PN-AAW-624

1980

CIMMYT Report On WHEAT IMPROVEMENT

A Report on the Wheat Improvement Program
of the International Maize and Wheat Improvement Center
El Batan, Mexico

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Director's Introduction

In February, 1981, the agricultural scientific community suffered the loss of one of its most dedicated and able members, Dr. R. Glenn Anderson, CIMMYT's Wheat Program Director. He is missed not only by his friends and colleagues in the Wheat Program, but also by hundreds of people the world over who had occasion to know him. Dr. Anderson's work made a decisive difference in the welfare of millions of rural and urban poor in the developing world. When I was chosen to succeed him, I found a program that was extremely well-staffed, imbued with the dedication, energy and enthusiasm of its former leaders, and primed to meet the wheat production challenges of the 1980s. I feel privileged to have the opportunity to participate in this global endeavor.

THE WORLD WHEAT SITUATION

Global wheat production in 1980 was close to record levels. At 446 million tons, production was about 6 million tons higher than long term, straight line projections. Most of the increase over 1979 levels of production was due to developed countries, which produced 25 million tons more in 1980 than in 1979. Primarily because of less than normal harvests in China, wheat production by the developing countries in 1980 was about five million tons below 1979.

"For the decade of the 1970s, production increases were proportionately much greater in developing countries than in the developed world."

For the decade of the 1970s, however, production increases were proportionally much greater in developing countries (nearly a 50 percent increase) than in the developed world (roughly a 35 percent rise). Much of the global production increase over the last decade was due to higher yields, which rose by some 30 percent for the world as a whole. Third World wheat producers increased yields by about 40 percent, thanks primarily to the widespread adoption of improved semidwarf wheats and investments in irrigation. Developed countries achieved a smaller increase (about 20 percent), but their initial yields were generally much higher.

Other factors, of course, also contributed to this rising production. On a global basis, the area planted to wheat expanded by roughly 5 percent over the 1970s (about 12 million hectares), and in many countries the percentage increase was much higher. The use of production inputs, primarily nitrogen fertilizer and irrigation water, has risen dramatically. For example, in 1974 the global use of nitrogen fertilizer stood at about 40 million tons. In 1980, only six years later, this figure had increased to almost 50 million tons, a jump of 25 percent.

The dependability of yield has also increased substantially across environments, primarily due to the distribution and adoption of management-responsive varieties possessing better resistance to diseases, particularly the rusts. Improved agronomic practices also play an important role in enhancing the dependability of yields. In Turkey, for example, production nearly doubled between 1970 to 1980, rising from 9 million to about 17.2 million tons. This impressive increase resulted primarily from the application of water-conserving cultural practices on the Anatolian Plateau. Varietal changes contributed little to this gain.

Over the past decade, world wheat consumption essentially kept pace with the increase in available supplies. In the developed world, the average wheat demand for all uses has leveled off at about 175 kg per capita per year. In the Third World countries, however, wheat has now become one of the single most important sources of calories, and to a lesser extent protein, in the diets of hundreds of millions of people. In the developing countries, wheat demand has increased by about 73 percent over the last ten years, a phenominal 5.4 percent annual growth rate that, were it to continue indefinitely, would result in a doubling of Third World demand for wheat every 13 years!

"In the developing countries, wheat demand has increased by about 73 percent over the last 10 years..."

The fact that most of the growth in demand for wheat during the last decade has ocurred in the Third World, while much of the increase in production (in absolute terms) was accomplished in developed countries, contributed to a considerable expansion in world wheat trade. Over the last 10 years, trade grew from about 53 million tons to about 92 million tons per year, and in 1980/81, developing countries as a group imported some 59

million tons of wheat. The Third World share of global wheat imports has steadily increased and, with only a few notable exceptions (such as India, Pakistan, Turkey and Argentina), the degree of wheat self-sufficiency of developing nations relative to rising demand has actually fallen somewhat during the 1970s.

WHEAT PROGRAM HIGHLIGHTS

Thus, as the CIMMYT Wheat Program moves into the 1980s, the challenge before us remains as clear and as immediate as it was at CIMMYT's inception. Our approaches to meeting this challenge, however, have changed as our opportunities and options have changed. The first 15 to 20 years of breeding and agronomic research here in Mexico focused on developing a semidwarf plant type, capable of greatly improving wheat production in many of the larger wheat-growing areas of the developing world. During this period, nearly all our efforts were concentrated on irrigated (or irrigable) regions in the Third World, such as the Gangetic and Indus plains of the Indian Subcontinent and the Yaqui Valley in Mexico.

"... as the CIMMYT Wheat Program moves into the 1980s, the challenge before us remains as clear and as immediate as it was at CIMMYT's inception. Our approaches to meeting this challenge, however, have changed ..."

During the last decade, a greater amount of our resources were directed toward addressing the problems of rainfed wheat production. The basic plant type did not change, but greater resistance to the rusts was incorporated and agronomic practices designed to enhance cultivation and production in rainfed areas were developed and promoted. As noted earlier, Turkey provides an excellent example of what a dedicated and energetic national program staff can do, with the assistance of institutions like Rockefeller Foundation, CIMMYT and Oregon State University (USA). The overall result of CIMMYT's efforts in rainfed environments, which were made in close collaboration with the affected national programs, has been a significant increase in wheat production in Argentina, parts of North Africa and the Middle East.

For the 1980s, the CIMMYT Wheat Program is gearing its efforts toward improving the level and stability of yields, particularly in the more marginal production environments. This means enhancing the resistance of our high-yielding, widely adapted, semidwarf lines to such organisms as *Septoria tritici, Helminthosporium* spp., and *Fusarium* spp. It also means the development of germplasm possessing greater tolerance to problem soils (eg. aluminum and salt tolerance), as well as to environmental extremes (eg. drought, cold and heat tolerance). We are also working to develop disease resistant germplasm that matures earlier, which would be suitable for the warmer subtropics.

To help accomplish these interrelated objectives, we are developing smaller, more site-specific bread wheat, durum, triticale and barley nurseries for testing and selection of germplasm. Lines are being advanced as F_2 bulk nurseries, and are classified according to their probable utility. For example, six F_2 nursery categories were used in the bread wheat program in 1980: spring x winter, irrigated, dryland, septoria resistance, aluminum toxicity resistance and early maturity. Our F_2 bulk nurseries are made available each year for international distribution, and mailed to cooperators according to requests and the appropriateness of geographic locations.

"... the CIMMYT Wheat Program is (now) gearing its efforts toward improving the level and stability of yields, particularly in the more marginal production environments."

In line with the broader CIMMYT Wheat Program objectives for 1980 and beyond, our bread wheat and durum wheat programs are achieving satisfactory progress in the incorporation of disease resistance and tolerance to problem soils and environmental extremes. Among our bread wheat materials, a large number of lines with excellent septoria resistance have now been identified. This was done by way of a cooperative screening and breeding program involving early-generation testing at Patzcuaro, Mexico, followed by evaluation of later generations at the Bet Dagan Experiment Farm in Israel. A cooperative shuttle breeding effort involving CIMMYT and three crop improvement programs in Brazil is showing steady progress (see Special Programs).

The development of durums with good stripe rust resistance has been quite successful. More resistance is needed, however, for leaf rust, and much more for stem rust. Recent data from international testing indicate that progress is being made in this regard.

As the world durum area expands, other diseases are becoming serious threats. Nearly all semidwarf durums show high levels of susceptibility to *Septoria tritici*, head scab, and the barley yellow dwarf virus. Much greater emphasis is being placed on screening for resistant germplasm in disease hot spot areas.

Efforts continue in the modification of the head architecture in durums to increase yield potential and to permit faster drying after rain and mist, thus reducing conditions for incidence of head-rotting diseases. Progress has been made in developing long, lax and semi-lax heads with greater spacing between spikelets, traits which reduce the incidence of these disease problems.

The special nature of triticale calls for somewhat different germplasm development objectives. In general, triticale has few problems with diseases, at least to date. They continue to demonstrate high levels of resistance to the rusts, to several smuts, and to powdery mildew. Good sources of resistance to septoria have been identified and selection should not be difficult. One major objective involves a continuous effort to improve seed type and test weights; more specifically to combine the high test weights of certain lines with the high yield and good adaptation found in many of the triticales. In the 1980 Sonora cycle, we identified a strain having a test weight higher than 80 kg/hl.

A permanent objective of our triticale breeding program is the introduction of greater genetic variation. This is being done by producing new amphiploids; by backcrossing triticale to its parental species, wheat and rye; and by introducing germplasm from other triticale programs around the world.

In 1980, the incorporation of disease resistance was the top priority of CIMMYT's barley improvement program. In the summer cycle at El Batan, uniform artificial epidemics were created for leaf rust and scald, and several resistant selections were made. Progress was also made toward identifying resistance to BYDV and loose smut. These materials will be further tested in disease hot spots, in collaboration with regional CIMMYT staff and national programs.

As usual, the work of our breeding programs in 1980 was greatly facilitated by the efforts of our various support units. The special germplasm development unit continued its work in such areas as protein improvement, aluminum toxicity tolerance, rust resistance, yield components, and the generation of new primary triticales. Our wide crosses unit made progress toward its primary objective of obtaining subtle alien gene transfers to wheat from such distantly related genera as *Elymus* and *Agropyron* species. The wheat milling and baking laboratory evaluated thousands of early generation and advanced lines previously selected on the basis of good grain type. And the pathology group, agronomy program, international nurseries, and training program all continued to fulfill their various responsibilities.

REGIONAL AND COOPERATIVE PROGRAMS

Of CIMMYT's wheat staff posted outside Mexico, most were assigned to regional programs. Only one staff member was working in a national program assignment—in Pakistan. His work focused mainly on production agronomy research. In 1980, three staff members assumed new regional responsibilities in North and West Africa, in South and Southeast Asia, and in cooperation with ICARDA. In total, the wheat program had staff assigned to seven regional programs in 1980. Reports from these staff members are contained herein.

The Wheat Program takes pride in the warm associations it has with scientists and leaders in countries all over the world. We consider ourselves to be full partners with national program scientists in our efforts to improve wheat, triticale and barley. We act as a clearing house for information and for germplasm distribution, we train promising young national program scientists, and we assist national programs more directly through our expanding regional activities.

Special mention, however, must be made of CIMMYT's unique relationship with the National Institute of Agricultural Research (INIA) of the Government of Mexico. Research on bread wheat, durum wheat, triticale and barley are conducted jointly, yet separately in many ways. The National Institute has its own research program within Mexico, yet germplasm flows freely between INIA and CIMMYT. CIMMYT operates the summer cycle nurseries at El Batan and Toluca, but with regular input from some INIA scientists. In the winter cycle, CIMMYT is privileged to work together with CIANO, the Northwestern Branch Section of INIA, on the CIANO station at Ciudad Obregon. The farmers' organization of the area, known as the PATRONATO, provide half of the operating costs needed for these winter nurseries. CIMMYT greatly appreciates this support; it is our hope for the future, as in the past, that our joint programs will continue to supply superior varieties to the farmers of Mexico.

SPECIAL PROGRAMS

In 1980, most of the special collaborative research programs described in the 1979 Annual Wheat Improvement Report continued unabated. Worthy of special mention are the spring x winter crossing programs, the Brazilian shuttle breeding project, and our regional disease surveillance program.

CIMMYT is working in cooperation with Oregon State University (OSU) to transfer useful genes between spring and winter wheats. Through this crossing program, spring x winter lines are emerging that possess higher yield potential and greater environmental stability than straight spring x spring varieties. For the last two years in the international nurseries, spring x winter selections have posted the top yield performance across all testing locations. These selections also appear to possess better resistance to *Septoria tritici* and stripe rust, as well as better drought tolerance.

In 1974, CIMMYT signed formal agreements relating to three breeding programs in Brazil for cooperative work on aluminum toxicity in wheat. This cooperative program involves the EMBRAPA, FECOTRIGO, and OCEPAR programs in Brazil. Crosses made both in Mexico and Brazil are designed to incorporate high yield, rust and septoria resistance, and semidwarf plant type into materials with tolerance to aluminum toxicity. Promising breeding materials

are shuttled in each successive generation between Brazil and Mexico as part of the improvement program. In 1980, a new laboratory facility was added at El Batan to permit rapid prelimianry screening for aluminum toxicity tolerance in relatively large amounts of breeding material. By the end of the 1980 season, 46 crosses with a variable number of sister selections per cross had been identified that had the sought-after combinations of good plant type, rust and septoria resistance, and aluminum toxicity tolerance.

CIMMYT's regional wheat disease surveillance program is funded by the Government of the Netherlands. The problems of wheat diseases in an area stretching from Morocco to East Africa to the Indian Subcontinent continue to be the major activity for the CIMMYT staff assigned to this program. In additon to normal regional program activities related to consultation and training assistance, these CIMMYT regional staff are working on two unique projects: a disease surveillance-early warning system for the region and a series of in-service pathology workshops focused on practical field and laboratory methods for inoculation, screening, and identification of disease resistant lines. Details concerning these activities are provided in the disease surveillance program annual report included in this document.

A NEW FORMAT

As I am sure you have noticed, this report is late in arriving. While the information contained herein is still of interest to our colleagues around the world, its timeliness has diminished considerably. This situation has arisen for numerous reasons, some controllable, others not. The important point is that we recognize the reader's need for more timely delivery of this and other pertinent information developed and/or analyzed by CIMMYT.

In an effort to accomodate a more rapid delivery schedule, we are significantly changing the format of CIMMYT's Annual Wheat Improvement Report. Beginning with the 1981 Report, we are shifting away from the all-inclusive format of past reports to a series of subprogram reports that include all relevant data for the year. These reports, of which there will be six, will be printed shortly after they are completed by the individual authors, rather than waiting for the completion of annual reports for all units in the Wheat Program. They will be printed in a rapid and less expensive fashion, similar to our nursery bulletins, and hence we will be able to include more information.

At this time, the six subprogram reports include bread wheat, durum wheat, triticale, barley, wide crosses and regional activities. These reports will be augmented each year with an in-depth examination of one of the crop programs. Other research information bulletins (eg. the milling and baking properties of triticale) will be developed as warranted. In this way, we intend to meet our colleagues' needs for timely, yet comprehensive reporting of CIMMYT's wheat breeding research.

Byrd C. Curtis

Byrd C. Curtis
Director, CIMMYT Wheat Program

Bread Wheat

The central objective of the CIMMYT bread wheat program continues to be the development of widely adapted, high-yielding, disease-resistant germ plasm for worldwide distribution. The initial emphasis on disease resistance, which focused on stem rust in the 1950s and 1960s, was expanded in the 1970s to include resistance to leaf and stripe rusts and *Septoria tritici*; it will be further expanded in the 1980s to include resistance to scab and helminthosporium. This expansion has been a three-phase process of widening our breeding strategy to continue to serve CIMMYT's worldwide mandate.

Phase 1 involved 15 to 20 years of breeding and agronomic research to develop a semidwarf plant type, one suitable to advance wheat production in many of the larger wheat-growing areas of the world. The rapid adoption of CIMMYT germplasm in the irrigated areas of the Gangetic and Indus plains of the Indian Subcontinent and the Yaqui Valley and Bajio region of Mexico were largely due to the benefits derived from that new plant type.

Phase 2 (about 1970 to 1980) required the expansion of germplasm production to address more directly the problems of rainfed wheat production, particularly in areas where rusts and septoria are endemic. The basic plant type remained unchanged. The result has been a substantial increase in wheat production in Argentina, North Africa, the Iberian Peninsula and the Middle East.

We see the third developmental phase of the CIMMYT bread wheat program to involve the incorporation of resistance to *Septoria tritici, Helminthosporium sp.*, scab, and aluminum toxicity into high-yielding, widely adapted, semidwarf wheats. The expected payoff is increased wheat production in large areas of Brazil, Argentina, the state of Michoacan in Mexico, Korea, Bangladesh, Nepal, the countries of the Mediterranean Basin, and China. Substantial progress has already been achieved in the incorporation of resistance to aluminum toxicity, but the ultimate utility of this germplasm will not be realized until resistance to scab, helminthosporium, and septoria is achieved individually and in the appropriate combinations. The success of Phase 3 rests largely in the hands of the national program cooperators, who are full partners in this research.

It is our belief that in areas where significant germplasm improvement has been realized, a concerted effort must be maintained to assure that high yield is sustained while genetic vulnerability to diseases is minimized. The CIMMYT bread wheat program will continue to open new avenues of research when requested by national program cooperators and, with the concurrence of the CIMMYT directing staff, where large areas of wheat production in the LDCs are affected.

With the regionalization of some CIMMYT activities, we have responded in our crossing and selection system in Mexico by channeling appropriate germplasm to specific regions. Nevertheless, CIMMYT's basic breeding philosophy remains unchanged; only widely adapted wheats are cycled in crosses to germplasm with specific disease resistance.

The world area occupied by semidwarf wheats continues to increase. In the 1979-80 season at least 30 million hectares in the LDCs were seeded to varieties containing semidwarf germplasm developed by CIMMYT and its national program partners. While the major activity of the bread wheat program continues to be the maintenance of high yield and wide adaptation with reduction of genetic vulnerability to septoria and the three rusts, it is felt that increased effort is necessary to incorporate resistance to scab and helminthosporium in a large proportion of the CIMMYT bread wheat germplasm. This will facilitate further expansion of wheat into more tropical environments.

The rapidly increasing practice of using crop rotations in which wheat follows rice, particularly in the Indian Subcontinent and Southeast Asia, dictates the development of early-maturing germplasm. This is another area of increased emphasis in the 1980s.

We again acknowledge the continuing cooperation we receive from Mexico's Centro de Investigaciones Agrícolas del Noroeste (CIANO), Ciudad Obregon, where a full breeding cycle is carried out each year. The facilities and interested support of CIANO scientists play an important role in CIMMYT wheat improvement programs.

Because of CIMMYT's global involvement, the bread wheat program must confront numerous problems associated with environmental variability. Thus a wide genetic base must be maintained for such characters as yield, wide adaptation, disease resistance and industrial quality. Here, Dr. Sanjaya Rajaram, leader of the bread wheat program, examines a promising Veery sister selection.

GERMPLASM RESOURCES

Genetic variability for (a) agronomic, (b) physiological, and (c) disease resistance characteristics are the building blocks that, in recombinations, produce germplasm useful over a diverse array of environments. During the 1950s and early 1960s, CIMMYT worked to replace the genes for tallness in normally tall wheats with the Norim 10 dwarfing genes. The narrowing of genetic background became a major concern, particularly in relation to resistance to diseases other than stem rust. Numerous scientists predicted doom for the world wheat crop due to genetic vulnerability. While CIMMYT scientists were fully aware of stem rust and septoria epidemics occurring during this period, over 25,000 well-planned crosses were made to combine semidwarf plant habit with Mexican wheats that possessed stem rust resistance, high spikelet fertility and day-length insensitivity. By the end of the 1960s, widely adapted, high-yielding, stem rust-resistant germplasm produced by CIMMYT was being rapidly adopted throughout the developing world. To further minimize the possibility of a pandemic outbreak of disease, CIMMYT made another 50,000 crosses that fortified disease resistance and diversified the germplasm base. The case of genetic vulnerability in relation to CIMMYT wheats continues to be argued in the scientific community. However, largely due to effective diversification of varieties by national wheat programs, no pandemic outbreak occurred in the 1970s.

Table 1. Varietal distribution by region and characteristics of entries in the spring wheat crossing block, 1980

Region	Characteristics	No. of entries
I.	Widely adapted high-yielding varieties	64
II.	Varieties from Andean region with high level resistance to stripe rust	11
III.	Varieties from Southern Cone region	57
IV.	Varieties from Brazil with high level resistance to aluminum toxicity and *Septoria nodorum*	10
V.	Varieties from North America showing high level resistance to stem rust	9
VI.	Varieties from Australia resistant to stem rust	10
VII.	High-yielding varieties from Indian subcontinent	13
VIII.	Varieties from Middle East and North Africa tolerant to *S. tritici*	32
IX.	Varieties from East Africa resistant to stem rust, stripe rust and *S. tritici*	57
X.	Varieties resistant to leaf rust in Mexico	55
XI.	Varieties resistant to *S. tritici* in Israel and Patzcuaro, Mexico	29
XII.	Early lines suitable for wheat-rice rotation in Southeast Asia	18
XIII.	Varieties with good industrial quality	59

A portion of this desired variability is available and is apparently of sufficient magnitude to protect the world's wheat crop. Tables 1 and 2 indicate CIMMYT efforts to diversify its base gene pool. Nevertheless, the battle between plant scientists and plant pathogens continues due to the ever changing virulence of fungi. Breeding approaches designed to negate the problems of genetic uniformity have

Table 2. Varietal distribution by region and country of entries in the winter wheat crossing block, 1980

Region and country		No. of entries
WESTERN EUROPE		54
France	24	
England	20	
Netherlands	3	
West Germany	5	
Austria	2	
EASTERN EUROPE		54
Hungary	16	
Poland	6	
Bulgaria	4	
Rumania	18	
Yugoslavia	8	
Czechoslovakia	2	
UNION OF SOVIET SOCIALIST REPUBLICS		7
FAR EAST		26
Japan	1	
South Korea	5	
Peoples Republic of China	20	
SOUTH AMERICA		22
Argentina	1	
Chile	21	
TURKEY		14
UNITED STATES OF AMERICA		161
Colorado	5	
Indiana	3	
Kansas	4	
Minnesota	1	
Nebraska	8	
Oklahoma	7	
Oregon	130	
Texas	1	
Washington	2	
TOTAL		338

been in use at CIMMYT for some time. Although debate on methods continues within the scientific community, we will continue to do whatever is necessary to address the problem. While a large rise in yield potential would be immensely satisfying to everyone, the 50,000 hybridizations planned for the 1980s will be primarily directed toward stabilizing disease resistance.

BREEDING AND TESTING LOCATIONS

Table 3 lists the seven locations in Mexico where CIMMYT breeding materials are evaluated for agronomic characteristics and disease resistance. These sites differ in daylength, relative humidity, temperature, soil type, rainfall amount and distribution, and disease spectrum.

Segregating materials and advanced lines are evaluated in Ciudad Obregon and Toluca alternately, which facilitates selection for superior plant type and resistance to the three rusts. Figure 1 shows temperature data for the CIANO experiment station (Ciudad Obregon) for the breeding cycles of 1978-79 and 1979-80, compared to the long term average for 1960-80. Record wheat yields were set in the 1978-79 season, while yields were lower for the 1979-80 season. This appears to be due, in part, to the generally warmer temperatures during flowering (February) for the 1979-80 season.

Advanced material is also tested in Mexico at El Batan, El Refugio, Los Mochis, and Rio Bravo for leaf and stem rust resistance. Patzcuaro, in the state of Michoacan, Mexico, provides conditions amenable to testing for resistance to *S. tritici*. Field screening for resistance to aluminum toxicity continues to be done in Brazil by EMBRAPA (Passo Fundo), FECOTRIGO (Cruz Alta) and OCEPAR (Paraná). In addition, laboratory analysis has been initiated as a preliminary screening method in El Batan.

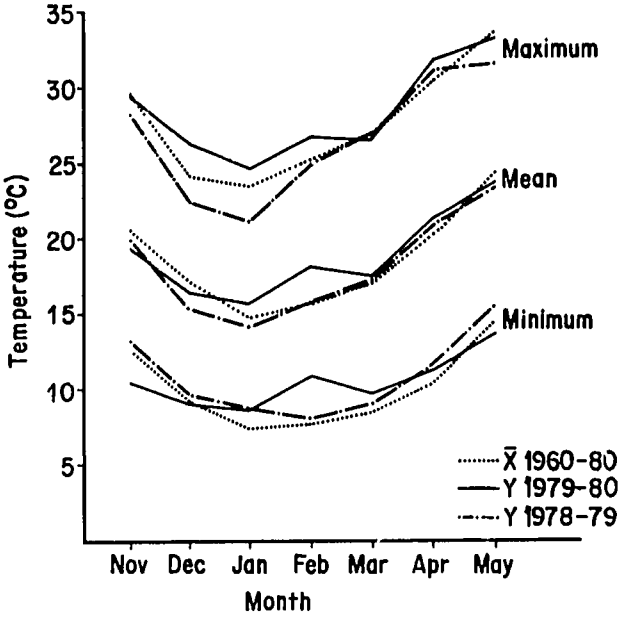


Figure 1. Comparison of air temperatures during the winter growing season for the period 1960-80, 1978-79 and 1979-80 at the CIANO Experiment Station, Ciudad Obregon, Sonora, Mexico

Table 3. Testing locations in Mexico with different disease spectra for wheat

Disease	Locations (with altitude in meters)						
	Ciudad Obregon (38)	Toluca (2640)	El Batan (2249)	Los Mochis (15)	El Refugio (1500)	Rio Bravo (30)	Patzcuaro (2043)
Stem rust	X	X	X		X	X	
Leaf rust	X		X	X	X	X	
Stripe rust		X	X				
Septoria tritici		X					X
Septoria nodorum		X					
Fusarium spp.(scab)		X					
Fusarium nivale		X					
Loose smut	X		X				

DEVELOPMENT OF GERMPLASM

Due to CIMMYT's global involvement, the bread wheat program must confront the numerous problems associated with environmental variability. For example, disease spectra, amount and distribution of precipitation, and soil type all contribute to the characterization of an individual location. Consequently, a wide genetic base must be maintained for characters such as yield, wide adaptation, industrial quality and disease resistance. Successful development of germplasm to fit these diverse environments is a product of well-planned hybridization, adequate selection, and, in CIMMYT's case, a large international system of multilocation testing.

Over 8,000 single, three-way, and four-way crosses were planned and made in the 1980 Ciudad Obregon and Toluca breeding cycles. High-yielding cultivars from the Southern Cone region of South America, the Andean region, Central America, the Indian Subcontinent, and Africa were used as recurrent parents. Donor parents from different areas of the world provided germplasm carrying genes for specific characteristics, such as disease resistance and industrial quality, but these parents were deficient in other desirable agronomic characteristics. The resulting F_1 progeny were selected in Ciudad Obregon and Toluca for disease resistance and agronomic type. Selected populations were advanced to nurseries, either F_2 Bulk (selections from F_1 simple crosses) or F_2 Individual (selections from three- and four-way crosses).

In 1980, major emphasis was placed on the following nurseries and materials: F_2 Bulk, 14th IBWSN, Elite trials, advanced lines suitable for highlands, early-maturing lines, aluminum tolerant lines, lines resistant to *S. tritici*, slow leaf rusting types, and multiplication of advanced material adapted to Mexico. These nurseries are discussed individually below.

F_2 populations

A total of 1,494 F_1 single crosses was harvested in Ciudad Obregon in 1980, advanced as F_2 bulk, and classified according to probable utility. Six categories were used: spring x winter, irrigation, dryland, septoria resistance, aluminum toxicity resistance, and early maturity. These F_2 bulk nurseries, each available for international distribution, were mailed to cooperators according to requests received and appropriateness of area. Priorities for each category were as follows:

Spring x winter	Areas where facultative wheats are adapted
Irrigation	Indian Subcontinent and other areas where irrigated wheat is common
Dryland	Primarily sent to North Africa, and the Andean and the Southern Cone regions of South America
Septoria	Areas where endemic infection occurs, such as North Africa
Aluminum	Brazil and East Africa
Early maturity	Indian Subcontinent and Southeast Asia

These nurseries were also grown at the Toluca station in Mexico, where single plants were selected for advancement in the CIMMYT breeding program.

14th IBWSN and Elite trials

Approximately 20 ha of land were planted to yield trials and small multiplication plots (PCs) at Ciudad Obregon for the 1979-80 season. Included were 1,922 advanced lines seeded in 63 yield trials and also in PCs. Small evaluation plots of each line were planted in Mexico at Los Mochis, Celaya, Rio Bravo, and Hermosillo to evaluate for leaf rust resistance.

The cultivars Pavon 76 and Nacozari 76, occuping approximately 80 percent of the 1980 wheat area of northwestern Sonora and northern Sinaloa, Mexico, were frequently used as check varieties in yield trials to compare productivity gains of the new lines. These comparisons are shown graphically in Figures 2 and 3. Although no statistical tests of significance are shown, the consistently superior performance of the experimentals indicates a slight increase in yield potential. All cultivars represented in these figures were made available to cooperators in the 14th IBWSN.

Four hundred thirty-one highest yielding lines with acceptable resistance were selected from yield experiments for the 14th IBWSN, which was sent to 250 locations worldwide. Five characteristics of the 30 best-performing lines at Cd. Obregon are presented in Table 4. The yield of each line is compared to the highest yielding check cultivar in the trial.

The cultivars shown in Table 4 will be tested in 1981

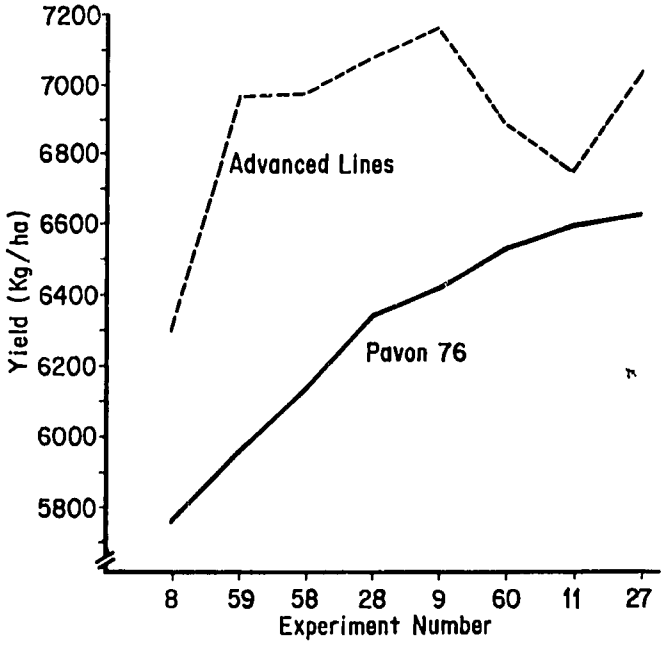


Figure 2. Yield of best advanced lines in relation to Pavon 76 in 8 trials in Ciudad Obregon, 1979-80

at the Ciudad Obregon, Celaya, and Hermosillo stations for possible inclusion in the next Elite Selection Wheat Yield Trial (ESWYT). This trial is distributed to selected locations which represent a wide array of climatic and disease conditions around the world.

For the 1979-80 season, three elite yield trials were seeded at Celaya, Hermosillo, and Ciudad Obregon in Mexico. Each consisted of 36 of the highest yielding entries from the previous year's test. The best yielding cultivars are compared to the local check in Tables 5, 6, and 7 for elite trials I, II, and III, respectively. The cultivars Veery"S" (CM 33027), Tast x Kal-Bb/Ana (CM 38236), and Crow"S" (CM 40457) were the highest yielding cultivars.

Sisters of the cross Veery were derived from the spring x winter three-way combination Kvz-Buho x Kal-Bb. They have exhibited the highest average yield of any of the CIMMYT bread wheats, both in Mexico and internationally. Tast x Kal-Bb/Ana is heterogeneous for maturity and is being reselected for further exploitation. The excellent yield, plant type, and rust resistance of Crow"S" merit further testing of this line as a possible variety.

Cultivars for highlands

Wheat production in the highlands of the Andes and East Africa has lagged behind the breakthroughs in such favorable areas as the irrigated plains of India. Highland environments are characterized by conditions conducive to high intensity disease development. Stem and stripe rusts are the most common yield constraints, followed by septoria, fusarium, and other foliar pathogens. Except in Guatemala, the lack of adapted varieties, in combination with poor cultural practices, has resulted in low average yields. CIMMYT regional programs are now working in the highlands of Latin America and East Africa to confront these problems more adequately.

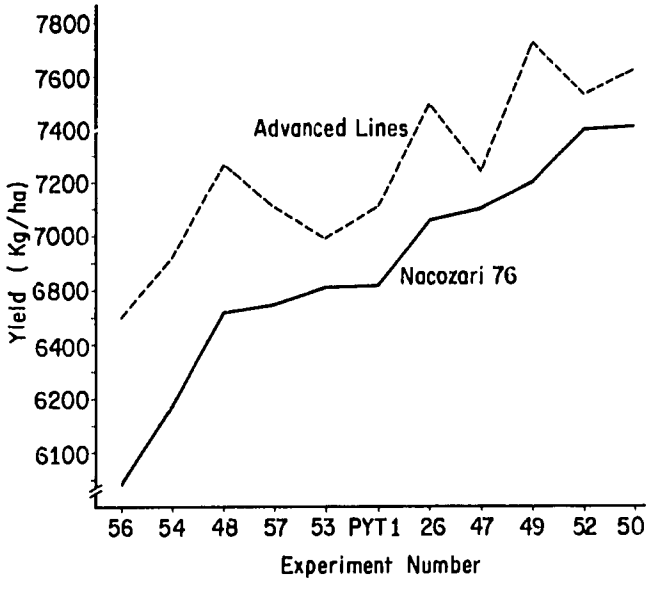


Figure 3. Yield of best advanced lines in relation to Nacozari 76 in Ciudad Obregon, 1979-80

The breeding program in Mexico is now better equipped to direct crosses for these areas, as a result of input from the regional programs and more active national programs. Germplasm can be screened in Toluca (a highland location); however, land restrictions have not permitted the establishment of annual highland yield trials. A limited number of yield tests in El Batan, together with comprehensive disease evaluations for stripe rust, fusarium, and scab, have revealed a large amount of material that appears to be well-suited to highland environments. All the cultivars listed in Table 8 possess adequate resistance to foliar pathogens, including stripe rust, under the conditions of El Batan and Toluca. These lines were not among the highest yielding in Ciudad Obregon, but they have shown promise for the highlands. The cultivar Tanager"S" has performed well in the high plateau of Mexico and also in Guatemala.

Although the total area planted to wheat in the highland areas of the world appears small when compared to other environmental classifications, it is still an important food source for millions of subsistence-level farmers. The CIMMYT bread wheat breeding program has limited its involvement in these areas to observation and classification of existing germplasm for further testing by national programs. Currently 250 such advanced lines have been identified.

Aluminum toxicity resistance

In 1974 CIMMYT signed formal agreements relating to three breeding programs in Brazil for cooperative work on aluminum toxicity in wheat. This "shuttle breeding" program involves the EMBRAPA, FECOTRIGO and OCEPAR programs in Brazil. Crosses made in Mexico and Brazil are designed to incorporate high yield, rust and septoria resistance, and semidwarf plant type, along with resistance to aluminum toxicity. This material is shuttled in each successive generation between Brazil and Ciudad Obregon, Toluca or El Batan. Brazilian scientists regularly visit the CIMMYT nurseries to make crosses and selections, and CIMMYT scientists participate in selection and evaluation of material in Brazil. In 1980 a new laboratory facility was added at El Batan to facilitate rapid preliminary screening of relatively large amounts of breeding material.

Although progress in this program has been slow, by the end of the 1980 season 46 crosses with a variable number of sister selections per cross had been identified as having the sought-after combinations of good plant type, rust and septoria resistance, and resistance to aluminum toxicity (Tables 9a and 9b). These lines are not ready for release as varieties in Brazil due to a lack of scab resistance; however, they represent a significant step beyond the original unimproved varieties traditionally cultivated there.

Table 4. Characteristics of promising 14th .. 'SN advanced lines equal or superior to highest yielding check variety in the Yaqui Valley, . ,J-80

Cross and pedigree	Yield[1] kg/ha	Grain color	Plnt ht (cm)	Flow days	Leaf Rust Reaction		
					Ciudad Obregon	Los Mochis	Rio Bravo
Car422-Ana SWM-4610-2Y-20M-1Y-0M	6660 5605 Vul"S"	White	85	87	5MR	TMR-MS	TMS
F12.71-Coc SWM 5784-17Y-1M-4Y-5M-1Y-0B	6618 6051 Psn"S"	Red	80	82	10MR-MS	10MR	TMS-MR
Tzpp(2)-AnExlnia/Jar-Kvz CM-21335-9Y-3M-1Y-1Y-1Y-0B	6648 5605 Vul"S"	Red	80	79	0	5MR	TMR
Vee#1 CM-33027-F-8M-1Y-8M-1Y-2M-0Y	7149 7450 Yav	Red	95	83	TR	TMR	TMS
Vee"S" CM-33027-F-12M-1Y-2M-1Y-1M-0Y	8331 7980 Nac	Red	90	94	10MS-MR	10MS-MR	TMR
Vee"S" CM-33027-F-12M-1Y-4M-0Y	7435 5605 Vul"S"	Red	90	89	5MS	T-20MS-S	5MS-MR
Vee#2 CM-33027-F-12M-1Y-4M-2Y-2M-0Y	6723 7450 Yav	Red	90	85	5MR-MS	TMS	5MR-MS
Vee#3 CM-33027-F-12M-1Y-6M-0Y	6575 7450 Yav	Red	95	86	0	5M	10MR
Vee"S" CM-33027-F-15M-500Y-0M-87B-0Y	7336 7514 Yav	White	85	86	TMS	TMR	10MS
Bow"S" CM-33203-H-4M-1Y-0M-95B-0Y	5319 5111 Vul"S"	Red	75	77	TR	TMS-MR	TMR-MS
Bow"S" CM-33203-K-9M-2Y-1M-1Y-2M-0Y	6750 5605 Vul"S"	White	85	86	0	TMR	TMR
Hahn"S" CM-33682-L-1Y-1Y-4M-4Y-100B-502Y-0M	6878 5605 Vul"S"	Red	80	92	0	TMR	T-20MS-S
Hanh"S" CM-33682-L-1Y-1Y-4M-4Y-100B-503Y-0M	7120 5605 Vul"S"	Red	80	93	TMR	TMR-R	T-10S
Tsh"S" CM-34742-E-2M-5Y-3M-500Y-100B-504Y-0M	6504 6386 Cananea	White	90	79	TMS	5MS-MR	TS
Mor"S" CM-37130-15Y-1M-3Y-0M	5590 5047 Pew"S"	White	65	82	10MS	TMR	5R-MR
Jup-Bjy"S" CM-39992-8M-3Y-1M-0Y	8439 8420 Nac	White	85	79	5-40MR-MS	TR	5R-MR
Sap"S"-Mon"S" CM-40392-17M-1Y-1M-0Y	7913 7000 Nac	White	85	84	5MR	5MR-MS	5MS
Sap"S"-Huac"S" CM-40394-20M-1Y-2M-1Y-4M-1Y-0B	6776 6001 Vul"S"		95	82	10MS	5MS	5MS-MR
Nkt"S" CM-40454-11M-4Y-2M-3Y-0M	7137 7156 Yav	White	90	95	5MS	T-10MS	30MS-MR

Table 4. (continued)

Cross and pedigree	Yield[1] kg/ha	Grain color	Plnt ht (cm)	Flow days	Leaf Rust Reaction		
					Ciudad Obregon	Los Mochis	Rio Bravo
HI 666-Pvn"S" CM-40608-18M-4Y-1M-1Y-4M-1Y-0B	5684 5399 Vul"S"		90	77	TMR	TMR	T-20MS-MR
Him-CocxNac CM-41195-A-13M-2Y-3M-1Y-1M-0Y	6054 6091 Vul"S"	Red	85	81	10X	10S-MS	30MS
MN 72131-Pvn"S" CM-42402-30Y-1M-1Y-3M-1Y-0B	5688 5416 Vul"S"	Red	85	81	TMR	T-10MR-MS	10R-MR
MN 72131-Pvn"S" CM-42402-30Y-1M-1Y-3M-2Y-0B	5984 5639 Vul"S"	Red	85	80	TMR	TMR	5R-MR
Tob-Mon"S" CM-42633-1Y-1M-1Y-2M-1Y-0B	5927 5639 Vul"S"		95	79	10MS	10MS	5MR-MS
Jup-Emu"S"xGjo"S" CM-43598-11-8Y-1M-3Y-1M-0Y	6239 6030 Vul"S"	Red	80	75	0	TMR	5R
Kvz-TrmxPtm-Ana CM-43903-H-2Y-1M-3Y-2M-2Y-0B	6456 6359 Vul"S"	White	85	79	0	5MR-MS	10R-MR
Kvz-TrmxPtm-Ana CM-43903-H-2Y-1M-6Y-1M-2Y-0B	6590 6359 Vul"S"	White	80	81	TMR	TMR	TMS-S
Kvz-TrmxPtm-Ana CM-43903-H-4Y-1M-1Y-3M-3Y-0B	7108 6359 Vul"S"	White	85	78	TMS	5MR	TMR
{Coc/(Fn-ThxK58N/My54-N10BxAn"S")Tt-Sn 64xBza/}(Fr316/Mcm-KtxY50)Za CM-43956-A-1Y-1M-1Y-0M	5061 5047 Pew"S"	Red	80	78	5S	TMR-MS	30MS-MR
Ore F_1 158-FdlxKal-Bb/Nac CM-47634-1-1M-1Y-1M-0Y	6868 6530 Pvn	Red	80	83	TMS	TMR	5R-MR

[1]Top figure=yield of the cross; lower figure = highest yielding check

Early-maturing wheats

Several major wheat-producing countries have initiated crop rotations with rice and soybeans during one cycle, followed by wheat in the next. Examples are India, Pakistan, Bangladesh, South Korea and China. Earlier-maturing wheat varieties are needed to fit this type of production system. In cooperation with national programs, CIMMYT identified the varieties Sonalika and Inia 66 during the 1960s. These varieties are both high yielding and very early maturing. Sonalika currently occupies a large production area in the Indian Subcontinent, having maintained high yield and disease resistance for more than a decade. It is now losing its resistance to leaf rust and must be replaced.

Disease-resistant, early-maturing cultivars with yield potential similar to Sonalika have been identified in CIMMYT germplasm (Table 10). These have been made available to cooperators in the Indian Subcontinent and in Southeast Asia.

Septoria tritici resistance

A criticism voiced frequently in the early 1970s concerned the lack of sufficient resistance to *Septoria tritici* in Mexican semidwarfs. Septoria regularly reaches epiphytotic proportions in many areas of the world—particularly in the rainfed wheat regions of North Africa and Argentina. Unstable yield due to lack of sufficient resistance was characteristic of the semidwarf wheats released earlier in these areas.

Soon after its inception, CIMMYT became involved in testing for septoria resistance; however, lack of an adequate testing site in Mexico proved to be a handicap. Currently, a cooperative program of early-generation testing in

Patzcuaro, Mexico, followed by later-generation evaluation by Zahir Eyal at the Bet Dagan Experiment Farm in Israel, has served to identify a large number of lines with excellent septoria resistance.

Tables 11 and 12 list some of the most resistant semidwarf material identified by Dr. Eyal. The lines in Table 12 are slightly less resistant than those in Table 11, although the genetic base of each group is similar. Fifty-one of the 52 cultivars listed in these tables were derived from spring x winter crosses. The winter wheats Kavkaz and Aurora, from the Soviet Union, appear in the pedigrees of these cultivars. Kavkaz and Aurora each carry a small amount of rye genetic material, which probably accounts for their excellent resistance.

Breeding for septoria resistance is being further strengthened by sending larger amounts of material to areas where septoria regularly occurs in epiphytotic proportions. Selections are made at these locations and sent to Ciudad Obregon for plant type selection.

CIMMYT breeders believe a substantial increase can be made in wheat production in the state of Michoacan, Mexico, because wheat lines are now available with combined resistance to *S. tritici*, aluminum toxicity and rusts. A suitable linkage with the INIA program in Mexico can lead to an exploitation of this possibility.

Slow rusting

Stem rust resistance, stabilized in CIMMYT bread wheats in the late 1950s, has been retained. Generally, after two to three years of commercial production, the pathogen mutates and the varieties become susceptible to the new race. Two interesting cases have been the varieties Torim 73 and Pavon 76. Although each became susceptible to leaf rust within two years after release, the intensity of infection continued at a low level: for eight years in the case of Torim 73 and four years for Pavon 76. This type of host-parasite interaction is known as "slow rusting." It is characterized by low receptivity by the plant for the pathogen, long pathogen latency, and small pustule formation.

The cultivars listed in Table 13 have shown low severity of infection and longer-than-normal periods to sporulate for the last four seasons in Ciudad Obregon and El Batan. Leaf rust intensity over time is illustrated in Figure 4 for six of the most promising of these lines, as compared to Inia 66, the susceptible check: Minivet"S," Car 422-Anahuac, Tanager"S," and Harrier"S" all have high levels of the slow-rusting character; Pavon"S" and Veery"S" have lower levels. Special attempts will be made to incorporate the slow-rusting characteristic of these cultivars into future lines.

Multiplication of advanced lines for Mexico

The CIMMYT wheat program cooperates in Ciudad Obregon with CIANO (INIA) toward the development, multiplication and release of varieties. Responsibility for varietal release in Mexico rests solely with INIA; however, the involvement of CIMMYT personnel in germplasm development and the analysis of national and international data makes them partners in the process of selecting potential varieties.

Table 14 lists characteristics of seven advanced lines that are candidates for release by INIA. These cultivars are Veery"S," CM 33027 (four sister selections); Mor"S," CM 37130; Car 422-Anahuac, SWM 4610; and Thrush"S," CM 34742.

Table 5. Yield performance and leaf rust reaction of nine advanced lines compared to the local check in Elite Trial I at three locations in Mexico, 1979-80

Cross and Pedigree	Yield kg/ha				Leaf Rust Reaction		
	Cd.Obregon	Celaya	Hermosillo	Average	Cd.Obregon	Los Mochis	Rio Bravo
Veery"S" CM-33027-F-8M-1Y-8M-1Y-2M-0Y	8367	6988	4728	6694	TR	TMR	TMS
Veery"S" CM-33027-F-12M-1Y-2M-1Y-1M-0Y	7267	7127	5109	6501	5MS	10MS	10MS
Local Check	8246	6349	4540	6378	-	-	-
Veery"S" CM-33027-F-12M-1Y-4M-2Y-2M-0Y	7946	6361	4652	6319	5MR-MS	TMS	5MR-MS
Veery"S" CM-33027-F-12M-1Y-6M-0Y	7733	6944	4166	6281	0	5MS	10MR
Veery"S" CM-33027-F-12M-1Y-12M-1Y-2M-0Y	7279	6674	4777	6243	5MS-MR	10MS	10MR-MS
Veery"S" CM-33027-F-12M-1Y-1M-1Y-2M-0Y	7121	6702	4908	6243	TMR	20MS-MR	20X
Bobwhite"S" CM-33203-K-9[illegible]-2Y-1M-1Y-2M-0Y	7325	6277	4790	6130	0	TMR	TMR
Veery"S" CM-33027-F-12M-1Y-12M-1Y-1M-0Y	7175	6641	4502	6106	TMS	5MS	20MR
Veery"S CM-33027-F-12M-1Y-1M-1Y-1M-0Y	6942	6563	4811	6105	5MR-MS	10S-MS	5MS

Selections of the cross named Veery have been the highest yielding cultivars in CIMMYT nurseries for the last three years. Their plant type, leaf rust reaction, and quality characteristics are suitable for the irrigated valleys of northwestern Mexico. Mor"S" is shortest of the candidates for release and has a yield record equal to that of Yecora 70. It is suitable for irrigation, and is similar to Torim 73 and Yecora 70 in plant type and industrial quality, but has better leaf rust resistance. Car 422-Anahuac is a late-maturing, soft wheat with stable high yield. It is intended to replace the currently grown soft wheat Pima 77, which is susceptible to lodging. Thrush"S" is similar to Jupateco 73 in plant type and yield potential. It has shown stable yield in northwestern Mexico.

FUTURE PROJECTS

Substantial areas of spring wheat around the globe are affected by *Helminthosporium spp.* and scab (*Gibberella zea*). Both diseases are favored by warm humid climates, although they do not necessarily occur together. Heavy scab epiphytotics are common in China, Korea, Argentina and Brazil. Endemic areas of helminthosporium include Bangladesh, eastern India, Brazil, East Africa, states of Tamaulipas and Nayarit, Mexico, and will include all tropical environments as wheat continues to spread into these areas.

