistance. The advanced screening of 30 selections and the preliminary screening of 29 in the fall resulted in resistance for 4 accessions and 3 selections. However, only 1282-3 and 1282-16 were consistently resistant in both trials (Table 13).

Table 13. Summary of potato disease screening trials, AVRDC, 1976.[a]

Disease reaction	No. breeding materials screened	
	spring	fall
Late blight		
no infection (R)	17	-
infected on leaves/stems (S)	99	-
Total	116	-
Southern blight		
no infection or infection only on the outsides of the basal stems (R)	2	7
shoots show wilting but stems do not collapse (MR)	5	11
basal stems lose firmness, shoots collapse, tubers slightly infected (MS)	8	31
shoots collapsed and withered; tubers infected (S)	46	10
Total	61	59

[a]Late blight trials conducted at Taiwan Seed Service; Southern blight, AVRDC.

Physiology

Studies on the physiology of the white potato attempted to identify the reasons for low tuber formation in tropical climates. Exposure of some potato cultivars to high temperature produced an adverse effect on the tuber growth and final tuber yield but not on tuber initiation. The effect of high temperature could act directly on one or more of the enzymes involved in starch synthesis in the tuber. Alternatively, there could also be an indirect effect on tuber growth caused by reduction in the supply of assimilates to the tubers. Both possibilities have been the concern of AVRDC research during 1975 and 1976.

Research to determine the suitable tuber size for comparative studies revealed that activities of sucrose synthetase, UDPG pyrophosphorylase, and soluble starch synthetase increased with increasing tuber size, whereas ADPG pyrophosphorylase and granular starch synthetase remained relatively constant. The activity of phosphorylase, on the other hand, is higher in smaller tubers. Further studies showed that sucrose synthetase and UDPG pyrophosphorylase enzyme activities decreased when the heat-sensitive cultivar Norin-1 was grown under high night temperature (20-25°C), but increased slightly for the heat-tolerant selection 1284-5 under the same conditions (Table 14). The changes in the activities of these two enzymes may be responsible for the variation in tuber growth at high temperatures. However, it is premature to conclude that these enzymes influence the rate-limiting processes in vivo during tuber starch formation.

Table 14. Enzyme activities in potato tubers grown at two night temperature regimes, 1976, AVRDC

Enzyme	Norin No. 1				1284-5			
	15-20°C		20-25°C		15-20°C		20-25°C	
	specific	total	specific	total	specific	total	specific	total
Sucrose synthetase	4.90	36.9	3.9	25.0	2.0	9.6	3.0	16.6
Phosphorylase	19.90	149.0	21.2	134.2	21.0	102.5	29.9	143.2
ADPG Pyrophosphorylase	0.01	0.11	0.05	0.20	-	-	-	-
UDPG Pyrophosphorylase	0.05	0.41	0.05	0.32	0.05	0.23	0.06	0.25
Soluble starch synthetase	0.24	1.81	0.36	2.25	0.37	1.83	0.33	1.61
Granular starch synthetase	1.54	2.62	2.03	3.33	0.52	0.92	1.31	2.72

[a]Specific activity: n mole/min per mg protein. Total activity: n mole/min per g.

Reciprocal grafting experiments between heat-tolerant and heat-sensitive clones demonstrated that high night temperature limited tuber growth more through its effects on the haulm growth than on the tuber itself (Table 15). Follow-up growth analysis studies showed that net assimilation rate (NAR) decreased at tuber initiation and then increased for a short time in Norin 1 and a longer period in selection 1284-5. Within the same accession, high night temperature tended to reduce NAR.