Genetic variability for resistance to scab and helminthosporium is narrow; however, adequate levels of tolerance have been identified. The bread wheat program scientists intend to identify sources of tolerance and to select segregating material at hot spots around the world. Screening for scab will be done at Toluca; selected lines and populations will be shuttled to appropriate areas of the world for further testing.

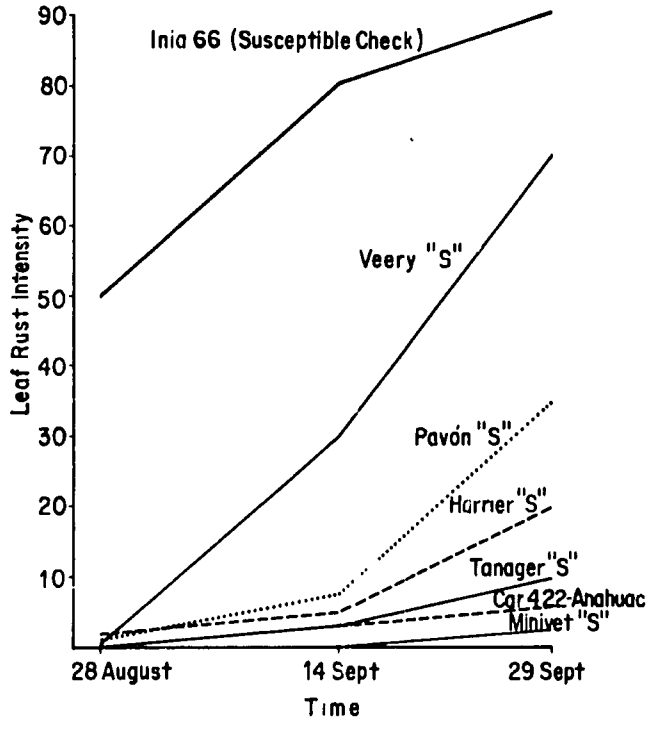


Figure 4. Slow rusting lines of bread wheat with low leaf rust intensity over time compared to INIA 66 (susceptible check) at El Batan, 1980

CONCLUSION

The CIMMYT bread wheat breeding program will follow its established methods for improving the yield, adaptation and disease resistance of semidwarf wheats. All products of these endeavors will continue to be available to cooperators through the international nursery system.

Table 6. Yield performance and leaf rust reaction of eight advanced lines compared to the local check in Elite Trial II at three locations in Mexico, 1979-80

Cross and pedigree	Yield kg/ha				Leaf Rust Reaction		
	Cd.Obregon	Celaya	Hermosillo	Average	Cd.Obregon	Los Mochis	Rio Bravo
TastxKal-Bb/Ana CM-38236-G-6Y-4M-4Y-3M-1Y-0M	6542	6874	4770	6062	TMR	TMR	5MS
Hork"S"-YmhxKal-Bb CM-38212-I-7Y-2M-1Y-3M-1Y-0M	7425	6794	3798	6005	20MS	20MS	40MS
R37-Ghls 121xKal-Bb SWM-4275-41M-1Y-4M-1Y-0M	6896	6869	4082	5949	0	TMR	TMS-MR
Dove"S" CM-38199-A-1Y-9M-1Y-0M	7042	6319	3679	5680	10MR-MS	TMR	20MR R
Hahn"S" CM-33682-L-1Y-9M-1Y-1M-1Y-100B-0Y	7342	6138	3485	5655	TMR	5MR-R	5MS-S
Sap"S"-Mon"S" CM-40392-17M-1Y-0M	7913	5402	3471	5595	TMR	5MR	T-10MS
Tanager"S" CM-30697-10M-1Y-10M-1Y-1B-0Y	7096	6286	3346	5576	TMR-MS	TMS	10MS
Ani"S" CM-26346-A-11Y-1M-3Y-1M-1Y-0B	6683	6591	3332	5536	TMR	TMR	5MS
Local check	7000	5569	2805	5124	-	-	-

Table 7. Yield performance and leaf rust reaction of 10 advanced lines compared to the local check in Elite Trial III at three locationsin Mexico, 1979-80

Cross and pedigree	Yield kg/ha				Leaf Rust Reaction		
	Cd.Obregon	Celaya	Hermosillo	Average	Cd.Obregon	Los Mochis	Rio Bravo
Crow"S" CM-40457-5M-3Y-1M-1Y-0M	6038	5916	4270	5408	0	TMR	5R-MR
Jup-Bjy"S" CM-39992-8M-3Y-1M-0Y	5700	6841	3499	5346	0	5MS	5MS
Koel"S" CM-34574-F-2M-1Y-1M-2Y-1M-1Y-0M	5846	6419	3520	5261	0	TR	20X
Mor"S" CM-37130-15Y-1M-3Y-0M	5713	6022	3846	5193	20MS	5MR-MS	5MS-MR
Yding"S"-Bjy"S" CM-40456-12Y-1M-1Y-0M	5779	6669	3013	5153	5MR-MS	5MR	10X
Crow"S" CM-40457-5M-3Y-1M-2Y-0M	5475	6541	3353	5123	0	TMR	TMR
Koel"S" CM-34574-F-1M-2Y-0M	5733	5966	3659	5119	0	TR	20MS
Gll-Aust 1161.157xCno-No/Pvn"S" CM-30326-2M-7Y-3M-1Y-2B-0Y	5896	5869	3554	5106	TMR	TMR	5MS
Crow"S" CM-40457-5M-3Y-1M-3Y-0M	5925	5805	3499	5076	0	TR	5R
Carp"S"-Bjy"S" CM-40452-1M-1Y-4M-0Y	5508	6633	2895	5012	20S	T-30MS-MR	20MS-S
Local check	5704	6044	3173	4949	-	-	-

Table 8. Performance of high-yielding advanced lines compared to standard cultivar in the high plateau of Central Mexico, El Batan, 1980

Experiment No.	Cross and pedigree	Yield (kg/ha)	Yield of standard cultivars as percent of advance lines			
			Cleopatra	Pavon76	Yavaros79 (Durum)	Cananea79 (Triticale)
Altiplano I	Tanager"S" CM-30697-2M-8Y-1M-1Y-1B-0Y	5908	61.0	99.6	61.7	75.0
	Tanager"S" CM-30697-2M-8Y-7M-1Y-1B-0Y	5896	61.1	99.8	61.8	75.2
	Tanager"S" CM-30697-2M-10Y 1M-2Y-2B-0Y	5775	62.4	101.9	63.1	76.8
	Tanager"S" CM-30697-2M-5Y-10M-1Y-1B-0Y	5637	63.9	104.4	64.7	78.6
Altiplano II	Harrier"S" CM-33435-P-1M-6Y-1M-1Y-1M-0Y	5875	47.7	75.1	64.9	70.1
	Hahn"S" CM-33682-L-1Y-1Y-9M-1Y-100B-0Y	5762	48.6	76.5	66.2	71.6
	Gallo-YrResel(B)/AuxKal-Bb CM-34603-A-1M-3Y-1M-5Y-3M-0Y	5637	49.7	78.2	67.6	73.2
	/(FrxKt48-Bt.5H/4777^{2}xLR-Fr)Pj/Huac"S" CM 33251-G-4M-7Y-6M-1Y-2M-0Y	5562	50.3	79.2	68.5	74.3
Altiplano III	Sparrow-Grajo"S" CM-35195-1M-3Y-1M-1Y-1B-0Y	6333	48.2	76.0	73.9	68.8
	Kal-BbxMoncho"S" CM-40226-7M-5Y-4M-0Y	5937	51.4	81.1	78.8	73.3
	Jup73-ZpxCoc75 CM-37614-B-14Y-3M-6Y-2M-0Y	5862	52.0	82.1	79.8	74.3
	Bjy"S"(TpxCno-Inia"S"/Cno-Inia"S"^{2}) CM-29989-122M-1Y-2M-0Y	5633	54.1	85.4	83.1	77.3

The spring x winter program has given better *Septoria tritici* resistance and top yields; it will continue to be an area of major emphasis.

Disease resistance—particularly for diseases which were formerly considered of minor importance—will receive increasing emphasis in the 1980s. Levels of resistance to the three rusts have improved to a level that "unmasks" other diseases symptoms. As wheat production expands into more tropical areas, foliar diseases become increasingly damaging. While continuing its heavy involvement in improving rust resistance, the bread wheat program will place added emphasis on developing productive germplasm with resistance to *Septoria tritici, Helminthosporium* spp., scab and aluminum toxicity. Increased resources are being directed toward the development of durable leaf rust resistance. The slow-rusting character is one type of resistance which appears to be promising.

While CIMMYT's global mandate prevents its involvement in breeding wheats for relatively isolated areas that have unique production constraints, we will continue to attempt to develop germplasm that addresses larger problem areas, such as screening for drought tolerance.

Table 9a. Promising advanced lines resistant to aluminum toxicity in Brazil

Cross	Cross number	No. of Sisters	Al^{+++} Toxicity reaction Cruz Alta	Passo Fundo (1-5*)	Plant height (cm)	Days to maturity	*S. tritici* (1-4)
Ald"S"-Emeck"S"	CM34820	1	S	2-3	100	145	2-3
Horto-Ald"S"	CM40762	1	R	1	115	146	1
Mrng-Aldan"S"	CM46961	3	R-MR	1-2	115	148	1-2
Pat19-Sis"S"	CM47000	1	R	2-3	105	147	2-3
Ias54-Bnq"S"	CM47027	1	MR	2	105	147	2
Ias64-Aldan"S"	CM47028	1	MS	2	105	149	2
Ias63-Ald"S"	CM47042	1	MR	1	110	140	1
Ias63-Aldan"S"	CM47046	3	S	2-1	105	148	2-1
Ias62-Aldan"S"	CM47049	1	MR	1-2	100	150	1-2
PF70354-Ald"S"	CM47090	4	R	1	105	146	1
PF70354-Mus"S"	CM47091	3	MS	1	105	149	1
Ias64-Aldan"S"	CM47207	6	MR-R	2-5	90-120	147	3-4,1
Ias58-Bjy"S"xBnq"S"	CM47971	1	R	1	100	147	1
Ias58(Kal-BbxCj"S"/Ald"S")	CM50464	1	R	1-2	120	145	1-2
Ias58-Mad"S"	CM50472	4	MR-R	1-2	95-120	145	1-2
PF70354-Aldan"S"	CM50487	1	R	2	100	147	2
Abura-Ald"S"	CM50513	1	R	1-2	105	147	1-2
Jac-Ald"S"	CM50523	1	R	1	100	147	1
CEP74230-Ald"S"	CM50642	1	MS	2	110	147	2
Ias64-HD2182xNac-Mn72131(Ias58-Ias44xAld"S" /Mrng)	CM51664	1	MS	2-3	105	149	2-3
Ald"S"-Ias58xAld"S"	CM55517	2	MR-R	1-2	95	147	1-2
Iac5-CocxPelSL1268.69-Ald"S"/Ald"S"-Huac"S"	CM55580	1	MR	1	115	149	1
Londrina-Ald"S"xNob	F11890	1	MR	1	105	146	1
Ias63-Ald"S"xGto-LV	F11915	27	MR-R	1	105-125	145-149	1
PF72640-PF7326xPF7065-Ald"S"	F11933	3	MR	1	115	148	1
(Cno-PjxIas55/Ald"S")Ias54-BH1344	B15961	1	R	1	120	148	1
En-Ald"S"	B16427	1	R	2	105	146	2
Pat24-Ald"S"xPat7388	B17437	1	R	1	110	145	1
PF70402-Ald"S"xPat72160-Ald "S"	B19789	13	MR-S	2-1	115-125	144-148	2-1

* Scale for Al^{+++} resistance: 1= Resistant
2= Moderately resistant
3= Moderately susceptible
4= Susceptible
5= Very susceptible

Table 9b. Promising advanced lines resistant to Aluminum toxicity in Brazil, and under laboratory screening in Mexico

Cross	Cross number	No. of sisters	Al^{+++} toxicity reaction		Plant height (cm)
			CIMMYT-Lab % tolerant plants	Passo Fundo (1-5)*	
Mrng-Pew"S"	CM46963	4	78.2	2-1	100
PF70354-Ald"S"	CM47090	1	50.0	1	100
Ald"S"-Ias58.103AxAld"S"	CM50386	1	81.5	1	90
Ias58(Kal-BbxCj/Ald"S")	CM50464	2	71.3	2	95
Ias58-Mad"S"	CM50472	4	81.8	1	120
JacxFury-7C/Her-Pvn"S"	CM51675	1	100.0	2	-
Mon"S"-Ald"S"	CM53460	3	87.2	2	105
Coq"S"-Tast x Cndr/Ald"S"	CM53465	1	78.6	2	110
Peg"S"-Cnt 10	CM53522	1	83.3	2	105
Kal-BbxAld"S"-B7408	CM53596	1	34.5	1	95
Aldan"S"-BH1146	CM53657	1	86.0	2-3	100
Peg"S"-BH1146	CM53660	1	32.1	2	110
PF7040-Ald"S"xPat72160-Ald"S"/Ald"S"-Huac"S"	CM55505	2	80.0	2-1	100
{Ias54{/Maya"S"(TpxCno-No/Bb-Cno)/Kal-Bb}}Mrng-Emu"S"x Iac5 (Aust-NadxKal22.7A-Bb/Ald"S")	CM57589	1	68.0	1	115
Ias64-Ald"S"xCqt-Ald"S"/Ald"S"-Ias58.130AxAld"S"/(Napo-Tob"S"x8156/Kal-Bb)Ald"S"/	CM58483	1	-	2-5	115
Ald"S"-BH1146xPF7483	F12297	1	44.8	1	120
PF70402-Ald"S"xPat72160-Ald"S"	B19789	2	69.2	-	115

* Scale for Al^{+++} resistance: 1= Resistant
2= Moderately resistant
3= Moderately susceptible
4= Susceptible
5= Very susceptible

Table 10. Early maturing advanced lines comparable in yield to Inia 66 and Sonalika, Ciudad Obregon, 1980

Cross and pedigree	Yield (kg/ha)	Percent of Inia	Percent of Sonalika
AnaxKal-Bb CM-37135-5Y-5M-4Y-1M-1Y-0M	6204	103.6	109.1
Tsh"S" CM-34742-E-2M-5Y-3M-500Y-100B-50CY-0M	6167	102.9	108.4
Inia (check)	5991	100.0	105.3
HI666-Pvn"S" CM-40608-18M-4Y-1M-3Y-4M-0Y	5924	98.9	104.1
Maya-Pvn"S" CM-39426-1M-2Y-4M-1Y-1M-0Y	5921	98.8	104.1
(Vcm-Cno"S"xCal/Nor-7C)TI Resel CM-36520-2Y-4M-4Y-2M-0Y	5886	98.2	103.5
/Cno-8156xTob-Cno(No/12300xLR-8156)/Plo CM-40699-55M-3Y-1M-3Y-2M-0Y	5798	96.8	101.9
Fury-Mo CM-86732-12Y-6M-3Y-0M	5783	96.5	101.6
Cj-CprxJup"S" CM-40105-13M-2Y-1M-0Y	5711	95.3	100.4
Sonalika (check)	5688	94.9	100.0
		Percent of Tanori	
Sdy-Cndr"S"xAna CM-43483-A-3Y-2M-1Y-2M-0Y	7038	113.9	114.6
Asp"S"-Bjy"S"xAld"S" CM-41219-1-1M-1Y-2M-0Y	6286	101.7	102.3
Tanori 71 (check)	6177	100.0	100.5
Sonalika (check)	6144	99.5	100.0

Table 11. List of CIMMYT-bred spring wheat lines with septoria leaf blotch coverages of 0-4% (data from Dr. Zahir Eyal, Bet-Dayan Experimental farm, Israel)

Cross and pedigree	Percent coverage	SPC 1/	Cross and pedigree	Percent coverage	SPC 1/
Kvz-Sprw"S" SWM-2892-18Y-2M-1Y-1M-0Y	2.00	0.8883	Bow"S" CM-33203-K-9M-3Y-4M-1Y-1M-1Y-0M	1.25	0.2273
Kvz-K4500.L.A.4 SWO-176-3M-1Y-4Y-1Y-1M-0Y-1Ptz-0Y	1.50	0.2381	Bow"S" CM-33203-K-9M-10Y-1M-5Y-2M-0Y	1.50	0.2273
Kvz-K4500.L.A.4 SWO-176-3M-1Y-4Y-1Y-1M-0Y-2Ptz-0Y	1.25	0.2273	Bow"S" CM-33203-K-9M-23Y-5M-4Y-1M-0Y	1.50	0.3182
Kvz-K4500.L.A.4 SWO-176-3M-1Y-10Y-1Y-2M-0Y-0Ptz-0Y	3.75	0.3636	Bow"S" CM-33203-K-9M-23Y-12M-1Y-1M-0Y	1.50	0.3182
Mus"S" CM-16780-J-1M-2Y-500M-0Y	1.50	0.2500	Bow"S" CM-33203-K-10M-7Y-3M-1Y-2M-0Y	1.50	0.2381
Mus"S" CM-16780-J-1M-2Y-501M-0Y	3.75	0.4500	Bow"S" CM-33203-K-10M-7Y-3M-1Y-3M-0Y	1.50	0.2381
Kvz-Up301 CM-20596-12Y-1M-1Y-0Y-3Ptz-0Y	3.75	0.4286	Bow"S" CM-33203-K-10M-7Y-3M-2Y-1M-0Y	1.50	0.2500
Kvz-GvxTito"S" CM-30817-C-8Y-3M-1Y-100B-0Y	4.00	0.7273	Bow"S" CM-33203-N-1M-2Y-500M-0Y	1.50	0.2500
Vee"S" CM-33027-F-7M-4Y-6M-5Y-2M-0Y	1.25	0.2273	Gll-CucxKvz-Sx CM-34630-D-5M-5Y-1M-2Y-2M-3Y-0M	1.50	0.2381
Kva-Ti/Maya"S"xBb-Inia CM-33089-W-3M-7Y-3M-0Y	1.75	0.5714	Gll-CucxKvz-Sx CM-34630-D-5M-5Y-5M-1Y-1M-0Y	1.50	0.2381
Bow"S" CM-33203-G-5M-1M-1Y-1M-0Y	1.50	0.4091	Gll-CucxKvz-Sx CM-34630-D-5M-5Y-5M-1Y-2M-0Y	1.50	0.2500
Bow"S" CM-33203-G-9M-5Y-1M-3Y-1M-0Y	1.50	0.3182	Gll-CucxKvz-Sx CM-34630-D-5M-5Y-6M-3Y-1M-0Y	1.50	0.2500
Bow"S" CM-33203-G-9M-5Y-1M-3Y-2M-0Y	1.50	0.3182	Gll-CucxKvz-Sx CM-34630-D-5M-5Y-6M-3Y-2M-0Y	1.50	0.2500
Bow"S" CM-33203-K-9M-2Y-1M-1Y-1M-0Y	1.25	0.2632	Cndr"S"-Mus"S" CM-39458-6M-2Y-2M-0Y	1.50	0.2778
Bow"S" CM-33203-K-9M-2Y-1M-1Y-2M-0Y	3.00	0.8000	Gov-AztxMus"S" CM-41257-1-8M-1Y-1M-2Y-0M	1.50	0.2000
Bow"S" CM-33203-K-9M-2Y-4M-1Y-1M-1Y-0M	3.00	0.8421	Gov-AztxMus"S" CM-41257-1-8M-5Y-2M-0Y	2.50	0.3636

1/ SPC=Septoria Progress Coefficient: $\frac{\text{Height of disease on plant (cm)}}{\text{Height of plant (cm)}}$

Table 12. List of CIMMYT-bred spring wheat lines with septoria leaf blotch coverages of 5-15% (data from Dr. Zahir Eyal, Bet-Dagan Experiment Farm, Israel)

Cross and pedigree	Percent coverage	SPC 1/
Peg"S" SWM-1368-500Y-1B-501Y-502M-0Y	6.50	0.7500
Peg"S" SWM-1368-500Y-1B-501Y-503M-0Y	12.75	0.8000
Kvz-Cj SWM-1430-4Y-3Y-1M-1Y-100B-500Y-0M	5.00	0.4762
Kvz-HD2009 SWM-2984-1M-1Y-1M-2Y-0M	6.50	0.8095
Vee"S" CM-33027-F-12M-1Y-1M-1Y-2M-0Y	13.75	0.8182
Vee"S" CM 33027-F-12M-1Y-3M-1Y-1M-1Y-0M	12.75	0.9048
Vee"S" CM-33027-F-12M-1Y-4M-1Y-1M-0Y	12.75	0.8571
Vee"S" CM-33027-F-12M-1Y-4M-2Y-3M-0Y	13.75	0.8036
Vee"S" CM-33027-F-15M-500Y-0M-0Ptz-0Y	9.00	0.7619
Vee"S" CM-33027-F-15M-500Y-1M-0Y-0Ptz-0Y	9.00	0.7500
(Kvz/Tob-CfnxBb)Blo"S" CM-33028-A-4M-6Y-11M-2Y-4M-0Y	13.75	0.9091
Kvz-J8216.67xSis"S" CM-33089-W-3M-5Y-1M-1Y-1M-0Y	6.75	0.6818
Bow"S" CM-33203-K-9M-9Y-4M-4Y-1M-1Y-0M	10.00	0.8182
Bow"S" CM-33203-K-10M-7Y-3M-1Y-1M-0Y	12.75	0.8500
Bb-Gll x Sjm"S"/Au-Ws1812 CM-34580-A-1M-3Y-8M-1Y-1M-0Y	5.25	0.8095
Gll-CucxKvz-Sx CM-34630-D-5M-2Y-1M-1Y-1M-1Y-0M	6.50	0.7619
Gll-CucxKvz-Sx CM-34630-D-5M-2Y-1M-1Y-2M-1Y-0M	13.75	0.7619
Gll-CucxKvz-Sx CM-34630-D-5M-2Y-1M-1Y-2M-2Y-0M	6.50	0.8000
Jup-Ald"S" CM-34920-5M-1Y-1M-1Y-1B-0Y	8.75	0.4762
Jup(7C-Pato(R)/LR64xInia-Bb)Ana CM-37760-C-21Y-2M-1Y-3M-0Y	8.75	0.5500

1/ SPC= Septoria Progress Coefficient: $\frac{\text{Height of disease on plant (cm)}}{\text{Height of plant (cm)}}$

Table 13. Varieties and advanced lines of bread wheat showing slow-rusting characteristics to leaf rust in Ciudad Obregon and El Batan for the growing seasons of 1978,1979,and 1980 (data for disease increase over time at El Batan, 1980)

Varieties and advanced lines	Leaf Rust Reaction, 1980		
	August 28	September 14	September 28
Pavon 76	3MS	40MS	60S
Pavon"S" CM-8399-D-4M-2Y-2M-3Y-1M-0Y	C	5MR	20MS
Pavon"S" CM-8399-D-4M-3Y-1M-0Y-(1-17B)-0Y	TMS	TMS	40S
Pavon"S" CM-8399-D-4M-3Y-1M-0Y-(1-6B)-0Y	0	TMS	40S
Pavon"S" CM-8399-D-4M-3Y-1M-0Y-(1-26B)-0Y	3MS	20MS	40MS
Jar-CnoxCin-Cno/Sr CM-1733-9M-1Y-1M-1Y-0M	TMS	10MS	40S
Como"S"(B) CM-4756-12Y-1M-1Y-0M	TMS	20MS	40MS
Ka"S" CM-5484-F-5Y-4M-3Y-3M-1Y-0M	5MS	30MS	50S
Emu"S" CM-8327-C-9M-1Y-1M-1Y-0M	TMS	20MS	30S
Ti Resel-Moncho"S" CM-34801-2M-5Y-500M-0Y	0	TMS	5MS
BR 74.72-Coc CM-36889-14Y-2M-0Y	TMS	10MS	10MS
Jup-ZpxCoc CM-37614-B-14Y-3M-1Y-0M	TS	10MS	40MS
Jup-ZpxCoc CM-37614-B-14Y-14M-1Y-0M	0	10MS	30MS
Minivet"S" CM-37705-G-2Y-3M-2Y-0M	0	TMS	5MS
Minivet"S" CM-37705-C-1Y-4M-0Y	0	5MS	5MS
Drongo"S" CM-37756-A-7Y-3M-1Y-0M	TMS	20MS	20MS
Drongo"S" CM-37756-A-7Y-4M-1Y-0M	3MS	30MS	30MS
Dove"S" CM-38199-L-11Y-1M-1Y-0M	0	10MS	10MS
Tanager"S" CM-30697-2M-8Y-7M-0Y	0	5MS	10S
Y50E-Kal3xHork"S" CM-32111-1M-1Y-12M-1Y-0M	0	5MS	10S
Veery"S" CM-33027-F-12M-1Y-4M-0Y	TMS	30S	70S
Veery"S" CM-33027-F-12M-1Y-10M-0Y	TMS	30S	70S
(LR64-Sn64xTzpp-An64/Pj)Emu"S" CM-33254-P-4M-1Y-0M	3MS	10MS	40MS
(LR64-Sn64xTzpp-An64/Pj)Emu"S" CM-33254-Q-2M-2Y-0M	TMS	30MS	50S
Harrier"S" CM-33435-Y-2M-3Y-0M	3MS	5S	20S
Tow"S" CM-34709-G-15M-500Y-0M	3MS	5MS	40S
Tow"S" CM-34709-G-2M-2Y-7M-2Y-0M	0	5MS	10MS
Tow"S" CM-34709-G-15M-10Y-8M-1Y-0M	0	10MS	20MS
(Gallo-Aust 1161.157xCno-No/Mon"S")Coc-Hork"S" CM-38455-B-6Y-7M-3Y-0M	5S	10MS	40S
Yd"S"xKal-Bb/Hork"S"-Mo CM-38558-A-7Y-7M-0Y	0	TMS	10MS
Yd"S"xKal-Bb/Hork"S"-Mo CM-38558-A-7Y-14M-2Y-0M	0	5MS	10MS
Car422-Ana SWM-4610-2Y-1/M-4Y-0M	0	5MS	10MS
Inia66 (susceptible check)	50S	80S	90S

Table 14. Characteristics of the most promising advanced lines of bread wheat for possible release by INIA in Mexico, 1980-81

Advanced lines	Ciudad Obregon		Yield Ciudad Obregon				Leaf rust reaction			Quality characteristics					
	Heading date	Plnt ht	77-78	78-79	79-80	$\bar{x}$	Obregon	Mochis	Rio Bravo	Grain 1/ type	Vol. wt	PK	Alveogram P/G	Alveogram W	% Prot
Veery"S" CM-33027-F-8M-1Y-8M-1Y-2M-0Y	86	100	-	7867	8367	8117	TMR	20MS-S	TMR	2 red	82.2	120	4.3	198	11.8
Veery"S" CM-33027-F-12M-1Y-4M-2Y-2M-0Y	93	85	-	8778	7946	8362	10MS-MR	40MS	5MS	2 red	82.0	84	8.4	231	10.5
Veery"S" CM-33027-F-12M-1Y-6M-0Y	92	95	7338	6452	7733	7174	0	5MS	10MR	2 red	81.8	120	9.2	226	11.6
Veery"S" CM-33027-F-12M-1Y-2M-1Y-1M-0Y	94	90	-	8331	6548	-	TMS-MR	10MS-MR	20MS-MR	2 red	81.6	73	8.1	228	10.2
Mor"S" CM-37130-15Y-1M-3Y-0M	77	70	6802	6237	5713	6251	10MS-MR	5MS	10MS	2 amber	82.1	120	8.9	354	10.1
Thrush"S" CM-34742-E-2M-5Y-3M-500Y-100B-504Y-0M	82	90	-	7778	7158	7468	TMS	5MS-MR	TS	2 amber	80.5	120	6.0	350	11.2
Car 422-Ana SWM-4610-2Y-20M-1Y-0M	94	90	7045	6583	7050	6893	30MS-MR	10MS-MR	TR	2 white	80.0	48	2.5	170	9.7

1/ 1= large; 3= small

Durum Wheat

Durum wheat (*Triticum turgidum* L. var. *durum*) is grown mainly in dryland areas of the world. The lower yields that persist in these traditional durum wheat areas are largely the result of inadequate levels of resistance to diseases and to lodging, plus slow acceptance of improved varieties. Because they are grown primarily in dryland areas, it has been difficult to evaluate either the true potential of durums or the danger of certain destructive diseases common to the genus *Triticum*. Satisfactory progress has been made to incorporate resistance to stripe rust, leaf rust, and stem rust into durum materials developed by CIMMYT, but more resistance is needed, especially to leaf rust and stem rust. As the durum area expands, other diseases are becoming serious threats, such as *Septoria tritici, Erysiphe graminis, Helminthosporium sativum, Fusarium roseum* and Barley Yellow Dwarf Virus (BYDV).

Newly developed improved semidwarf durum lines have yielded as much as 10,850 kg/ha, when grown with excellent cropping practices in disease-free areas of northwest Mexico. Twenty-five lines and checks included in tests yielded an average of 9,000 kg/ha during the 1978-79 season. The average yield of the Ninth Elite Durum Yield Trial (EDYT), grown during the 1978-79 season, was 24 percent higher than the first EDYT in 1971-72:4,363 kg/ha compared to 3,367. The average yield of the 10th International Durum Yield Nursery (IDYN) (3,577 kg/ha) was 17 percent higher than the first IDYN grown in 1969-70 (2,965 kg/ha).

These data indicate that good progress has been achieved, but great potential remains for yield improvement in durums.

Good seed set and fertility in long, lax head types, along with good hectoliter and 1000-kernel weights, may lead to higher yields in durums that are less susceptible to head diseases. Dr. Gregorio Vazquez, leader of the durum wheat program, looks for desired agronomic characteristics.

YIELD POTENTIAL

Durum yield trials planted in the Yaqui Valley in 1979-80 were few, due to losses of materials to frosts that occurred in Toluca during September, 1979. Among the reduced tests, however, some new lines exceeded the best checks by as much as 5 to 13 percent (Table 1). Also, results of international trials (9th EDYT and 10th IDYN, Tables 2 and 3) show average yields ranging from 4,019 to 4,868 kg/ha for several lines of Yavaros"S," Boyeros"S," and Cormorant"S." Some of the lines included in these trials also showed wide adaptability and good yield potential for many areas in the world.

RESISTANCE TO DISEASES

Satisfactory resistance to yellow rust, leaf rust, and stem rust has been shown in tests of materials conducted at several locations in Mexico. The same was not true for *Septoria tritici* and head scab (*Fusarium roseum*). Nearly all semidwarf durums showed high levels of susceptibility to these diseases in the rainy summer season tests conducted in Patzcuaro and Tepatitlán in the central part of Mexico. Tests from the Ninth EDYT, the Tenth IDYN, and from Mexico indicate a general lack of resistance in durum materials to *S. tritici, F. roseum, Puccinia graminis,* and *Helminthosporium sativum.* Tables 1 to 3 list some of the best lines for resistance to these diseases.

Data from the 10th and 11th International Durum Screening Nurseries (IDSN) indicate satisfactory levels of resistance to stripe rust (*Puccinia striiformis*). Good progress has also been made for resistance to leaf rust (*P. recondita*) and stem rust (*P. graminis*), as shown in tables 4 and 5. These data indicate the need to incorporate more resistance to *S. tritici* and to other diseases for which limited reports are available.

IMPROVEMENT OF OTHER AGRONOMIC CHARACTERISTICS

Work continues to incorporate cold resistance and cold tolerance into the durums. During the 1979-80 winter season, 543 new crosses were made, mainly using cold-resistant durum materials from Turkey.

Materials from various sources and origins are screened every growing season for earliness of heading and fast maturity; crosses are made to combine these traits with other desirable characteristics. Strong straw in semidwarf to medium-tall types are selected every season, particularly in

early generations where F_2 bulks are grouped in semidwarf, medium-tall, and tall stature. Such materials are distributed to various durum areas in the world.

Leaf area, leaf position, and canopy continue to receive attention. The goals include better utilization of light and water, and possibly reduced incidence of certain diseases. Efforts continue to incorporate lax and semi-lax head types with more space between the spikelets—which might permit faster drying after rain and mist, thus reducing conditions for incidence of such diseases as head scab and other head-rotting problems.

Good seed set and fertility in long, lax head types, along with a good hectoliter and 1000-kernel weight may lead to higher yields in durums that are less susceptible to head diseases. Lines with excellent fertility, high test weight, and with high 1000-kernel weight are being intercrossed to develop new durums with higher yield potential.

DURUM WHEAT QUALITY

Some countries have surpluses in durum production, and are in a position to export, especially to industrialized countries in Europe. This requires durums that provide satisfactory macaroni quality. Although the major concern in CIMMYT is to develop high yielding, widely adapted durum materials, attention is also given to various quality characteristics, such as satisfactory pigment content in semolina, macaroni color, and gluten strength or consistency.

Table 6 gives quality data for the highest yielding durum lines in the Yaqui Valley for 1979-80. The great possibilities for combining satisfactory quality and high yield are clear. Table 7 shows a group of semidwarf lines and varieties that are used to improve the quality of semidwarf materials developed by CIMMYT. Protein content of 10 percent and higher, carotene content maintained at or above 5 ppm, and medium-strong to strong gluten strength are the satisfactory standards of quality in the durum program.

INTERNATIONAL NURSERIES AND COOPERATION

Three international durum nurseries—Elite Durum Yield Trial (EDYT), International Durum Yield Nursery (IDYN), and International Durum Screening Nursery (IDSN) —were distributed in 1980. Other nurseries distributed included materials at early stages of development, the F_2-Irrigated, F_2-Dryland, and F_2-Cold Tolerant groups. A notable increase in requests for the F_2-Cold Tolerant group came from European countries.

Special groups of materials, such as Crossing Blocks, Small Plots and F_2 bulks of crosses with resistance to *S. tritici*, as well as interspecific *aestivum x durum* crosses, were sent to several places in the world.

New varieties evolved from CIMMYT durum materials were named and released in various countries. Reports were received of the following:

Argentina:	La Dulce =(Jo"S" x RD119-2W-4Y/AA"S") Yemen"S"-Cr"S" CD-595
Cyprus:	Mesaoria=AA"S"-Volunteer D-31728
Ethiopia:	Boohai=Coot"S"-Candeal II CD-3862
	Hora=Tezontle CD-10549
India:	Three semidwarfs from CIMMYT: DWL-5002, DWL-5023, RAJ-1555
Kenya:	Mwewe=Fg"S"-Leeds CM-9821
	Njiwa=Fg"S"-Leeds CM-9821
	Kenjewa=Cr"S" x Jo"S"-Gs"S" CM-9723
Tunisia:	Ben Bachir 78=Stork"S" = Mexicali"S"
	Karim 79=Bittern"S" =Yavaros"S" CM-9799
Egypt:	Sohagi=Mexicali"S" CM-470
Mexico:	Yavaros 79=Bittern"S" CM-9799

In 1980, the milling and baking laboratory evaluated hundreds of durum lines for pigment content in semolina, macaroni color, and gluten strength.

Table 1. Highest yielding durum lines and selected agronomic and disease data, Ciudad Obregon, Sonora, Mexico, 1979-80

Cross and pedigree	Yield kg/ha	% best check	Days to flower	Plant ht (cm)	Reaction to*			
					leaf rust	stripe rust	*S.tritici*	scab
Yavaros"S" CM-9799-126M-1M-3Y-0Y-1B	7276	105	82	85	TR	0	7-8	2/60
Winged"S" CM-18577-11Y-6Y-2Y-0Y	7227	105	81	85	20S	0	6-8	3/60
Rokel"S" CD-1895-12Y-0Y-2E	7490	105	81	85	104-MR	TR	5	2/30
Rokel"S" CD-1895-12Y-1Y-8B-0Y	7600	105	78	80	5MS	TR	8	3/70
Ente"S"-Mexi"S" CD-8153-12M-3Y-4M-1Y-0M	8306	106	85	75	10MS-MR	TR	7	3/50
Lds Mut-Teal"S" CD-12427-4Y-2M-2Y-4M-1Y-0M	7331	106	81	75	TMR	0	8	4/70
Chichicuilote"S" CD-1314-A-1Y-2Y	7835	110	80	90	5MS	TR	6	1-2/40
Shwa"S"-Bit"S" CD-20626-5M-2Y-1M-0Y	7830	112	83	80	5MR	TR	8	3-4/60
Erpel"S"-Gs"S"xBoy"S" CD-2504-3-A-1Y-3M-0Y	7893	113	85	90	5MS	10MR	8	3/50

* Disease reaction represents highest reading from several locations:
R= resistant, MR=moderately resistant, S=susceptible, MS=moderately susceptible,
TR= trace resistant, TS=trace susceptible.
Reaction to *Septoria tritici*, from 0-9,9= very susceptible.
Reaction to head scab, from 0-5= degree of infection and 0-100 = percent of infected heads.

Table 2. Top ranking durum lines for yield, agronomic characteristics, and disease reaction of the 9th EDYT, 1978-1979

Entry No.	Variety, or cross and pedigree	Yield	Flow days	Leaf rust	*Septoria tritici*	1000 G.W. (grams)
1	Cit"S"-Can.02133xPg"S"/Cr"S" CD-1610-C-1Y-3Y			3	39	
2	Mexi"S"-Fg"S" CD-1895-12Y-0Y-2E			2		
3	Bittern"S" CM-9799-126M-1M-4Y-0Y	4868				
4	Bittern"S" CM-9799-126M-1M-5Y-0Y	4859				
5	Goose"S" CM-10143-6M-3Y-1M-2Y-0Y					
6	Can.02199xJo"S"-AA"S"/S15-Cr"S" CD-10535-D-1M-3Y-0M				28	
7	Mca"S"xJo"S"-AA"S"/Pg"S"-Fg"S" CM-14646-C-1Y-1M-1Y-0Y					
8	Gs"S"-Cr"S"xRuff"S"/Mexi"S" CD-1314-A-1Y-2Y					
9	Geier"S"-USA.0676xJo"S"-Cr"S" CD-10569-C-10M-1Y-0M	4667				55
10	Gta"S"-Mexi"S" CD-771-1Y-2Y-4M-0Y					54
11	Ibis"S"-Gta"S" CM-18577-11Y-6Y-2Y-0Y					
12	Jo"S"-gr"S"xMario"S" CD-7459-9Y-7M-0Y					
13	Boyeros"S" CD-4404-B-9Y-3M-0Y	4754			13	
14	Jo"S"-AA"S"xMexi"S" CD-7917-5M-1Y-1M-0Y		95		33	54
15	Ato"S"xAA"S"-Plc"S"/Cr"S"-Gs"S" CD-10011-23M-3Y-4M-0Y			3		
16	Gdo.VZ512-Cit"S"xRuff"S"-Fg"S" CD-10549-U-7M-2Y-1M-0Y					
17	Bit"S"-AlderxMexi"S"/Gta"S"-Fg"S" CD-16677-A-7M-9Y-0M			4		58
18	Gediz"S"-Fg"S"xRabi"S"-31810 CD-16707-H-3M-3Y-0M					
19	BD1543-Inrat6gxCoot"S"/Gta"S" CD-13557-J-3Y-3M-1Y-0M			3		
20	Ente"S"-Mario"S" CD-7498-14Y-6Y-1M-1Y-0M					59
21	Cocorit 71 (Durum check)	4258	93			
22	Mexicali75 (Durum check)	3981	90			54
23	Pavon 76 (Bread wheat check)	4456				
24	Mapache (Triticale check)	4823	92	0		
25	Local check	4068				
	Number of observations	36	23	8	2	8

Reaction to leaf rust and *Septoria tritici* given as coefficient of infection.

Table 3. Top ranked durum lines and varieties for yield, agronomic characteristics, and disease reaction of the 10th IDYN, 1978-79

Entry No.	Variety, or cross and pedigree	Yield kg/ha	Flow days	Stripe rust	Leaf rust	Stem rust	Powd. mild.	Sept. trit.	1000 G.W.	Test wt.
1	7175/Ward D-74108		92			2		19		
2	68111/Rugby x Ward							16		
3	A63040-Sentry D-66058-81T-1T-2T-2T-0T		2					23		
4	Naimus/lakota D-2907-55-29-5-11					1		20		
5	Crosby						30	17		
6	U.S.D.A. 508					1	30			
7	Wakooma							21		
8	P66/253			2			27			
9	Cfn-Fg"S"xPtl"S" CM-17780-A-7M-1Y-1Y-0Y			0	5					
10	Cormorant"S" CM-2999-49Y-4M-3Y-0M	4019			5				47	
11	Bittern"S" CM-9799-126M-1M-3Y-0Y	4137			4		19			78
12	Bittern"S" CM-9799-126M-1M-5Y-0Y	4137			3					78
13	Rabi"S"-31810 CM-10172-37M-0Y-2Y		94			4			47	
14	Cr"S"-F3 Tun x AA"S"/Fg"S" CM-10200-9BK-1BK-2Y									
15	Ch67-Jo"S"xCr"S" CM-12857-10Y-2M-1Y-0Y									
16	Mapache (Triticale check)	4423			6	4	6			
17	Cit"S"-Mca"S"(Pg"S"/Gll"S"xLds-56-1) CM-14562-J-600Y-1M-2Y			1						
18	Jo"S"-Cr"S"xCr"S"-Gs"S" CM-17274-5L-5L			2					48	
19	Plc"S"-Ruff"S"xGta"S"-D6715 CM-17904-D-3M-1Y-0Y		94	1						
20	Cr"S"-USA02299 CM-18882-2Y-0Y		94	1				47		
21	Alder"S"-Mexi"S" CM-19639-A-1Y-3Y-0Y		93				30			
22	Jo"S"/61-130xLds D-26844-18Y-4M-0Y									
23	Mexicali 75 (Durum check)	3692	91						47	
24	Pavon 76 (Bread wheat check)	4233				3				79
25	Local check	3988								
	Number of observations	118	84	22	34	19	10	15	34	40

Reaction to all diseases given as coefficient of infection
Flow days= days to flower
Powd. mild. = Powdery mildew
1000 G.W. given in grams and test weight as kilograms per hectolitre

Table 4. Durum wheat lines of the 10th IDSN, showing resistance to diseases, 1978-79

Variety, or cross and pedigree	Coef. of infection
Resistance to stripe rust (6-5 observations on leaf) and head)	
Ato"S"xAA-Plc"S"/D67.2 CD-10023-3M-4Y-1M-1Y-1M-0Y	0.0-0.0
Gta"S"-USA.0445 D-31-1B-2Y-2B	0.1-0.0
Jo"S"-Cr"S"xUSA.0679/Jo"S"-gr"S" CD-10579-F-6M-1Y-4M-0Y	0.1-0.0
Paraná-Pg"S"xGta"S" CD-10654-C-1M-1Y-8M-1Y-0M	0.1-0.0
BD101-1B	0.2-0.0
Memo"S" CD-10521-I-4M-3Y-1M-1Y-0M	0.2-0.0
Resistance to leaf rust (15 observations)	
USA.0640-Fg"S"xFg"S"^{2}-Ruff"S" CD-14119-F-1Y-4M-1Y-4M-0Y	0.6
Ruff"S"-Fg"S" CM-9880-20M-1Y-1M-1Y-1B	0.7
Bo"S"-Gs"S"xCoot"S"/Rabi"S" CD-10454-24M-1Y-4M-1Y-1M-0Y	1.0
Ente"S"-Mexi"S" CD-8153-12M-3Y-3M-1Y-0M	1.0
Swan"S" CD-16707-G-7M-5Y-2M-0Y	1.1
Sco"S" CD-16906-H-5M-2Y-7M-0Y	1.1
Gdo.VZ394	1.1
Resistance to stem rust (18 observations)	
Rehe"S" CD-13102-10M-1Y-0M	1.0
(Ch67xJo"S"-Cr"S"/Ward)Mexi"S"-Cand.II CD-14432-B-3Y-M-1Y-0M	1.2
Stil"S" CD-16677-A-3M-6Y-0M	1.6
Swan"S" CD-16707-F-1M-5Y-4M-0Y	1.7
(Kif"S"xVZ488-Ld390/2/Cp/F3/Cp-Yuma)Coot"S"-Mario"S" CD-12390-5Y-1M-1Y-2M-0Y	1.7

Table 4. (continued)

Variety or cross and pedigree	Coef. of infection
Resistance to Powdery mildew (2 observations)	
BD209	0.0
(Dack"S"/Cfn5-Fg"S"xPlc"S")Yel"S" CD-19752-A-4Y-1M-0Y	0.0
(Plc"S"xSalti.Autma-Hiti/Fg"S")Mexi75 CD-16895-A-3M-2Y-2M-0Y	0.0
(Plc"S"xSalti.Autma-Hiti/Fg"S")Mexi75 CD-16895-A-3M-2Y-3M-0Y	0.0
(Plc"S"xSalti.Autma-Hiti/Fg"S")Mexi75 CD-16895-A-3M-2Y-5M-0Y	0.0
Cr"S"-Gs"S"xMarte"S"-Mexi"S" CD-9687-11Y-2M-4Y-2M-0Y	0.0
Win"S"-Magh"S" CD-12459-7Y-1M-2Y-2M-0Y	0.0
D.Coll.024-Coot"S"xFg"S" CD-13570-E-2Y-3M-3Y-1M-0Y	0.0
Mexi"S"-Gta"S" CD-1896-1Y-3Y-2M-0Y	0.0
Mexi"S"-P66.270/Gta"S" CD-13252-8Y-2M-1Y-0M	0.0
Gdo VZ394	0.0
Resistance to *Septoria tritici* (6 observations)	
Erpel"S"-Ruso CD-10437-13M-3Y-1M-2Y-2M-0Y	35.5
Rabi"S"/Ld390xBelle-Tc60[2] CM-10171-2BK-1BK-1B	35.7
Erpel"S"-Ruso CD-10437-8Y-1M-2Y-3M-0Y	35.7
Win"S"-Magh"S" CD-12459-7Y-1M-2Y-2M-0Y	35.7
{/(AA"S"-Gs"S"xCit"S"/Ruff"S")Albe"S"/Kif"S"}USDA.0595 CD-19571-B-8Y-2M-0Y	36.5

Table 5. Durum wheat lines of the 11th IDSN, showing resistance to diseases, 1979-80

Variety, or cross and pedigree	Coef. of infection
Resistance to stripe rust (4 observations on leaf)	
Kol"S"	0.0
CD-10011-14M-2Y-1M-2Y-0M	
Memo"S"	0.0
CD-10521-I-4M-1Y-3M-1Y-0M	
Jo"S"-Cr"S"xUSA.01679/Jo"S"-gr"S"	0.0
CD-10579-F-6M-1Y-4M-0Y	
Misri-Mexi"S"xSnipe"S"	0.0
CD-10662-F-1M-1Y-2M-1Y-0M	
Misri-Mexi"S"xSnipe"S"	0.0
CD-10622-F-1M-1Y-2M-3Y-0M	
Win"S"	0.0
CM-18577-11Y-6Y-2Y-0Y	
Win"S"	0.0
CM-18577-11Y-7Y-1Y-1M-0Y-0ke	
gr"S"-S Cp x St464/Cr"S"	0.0
CM-19742-D-5Y-1M-2Y-2Y	
Frig"S"	0.0
CM-17904-B-3M-1Y-1Y	
Mexi"S"-Gta"S"	0.0
CD-1896-1Y-3Y-0ke	
Kranish"S"	0.0
CM-199-29M-1Y-1M-0Y	
Kif"S"	0.0
CM-14662-D-14Y-3M-1Y-1Y-0M	
Frig"S"	0.0
CM-17904-B-3M-1Y	
Algerian 86	0.0
Ato"S"xAA"S"-Plc"S"/D67.2	0.0
CD-10023-3M-4Y-1M-1Y-1M-0Y	
R143	0.0
Sca"S"	0.0
CM-18537-1Y-0Y-1B	
(Plc"S"xSalti.Autma-Hiti/Fg"S")Mexi75	0.0
CD-16895-H-4M-1Y-2M-1Y-0M	
Resistance to leaf rust (9 observations)	
Pg"S"-Cit"S"	4.3
CD-8142-3M-3Y-1M-1Y-1M-0Y	
Gdo.VZ578-Gta"S"	4.3
CD-8544-26M-4Y-1M-1Y-2M-0Y	
LdsMut-Teal"S"	4.3
CD-12427-4Y-2M-2Y-2M-2Y-0M	
Sche"S"	5.3
CD-19321-C-1Y-6M-1Y-0M	
USA.0640-Fg"S"xFg"S"^{2}-Ruff"S"	5.3
CD-14119-E-7Y-1M-2Y-1Y-0M	
Sca"S"	5.7
CM-18537-1Y-0Y-1B	

Table 5. (continued)

Variety or cross and pedigree	Coef. of infection
Resistance to stem rust (5 observations)	
LdsMut-Teal"S" CD-12427-4Y-2M-2Y-2M-2Y-0M	0.6
LdsMut-Teal"S" CD-12427-4Y-2M-2Y-2M-1Y-0M	2.6
Gta"S"-Pg"S"xUSDA.0580 CD-18533-3Y-2M-2Y-0M	2.8
Boy"S"-Snipe"S"xGediz"S"-Corm"S" CD-19832-A-5Y-1M-0Y	2.9
Ralle"S"xCh67-Jo"S"/Ruff"S"-Fg"S" CD-13229-15Y-2M-1Y-2M-1Y-0M	3.9
USA.0640-Fg"S'xFg"S"^{2}-Ruff"S" CD-14119-E-7Y-1M-2Y-1M-0M	3.9
Resistance to Powdery mildew (4 observations)	
Yav"S" CM-9799-126M-1M-5Y-0Y	0.0
Tezontle"S" CD-10549-U-7M-2Y-1M-0Y	0.0
Mexi"S"-Magh"S" CD-3879-29M-1M-0Y-1B	0.0
Ful"S"-Fg"S"/Oyca"S"xRuff"S"-Fg"S" CD-17305-A-5M-1Y-1M-0Y	0.0
Ful"S"-Fg"S"/Oyca"S"xRuff"S"-Fg"S" CD-17305-A-5M-4Y-1M-0Y	0.0
Resistance to *Septoria tritici* (3 observations)	
Ente"S"-Mexi"S" CD-8153-12M-3Y-1M-2Y-1M-0Y	0.0
Duro 73-Ibis"S"x1150-KR59 F4 Lamb-2Y-1M	3.7
LdsMut-Teal"S" CD-12427-4Y-2M-2Y-2M-2Y-0M	7.3

Table 6. Highest yielding durum lines and their quality data, Ciudad Obregon, Sonora, Mexico, 1979-80

Cross and pedigree	Yield kg/ha	%Best check	Test wt.	Grain type	%YB	%Black point	Prot. %	Car. cont.	Gluten color	Gluten Strength
Yavaros"S" CM-9799-126M-1M-3Y-0Y-1B	7276	105	83.2	1+	0	10	9.7	4.0	7	1/2F
Winged"S" CM-18577-11Y-6Y-2Y-0Y	7227	105	80.2	2	0	20	9.8	6.9	10	F
Rokel"S" CD-1895-12Y-0Y-2E	7490	105	80.0	2+	10	10	9.5	6.6	8	F
Rokel"S" CD-1895-12Y-1Y-8B-0Y	7600	105	78.8	2+	20	10	9.5	7.5	8	F
Ente"S"-Mexi"S" CD-8153-12M-3Y-4M-1Y-0M	8306	106	78.4	2	0	T	10.2	7.2	8	F
LdsMut-Teal"S" CD-12427-4Y-2M-2Y-4M-1Y-0M	7331	106	81.4	2	0	10	10.6	3.2	3	F
Chichicuilote"S" CD-1314-A-1Y-2Y	7835	110	82.0	2	20	10	9.7	3.0	4	F
Shwa"S"-Bit"S" CD-20626-5M-2Y-1M-0Y	7830	112	82.2	1+	10	10	9.8	5.6	7	MS
Erpel"S"-Gs"S"xBoy"S" CD-25043-A-1Y-3M-0Y	7893	113	80.4	2	T	10	9.7	7.2	5	F

Test weight = kilograms per hectolitre
% Y B = Yellow berry percentage
Prot.% = Protein percentage
Car. cont = Carotene content in parts per million, 10 ppm the best
Gluten color: Scale 1-10, ten the best
Gluten strength: F=strong, 1/2F= medium strong, MS= very weak

Table 7. Durum wheat lines having good quality

Cross and pedigree	Prot. %	Car.cont. (ppm)	Gluten color	Gluten strength
Cocorit 71 (check)	9.8	3.9	5	F
Mexicali 75 (check)	10.2	6.4	7	F
Yavaros 79 (check)	9.6	5.0	6	1/2F
Quilafen (check)	12.8	8.7	10	F
Cando (check)	13.6	11.1	7	1/2F
Guillemot"S" CM-14646-C-1Y-1M-1Y-0Y	10.1	7.0	10	F
Frigates"S" CM-17904-B-3M-1Y-1Y	11.1	6.3	8	F
Rokel"S" CD-1895-12Y-2Y-2M-0Y	10.2	7.5	8	F
Ente"S"-Mexi"S" CD-8153-12M-3Y-4M-1Y-0M	10.2	7.2	8	F
Shwa"S"-Bit"S" CD-20626-5M-6Y-1M-0Y	11.0	7.4	7	1/2F
Gediz"S" D-27534-1M-1Y-1M-0Y	10.0	7.6	8	1/2F
Cit"S"-Gs"S"/Pg"S"xLds-56.1 CM-14542-B-1Y-1M-3Y-0AP	9.9	7.0	9	F
Winged"S" CM-18577-11Y-6Y-2Y-0Y-15B-0Y	9.7	7.2	8	F
Rokel"S" CD-1895-12Y-1Y-8B-0Y	9.5	7.5	8	F
S15-Cr"S"/Cit"S"-AA"S"xFg"S" CD-7443-11Y-4M-0Y	9.6	6.9	8	F
/(Durum^{6}xBD1548-N262-B/Gad"S")Ful"S"/Boy"S" CD-25395-A-3Y-1M-0Y	9.5	8.1	7	F
Mexi 75-Gediz"S" CD-26264-3B-1Y-0Y	9.9	7.6	7	F

Car.cont.= Carotene content in parts per million, 10 ppm the best
Gluten color: Scale 1-10, ten the best
Gluten strength : F=strong,1/2F=medium strong

Triticale

The improvement of triticale as a commercial crop is steadily moving forward. Many countries have expressed interest in the crop, but as yet the area under commercial production is only slowly increasing. There appear to be two main barriers to introducing triticale: one is an initial skepticism among researchers and growers toward something new, and the other is a reluctance of food processors to accept triticale because they lack experience with the grain. It is encouraging, however, to see that as both groups gain this experience, the production of triticale is increasing quite rapidly in areas where this crop has an advantage over wheat.

Once a certain level of production and experience is reached, there is good acceptance of triticale. In Canada, for example, where the variety Welsh was released in 1978, the total area under production in 1979 was estimated to be about 20,000 ha. In 1980, the province of Manitoba, Canada, had by itself about 20,000 ha sown to triticale. In Kenya, the production of triticale underwent roughly a five-fold increase from 1980 to 1981. The area sown to triticale in the USSR, which in 1979 was estimated to be 200,000 ha, increased to an estimated 400,000 ha in 1980. And in the People's Republic of China, area estimates of octoploid triticale were 30,000 ha in 1980, versus 15,000-20,000 ha in 1979. Both China and the USSR grow winter triticales. The area under triticale production is, of course, still limited in comparison to the traditional cereal crops. As these examples show, however, some important advances have been made during the past year.

With the exception of these few countries, detailed information on the commercial production of triticales is scarce. Since most varieties have been released in only the last two years, it can be presumed that most are in the process of seed multiplication and that little seed has yet reached farmers.

A number of spring triticale varieties have been released during the last few years and more were added to the list in 1980. The 1980 releases are:

Cross or CIMMYT name	Released as	Country of release
Beagle selection	Carmen	Manitoba, Canada
Beagle selection	OAC Triwell	Ontario, Canada
Inia-Armadillo	Coorong	South Australia, Australia
Drira selection	Nyngadoo	New So. Wales, Australia

The main objectives of the triticale breeding program are to improve yield potential, broaden adaptation, improve disease resistance, and improve test weight and industrial quality of the seed. This report gives highlights of 1980 activities in each area.

YIELD AND ADAPTATION

To meet the objective of increasing the yield potential and adaptation of triticales in general, we use a combination of results obtained from testing sites in Mexico and results obtained by cooperators growing the international nurseries. During the 1979-80 crop cycle in Ciudad Obregon, Sonora, about 900 advanced triticale lines were yield-tested; 285 were selected on the basis of yield, improved seed type, disease resistance, and suitable agronomic type. These lines were included in the 12th International Triticale Screening Nursery (12th ITSN), which was distributed to about 185 locations throughout the world.

Table 1 shows yields of selected lines that were tested at three irrigated sites in Mexico. On average, there was only a slight yield advantage over the check varieties. However, except for two lines that are shorter in stature, all lines were considerably better in test weight. Table 2 shows the preliminary results for yield and test weight in the 11th International Triticale Yield Nursery (ITYN). These data demonstrate the improved yields of the newer lines, which have equal or better test weights than the check varieties. Table 3 includes the triticale lines in the top 10 percent in yield from 31 locations for the 11th International Triticale Screening Nursery (ITSN). These lines displayed up to an 18 percent improvement in yield over the best check variety (Caborca 79) over all locations.

Triticale generally flowers as early as wheat, but maturation takes considerably longer, causing problems in areas with a short growing season or high temperatures prior to harvest., Dr. Frank Zillinsky, leader of the triticale improvement program, looks over a field of triticale under commercial production.

A high proportion of the widely adapted, high-yielding strains possess the complete rye genome. Most of these strains are tall and late-maturing. The broadly adapted material can be improved by introducing dwarfing and earliness. Efforts to develop high-yielding triticale lines possessing the so called one-gene dwarf have been successful through a single chromosome substitution, replacing 2R with 2D. The development of high yielding, two-gene dwarfs has been much more difficult. However, results from recent tests show that some of the recently developed two-gene dwarfs are at least equal in yield potential to the tallest types but are generally lacking in test weight. The objective now is to combine yield potential and high test weight in the dwarf plant stature. These qualities will provide needed straw strength under highly productive conditions, and will serve as parents in crosses to primary triticales that are generally too tall.

Preharvest sprouting is another problem delaying the acceptance of triticale in areas having humid conditions during harvest. With cooperation from scientists in the Patzcuaro region of Michoacan, Mexico, improvements in tolerance to preharvest sprouting have been made. Varieties such as Bacum were highly susceptible to sprouting under conditions existing in this region, but during the past 3 years new lines have been introduced and tested, some of which have better resistance to sprouting, making them more acceptable for commercial production. Harvesting conditions at the Toluca nursery provide a further opportunity for selection

Table 1. A summary of results of selected triticale lines tested at three locations in Mexico: Cd. Obregon, Hermosillo, and Celaya

	Strain identity	Avg. yield (kg/ha)	Yield % of best check	Test wt. (kg/hl)	Plant height (cm)
ETYT I	Caborca 79 (check)	6162	100	70.0	110
	Ptr x Octo Bulk-Bush X 31731-1Y-1M-1Y-0M	6199	100	73.6	115
	E3 - Arm x M2A/Addax X 33113-J-1Y-1M-0Y	6214	101	66.8	90
	Ptr x Octo Bulk-Bush X 31731-7Y-3M-1Y-0M	6222	101	73.3	110
	Cml - Kal x Kal X 32709-6Y-1B-1Y-0B	6261	102	63.8	100
	Puma"S" X 27554-A-1M-6Y-3M-1Y-0M	6476	105	72.3	110
ETYT II	Cananea 79 (check)	5660	100	66.4	115
	Muskox"S" X 15570-1Y-1B-100B-0Y	5664	100	73.8	130
	Juanillo 159	5745	101	69.8	135
	Chiva"S" X 24551-8Y-3M-1Y-0M	5826	103	72.8	115
	Nv - Lince = Liebre"S" X 31100-5Y-1M-2Y-0M	5831	103	71.7	120
	Bur - Abn = Boa"S" X 24560-9Y-3M-1Y-0M	5899	104	69.6	105

against preharvest sprouting. The most promising sources of resistance to sprouting appear to be winter-type triticales, some spring-type triticales obtained from Brazil, and some ryes recently developed in northern Europe.

Triticale strains generally flower as early as wheat, but maturation takes considerably longer, causing problems in areas with a short growing season or high temperatures prior to harvest. Two approaches are used to develop earlier maturing varieties. One involves making crosses between earlier triticales and selecting for earliness, and it appears that some progress can be made in this way. Second, since the relative lateness of triticales may be due to the rye parent, we are attempting to obtain early, light-insensitive ryes. This is being done, in part, by selection under different daylengths. Also, in cooperation with Dr. Metzger at Oregon State University, USA, we hope to obtain early ryes via mutation with EMS treatment.

SEED TYPE AND TEST WEIGHT

One of the major objectives of the triticale program for the last few years has been to combine the high test weight of certain lines—such as Camel"S" and Panda"S"—with the high yield and good adaptation found in many of the triticales. We have also tried to find triticales with greater stability for good grain type. It has been fairly easy to find triticales that produce high test weights under the best conditions, but when grown under poor conditions, the test weight drops sharply. Tables 4 and 5 show that we now have triticales with good stable test weight, based both on international and Mexican data. Table 4 lists 15 lines that, over six locations, had test weights within 90 percent of the wheat variety Pavon. Table 5 summarizes the performance of certain lines over four test locations in Mexico. Normally, good tests weights are produced only at the Sonora location; Huamantla and El Batan are intermediate to poor, depending on the year; the Toluca station normally produces poor test weights. The 13 lines listed in Table 5 not only had more than 10 percent higher test weight than the standard check triticales, but nearly all of them also had higher yields.

In the Sonora cycle—for the first time—we identified a strain having a test weight higher than 80 kg/hl. We have no idea how high the test weight can be raised by selection, but we feel that we have now reached an acceptable level of test weight for the good grain-type triticales. Work will continue toward further increasing and stabilizing test weights.

By the end of 1980, only one country (USA) had set an official standard for the test weight of triticale—56 pounds per bushel (about 70 kg/hl). Many CIMMYT lines have now reached that standard. We believe realistic stan-

Table 2. The highest yielding lines from the Eleventh International Triticale Yield Nursery, giving average yield and test weight over 24 locations

Entry No.	Variety or strain	Average yield (kg/ha)	Test weight (kg/hl)
17	Beaguelita X 22427-101Y-2M-6M-1M-1Y-0M	4624	63
8	Ram"S" X 12257-1N-0M	4534	64
9	Tigre"S" X 27947-22M-1Y-0M	4517	69
11	Bgl"S" - M2A - Cin X 15673-A-1Y-2Y-8M-0Y	4460	67
2	Beagle (check)	4389	64
1	Cananea 79 (check)	4389	64
12	Tcl Bulk 50 - MA X 15684-3Y-1Y-0M	4382	65
20	T 107.18 - M2A x Mpe X 25947-22M-1Y-0M	4325	68

Table 3. The highest yielding lines[1] from the Eleventh International Triticale Screening Nursery averaged over 31 locations, in percent of best check variety

11th ITSN Entry No.	Cross and pedigree	Yield (kg/ha)	Percent of Caborca 79
328	L.O. Bulk	4294	118
275	W74.103 - Adda/Bgl - M2A x IRA X 33470-C-1Y-5M-1Y-0M	4237	116
322	Puppy - Bgl B-38	4045	111
144	Juanillo 96 (8 sisters) X 21295	3984	109
325	Llama - F3 Spy x Bgl B-128-100B-101Y-0B	3886	107
230	FS 381 - FS 1795 X 29387-1Ke-1Y-0B	3871	106
192	Chiva"S" X 24551-8Y-3M-1Y-0M	3846	105
323	Drira - IA x Bgl B-85	3836	105
190	M2A - Rahum (2 sisters) X 24548-3Y-3M-2Y-0M	3804	104
70	Topo 120 (2 sisters)	3793	104
79	Tj - Bgl"S" (3 sisters) X 16134-35Y-1Y-1M-1Y-2B-0Y	3767	103
181	FS 1795 - Lnc X 24369-4H-1Y-1M-1Y-0M	3754	103
16	M2A - Kla"S" X 12725-A-1Y-1Y-2Y-0M-4Y-0M	3748	103
32	Delfin 99	3746	103
172	IA - Nv"R" X 23988-B-1Y-1M-1Y-0M	3739	103
162	Bgl"S"/Bgl"S" x ITA-Leo X 22551-100Y-100Y-13M-1Y-1M-0Y	3705	102
220	M2A - Rahum X 27342-13Y-1M-0Y	3698	101
21	IGA - M2A x IA - M2A X 14527-D-4Y-4Y-2Y-1M-1Y-100B-0Y	3680	101
289	Panda"R" - Rahum (2 sisters) X 36517-1151H-1Y-0M	3672	101
165	Polar"S" X 22591-100Y-101Y-4M-1Y-0M	3650	101
247	Rahum"S" - M2A X 31124-7Y-3M-0Y	3644	101
7	Caborca 79 = Bura	3630	100

[1] Best 10% are reported and only highest sister included, number of sisters given in parentheses.

dards should be set for the test weight of triticale, and it should not be assumed that triticale must produce grain identical to wheat. It is noteworthy that the improvement in grain type seems to be independent of whether the triticale is complete or substituted. The sister lines IA-Kla x Cal/Bgl, numbers 273 and 278 in Table 5, are complete triticales (containing all seven rye chromosomes); the rest of the lines have one or more substitutions.

Table 4. Lines from the 11th ITSN with highest average test weight over 5 locations, as a percent of Pavon 76 (bread wheat check)

11th ITSN Entry No.	Cross and pedigree	Test weight (kg/hl)	Percent of Pavon 76
103	Pavon 76	74.7	100
39	Muskox"S" X 15570	70.2	94
115	Bgl"S" - M2A X 18701-6Y-1M-1Y-1M-0Y	70.1	94
35	Delfin 76	69.9	94
125	Teddy"S" X 19649-A-9Y-1Y-1M-1Y-101Y-0Y	69.5	93
34	Delfin 75	69.3	93
40	Muskox"S" X 15570	69.1	93
275	W 74.103-Addax/Bgl-M2A x IRA X 33470-C-1Y-5M-1Y-0M	68.9	92
45	Muskox"S" X 15570-1Y-1B-100B-0Y	68.7	92
293	Panda"R" - Abn X 36518-198H-1Y-0Y	68.7	92
291	Panda"R" - Abn X 36518-161H-1Y-0M	68.0	91
56	Bgl - M2A X 15670	67.6	91
121	Fg"S" - Spy x Nv"S" X 19188-100Y-2Y-1M-0Y	67.6	90
54	Um 940"S" - My 64 x FS 381 X 15667-5Y-7M-2Y-1M-0Y	67.3	90
86	Cin - Pi 62 x Pato/Bgl X 16350	67.2	90
165	Polar"S" X 22591-100Y-101Y-4M-1Y-0M	67.2	90

DISEASE RESISTANCE

Triticales continue to have a high level of resistance to the three cereal rusts and to several different smuts, as evidenced by reactions recorded in the international triticale nurseries. Resistance to powdery mildew also appears to remain at a high level. In the 11th ITYN, three locations reported on powdery mildew reactions: of 21 triticales in this nursery, 2 lines were rated to have 4 percent infection while 19 lines were rated zero. The two bread wheat and one durum check varieties had scores of 28, 53, and 19 percent infection, respectively.

Triticales are also showing good resistance to *Septoria tritici*. In tests conducted on the screening nurseries at Tel Aviv University in Israel, Z. Eyal found that 7 percent of the bread wheats, 7 percent of the durum wheats, and 26 percent of the triticales were rated resistant to *S. tritici*. There appears to be considerable variation among the triticales, and selecting for resistance should not be a major problem.

Some of the minor wheat diseases have been more of a problem on the triticales. Bacterial blight, caused primarily by *Xanthomonas transluscens*, often infects the triticale

Table 5. Yield and test weight, averaged from Sonora, Huamantla, El Batan, and Toluca of selected lines from the Twelfth International Triticale Screening Nursery that had both high yield and high test weight in comparison to the standard check varieties

Yield rank	12th ITSN Entry No.	Line	Yield (kg/ha)	Yield % of Cananea 79	Test wt. (kg/hl)	Test wt.% of Cananea 79
1	273	IA-Kla x Cal/Bgl B-199 (Merino"S")	5818	118	71.1	113
2	194	Panda x Octo Bulk-Bush X 35781-411H-2Y-1M-0Y	5392	110	69.5	110
3	247	Panda - Yoreme X 36521-40H-1Y-1M-0Y	5306	108	71.0	113
4	219	Panther"S" - M1A X 36471-22M-2Y-2M-0Y	5119	105	70.9	112
5	218	Panther"S" - M1A X 36471-22M-2Y-1M-0Y	5102	104	70.6	112
6	199	Panda - Bacum"S" X 35784-423H-1Y-2M-0Y	5102	104	70.4	112
7	191	Panda x Octo Bulk-Bush X 35781-96H-1Y-2M-0Y	5087	104	72.2	115
8	278	IA-Kla x Cal/Bgl B-199 (Merino"S")	5068	103	69.9	111
9	114	Ye x IA-Bush X 31095-1Y-4M-1Y-3M-0Y	4937	101	70.3	112
10	2	Caborca 79 (check)	4953	101	65.1	103
11	189	Panda x Octo Bulk-Bush X 35781-72H-1Y-1M-0Y	4909	100	70.0	111
12	238	Panda - Arabian X 36518-233H-3Y-1M-0Y	4890	100	70.5	112
13	1	Cananea 79 (check)	4892	100	62.8	100
14	195	Panda x Octo Bulk-Bush X 35781-497H-1Y-1M-0Y	4842	99	69.8	111
15	222	Panda - Rahum X 36517-5H-1Y-1M-0Y	4779	98	71.7	114
16	4	Beagle (check)	4763	97	62.2	99

strains in breeding nurseries and at times in commercial fields. Studies by B.M. Cunfer at the University of Georgia, USA, show considerable variation among triticales in reaction to *X. transluscens*, and he has identified the following lines as being resistant: Seventh ITSN entry numbers 20 and 69 (M2A-BgC), UPT 72142, and the California variety Siskiyou.

Several *Fusarium* species infect triticales, especially the species that cause scab, such as *F. culmorum* and *F. graminearum*. Heavy attacks of head scab have occurred in certain areas of East Africa and in Brazil. Resistance to scab is rare in small grain cereals, and it is difficult to screen for resistance because the disease incidence in nature is often sporadic. Several lines received from the triticale program at Passo Fundo, Brazil, are considered to have improved tolerance to scab, and crosses with these lines are being initiated.

In general, the triticales have few problems with diseases, even under commercial production. In Kenya many of the wheat varieties require application of fungicides for commercial production, but triticale can be produced successfully without fungicide. Also, in the highlands in Mexico, much less incidence of disease is found in the triticales than in other cereals. Resistance to diseases provides triticale with an advantage in many places where diseases cause severe problems in the wheats.

Triticales generally have few disease problems, but *Fusarium* spp., such as *F. graminearum* (shown here), can cause problems. Several triticale lines from Passo Fundo, Brazil, demonstrate improved resistance to scab.

WIDENING THE GERMPLASM BASE

A continuous effort to introduce more genetic variation into materials in the triticale program is required. This can be done by producing new amphidiploids—both hexaploids and octoploids; by back-crossing triticale to its parental species, wheat and rye, and by introductions from other triticale programs throughout the world.

In both the Sonora and the Mexican Plateau (summer) cycles, crosses are made between bread wheat (*Triticum aestivum*) and rye, since there are no special problems in making those crosses. Durum wheat (*T. durum*) and rye crosses are made only in the summer cycle because of the need to go through embryo-culturing to produce amphiploids. In 1980, about 200 primary octoploid and 50 primary hexaploid triticales were produced. These are used in crosses with so-called secondary triticales, those that have been produced by intercrossing triticales and by selection.

Most material in the CIMMYT triticale program is of the hexaploid type. In 1978, increased emphasis was given to octoploid triticales, and there are now about 400 primary octoploid triticales in the program. These are used for crossing to hexaploid triticales and also in crosses between octoploids to obtain improved octoploids. The work with octoploids is relatively new, and as yet we have few results. However, reports from China indicate these triticales may have good potential.

To produce better primary triticales, some effort should be directed toward improving rye. We are especially interested in dwarf and early ryes. A natural dwarf rye mutant, called Snoopy, was identified in about 1972. This strain was of poor agronomic type, so crosses were made between Snoopy and ryes from the world rye collection. We now have imporved rye dwarfs, but the problem is to introduce these dwarfing genes into triticale.

Much information is available on the crossability of wheat to rye, but little is known about the crossability of rye to wheat. It is a question of whether inbred, self-fertile ryes are better than cross-pollinating ryes as parents. We have some indication (Table 6) that the self-fertile forms may be better. Ryes selected for self-fertility yielded twice as many embryos as did the ryes from the world rye collection.

Since most rye improvement has been done in winter types, crosses are now being made between winter and spring ryes to obtain improved spring lines. No attempt is being made to produce rye varieties; rather, these efforts seek ryes that will be better parents in producing new triticales.

Interspecific crosses are being made routinely between triticale x bread wheat and triticale x rye. Much promising material has come from these crosses. We have attempted to bring variation into the A and B genome by crossing triticale with durum wheat, but these crosses have not been successful so far; even by going through embryo culture, we have obtained few plants. It seems that the variability present in durum wheat cannot be utilized by crossing triticale to durum. The alternative is to produce primary hexaploid triticale instead.

Most material introduced from programs in Europe and North America are winter-type triticales. This material is used in crosses with spring triticales, and the spring x winter type crosses have been especially useful in selecting for forage-type triticales.

Table 6. Number of embryos extracted per crossed spike from three different rye populations

Population	Number of embryos per spike crossed	Number of spikes	Number of cross combinations
Snoopy-selected for dwarfness, self-compatibility, and fertility	6.4	205	27
Snoopy-selected for dwarfness and seed type	4.2	110	15
World Rye Collection	3.2	83	13

INDUSTRIAL QUALITY

The CIMMYT triticale program is also concerned with improving the industrial quality of triticale grain. This work is done in conjunction with CIMMYT's industrial quality laboratory. Significant progress has been made. We now have triticales that approach the quality of wheat on two major quality characteristics, flour yield and loaf volume.

Falling number, a measure of alpha-amylase activity, has also been improved. The falling number is a quality indicator and also plays a role in determining sprouting tolerance.

Selection for hardness of the grain has resulted in a number of triticale strains that approach the hardness of wheat. With these recent improvements, we are now making crosses specifically aimed at further gains in industrial quality.

The milling and baking laboratory routinely tests triticales for such quality characteristics as flour yield and loaf volume. CIMMYT now has lines that approach the quality of wheat for bread making.

Barley

After almost eight years of breeding, the barley program at CIMMYT has entered a new phase. In its early stages, the program focused on generating germplasm with high yield potential, wide adaptation, high nutritional quality, lodging resistance and hull-less grain. These areas are not being left aside, but at the present time most of our efforts are now directed toward incorporating disease resistance into the breeding material. By identifying new sources of germplasm with resistance to several diseases, it is hoped that future materials will have better resistance.

In general, it was found that the 1979-80 cycle in Ciudad Obregon, Sonora, and the summer cycle in El Batan were [illegible] and permitted the selection of good phenotypes. Because of its very special conditions, the Yaqui Valley at Ciudad Obregon offers an excellent environment in which to determine the maximum yield potential of the new materials. During the 1979-80 cycle more than 450 lines were evaluated in replicated yield trials to determine their maximum yield potential. Each yield trial contained 20 breeding lines and 5 checks planted in 3 replications. The trials were divided into three groups as follows: hulled grain, hull-less grain, and early lines.

Hulled barley

Table 1 lists a number of hulled lines from 17 trials showing an average yield of more than 5.5 tons/ha. The average yield of the local check is also given.

Hull-less grain

Breeding for hull-less types has occupied a good portion of our time, and now the hull-less character is incorporated into about 35 percent of the breeding material. A considerable number of advanced hull-less lines have been generated. Table 2 lists the hull-less lines from five replicated yield trials grown at Ciudad Obregon with an average yield of more than 5 tons/ha. The average yield of the local check is also given.

Earliness

Material with a short growing cycle has been generated and several advanced lines were tested in yield trials in 1980. Table 3 lists seven early lines that demonstrated good yield potential.

Early maturing barleys that are 30 to 40 days earlier to harvest and can yield in the 3.5 to 4.5 ton/ha range were identified in 1980. More extensive multilocational testing of these materials is now underway. Dr. Enrique Rodríguez, leader of the barley program, surveys a plot of early maturing germplasm.

NUTRITIONAL VALUE

Improving the nutritional value of barley is one of the continuing objectives of the CIMMYT program. Several advanced lines have been selected that carry the high-lysine gene from the variety Hyproly. Table 4 lists some of the advanced lines with high protein and/or high lysine characteristics.

Some materials coming from the highlands of Ethiopia and Nepal tend to be high in protein and/or lysine. In 1980, Ethiopian barleys collected by the late G. A. Weibe were analyzed in CIMMYT's protein laboratory to determine their protein and/or lysine value. Table 5 lists the entries that displayed high values. These lines have been incorporated into the quality crossing block for use in the next crossing cycle.

DISEASE RESISTANCE

Incorporation of disease resistance received first priority over the past year. The 1980 summer cycle at El Batan was one of the best in years to screen for disease resistance. Artificial epidemics were created for leaf rust (*P. hordeii*) and scald (*Rhynchosporium secalis*), and some resistant selections were made. Table 6 lists segregating F_2 populations that showed resistance to leaf rust and scald when inoculated with race mixtures of both diseases. Resistant segregates were also found in some other crosses. Table 7 lists the best multiple crosses demonstrating acceptable levels of resistance to leaf rust and scald.

In the summer nursery at Huamantla, Tlaxcala, Mexico, there was an epidemic of barley yellow dwarf virus, but the infection was erratic. Selections for resistance were made, but further evaluation is required before any conclusions can be drawn.

By using artificial inoculations of a mixture of chlamydospore isolates, several lines were identified as being resistant to loose smut. Table 8 lists some of the en-

Table 1. Highest yielding hulled barley lines from replicated yield trials grown at Cd. Obregon, Sonora in 1979-80

Entry No.	Variety, or cross and pedigree	Yield (kg/ha)
176	11012.2/Cq-CMxApm/Api-CM67(CM67/Sht Wocus-AproxWa6704.62)7 CMB75A-1620-E-1B-3H-2Y-2B-2Y-0B	5735
170	11012.2/Cq-CMxApm/Api-CM67(CM67/Sht Wocus-AproxWa6704.62)7 CMB75A-1620-E-1B-1H-1Y-1B-4Y-0B	5583
181	11012.2/Cq-CMxApm/Api-CM67(CM67/Sht Wocus-AproxWa6704.62)7 CMB75A-1620-E-1B-5H-2Y-2B-1Y-0B	5743
205	11012.2/Cq-CMxApm/Api-CM67(CM67/Sht Wocus-AproxWa6704.62)7 CMB75A-1620-E-5B-5H-2Y-1B-1Y-0B	5717
208	11012.2/C1-CMxApm/Api-CM67(CM67/Sht Wocus-AproxWa6704.62)7 CMB75A-1620-E-5B-5H-2Y-1B-5Y-0B	5554
183	11012.2/Cq-CMxApm/Api-CM67(CM67/Sht Wocus-AproxWa6704.62)7 CMB75A-1620-E-1B-5H-5Y-1B-1Y-0B	5518
377	11012.2/Cq-CMxApm/Api-CM67(CM67/Sht Wocus-AproxWa6704.62)7 CMB75A-1620-E-1B-1Y-1B-1Y-2B-0Y	6126
379	11012.2/Cq-CMxApm/Api-CM67(CM67/Sht Wocus-AproxWa6704.62)7 CMB75A-1620-E-1B-1Y-1B-2Y-1B-0Y	6116
376	11012.2/Cq-CMxApm/Api-CM67(CM67/Sht Wocus-AproxWa6704.62)7 CMB75A-1620-E-1B-1Y-1B-1Y-1B-0Y	5826
387	11012.2/Cq-CMxApm/Api-CM67(CM67/Sht Wocus-AproxWa6704.62)7 CMB75A-1620-I-1B-1Y-1B-1Y-1B-0Y	5607
267	Apm-AthsxGva/Api-CM67xMzq CMB75A-858-2B-1Y-2B-1Y-1B-0Y	5554
254	BeaconxCM67-Mona CMB75A-354-6B-1Y-1B-1Y-2B-0Y	5547
289	Br6705.15.1/Api-CM67x11012.2 CMB75A-1345-12B-1Y-1B-1Y-1B-0Y	5936
291	Br6705.15.1/Api-CM67x11012.2 CMB75A-1345-14B-1Y-1B-1Y-2B-0Y	5653
321	Cq-Jubilee x DL70 CMB75A-402-4H-2Y-1B-1Y-2B-0Y	5820
333	CM67-U.Sask1800xPro-CM67/DL70 CMB75-526-1B-1Y-1B-1Y-1B-0Y	6325
347	Ore"S"xApi-CM67/Ore"S" CMB75A-1400-B-5B-1Y-1B-1Y-1B-0Y	5566
349	(CM67-U.Sask1800xPro-CM67/Mzq)Ds-Apro CMB75A-1413-A-3B-1Y-1B-1Y-1B-0Y	5509
371	3309-RM1508/Api-CM67xMzq CMB75A-1583-F-4B-1Y-1B-1Y-1B-0Y	5540
405	(CM67-U.Sask1800xPro-CM67/DL70)Api-CM67x70.22375 CMB75A-1714-J-3B-1Y-1B-2Y-1B-0Y	6367
406	(CM67-U.Sask1800xPro-CM67/DL70)Api-CM67x70.22375 CMB75A-1179-C-1B-1Y-1B-1Y-1B-0Y	6345
411	Pyo-5106xMin906 CMB75A-1179-C-1B-1Y-1B-1Y-1B-0Y	6333
412	Pyo-5106xMin906 CMB75A-1179-C-1B-1Y-1B-1Y-2B-0Y	5958
500	Avt-Local D8xDL70 CMB74A-301-22B-1Y-1B-2Y-1B-0Y	5717
	Cerro prieto (hulled local check)	4598

tries in the crossing block with resistance to the disease. Many lines with leaf rust and/or scald resistance have been identified, and these are now grouped separately in the crossing block. It is hoped that by intercrossing these materials, and by crossing to high yielding lines, the level of resistance of the new high yielding germplasm will be increased. This material will be further tested to assess its resistance in "hot spots" where the incidence and virulence of the pathogen is greater.

Spring x winter crosses

The crossing of spring and winter barleys offers new materials for areas where neither the spring nor the winter types can ordinarily adapt to the growing environment. The light-insensitive types bred so far by the CIMMYT barley program are too early for some countries in the Mediterranean region (Spain and Portugal) and in the North African region (Morocco, Algeria and Tunisia). These countries should find these new materials useful.

During 1979, a total of 244 spring x winter crosses were sent as F_2 bulks to more than 50 locations having long growing cycles. Observations in 1980 demonstrated that these crosses were far superior to the crosses of spring x spring types. Table 9 lists some of the outstanding crosses observed in Spain and Algeria. We propose that more of these crosses be exploited in these areas. To exploit the spring side of these crosses, a total of 234 F_2 bulk populations were grown in the high plateau of Mexico. It was observed that these crosses have a long growing cycle for Mexican conditions; there were some, however, that showed excellent segregates and several selections were made.

INTERNATIONAL NURSERIES

Expansion of CIMMYT regional programs has enabled us to cooperate more closely with national programs, research centers and educational institutions. A principle means of cooperation is through the international nurseries. In 1980, little change was made in types of nurseries distributed, but the number of nurseries distributed increased significantly. Table 10 summarizes this information.

Table 2. Highest yielding hull-less barley lines from replicated yield trials grown at Ciudad Obregon, Sonora in 1979-80

Var. No.	Cross and pedigree	Yield (kg/ha)
525	Ore"S"xApi-CM67 CMB76-322-17Y-1B-3Y-1B-2Y-0B	5243
513	Ore"S"xMzq CMB76-248-1Y-2B-1Y-1B-3Y-0B	5106
567	CM67-U.Sask1800xPro-CM67/Ore"S"-WI2198 CMB76-806-F-2Y-1B-4Y-1B-2Y-0B	5306
587	Mzq-Ore"S" CMB75A-21-1B-2Y-1B-2Y-1B-2Y-1B-0Y	5016
616	U.Sask1766-ApixH272/Apm-1B65xOre CMB75A-1526-H-1B-1Y-1B-1Y-2B-0Y	5086
617	Strain205-Min907/CH-Dux70.22081 CMB75A-1578-F-2B-1Y-1B-1Y-1B-0Y	5021
America (hull-less local check average yield)		3267

Table 3. Highest yielding early lines from replicated yield trial grown at Ciudad Obregon, Sonora in 1979-80

Var. No.	Cross and pedigree	Yield (kg/ha)	Maturity (days)
700	HjaC4715xOlli-M64.69/Puebla CMB76-496-2Y-1B-1Y-1B-1Y-0B	3337	85
703	Mona-Ben x Impala CMB76-516-1Y-1B-1Y-1B-3Y-0B	3226	95
750	Api-CM67xB1 CMB75-88-4Y-1M-1Y-1B-2Y-0B	4744	100
747	CM65.167-M66.64.1xMona/Aths CMB75A-181-13B-2Y-1B-1Y-2B-0Y	4131	112
	Mona (early check average yield)	3479	120

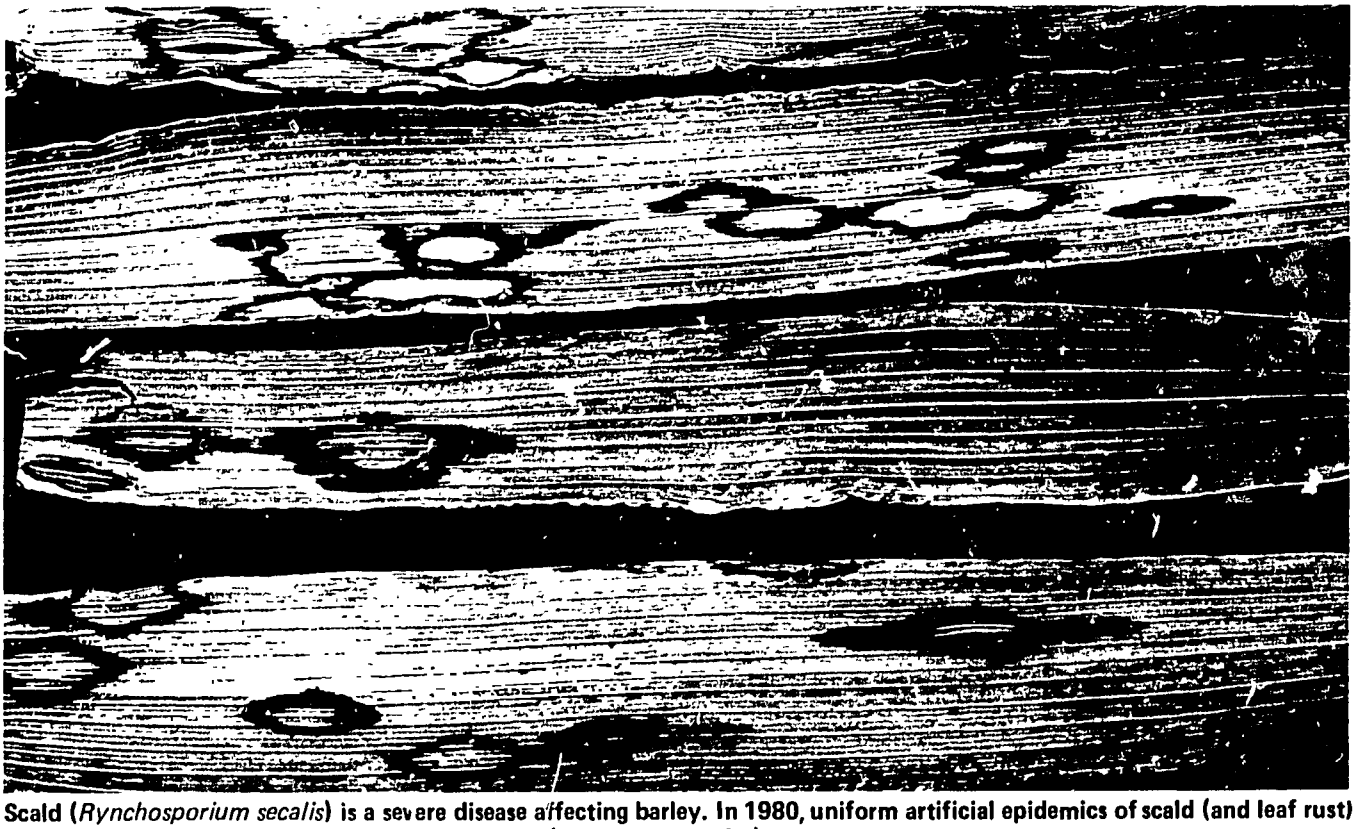
Some barley materials coming from the Ethiopian highlands tend to be high in protein and/or lysine. These lines have been incorporated into the quality crossing block.

Table 4. Advanced lines from the 8th IBON with high protein and/or high lysine

Row No.	Cross and pedigree	Protein (%)	% Lysine in Prot.
21	Nopal/11012.2-CM67xPor-U.Sask1800 CMB76-289-18Y-1B-1Y-1B-1Y-0B	12.6	4.24
33	Api-CM67x1454 CMB76-410-15Y-1B-1Y-1B-3Y-0B	18.4	
92	F_3 Bulk Hip 76A-15-1B-500Y-0B	13.4	4.24
117	NopalxHulless-Cq CMB75A-994-1B-1Y-1B-2Y-1B-0Y	13.3	4.15
118	NopalxHulless-Cq CMB75A-994-1B-1Y-1B-2Y-2B-0Y	12.6	4.28
152	(Apm-Dwarf21xPor-IB65/Bal16/Nopal"S" CMB75A-1383-M-1B-1Y-1B-1Y-1B-0Y	15.4	
168	Apm-GvaxDs-Apro/Por-U.Sask1800x11012.2 CMB75A-1544-B-1B-1Y-1B-1Y-1B-0Y	13.4	4.18
224	Nopal"S"-Ager CMB76-434-18Y-1B-2Y-1Y-0B	12.7	4.56
249	Bco.Mr-AvtxCelaya"S" CMB73-422-A-3Y-1B-1Y-1B-1Y-0B-9B-0Y	16.4	
252	Celaya-5107 CMB76-2-5Y-1B-1Y-1B-4Y-0B	15.6	
264	Api-CM67x1594 CMB76-412-5Y-1B-1Y-2B-2Y-0B	15.9	
272	ERxOlli-M64.69/Sultan-Nackta CMB76-601-1Y-1B-1Y-2B-1Y-0B	15.3	
283	(Burk^2-Aprox11016.2/CM67-U.Sask1800xProCM67)G134-ApmxNackta CMB76-1005-A-1Y-1B-1Y-1B-4Y-0B	15.7	
307	Api-CM67xChoya/Apm-IB65xGva CMB75A-1497-A-1B-1Y-1B-4Y-1B-0Y	15.7	
321	CelayaxApm-IB65 CMB76-6-7Y-1B-1Y-1B-1Y-0B	15.6	
327	Api-CM67xAger CMB76-408-17Y-1B-3Y-1B-3Y-0B	17.4	
330	Mari-CohoxSultan-Nackta CMB76-613-7Y-1B-1Y-1B-1Y-0B	15.5	
333	Sultan-Nackta x RM1508-Gva CMB76-672-2Y-2B-2Y-1B-2Y-0B	16.2	
	Apizaco (check)	13.7	2.92

Table 5. Barley lines from G.A. Weibe Ethiopian collection with high protein and/or high lysine

Collection No.	Collection identification	Protein (%)	% Lysine in prot.
382203	GAW 38-14 10K N Gondar	15.0	
382377	GAW 105-3 13K W Ambo	15.0	
382751	GAW 33-6 12K S Gondar	9.4	4.6
382755	GAW 34-3 2K N Gondar	8.9	4.5
382778	GAW 38-8 10K N Gondar	8.4	4.6
382813	GAW 43-5 18K N Gondar	10.3	4.9
382823	GAW 45-2 19K N Gondar	10.3	4.9
382831	GAW 46-1 25K N Gondar	12.2	4.3
383028	GAW 99-1 241K NE Jimma	10.8	4.3
383195	GAW 151-2 175K SE AA	10.7	4.6



Scald (*Rynchosporium secalis*) is a severe disease affecting barley. In 1980, uniform artificial epidemics of scald (and leaf rust) were created and some resistant materials selected (see Tables 6 and 7).