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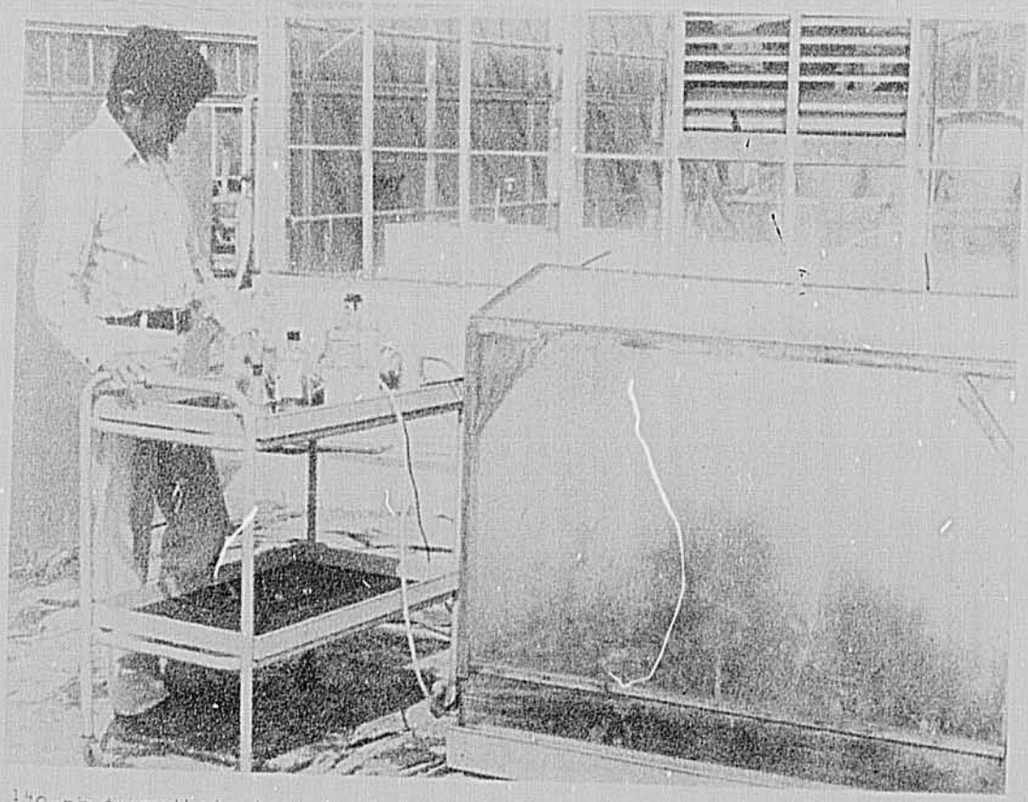
The leaf area of heat-sensitive Norin 1 was substantially reduced under conditions of high night temperatures, yet that of selection 1284-5 was not greatly affected. Concentrations of soluble sugar and starch from different plant parts were also determined in the same experiment. Clones from Norin 1 accumulated less soluble sugar and starch during high night temperatures than during lower temperature conditions. The heat-tolerant 1284-5 showed no differences under either high or low temperature conditions. This implies that more non-structural carbohydrates eventually become available for tuber growth. Potassium, an element reported to influence the translocation processes in white potato, was determined not to be a major limiting factor in tuber growth under high night temperature conditions.



^{14}C-photosynthate translocation studies in white potato; 1976, AVRDC.

Studies of the effect of night temperature on the translocation of 14-C photosynthate in both the heat sensitive cultivar, Norin 1, and the heat tolerant 1284-5 showed that there is greater translocation of 14-C photosynthate to the tuber at low night temperatures than at high night temperatures for Norin 1 (Table 16). There is no difference in the translocation of 14-C photosynthate to the tuber of the heat tolerant selections subjected to high or low night temperatures. This implies that the translocation of photosynthates plays an important role in potato tuber enlargement. Experiments during 1976 investigated varietal differences of photosynthetic rate and dark respiration in response to temperature. Measurements of the net photosynthetic rates (NPR) of leaf disks at varying *in vitro* temperatures showed lower NPR in plants grown under high temperatures. Norin 1, grown under high temperatures, had the highest dark respiration rate at all *in vitro* temperatures. A second experiment using infra-red gas analysis revealed that the NPR decreased in Norin 1 and increased in the heat-tolerant selection, 1284-3, as leaf chamber temperatures increased.

Table 16. Effect of temperature on translocation of ^{14}C photosynthate in Norin 1; 1976, AVRDC.