Table 6. Segregating F_2 Bulk populations with a high proportion of plants resistant to *Puccinia hordei* and *Rhynchosporium secalis* at El Batan, Mexico (1980)

Row No.	Cross and pedigree
319	(M66.85.Aths/Api-CM67 x Ds-Apro)St2-D x Md-Br/Ase-CM.11.2wl CMB79A-372
327	Sotol"S"-Local Barley CMB79A-381
328	Sotol"S"-CI 10713 CMB79A-382
342	(M69.77-Shi-r.Kci No87/CM67.U.Sask1802 x Ds-Apro 1Y) Barley 305 CMB79A-398
398	Kristina-CI 9642 CMB79A-438
387	Emir x PI 6384-Capuchona CMB79A-447
671	/(Ba116-Mzq/M67.18-M14 x Ds-Apro)Che CI 1111/CI 12651 CMB79A-753
672	/(Ba116-Mzq/M67.18-M14 x Ds-Apro)Che CI 1111/CI 5847 CMB79A-754
677	Union-PI 356108.5D CMB79A-761
679	Union-CI 12568 CMB79A-763
750	Gal x (Ki-CI2376)^2(Pi-CM67 x D171/Maswi-Bon CMB79A-837
752	Cer-Rosada x P71318 CMB79A-839
753	Cer-Rosada x Emir CMB79A-840
754	Cer-Rosada x Zephyr CMB79A-841
757	S.M.F7-75.13/(Ba116-Mzq/M67.18-M14 x Ds-Apro)Iris/ CMB79A-844
759	(Dorada/Pb-Gal x Fun)Api-CM67 x DL71/Maswi-Bon CMB79A-847

Table 7. Best multiple crosses for resistance to leaf rust and scald (*Rhynchosporium secalis*) at El Batan, Mexico (1980)

Row No.	Cross and pedigree
857	Mzq-H251(M69.77-Shi.R.Kci No.87/CM67-U.Sask1802xDs Apro 1Y) CMB80-857
901	(Api-CM67xI12.66.L2966.69/CN48-CI8995)Maswi-Bon CMB80-901
926	(69.82xApam-IB65/Mcu3021.5D-Ben)7028-2759 CMB80-926
939	F3 Bulk Hip-Edda x Pitayo-D173 CMB80-939
961	/Abed-LofaxAbn(11012.2-TernxOre/Np CI593)/Pitayo-CamxAvt-RM1508 CMB80-961
1136	Sotolx2762-BC/11012.2-TernxH252 CMB79A-1077-A
1232	SD729-Porx721B58/Pitayo CMB79A-1143-C
1305	(Api-CM67xHBCC XXVIII/FB73.126)CI3909.2xM66.151-Manker CMB79A-1143-C
1325	/(Avt-Local D8xDL70-Pitayo/RM1508)C4005.75/Api-CM67x10876.1 CMB79A-1195-A
1326	/(Avt-Local D8xDL70-Pitayo/RM1508)C4005.75/Api-CM67x10876.1 CMB79-1195-B
1327	/(Avt-Local D8xDL70-Pitayo/RM1508)C4005.75/Api-CM67x10876.1 CMB79A-1195-C
1529	Mari-CohoxCI1775/Pitayo-Cam x Avt-RM1508 CMB79A-1320-C
1591	/Ore"S"x33.4-Bahtim10(Po/Ki-Ba^{3}xMonte Cristo)/Nopal"S" CMB79A-1361-A
1647	Api-CM67xDL71/Duchicela/Minn1116xApm-IB65(CM67-U.Sask1800xPro-CM67/Celaya)/ CMB79A-1405-B
1669	(11012.2-Tern/Por-EB1053xCM67)Por-U.Sask1800xRM1508Ahor20057-CN271/(CN42-CI7772/Fun^2-TchxFun)Ki-CI2376/Sotol CMB79A-1419-A
1670	/(11012.2-Tern/Por-EB1053xCM67)Por-U.Sask1800xRM1508/Galeras-PI6384 Mzq-Gva CMB79A-1420-A
1683	(Bahtim 7-DL71xAs57/Bra-TryxTJ^2)Ore"S" CMB79A-1425-A
2392	Manker-Schuyler x Cerro Prieto CMSWB79A-542-B
2406	Nackta-Mich62.420-12xRow 134.73 CMSWB79A-555-A
2407	Nackta-Mich62.420.12x134.73 CMSWB79A-555-B

Table 8. Entries in the barley crossing block resistant to loose smut

Row No.	Cross and pedigree
6	Tlaxcala
20	CQ-UN6,UN3
23	Hor728 CI 11577
41	Tequila CMB72-76-6Y-3B-1Y-0B
77	Por-U.Sask1766xBenton CMB74A-126-500B-500Y-501B-0Y
83	Beacon/CM67-U.Sask1800xPro-CM67 CMB75A-353-500M-500Y-0B
87	BDGC-Gas/M64.69-M6S.211 x XV2240 CMB76-281-500Y-0B
97	Nopal"S"-Ore"S" CMB75A-989-500H-501Y-500B-0Y
108	CelayaxMzq-Gva CMB76A-4-500B-0Y
241	Apam-HC1905/CelayaxDs-Apro CMB76A-104-500B-0Y
284	Apam-IB65x70.22429 CMB75.43-4Y-1B-500Y-0B
294	Bonanza
298	CI 4466
302	CI 3909.2 502Y-500B-501Y-0B
325	Oregano CMB72A-243-H-500B-502Y-0B
359	Tern
360	Maris Canon
383	CI 2228
384	Nepal CI 593
388	Mari-Coho/Friska-4839x7004 CMB76-615-10Y-501B-500Y-0B
401	OC640-Mari CMB73-336-500B-500Y-0B

Table 9. Outstanding F2 spring x winter crosses grown at El Encin Station in Spain and Khroup Station in Algeria

Row No.	Cross and Pedigree
28	FB74.505.02/(Api-CM67/Apm-Dwarf II-1Y- x Por-Kn27)RM1508-11012.2 CMSWB-78A.57
29	FB74.505.02/Api-CM67 x Ore CMSWB 78A-58
35	WA 1245-68/Api-CM67 x Ore CMSWB-78A-66
45	FB44(11016.2 x Apm-IB65/Ds-Apro x 11012.2) CMSWB-78A-123
104	Zabet (Choya-IC18867/Api-CM67 x Ds-Apro) CMSWB-78A-170
106	Omugi-Bord Ranq L.A/CM67-U.Sask1800 x Pro-CM67 CMSWB-78A-180
112	1658- x Betles-Coho CMSWB-78A-191
115	N.Y.516 B.3B.1 x Ds-Apro CMSWB-78A-201
119	Schuyler-CI 15475 CMSWB-78A-216
158	Mzq-Gva x FB.73.103 CMSWB-78A-325
161	(Pro-Tol I/5106)FB44 CMSWB-78A-332
199	Mariscanon x Hja 33.81-Malta CMSWB-78A-404
200	Nacta-Pioneer CMSWB-405
244	CI 5824-1356.70 CMSWB-78A-578

Table 10. Type of barley nurseries and number of locations where these nurseries were distributed by CIMMYT in 1980

Type of nursery	Number of locations
IBYT	89
IBON	96
F2 Bulk Spring x Winter	50
F2 Bulk Spring x Spring	43
F2 Zona Andina	15
Crossing Block	49
Crossing Block Quality	15
Miscellaneous Barleys	39
Total number of nurseries	396

Base Support Programs

- Pathology
- Germplasm Development
- Milling and Baking Laboratory
- Agronomy
- Training
- Wide Crosses
- International Nurseries

Pathology

In rural societies, plant diseases have long been associated with crop losses, but they rarely attain calamitous levels. Plant diseases can have an impact on social stability because of their effect on food supply. The impact is likely to be stronger when the main source of food changes from simple, extensive, low-yielding agriculture to complex, intensive systems aimed at continuous high yields. Disease outbreaks are biological phenomena of sudden occurrence, usually linked to some variable combinations of environmental factors. Diseases thus conflict with continuity of high crop yields, the essential character of modern systems of food production. Pathology therefore contributes to wheat breeding by identifying sources of resistance and by helping to select progeny that best combine disease resistance with other desirable traits.

National wheat breeding programs can concentrate on local diseases, but the global responsibility of CIMMYT requires concern for almost all diseases. Pathogen populations express genetic variability in differential virulence, and this potential for change brings an additional threat to stable crop performance. Long lasting resistance to a broad array of pathogens is sought in cultivars adapted to a wide range of environments. In pursuing this goal, CIMMYT germplasm is selected for resistance to diseases that occur naturally in Mexico; the best materials are then tested in other locations.

Advanced CIMMYT lines that became available in 1980 were screened for disease resistance at eight locations in Mexico to identify superior entries that will constitute the international nurseries. The testing locations and the prevailing diseases are: Ciudad Obregon, Sonora, for leaf rust, stem rust; El Batan, Mexico, for leaf rust, stripe rust, stem rust; El Refugio, Guanajuato, for leaf rust, stem rust; Los Mochis, Sinaloa, for leaf rust; Patzcuaro, Michoacan, for septoria blight, head scab; Rio Bravo, Tamaulipas, for leaf rust; Tepatitlan, Jalisco, for head scab; and Toluca, Mexico, for stripe rust, leaf rust, fusarium leaf blight, and head scab.

Critical tests for broad and long-lasting resistance are carried out in CIMMYT international nurseries, which are grown and assessed by cooperating scientists worldwide. Analysis in this report covers the 12th IBWSN and the ISEPTON IX, which were made up in Mexico in 1978, grown worldwide in 1978-79, and reported back to CIMMYT during 1980.

Stem rust (*Puccinia graminis tritici*) epidemics were severe in the Southern Cone of South America. Epidemics in the summer nurseries at El Batan, El Refugio and Celaya provided good selection pressure in 1980.

INTERNATIONAL NURSERIES

Rusts

Rust fungi are the most important single group of pathogens that constrain cereal production. The network of tests for the 12th IBWSN stretched over several epidemiological units and climatic conditions, thus providing a strict evaluation of the resistance of cultivars to rusts.

Rust development was excellent for tests in the Indian Subcontinent; temperatures slightly above average and late rains at the end of 1978 contributed to a high incidence of stem rust and leaf rust in Maharashtra, Karnataka, and Andhra Pradesh, India. Leaf rust and stripe rust developed satisfactorily over the Punjab as well. Stem rust epidemics were severe in the Southern Cone of South America. In Mexico, stem rust and leaf rust epidemics provided adequate selection pressure in the summer nurseries at El Batán, El Refugio, and Celaya, but early frosts hampered stripe rust development in Toluca. Intense stripe rust occurred in areas where it is endemic, such as the Rift Valley in Kenya, the Andean countries, the Pacific Northwest of the United States, and the northern European countries; temperatures below average in Jizzan, Saudi Arabia, favored stripe rust development there.

Raw data for rust reaction consist of: (a) **host response**, or degree of susceptibility, given by the steps R (resistant), MR (moderately resistant), MS (moderately susceptible), S (susceptible), or combinations thereof; and (b) **severity of infection**, assessed by the modified Cobb scale that ranges from 0 (no infection) to 100 (visual saturation, representing about 37 percent of actual area of tissue infected). Degrees of host response are given numerical values as follows: R=0.2, MR=0.4, MS=0.8, and S=1.0. Coefficients of

infection (CI) are computed for each entry at each location and are defined as the product of the numerical value of host response times the severity of infection.

Average coefficients of infection (Avg CI) for each entry over several sites permit the identification and ranking of the most resistant lines. Values may be set arbitrarily to designate as outstanding those lines having Avg CI equal to or less than the value set—usually 10. When outstanding entries become too numerous, selection may be made more intense by lowering the value of acceptable Avg CI. In this report, the Avg CI values set to identify outstanding lines in the 12th IBWSN are 5.0 for stem rust, 4.0 for leaf rust, and 3.0 for stripe rust. Superior lines and the testing sites are listed in Tables 1, 2, and 3.

Twenty-seven lines were selected under the criteria for stem rust, 39 for leaf rust, and 51 for stripe rust. All

Table 1. Bread wheat genotypes from the Twelfth International Bread Wheat Screening Nursery highly resistant to *Puccinia graminis tritici* at most of 23 locations* (average coefficient of infection equal to or less than 5.0)

Entry	Variety, or cross and pedigree	Avg. C.I.
461	KVZ - K4500.L.A.4 SW0176-3M-1Y-6Y-1Y-2M-0Y	2.1
459	KVZ - K4500.L.A.4 SW0176-3M-1Y-4Y-1Y-1M-0Y	3.1
328	TORIM 73 x KAL-BB CM37130-15Y-1M-3Y-0M	3.2
327	TORIM 73 x KAL-BB CM37130-15Y-1M-1Y-0M	3.6
305	ZA 75 - EMU"S" CM36689-10Y-8M-1Y-0M	3.6
58	VEERY"S" CM33027-F-15M-500Y-0M	3.7
388	EMU"S" - MILDRESS x KAL-BB CM38199-A-1Y-9M-1Y-0M	3.7
383	(ORE F1 158-FDL x MEXIFEN"S"-TIB 63[2]) COC 75 CM37987-I-1Y-4M-0Y	3.9
44	TANAGER"S" CM30697-2M-14Y-0M	4.0
130	TANAGER"S" CM30697-2M-3Y-3M-0Y	4.2
439	BURGUS 2. SORT 12.13 x KAL-BB SWM3115-2M-4Y-1M-1Y-0M	4.2
343	JUP 73-ZP"S" x COC 75 CM37614-B-14Y-6M-1Y-0M	4.2
132	TANAGER"S" CM30697-2M-8Y-4M-0Y	4.2
435	CEB 148(CNO"S"-INIA"S" x LFN/TOB x KL. PET-RAF) SWM1368-500Y-1B-501Y-502M-0Y	4.4
202	VEERY"S" CM33027-F-12M-1Y-5M-1Y-0M	4.4
210	CHAT"S" CM33090-M-4M-2Y-5M-0Y	4.5
211	CHAT"S" CM33090-M-4M-2Y-5M-1Y-0M	4.6
212	CHAT"S" CM33090-N-1M-1Y-0M	4.6
34	(PTS/TOB-CFN x BB)BB x HD832.5.5 -0N CM20769-A-8Y-1M-2Y-5M-1Y-0M	4.7
341	JUP 73-ZP"S" x COC 75 CM37614-B-14Y-4M-3Y-0M	4.8
71	PAVON"S" CM8399-D-4M-3Y-0M-0BK	4.8
296	MOCHIS 73 - PAVON"S" CM35269-1M-7Y-8M-0Y	4.8
382	(ORE F1 158-FDL x MEXIFEN"S"-TIB 63[2]) COC 75 CM37987-I-1Y-2M-2Y-0M	4.8
26	PAVON"S" CM8399-D-4M-3Y-1M-0Y-(1-23B)	4.8
342	JUP 73-ZP"S" x COC 75 CM37614-B-14Y-5M-1Y-0M	4.9
384	(ORE F1 158-FDL x MEXIFEN"S"-TIB 63[2]) COC 75 CM37987-I-1Y-6M-0Y	4.9
62	BOBWHITE"S" CM33203-N-1M-2Y-0M	5.0

* Locations:

1. Egypt, Cairo
2. Egypt, Kafr El-Sheik
3. Tanzania, Lyamungu
4. Zambia, Lusaka
5. South Africa, Orange Free State
6. South Africa, Cape Province
7. India, Maharashtra
8. India, Delhi
9. India, Madhya Pradesh
10. India, Karnataka
11. India, West Bengal
12. Pakistan, Punjab, Bahawal
13. Pakistan, Punjab, Lyallpur
14. Pakistan, Sind
15. Saudi Arabia, Jizan
16. Greece, Thessaloniki
17. USA, Montana
18. Mexico, Celaya, INIA
19. Mexico, El Refugio, INIA
20. Brazil, Parana
21. Chile, Vallemar
22. Argentina, Buenos Aires
23. Argentina, Cordoba

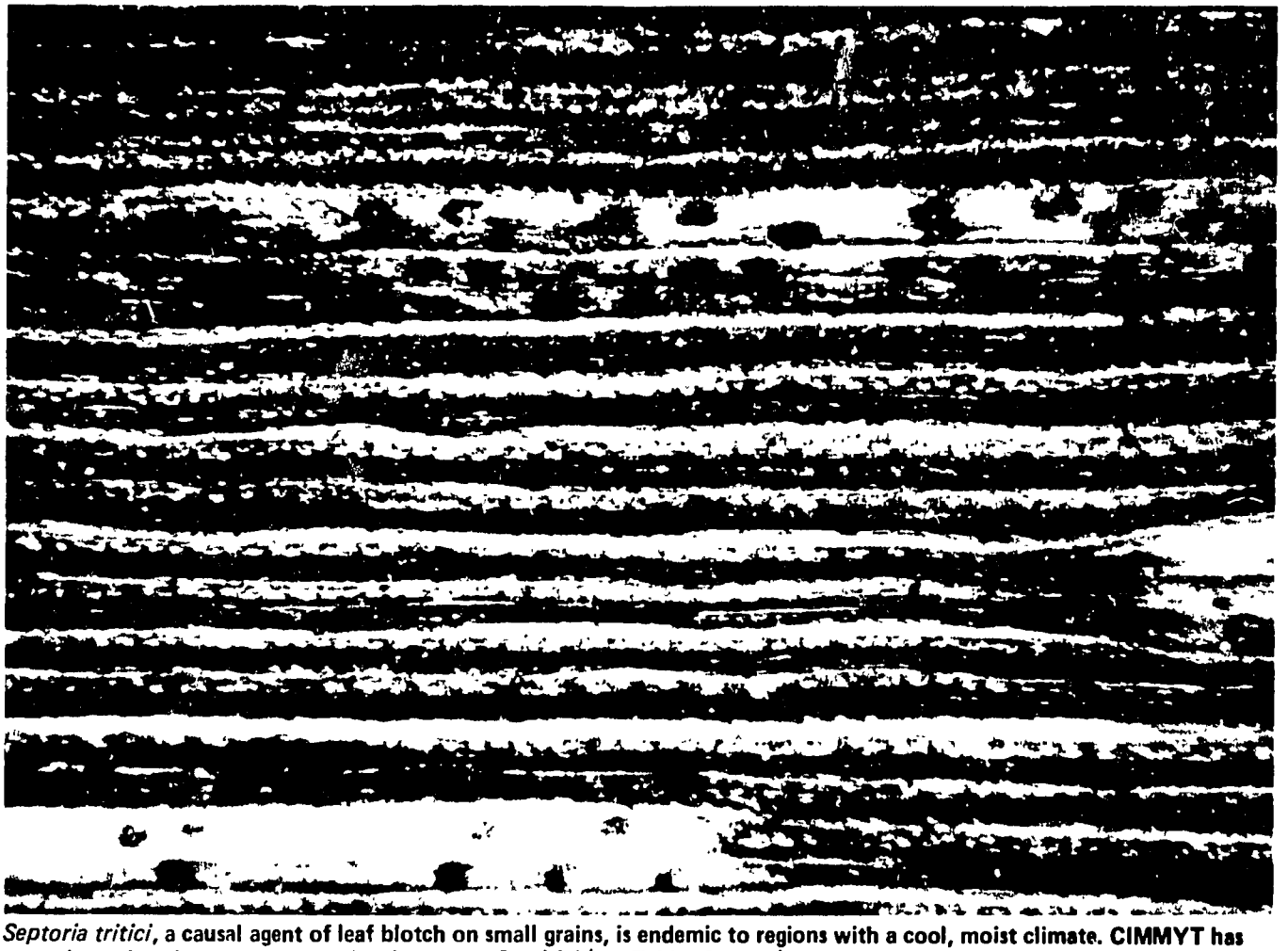
lines represent the progeny from 50 different crosses. Thirteen of these crosses contributed selections that excelled for any two rusts. Crosses CM 37614 = JUP73-ZP"S" x COC75, and CM 33202 = Bobwhite"S" covered the range of the three rusts in entries resistant to stripe rust and to either stem rust or leaf rust; one selection from CM 37987 = (ORE F1 158-FDL x Mexifen"S" – TIB63 (2)) COC75 (entry 383) was marked for all three rusts. Entries 267 and 268, selected from CM 34630 = Gallo – Cuckoo x Kvz-SX, showed remarkably low Avg CIs (high resistance) for stripe rust (0.5 and 0.2) and for leaf rust (0.8 and 1.0). Entry 461, derived from the spring x winter cross SWO176 = Kvz-K4500.L.A.4, had a low Avg CI for stem rust (2.1) and for leaf rust (1.0).

The broad resistance to rusts expressed by Bobwhite "S," Chat"S," Pavon"S," Tanager"S," Towhee"S," and Veery"S" may be derived from the CIMMYT advanced line Kal-Bb. USSR winter wheat cultivars Kavkaz and Aurora should also be considered as the possible sources of resistance in Kvz-K45000.L.A.4, Bobwhite "S," Chat "S," and Veery"S."

Leaf blotch and glume blotch

Septoria tritici and *S. nodorum*, the causal agents of leaf blotch and glume blotch, occur endemically in regions with a cool, moist climate—such as southern Brazil, Paraguay, Argentina, northern Europe, the southern and eastern coastal areas of the Mediterranean, and some intermountain valleys in Afghanistan and other Middle East countries. As more wheat is grown in blotch-prone areas, the importance of the septoria diseases is likely to increase; this phenomenon is now evident for glume blotch in the lower Mississippi Valley in the USA.

Because of apparent differences in virulence among populations of *Septoria* in diverse geographical regions, thorough germplasm evaluation calls for multilocation testing. Leaf blotch and, to a lesser extent, glume blotch occur naturally in Mexico, near Patzcuaro Lake, Michoacan. Basic and advanced CIMMYT nurseries are screened there; most resistant lines are further tested in Ciudad Obregon for good plant type and resistance to leaf and stem rust. The best lines are then put into the International Septoria Observation Nursery (ISEPTON), which is grown and



***Septoria tritici*, a causal agent of leaf blotch on small grains, is endemic to regions with a cool, moist climate. CIMMYT has germplasm that demonstrates good resistance to *S. tritici* (see Tables 6 and 7).**

evaluated by cooperating scientists in locations where the climate favors blotch development. Results are reported here for leaf blotch (Tables 4 and 5) and glume blotch (Tables 6 and 7) in the 12th IBWSN and IX ISEPTON.

In general, CIMMYT lines have moderate resistance to leaf blotch. The entry with the least infection in the 12th IBWSN (Table 4) is a selection from CM 34630 = Gallo-Cuckoo x Kvz –Sx; its average infection was 35.8 percent (3.5 in the 0-9 scale). Two other selections from the same cross expressed high resistance. Other promising crosses included CM 33203 = Bobwhite"S" (11 selections) and SWM 1368 = Ceb 148 (Cno"S"-Inia"S" x Lfn/Tob x Kl. Pet-Raf) (2 selections).

The best CIMMYT line in the ISEPTON IX (Table 5) was a Bobwhite selection (entry 15), which ranked seventh with 44.9 percent leaf blotch infection (4.1 in the 0-9 scale). Most of the lines that had less than 50 percent average infection in the ISEPTON IX are selections or cultivars from South America. Efforts to transfer their resistance onto earlier, shorter background cultivars continue.

Regarding glume blotch, 56 lines in the 12th IBWSN had less than 20 percent average infection. CM 33203 = Bobwhite"S" occurs most commonly (eight selections), followed by CM 33027 = Veery"S" and CM 37987 = (ORE F1 158-FDL x Mexifen"S" – Tib63 (2)) Coc 75, with five selections each, and CM 34630 = Gallo – Cuckoo x Kvz-Sx with three selections. Likely sources of resistance to glume blotch are the CIMMYT lines Alondra and Kal-Bb, and the USSR winter wheat Kavkaz; they appear in several crosses in Table 6.

Alondra ranked among the glume blotch-resistant entries in ISEPTON IX (Table 7). Other CIMMYT lines in that group are a Bobwhite selection and one selection from CM 21335 = Tzpp^2 – Ane x Inia/Cno-Jar x Kvz. All other ISEPTON IX entries with less than 45 percent infection (4.1 in the 0-9 scale) are Brazilian accessions.

Powdery mildew

This fungal disease is favored by cool moist climates; it is endemic in northern and eastern Europe, southern

Table 2. Spring type wheats from the Twelfth International Bread Wheat Screening Nursery highly resistant to *Puccinia recondita* at most of 23 sites* (average coefficient of infection equal to or less than 4.0)

Entry	Variety, or cross and pedigree	Avg. C.I.
267	GALLO - CUCKOO x KVZ - SX CM34630-D-5M-2Y-3M-3Y-0M	0.8
226	BOBWHITE"S" CM33203-K-9M-9Y-4M-1Y-0M	1.0
461	KVZ - K4500.L.A.4 SW0176-3M-1Y-6Y-1Y-2M-0Y	1.0
268	GALLO-CUCKOO x KVZ - SX CM34630-D-5M-5Y-3M-1Y-0M	1.0
228	BOBWHITE"S" CM33203-K-9M-10Y-1M-5Y-0M	1.5
227	BOBWHITE"S" CM33203-K-9M-9Y-4M-4Y-0M	1.5
390	T. AEST x KAL-BB/ANAHUAC 75 CM38236-A-14Y-10M-1Y-0M	1.6
76	/FKN(FR x KAD-GB)(2)/BB-CHA CM25988-8Y-3Y-2Y-2M-0Y	2.0
112	/CAL x CNO-SON(CNO x NAD-CHRIS/SON-KL.REND x BB)/HORK"S" CM30105-9Y-1M-1Y-0M	2.1
195	(HUA(R)(2) x MY 54-N10B/NPO)MUSALA"S" CM32859-1M-1Y-1M-0Y	2.1
430	HEIMA - COC 75 x BJY"S" CM41195-J-7M-1Y-0M	2.5
141	KVZ x BB-CHA/TORIM 73"S" CM30832-Z-3Y-1M-4Y-1M-0Y	2.6
328	TORIM 73 x KAL-BB CM37130-15Y-1M-3Y-0M	2.8
138	TANAGER"S" CM30697-2M-15Y-1M-0Y	2.9
113	/CAL x CNO-SON(CNO x NAD-CHRIS/SON-KL.REND x BB)/ HORK"S" CM30105-9Y-1M-4Y-0M	3.0
225	BOBWHITE"S" CM33203-K-9M-1Y-6M-4Y-0M	3.0
232	BOBWHITE"S" CM33203-K-9M-33Y-1M-2Y-0M	3.0
98	MAYA 74"S" - SPARROW"S" CM29223-3M-4Y-4M-0Y	3.1
130	TANAGER"S" CM30697-2M-3Y-3M-0Y	3.1
229	BOBWHITE"S" CM33203-K-9M-12Y-1M-0Y	3.1
333	BB-KAL x ALD"S"/7C CM37557-D-5Y-2M-0Y	3.1
231	BOBWHITE"S" CM33203-K-9M-19Y-3M-3Y-0M	3.1
73	/FKN(FR x KAD-GB)(2)/BB-CHA CM25988-8Y-3Y-1Y-1M-1Y-0B	3.2
383	(ORE F1 158-FDL x MEXIFEN"S"-TIB 63^2) COC 75 CM37987-I-1Y-4M-0Y	3.2
409	/CNO-8156 x TOB66-CNO(N066/12300 x LR6-8156)/TI 71 RESEL CM39365-3M-2Y-0M	3.2
74	/FKN(FR x KAD-GB)(2)/ BB-CHA CM25988-8Y-3Y-2Y-1M-0Y	3.3
94	(TP x CNO-N066/BB-CNO)ZA 75 CM29077-4M-3Y-3M-2Y-0M	3.3
391	T. AEST x KAL-BB/ANAHUAC 75 CM38236-L-6Y-1M-0Y	3.3

Brazil, Paraguay, the Pacific Northwest of the United States, and northwest Turkey. Resistance to powdery mildew is important in wheat cultivars that are apt to be grown in areas where climatic conditions may trigger severe outbreaks.

CIMMYT's strategy for developing wheats resistant to powdery mildew has been the continued use of parents with proven resistance. Selection cannot be done in breeding nurseries because the disease does not occur significantly in Mexico. Nevertheless, CIMMYT wheats have achieved adequate levels of resistance. Tables 8 and 9 list entries with less than 15 and 20 percent average infection, respectively, in the 12th IBWSN and ISEPTON IX.

Cross 8156 = Penjamo 62"S" – Gabo 55, from which Siete Cerros (7C), Kalyansona (Kal), and Super X (Sx) were selected, has long withstood powdery mildew. All but one of the 12th IBWSN lines with less than 12 percent infection (Table 8) are direct selections from 8156 or have one such selection in their parentage. The exception (entry 459) is a selection from SW0176 = Kvz – K 4500.L.A.4. Several Patzcuaro reselections of this same line also ranked among the lines resistant to powdery mildew (Table 9). Kavkaz appears to contribute resistance to powdery mildew as well.

Helminthosporium leaf spotting

To increase food production, it might be possible in several countries to grow wheat in humid, warm, tropical lowlands, either by itself or in rotation with rice. Such attempts have been thwarted by the occurrence of at least two species of helminthosporium that cause extensive leaf spotting and defoliation.

Although natural inoculum tends to be mixed, epidemics in Zambia are caused primarily by *H. sativum*; in Bangladesh they are due predominantly to *H. tritici-repentis*. In Paraguay both species may combine with other foliar pathogens to produce an inextricable syndrome of leaf spotting.

Table 2. (Continued)

Entry	Variety, or cross and pedigree	Avg. C.I.
41	PV18A-CN067 x WE/SX(NOR 67/CNO-CHR x ON)7 CM26607-D-14Y-1M-1Y-0B	3.5
77	/FKN(FR x KAD-GB)(2)7BB-CHA CM25988-8Y-3Y-2Y-3M-0Y	3.5
92	(TP x CNO-N066/BB-CNO) ZA 75 CM29077-4M-3Y-2M-0Y	3.7
125	SISKIN"S" - CANARIO"S" CM30610-1M-1Y-2M-0Y	3.8
330	AZ 67 x CNO-7C CM37229-9M-3Y-0M	3.8
244	MAIPO"S" - PJ 62 x EMU"S" CM33254-T-1M-1Y-6M-1Y-0M	3.9
431	GOLDEN VALLEY - A7 67 x MUSALA"S" CM41257-I-8M-3Y-0M	3.9
95	(TP x CNO-N066/BB-CNO) ZA 75 CM29077-4M-4Y-1M-2Y-0M	4.0
215	BOBWHITE"S" CM33203-F-4M-8Y-1M-0Y	4.0
245	MAIPO"S" - PJ 62 x EMU"S" CM33254-T-1M-1Y-6M-3Y-0M	4.0
337	JUP 73 - ZP"S" x COC 75 CM37614-B-14Y-3M-1Y-0M	4.0

* Locations:

1. Tanzania, Lyamungu
2. Mozambique, Maputo
3. Malawi, Ntcheu
4. South Africa, Orange Free State
5. South Africa, Cape Province
6. Bangladesh, Joydebpur
7. Bangladesh, Ishurdi-Palua
8. India, Maharashtra
9. India, Delhi
10. India, Punjab, Ludhiana
11. India, Madya Pradesh
12. India, Uttar Pradesh
13. India, Karnataka
14. India, West Bengal
15. India, Andhra Pradesh
16. Pakistan, Punjab, Lyallpur
17. Pakistan, Sind, Tandojam
18. Lebanon, Bekaa Valley
19. Saudi Arabia, Jizan
20. Turkey, Izmir
21. Greece, Thessaloniki
22. Poland, Blonie
23. Mexico, Los Mochis, Sinaloa
24. Mexico, Cd. Obregon, Sonora
25. Mexico, Rio Bravo, Tamaulipas
26. Mexico, El Batan
27. Mexico, Celaya, Guanajuato
28. Mexico, El Refugio, Guanajuato
29. Argentina, Cordoba
30. Brazil, Distrito Federal
31. Chile, Chillan

Since these pathogens do not occur in the fertile crescent or other centers of diversity for wheat, it is unlikely that the crop species would have developed any degree of resistance. Under natural, unusually severe infections of *H. sativum* in Poza Rica, Mexico, no line from basic or advanced CIMMYT nurseries has survived.

Assessment of entries in the 12th IBWSN under a severe epidemic at Mount Makulu Research Station, Zambia, indicates more differential response (Table 10). Six out of the seven top lines have Kavkaz in their parentage; all lines that are not Kavkaz progeny have 8156 derivatives at least once in their parentage.

STUDIES IN MEXICO

Virulence analysis of leaf and stem rust fungi

In the complementary genic system of rust fungi and their hosts, any resistance gene or combination of genes in the host protects it against a fungus that lacks the matching (or complementary) virulence gene or combination of genes. The virulence spectrum of rust populations is studied in a program of breeding for rust resistance because an increased frequency of virulence genes—singly or in certain combinations—may signal the outbreak of new rust types that are not resisted by the genetic makeup of some cultivars.

Populations of wheat leaf rust and stem rust in Mexico have been surveyed by two independent approaches. First, lines that carry a single resistance gene to leaf rust (Lr-gene) or to stem rust (Sr-gene) are planted where CIMMYT nurseries are grown. Natural infections are allowed and their levels are assessed when the crop is in early-dough stage. Average CIs of each line measure the relative frequency of the matching virulence gene. One or more lines without effective resistance genes may be used to gauge the environmental ceiling for infection.

In the second approach, single-pustule isolates derived from field samples are inoculated onto appropriate sets of single Lr—or Sr—lines in the seedling stage. The combination of virulence genes present in each isolate may be ascertained from the host reactions. Frequency of virulence genes, or combinations of them, may be obtained directly by tallying isolates capable of attacking the corresponding line or lines.

Average CIs for leaf rust in 1978, 1979, and 1980 are given in Table 11. Data show a general decline in rust infection; Thatcher, a check line with no effective Lr-gene fits that trend, too. It therefore appears that weather has restricted leaf rust infection.

Table 12 lists frequency of virulence genes tallied from single pustule isolates for the last three years in the Yaqui Valley, Sonora, as well as for five locations in Mexico during 1980. No virulence gene increased significantly in frequency within the leaf rust population sampled in 1980 compared to the previous two years. Virulence genes complementary to Lr-17 and -23 were far less frequent in 1980 than in 1978 or 1979; those complementary to Lr-3ka, -16, and -EG were not found at all in 1980. Frequency of virulence genes in the Yaqui Valley, El Fuerte, El Carrizo, Sinaloa, Rio Bravo, Tamaulipas, El Batan, and Oaxaca state generally agrees with similar data available for other years. Regional differences in frequency of virulence genes became more marked in 1980. In the north (Yaqui Valley, El Fuerte, El Carrizo, and Rio Bravo), the minimal virulence formula comprises genes matching Lr-1, -10, -14a, and -14b, while in the Central Plateau (El Batan) and the southern mountains of Oaxaca, the minimal combination consists of virulence genes complementary to Lr-2a, -2b, -2c, -3, -14a, and -14b.

In conclusion, it appears that leaf rust populations present in Mexico are evolving toward simpler genotypes, with respect to the range of resistance genes available for tests. A declining trend in infection level of stem rust is also evident from Avg CI ratings for 1978, 1979, and 1980 (Table 13). Sr-5—an ineffective resistance gene in Mexico, which acts as a check to measure environmental limits to rust infection—indicates that 1980 was not strikingly unfavorable when compared to 1978 (Avg CIs of 51 and 58, respectively). However, differences may be observed in Avg CI for Sr-7b, -8, -9a, -9d, -9e, -12, -14, -26, -29, Tt-1, and Tt-2.

There also may be a trend toward simpler genotypes in the stem rust population of Mexico. A limited number of single-pustule isolates corroborated the prevalence of virulence formula RPQ (standard race 113). Exploration of sites with broader arrays of virulence must continue, because RPQ isolates do not test thoroughly for broad resistance in cultivars.

Screening for loose smut resistance

Loose smut is a location-specific disease that can be controlled chemically. It occurs as a production constraint in areas of Argentina, Algeria, India, and Pakistan, where failure to inspect seed fields or inadequate seed treatment may result in severe disease outbreaks. Genetic resistance is available within CIMMYT germplasm, and the screening technique is simple and effective.

Crossing blocks and screening nurseries of bread and durum wheat, triticale, and barley are tested annually. Susceptible advanced lines or lines apt to be crossed are discarded. Triticale and durum wheat are generally resistant. Bread wheat and barley have widely variable reactions. Resistant lines are tested repeatedly to reduce chances of escapes. The final aim is to produce a loose smut elite nursery made up of lines resistant worldwide.

Progress reports on this disease are fragmentary and subject to change; the composition of the nurseries changes continually, and the pathogen population is also unstable. Nevertheless, Table 14 gives a list of 18 resistant bread wheat lines in the 13th IBWSN and the spring crossing block for winter cycle 1979-80.

Table 3. Bread wheat lines in the Twelfth International Bread Wheat Screening Nursery with a high degree of resistance to *Puccinia striiformis* at 24 sites[x] (average coefficient of infection equal to or less than 3.0)

Entry	Variety, or cross and pedigree	Avg. C.I.	Entry	Variety, or cross and pedigree	Avg. C.I.
268	GALLO - CUCKOO x KVZ - SX CM34630-D-5M-5Y-3M-1Y-0M	0.2	201	VEERY"S" CM33027-F-12M-1Y-4M-0Y	1.6
199	VEERY"S" CM33027-F-12M-1Y-3M-1Y-0M	0.3	139	KVZ-GV/TP(CNO-INIA"S")3/ CM30819-J-2Y-8M-1Y-2M-1Y-0B	1.7
238	BOBWHITE"S" CM33203-N-1M-2Y-500M-0Y	0.4	312	BR 74.72 - JUP 73 CM36889-14Y-3M-2Y-0M	1.7
236	BOBWHITE"S" CM33203-N-1M-1Y-1M-1Y-0M	0.4	266	GALLO - CUCKOO x KVZ - SX CM34630-D-5M-2Y-1M-1Y-0M	1.7
267	GALLO - CUCKOO x KVZ - SX CM34630-D-5M-2Y-3M-3Y-0M	0.5	203	VEERY"S" CM33027-F-12M-1Y-6M-0Y	1.7
339	JUP 73 - ZP"S" x COC 75 CM37614-B-14Y-4M-1Y-0M	0.9	344	JUP 73 - ZP"S" x COC 75 CM37614-B-14Y-6M-3Y-0M	1.8
337	JUP 73 - ZP"S" x COC 75 CM37614-B-14Y-3M-1Y-0M	0.9	198	VEERY"S" CM33027-F-12M-1Y-3M-0Y	1.8
343	JUP 73-ZP"S" x COC 75 CM37614-B-14Y-6M-1Y-0M	0.9	176	KAL-BB x CJ 71"S"/HORK"S" CM32418-1M-1Y-6M-1Y-0M	1.8
202	VEERY"S" CM33027-F-12M-1Y-5M-1Y-0M	1.1	237	BOBWHITE"S" CM33203-N-1M-1Y-6M-1Y-0M	1.8
452	CAR 422-ANAHUAC 75 SWM4610-2Y-4M-6Y-0M	1.3	278	TOWHEE"S" CM34709-Q-2M-2Y-15M-1Y-0M	1.8
338	JUP 73 - ZP"S" x COC 75 CM37614-B-14Y-3M-7Y-0M	1.5	231	BOBWHITE"S" CM33203-K-9M-19Y-3M-3Y-0M	1.8
204	VEERY"S" CM33027-F-12M-1Y-9M-0Y	1.3	335	JUP 73 - ZP"S" x COC 75 CM37614-B-12Y-4M-5Y-0M	1.9
342	JUP 73-ZP"S" x COC 75 CM37614-B-14Y-5M-1Y-0M	1.3	205	VEERY"S" CM33027-F-12M-1Y-10M-0Y	1.9
415	CHIROCA"S" - HORK"S" CM39812-8M-5Y-0M	1.5	227	BOBWHITE"S" CM33203-K-9M-9Y-4M-4Y-0M	1.9
439	BURGUS 2. SORT 12.13 x KAL-BB SWM3115-2M-4Y-1M-1Y-0M	1.6	213	CHAT"S" CM33090-T-1M-4Y-0M	2.0

Table 3. (continued)

Entry	Variety, or cross and pedigree	Avg. C.I.
390	T. AEST x KAL-BB/ANAHUAC 75 CM38236-A-14Y-10M-1Y-0M	2.0
166	Y50E-KAL(3) x HORK"S" CM32111-1M-1Y-12M-1Y-0M	2.1
62	BOBWHITE"S" CM33203-N-1M-2Y-0M	2.1
228	BOBWHITE"S" CM33203-K-9M-10Y-1M-5Y-0M	2.2
230	BOBWHITE"S" CM33203-K-9M-15Y-1M-4Y-0M	2.2
454	CAR 422-ANAHUAC 75 SWM4610-2Y-17M-4Y-0M	2.3
23	EMU"S" CM8327-C-9M-1Y-1M-1Y-0M	2.4
434	BON-YR 70/T. AEST x KAL-BB CM41860-A-5M-1Y-0M	2.3
229	BOBWHITE"S" CM33203-K-9M-12Y-1M-0Y	2.3
226	BOBWHITE"S" CM33203-K-9M-9Y-4M-1Y-0M	2.4
431	GOLDEN VALLEY - AZ 67 x MUSALA"S" CM41257-1-8M-3Y-0M	2.4
393	(TAC-12300 x AZ 67/TORIM 73) JUP"S" BCH"S" CM38324-K-1Y-11M-0Y	2.5
35	TZPP(2) - ANE x INIA/JAR-KVZ CM21335-C-9Y-3M-1Y-1Y-1Y-0B	2.6
98	MAYA 74"S" - SPARROW"S" CM29223-3M-4Y-4M-0Y	2.6
275	TOWHEE"S" CM34709-G-15M-10Y-5M-2Y-0M	2.7
341	JUP 73-ZP"S" x COC 75 CM37614-B-14Y-4M-3Y-0M	2.8
54	VEERY"S" CM33027-F-1M-9Y-0M	2.9
448	(NDD-WW x LEE-FN/N) TI 71 RESEL SWM4589-7Y-1M-3Y-0M	3.0
383	(ORE F1 158-FDL x MEXIFEN"S"-TIB 63[2]) COC 75 CM37987-1-1Y-4M-0Y	3.0
426	COLOTANA - HUAC"S" CM40561-2M-4Y-0M	3.0
225	BOBWHITE"S" CM33203-K-9M-1Y-6M-4Y-0M	3.0

* Locations:

1. Egypt, Cairo
2. Egypt, Kafr El-Sheik
3. Egypt, Kalobia
4. Morocco, Rabat
5. Tanzania, Lyamungu
6. Kenya, Rift Valley
7. Turkey, Izmir
8. Israel, Bet-Dagan
9. Saudi Arabia, Jizan
10. India, Punjab, Ludhiana
11. Pakistan, Punjab, Bahawal
12. Pakistan, Punjab, Lyallpur
13. Pakistan, Islamabad
14. Nepal, Rupandehi
15. Australia, Victoria
16. England, Cambridge
17. USA, South Dakota
18. USA, Montana
19. USA, Oregon
20. Mexico, El Batan
21. Colombia, Cundinamarca
22. Ecuador, Quito, Pichincha
23. Argentina, Buenos Aires
24. Chile, Chillan

Table 4. Spring type genotypes from the Twelfth International Bread Wheat Screening Nursery moderately resistant to *Septoria tritici*, data from 16 locations* (maximum percent infection = 45.0)

Entry	Variety, or cross and pedigree	% infection
267	GALLO - CUCKOO x KVZ - SX CM34630-D-5M-2Y-3M-3Y-0M	35.8
231	BOBWHITE"S" CM33203-K-9M-19Y-3M-3Y-0M	37.8
219	BOBWHITE"S" CM33203-G-9M-2Y-501M-501Y-0M	37.9
229	BOBWHITE"S" CM33203-K-9M-12Y-1M-0Y	38.5
232	BOBWHITE"S" CM33203-K-9M-33Y-1M-2Y-0M	39.7
268	GALLO - CUCKOO x KVZ - SX CM34630-D-5M-5Y-3M-1Y-0M	40.0
218	BOBWHITE"S" CM33203-G-9M-2Y-501M-500Y-0M	40.5
54	VEERY"S" CM33027-F-1M-8Y-0M	40.6
226	BOBWHITE"S" CM33203-K-9M-9Y-4M-1Y-0M	40.9
436	CEB 148(CNO"S"-INIA"S" x LFN/TOB x KL. PET-RAF) SWM1368-500Y-1B-501Y-503M-0Y	41.7
266	GALLO - CUCKOO x KVZ - SX CM34630-D-5M-2Y-1M-1Y-0M	41.4
230	BOBWHITE"S" CM33203-K-9M-15Y-1M-4Y-0M	41.7
227	BOBWHITE"S" CM33203-K-9M-9Y-4M-4Y-0M	42.9
61	BOBWHITE"S" CM33203-K-9M-24Y-0M	43.2
235	BOBWHITE"S" CM33203-K-12M-14Y-3M-0Y	43.5
233	BOBWHITE"S" CM33203-K-12M-1Y-5M-5Y-0M	43.6
252	MAYA 74"S"-YDING"S"/2/HK38MA(4777X REI-Y/KT)/ YR 70/ CM33477-L-2M-7Y-5M-1Y-0M	43.6
444	PUMAFEN x KAL-BB SWM4206-3Y-3M-2Y-0M	43.7
435	CEB 148(CNO"S"-INIA"S" x LFN/TOB x KL. PET-RAF) SWM1368-500Y-1B-501Y-502M-0Y	43.8
389	EMU"S" - MILDRESS x KAL-BB CM38199-L-11Y-1M-1Y-0M	44.3

* Locations:

1. South Korea, Chunnam
2. Afghanistan, Kunduz
3. Morocco, Rabat
4. Ethiopia, Shoa
5. South Africa, Cape Province
6. Cyprus, Athalassa
7. Australia, Victoria
8. Portugal, Alentejo
9. Poland, Blonie
10. Spain, Cadiz
11. USA, California
12. USA, Oregon
13. Mexico, Patzcuaro
14. Colombia, Cundinamarca
15. Bolivia, Cochabamba
16. Argentina, Cordoba

Table 5. Spring wheat varieties and advanced lines in the Ninth International Septoria Observation Nursery moderately resistant to *Septoria tritici* at most of 19 locations* (maximum average percent = 50.0)

Entry	Variety, or cross and pedigree	Origin	Avg. % infection
187	B.7408	Brazil	38.5
173	Bordenave Puan-H380M 2340-H328 CB0712000	Argentina	42.0
191	Colonias -1Ptz-0M-0Ptz-0Y	Brazil	42.5
182	CNT-8	Brazil	43.7
192	S12-Nb B529-22C-1C-0C-0M-0Ptz-0Y	Brazil	43.8
196	Colotana CI13556; PI214392	Brazil	43.8
15	Bobwhite"S" CM33203-S-1M-5Y-1M-0Y-0Ptz-0Y	Mexico	44.9
177	Nova Prata	Brazil	45.0
172	Magnific G = MAG.G	Argentina	45.5
179	IAS 64	Brazil	45.6
218	Weibull 7389	Sweden	45.6
178	IAS 63	Brazil	46.2
186	PF.70354 = IAS54-IAS20 -2Ptz-0Y	Brazil	46.2
166	II.64.20 = CI13654-I160105 -0Ptz-0Y	USA	46.7
165	Era-CHM x 12325 (LA x Heod) (Heiner's)	USA	47.3
185	PF.70354 = IAS54-IAS20 -1Ptz-0Y	Brazil	47.5
16	Bobwhite"S" CM33203-S-1M-5Y-4M-0Y-0Ptz-0Y	Mexico	47.9
171	Massaux-Gabo -0Ptz-0Y	Argentina	47.9
176	Jacui	Brazil	47.9
202	Kt54 x Fr-Fn/Y I113747-2N-SE-KE-1E-0Y-0Ptz-0Y	Ecuador	47.9
164	CI13654 = II.60.105-II.64.20 -0Ptz-0Y	USA	48.4
167	ND499 x Waldron-RL4205/Conley -ND122 x Wis261-ND535.FA.11.118	USA	48.4
188	B.7455	Brazil	48.7
189	PAT.73147 = Ga-J9276.67	Brazil	48.7

* Locations:

1. USA, Oregon
2. Mexico, Patzcuaro
3. Guatemela, Quetzaltenango
4. Paraguay, Capitan Miranda
5. Chile, Carillanca
6. Bolivia, Cochabamba
7. Argentina, Pergamino
8. Korea, Suweon
9. Portugal, Elvas
10. Belgium, Gembloux
11. Italy, Rome
12. Poland, Blonie
13. Kenya, Njoro
14. Algeria, Algiers
15. Algeria, Oued Smar
16. Ethiopia, Holetta
17. Tanzania, Iringa
18. South Africa, Cape Province
19. Turkey, Izmir

Table 6. Spring type genotypes from the Twelfth International Bread Wheat Screening Nursery resistant to *Septoria nodorum* at 5 locations* (maximum average percent infection = 20.0)

Entry	Variety, or cross and pedigree	% infection
144	JUP 73 - ALD"S" CM36867-7Y-2M-3Y-0M	11.0
200	VEERY"S" CM33027-F-1M-9Y-0M	11.0
358	(BB-CNO x INIA-SOTY/SPARROW"S") PAVON"S" CM37705-G-3Y-1M-4Y-0M	13.8
145	KL. H686.F2600-SR70 x TOB66-CNO"S" CM30920-1-1Y-1M-1Y-1M-1Y-0B	13.8
400	VEERY"S" CM33027-F-1M-9Y-0M	13.8
267	GALLO - CUCKOO x KVZ -SX CM34630-D-5M-2Y-3M-3Y-0M	13.8
439	BURGUS 2. SORT 12.13 x KAL-BB SWM3115-2M-4Y-1M-1Y-0M	13.8
329	DESC. #2 x KAL-BB CM37154-8Y-5M-1Y-0M	13.8
266	GALLO - CUCKOO x KVZ - SX CM34630-D-5M-2Y-1M-1Y-0M	13.8
389	EMU"S" - MILDRESS x KAL-BB CM38199-L-11Y-1M-1Y-0M	13.8
300	VEERY"S" CM33027-F-1M-9Y-0M	15.0
285	TI 71 RESEL - MONCHO"S" CM34801-2M-5Y-500M-0Y	16.3
364	BCH"S" x Y50F-KAL(3)/HORK"S" CM37726-A-2Y-3Y-0Y	16.5
233	BOBWHITE"S" CM33203-K-12M-1Y-5M-5Y-0M	16.5
276	TOWHEE"S" CM34709-P-3M-8Y-2M-1Y-0M	16.5
100	VEERY"S" CM33027-F-1M-9Y-0M	16.5
268	GALLO - CUCKOO x KVZ - SX CM34630-D-5M-5Y-3M-1Y-0M	16.5
134	TANAGER"S" CM30697-2M-10Y-4M-0Y	16.5
218	BOBWHITE"S" CM33203-G-9M-2Y-501M-500Y-0M	16.5
438	KVZ - HD 2009 SWM2984-1M-1Y-1M-2Y-0M	16.5
447	NDD-SEL 101(2) x PAVON"S" SWM4249-1Y-0M-5Y-0M	16.5
83	BLUE JAY"S" - TORIM 73 CM28173-18Y-7M-5Y-0M	16.5
360	SIETE CERROS	16.5
54	VEERY"S" CM33027-F-1M-9Y-0M	16.5
123	GALLO-AUSTII 61.157 x CNO-N066/ PAVON"S" CM30326-2M-7Y-3M-0Y	17.8
304	ZA 75 - PAVON"S" CM36681-19Y-11M-1Y-0M	19.0
386	(ORE F1 158-FDL x MEXIFEN"S"-TIB 63 2) COC 75 CM37987-1-1Y-5M-0Y	19.3
219	BOBWHITE"S" CM33203-G-9M-2Y-501M-501Y-0M	19.3
138	TANAGER"S" CM30697-2M-15Y-1M-0Y	19.3
78	/(PAK F4 6313/TOB-CFN X BB) B. MAN- ON X CAL/ MAYA 74"S" CM26346-A-11Y-1M-3Y-1M-1Y-0B	19.3