Temperature treatment	Time (hr)	Plant part	Specific activity (x 103 cpm/g dry wt.)	Total (x 103 cpm)	Distribution (%)
		Tuber	170	2618	34.24
		Root	218	44	0.57
25°C	4	Stem	225	1215	15.89
		Leaf	819	3767	49.28
		Total		7644	100.00
		Tuber	360	4392	44.83
		Root	183	55	0.56
18°C	4	Stem	288	1210	12.35
		Leaf	881	4141	42.26
		Total		9798	100.00

The 1975 and 1976 experiment results suggest that decreased tuber growth under both high day and night temperatures can be ascribed to direct effects on haulm growth. The primary effect is a reduction in the supply of assimilates to the tuber or associated changes. Questions and confirmation regarding these data will provide the focus for 1977 research.

Nutrition

Ninety selected white potato lines grown under hot, humid summer conditions and able to produce marketable size tubers were examined for nutritional quality. The frequency distribution curve for dry matter content followed the normal distribution with a range from 13 to 26%, and a mean of 19%. This value is slightly lower than the norm reported for winter potatoes in Taiwan (22%). Vitamin C was also normally distributed with a range from 11 to 38 mg/100 g, and a mean of 25. The mean was much higher than that reported in Taiwan for winter production (7 mg/100 g). Protein content is comparable for summer and winter grown potatoes, and ranged from 1.3 to 4.4% with a mean of 2.3%. The mean for protein content in Taiwan's winter production is the same. The maximum allowable glycoalkaloid level in potatoes is 20 mg/100 g, but preferably below 10. Total glycoalkaloid (TGA) content among the AVRDC breeding lines was as high as 77.5 mg/100 g. However, 53% of the selected lines had TGA content below 20 mg/100 g, and 32% were below 10 mg/100 g (Figure 5). Further attention will be given to this problem in future research.

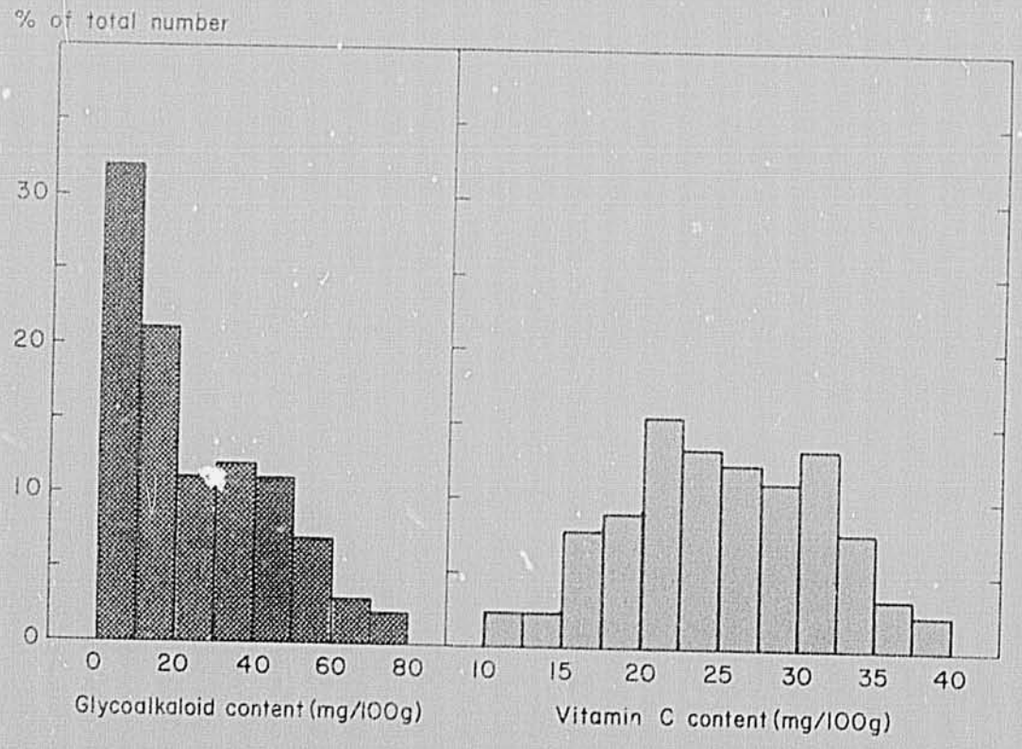


Fig. 5. Distribution of 90 summer white potato lines by glycoalkaloid and vitamin C content, 1976, AVRDC.