Table 6. (Continued)

Entry	Variety, or cross and pedigree	% infection
102	MAYA 74"S" - MONCHO"S" CM29251-3M-2Y-15M-2Y-0M	19.3
190	ABURA - MAZOE (GB) x BCH"S" CM32622-15M-3Y-0M	19.3
232	BOBWHITE"S" CM33203-K-9M-33Y-1M-2Y-0M	19.3
179	PAVON"S" (PATO (R)-CAL/7C x BB-CNO) CM32535-4M-3Y-4M-2Y-0M	19.3
383	(ORE F1 158-FDL x MEXIFEN"S"-TIB 63 COC 75 CM37987-1-1Y-4M-0Y	19.3
101	MAYA 74"S" - MONCHO"S" CM29251-3M-2Y-5M-3Y-0M	19.3
384	(ORE F1 158-FDL x MEXIFEN"S"-TIB 63^2) COC 75 CM37987-1-1Y-6M-0Y	19.3
444	PUMAFEN x KAL-BB SWM4206-3Y-3M-2Y-0M	19.3
446	NDD-SEL 101(2) x PAVON"S" SWM4249-1Y-4M-2Y-0M	19.3
193	ABURA - MAZOE (GB) x BCH"S" CM32622-38Y-1M-1Y-0M	19.3
375	YMH - POPO"S" x 7C CM37855-A-1Y-8M-3Y-0M	19.3
310	BON - JUP 73 CM36872-27Y-16M-1Y-0M	19.3
215	BOBWHITE"S" CM33203-F-4M-8Y-1M-0Y	19.3
217	BOBWHITE"S" CM33203-G-9M-2Y-500M-500Y-0M	19.3
377	YMH - POPO"S" x 7C CM37855-A-1Y-10M-4Y-0M	19.3
381	(ORE F1 158-FDL x MEXIFEN"S"-TIB 63^2) COC 75 CM37987-1-1Y-2M-1Y-0M	19.3
352	/NAR59 x CNO"S"(2)-TOB//(SON64-KL.REND CNO x LR64(2)-SON 64)CNO x NAD-CHR"S") R70//EMU"S" CM37689-K-4Y-7M-2Y-0M	19.3
178	PAVON"S" (BB-CNO"S" x JAR/ORIZABA"S") CM32534-17Y-6M-1Y-0M	19.3
81	/(PAK F4 6313/TOB-CFN x BB)B.MANON x CAL/MAYA 74"S" CM26346-B-12Y-8Y-3M-1Y-0B	19.3
187	MO73/TP(CNO-INIA"S")(3)/ CM32565-7Y-3M-1Y-0M	19.3
132	TANAGER"S" CM30697-2M-8Y-4M-0Y	19.3
287	YDING"S" - PCI"S" CM35044-68M-7Y-0M	19.3
385	(ORE F1 158-FDL x MEXIFEN"S"-TIB 63^2) COC 75 CM37987-1-1Y-2M-0Y	19.4
231	BOBWHITE"S" CM33203-K-9M-19Y-3M-3Y-0M	19.4
227	BOBWHITE"S" CM33203-K-9M-9Y-4M-4Y-0M	19.4
324	KAL-BB x ALD"S" CM37127-16Y-1M-0Y	19.4

* Locations:
1. South Korea, Chunnam
2. Afghanistan, Kunduz
3. Poland, Blonie
4. Malawi, Ntcheu
5. Brazil, Parana

Table 7. Spring type wheats from the Ninth International Septoria Observation Nursery moderately resistant to *Septoria nodorum* at most of 10 sites* (maximum average percent infection = 45.0)

Entry	Variety, or cross and pedigree	Origin	Avg. % infection
176	Jacui	Brazil	31.0
178	IAS 63	Brazil	31.0
179	IAS 64	Brazil	33.3
182	CNT-8	Brazil	33.3
177	Nova Prata	Brazil	34.4
187	B-7408	Brazil	34.4
175	Maringa	Brazil	35.5
194	Pel 72380-Arthur 71 Br13374-0A-1Y-500Y-0M-1Ptz-0Y	Brazil	35.5
189	PAT.73147 = Ga-J9276.67	Brazil	38.0
183	CNT-10 = Pel.72018	Brazil	39.4
188	B-7455	Brazil	41.0
14	Bobwhite"S" CM33203-K-12M-14Y-3M-0Y-1Ptz-0Y	Mexico	42.1
190	PAT.73190 = (7C-Pj62 x Kl.Pet-Raf/ Cno"S")PF12768	Brazil	43.0
11	Alondra"S" CM11683-A-1Y-1M-1Y-7M-0Y-0Ptz-0Y	Mexico	44.4
69	$Tzpp^2$-An_E x Inia/Cno-Jar x Kvz CM21335-C-9Y-3M-1Y-1Y-0B-0Ptz-0Y	Mexico	44.4
184	PF.7339	Brazil	44.4
155	Aepoglom-11.64.27 = MN72131	USA	45.0

* Locations:
1. USA, Montana
2. USA, Georgia
3. USA, Texas
4. Brazil, Parana
5. Brazil, R.S., Passo Fundo
6. Brazil, R.S., Cruz Alta
7. Ireland, Dublin
8. West Germany, Oberer Lindehof
9. Holland, Geertsema-Groningen
10. Poland, Blonie

Table 8. Bread wheat genotypes from the Twelfth International Bread Wheat Screening Nursery highly resistant to *Erysiphe graminis* at 9 locations* (maximum average percent infection = 15.0)

Entry	Variety, or cross and pedigree	% infection
42	TUCAN"S" - MONCHO"S" CM30005-8Y-1Y-0B	4.1
227	BOBWHITE"S" CM33203-K-9M-9Y-4M-4Y-0M	5.9
228	BOBWHITE"S" CM33203-K-9M-10Y-1M-5Y-0M	6.6
304	ZA 75 - PAVON"S" CM36681-19Y-11M-1Y-0M	7.1
229	BOBWHITE"S" CM33203-K-9M-12Y-1M-0Y	7.2
226	BOBWHITE"S" CM33203-K-9M-9Y-4M-1Y-0M	7.8
41	PV18A-CN067 x WE/SX(NOR 67/CNO-CHR x ON)7 CM26607-D-14Y-1M-1Y-0B	8.6
360	SIETE CERROS	8.6
392	MOCHIS 73 x Y50E-KAL(3)/KAL-BB x MILDRESS CM38274-D-1Y-15M-0Y	9.1
394	(SX/PJ62-WRT x CAL) YDING"S" - HORK"S" CM38359-N-1Y-5M-1Y-0M	9.1
171	Y50E-KAL(3) x HORK"S" CM32111-1M-2Y-4M-1Y-0M	9.2
167	Y50E-KAL(3) x HORK"S" CM32111-1M-1Y-12M-2Y-0M	9.3
166	Y50E-KAL(3) x HORK"S" CM32111-1M-1Y-12M-1Y-0M	9.3
1	SIETE CERROS	9.5
209	CHAT"S" CM33090-M-4M-2Y-4M-3Y-0M	9.6
305	ZA 75 - EMU"S" CM36689-10Y-8M-1Y-0M	9.6
8	ZARAGOZA 75	10.1
173	HORK"S" - TITO"S" CM32219-8M-2Y-1M-0Y	10.5
208	CHAT"S" CM33090-M-4M-2Y-4M-0Y	10.6
225	BOBWHITE"S" CM33203-K-9M-1Y-6M-4Y-0M	10.6
210	CHAT"S" CM33090-M-4M-2Y-5M-0Y	10.6
172	PV18A-CNO 67 x HORK"S" CM32151-8Y-2M-4Y-0M	10.6
169	Y50E-KAL(3) x HORK"S" CM32111-1M-2Y-1M-1Y-0M	10.6
162	YR 70 RESEL (B) - HORK"S" CM31934-1Y-1M-2Y-0M	11.0
417	(ORIZABA"S" x CNO"S"-N066/KAL)HORK"S" CM39813-11M-1Y-0M	11.2
170	Y50E-KAL(3) x HORK"S" CM32111-1M-2Y-4M-0Y	11.7
339	JUP 73 - ZP"S" x COC 75 CM37614-B-14Y-4M-1Y-0M	11.7
459	KVZ - K4500.L.A.4 SW0176-3M-1Y-4Y-1Y-1M-0Y	11.8
325	KAL-BB x ALD"S" CM37127-16Y-5M-3Y-0M	11.9
375	YMH - POPO"S" x 7C CM37855-A-1Y-8M-3Y-0M	11.9
168	Y50E-KAL(3) x HORK"S" CM32111-1M-2Y-1M-0Y	12.1

Table 8. (continued)

Entry	Variety, or cross and pedigree	% infection
105	MAYA 74"S" - MONCHO"S" CM29251-3M-17Y-4M-0Y	12.6
230	BOBWHITE"S" CM33203-K-9M-15Y-1M-4Y-0M	12.6
333	BB-KAL x ALD"S"/7C CM37557-D-5Y-2M-0Y	12.8
98	MAYA 74"S" - SPARROW"S" CM29223-3M-4Y-4M-0Y	12.9
374	YMH - POPO"S" x 7C CM37855-A-1Y-8M-1Y-0M	13.0
415	CHIROCA"S" - HORK"S" CM39812-8M-5Y-0M	13.1
149	BUCKBUCK CM31678-R-4Y-2M-15Y-2M-0Y	13.3
232	BOBWHITE"S" CM33203-K-9M-33Y-1M-2Y-0M	13.3
165	Y50E-KAL(3) x HORK"S" CM32111-1M-1Y-9M-0Y	13.3
344	JUP 73 - ZP"S" x COC 75 CM37614-B-14Y-6M-3Y-0M	13.4
342	JUP 73 - ZP"S" x COC 75 CM37614-B-14Y-5M-1Y-0M	13.4
462	FURY - KAL(2) CMH73A-599-2B-1Y-1B-1Y-1B-500Y-0M	13.4
414	KAL-MUSALA"S" CM39613-20M-1Y-0M	13.6
206	KVZ-TI 71/MAYA 74"S" x BB-INIA CM33089-W-3M-7Y-3M-0Y	13.6
338	JUP 73 - ZP"S" x COC 75 CM37614-B-14Y-3M-7Y-0M	13.7
160	SIETE CERROS	13.7
59	KVZ-TI71/MAYA 74"S" x BB-INIA CM33089-W-3M-11Y-0M	13.8
438	KVZ - HD 2009 SWM2984-1M-1Y-1M-2Y-0M	13.8
260	SIETE CERROS	13.9
87	BROCHIS"S" - 7C CM28732-8Y-1M-0Y	13.9
341	JUP 73-ZP"S" x COC 75 CM37614-B-14Y-4M-3Y-0M	14.1
60	SIETE CERROS	14.1
88	HORK"S" x Y50E-KAL(3) CM29025-1M-3Y-1M-0Y	14.2
439	BURGUS 2. SORT 12.13 x KAL-BB SWM3115-2M-4Y-1M-1Y-0M	14.3
309	BON - JUP 73 CM36872-27Y-10M-0Y	14.3
101	MAYA 74"S" - MONCHO"S" CM29251-3M-2Y-5M-3Y-0M	14.4
33	BB-KAL CM9160-11M-5Y-4M-0Y	14.6
25	PAVON"S" CM8399-D-4M-3Y-1M-0Y-(1-268)	14.7
237	BOBWHITE"S" CM33203-N-1M-1Y-6M-1Y-0M	14.7
43	TANAGER"S" CM30697-2M-11Y-0M	14.9
151	BUCKBUCK CM31678-R-4Y-2M-21Y-0M	14.9
224	BOBWHITE"S" CM33203-K-9M-1Y-1M-3Y-0M	14.9
23	EMU"S" CM8327-C-9M-1Y-1M-1Y-0M	15.0

* Locations:

1. USA, Oregon
2. Brazil, Distrito Federal
3. Brazil, Rio Grande do Wul
4. East Germany, Magdeburg
5. Czechoslovakia, Czechia
6. Norway, Oslo
7. Poland, Blonie
8. England, Cambridge
9. Greece, Thessaloniki

Table 9. Entries in the Ninth International Septoria Observation Nursery with a high degree of resistance to *Erysiphe graminis* loca-
tions* (maximum average percent infection = 20.0)

Entry	Variety, or cross and pedigree	Origin	Avg. % infection
52	Veery"S" CM33027-F-15M-500Y-1M-0Y-0Ptz-0Y	Mexico	8.9
158	Kvz-4500.L.A.4 SW0176-3M-1Y-11Y-1Y-1M-0Y-0Ptz-0Y	USA	8.9
13	Bobwhite"S" CM33203-J-11M-4Y-1M-0Y-1Ptz-0Y	Mexico	11.1
14	Bobwhite"S" CM33203-K-12M-14Y-3M-0Y-1Ptz-0Y	Mexico	11.1
159	Kvz-4500.L.A.4 SW0176-3M-1Y-10Y-2Y-2M-0Y-0Ptz-0Y	USA	11.1
211	K4500.4 0Ptz-0Y	Kenya	11.1
214	Romany x Gabo-Gamenya 0Ptz-0Y	Kenya	11.1
16	Bobwhite"S" CM33203-S-1M-5Y-4M-0Y-0Ptz-0Y	Mexico	13.3
51	Veery"S" CM33027-F-15M-5o	Mexico	13.3
73	TL/Bb x CC-Inia CM22099-10M-7Y-2Y-5Y-1M-0Y-0Ptz-0Y	Mexico	13.3
150	Cebeco 148(Cno"S"-Inia"S" x Lin/ Kl.Pet-Raf) SWM1368-500Y-1B-501Y-1M-0Y-0Ptz-0Y	Mexico	13.3
165	Era-CHM x 12325 (LA x Heod) (Heiner's)	USA	13.3
69	Tzpp2-Ane x Inia/Cno-Jar x Kvz CM21335-C-9Y-3M-1Y-1Y-0B-0Ptz-0Y	Mexico	15.5
93	Maya 74"S"-Tzpp/Cno-Pj61 x UP301 CM31536-X-1Y-4M-1Y-500M-0Y-0Ptz-0Y	Mexico	15.5
152	CAR422-Papaju SWM4610-2Y-15M-0Y-1Ptz-0Y	Mexic	5
153	(Dim/Son-Kl.Rend x Bb)Tob"S"-8156 x CC-Inia 89-1B-0Y-1Y-0Y-0Ptz-0Y	Mexico	15.5
156	Kvz-4500.L.A.4 SW0176-3M-1Y-4Y-1Y-1M-0Y-1Ptz-0Y	USA	15.5
212	K6106.9 0Ptz-0Y	Kenya	15.5
15	Bobwhite"S" CM33203-S-1M-5Y-1M-0Y-0Ptz-0Y	Mexico	17.8
83	Maya 74"S"-Moncho"S" CM29251-3M-12Y-4M-0Y-1Ptz-0Y	Mexico	17.8
92	Kvz x Bb-Cha/Torim 73 CM30832-Z-3Y-1M-4Y-1M-0Y-1Ptz-0Y	Mexico	17.8
104	Maya 74"S"-Sparrow"S" x Sap"S" CM33475-1-8M-2Y-2M-0Y-1Ptz-0Y	Mexico	17.8
105	Maya 74"S"/Cno"S"-Pj62 x Gallo HK38MA(4777 x Rei-Y/Kt) Yr CM33477-L-1M-13Y-3M-0Y-0Ptz-0Y	Mexico	17.8
151	R37.Golils 121/Cno-Inia"S" x HD832-On SWM4585-6Y-7M-0Y-1Ptz-0Y		
215	Kafue PI.314909 0Ptz-0Y	Kenya	17.8

* Locations:

1. USA, Oregon
2. USA, Indiana
3. Brazil, R.S., Cruz Alta
4. West Germany, Oberer Lindenhof
5. Poland, Blonie

Table 10. Spring wheat entries in the Twelfth International Bread Wheat Screening Nursery resistant to *Helminthosporium sativum* at the Mount Makulu Research Station in Zambia

Entry	Variety, or cross and pedigree	Scale 0-9 flag	Scale 0-9 head
438	Kvz-HD2009 SWM2984-1M-1Y-1M-2Y-0M	1	1
56	Veery"S" CM33027-F-4M-5Y-0M	1	2
55	Veery"S" CM33027-F-4M-3Y-0M	1	3
110	Tucan"S" - Moncho"S" CM30005-41M-1Y-0M	1	3
205	Veery"S" CM33027-F-12M-1Y-10M-0Y	1	5
35	$TzPP^2$-An_E x Inia/Jar-Kvz CM21335-C-9Y-3M-1Y-1Y-1Y-0B	2	1
22	Moncho"S" CM8288-A-3M-6Y-5M-1Y-0M	2	2
134	Tanager"S" CM30697-2M-10Y-4M-0Y	2	2
216	Bobwhite"S" CM33203-F-4M-8Y-5M-0Y	2	3
323	Kal-Bb x Aldan"S" CM37127-500M-0Y	2	3
20	Jupateco 73	2	4
276	Towhee"S" CM34709-P-3M-8Y-2M-1Y-0M	2	4
132	Tanager"S" CM30697-2M-8Y-4M-0Y	2	5
133	Tanager"S" CM30697-2M-8Y-7M-1Y-0B	2	5
23	Emu"S" CM8327-C-9M-1Y-1M-1Y-0M	3	3
183	Pavon"S" - Huacamayo"S" CM32537-21Y-2M-6Y-0M	3	3
184	Pavon"S" - Huacamayo"S" CM32537-22Y-2M-1Y-0M	3	3
24	Pavon"S" CM8399-D-4M-3Y-0M	4	6
135	Tanager"S" CM30697-2M-10Y-8M-0Y	5	3
136	Tanager"S" CM30697-2M-11Y-1M-0Y	5	3
164	Coc75-Hork"S" CM32041-78M-2Y-0M	5	4
333	Bb-Kal x Aldan"S"/7C CM37557-D-5Y-2M-0Y	5	5
334	Bb-Kal x Aldan"S"/7C CM37557-D-5Y-1M-3Y-0M	5	5

Table 11. Comparison of average coefficient of leaf rust infection in 1978, 1979, and 1980 on Thatcher and Thatcher-backcross lines[1], each with a single resistance gene (Lr-), from uniform nurseries planted in Mexico[2]

Source of resistance	Resistance gene	1978	1979	1980
Thatcher	-	73	77	54
Centenario	1	64	54	43
Webster	2a	67	59	39
Carina	2b	66	58	40
Loros	2c	69	54	36
Democrat	3	77	57	48
Aniversario	3ka	25	32	25
Transfer	9	.4	.1	.1
Exchange	10	39	38	51
Exchange	12	66	63	51
Manitou[1]	13	49	43	37
Selkirk	14a	72	55	51
Maria Escobar	14b	52	32	33
Exchange	16	46	38	30
Klein Lucero	17	50	43	33
Africa 43	18	51	47	37
T 4	19	.4	.1	1.3
RL 5406	21	15	9	19
RL 5404	22	17	14	25
Lee 310	23	39	27	26
Agent[1]	24	7	2	.2
El Gaucho	EG	36	32	29
Terenzio	T	23	12	14
Carina	B	64	43	30
Exchange	Exch	59	38	33
PI 58548	1+	38	28	29
PI 268316	C	55	38	21

[1] Carriers for Lr-13 and -24 are not Thatcher-backcross lines

[2] Data from 11 locations in 1978, 10 in 1979, and 6 in 1980. The latter are Ciudad Obregon (Sonora), El Carrizo (Sinaloa), Rio Bravo (Tamaulipas), Toluca (Mexico), and El Refugio and Celaya (Guanajuato)

Table 12. Percentage of single-pustule isolates of wheat leaf rust that overcome each of 16 selected Lr- genes, as observed on rust populations sampled in Yaqui Valley from 1978 to 1980, and at 5 locations throughout Mexico in 1980

Lr-gene	Yaqui Valley, Sonora 1978	1979	1980	El Fuerte (Sin) 1980	El Carrizo (Sin) 1980	Rio Bravo (Tamps) 1980	El Batan (Mex) 1980	Oaxaca State 1980
1	97	97	83	50	52	81	19	25
2a	37	8	21	25	52	52	87	83
2b	30	7	50	46	48	48	92	81
2c	34	10	38	75	67	33	91	85
3	90	99	29	13	33	57	70	61
3ka	45	19	0	25	4	5	6	2
10	47	93	63	100	85	43	9	7
14a	95	100	75	100	85	52	64	58
14b	94	100	75	100	93	52	87	81
16	21	0	0	0	0	0	0	0
17	66	100	17	100	44	38	11	10
21	18	1	25	0	4	5	3	0
23	66	94	25	63	37	26	56	46
24	1	1	0	0	11	0	4	7
EG	26	12	0	0	0	5	3	5
T	24	1	13	13	7	2	1	1

Table 13. Comparison of average coefficients of stem rust infection in 1978, 1979, and 1980 on lines carrying a single resistance gene (Sr), from uniform nurseries planted in Mexico[1]

Resistance gene	1978	1979	1980
Sr -5	58	36	51
-7b	51	11	12
-8	45	13	8
-9a	35	13	16
-9d	47	5	11
-9e	27	4	5
-10	15	2	10
-12	34	6	12
-13	16	8	12
-14	19	7	8
-15	53	42	45
-16	36	11	21
-22	8	2	6
-24	6	.1	.3
-25	2	1	3
-26	10	1	.2
-27	.1	1	1
-29	14	2	.3
-30	5	1	3
-Tt 1	13	.4	1
-Tt 2	11	1	2
-Gt	7	0	2

[1] Data from 8 locations in 1978, 5 in 1979, and 4 in 1980. The latter are Río Bravo (Tamps.), Toluca (Mexico), and Celaya and El Refugio (Guanajuato)

Table 14. Entries from the 13th IBWSN with low proportion of smutted heads in at least two separate tests for loose smut resistance

Entry	Cross and pedigree	Percent[1]
6	Wq-RM x Kal-Bb SWM 1445 8Y-2M-500Y-502M-500Y-502M-500Y-0M	0
164	BNQ"S" CM 32556 3M-1Y-3M-1Y-1B-1Y-0M	0
233	BOW"S" CM 33203 K-9M-24Y-1M-1Y-1M-2Y-0M	0
249	Maipo"S" -Pj 62 x Emu"S" CM 33254 T-1M-1Y-6M-500Y-0M	0
527	TC 750434-1R-1C-0S	0
354	C22 - Torim 73 CM 36834 25Y-1M-8Y-1M-0Y	1.3
30	Car 422-Ana 75 SWM 4610 2Y-20M-1Y-0M	2.6
217	BOW"S" CM 33203 K-9M-10Y-1M-5Y-2M-0Y	2.6
167	MAD"S" CM 32586 79M-1Y-2M-0Y	3.2
414	Chiroca"S" - Hork"S" CM 39812 8M-5Y-0M	3.2
435	HD 1220 - Kal^3 x Nacozari 76 CM 40454 11M-4Y-2M-1Y-0M	3.7
445	Yding"S" - BJY"S" CM 40456 12Y-1M-1Y-0M	3.8
201	Anza	4.4
430	SAP"S" - MON"S" CM 40392 17M-1Y-2M-0Y	4.4
467	Pato-On x Maya 74 Bb-Ron x Maya 74 CM 40739 30M-1Y-1M-0Y	5.0
436	HD 1220 - Kal^3 x Nacozari 76 CM 40454 11M-4Y-2M-3Y-0M	5.6

[1] Maximum observed proportion of smutted heads, out of at least two tests

Germplasm Development

Within CIMMYT's germplasm development program, work focuses on the improvement of bread wheat, durum wheat, triticale, and to a lesser extent, barley and rye. In cooperation with the wide cross program, some interspecific and intergeneric crosses are also made. This report discusses the development status of various germplasm improvement projects and presents the results of project efforts.

BREAD WHEAT IMPROVEMENT

Protein content

In the 1979 Annual Report on Wheat Improvement, several lines derived from crosses of NapHal and Frondosa that showed good agronomic characteristics and high protein content in the grain were reported. Among this material, lines with higher protein content produce lower yields. According to analyses by the protein quality laboratory, some of these high protein content lines produce grain containing from 18 to 20 percent protein in whole kernel. Compared to conventional wheats, this represents a difference of 4 to 6 percentage points. At this time, however, insufficient data are available to demonstrate how much of this difference might be transferred to higher yielding bread wheats. During the 1979-1980 season, several lines derived from NapHal and Frondosa were crossed with high yielding wheats in an initial effort to determine the extent to which high protein content can be combined with high yield characteristics. Results of some of these crosses are reported in Table 1.

Tolerance to aluminum toxicity

Efforts to develop dwarf germplasm that possesses good tolerance to aluminum toxicity continued in 1980. At the same time, materials are being sought that perform well under Brazilian agricultural conditions. This means that in addition to tolerance to aluminum toxicity, these materials will need good resistance to such diseases as the rusts, fusarium, septoria, powdery mildew, etc. Brazilian wheats are used as recurrent backcross parents to develop these disease resistant materials.

Short straw lines showing good aluminum toxicity tolerance were developed rather quickly, and some of these materials have been tested in Brazil during the last three years. Individual plant selections, as well as advanced lines, were sent to different locations in Brazil in 1980. One hundred ten individual plants and eight checks were sown in the following locations: El Batan, Mexico; Passo Fundo, R.S., Brazil; Cruz Alta, R.S., Brazil; and Cascavel, P.R., Brazil. Data from Brazil on the number of plant rows resistant to aluminum toxicity may be summarized as follows:

Location	Susceptible Lines	Resistant Lines
Passo Fundo	26	84
Cruz Alta	82	28
Cascavel	18	83

Those lines proving to be resistant to aluminum toxicity in all three locations are reported in Table 2. The performance of these lines under site-specific conditions demonstrates the success achieved in developing aluminum toxicity tolerant wheats with more convenient plant heights, including triple dwarf types. This success now allows the focus of more attention on the improvement of disease resistance and yield potential.

At this time, some Brazilian wheats reported as resistant to fusarium, septoria, powdery mildew, and helminthosporium are available. Table 3 reports those wheats demonstrating resistance to certain diseases in Brazil. These wheats are now being crossed to improve their agronomic characteristics. Lines derived from these crosses will be tested to identify those showing disease resistance similar to their parents.

Brazilian wheats characteristically have small heads with few kernels, and efforts to improve these traits are continuing. Efforts to incorporate better yield characteristics in Brazilian wheat involve crossing the best semidwarf lines having Brazilian germplasm with parents having a large

Individual lines often carry one or more characters useful to CIMMYT breeders, but those traits usually are intermixed with less desirable characters. To capitalize on potentially valuable germplasm, the germplasm development unit, under the leadership of Ing. Ricardo Rodríguez, attempts to transfer useful genes to lines with good agronomic characters.

number of spikelets per spike and kernels per spikelet. Lines being used include those derived from CMH74A.582, CMH76.1084, and CMH77A.917 crosses. These lines can produce 12 to 14 spikelets per spike, with 7 to 9 grains per spikelet under Yaqui Valley (northwest Mexico) conditions. It may be possible to identify some lines with large spikes for the 1980-1981 season that can be tested in Brazil, but rapid progress in improving the yield of Brazilian wheats is not anticipated.

Rust resistance

Work begun several years ago in the development of isogenic dwarf lines resistant to rusts was continued in 1980. This year several high yielding lines derived from the cross Agatha x Yecora 70 were identified as having good resistance to *Puccinia recondita* (leaf rust). Table 4 reports on the performance of some of these lines tested in a yield trial conducted during the 1979-1980 cycle. Several lines derived from the cross Agatha x Yecora 70 showed excellent leaf rust resistance and good yield, similar to that of the Ciano 79 variety. The increased yield is apparently due to the rust protection provided by the Lr-19 gene obtained from Agatha.

In the same trial, lines derived from crosses involving RL6010 were tested. RL6010 carries the Lr-9 gene, and is the probable source of leaf rust resistance observed in RL6010 progeny. These lines, however, did not yield as much as those derived from Agatha x Yecora 70, perhaps because fewer backcrosses were involved. The procedures involved in making these backcrosses and selections have been described in detail in earlier reports. During future cycles, efforts will continue to evaluate the yield of materials obtained via the Lr-9 and Lr-19 gene transfer process.

Solid stem development

The tiny wheat stem sawfly larvae (*Cephus cintus*) can cause extensive damage as it progresses through its life-cycle. Adult sawflies deposit eggs on the upper nodes of stems, and the larvae then bore into the stems and work downward. Eventually the larvae cut grooves around the base of the stems, causing stem breakage. Stem solidness acts as a deterrent to the larvae and is a selective trait in conventional wheats to combat this problem. Fortuna is the solid-stemmed variety being used as the source of this characteristic. Unfortunately, Fortuna is a weak strawed, late maturing variety. Despite this difficulty, however,

Table 1. Crosses involving high protein and high yield parents

No.	Cross	Cross number	Percentage of protein*
1	CMH75A.66 x Cno79	CMH80.21	20.0
2	Ron2-Fnd x CMH74A.582/CMH72A.429-Hork"S"^{3}	CMH80.25	19.4
3	Ron2-Fnd x CMH74A.582/Imuris	CMH80.27	19.4
4	(Cal-NH x Za75/Cal-NH)(CMH72A.429-Hork"S"^{3})	CMH80.39	18.0
5	(Cal-NH x Za75/Cal-NH)(Agatha-Ti.71^4)	CMH80.40	18.0
6	(Cal-NH x Za75/Cal-NH)(CMH72A.429-Hork"S"^{3})	CMH80.42	20.3
7	(Cal-NH x Za75/Cal-NH)Imuris	CMH80.44	20.3
8	CMH76.217 x H499.71A-S.X^3	CMH80.85	18.2
9	CMH76.217 x Pavon"S"	CMH80.86	18.2
10	CMH76.217 x CMH72A.429-Hork"S"^{3}	CMH80.87	18.2
11	CMH76.217 x Imuris	CMH80.90	18.2
12	CMH76.217-CMH76.207 x Cno79	CMH80.122	18.2
13	CMH76.217-CMH76.207 x Agatha - Ti.71^4	CMH80.121	18.2
14	Cal-NH x CMH73A.497//Agatha-Ti.71^4	CMH80.115	19.9

* Grain protein determined by means of the Infralyzer 400

several crossing and screening cycles have resulted in populations of dwarf solid stem material with good agronomic characteristics. Among these populations, the following are the best segregating material:

(Fta-Cj71) (Fury-Kal2)2
(Fta-Cj71 x Fury-Kal2/Pavon "S") (Fta-Cj71 x Fury-Kal2)
Fta-Cj71 x Fury-Kal2/Pavon "S"
H622.71 - SX x Fta - Cj71
Fta-Cj71 x CMH74A.754

Yield components

Large spikes, providing a high number of spikelets per spike (s/S), are characteristic of the winter wheat variety Tetrastichon. Years ago, this large spike trait was transferred to spring wheats. In the early maturing lines, there is less time for the spikes to develop, but even so, 4 to 6 s/S more than the conventional wheats can be recovered. This remains true for some segregates from the cross CMH74.540 x Tetrast-CMH74.540-He.1, and the best lines derived from this cross are being used to carry out new crosses with parents showing good grain filling characteristics—a persistant deficiency of these materials.

As stated in earlier reports, Morocco and CMH72.428 are the main sources of high numbers of grains per spikelet (G/s). It has also been reported that the length of the growing cycle does not seem to have a significant influence on the expression of this character, since early maturing lines showing the same G/s as their parents have been obtained. However, the materials obtained so far are still deficient in grain plumpness, and they possess a low tillering potential. To find ways to improve these important yield factors, new crosses with good tillering and good grain types are being made.

Progress continued in 1980 toward improvement of tillering in lines showing high s/S and G/s. Important advances were achieved with some crosses whose F_2 progeny segregated with some big spike plants showing 10 to 20 stems per plant, under conditions at El Batan. The main

CIMMYT scientists are continuing their research to determine whether maximum yield potential can be pushed even higher with larger heads possessing good grain-filling characteristics.

Table 2. Segregating lines resistant to aluminum toxicity, grown at El Batan and tested at three different locations in Brazil

No.	Variety or cross	Tolerance to Aluminum* Cruz Alta	Passo Fundo	Cascavel	Plant Ht. at El Batan (cm)
1	Jupateco	-	4	5	70
2	Pavon 76	-	2	4	85
3	Za75	-	5	4	75
4	P.Ar	-	1	1	115
5	Alondra"S"	-	4	4	75
6	Ias.20	-	1	1	125
7	BH.1146	-	1-2	1	125
8	Maringa	-	1	1	115
9	H567.71-P.Ar[3] CMH77.308-1Y-4B-1Y-5B-1Y	MR	1	2	70
10	H567.71-P.Ar[3] CMH77.308-1Y-4B-1Y-10B-2Y	R	1	2	70
11	H567.71-P.Ar[3] CMH77.308-1Y-4B-6Y-10B-1Y	MR	1	2	70
12	Za.75-P.Ar x Alondra"S" CMH78 380-2Y-1B-1Y	MR	1	1	Seg.
13	Ias.20-H567.71xIas.20[2] CMH77.205-1Y-1B-7Y-1B-1Y	MR	1	1	70
14	Ias.20-H567.71xIas.20[2] CMH77.205-1Y-1B-8Y-5B-1Y	MR	2	1	80
15	Ias.20-H567.71xIas.20[2] CMH77.205-1Y-1B-9Y-1B-1Y	MR	2	1	80
16	BH.1146-H567.71xBH.1146 CMH78.410-4Y-1B-1Y	MR	2	1	45
17	FKN-Cj71xFKN/CNT.8 CMH78.335-4Y-4B-1Y	MR	2	1	60
18	Ias.20-H567.71xIas.20/Maringa[3] CMH78.443-4Y-4B-2Y	MR	1-2	1	55
19	Ias.20-H567.71xIas.20/Maringa[3] CMH78.443-4Y-4B-3Y	MR	1	1	55
20	(Ias.20-H567.71xIas.20/Alondra"S")(Ias.20-H567.71xIas.20/P.Ar) CMH78A.448-9B-5Y	MR	1	1	35
21	Ias.20-H567.71xIas.20/Ias.58 CMH78.390-2Y-2B-1Y	MR	1	1	50
22	Ias.20-H567.71xIas.20/Ias.58 CMH78.390-2Y-2B-3Y	MR	1	1	45
23	Ias.20-H567.71xIas.20/Ias.58 CMH78.390-2Y-2B-4Y	MR	1	1	45
24	Ias.20-H567.71xIas.20/Ias.58 CMH78.390-2Y-4B-3Y	MR	1	1	55
25	H567.71-P.Ar x Maringa CMH78.385-8Y-1B-1Y	MR	2	2	50
26	H567.71-P.Ar x BH.1146 CMH78.383-1Y-5B-3Y	MR	2	1	Seg.

* 1 = R = Resistant, 2 = MR = Moderately resistant, 3 = MS = Moderately susceptible, 4 = S = Susceptible, 5 = HS = Highly susceptible

Table 3. Wheats resistant to certain diseases present in Brazil

Variety or cross	Resistant to			
	Septoria	Fusarium	Erisiphe	Helminthosporium
B-7	X	X		
Fronteira	X	X		
IAS-17	X	X		
J8212.67	X	X		
Nova Prata	X	X		
Pel.12298.65	X	X		
S-20	X	X		
Girva	X	X	X	
PAT-7219	X	X		X

problem that persists in all materials showing either high s/S, G/s, or both is shriveled grain. Therefore, much of the improvement effort carried out with this material is directed toward improving its grain filling characteristic.

DURUM WHEAT IMPROVEMENT

There are five major aspects to the work being done with durum wheat: (1) transfer of dwarf characteristics from S.948.A1 (*Triticum aestivum*) to durum wheats, (2) development of genetic material showing lax spikes, (3) development of genetic material with large grain, (4) development of genetic material with solid stems, and (5) the development of genetic material showing higher numbers of s/S and G/s.

It is possible to improve the dwarfing characteristics of durum wheat while maintaining desirable genetic traits. Some lines from the cross CMH567.71 x Cocorit 71 have shown phenotypic similarities to durum wheats, while growing at El Batan to a height of 80 to 85 cm. Backcrosses of this material with Cocorit 71 were begun in 1980 to obtain a Cocorit type with dwarfness from S.948.A1. Success in producing several lines showing lax spike and large grain characteristics has also been achieved.

In the effort to develop genetic material having solid stem characteristics, some very promising materials have been screened. The original source for solid stem germplasm is again Fortuna, and some of the lines obtained possess a layer of solid stem tissue thicker than the parental Fortuna variety. This characteristic is better expressed in lines derived from certain interspecific crosses, such as (Fortuna-Maya "S" x Fortuna/S10B3) Mexicali 75, and (Fortuna-Maya "S" x Fortuna/S10B3) Mexicali 75^2. Although backcrossed Mexicali 75 plants display durum phenotypic traits, it will be necessary to continue backcrossing with this variety to better fix all its characteristics.

Significant advances have been made toward the development of durum genetic material with higher numbers of s/S and G/s. During 1980, a number of homozygous, or nearly homozygous, lines were identified. These lines have seven to nine florets and four to five grains per spikelet, demonstrating a good proportion of fertile florets. The best lines with higher numbers of G/s are derived from E.Co. x Petrel"S" and E. Co.-Petrel"S" x E.Co. Some interspecific crosses are also being made to transfer the higher number of s/S and G/s in bread wheat to durum wheat, despite a lack of conclusive evidence that this transfer is possible.

TRITICALE IMPROVEMENT

Over the last few years, efforts have been made to develop short straw triticales. The strategy chosen was to transfer dwarfing from wheat to triticale, and some of the successful crosses include:

H227.69 x Tor."S" - Tob.66
Beagle x S.948.A1 - Bza.4
CMH72A.576 x H569.71

The cross H227.69 x Tor."S" - Tob.66 (cross number CMH74.1211) inherited the semidwarf character from the wheat line Tor."S," which probably carries a combination of Norin 10 and Tom Thumb genes. The lines derived from Beagle x S.948.A1-Bza.4 obviously have the S.948.A1 dwarfing genes, while the material derived from CMH72A.576 x H569.71 must carry genes from S.948.A1 and Norin, since the parents of H569.71 are S.948.A1 and Ciano 67. Triticales recovered from the cross CMH72A.576 x H569.71 show short strawed plants with good uniformity, early maturity, and acceptable grain. Table 5 reports several lines derived from the aforementioned crosses that showed good performance in 1980. Some of these lines are being used to add the short straw character to other varieties and lines with excessively tall stature, such as IGA, Mapache, Beagle, Drira, and Panda.

Some new wheat x rye crosses are also being made to form new primary triticales that are likely to express dif-

Table 4. Comportment of lines resistant to leaf rust, tested in a yield trial during the 1979-80 cycle at CIANO

Order by Yield	Y-79-80 Var.No.	Variety or line		Yield (Kg/ha)	Days to flower	Plant Ht. (cm)	Leaf rust*
1	139	Agatha-Yec70^4	CMH78.610-5Y-0B	5889	73	70	0
2	140	Agatha-Yec70^3	CMH77A.485-4B-5Y-0B	5722	73	70	TR
3	148	Ciano 79		5722	77	85	TMR
4	137	Agatha-Yec70^3	CMH77A.485-8B-4Y-0B	5639	74	70	TR
5	141	Agatha-Yec70^3	CMH77A.485-5B-2Y-0B	5611	73	70	TR
6	142	Agatha-Yec70^2	CMH77.490-2Y-2B-1Y-0B	5389	77	75	0
7	135	Agatha-Yec70^3	CMH77A.485-8B-1Y-0B	5194	74	70	TMR
8	143	Agatha-Yec70^2	CMH77.490-2Y-2B-10Y-0B	5194	77	75	0
9	136	Agatha-Yec70^3	CMH77A.485-8B-3Y-0B	5111	73	70	TR
10	149	Jupateco 73		4972	73	95	30MS-S
11	138	Agatha-Yec70^3	CMH77A.485-8B-5Y-0B	4644	74	70	TR
12	147	Yecora		4639	72	70	30MS-S
13	150	Potam 70		4583	67	80	40MS-S
14	129	RL6010-Jup73^2	CM77A.464-1B-0Y	4278	73	85	0
15	131	RL6010-Yec70^2	CMH77A.466-8B-5Y-0B	4278	67	60	TMR-MS
16	130	RL6010-Yec70^2	CMH77A.466-8B-3Y-0B	4250	70	60	5R-MR
17	133	RL6010-Yec70^2	CMH77.478-1Y-2B-0Y	4194	70	60	TMR
18	144	Agatha-Ptm70^2	CMH77.491-4Y-1B-1Y-0B	3917	71	70	5R-MR
19	134	RL6010-Yec70^2	CMH77A.466-8B-4Y-0B	3722	70	60	TMR-MS
20	132	RL6010-Yec70^2	CMH77A.466-8B-0Y	3639	71	65	TMR-MS
21	128	RL6010-Jup73^2	CMH77A.464-10B-9Y-0B	3611	71	80	0
22	145	Agatha-Ptm70^2	CMH77.491-4Y-5B-1Y-0B	3278	72	85	TR-MR
		CV = 11.31	DMS	5%	1175.67 kg/ha		
				1%	1571.33 kg/ha		

* The resistance to leaf rust is apparently provided by the Lr-19 gene (found in Agatha) and the Lr-9 gene (found in RL6010)

ferent genetic traits, since the parents used in these crosses are different from those used in the conventional triticale improvement program. These parents possess the following characteristics:

Bread wheats:	High number of s/S Large and full grain Excellent fertility
Durum wheats:	Large and full grain
Ryes:	Short straw Early maturity High numbers of s/S and G/s Excellent fertility Large and full grain

The new wheat x rye crosses are being used to explore the potential for transferring these favorable characteristics to triticale. Bread and durum wheats were discussed earlier, but it should be noted that due to advanced selections made in Snoopy rye, better rye material is now available. These selections resulted in lines with uniform plant height and early maturity, and some of the advanced selections have better rust resistance, better fertility, higher numbers of s/S and G/s, and improved grain types. Additional crosses have been made using the most uniform Snoopy selections and various other ryes. In some cases, rye lines showing better agronomic characteristics, better grain and higher crossing ability have been derived. Efforts continue toward incorporating these characteristics into the new triticales.

Table 5. Triticale lines showing uniform short straw, derived from triticale x wheat crosses

No.	Variety, or cross and pedigree		Plant ht. (cm)
1	H277.69xTor"S"-Tob.66/F.S.1029	CMH74.1211-3Y-1B-1Y-7Y-3Y-1B-0Y	55
2	CMH74.1211-Bgl	CMH76A.1076-7B-4Y-0F-1B-6Y-0B	95
3	CMH74.1211-Bgl	CMH76A.1076-7B-4Y-0F-1B-2Y-0B	90
4	CMH74.1211-Bgl	CMH76A.1076-7B-4Y-0F-1B-3Y-0B	95
5	CMH74.1211-Bgl[4]	CMH77A.1122-6B-4Y-1B-1Y-0B	45
6	CMH74.1211-Bgl[4]	CMH77A.1122-6B-4Y-4B-1Y-0B	55
7	CMH74.1211-Bgl[4]	CMH77A.1122-6B-4Y-4B-3Y-0B	55
8	CMH74.1211-Bgl[4]	CMH77A.1122-6B-6Y-1B-1Y-0B	60
9	CMH74.1211-Bgl[4]	CMH77A.1122-25B-3Y-5B-1Y-0B	65
10	CMH74.1211-CMH74A.888[2]	CMH78.1266-5Y-6B-2Y-0B	80
11	CMH74.1211-CMH74A.888[2]	CMH78.1266-5Y-6B-3Y-0B	80
12	CMH74.1211-CMH74A.888[3]	CMH78A.1299-1B-0Y	55
13	Bg1xS948A1-Bza[4]	CMH76.1279-1Y-1B-1Y-1B-3Y-3B-1Y-0B	50
14	Bg1xS948A1-Bza[4]	CMH76.1279-1Y-1B-1Y-1B-4Y-6B-1Y-0B	40
15	Bg1xS948A1-Bza[4]	CMH76.1279-1Y-2B-4Y-1B-0Y	(
16	CMH72A.576-H569.71	CMH77.1135-3Y-1B-2Y-0B	65
17	CMH72A.576-H569.71	CMH77.1135-3Y-1B-1Y-0B	65
18	CMH72A.576-H569.71	CMH77.1135-3Y-1B-1Y-2B-1Y-0B	60
19	CMH72A.576-H569.71	CMH77.1135-3Y-1B-4Y-7B-1Y-0B	65
20	CMH72A.576-H569.71	CMH77.1135-3Y-5B-4Y-1B-3Y-0B	65
21	CMH72A.576-H569.71	CMH77.1135-3Y-1B-1Y-1B-0Y	75
22	CMH72A.576-H569.71	CMH77.1135-3Y-1B-1Y-6B-0Y	80
23	CMH72A.576-H569.71	CMH77.1135-3Y-3B-1Y-4B-0Y	85
24	CMH72A.576-H569.71	CMH77.1135-3Y-5B-6Y-1B-0Y	75
25	Beagle		110

Milling and Baking Laboratory

CIMMYT's milling and baking laboratory has three basic objectives: (1) the evaluation and screening of early generation lines (F_3 and F_4) for good grain type, which results in very few advanced lines with low test weights; (2) the further evaluation of those early generation lines with good grain type for such characteristics as gluten strength and pigment content (in durum wheats); (3) the evaluation of advanced materials for their test weights, rheological characteristics, gluten strength, protein content, and other milling and baking qualities.

In 1980, the laboratory evaluated the various quality characteristics of segregating materials, and of lines in the International Bread Wheat Screening Nursery (IBWSN), International Durum Screening Nursery (IDSN), and International Triticale Screening Nursery (ITSN). The parental material of the bread wheat, durum wheat, and triticale programs was also evaluated, and five lines of naked barley were tested in varying mixtures with wheat flour for their bread making quality.

Each year, approximately 50 percent of the early generation material from the bread wheat, durum wheat, and barley programs is discarded due to poor seed type. Higher selection pressure is placed on triticale; about 80 percent of the F_3 and F_4 seed is discarded. The seed that is kept then undergoes a variety of laboratory tests. The tests performed vary with the crop.

From the bread wheat program, 17,478 individual plants (F_3 and F_4) were retained in 1980 from early generation selections made during the Yaqui Valley season. These lines were then tested for gluten strength using the micro-Pelshenke test. From the durum wheat program, 6,951 individual selections were kept and evaluated for pigment content (semolina with high pigment content is preferred for the preparation of pastas). From the barley program, 12,733 selections were made for seed type, while from the early generation triticales, some 14,593 selections were judged worthy of retention.

Screening of early generation materials for grain type is conducted each year by the milling and baking laboratory staff. Here, Dr. Arnoldo Amaya, coordinator of the laboratory, examines seed in the field.