International cooperation

During 1976, AVRDC honored requests for potato breeding materials in both clonal and true seed forms from local and international cooperators.

Distribution of clonal samples from our Mexican collection of cultivated tetraploids is strictly controlled by Taiwan quarantine regulations; however, AVRDC provided a limited sample of tubers derived from above-ground cuttings of 42 accessions in 1976 to scientists who expressed interest in these materials.

The Taiwan Sugar Research Institute (TSRI) tested potato as a crop which might be grown on sugar lands left idle during spring. One spring and two fall yield trials served as multiplication plots (Table 17). Each trial was replicated and will be planted for yield selection again in 1977.

Table 17. Summary of yield trials using AVRDC selections; 1976, Taiwan Sugar Research Institute.

Season	Location	Duration	No. entries	No. selections	Marketable yield range	Yield of check (Norin 1)
		(day)			(t/ha)	(t/ha)
Spring	Tainan	99	22	6	9-12	7
Fall	Pou-li	92	64	8[a]	21-35	9
Fall	Tainan	98	64	incomplete	16-51[b]	11

[a]Selection based mainly on yield and tuber appearance. [b]This range includes only all AVRDC selections.

Taichung District Agricultural Improvement Station (Taiwan) tested 37 AVRDC selections to determine a high-yielding replacement for the local variety, Kennebec, for early fall planting. Planting occurs when soil temperature is high and, since the potatoes follow paddy rice, when soil moisture is excessive. The tests produced only one selection (1284-19) which was an improvement over Kennebec under these conditions.

AVRDC's Philippine Outreach Program (Los Baños) conducted trials in which eleven cycle 1 selections produced substantially higher yields than three local cultivars. The best six selections are compared to the local cultivar, Fina, in Table 18.

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Table 18. Mean yields of 6 white potato (cycle 1) selections compared to the local cultivar Fina in a fall trial; 1975-76, Philippines.[a]

AVRDC selection no. (or cultivar name)	Mean yield		Plants surviving to harvest
	(t/ha)	(g/plant)	(%)
1284-19	10	281	70
1282-16	7	201	80
1282-15	7	163	70
1282-18	6	300	50
1282-4	6	243	70
1487-5	6	162	80
(Fina)	1	65	30
LSD 5%	3	87	

[a]12 entries were planted Nov 17 (2975) and harvested Jan 20 (64 days) at Bureau of Plant Industry Economic Garden, Los Baños, Philippines; 1.5 m by 1.5 m plots; 2 replicates.
[b]Bacterial wilt (*Pseudomonas solanacearum*) was a serious problem in this trial.

Comparison between AVRDC selections and one of the checks, Red Pontiac, POP, Los Baños, Philippines.

Training

AVRDC's research and production training programs offer a wide range of opportunities to vegetable research workers and production specialists in tropical countries. The participants learn by doing at the side of AVRDC's scientific staff. Upon their return home, they strengthen national programs and serve as valuable cooperators in the testing of AVRDC breeding materials and technology under local conditions.

During 1976, 57 trainees from nine countries participated in the various training programs. In the white potato program, Jaime B. Rebigan from the Philippines conducted research regarding the evaluation of glycoalkaloid content in AVRDC white potato breeding lines, and participated in experiments in flower induction. Jiun Yih Kuo from Taiwan conducted a yield trial for fall cropping season.

A training brochure which describes the training opportunities at AVRDC in greater detail is available by writing to the Training Officer.

Trainees record yield results as part of their research, AVRDC.

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