EVALUATION OF ADVANCED MATERIAL

Advanced lines from the bread wheat, durum wheat, and triticale programs were evaluated in 1980 for various milling and baking qualities. Some 1,784 advanced lines and varieties of bread wheat were tested for their rheological characteristics, and milling and baking quality. Included in this material were lines from the 14th IBWSN, which represents the highest yielding of CIMMYT's bread wheats. These lines have differing gluten types that allow for the preparation of different products; some lines with weak elastic gluten are appropriate for making cookies, while others have the strong gluten necessary for baking sandwich bread. Table 1 reports those lines from the 14th IBWSN that possess strong-balanced gluten and good bread making quality; Table 2 reports those lines having extensible gluten and good cookie making quality.

In the durum wheat program, 661 lines from the crossing block and the 12th IDSN were tested for their pigment content and gluten quality. Durum wheat has a tenacious gluten, lacking the DD genome that provides elasticity. Because of this, most durum wheat is used in the preparation of pastas. To breeders, pigment content and gluten quality are important selection parameters, in that they affect the commercial desirability of a given variety; high pigment content and strong gluten are preferred for the preparation of pastas. Due to this kind of selection pressure, the pigment content and gluten quality of CIMMYT's high yielding durum wheats have increased over the past decade, and are now at very acceptable levels.

Five hundred and thirty advanced triticale lines were evaluated in 1980: 246 from the crossing block and 284 from the 12th ITSN. Table 3 presents the range of values obtained for test weight, flour yield, flour protein, falling number, and loaf volume. Only seven samples from the 12th ITSN had test weights below 70 kg/hl, and only four had flour yields below 60 percent. These results indicate that as grain type improves, test weights and flour yields are approaching those of the best bread wheats.

WHEAT-BARLEY FLOUR BLENDS

Barley contains a relatively low level of gluten, making it undersirable for the production of yeast breads. However, when mixed with wheat flour in the right proportions, naked barleys can be used in commercial bread making. This may prove particularly useful to those countries that produce insufficient wheat for their domestic needs, yet have adequate levels of barley production.

In 1980, the baking quality of five different naked barleys were tested (Table 4) in 10, 20, and 30 percent blends with wheat flour (variety Pavon 76). The barleys and wheat were milled in a Brabender Senior mill. Among the findings and observations:

- During the baking process, a slight increase in mixing time occurred as the level of barley flour in the blend increased.
- Dough extensibility decreased as the level of barley flour increased; however, the handling characteristics of all the barley blends were acceptable.

Table 1. Lines from the 14th IBWSN with strong-balanced gluten and good bread making quality (1980)

14th IBWSN	Cross and pedigree	Protein %	Sedim. c.c.	Alveogram W	Alveogram P/G	Loaf Vol. c.c.	Water Abs.
29	TTM "S" CM-30136-3Y-1Y-0M-4B-0Y	11.6	38	335	6.0	900	67.7
32	Pci "S" - Pvn "S" CM-30185-1Y-1Y-5M-1Y-1B-0Y	11.0	44	340	5.0	895	67.1
50	Psn "S" CM-32418-1M-1Y-6M-1Y-1M-1Y-0M	12.5	32	302	4.9	875	67.6
54	Pvn "S" (Pato(R)-Cal/7C x BB-Cno) CM-32535-4M-3Y-4M-2Y-0M	11:5	38	327	4.1	855	66.4
55	Pvn "S" (Pato(R)-Cal/7C x BB-Cno) CM-32535-4M-4Y-1M-500Y-101B-501Y-0M	11.2	38	421	5.2	900	67.6
130	Shr "S" CM-33489-A-1M-5Y-0M-56B-0Y	12.2	52	493	5.7	940	71.0
160	Yd "S" - Pci "S" CM-35044-177M-1Y-1M-1Y-1M-1Y-0B	12.4	50	367	4.8	880	69.1
263	HI 666-Pvn "S" CM-40608-1Y-1M-2Y-5M-2Y-0B	12.2	50	414	5.2	850	70.3
264	HI 666-Pvn "S" CM-40608-18M-4Y-1M-1Y-2M-1Y-0B	13.0	56	564	7.4	915	71.8
266	HI 666-Pvn "S" CM-40608-18M-4Y-1M-1Y-5M-1Y-0B	13.2	60	501	7.6	895	72.0
288	Pato-On x May. (Bb/Pato x INIA-Napo) CM-40738-12M-1Y-2M-1Y-2M-0Y	12.1	57	352	3.3	830	65.0
303	Yd "S"/Tob-Era x Tob-Cno CM-42310-8Y-4M-5Y-1M-3Y-0B	11.3	48	351	5.9	945	65.4
319	(Tzpp x IRN46-Cno/II 46.27)Jar-Cno x Cfn-Cno/Sr CM-42475-7Y-3M-1Y-4M-1Y-0B	12.5	59	447	4.4	840	66.3
376	Jup-Emu "S" x Gjo "S" CM-43598-11-1Y-1M-1Y-5M-1Y-0B	12.2	58	345	5.5	895	64.3
377	Jup-Emu "S" x Gjo "S" CM-43598-11-1Y-1M-1Y-8M-1Y-0B	11.8	55	390	5.3	865	68.2
373	Jup-Emu "S" x Gjo "S" CM-43598-11-1Y-1M-1Y-8M-2Y-0B	11.7	55	393	4.1	860	68.7
381	Jup-Emu "S" x Gjo "S" CM-43598-11-1Y-2M-3Y-2M-2Y-0B	11.4	65	397	5.3	880	67.4

- Satisfactory loaf volume, crumb texture, and crumb color can be obtained utilizing barley blends of up to 20 percent; higher concentrations of barley flour in the blend result in bread with unacceptable characteristics (Figure 1).

In addition to the tests conducted with wheat-barley flour blends, the effect on the baking quality of wheat flour when mixed with barley meal was examined. The same wheat variety and naked barleys were used; the wheat flour was blended with the five naked barley meals

Table 2. Lines from 14th IBWSN with extensible gluten and good cookie making quality (1980)

14th SN No.	Cross and pedigree	Protein %	Alveogram W	Alveogram P/G	Loaf Vol. c.c.	Cookie quality
9	Myna"S" SWM-4589-7Y-18M-1Y-1M	10.2	170	1.9	690	VG
124	SWF"S" CM-33232-B-6M-12Y-1M-1Y-1M-0Y	11.2	78	2.2	605	VG
126	Jun"S" CM-33483-C-7M-1Y-0M-3B-0Y	11.2	239	3.0	925	G
127	Jun"S" CM-33483-C-7M-1Y-0M-5B-0Y	11.0	249	1.7	890	VG
128	Jun"S" CM-33483-C-7M-1Y-0M-11B-0Y	11.1	245	2.9	915	VG
129	Jun"S" CM-33483-C-7M-1Y-0M-20B-0Y	11.2	253	2.4	890	VG
158	YD"S"-Pci"S" CM-35044-43M-1Y-1M-1Y-1M-1Y-0B	11.1	150	2.0	795	VG
163	YD"S"/(Fn-Th^{3}x1144.29-Th^2/Cfn)Sr/ CM-35735-1M-2Y-1M-1Y-1B-1Y-0M	11.8	196	2.6	740	G
164	Oln-Trm CM-36820-10Y-17M-4Y-1M-0Y	11.6	150	2.3	770	G
237	Yd"S"-Bjy"S" CM-40456-12Y-1M-2Y-1M-0Y	10.3	127	2.2	580	VG
238	Yd"S"-Bjy"S" CM-40456-12Y-1M-2Y-2M-1Y-0B	10.8	142	2.1	660	G
239	Yd"S"-Bjy"S" CM-40456-12Y-2M-1Y-1M-1Y-0B	10.6	149	2.6	740	VG
240	Yd"S"-Bjy"S" CM-40456-19Y-1M-2Y-2M-1Y-0B	10.4	176	3.4	720	VG
248	K4500.2-Bjy"S" CM-40480-16Y-2M-2Y-1M-2Y-0B	10.8	209	2.3	850	VG
249	K4500.2-Bjy"S" CM-40480-16Y-2M-2Y-2M-1Y-0B	10.1	188	2.9	845	VG
250	K4500.2-Bjy"S" CM-40 480 - 16Y-2M-2Y-2M-1Y-0B	10.8	160	2.2	845	G
251	K4500.2-Bjy"S" CM-40480-16Y-2M-2Y-4M-0Y	10.9	131	1.9	800	VG
294	Him-CocxNac CM-41195-A-13M-2Y-3M-1Y-1M-0Y	10.5	174	3.4	680	VG
330	/Mo(Nd-WW xLee-Fn/N)/Nac CM-43356-M-4Y-3M-1Y-1M-1Y-0B	10.4	142	2.6	715	VG
333	/Mo(Nd-WW x Lee-Fn/N)/Nac CM-43356-M-4Y-3M-3Y-1M-1Y-0B	11.0	172	2.5	735	VG
334	/Mo(Nd-WW x Lee-Fn/N)/Nac CM-43356-M-4Y-3M-3Y-2M-2Y-0B	10.5	177	2.6	705	VG
351	Cmt-Mo x Trm CM-43381-D-1Y-4M-2Y-1M-1Y-0B	11.2	106	2.3	760	G
357	Cmt-Mo x Trm CM-43381-D-1Y-4M-4Y-2M-2Y-0B	10.7	121	2.3	810	VG
358	Cmt-YrxMon"S" CM-43405-A-3Y-1M-1Y-1M-1Y-0B	10.9	118	2.6	790	VG
359	Cmt-YrxMon"S" CM-43405-A-2Y-1M-1Y-1M-2Y-0B	10.9	121	2.5	835	VG
428	Tc 750434-3R-2C-0S	10.5	71	1.2	560	VG

at concentrations of 10 and 20 percent. Wheat meal was also mixed with wheat flour in the same proportions as the barley meal, thus allowing for a comparison of differential effects in baking. Findings and observations include the following:

- Differences in mixing time were not observed between the control (wheat flour alone) and the various blends.
- There was a marked decline in loaf volume, crumb color, and crumb texture when the 10 percent barley meal blend was used; the bread produced with the 10 and 20 percent wheat meal blend were of inferior quality compared to the control, but they were significantly better than any of the bread produced from the 10 percent barley meal blend.
- When the 20 percent barley meal blend was used, the breads obtained had low volume with very compact and dark crumb.
- It was thus concluded that while bread quality was adversely affected by the presence of barley meal in the blend, naked barley meal blended with a strong wheat flour at the 10 percent (barley) level results in bread of acceptable quality (Figure 2). Among the naked barleys used (Table 4), PM41 proved to be the best, i.e., had the least adverse impact on loaf quality characteristics, while PM53 was the poorest.

Table 3. Some quality characteristics of triticale (advanced material) from the 1980 crossing block and the 12th ITSN

Parameter	Crossing Block*	12th ITSN*
Test weight (kg/ha)	62.6 - 78.0	68.8 - 78.9
Flour yield (%)	59.9 - 73.0	55.8 - 75.7
Falling number (seconds)	60 - 395	62 - 440
Percent protein in flour	8.7 - 11.7	8.6 - 11.0
Loaf volumn (cc)	380 - 760	415 - 765

* Data presented represent the range of values obtained for each parameter

Table 4. Naked barleys used in the barley-wheat flour and barley meal-wheat flour tests conducted in 1980

Origin Y79-80	Cross and pedigree
PM-32	U. Sask 1766-Api x Bco. Mr-Gva CMB75-177-1Y-1B-1Y-1B-1Y-0B
PM-38	(Apam-EB1053 x Por-Dwarf 21/Gva)RM1508-M64.76 CMB74A-1667-A-1B-1Y-1B-1Y-1B-0Y
PM-41	Apam-IB65/Apam-Aths x Gva CMB75-74-1Y-1B-1Y-1B-1Y-0B
PM-48	11012.2-Tern x Api-CM67 CMB75-505-5Y-1B-1Y-1B-1Y-0B
PM-53	Apam-11012.2 x Nepal CI593 CMB74-888-A-1Y-1B-1Y-1B-500Y-500B-0Y

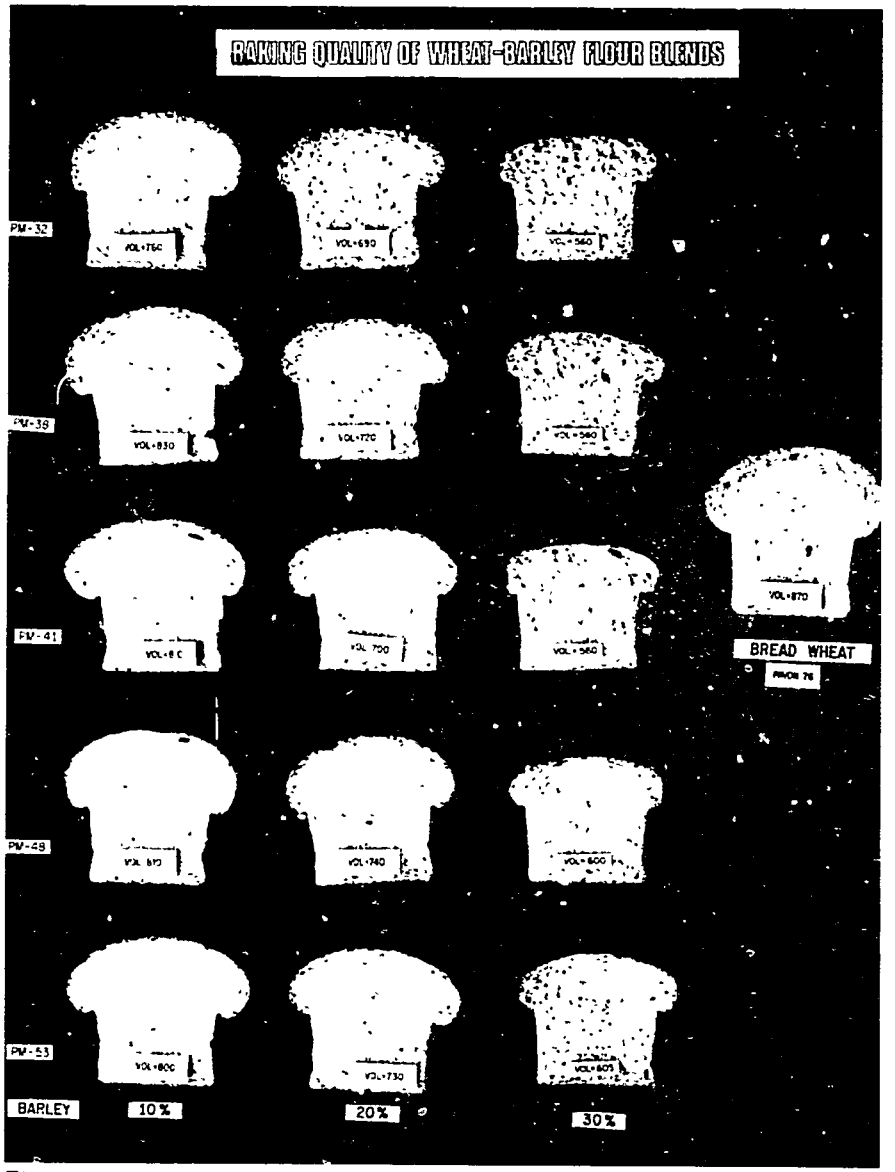


Figure 1. When mixed with wheat flour in the right proportion (up to 20 percent of the mixture) naked barley flour can be used in commercial bread making.

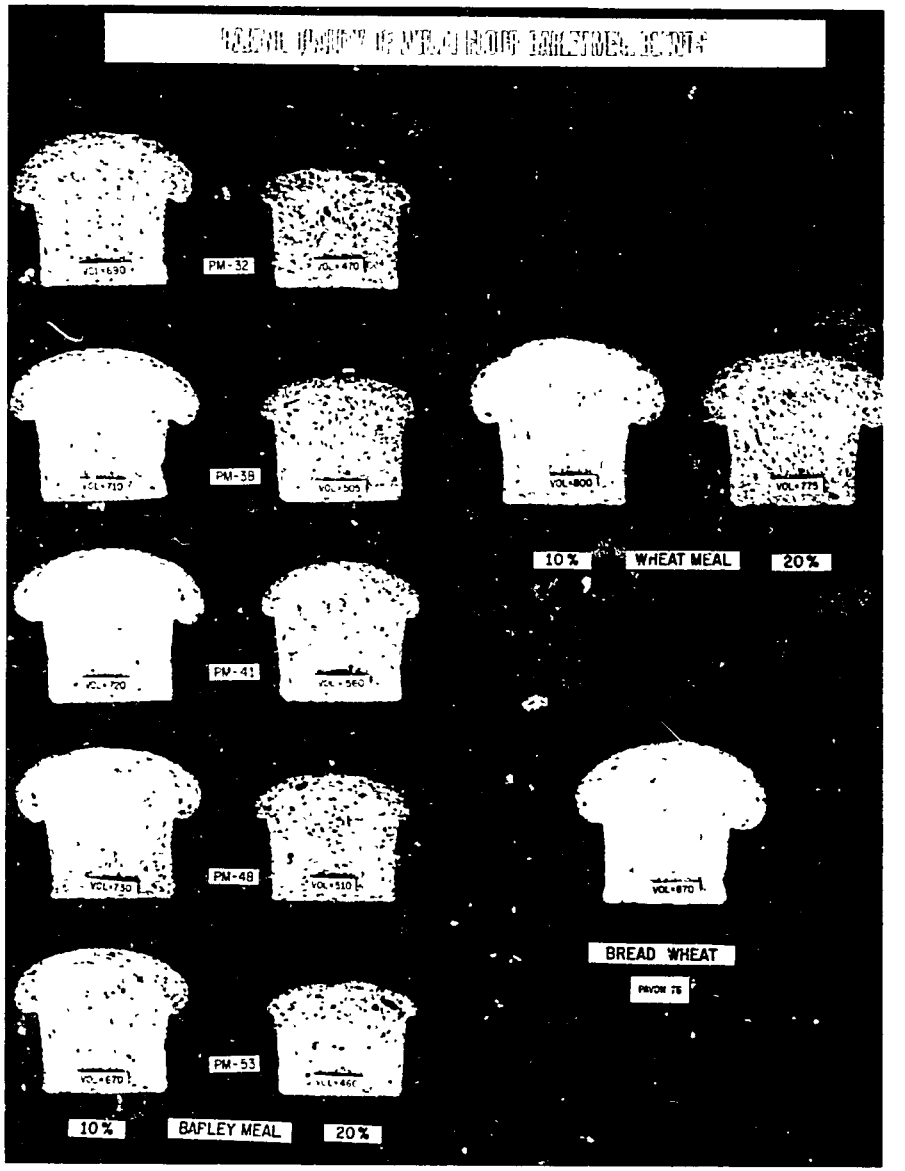


Figure 2. Naked barley meal, when mixed with a strong wheat flour (10 percent barley meal - 90 percent wheat flour) results in a bread of acceptable quality.

TRIAL#1E
NITROGEN
X
PHOSPHOROUS
N=0
P_2O_5=0
TRIAL#1E
NITROGEN
X
PHOSPHOROUS
N=225
P_2O_5=90
88

Agronomy

The agronomy base program serves four interwoven purposes: 1) training of post-doctoral fellows in agronomic principles and practices to prepare them for CIMMYT regional programs; 2) training young scientists from national programs in production agronomy; 3) development of weed control, fertilizer, and irrigation recommendations for use on the breeders' nurseries in Mexico; 4) investigations into agronomic problems commonly found in many locations throughout the world.

TRAINING

A new training program was started in the Yaqui Valley for agronomists from irrigated areas. Trials were planned and carried out on the CIANO Experiment Station and on farmers' fields to demonstrate principles of both experimentation and crop production. On-station trials included scheduling of irrigation by different methods, the effect of moisture stress on crops at different times of the season, moisture-nitrogen interactions, seeding densities, time of application of 2,4-D, and time of applications of nitrogen and fertilizer placement. The trials conducted off-station evaluated the importance of limiting factors (fertilizer, weed control, variety), nitrogen and phosphorus fertilization, herbicides, micronutrients, method of seeding, and seeding rates. Demonstrations were also conducted utilizing different levels of nitrogen and seeding rates to determine their effects on lodging in several commercial and new varieties.

NURSERY MANAGEMENT

Weed control

The Toluca station has the most troublesome weed control problem of the three main breeding stations. The predominant weed there is *Poa annua*, which has only been controlled successfully in trials by some of the substituted ureas and triazines. However, because of the nature of these herbicides and the erratic early-season rainfall pattern and high incidence of heavy rainstorms, the behavior of these herbicides is variable from year to year. For the past five years, methabenzthiazuron (Tribunil) has been used either of two ways: pre-emergence on the durums (to avoid phytotoxicity on this species) or in a tank-mix with bromoxynil (Brominal) applied post-emergence in the bread wheat and triticale nurseries. Excellent weed control was obtained in 1980 with these products, but in past years there have been seasons when control was poor and phytotoxicity marked.

Chlortoluron (Dicuran) applied at doses as low as 0.25 kg/ha active ingredient (a.i.) pre-emergence gave excellent control in 1979. This product shows greater selectivity for wheat compared to the other substituted ureas, and thus, less phytotoxicity. However, chlortoluron is more soluble than methabenzthiazuron, and the heavy early rains in 1980 leached it out of the soil surface. Control with pre-emergence applications was erratic depending on crop seeding date. Good results were obtained from a logarithmic application of chlortoluron from 1.6 kg/ha a.i. to 0.1 kg/ha a.i. at 20 days post-emergence. *Poa annua* was controlled completely by rates above 0.5 kg/ha a.i. Broadleaf weeds were not controlled as well: *Malvastrum* survived at rates below 1.2 kg/ha a.i., as did *Galinsoga* spp. and *Brassica* spp. at rates of 0.8 kg/ha a.i. and below. There was no phytotoxicity in the bread wheats and triticales even at the top rate of 1.6 kg/ha a.i.; the durum showed slight phytotoxicity down to 1.2 kg/ha a.i. It would appear from these trials that a mixture of 0.6 kg/ha a.i. chlortoluron and 0.24 kg/ha a.i. bromoxynil may give excellent overall control with sufficient buffer against phytotoxicity.

Other herbicides tested in Toluca in 1980 were diuron (Karmex), oxyfluorfen (Goal), terbutryne (Igran), and dinitro (Premerge). Diuron applied pre-emergence gave control of weeds similar to chlortroluron pre-emergence; it was better than methabenzthiazuron in terms of phytotoxicity on all species except barley. However, in some seasons the low solubility of diuron is disadvantageous, and poor control is obtained with higher phytotoxicity. Oxyfluorfen pre-emergence gave excellent control of all weeds with applicaton rates of 0.1 kg/ha a.i. and above. Early phytotoxicity of this product, even though signs of phytotoxicity

An on-going function of the agronomy program is to conduct routine fertilizer requirement trials. In 1980, trials were conducted at the El Batan, Toluca and CIANO stations designed to determine fertilizer requirements for breeders' nurseries.

have disappeared by flowering, precludes its use in the nurseries Terbutryne did not give good results on *P. annua*, and phytotoxicity was severe at rates above 0.6 kg/ha a.i. and in durum wheat below this level. Dinitro showed excellent control of *P. annua* and broadleaf weeds at rates above 1.0 kg/ha a.i. Phytotoxicity, especially in the durum wheat, was marked at that rate.

Weed control in the 1980 El Batan season was poorer than normal, due to a prolonged early drought and a shortage of water for irrigation. The recommended applications at this site include diclofop (Illoxan) for control of the two major grass weeds, *Eleusine tristachya* and *Eragrostis mexicana*; bentazon (Basagran) for control of *Portulaca ceracea*, the first generations of *Amaranthus* spp. and *Galinsoga* spp. plus other broadleaf weeds; bromoxynil (Brominal) for control of the second generation of these weeds.

Diclofop again proved to be the best herbicide of those tested against grass weeds—control was complete when 1.0 kg/ha a.i. was applied pre-emergence to wet soil (after the seeding irrigation). However, 99 percent control was achieved with 0.5 kg/ha a.i. pre-emergence and 97 percent control with 0.5 kg/ha a.i. plus 0.5 percent surfactant at 10 days post-emergence. By 20 days post-emergence, this herbicide was still effective, giving 96 percent and 91 percent, control, with 1.0 kg/ha a.i. and 0.5 kg/ha a.i. plus 0.5 percent surfactant, respectively. Three substituted ureas, methabenzthiazuron (Tribunil), linuron (Lorox) and diuron (Karmex) were also included in the trials, but gave little control of *Eleusine*, although control of *Eragrostis* ranged from 57 to 73 percent.

Bromoxynil, bentazon, 2,4-D, methbenzthiasuron, chlortoluron, and diuron were compared alone and in combinations for broadleaf weed control on two sites with different weed spectrums. Best season-long control was obtained with diuron; this herbicide will be screened further for possible use in the nurseries. The normal application of bentazon followed by bromoxynil gave adequate control of the broadleaf weeds, but its performance was affected by drought.

Trials on farmers fields showed excellent control of *Sicyos* spp. (wild cucumber) with 0.24 kg/ha a.i. bromoxynil (Brominal) applied 20 days post-emergence. This herbicide

Herbicide (2, 4-D) is applied by CIMMYT agronomy trainees using two different sprayers. On the left, a backpack sprayer is employed and on the right, an ultra-low volume sprayer is used.

has now been registered in Mexico and demonstrations are planned against *Sicyos* spp., a serious pest of wheat, maize, and beans in many parts of the Mexican highlands.

On the CIANO station near Ciudad Obregon, the main weeds are *Avena fatua, Phalaris minor, Chenopodium* spp., *Amaranthus* spp., *Polygonum* spp., *Portulacca oleracea*, and *Sisymbrium irio*. All the broadleaf weeds are controlled adequately with applications of bentazon (Basagran) early post-emergence, and bromoxynil (Brominal) two to three weeks later. With later seedings, once temperatures have dropped, *P. oleracea* does not germinate, and the bentazon application can be omitted. The main problems are the two grassy weeds. No herbicide has yet been found to control both weeds in the open nursery seedings. Diclofop (Iloxan) has done best when applied about 14 days post-emergence. However, *P. minor* is controlled better with earlier applications; *A. fatua* control is better with later applications. A compromise in dates leaves some of both weeds remaining.

Best control of *A. fatua* in solid stands was again obtained with flamprop-methyl (Mataven) at 35 days post-emergence, also giving 85 per cent control of *P. minor* at 0.6 kg/ha a.i. In one trial at 1.0 kg/ha a.i., however, diclofop applied 28 days post-emergence gave almost complete control of both grass weeds.

Pot trials on *Malva parviflora*, which is of increasing importance in the Yaqui Valley, showed that this plant was controlled completely by early post-emergence applications of either 1.0 kg/ha a.i. methabenzthiazuron (Tribunil) or 1.0 kg/ha a.i. bentazon (Basagran).

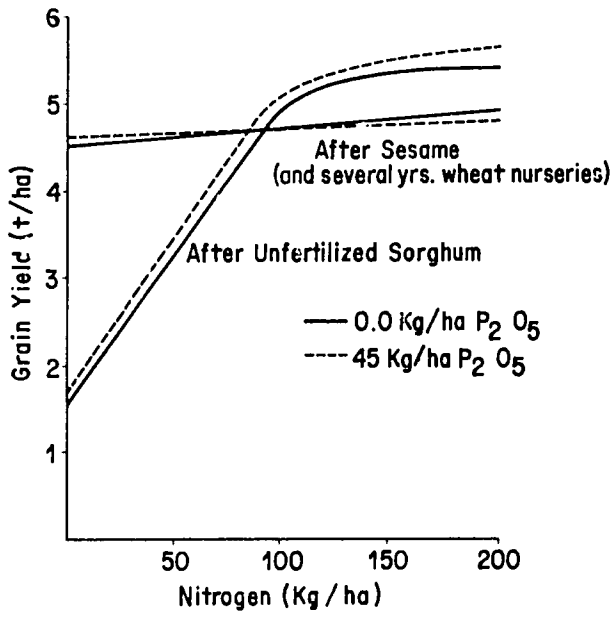


Figure 1. Grain yields of wheat at different levels of nitrogen and phosphorous in two trials at CIANO (1979/80)

Fertilizers

Routine trials at El Batan, Toluca, and CIANO investigated fertilizer requirements for the breeders' nurseries. Where trials followed several years of breeders' nurseries, nitrogen responses were small or non-existent at all three sites. There was no significant response to phosphorus or potassium after a fertilized wheat crop.

The recommendations for nitrogen, based on the level required to produce maximum yield of a solid seeded crop, are probably too high for the open nursery seedings. It is expected that residual fertility will be high after rates for maximum yield; studies are now under way to determine how much fertilizer applications can be reduced. A comparison of yield at different levels of applied fertilizer in two trials on the CIANO station are shown in Figure 1. One trial followed a summer sesame crop after several years of wheat nurseries. The other trial followed an unfertilized sorghum crop that was seeded to reduce and equalize fertility in the field.

Zinc, iron, and manganese were also applied in one trial at CIANO, based on observation of soybeans indicating that one or more of these elements might be limiting. No significant response in yield was obtained with any one or combination of these elements.

OTHER PROJECTS

Nitrogen x variety interaction

Many trials were conducted to investigate interactions between nitrogen and variety with respect to yield. The results generally have shown that when residual fertility is low there is little yield difference among varieties; as applied nitrogen is increased, the yield advantage of the varieties with a higher yield potential becomes more apparent, to a point where yield no longer increases with increasing

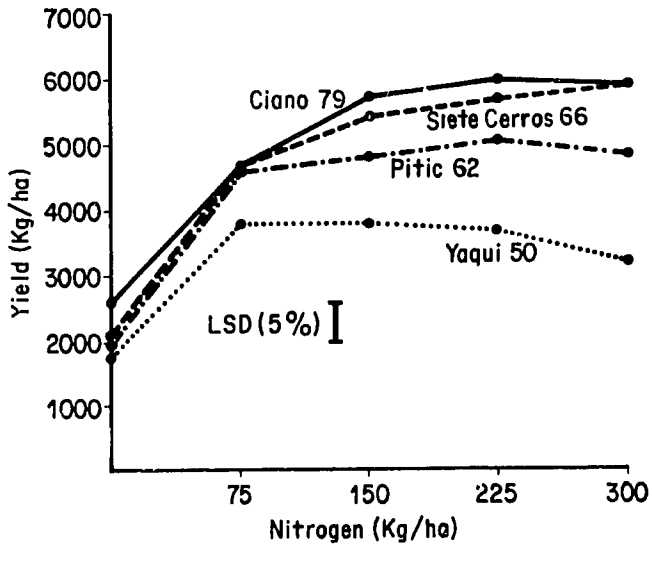


Figure 2. Effect of nitrogen on four varieties of bread wheat, 1979-80

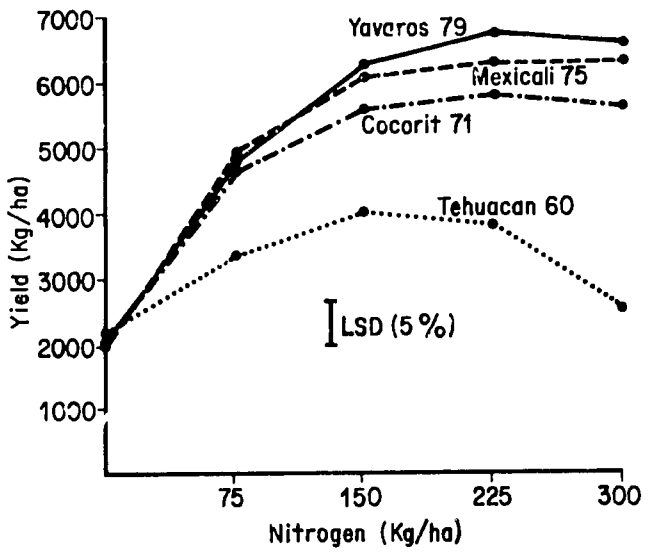


Figure 3. Effect of nitrogen on four varieties of durum wheat, 1979-80

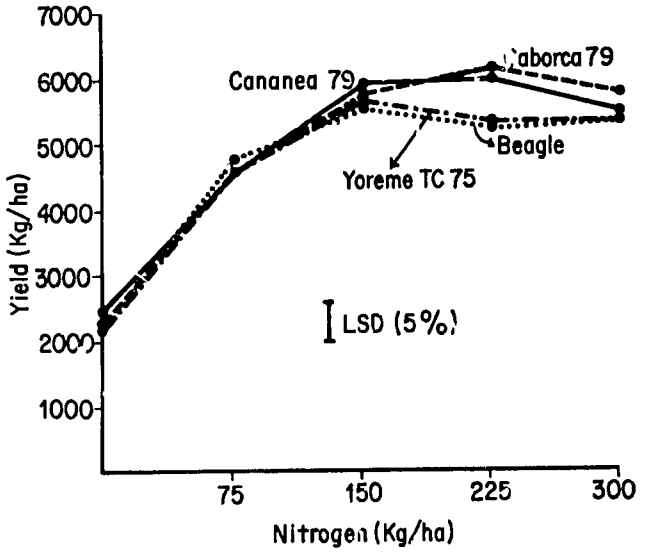


Figure 4. Effect of nitrogen on four varieties of triticale, 1979-80

fertility. Among the high yield potential varieties of bread wheat, durum wheat, and triticale, there has been no significant nitrogen-x-variety interaction.

A similar trial was conducted at CIANO in 1979-80. Unfertilized sorghum had been grown to reduce residual fertility, and a number of varieties released in Mexico over the past 30 years were included (the complete time span was not available for the durums and triticales). Nitrogen response curves for the entries of each species are shown in Figures 2, 3, and 4.

Without applied nitrogen there was no significant difference between yields among the durum wheats and triticales. Among the bread wheats, only Yaqui 50, the oldest variety, yielded significantly lower than the highest yielding variety, Ciano 79. As nitrogen applications increased, so did the difference among varieties. This appears most clearly in the five durum varieties. Among bread wheat varieties (at 225 kg/ha applied nitrogen), there were no significant yield differences among varieties released since 1973. Weather conditions may have been limiting in this season; in past trials Pavon 76 and Ciano 79 have shown markedly higher yield potentials than Jupateco 73.

Integrated weed control

A trial was started at the end of the 1978-79 winter season to compare effects and evaluate the interactions of five factors on long-term reductions in populations of *A. fatua* and *P. minor*. The five factors are (1) handling of the wheat stubble, (2) summer fallow, or soybeans as a summer crop, (3) wheat pre-irrigation, or seeded dry and then irrigated, (4) seeding rates, and (5) number of years of chemical control.

The effect of seeding rate on yield in the presence and absence of chemical control is shown in Table 1. In the absence of herbicide, a higher seeding rate led to greater yield, resulting from increased competitiveness of the crop.

Table 1. Grain yields (g/m^2) at two seeding densities, with and without chemical grass weed control (meaned over all main and sub-treatments)

	Seed rate		
Weed control	100 kg/ha	200 kg/ha	Mean
No herbicide	198	283	241
With herbicide	480	442	461
Mean	339	363	351

LSD(5%) = 31 kg/ha
CV% = 12.2

However, when herbicide (flamprop-methyl) was used, a higher seeding rate (which led to lodging) was detrimental to yield with the variety Pavon.

Wheat yields, visual weed scores, and populations of both wild oats and *P. minor* are shown in Table 2. These results refer only to those treatments where no chemical control was applied for grass weeds in this season. Significant differences were found for yield and weed scores, but interpretation must await results from more than a single season.

Pre-irrigating and disking before seeding significantly increased yields, apparently because of decreased weediness and smaller wild-oat populations. Wild oat populations were significantly reduced from 93 plants/m^2 to 36 plants/m^2 by pre-irrigation. However, *P. minor* populations were higher with this treatment, probably reflecting the decrease in the population *A. fatua.*

The effect of increased competition on *P. minor* populations was again evident in a comparison of wheat seeding rates. At the higher seeding density, 200 kg/ha, *P. minor* populations were almost 50 percent less, while wild oat populations were reduced less than 15 percent.

This trial is scheduled to run for four years to test the long term effects of these treatments and identify cultural practices that will reduce yield losses due to these two grassy weeds.

Table 2. Main effects[1/] on yield and weed populations of treatments in the integrated grass weed control trial, 1980

Treatment of wheat stubble	Summer crop	Yield (g/m^2)	Visual weed score[2/]	Oats (pl/m^2)	Phalaris (pl/m^2)
Plough/disk	Fallow	252	7.4	60	41
Plough/disk	Soybeans	246	6.8	62	31
Disk	Fallow	188	7.8	104	27
Disk	Soybeans	270	6.0	54	47
Burn/disk	Fallow	253	6.2	56	40
Burn/disk	Soybeans	273	4.2	45	38
Lv. stubble	Fallow	222	7.8	55	62
Lv. stubble	Fallow	221	7.3	82	25
Significance of F-ratio		**	**	*	*
LSD (5%)		60	2.2	45	28
Pre-irrigate/disk/seed		277	5.8	36	45
Seed/irrigate		204	7.5	93	33
Significance of F-ratio		**	**	**	**
LSD (5%)		25	0.8	17	11
100 kg/ha seed		198	7.6	69	50
200 kg/ha seed		283	5.8	60	28
Significance of F-ratio		**	**	*	**
LSD (5%)		19	0.6	12	9
PF Main x sub		**	**	**	N.S.
PF Main x sub-sub		N.S.	N.S.	N.S.	N.S.
PF Sub x sub-sub		N.S.	N.S.	N.S.	N.S.
PF Main x sub x sub-sub		**	*	N.S.	**
CV%		19.2	21.3	46.5	57.0

1/ Main effects = mean effect over main treatments

2/ Scale 0-10: 0 = no weeds, 10 = no crop

Training

CIMMYT training programs are designed to attract and encourage trainees who demonstrate leadership ability, and who are potential future research leaders in national programs. Young researchers and extension personnel from developing countries, usually with some experience in national agricultural programs, spend one crop cycle in Mexico fully participating in research or the development of production practices. CIMMYT's training philosophy stresses practical and applied skills directed toward increasing the level and dependability of crop yields.

A trend observed in recent years—growing enrollment in irrigated and rainfed agronomy training—continued in 1980. Six in-service training courses were offered, and the number of trainees participating in each course were as follows:

Course	Number of Trainees
Irrigated Wheat Agronomy	15
Rainfed Wheat Agronomy	10
Wheat Breeding	16
Wheat Pathology	6
Cereal Technology	2
Experiment Station Management	4

Production (irrigated and rainfed) agronomy trainees learn to identify the constraints limiting production in farmers' fields. The training process emphasizes on-farm testing, verification, and demonstration, in addition to experiments conducted on the station. On-station experiments are used when a trial requires close control or treatments that are difficult to apply under farmers' conditions. The goal is to teach trainees how to conduct their research and demonstrations given farmers' realities, including climatic, biological, social, and economic constraints.

Breeders, pathologists, and cereal technology trainees participate in many day-to-day activities of CIMMYT's programs. The emphasis here is to teach them to work as a team, interacting among disciplines, and one of the main techniques used by CIMMYT for teaching and identifying good researchers is a great deal of hands-on field work.

Trainees in breeding and pathology planted nurseries on-station as well as in farmers' fields. Working in farmers' fields helps these trainees better understand the kind of research that production agronomists should conduct on their plots. They screened thousands of lines for resistance to several diseases, and conducted yield trials to determine yield potential and adaptation under circumstances different than the El Batan or Toluca stations.

In discussions about the CIMMYT training program, the question often arises as to which countries send trainees, and what happens to them after they return home. Table 1 is a summary of the national origins of CIMMYT wheat trainees from 1966 through 1980—a total of 569 trainees from 62 countries. The number and origin of trainees enrolled in 1980 are also reported—53 persons from 27 countries. These data include only those trainees who completed their programs before the end of 1980.

It is interesting to note that countries not considered to be traditional wheat producers are increasingly attempting to save foreign exchange on wheat imports by growing small grains. The African continent comprises the largest group of countries in this category. These new national efforts give rise to a need for trained personnel to (1) work in new national programs and (2) strengthen programs already in existence.

To determine the current activities of CIMMYT wheat trainees, a random sample from the 1976 program was studied. Among those persons contacted, there exists a strong motivation to continue their professional development; a good proportion were involved in graduate training.

Trainees participate in many of the day-to day activities of CIMMYT's wheat improvement programs. Hands-on field work, in combination with classroom study, gives trainees practical experience with many crop improvement techniques used by CIMMYT. Here, a trainee practices proper disease innoculation procedures.

VISITING SCIENTISTS

In 1980, forty-three scientists visited the wheat program during the winter season in Sonora, Mexico; ten visited the El Batan headquarters and Toluca during the summer season. These scientists were involved in wheat

program activities for periods of one to four weeks, depending on the nature of the visit.

Most of these visitors came from some 20 developing countries. Their main objectives were to collect germplasm, to interact with CIMMYT staff, to discuss mutual problems, and to design strategies for improving wheat production around the world.

CIMMYT 1976 wheat trainees who went on to or are pursuing graduate work after training in Mexico

	1976 trainees per region	Number in graduate training	Institution
Latin America	13	7	4 Mexico, 2 USA, 1 Japan
Africa	10	2	2 USA
Middle East	4	1	1 USA
Far East	10	0	
USA	1	1*	1 USA

* Ph.D.candidate; others in M.S. programs

In 1980, trainees screened thousands of lines for resistance to several diseases, and conducted yield trials to determine yield potential and adaptation.

TABLE 1. Number and national origin of wheat trainees, 1966-1980

	1966-1980	1980
LATIN AMERICA	**159**	**8**
Argentina	14	0
Bolivia	14	1
Brazil	18	0
Chile	11	3
Colombia	5	0
Dominican Republic	1	0
Ecuador	18	2
Guatemala	8	0
Guyana	1	0
Honduras	1	0
Mexico	44	0
Panama	1	0
Paraguay	6	1
Peru	16	1
Uruguay	1	0
NORTH AFRICA AND MIDDLE EAST	**196**	**15**
Algeria	52	3
Cyprus	1	0
Egypt	14	2
Iran	8	0
Iraq	5	0
Jordan	6	1
Lebanon	4	0
Libya	4	0
Morocco	20	2
Saudi Arabia	2	1
Sudan	3	0
Syria	7	1
Tunisia	26	2
Turkey	40	3
Yemen	3	0

	1966-1980	1980
AFRICA,SOUTH OF THE SAHARA	**59**	**7**
Cameroon	1	0
Chad	1	0
Ethiopia	12	1
Kenya	7	0
Lesotho	1	0
Madagascar	1	1
Malagasy	1	0
Malawi	2	0
Mali	2	1
Nigeria	15	1
Rwanda	2	0
Senegal	1	1
Somalia	1	0
Tanzania	5	1
Zaire	2	0
Zambia	6	1
SOUTH,SOUTHEAST AND EAST ASIA	**135**	**22**
Afghanistan	13	0
Bangladesh	30	6
Burma	1	1
India	18	4
Korea	10	1
Nepal	15	3
Pakistan	46	7
Philippines	2	0
OTHER COUNTRIES	**20**	**1**
France	1	0
Hungary	2	0
Poland	3	0
Portugal	2	0
Rumania	2	0
Spain	3	1
USA	4	0
USSR	3	0
TOTAL: Countries	**62**	**27**
Individuals	**569**	**53**

Wide Crosses

The intergeneric hybridization program at CIMMYT has resulted in a number of *Triticeae* hybrids. Genera included in the 1980 crossing program were *T. aestivum, Hordeum* spp., *Agropyron* spp., *Elymus* spp., and *Secale* spp. Crossing between the various genera was done under field conditions at El Batan and CIANO, near Ciudad Obregon, Mexico. Additional crosses dictated by pollen availability were made either in growth chambers or greenhouses. Growth chamber conditions were a 14-hour day, 15°C day/10°C night, and 45% relative humidity. The greenhouses were maintained under natural daylight plus supplemental fluorescent lighting for a total of 15 hours, 20°C night and approximately 45% relative humidity.

The objectives of the program continue to be the transfer to wheat *(Triticum aestivum L.)* of the following characteristics:

- High lysine and protein from *Hordeum* species;
- Barley yellow dwarf resistance from *H. vulgare* and/or *Agropyron smithii*;
- Salt tolerance from *Agropyron distichum, A. elongatum,* or some *Elymus* species;
- Drought tolerance from some *Elymus* species;
- Resistance to leaf spotting diseases from *Elymus* species, especially *E. arenarius, E. giganteus,* or *E. mollis;*
- Fusarium (scab) and helminthosporium resistance from alien sources that are being pathologically screened;
- Rust resistance from some *Agropyron* species and their amphiploid sources.

The focus of CIMMYT's wide cross work is not higher genetic yield *per se*, but rather to obtain better resistance to diseases and greater tolerance to environmental extremes. Dr. A. Mujeeb Kazi, leader of the wide crosses program, has developed effective procedures for advancing F_1 hybrids and testing agricultural practicality.

PRODUCTION OF F_1 COMBINATIONS

The spikes were emasculated and then pollinated with pollen from the desired alien parent. Pollination occurred either the next day or after two to three days, depending upon stigma receptivity. Two post-pollination applications of gibberellic acid (GA_3) at 75 ppm (aqueous) were applied with a syringe to the floret cups on two successive days. The embryos were excised and cultured after 18 to 20 days. Upon differentiation the plantlets were transferred to peat pots and maintained in the growth chamber under high humidity until the four-leaf stage. The seedlings were then transferred to potting soil in the greenhouse.

Intergeneric hybrids were defined as plants possessing the chromosome complement from both parents at some time during hybrid development. This characteristic should be cytologically detectable somatically, and preferably meiotically. Hybrids were somatically and meiotically identified, allowed to grow, and eventually cloned. To induce hybrid amphiploidy, a colchicine treatment concentration of 0.2%, plus 2.0% dimethylsulfoxide (DMSO) was used. This solution was applied to the tillers by the capping method for four hours, or for six hours by the aerated root treatment.

PRODUCTION OF BACKCROSS (BC) I PROGENY

The spikelets on the male-sterile F_1 hybrids were clipped and then pollinated with the desired parent to obtain BC_I progeny. The pollination, embryo culture (if necessary), and gibberellic acid treatments were similar to those described above for the production of F_1 hybrids, any amphiploids, and of the BC progenies.

BARLEY X WHEAT HYBRIDS

The F_1 hybrid of *H. vulgare* (2n=14,HH) x *T.turgidum* (2n=4x=28, AABB) had an n=3x=21, HAB chromosome composition. Its BC_I combination (*H. vulgare–T.turgidum*) x *T.turgidum,* gave progeny that was still 2n=3x=21, HAB and apomictic, or had the expected n=5x=35, HAABB, BC_I composition (Figure 1). The BC_I plant was both male- and female-sterile, and set no BC_{II} seed when it was pollinated by *T. turgidum*.

Interesting results were also obtained from the cross *H.vulgare* (2n=14,HH) x *T.aestivum* (2n=6x=42,AABBDD). The male sterile F_1 hybrids (n=4x=28, HABD), when

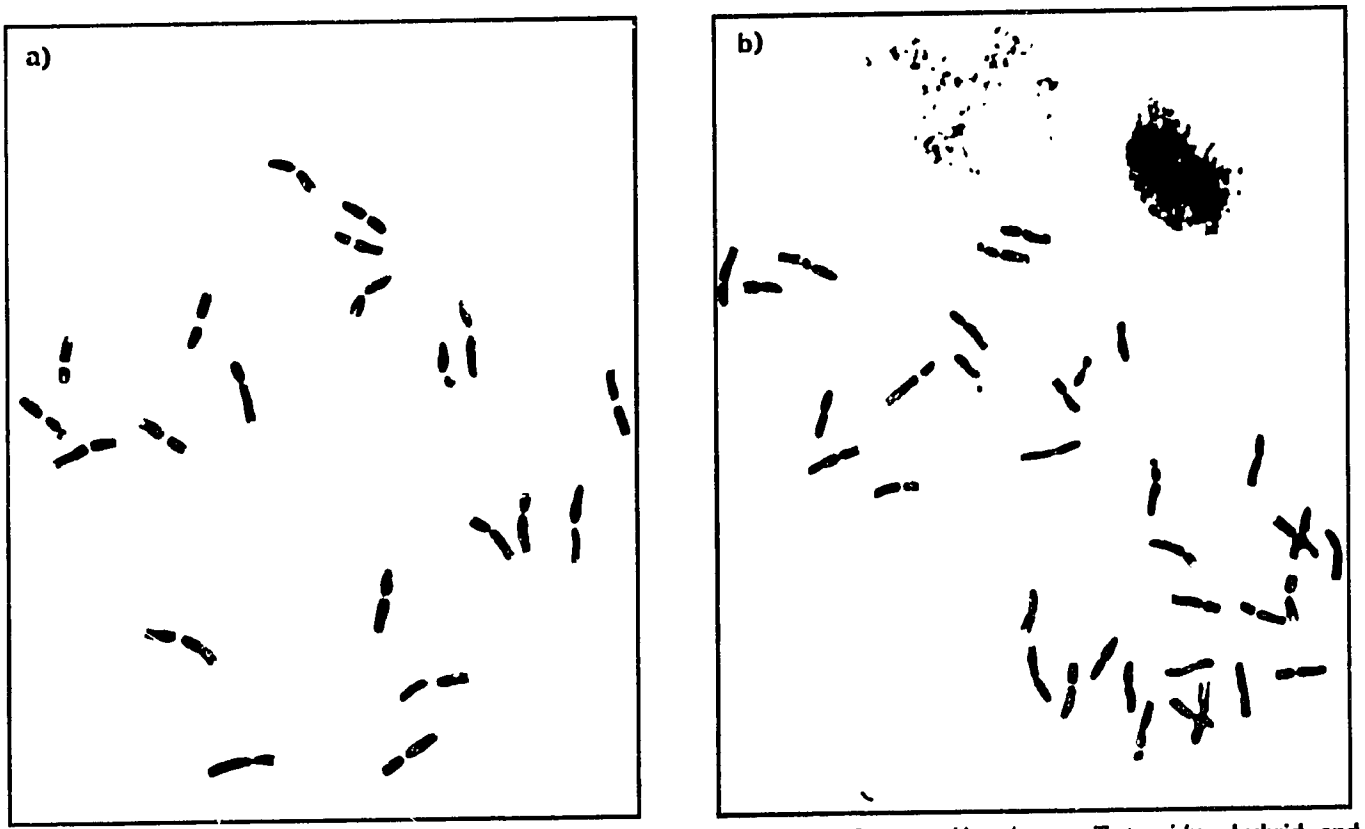


Figure 1. A somatic squash showing (a) 21 chromosomes, n=3x=21, HAB, from an *H. vulgare* x *T. turgidum* hybrid, and (b) 35 chromosomes, 2n=5x=35, HAABB, from an *H. vulgare-T. turgidum* x *T. turgidum* backcross I plant

backcrossed to *T. aestivum*, produced BC_I progeny that possessed from 27 to 50 chromosomes instead of the normal 49, HAABBDD composition.

The BC_I plants with 27 or 28 chromosomes were considered to be apomicts. The BC_I plants were pollinated with several commercial *T. aestivum* cultivars, to produce BC_{II} progeny (Table 1), whose chromosome numbers ranged from 42 to 49. None of the BC_{II} were self-fertile. Additional pollinations of the BC_{II} plants with *T. aestivum*, however, have produced BC_{III} seed. To restore self-fertility in BC_{II} and beyond, the reciprocal cross (wheat x barley) has been made. The development of this program will follow the steps outlined in Figure 2.

HYBRIDS INVOLVING *AGROPYRON* AND *ELYMUS* SPECIES

CIMMYT's emphasis on *Agropyron* and *Elymus* species is directed mainly toward transfer to *T. aestivum* —either directly or through bridge species—characteristics associated with salt tolerance, drought tolerance, rust resistance, helminthosporium resistance, fusarium (scab) resistance, and generalized leaf-spotting tolerance

Sources of resistance are identified either through the literature, habitat, exchange of information, or are being identified by screening in our pathology division. Seed from 121 species of *Agropyron* and *Elymus* were obtained from Dr. D. R. Dewey, and plants from these entries were maintained in the greenhouse at El Batan, Mexico, for seed multiplication and crossing. Fusarium (scab) and helminthosporium testing will be done in Toluca and Poza Rica in 1981 and 1982.

The hybrid combinations made with *Agropyron* and *Elymus* species maintained at CIMMYT, with their cytological details, are presented in Table 1. The projected advance of these hybrids fits closely the schematic used for wheat x barley hybrids (Figure 2). Backcross I progenies have been obtained for several combinations that will be advanced and cytologically analyzed during 1981. Of special mention are the combinations of *T. turgidum, T. timopheevii,* and *T. aestivum* with *A. elongatum* (2n=10x =70) (Table 1). These hybrid combinations will receive greater research emphasis in the years ahead. The *A. elongatum* habitat in Argentina was soil encrusted with salt. Seed was collected by a colleague and classified (according to habitat) to be a salt-tolerant source. The critical laboratory testing for this tolerance is now underway through cooperative research.

Dr. R. Pienaar obtained F_1 hybrids, amphiploids, and BC_I progeny of *T. turgidum* and *T. aestivum* with *A. distichum* (a salt tolerance source). He provided CIMMYT

Table 1. Some intergenetic hybrid combinations with *Agropyron* and *Elymus* species

Hybrid combination detail	Somatic chromosome count	F1	BC1
A.elongatum x *T.turgidum* (2n=14) (2n=4x=28)*	n=3x=21	*	
A.elongatum x *S.cereale* (2n=4x=28) (2n=14)*	n=3x=21	*	*
A.elongatum x *H.vulgare* (2n=4x=28) (2n=14)	n=3x=21	*	
A.elongatum x *T.aestivum* cv. Pavon (2n=4x=28) (2n=6x=42)*	n=5x=35	*	*
A.elongatum x *T.aestivum* cv. Jupateco (2n=4x=28) (2n=6x=42)*	n=5x=35	*	*
A.fibrosum x *T.turgidum* cv. Grano grande* (2n=4x=28) (2n=4x=28)	n=4x=28	*	*
A.fibrosum x *T.turgidum* cv. Cocorit 71 (2n=4x=28) (2n=4x=28)*	n=4x=28	*	*
A.fibrosum x *T.turgidum* cv. Mexicali (2n=4x=28) (2n=4x=28)*	n=4x=28	*	*
A.fibrosum x *T.aestivum* cv. Pavon (2n=4x=28) (2n=6x=42)	n=5x=35	*	*
A.fibrosum x *T.aestivum* cv. Pavon (2n=4x=28) (2n=6x=42)	n=2x=14	Polyhaploid of *A.fibrosum*	
A.trachycaulum x *T.turgidum* cv. Cocorit 71 (2n=4x=28) (2n=4x=28)*	n=4x=28	*	*
A.trachycaulum x *T.turgidum* cv. Mexicali (2n=4x=28) (2n=4x=28)*	n=4x=28	*	*
A.trachycaulum x *T.aestivum* cv. Nacozari (2n=4x=28) (2n=6x=42)*	n=5x=35	*	*
A.elongatum x *T.turgidum* cv. Cocorit 71 (2n=10x=70) (2n=4x=28)	n=7x=49	*	*
A.elongatum x *T.timopheevii** (2n=10x=70) (2n=4x=28)	n=7x=49	*	*
A.elongatum (2n=10x=70) *T.aestivum* (2n=6x=41) cv. Bonza*	n=8x=56	*	*
cv. Chinese Spring*	n=8x=56	*	*
cv. Pavon*	n=8x=56	*	*
cv. Zaragoza*	n=8x=56	*	*
*Timopheevii** x *A.elongatum* (2n=10x=70)	n=7x=49	*	*
*T.turgidum** x *A.elongatum* (2n=10x=70)	n=7x=49	*	*
T.aestivum x *A.elongatum* (2n=10x=70)	n=8x=56	*	*
cv. Chinese Spring*	n=8x=56	*	*
cv. Chinese Spring Ciano (E)*	n=8x=56	*	*
cv. Pavon*	n=8x=56	*	*
cv. Nyu Bay*	n=8x=56	*	*
cv. Zaragoza*	n=8x=56	*	*

Table 1.(continued)

Hybrid combination detail	Somatic chromosome count	F1	BCI
T.turgidum x *A.junceum* (2n=4x=28) (2n=6x=42)	n=5x=35	*	
*T.aestivum** x *A.junceum* 1/ (2n=6x=42) (2n=6x=42)	n=6x=42	*	*
T.turgidum-A.elongatum(C-1) x *A.elongatum* (2n=6x=42) (2n=10x=70)	n=8x=56	*	*
T.turgidum-A.elongatum(C-1) x *T.aestivum* (2n=6x=42) (2n=6x=42) cv. Bonza	n=6x=42	*	
T.turgidum-A.elongatum(C-1) x *T.aestivum* (2n=6x=42) (2n=6x=42) cv. Chinese Spring	n=6x=42	*	
T.turgidum-A.elongatum(C-1) x *T.aestivum* (2n=6x=42) (2n=6x=42) cv. Pavon	n=6x=42		
T.turgidum-A.elongatum(C-1) x *T.aestivum* (2n=6x=42) (2n=6x=42) cv. Zaragoza	n=6x=42	*	
E.dahuricus x *T.aestivum* cv. Pitic (2n=6x=42) (2n=6x=42)	n=6x=42	*	
E.agropyroides x *T.aestivum* (2n=6x=42) cv.Chinese Spring-Cinao(E)	n=6x=42	*	
cv.Bonza	n=6x=42	*	
cv.Nyu Bay	n=6x=42	*	
cv.Zaragoza	n=6x=42	*	
E.canadensis x *H.vulgare* (2n=4x=28) (2n=14)	n=3x=21	*	
H.vulgare x *E.canadensis* (2n=14) (2n=4x=28)	n=3x=21	*	
E.canadensis x *T.aestivum* (2n=4x=28) (2n=6x=42)	n=5x=35	*	
T.aestivum x *E.giganteus* 2/ (2n=6x=42)* (2n=4x=28)	n=5x=35	*	*
H.vulgare x *E.patagonicus* (2n=14) (2n=6x=42)	n=4x=28	*	

* = Backcross parent
1/ = Amphiploid produced
2/ = Advanced up to and including BCIII

with the BC_I and amphiploid seed from these combinations, and CIMMYT provided Dr. Pienaar with the F_1 seed from the *T. aestivum* with *A. elongatum* combination.

The *E. canadensis* (2n=4x=28, SSHH) x *H. vulgare* (2n=14, HH) and *H. vulgare* x *E. patagonicus* (2n=6x=42, $S_2S_2H_2H_2H_3H_3$) combinations, used initially as bridging crosses for eventual genetic transfers to *T. aestivum*, have contributed a wealth of cytogenetic information concerning the H genome homology between *Hordeum* and *Elymus* species. This has caused us to re-evaluate the H genome homology between *Hordeum* and *Elymus*, and also to consider relationships with *H. bogdanii* for elucidating pairing homology (between *H. vulgare* and *H. bogdanii*).

The F_1 hybrid of *T. aestivum* x *E. giganteus* had an n=5x=35, ABDJX composition. Its BC_I progeny, i.e., *T. aestivum–E. giganteus* x *T. aestivum* "Chinese Spring," "Pavon," "Zaragoza," were either 2n=8x=56, AABBDDJX or 2n=8x=55, AABBDD (JX-1). Pollinating the BC_I plants with *T. aestivum* cultivars produced a BC_{II} progeny that was expected to possess the 42 AABBBD wheat chromosomes, plus 0 to 14 JX chromosomes from *E. giganteus*. The chromosome range observed for these BC_{II} plants was from 44 to 54. Some BC_{II} plants were partially self-fertile (approximately 48% seed-setting) (Figure 3). BC_{III} seed setting (Figure 3) varied from 30.0% to 76.0 %, according to the *T. aestivum* cultivar used for back-crossing. The cultivars were Bonza, Chinese Spring, Chinese Spring-Ciano (E), Ciano, Pavon, and Zaragoza. The BC_{III} seed, and BC_{II} selfed seed, will be analyzed cytologically in 1981, with progeny advanced to develop *E. giganteus* addition lines to *T. aestivum*.

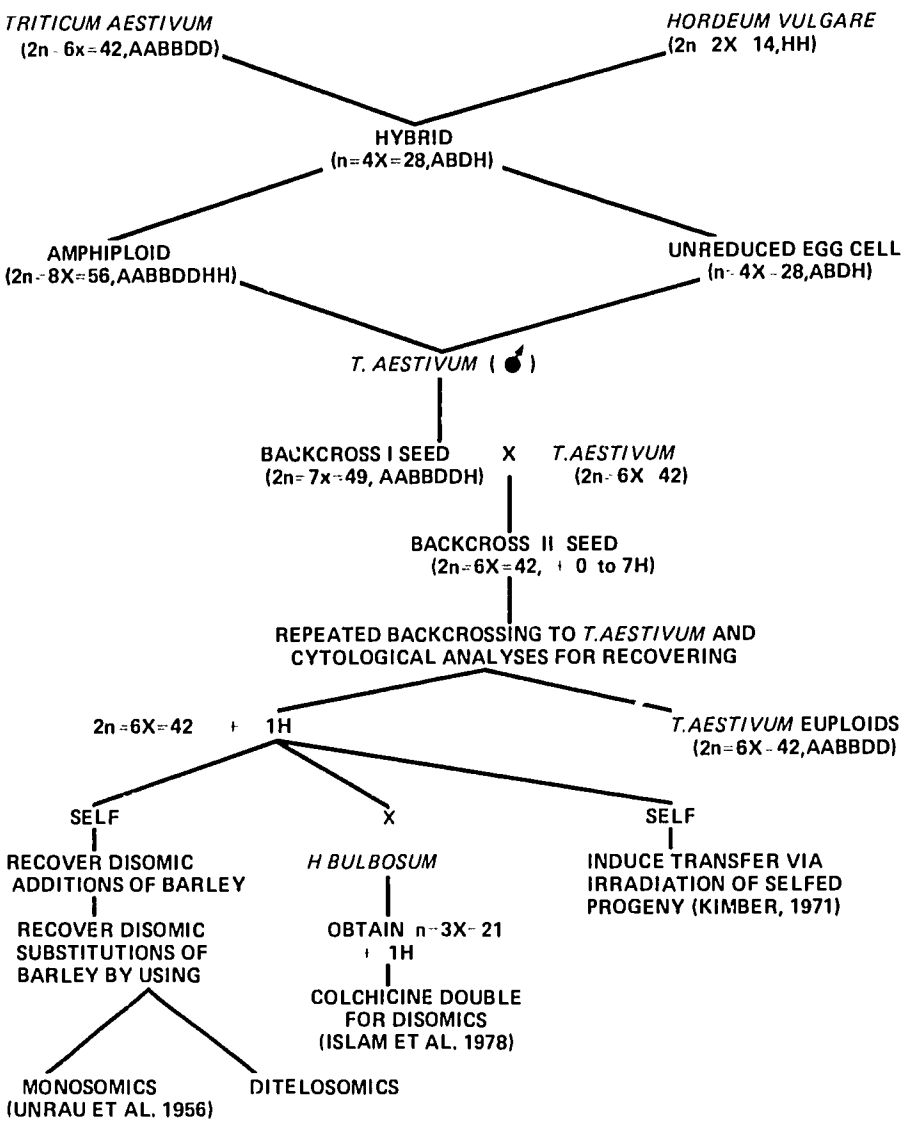


Figure 2. A schematic presenting the procedure for developing from *T. aestivum* (2n=6x=42, AABBDD) x *H. vulgare* (2n=14, HH) hybrids, *H. vulgare* addition lines, substitution lines, subtle genetic transfer, and recovering *T. aestivum* euploids

Figure 3. Selfed seed setting on a BC_{II} *(T. aestivum-E. giganteus - T. aestivum) x T. aestivum* plant (left), and seed setting when it was pollinated with *T. aestivum* cv. Pavon for BC_{III} seed formation. The BC_{II} plant possessed 49 chromosomes, 21 $_{II}$ (bivalents) 7_{I} (univalents). The univalents were of the *E. giganteus* genome(s)

CIMMYT has developed the C-banded karyotype of *E. junceus*, 2n=14,JJ, which is one genome of *E. giganteus*. Banding of the *E. giganteus* JJXX complement is in progress. The technique has to be tested on the F_1, BC_I, BC_{II}, and BC_{III}, and will aid in identifying the *E. giganteus* addition lines in a *T. aestivum* background.

TRIGENERIC HYBRIDS

A manipulation of crossing procedures may help to overcome problems due to gene penetrance and the possible lack of gene expressivity in alien genetic backgrounds. The use of trigeneric hybrids is one such manipulative procedure. When the BC_I *(H. vulgare–T. aestivum)* x *T. aestivum* plants

with 2n=7x=49, HAABBDD were pollinated with *S.cereale* (2n=14,RR), trigeneric hybrids were obtained that possessed either 29 or 32 chromosomes. In either case, C-banding revealed the presence of the seven rye chromosomes. This fits the expected model of the trigenerics possessing 21ABD + 7R +0 to 7H chromosomes.

In the combination *T. aestivum–E. giganteus* x *S. cereale,* the somatic count was 42: 21ABD + 14JX + 7R. The rye chromosomes here were also identified by C-banding, and it will be interesting to observe meiosis of this trigeneric hybrid.

In considering the trigeneric *T. aestivum–E.giganteus* x *A. elongatum,* the F_1 between *T. aestivum x E. giganteus* indicated no possibility of a direct alien gene transfer due to lack of pairing between *T. aestivum* and *E. giganteus* chromosomes. To explore whether the trigeneric route would be beneficial, an *Agropyron* germplasm source was chosen that earlier had been classified to be a salt-tolerant source. The trigeneric hybrids produced have 70 somatic chromosomes, 21ABD +14JX +35 (Ag.).

The (*T. aestivum–E. giganteus*) x *T. aestivum* BC_1 plant, with 56 chromosomes (42AABBDD + 14JX), was also pollinated by *A. elongatum* to yield trigeneric hybrid seed. These have a somatic range of from 59 to 65, i.e., three to nine *E. giganteus* chromosomes were present. Meiotic analyses of these trigeneric hybrids are scheduled for 1981.

Obtaining intergeneric hybrid combinations among *Agropyron, Elymus, Hordeum, Secale* and *Triticum* species has not been difficult. A routine procedure that is strongly complemented by cytology has been developed for advancing the F_1 hybrids and for testing agricultural practicality. Genetic penetrance is readily detectable, but obstacles exist regarding genetic expressivity. The latter will receive more attention in future investigations.

Papers resulting from CIMMYT's investigations that were submitted in 1980 and have been published are:

MUJEEB-KAZI, A. "*Triticum timopheevii x Secale cereale* Crossability." *J. Heredity* 72:227-228, 1981.

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RODRIGUEZ, R. and A. MUJEEB-KAZI. "Cytogenetics of Some Intergeneric Hybrids Between *Elymus, Hordeum* and *Triticum.*" *Agr. Abstracts,* 1980. Ann. Meetings, Detroit, Mich., U.S.A., p. 67, 1980.

International Nurseries

International testing of germplasm is an integral part of CIMMYT's wheat improvement efforts. By growing identical nurseries at many locations and under a variety of conditions, plant breeders are able to judge more quickly the adaptability, comparative yielding ability, and breadth of disease resistance of each entry. One year of testing at many locations could not be equalled by decades of testing at a single location.

Cooperators who grow CIMMYT nurseries are requested to supply performance data to CIMMYT for compilation, analysis, and subsequent distribution worldwide

CIMMYT's international testing program also provides a mechanism for distributing germplasm. Collaborators are free to use the material in any nursery in whatever ways best suit their needs. Options include using CIMMYT germplasm in crosses with local varieties, and even moving an entry directly into multiplication for eventual release as a variety.

In 1980, thirty-seven nurseries were distributed to 257 cooperators in 101 countries. These nurseries consisted of some 10,438 different lines of bread and durum wheats, barley, and triticale.

NURSERY CATEGORIES

Nurseries distributed by CIMMYT fall into five different categories:

Yield nurseries

Entries in yield nurseries are usually advanced materials (from F_5 to F_7), or varieties already released commercially. Entries may come from national programs, as well as from the CIMMYT program. National program "nominations" are grown and evaluated in Mexico for possible inclusion in subsequent yield nurseries.

Yield nurseries serve three purposes: (1) they allow the performance of advanced lines to be assessed over a wide range of conditions; (2) they permit the comparison of performance characteristics of varieties from many sources at each trial location; (3) they provide sources of genetic variability that cooperators may use directly or in crosses.

Each year nearly a million packets of seed are distributed to cooperators around the world, who then grow the nurseries, evaluate the performance of individual lines, and return the data to Dr. Maximino Alcala for compilation and analysis.

Screening nurseries

These nurseries serve functions similar to yield nurseries, but selection criteria are different. While yield must be adequate, selection is generally made for physiological appearance and disease resistance. Lines that have performed well in Mexico on all measures may be entered in screening nurseries.

Disease nurseries

These nurseries are sent to locations where particular diseases are likely to occur, and provide an effective way to identify and evaluate potential sources of disease resistance. Agronomic evaluation receives lesser emphasis.

Early generation F_2 (segregating populations)

F_2 materials are sister plants from the same cross, but they possess widely different genetic potential and physiological characteristics. From these segregating populations, CIMMYT plant breeders select individual plants having desirable characteristics. Nurseries are compiled and sent to cooperators according to climatic conditions, soils, moisture availability, the local disease spectrum, and prevailing cultural practices.

Crossing blocks

Potential parent lines are selected for use in crossing programs, and entries in each crossing block are arranged according to their previously identified genetic superiority for one or more traits. Cultivars and lines are grouped for their high yield and/or wide adaptation, disease resistance, adaptation to certain regions, tolerance to aluminum toxicity, yield structure characters, and industrial quality. As many as 500 lines may be included in a crossing block.

INTERNATIONAL NURSERIES FOR 1980

Bread wheat

Seventeenth International Spring Wheat Yield Nursery (ISWYN)
Second Elite Selection Wheat Yield Trial (ESWYT)
Fourteenth International Bread Wheat Screening Nursery (IBWSN)
Aluminum Screening Nursery
International Septoria Observation Nursery (ISEPTON)
F_2 Irrigated
F_2 Dryland
F_2 Aluminum
F_2 Septoria
F_2 Early
F_2 Helminthosporium
Small Multiplication Plots

Durum wheat

Twelfth International Durum Yield Trial (IDYN)
Tenth Elite Durum Yield Trial (EDYT)
Twelfth International Durum Screening Nursery (IDSN)
F_2 Cold Tolerant
F_2 Dryland
F_2 Irrigated
Crossing Block
Small Multiplication Plots

Triticale

Twelfth International Triticale Yield Nursery (ITYN)
Twelfth International Triticale Screening Nursery (ITSN)
Triticale Disease Resistance Nursery (TDRN)
Forage Lines
F_2 Irrigated
F_2 Dryland
F_2 Spring x Winter
Crossing Block
Small Multiplication Plots

Barley

Third International Barley Yield Trial (IBYT)
Eigth International Barley Observation Nursery (IBON)
F_2 Spring x Spring
F_2 Spring x Winter
F_2 Andean Zone
Crossing Block
Crossing Block Quality
Miscellaneous Material

Regional and In-Country Activities

- Disease Surveillance Program
- Andean Region
- Southern Cone Region
  - Southern Cone Agronomy
- North and West Africa and Iberia
- Eastern and Southern Africa
- South and Southeast Asia
- Pakistan

Disease Surveillance Program

The CIMMYT Disease Surveillance Program (DSP) is concerned with the phytopathological factors that affect wheat production in the principal wheat and barley producing countries of Asia, Africa, and the Middle East. The main objective of the program is to help maximize yield per unit of area and to minimize downturns in production caused by diseases. Disease monitoring is an integral part of the DSP, because disease-causing organisms are mutationally dynamic and therefore capable of rather rapid changes in virulence spectra; this, in turn, can reduce the stability of crop production.

The geographic area covered by the DSP is extensive and ecologically diverse. It stretches from Morocco in the west to the Philippines in the east; from southern Europe in the north to the southern tip of Africa in the south. In terms of area and total production, wheat and barley are the number two and number four ranked crops, respectively. The cultivars grown range from local selections of land race populations to highly improved dwarf and semidwarf types. These latter improved varieties are capable of withstanding a multitude of environmental conditions, ranging from harsh, cold continental climates, to the warmer, humid semitropical climates where spring habit types are grown during the shortest (and coolest) season.

REVIEW OF THE SEASON

In general, and across the entire region, the diseases affecting wheat and barley production did not reach epidemic proportions in 1980, except in a few localized areas.

The rusts

Leaf rust of wheat (brown rust), caused by *Puccinia recondita*, continues to be the most prevalent and widespread foliar disease in the region. Of the 52 countries participating in the DSP, 24 reported leaf rust; 16 of these reported significant levels of severity.

Stem rust (black rust), caused by *P. graminis*, was reported by 20 countries, but reached significant levels of severity only in Kenya, Ethiopia, parts of Egypt, Turkey, Italy, Yugoslavia, Romania, Pakistan and India. These countries experienced measurable losses, but not of epidemic proportions.

Leaf rust of barley, caused by *P. hordei*, was reported by 19 countries in the region, 10 of which reported significant levels of severity. Even so, losses were probably not measurable, except in parts of Morocco, coastal Turkey and India.

Stripe rust (yellow rust), caused by *P. striiformis*, was reported by 18 countries, but reached significant levels of severity only in the cooler countries of the region. Of the 52 countries in the DSP, only 35 have ever reported significant levels of stripe rust.

Other foliar diseases

Tan spot, caused by *Helminthosporium tritici-repentis*, is present in nearly all of the DSP countries. Of all the helminthosporium diseases affecting small grain cereals, *H. tritici-repentis* in the least familiar, yet under certain conditions it can cause premature defoliation and result in considerable production losses (primarily by reduced test weights). Spot blotch, caused by *H. sativum*, is also found in most of the DSP countries, but is more severe in countries with warmer, more humid climates, such as Zambia, Kenya, Ethiopia, Bangladesh, eastern India, southern Nepal, and the countries of Southeast Asia (where wheat and barley are relatively new crops). Net blotch, caused by *H. teres*, and barley stripe, caused by *H. gramineum*, have been reported in a few DSP countries, but usually only in trace amounts.

Leaf blotch, caused by *Septoria tritici*, was reported in 1980 by only 12 countries, and apparently reached significant levels of severity only in the Caspian Sea area of Iran. Glume blotch, caused by *S. nodorum*, is more restricted than *S. tritici* in its habitat, and was reported by only 5 of the region's 52 countries.

Powdery mildew, caused by *Erysiphe graminis*, was reported by 9 countries in the region, yet reached significant levels of severity only in the Caspian Sea area of Iran and in parts of the Marmara Sea area of Turkey. Losses attributed to this disease were minimal.

Flag smut, caused by *Urocystis agropiri*, is not considered to be a major disease of wheat in the region, even though reported every year by all countries in the Indian Subcontinent, Near and Middle East, and North Africa.

***Heminthosporium tritici-repentis* is found in nearly all the DSP countries, yet is one of the least familiar helminthosporium diseases. The disease can cause considerable production losses, primarily through reduced grain filling.**

Soil-borne diseases

Such soil-borne diseases as root rots and seedling blights were encountered this season in the semiarid parts of the region, and even in several countries possessing climatic conditions unfavorable to the diseases. The assessment of these diseases, however, remains inadequate and there is little information available regarding their prevalence.

Head diseases

The smut and bunt diseases, caused by *Ustilago* spp. and *Tilletia* spp., are persistent recurring disease problems throughout the DSP region. Losses inflicted by these diseases vary from country to country, depending on the interactions of a number of factors. Across the region, conservative estimates of annual losses range between one and three percent, and 1980 was no exception.

Viral diseases

Wheat streak mosaic, East African streak, soil-borne mosaic, and barley stripe mosaic were the viral diseases reported in 1980. Of these, only soil-borne mosaic virus caused significant losses, and only in the Alpu district of Eskischer Province, Turkey. Overall, viral diseases of small grain cereals were not of economic importance in the region during 1980.

DISEASE MONITORING AND REGIONAL NURSERIES

The CIMMYT DSP strives to establish a sound knowledge of the factors involved in wheat disease epidemics. A specific objective of the program is the description of local or regional pathogen populations in terms of their range of virulence. This information permits the distinguishing of geographical zones that have different pathogen populations,

i.e., epidemiological units. Continuous monitoring of virulence across epidemiological units should disclose changes in pathogen populations and pathways of inoculum movement. Ultimately this epidemiological knowledge should be used to implement the strategic geographic placement of wheat cultivars as a means of disease control.

The Regional Disease Trap Nursery (RDTN) is designed to study geographic differences in populations of cereal rusts and other pathogens. For the 1980 RDTN, data were analyzed for 112 bread wheat cultivars, 17 durum wheat cultivars and 17 barley cultivars. The information included here came from 58 locations, representing 27 countries or natural regions in Asia, Africa, Europe and the Americas. Diseases assessed this year are leaf rust, stem rust, septoria blotch, powdery mildew, and helminthosporium leaf blotch.

The vast amount of information generated by the RDTN may be summarized in numerous ways, as indicated in past Annual Wheat Reports. Tables 1, 2, and 3 illustrate additional approaches to data interpretation. Table 1 gives, for each country or region, the number of bread wheat cultivars (out of 112), durum wheat cultivars (out of 17), and barley cultivars (out of 17) susceptible to each of the six diseases assessed. Great differences in disease profiles are apparent from Table 1. For example, assessments from Iran include all six diseases for the three crops; septoria and powdery mildew populations exhibit the widest range of virulence against all three crops (103 and 112 susceptible

Table 1. Virulence spectra of selected cereal diseases for 27 countries or regions that reported disease data from the 1980 Regional Disease Trap Nursery. Data represent number of entries that exhibited a susceptible reaction at one or more sites in the respective country or region

		Bread wheat (112 entries)					
Country or region	Number of sites included	Leaf rust	Stripe rust	Stem rust	Septoria	Powdery mildew	Helminthosporium
Bangladesh	3	71	-a/	2	-	-	16
Nepal	3	76	-	29	-	0	39
Pakistan	6	73	68	40	-	0	-
Turkey	4	98	65	91	1	42	4
Iran	3	52	7	35	103	112	1
Israel	2	40	31	-	27	-	-
Egypt	3	100	16	88	-	-	-
Algeria	2	15	14	-	1	9	0
Morocco	3	98	6	17	9	0	-
Iberian peninsula	3	16	51	17	25	19	-
France	1	12	46	-	-	14	-
Italy	5	57	46	72	-	9	-
Yugoslavia	2	86	-	70	15	30	-
Greece	1	15	-	9	-	0	-
Bulgaria	2	63	34	37	-	20	-
Arabian peninsula	2	61	-	46	1	0	12
Sudan	1	-	-	34	-	-	0
Kenya	3	11	91	-	0	-	-
Tanzania	1	9	57	5	-	-	-
Mexico	1	72	-	-	-	-	-
England	1	-	-	-	33	8	-
The Netherlands	1	1	19	-	-	-	-
Czechoslovakia	1	-	-	41	-	-	-
Switzerland	1	21	34	6	-	29	-
Romania	1	58	41	61	49	-	-
Cyprus	1	23	6	14	1	-	-
Ecuador	1	-	28	-	-	-	-

a/ No data reported on this disease

bread wheat cultivars, respectively, 10 and 14 susceptible durum cultivars, and 16 and 17 susceptible barley cultivars). In contrast, disease assessments reported from the Netherlands suggest that local populations have a much narrower virulence range against CIMMYT germplasm. An alternative interpretation, the lack of a favorable environment for disease development, may be disregarded in relation to stripe rust because the susceptible check, *Triticum spelta saharense,* had a disease assessment of 90/100.

Table 1 also illustrates that crops in a certain country or region can be more prone to specific diseases than in another country or region. Thus, disease assessments suggest a higher disease potential for barley from stripe rust in Romania than in nearby countries. In fact, nearly 75 percent of the barley lines tested in Romania succumbed to the stripe rust fungus. This kind of analysis of Table 1 leads to the identification of hot spots where severe selection pressure may be applied to cereal germplasm.

When cultivars are classified as local, improved, or dwarf (if applicable), their respective disease assessments may help diagnose trends toward greater or lesser disease potential. The data in Table 2 are arranged in this fashion for all six diseases and all three crops. It is evident that maximum disease intensity is not affected by the class of cultivars. Average disease intensity, however, is dramatically reduced for the three rusts by using improved or dwarf cultivars of bread wheat and durum wheat. No clear pattern appears for powdery mildew or septoria. There seems to be a trend toward increased intensity of helminthosporium blotch on improved and dwarf wheat cultivars. If this trend is confirmed, it may indicate a loss of resistance

Table 1. Continued

		Durum wheat (17 entries)					
Country or region	Number of sites included	Leaf rust	Stripe rust	Stem rust	Sep-toria	Powdery mildew	Helmintho-sporium
Bangladesh	3	10	-	0	-	-	1
Nepal	3	11	-	3	-	0	8
Pakistan	6	15	12	5	-	-	-
Turkey	4	17	11	16	1	8	0
Iran	3	8	7	1	10	14	2
Israel	2	5	8	-	6	-	-
Egypt	3	17	3	13	-	-	-
Algeria	2	0	1	-	1	2	0
Morocco	3	15	0	9	0	0	-
Iberian peninsula	3	3	3	5	2	2	-
France	1	3	6	-	-	1	-
Italy	5	15	10	16	-	1	-
Yugoslavia	2	17	-	8	0	3	-
Greece	1	7	-	0	-	0	-
Bulgaria	2	13	3	3	-	0	-
Arabian peninsula	2	13	-	13	0	0	5
Sudan	1	-	-	17	-	-	0
Kenya	3	2	14	-	0	-	-
Tanzania	1	0	4	0	-	-	-
Mexico	1	4	-	-	-	-	-
England	1	-	-	-	3	3	-
The Netherlands	1	0	2	-	-	-	-
Czechoslovakia	1	-	-	11	-	-	-
Switzerland	1	5	1	11	-	0	-
Romania	1	5	1	14	7	-	-
Cyprus	1	1	-	1	0	-	-
Ecuador	1	-	3	-	-	-	-

through breeding in the absence of intense selection. Thus, results from trap nurseries may also be used as feedback information to help guide breeding strategies.

Typically, the effectiveness of trap nurseries depends upon a differential genetic interaction among a number of host cultivars and pathogen isolates. Table 3 illustrates a pattern of differential reactions for leaf rust. Eight wheat lines from Novi Sad, Yugoslavia, responded differentially to leaf rust populations in nine countries in such a way that no two lines responded identically. Likewise, no two rust populations produced identical patterns on the differential lines. Similarities in response among locations within a given geographic area help define epidemiological units.

In addition to the RDTN, a large volumn of information about the virulence spectra of pathogen populations in the region is generated by the Regional Disease and Insect Screening Nursery (RDISN). Data also come from all other CIMMYT distributed nurseries and many national cereal research program nurseries. These data are evaluated in cooperation with national program scientists, and the information thus derived is made available to them and to CIMMYT, where it is quickly utilized in on-going germplasm development programs. This is a continuous process, resulting in the ready availability of high yielding, widely adapted, and disease resistant material from which national programs can select, further improve (if they choose), and release new cultivars. In this process, the DSP role is to faciliate the flow of information and material, thereby reducing the lag time and the number of erroneous decisions made regarding varietal release.

TRAINING

CIMMYT staff in the region travel extensively, consulting with national program scientists, evaluating nursery materials, and conducting informal on-the-job

Table 1. Continued

		Barley (17 entries)					
Country or region	Number of sites included	Leaf rust	Stripe rust	Stem rust	Septoria	Powdery mildew	Helminthosporium
Bangladesh	3	0	-	1	-	-	1
Nepal	3	2	12	1	-	0	11
Pakistan	6	1	1	14	-	-	-
Turkey	4	16	0	15	0	7	3
Iran	3	3	0	15	16	17	5
Israel	2	6	0	-	-	-	-
Egypt	3	16	0	9	-	-	-
Algeria	2	1	1	-	0	4	1
Morocco	3	12	3	0	0	0	15
Iberian peninsula	3	8	0	0	0	1	0
France	1	11	1	-	-	2	-
Italy	5	15	4	16	-	15	-
Yugoslavia	2	17	-	17	4	2	-
Greece	1	11	-	0	-	0	-
Bulgaria	2	10	1	2	-	2	-
Arabian peninsula	2	6	-	14	0	0	0
Sudan	1	-	-	17	-	-	8
Kenya	3	0	2	-	0	-	-
Tanzania	1	3	2	0	-	-	-
Mexico	1	0	-	-	-	-	-
England	1	-	-	-	0	0	-
The Netherlands	1	1	0	-	-	-	-
Czechoslovakia	1	-	-	15	-	-	-
Switzerland	1	0	0	0	-	0	-
Romania	1	13	12	17	13	-	-
Cyprus	1	12	-	0	-	5	1
Ecuador	1	-	8	-	-	-	-

Table 2. Summary of disease intensity data for the 1980 Regional Disease Trap Nursery (RDTN) on bread wheat, durum wheat and barley cultivars, classified as local, improved or dwarf

Disease	Range of scale	Number of reporting locations	Category of cultivar	Bread wheat (112 cultivars)		Durum wheat (17 cultivars)		Barley (17 cultivars)	
				Average	Maximum	Average	Maximum	Average	Maximum
Leaf rust	0-100	54	Local	39.3	100S	17.2	100S	12.0	100S
			Improved	12.8	100S	10.1	80S	11.6	100S
			Dwarf	8.8	100S	10.0	90S	-	-
			All	13.1		12.1		11.6	
Stripe rust	0-100	42	Local	20.2	100S	8.6	65S	6.4	80S
			Improved	8.2	100S	3.6	50S	3.6	100S
			Dwarf	9.4	80S	2.8	40S	-	-
			All	9.6		4.8		3.9	
Stem rust	0-100	46	Local	19.5	100S	20.0	100S	7.0	70S
			Improved	8.9	100S	8.3	90S	7.5	100S
			Dwarf	4.7	100S	6.6	80S	-	-
			All	7.9		11.4		7.5	
Powdery mildew	0-9	33	Local	3.0	9	1.9	8	2.6	9
			Improved	2.3	9	2.0	9	2.5	9
			Dwarf	2.3	9	2.1	7	-	-
			All	2.4		2.0		2.5	
Septoria	0-9	25	Local	2.2	9	2.0	7	0.9	7
			Improved	2.3	9	2.1	9	1.2	9
			Dwarf	2.7	9	2.2	9	-	-
			All	2.5		2.1		1.2	
Helminthosporium	0-9	11	Local	1.3	6	1.4	8	4.1	7
			Improved	1.9	8	1.8	7	3.4	9
			Dwarf	2.5	9	1.6	6	-	-
			All	2.1		1.7		3.5	

or in-the-field training of younger, less experienced national program staff. Assistance and training in data analysis and interpretation is also provided, so that better decisions concerning varietal release can be made.

The lack of severe and uniform disease pressure, as well as inconsistent methodologies for disease screening in many national programs, still hampers progress. Cultivars without adequate levels of disease resistance are often developed and, when released, their useful life expectancy is relatively short. This inability on the part of many national programs to conduct effective disease screening and monitoring activities resulted in the development of a series of workshops focusing on disease methodologies. Funded by the Government of the Netherlands in 1976, the workshops are conducted in cooperation with the Institute for Plant Protection (IPO), Wageningen, The Netherlands. To date, six major (10 to 12 day) workshops have been held in India, Pakistan, Turkey, Kenya, Syria and Chile. The emphasis has been on the techniques and equipment needed to carry out effective disease screening activities, especially for the rust diseases. In 1980, two shorter (3 to 5 day) workshops were held in Bangladesh and Nepal, attended by 20 and 16 trainees, respectively. Several sets of the necessary equipment were also provided to each country by the Government of The Netherlands. Indicators of the effectiveness of these workshops include:

- a greater awareness of the importance of plant diseases in national variety improvement programs;
- a greater effort by national program pathologists and breeders to ensure uniform artificial inoculations;
- a generally high level of use of the donated equipment;
- an increased resistance to major diseases in advanced national program materials; and
- the fact that the majority of participants in the workshops are still active in national program varietal improvement projects.

It is encouraging to note the increased use of additional locations for disease screening, both within country and in neighboring countries that have an impact on the disease situation of the distributing country. A good example is Turkey, which now conducts experimental trials at eleven Turkish research institutes, plus more that 20 "off-station" locations within country. In addition, advanced material from the winter and spring wheat and barley projects are now sent to 10 to 12 locations outside the country, particularly to the Balkan countries, which the DSP has shown to be one of the major pathways for diseases important to Turkey. This multi-location testing concept is also practiced by a number of other countries in the RDTN region, and by CIMMYT in the development of broad-spectrum resistance germplasm.

Inherent in the concept of multi-location testing is the value of germplasm exchange, not only by CIMMYT and other international organizations, but by the national programs themselves. By receiving, growing, and testing the international, regional, and national observation or screening nurseries, cooperators have access to a very large array of germplasm from which to select material suitable for their own conditions. Multi-location testing is not a new concept, but this approach, and the greater access to new or different germplasm it provides, is a major part of the DSP training, information, and technical assistance effort.

It bears re-emphasizing that there is a persistant need to increase national program capabilities in the monitoring and analysis of major disease pathogens. This analysis should be oriented toward cataloging the germplasm base of the breeding program, rather than the taxonomic aspects of classification. Both can be accomplished, but the priorities assigned and the way the analysis is done determine its immediate usefulness. Most developing countries still lack the facilities and manpower required for such work. Therefore, increased support must be given (and sources of funds identified) to help these countries in this endeavor.

Table 3. Reaction of eight differential wheat cultivars to nine leaf rust populations, identified according to the country or natural region where they occur. Susceptible reaction is indicated by (+) and resistance is indicated by a blank space (source: 1980 RDTN)

	Country or natural region								
Wheat cultivar	Nepal	Turkey	Iran	Egypt	Italy	Yugoslavia	Bulgaria	Arabia	Romania
NS 1201	+	+		+	+	+	+		
NS 1820		+	+	+		+		+	
NS 1830		+				+			+
NS 2568/2				+			+		+
NS 2630/1		+				+	+		
NS 2699		+					+		
NS 704/49		+		+		+			
NS 709/75	+			+		+			+

Andean Region

The basic objective of CIMMYT's Andean program continues to be the increase of wheat production through assistance to the region's national small grains programs. This is to be achieved by: (1) providing high yielding, disease resistant germplasm that is well adapted to the region; (2) increasing germplasm exchange within the region; (3) continual training of personnel at CIMMYT base in breeding, production agronomy, pathology, and cereal technology; (4) timely visits by CIMMYT regional and base staff to give technical assistance and catalyze progress wherever possible; (5) organizing workshops and conferences as a means of increasing information exchange and regional integration of the small grains programs.

In the Andean region, the areas planted to wheat in 1980 approximated that of 1979. Colombia was notable, with a 6,000 ha increase in wheat area. Total area was between 230,000 to 245,000 ha, depending upon sources cited. Yields averaged less than 1.0 t/ha in most areas, except Colombia which continues at about 1.4 t/ha. Ecuador, Colombia, Peru and Bolivia imported about two million tons of wheat in 1980, and unless local production increases, imports are predicted to continue to increase.

In principle, all four wheat producing countries in the region (Venezuela excluded) are very interested in increasing domestic production. The important constraints to achieving these increases appear to be primarily agronomic and economic in nature. Experiment stations in the region are obtaining yields of 4 to 7 t/ha, but average yields of less than 1 t/ha are being obtained in farmers' fields. The most efficient farmers in the region, however, are achieving yields of up to 4 t/ha. This indicates that germplasm is not a primary constraint. Thus, emphasis will now be shifted toward on-farm research, verification, and demonstration. The Andean wheat program is attacking production problems with all its available resources, and the posting of a regional agronomist in the near future will help immensely. It is important to emphasize that efforts to produce high yielding, broadly adapted, and disease resistant germplasm will continue. Diseases are an ever present problem and will be dealt with continually. There is no doubt that CIMMYT's comparative advantage lies in the development of germplasm and appropriate technology.

In general, the essence of the economic constraints to increased production lie in a morass of limiting factors, such as appropriate guaranteed prices, readily available credit, reasonable prices for inputs, marketing problems, technical aid on-farm, and seed availability. The Andean wheat program will continue to emphasize the agronomic and germplasm (especially disease) problems in the region, and will deal with economic obstacles in conjunction with our regional economist as much as possible.

Data concerning barley are scarce, but it appears that the planted area is in the range of 400,000 ha for the four countries (Colombia, Ecuador, Peru, Bolivia). Average yields are less than 1.0 t/ha, with the exception of Colombia (1.4 t/ha). Stripe rust has severely reduced yields, especially with small farmers who cannot economically apply fungicides. Nevertheless, the barley breeding programs in each country are working to resolve the problem and new varieties are being released. Barley yellow dwarf virus (BYDV) continues to be a somewhat cryptic problem, in barley as well as wheat. The basic limiting factors affecting wheat production also affect barley, although in all countries private industry gives differing levels of support.

GERMPLASM DEVELOPMENT

The provision of high yielding, disease resistant, and well adapted germplasm continues to be the main function of any CIMMYT regional wheat program. The Andean region received a total of 141 wheat, barley and triticale nurseries in 1980, which were distributed as follows: Peru (53), Ecuador (39), Colombia (11), Bolivia (28), Guyana (6), and Venezuela (4). It should be remembered that countries like Peru have several organizations working with wheat and barley, which increases nursery requests greatly. Due to the coffee rust problem in the region, quarantine regulations have become more stringent, thus impeding germplasm movement. In certain countries, internal problems within the national programs have delayed the removal of seed from customs up to four months, resulting in some nurseries not being planted this season.

The Andean wheat program distributed the following wheat nurseries: 24 sets of the Latin American Disease and Observation Nursery (VEOLA), comprised of 469 entries each; 27 sets of the Latin American Rust Trap Nursery (ELAR), each with 136 entries; and 10 sets of the Regional Wheat Yield Trial (ERTA), each set containing 10 entries. Due to problems in the Ecuadorian barley program, the barley VEOLA was not sent in 1980. Details concerning the goals of VEOLA and the ELAR are in the 1979 annual report.

In 1980, the Southern Cone countries held two meetings partially concerned with germplasm exchange. These meetings were sponsored by the Southern Cone BID/IICA project. The salient points from these sessions are (1) the VEOLA was divided into two parts, VEOLA-Zona Andina and VEOLA-Cono Sur, and (2) the Southern Cone rust and leaf rust trap nurseries have been combined into the ELAR and will be put up and dispatched from Quito.

On the basis of pathology alone, CIMMYT believes that the VEOLA should not be divided into two nurseries. The Southern Cone should screen germplasm that is resistant to prevalent races in the Andean Zone, and vice versa, since ELAR data indicate movement of races from one region to the other. Prophetically, barley yellow rust (race 24) was found north of Santiago, Chile, in November 1980.

In June, 1980, CIMMYT and ICA (Colombia) sponsored a wheat-barley workshop in Bogota, and it was agreed by the participants to initiate replicated regional wheat and barley yield trials. CIMMYT agreed to make available and distribute the ERTA (Ensayo de Rendimiento de Trigos Andinos), and Jose Sierra, Malterías de Colombia, S. A., based in Bogota, agreed to take charge of the ERCA (Ensayo de Rendimiento de Cebadas Andinas) CIMMYT is pleased to have private industry participation in this effort.

The basic objective of these regional yield trials are to identify well adapted, disease resistant germplasm with high yield potential in the region, and to exchange candidate lines between programs. The best materials will be sent to CIMMYT, Mexico, for crossing with their outstanding germplasm, and F_2 seed from these crosses will be sent to the region for selection under local conditions. Data on promising lines in the region have been transmitted to CIMMYT, Mexico, for use in crossings. The following lines may be released in 1981:

Ecuador

Altar"S"=Tob"S" x Desc-Fr
EII 3965-1e-0e-0e-4e
Saraguro"S"=Tob"S"-Npo63
EII 3958-2e-0e-0e-9E

Colombia

Pavon"S"
Alondra"S"

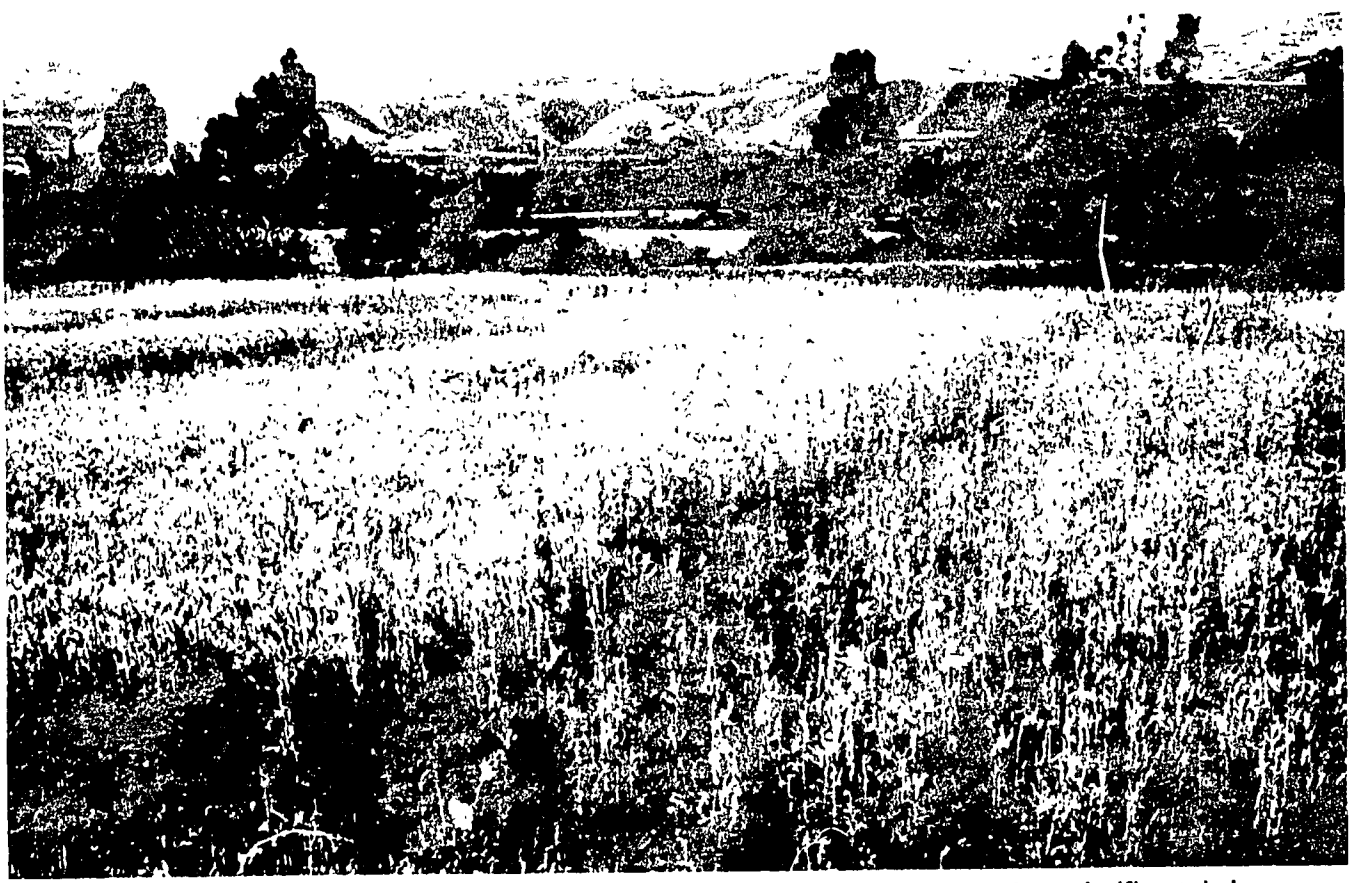
Bolivia

Anhinga"S"=D23234-52M-3Y-1M-0Y (durum wheat)

Perú

UNA 80 (barley)= UNA 8308 (not CIMMYT related)

Over the last three years, triticale yield trials in Ecuador have indicated excellent adaptation, yield potential, and disease resistance. This year an M_2A-IA (X12665-14Y-1Y-6M) is being multiplied at Station Catalina for industrial



Countries of the Andean region imported about 2 million tons of wheat in 1980, representing a significant drain on foreign exchange. Efforts are continuing in Ecuador and the other countries of the Andean region to provide high-yielding, disease resistant and well-adapted CIMMYT germplasm.

testing, and is also being tested in on-farm trials. As noted in the 1979 report, emphasis should be placed on studying the possibilities of triticale in the Andean region.

The search for germplasm with unique adaptation continues. All of the Andean countries are interested in growing wheat in non-traditional areas, viz., coastal Ecuador; lowland (north of Santa Cruz and the Chaco) Bolivia; coastal Peru; savannah Guyana. All these areas have programs in which CIMMYT materials are being tested. Colombia wants to test materials in the acid soils of the "Llanos," and on the Atlantic coast also, but no trials are in progress. Coastal Peru presents no biological problems for CIMMYT wheat.

PATHOLOGY

The major wheat disease problems in the Andean Highlands are stripe rust and barley yellow dwarf virus (BYDV). In barley, the major diseases are stripe rust, leaf rust, and BYDV. Some yield loss data due to BYDV were obtained in Ecuador in 1980 and losses averaged approximately 20o/o in several trials. Loss data from other areas do not exist, but widespread infection was observed in Ecuador and Peru in 1980. Resistance must be obtained in wheat and broadened in barley. A grant proposal to this end is in the process of being submitted in conjunction with the University of California, Davis.

Preliminary data from ELAR nurseries indicate that stripe rust resistance in wheat is adequate at this time, probably for two reasons: (1) breeding efforts over the last decade have been successful, and (2) for economic reasons, wheat area has declined by over 50%/o in Colombia and Ecuador. No important change in stripe rust virulence has been noted in the last three years. However, breeding programs must strive to maintain these high levels of resistance.

In most cases, former CIMMYT trainees are inoculating their nurseries with stripe rust. In 1979, a workshop was held in Santiago, Chile, focusing on pathology techniques relevant to breeding programs. Equipment donated by the Royal Government of the Netherlands is in place at this time and should facilitate good pathology support for the breeding programs.

The ELAR and VEOLA nurseries are important pathology tools for the entire South American continent. At this time, however, there is still a severe bottleneck in data analysis. This bottleneck is in the process of being resolved with the help of CIMMYT's computer center and IPO, Wageningen. A preliminary report on the 1st and 2nd ELARs as well as the 1st and 2nd barley VEOLAs has been submitted to CIMMYT base and cooperators. Finally, the utility of the ELAR for South America will be enhanced by the inclusion of the Southern Cone stem and leaf rust nurseries.

Stripe rust in barley continues to be the main disease in the highlands, while BYDV and leaf rust are apparently second and third in importance. Barley scald and various helminthosporium diseases may be of local importance. Although good stripe rust resistance is available in recently released materials, they are not yet widely planted.

In Peru, the cultivar Zapata is now susceptible to stripe rust (Race 24). The recently released UNA 80 is still highly resistant. This year, barley mixtures with differing levels of resistance are being tested at Station Catalina as a possible means of delaying erosion of stripe rust resistance in barley. The fact that Race 24 has now arrived in Chile highlights the need for multilocation testing and diversification of barley germplasm.

Efforts by national programs to incorporate the Yd_2 gene for BYDV resistance, as well as stripe and leaf rust resistance, must increase. As wheat moves into non-traditional areas, new pathological problems can be expected to occur. In some areas, such as the Bolivian Chaco and coastal Peru, familiar diseases such as stem and leaf rust are problems, In the warmer areas of coastal Peru and Ecuador, however, foot rots, such as *Sclerotium rolfsii*, and many foliar blights will be important.

TRAINING

In 1980, the Andean regional program provided training funds for three in-service trainees: one from Bolivia (CORGEPAI, irrigated production) and two from Ecuador (INIAP, breeding). One additional trainee from Peru (MAG, production) was sponsored by CIDA.

Training efforts should be intensified. There is a continual loss of trained personnel from national programs to private industry and to other countries. Until salaries are commensurate in national programs, this loss will continue. Paradoxically, at times and in certain countries (such as Peru), money is available, yet it is difficult to identify good candidates. Generally, however, this is not the case. A final comment on training: during a recent visit to Bolivia, the USAID director asked what percentage of former trainees were still working in the speciality for which they were trained at CIMMYT. Pride can be taken in the fact that in Bolivia, every former trainee is still working in small grains and with their original projects. In other countries of the region the average is over 90 percent.

WORKSHOPS AND CONFERENCES

The Andean regional program helped to organize and participated in several workshops and conferences held in 1980. These meetings, and some of the conclusions and recommendations forthcoming, were noted earlier. Numerous visits were made by regional staff to experiment stations and on-farm trials located in various countries throughout the region. Five scientists from the region also visited CIMMYT, Mexico, to select materials useful to national programs and to interact with CIMMYT base staff and visitors. The resulting discussions concerning regional integration and constraints to increasing yields proved extremely helpful in fulfilling the objectives of the Andean regional program.

Southern Cone Region

In its second year, CIMMYT's regional program in the Southern Cone countries of Latin America further clarified its role and priorities in assisting the national programs of the region. CIMMYT's primary objective in all its regional wheat programs is to increase wheat production through (1) germplasm introduction and evaluation, (2) training of national program technical staff, (3) assistance in and complementation of operational aspects of research projects, and (4) distribution of scientific information to, from, and within the region.

Detailed information regarding the area seeded to wheat, production, consumption, and climatic patterns were discussed in the 1979 report. During 1980, there were few changes in total area seeded and production, but differing trends were observed in individual countries. Argentina increased its wheat area by over 10 percent (due to international demand), while Brazil reduced its wheat area by approximately 20 percent (primarily because of the previous year's crop failure). Chile continued its trend toward area reductions because of the high costs of production and a free market government policy that allows millers to import a uniform quality of wheat without being subjected to any substantive restriction (with the assistance of low interest long-term loans). Paraguay and Uruguay remained fairly constant in comparison to 1979.

During 1980, the Brazilian government made a long-awaited decision to reduce somewhat a high subsidy to consumers. In the short-term, this decision has resulted in increasing the price of bread in urban areas. The long-term effects on the demand for and production of wheat are difficult to visualize at the present time. In Brazil, the government decision to lend only a portion of the cost of production (thereby forcing the farmer to use his own capital) may be affecting the area seeded to wheat more than anything else. Previously, large numbers of farmers seeded wheat (a high risk crop) in a wheat-soybean rotation system in the southern part of Brazil, simply because it presented no capital loss to them while covering their fields during winter (guarding against erosion).

Argentina, on the other hand, is gaining more confidence as an exporter of wheat, and the price its farmers receive compares favorably with the international price. This year, for the first time, approximately one and a half million hectares of wheat were fertilized with nitrogen. The availability of nitrogen and phosphorus fertilizers at reasonable prices will further increase their use, thereby increasing wheat production tremendously even at the present leval of area seeded. In addition, Argentina is very much aware of the important role it can play in total world food production, especially for Latin America.

In most countries agricultural research programs are under fire from their administrators to prove their economic worth. It is fair to say that wheat (cereal) production research in this region depends primarily on economic and political considerations, and only in certain specific cases on biological constraints. Much can be achieved in the Southern Cone by effective production policies combined with agressive agronomic research. Crop improvement research must continue at least at the current level to add stability to future production.

CROP STATUS DURING 1980

It is important to record and summarize various factors affecting wheat production each year so that over a period of time recurring factors can be identified and incorporated into the improvement program.

Argentina

Early heavy rains in the Buenos Aires province provided excellent seeding conditions in some areas, but also delayed seeding operations in the south. During the early growth period, a severe drought covering the north of Buenos Aires, Santa Fe, and Cordoba provinces reduced early production estimates from about 10 million tons down to 8 million tons. The year climaxed with a heavy hail at harvest time that completely destroyed all standing vegetation on about 80,000 ha of land in Cordoba and Santa Fe provinces (about 30,000 ha of wheat were destroyed). The Marcos Juarez Experimental Station of INTA (National Institute of Agriculture and Livestock Research), which is located in this area, lost all of its wheat research program material, including large seed multiplication plots.

Late rains, combined with high temperatures, brought serious problems of leaf blotch and head scab diseases on the experimental stations. Farmers' fields were also affected, but at a lower level. Loose smut in the farmers' fields remains heavy, yet nothing is being done to ensure seed treatment and reduce the losses. As mentioned in the 1979 Annual Wheat Report, the value of the wheat crop lost in certain areas to loose smut (an average of 8 percent) is sufficient to buy enough nitrogenous fertilizer to raise yield

levels by about 50 percent. Due to all these problems, 1980 turned out to be only a fair wheat production year.

Argentina maintained its malting barley area at approximately 250,000 ha, thereby producing roughly 340,000 tons of the crop. Forage barley and triticale areas remained fairly constant, though an increase in the triticale area is expected when the newer varieties are released.

Brazil

A good crop in the northern wheat region (Matto Grosso do Sul, Parana, and Sao Paulo states) virtually saved the country from a total disaster. A late September frost, for the second consecutive year, destroyed about 40 percent of the state of Rio Grande do Sul wheat crop.

The uncertainity of a wheat harvest in the south is forcing many farmers to abandon wheat and look into alternative cropping patterns, Unfortunately, there are very few alternatives for a winter crop. However, both EMBRAPA (The National Research Organization) and FECOTRIGO (The Farmers Federation) are intensifying their research efforts on crop diversification, and are considering wheat as only a component crop to be grown every third or fourth year. This shift in cropping is also becoming necessary because of root diseases, which are causing significant losses every year.

These problems have resulted in increasing barley, maize and flax areas in the Rio Grande do Sul, and the introduction of rape seed. The barley area in Brazil went up from about 95,000 ha in 1979 to approximately 110,000 ha in 1980. Most of it is localized in the states of Rio Grande do Sul and Parana, and is under contract by the breweries. Brazil produces about one-third of the malt

In cooperation with Brazilian researchers, a number of high-yielding acid-and aluminum-tolerant lines with improved disease resistance are being rapidly developed using the shuttle breeding technique.

consumed in the country. Further increases in the area seeded will require financial stimulation and a minimum support price.

All barley varieties are owned and distributed by the brewers. Four major varieties are Vola, FM 404, FM 424, and Antarctica-4. All are very susceptible to loose smut and require seed treatment. Other major disease problems are leaf rust, helminthosporium leaf spots, and barley yellow dwarf virus in heavy aphid years. Leaf scald caused by *Rhyncosporium secalis* is very irregular. The acid soils require liming since most barley varieties grown are not tolerant to aluminum toxicity.

Despite the clear advantages of triticale in adaptation and yield on the experimental plots, no varieties have yet been released for commercial purposes. The reasons seem to be the lack of markets and the lack of a developed price and quality structure.

Chile

A long period of rain at seeding time further reinforced the tendency to reduce area sown to wheat. A recent published figure of area seeded to wheat (432,160 ha) represents a reduction of over 20 percent from 1979. Considering 1980 to be a fair to good wheat year in Chile, production should reach about 700,000 tons (only a third of the national demand).

The area planted to barley was reduced to 49,000 ha from 60,000 ha the previous year. The lower yields of the present varieties is a limiting factor. In addition, Race 24 of barley stripe rust, which created havoc in the Andean region, was observed in northern Chile (Ovalle) for the first time. Its movement into the major barley growing areas of the south may still take some time, but once there it will significantly reduce the area under barley, since all varieties grown at present are highly susceptible.

Paraguay

Due to poor harvest conditions and serious sprouting of standing wheat (especially Timgalen), farmers responded with very little increase in the total area seeded to wheat in 1980. In addition, roughly 30 percent of the area was seeded very late, and suffered from high temperatures and a lack of moisture throughout its growth cycle. The final blow came with the late frost of mid-September that covered vast areas of the Itapua region of southern Paraguay. This reduced an expected crop of over 60,000 tons to roughly 45,000 tons. The same frost seriously affected the Chaco region of Argentina and the Rio Grande do Sul state of Brazil.

As to diseases, leaf rust and powdery mildew are important every year, while septoria leaf blotch and head scab are more irregular. Chemical control of these diseases is widely practiced, and a strong effort to develop genetically resistant varieties is underway. Introduction of the variety Alondra from Brazil is having very good results.

Uruguay

Early season rains delayed wheat seeding operations all over Uruguay. Once seeded, however, the year turned out to be climatologically fairly normal, and production is estimated at about 250,000 tons of wheat, with an average yield of 1,000 kg/ha.

There were low levels of septoria leaf blotch and the rusts on the commercial farms. Heavy head scab appeared later in the season, but had little influence on yield. Two varieties are grown on more than 70 percent of the wheat area in the country—Estanzuela Tarariras and Marcos Juarez INTA (an Argentine introduction). Both these varieties carry partial resistance to head scab.

Weeds are a serious problem in the wheat crop. Herbicide application is widely accepted by farmers to control broadleaf weeds belonging to the Cruciferae and Compositae families. Other serious weeds are *Lolium multiflorum* (ryegrass) and *Sorghum halepense* (johnson grass). These weeds often cause the discarding of certain seed multiplication fields.

Approximately 45,000 ha of barley was grown during 1980, all for malting. Most varieties are of Argentine origin, Bonita being the most popular.

There is a definite demand for long-cycle, double purpose (forage-grain) wheat varieties, to be seeded early in April or May. Such varieties must carry a high degree of resistance to septoria leaf blotch to be accepted and productive. Cargill Seed Company (Argentine Branch) is testing some of their advanced lines, but the need to diversify such materials remains high for the national program.

Uruguay, an exporter of small amounts of wheat in the past, is barely producing enough wheat to meet its own needs. The government announced a new price structure just before the 1980 harvest (approximately US $250/ton), with the necessary upward adjustments through April 1981. Farmers may respond to these price adjustments by increasing the area sown to wheat during 1981, and by applying more fertilizer.

GERMPLASM DEVELOPMENT

The distribution of broadly adapted, high yielding, and disease resistant germplasm continues to be the major goal of the CIMMYT wheat program. Regional programs help to orient such a distribution, and assist in implementing this material at the national level. The objective is to complement national program efforts with a problem-solving approach. The role of the regional programs remains the analysis of local varieties and CIMMYT breeding materials to achieve faster progress toward the development of superior germplasm for the region.

Agronomic type and adaptation

One way to fulfill this function is to identify the common progenitors that demonstrate a superior general ability to combine in the early segregating populations. A

group of such progenitors in wheat identified for the Southern Cone is rovided here:

Hork"S"	Brochis"S"	Alondra"S"
Sparrow"S"	Kal-Bb	$Y50_E$-Kal3
Kvz-K 4500 LA	Ti 71-Pci"S"	Anahuac 75
Carp-Bjy"S"	x Kvz-Ti	Pavon"S"
Aepoglom II 64.27	Tzpp x IRN 46-	Veery"S"
(MN 7213)	Cno 67/Protor	Sunbird"S"
Bobwhite"S"	Chiroca"S"	Musala"S"

Another way to accomplish this objective is to select advanced lines that perform well over most of the region, and to recycle them in the breeding program. A group of such lines from various nurseries are presented in Tables 1 and 2.

Table 1. Outstanding bread wheat lines selected over the Southern Cone region

13th IBWSN Entry No.	Variety, or cross and pedigree	
14	(Th^6-KF x Lee^6-KF/Cal)Ald "S"	SWM 3410-1M-1Y-1M-1Y-4M-1Y-0M
38	Kvz-K 4500 L.A. 4	SWO 176-3M-1Y-4M-1Y-1M-0Y-1Ptz-0Y
39	"	SWO 176-3M-1Y-4M-1Y-1M-0Y-2Ptz-0Y
44	Chukar "S"	CM 20769-A-8Y-1M-2Y-5Y-0Y
46	$Tzpp^2$-An_E x Inia/Jar-Kvz	CM 21335-9Y-3M-1Y-1Y-1Y-0B
68	Cno-7c x Kal-Bb/Pci "S"	CM 29686-10Y-1Y-1M-5Y-1B-0Y
125	Buckbuck "S"	CM 31678-R-4Y-2M-5Y-0M
126	"	CM 31678-R-4Y-2M-21Y-0M
128	"	CM 31678-R-4Y-2M-21Y-2M-0Y
133	"	CM 31678-R-4Y-2M-500Y-13M-0Y-0Ptz-0Y
134	"	CM 31678-R-4Y-2M-500Y-506M-501Y
135	"	CM 31678-R-4Y-2M-500Y-501M-503Y
171	Ald "S"/Cal x Bb-Cno	CM 32595-5Y-2M-1Y-1M-1Y-0M
177	Veery "S"	CM 33027-F-12M-1Y-4M-0Y
178	"	CM 33027-F-12M-1Y-3M-1Y-0M
179	"	CM 33027-F-12M-1Y-1M-1Y-1M-0Y
181	"	CM 33027-F-12M-1Y-1M-1Y-2M-0Y
182	"	CM 33027-F-12M-1Y-4M-1Y-1M-0Y
206	Bobwhite "S"	CM 33203-G-9M-5Y-1M-3Y-2M-0Y
207	"	CM 33203-G-9M-5Y-1M-1Y-4M-2Y-0M
225	"	CM 33203-K-9M-19Y-3M-3Y-0M
228	"	CM 33203-K-9M-19Y-3M-4Y-1M-0Y
237	"	CM 33203-K-10M-7Y-3M-1Y-2M-0Y
243	"	CM 33203-N-1M-2Y-500M-0Y
264	Hahn "S"	CM 33682-L-1Y-1Y-1M-3Y-100B-506Y-0M

Aluminum toxicity

A cooperative effort between CIMMYT and several Brazilian institutions (EMBRAPA, FECOTRIGO, OCEPAR) has been underway to develop semi-dwarf wheat materials that will resist the aluminum toxicity of the acid soils of Brazil and some parts of Africa. The advanced material from this effort, selected alternatively in Brazil and Mexico, is already in preliminary yield tests and giving excellent results (Table 3). A newer cycle of early generation material,

Table 1. Continued

13th IBWSN Entry No.	Variety, or cross and pedigree	
265	Hahn "S"	CM 33682-L-1Y-1Y-4M-4Y-100B-500Y-0M
266	"	CM 33682-L-1Y-1Y-4M-4Y-100B-502Y-0M
267	"	CM 33682-L-1Y-1Y-4M-4Y-100B-503Y-0M
268	"	CM 33682-L-1Y-1Y-8M-1Y-100B-0Y
272	Koel "S"	CM 34574-F-2M-1Y-1M-2Y-1M-1Y-0M
273	"	CM 34574-F-2M-1Y-1M-3Y-2M-2Y-0M
279	Gallo-Yr Resel(B)/Au x Kal-Bb	CM 34603-A-1M-3Y-3M-1Y-1M-0Y
282	Sunbird "S"	CM 34630-D-5M-2Y-1M-1Y-0M
283	"	CM 34630-D-5M-2Y-1M-1Y-1M-1Y-0M
284	"	CM 34630-D-5M-2Y-1M-1Y-2M-1Y-0M
285	"	CM 34630-D-5M-2Y-1M-1Y-2M-2Y-0M
286	"	CM 34630-D-5M-2Y-3M-3Y-0M
287	"	CM 34630-D-5M-5Y-1M-2Y-2M-3Y-0M
288	"	CM 34630-D-5M-5Y-5M-1Y-1M-0Y
294	Towhee "S"	CM 34709-Q-2M-2Y-10M-3Y-1M-0Y
332	Sparrow "S"-Grajo "S"	CM 35195-1M-3Y-1M-1Y-1B-0Y
333	"	CM 35195-1M-3Y-1M-1Y-1B-2Y-0M
338	Sparrow "S"-Huacamayo "S"	CM 35218-1M-6Y-5M-1Y-1B-0Y
411	Pci "S"-Maya 74 "S"	CM 39442-6Y-1M-2Y-0M
435	Neelkant "S"	CM 40454-11M-4Y-2M-1Y-0M
498	T. Lumpton 363.30-Cha#2xBjy"S"	CM 43526-V-1Y-1M-3Y-0M
511	Cndr"S"-Ana 75xCndr"S"-Mus"S"	CM 44321-A-1Y-2M-2Y-0M
512	"	CM 44321-A-1Y-3M-1Y-0M
513	"	CM 44321-A-1Y-3M-2Y-0M
514	"	CM 44321-A-1Y-3M-4Y-0M

Table 2. Selected tritical strains over nine locations of the Southern Cone region

11th ITSN Row No.	Variety, or cross and pedigree	
1	Mapache	
2	Beagle	
3	Rahum	
15	M_2A-1A	x 12665-11Y-3Y-9M-1Y-1M-100Y-0M
49	IRA-M_2A	x 15562-3Y-1M-3Y-3M-1Y-100B-100Y-0B
67	Shepherd "S"	x 15754-A-5Y-1Y-1M-2Y-4B-0Y
82	IA-M_2AxPi62/Bgl "S"	x 16304-103Y-1Y-1M-1Y-0M
111	IA-Spy	x 17117-25Y-3Y-4B-0Y
137	Juanillo 88	x 21295
143	Juanillo 95	x 21295
157	Beaguelita "S"	x 22427-100Y-2M-2Y-0M
158	Beaguelita "S"	x 22427-101Y-2M-3Y-4M-2Y-0M
174	M_2A-Bulk E_2xNv "S"	x 24207-3Y-1M-3Y-1M-0Y
176	M_2A-Bulk E_2xCml "S"	x 24209-3Y-1M-5Y-1M-2Y-0M
178	Abn "R"- M_1A	x 24319-1Y-4M-2Y-0M
185	M_1A-FS477	x 24401-B-1Y-3M-1Y-1M-3Y-0M
188	M_1A-FS477	x 24401-B-1Y-3M-1Y-2M-4Y-0M
216	T 107.18-M_2A x M_2A	x 25723-B-1Y-5M-1Y-0M
228	Rahum "S"- Panther "S"	x 29340-1M-1Y-4M-2Y-0M
265	Abn-Cha #2	x 32636-2Y-3B-7Y-0B
279	Panda"R"xOcto Bulk-Bush	x 35781-395H-1Y-0M
282	Panda"R"-Rahum	x 36517-288H-2Y-0M
309	Panda"R"-Ye	x 36521-30H-1Y-0M
317	Panda"R"-Ye	x 36521-166H-2Y-0M
325	Llama-F_3 Spy x Bgl	B 128-100B-101Y-0B

first screened through a laboratory technique, is under selection, and some of the outstanding crosses are:

PRL "S" - Alondra "S"	CM 62304
Maringa - Imuris 79	CM 62324
Jacui - Alondra "S"	CM 62331
Jacui - Buckbuck "S"	CM 62332
Jacui/Kal - Bb x Ald "S"	CM 62334
IAS 58 - Alondra "S"	CM 62342
IAS 58/Kal - Bb x Ald "S"	CM 62345

To identify a wider base for resistance to aluminum toxicity, a large group of advanced lines from Mexico were tested in 1980 in a cooperative effort with EMBRAPA, Brazil. Some of these lines were tested for the second time, and the superior selections from the first and second years are presented in Table 4. The net result of these selections is that the long believed myths that (1) semidwarf or dwarf materials cannot carry resistance to aluminum toxicity, and (2) that high floral fertility will not be expressed under Brazilian conditions, are clearly refuted. To make these newer lines productive, disease resistance needs to be incorporated. A plant type with good agronomic characters is already available.

Regional nurseries

The primary responsibility for the distribution of germplasm lies with the CIMMYT wheat program based in Mexico. In 1980, a total of 175 different nurseries (Argentina-55, Brazil-59, Chile-47, Paraguay-10, and Uruguay-4) were sent out by the base wheat program. However, regional nurseries are distributed to facilitate the exchange of germplasm that has been principally developed within the region. The VEOLA (Latin American Disease and Observation

Table 3. Outstanding entries of the First Aluminum Screening Nursery, Brazil

Row No.	Variety, or cross and pedigree	
10	PAT9 - Pel72018	B 14440-0M-2T-1T-0T-0Y
63	PF72640-PF7326 x PF7065-Ald"S"	F 11933-B-500M-600JG-1T-0T-oY
64	Ald"S"-PAT739	B 17102-25-Z-0A-310A-0A-0Y
67	Ho-Ald"S"	CM 40762-10Z-0A-307A-0A-0Y
68	Ho-Ald"S"	CM 40762-11Z-0A-306A-0A-0Y
76	Pel72380-Atr71	B 13374-21Z-1A-305A-0A-0Y
77	Pel72380-Atr71	B 13374-165Z-4A-2A-2A-0A-0Y
94	(IAS58-IAS55xAld/IAC5)Ald"S"-IAS58xAld"S"	CM 55517-B-1F-703Y-4F-0Y
113	PF70354-A`d"S"	CM 47090-13M-1Y-1F-702Y-7F-0Y
198	IAS63-Ald"S" x Gto-LV	F 11915-A-502M-1Y-1F-701Y-3F-0Y
203	"	F 11915-A-502M-1Y-1F-701Y-8F-0Y
206	"	F 11915-A-502M-1Y-1F-701Y-14F-0Y
213	"	F 11915-A-502M-1Y-3F-701Y-5F-0Y
214	"	F 11915-A-502M-1Y-3F-701Y-8F-0Y
219	"	F 11915-A-502M-1Y-3F-701Y-13F-0Y

Table 3. Continued

Row No.	Variety, or cross and pedigree	
262	"	F 11915-A-502M-1Y-3F-701Y-19F-0Y
263	"	F 11915-A-502M-1Y-3F-701Y-20F-0Y
264	"	F 11915-A-502M-1Y-3F-701Y-22F-0Y
266	"	F 11915-A-502M-1Y-3F-702Y-3F-0Y
267	"	F 11915-A-502M-1Y-3F-702Y-4F-0Y
268	"	F 11915-A-502M-8Y-2F-702Y-1F-0Y
306	IAS54-Bnq"S"	CM 47027-6Y-6M-1Y-0Y
364	Cqt-Ald"S"	CM 46981-2M-1Y-2F-1Y-0Y
376	PF70354-Mus"S"	CM 47091-7M-1Y-1F-1Y-0Y
386	PF70402-Ald"S"x PAT72160-Ald"S"	B 19789-H-501M-3Y-3F-1Y-0Y
394	"	B 19789-H-502M-2Y-3F-2Y-0Y
410	"	B 19789-H-504M-7Y-6F-2Y-0Y
412	"	B 19789-H-504M-7Y-7F-3Y-0Y

Nursery) is one such nursery distributed by the CIMMYT Andean regional program, based in Quito, Ecuador.

In one of the meetings sponsored by the Southern Cone BID/IICA project, wheat breeders from various national programs opted for dividing the VEOLA into two parts (one each for the Andean and Southern Cone countries). This decision was based on the utility of germplasm for the two regions. While this decision may be questioned from a pathological standpoint, it does relieve breeders of both regions from taking notes on materials less useful to their programs. Both the VEOLA (Andean region) and the LACOS (Advanced Lines of Southern Cone), however, will be coordinated by CIMMYT and planted at key locations outside their specified region to keep track of the common problems and leakages from one region to another.

Various rust trap nurseries organized by the national programs were merged with the ELAR (Latin American Rust Nursery) to avoid duplications and provide a much larger scope of virulence study over both regions of Latin America. In addition, several other disease-specific nurseries were organized for distribution in the region by the Southern Cone BID/IICA project.

Varietal releases and seed multiplication

A detailed description of wheat varieties was presented in the 1979 annual report. Most national programs in the region are fairly advanced and are aware of the importance of new varieties. However, in most cases their dominion is limited to the release of varieties. There is very little coordinated effort to demonstrate newly released varieties in the farmers' fields, or to multiply seed rapidly enough to create an impact on national production. As a result, many varieties, even five years after their release, cover only a small proportion of the national wheat area.

During 1980, ninteen new varieties (six of CIMMYT origin) were released in the region (Table 5). If these varieties are multiplied and released to farmers, a significant impact on production should be achieved.

Several outstanding lines of CIMMYT origin are undergoing advanced yield tests in the region. Some that may be released as varieties in the near future include the crosses below and on the next page:

Alondra "S"	CM 11683
Nacozari "S"	CM 5287
Pavon "S"	CM 8399

Veery "S"	CM 33027
Bobwhite "S"	CM 33203
Chat "S"	CM 33090
Sunbird "S"	CM 34630
Buckbuck "S"	CM 31678
Kvz x Cno-Pi	SWM 1285
PV18 x Cno-Jar "S"	CM 21692

Triticale

Strong triticale programs are in operation in Argentina, Brazil and Chile. All have promising advanced materials identified and are now at a decision point that may well decide the future of triticale in the region.

Table 4. Wheat selections resistant to aluminum toxicity, Passo Fundo, Brazil

	Variety, or cross and pedigree	
2/	Jup73-Zp"S"x Coc75	CM 37614-B-12Y-5M-1Y-0M
2/	C22-Torim73	CM 36834-25Y-3M-2Y-1M-1Y-0M
2/	C22-Torim73	CM 36834-25Y-3M-3Y-1/2M-0Y
2/	Sunbird"S"	CM 34630-D-1M-9Y-6M-2Y-1M-0Y
2/	(Bb-CnoxInia-Soty/Sprw"S")Pvn"S"	CM 37705-K-5Y-3M-1Y-1M-1Y-0M
2/	(Kvz/Tob-CfnxBb)Blo"S"	CM 33028-I-1M-3Y-1M-1Y-1M-1Y-0M
	Buckbuck "S"	CM 31678-R-4Y-2M-500Y-506M-502Y-501M-0Y
	G11-Yr Resel(B)/AuxKal-Bb	CM 34603-A-1M-3Y-3M-1Y-1M-0Y
	Jup73-Zp"S" x Coc	CM 37614-B-14Y-3M-6Y-2M-0Y
	Titmouse"S"	CM 30136-18M-1Y-1M-0Y
	Kvz-Trm x Ptm-Ana	CM 43903-H-2Y-1M-2/5Y-1/2M-0Y
	"	CM 43903-H-2Y-1M-5Y-1M-2Y-0B
	"	CM 43903-H-2Y-1M-6Y-1M-1/2Y-0B
	"	CM 43903-H-4Y-1M-3Y-4M-2Y-0B
	Maya"S"-Mon"S" x Kvz-Trm	CM 44083-N-3Y-1M-1Y-5M-0Y
	Cmt-Mo x Trm	CM 43381-D-1Y-1M-2Y-1M-2Y-0B
	Cmt-Mo x Trm	CM 43381-D-1Y-2M-2Y-1/2M-1/2Y-0B
	Madeira"S"	CM 32586-69M-1Y-1M-2Y-1M-1Y-0B
	Abura-Mazoe(Gb)x Bch"S"	CM 32622-10M-1Y-4M-1Y-1M-1Y-0B
	Abura-Mazoe(Gb)x Bch"S"	CM 32622-10M-1Y-5M-3Y-1M-1/2Y-0B
	/Cno-8156 x Tob-Cno(N066/1200 x LR-8156)/ Plo	CM 40699-55M-5Y-4M-0Y
	Bananaquit "S"	CM 32556-3M-1Y-3M-1Y-1B-1Y-0M

2/ Lines selected for two years in a row

Table 5. Wheat varieties released in Southern Cone region, 1980

Variety	Cross and pedigree	Institution
ARGENTINA		
*Chasico INTA	B.Man/Son 64A x Ske-Ane II 18903-17M-3R-3C-1T-2Bv-0Bv	INTA
Buck Pucara	B.Cimm/Cal-Tob x Bb-CC	Criadero Buck
Cooperacion Cabildo	/B.Atl(Kl.Anv-Black hull x Pentad x Mq x General Roca)/ V. Mar V. Sol - Jar "S"	Criadero Cabildo
*Trigal 707	Jar"S"-Fsa x Son64/Tob 66	Cargill
*Trigal 708	/(Jar"S"-Np63 x LR64/Tzpp-An)Cno"S"/Tob66	Cargill
Trigal 800	Scout^5-Agent x Nad63 - C0652643	Cargill
Bonaerense Valverde (Durum)	Gerardo516	INTA
BRAZIL		
Acegua (B7423)	IAS50-B8	IPAGRO
BR 5 (PF74354)	IAS59 x IAS52 - Gasta	EMBRAPA
BR 6 (Pel 73538)	IAS20-Toropi	EMBRAPA
Charrua (CEP 745)	SA3423** - IAS57	FECOTRIGO
Nhu Pora (CEP 74139)	SA3423** - IAS57	FECOTRIGO
Mitacore (IA 783)	Jar"S"-IAS50	IAPAR
Tifton	(Sel Tifton 72/59)(Ga1123/N10B x Nemarg x Hadden^2) CI13524-Asozan x Purdue5714B)	IPAGRO
*Alondra 4546 (ML)	D6301-Nai60 x Wq-Rm/Cno^2-Chr CM11683	IAPAR/OCEPAR
*Tucano (OC 73005)	Son64-El Gaucho	OCEPAR
*El Pato (Pato R)	Tzpp-Son64A x Nar59	OCEPAR
Candiota (MR74044)	PF11.1000/62-SX	MR Seeds
PARAGUAY		
7605 (C 7605)	J 9281-67-LR64A B 550	IAN

* Varieties of CIMMYT origin
** SA 3421 - FKN/(Yt54-Kt 54/Mt x Sg-Qna)Md x McM-Ex/

Argentina seems to be in a rather fortunate situation. The triticale program is developing forage types, and there are already over 20,000 ha of forage triticales grown in the Pampa region. The newer material at INTA-Bordenave Experiment Station is much superior to the already grown varieties (Rosner, Don Santiago, and 6TA 203). Yields of up to 38 t/ha of green matter and 8 t/ha of dry matter have been obtained in four replication forage trials. Results of a few outstanding lines from two experiments and their checks are presented in Table 6.

Brazil and Chile seem to be in a similar situation. National programs in both countries have superior materials identified and multiplied to some extent. In Brazil, the yield advantage of triticales over wheat in the acid soils of the south is overwhelming. In Chile, this advantage is not as great. Lack of data on industrial quality, and strong and favorable evidence of its performance under farmers' conditions appear to be a bottle-neck in the program. However, both countries are aware of the responsibilities inherent in a first release, and are looking to the industrialized nations to provide some solutions.

One possible solution, little explored by industry, is a mixture of triticale with wheat to produce locally consumed products. The important decisions, however, are establishment of local quality standards and a pricing pattern for triticale that will provide incentives to both the farming and industrial community to seriously consider this man-made crop.

Table 6. Results of the triticale forage tests, Bordenave, Argentina, 1980

Cross and pedigree		Yield kg/ha	
		Green matter	Dry matter
Experiment 1:			
274/320 x Late Pit	(x21717)-0YA-1Bv-1Bvp-p	27842	5622
Dakold 97	1 Bvp-p	27321	6084
URSS 3310	9m-0Y-1Y-2Bvp-p	26825	6055
(Kiss x 193-803/358)Rm	(x23315)	24896	5643
274/320		24233	5228
URSS Tcl#3310(Bv-Tobi"S"xM_2A/Bush)	(x21818)	23875	5496
Choique INTA	(Rye check)	19704	4174
Oliveros Litoral	(Barley check)	17946	3927
Surgrain	(Oats check)	6358	1037
Don Santiago	(Triticale check)	11000	2585
6TA 203	(Triticale check)	12283	2765
6TA Sel. Bordenave	(Triticale check)	18208	3925
Experiment 2:			
274/320	12p -7M-0M-1Y-1M-0M	38033	8271
274/320	12p-6M-6Y-21M-1Y-1M-0M	34013	7265
V 68	10M-0M	32000	7130
URSS 3310	Rec 71/95 9M-0Y-1Y-2M	31542	7104
274/320	12p-6M-6Y-0M	31342	6904

Data: Ing. Santiago Garbini, Experiment Station INTA, Bordenave, Argentina

PATHOLOGY

The disease situation in the Southern Cone countries remains complex and constitutes a major biological constraint to wheat and barley production.

The three rusts (stem, leaf, and stripe), together and individually, present a serious problem. There has been little organized study of epidemiology on a regional basis. Spore movement data within a country, or from one country to another, is virtually non-existent. There is a strong indication that in many countries of the region, rust spores over-summer in the stubble. However, criss-cross wind patterns over the pampa during the wheat season make it possible for rust spores to move from one country to another (except Chile) without any difficulty.

While there has been little change in virulence patterns observed over the region during 1980, two deviations marked the year in Chile. One was a severe virulence of stem rust on the durum wheats in Vallenar, in northern Chile. Very few lines of the Eleventh International Durum Screening Nursery were observed to be resistant. Some of these lines are presented in Table 7. The second deviation was the arrival of Race 24 of barley stripe rust in Ovalle (northern Chile). This development will definitely hurt barley production in the country.

Table 7. Selected durum lines resistant to stem rust in Chile

11th IDSN Row No.	Variety, or cross and pedigree		Reaction
1	Guil"S"	CM 14646-C-1Y-1M-1Y-0Y	TR
2	Guil"S"	CM 14646-C-1Y-1M-1Y	TR
6	Boy"S"	CD 4404-B-9Y-3M-0Y	TR
15	Jo"S"-Cr"S"x USA 01679/Jo"S"-Cr"S"	CD 10579-F-6M-1Y-4M-0Y	TR
16	Misri-Mexi"S"x Snipe"S"	CD 10662-F-1M-1Y-2M-1Y-0M	TR
39	ZB-Mah-M'RarixS15-Cr"S"/Mexi"S"	CD 1283-A-4Y-1Y-1M-0Y	TR
51	Yavaros"S"	CM 9799-126M-1M-3Y-0Y-1B	10M
66	Algerian 86		10MR
76	Guil"S"-Mexi 75 x USA 0575	CD 19576-G-1Y-1M-0Y	10MR
79	Gad"S"-Snipe"S" x Gediz"S"	CD 19646-A-7Y-1M-0Y	TR
82	Sca"S"-Kif"S"xAeg.elong-Tac 0Y	CD 19675-C-6Y-1M-0Y	TR
86	Boy"S"-Snipe"S"x Gediz"S"-Corm"S"	CD 19832-A-5Y-1M-0Y	10MR
98	Swan"S"	CD 16707-E-1M-2Y-5M-0Y	20MR
113	USA0640-Fg"S"x Fg"S"^{2}-Ruff"S"	CD 14119-E-7Y-1M-2Y-3M-0Y	TR
123	GdoVZ578-Gta"S"	CD 8544-26M-4Y-1M-1Y-2M-0Y	20MR
131	Magh72		TR
142	Aeg.elong.x Tac-0Y/S15-Jo"S"	CD 18433-8Y-2M-3Y-0M	TR
144	Gta"S"-Pg"S" x USDA580	CD 18533-3Y-2M-2Y-0M	10MR
145	Gta"S"-Pg"S"xUSDA580	CD 18533-14Y-1M-2Y-0M	20MR
151	Sche"S"	CD 19321-C-1Y-6M-1Y-0M	10MR
157	Oyca"S"-Magh"S"x Ruff"S"-Fg "S"	CD 16913-B-2M-2Y-3M-3Y-0M	TR
158	Oyca"S"-Magh"S"x Ruff"S"-Fg"S"	CD 16913-B-2M-2Y-3M-4Y-0M	TR
159	Leeds Mut-Teal"S"	CD 12427-4Y-2M-2Y-2M-1Y-0M	TR
161	Leeds Mut-Teal"S"	CD 12427-4Y-2M-2Y-2M-2Y-0M	TR
164	USA 0640-Fg"S" x Fg"S"-Ruff"S"	CD 14119-E-7Y-1M-2Y-2M-1Y-0M	TR

The effective leaf rust genes over the entire region are Lr-9, Lr-17, Lr-18, Lr-19, Lr-21, and Lr-24. Some others —Lr-3, Lr-3 ka, Lr-12, and Lr-22—have high readings only at a specific site, while Lr-T maintained a low level infection throughout the region. The situation in stem rust is more precarious. Only Sr-9e, Sr-22, Sr-24, Sr-26, and Sr-27 are effective in the region. Virulence for both Sr-9e and Sr-22 are known to be present in Brazil and Chile. Sr-Tt2 gives a low level of resistance in the region. The widespread distribution of the ELAR will help establish a regular basis for observation and analysis of the rust situation in the region.

Rust screening in the region is likely to improve further as the disease inoculum storage and inoculation equipment (courtesy of the Royal Government of the Netherlands) is used by the national programs that participated in the Cereals Disease Workshop held in Santiago, Chile, during December, 1979. Such screening will also become more necessary as wheat moves further into non-traditional areas of Brazil and Paraguay, where climatic conditions are perfect for the development of leaf and stem rusts.

The other serious disease on wheat in the region is caused by *Septoria* spp. Each year, southern Brazil, Uruguay, the northern pampa of Argentina, and the coastal region and southern portion of Chile are affected by one or more *Septoria* spp. Although the disease appears every year, its timing and severity depends very much on climatic conditions. A concerted effort to create artificial epidemics in the segregating and advanced populations will definitely enhance selection of superior types. Meanwhile, farmers are using chemical control measures where the situation is bad. A list of resistant lines selected from the 10th ISPETON is given in Table 8. Forming a collection of lines from the region will also help identification of generally resistant types.

Head scab caused by *Gibberella zeae* is another important disease in the region. Although no loss estimates are available, most of the varieties of the region are highly susceptible, and can suffer serious reductions in yield if scab comes at the flowering stage. Through artificial inoculation techniques under controlled conditions, some wheat genotypes carrying resistance have been identified, but they are so poor in agronomic type and yield that they can only be used as progenitors to transfer resistance to useful plant types.

There are several known varieties, such as Klein Atlas and E. Young, that demonstrate superior scab resistance under field conditions. During 1980, scab was rather severe in Argentina and Uruguay. Field observations indicated superior resistance in the genotypes listed on the next page. These lines are of CIMMYT origin (from the 13th IBWSN) and will require further testing to confirm their resistance.

Table 8. Selections from the 10th ISEPTON resistant to Septoria spp. in six locations of the Southern Cone region

10th ISEPTON Row No.	Variety, or cross and pedigree	
3	Kvz-Sparrow"S"	SWM 2892-18Y-2M-1Y-1M-0Y
4	Kvz-Iorim 73	SWM 3879-9Y-13M-3Y-1M-0Y
21	Titmouse"S"	CM 30136-3Y-1Y-0M-100B-0Y
28	Madeira"S"	CM 32586·101M-1Y-1M-0Y
32-35	Bobwhite"S"	CM 33203-H-8M-8Y-1M-1/2Y-1/2/3M-0Y
62	Moncho"S"-Zaragoza 75	CM 36714-1M-1Y-1M-0Y
81-82	Ti71-Tob66 x Ald"S"	CM 33217-T-6M-1Y-1M-1Y-3/4Y-0M
84	Kal-Bb x Ald"S"	CM 37127-16Y-3M-1Y-2M-0Y
91	Heima-Jup"S"x Bjy"S"	CM 41195-D-4M-1Y-1M-0Y
134	Hahn"S"	CM 33682-L-1Y-1Y-8M-1Y-100B-0Y
135-137	Hahn"S"	CM 33682-L-1Y-9Y-1M-1/3Y-1/100B-0Y
138	Sparrow"S"-Jup73/T.aest x Kal-Bb	CM 34184-A-1Y-1Y-8M-1Y-1B-0Y
155	S12-B8 x PJ62/Huac"S"	CM 40564-4M-1Y-2M-0Y
170	ND487(ND 457/Agent-T1673-Kt48 x Suw 92)	FA 12-153

39	Kvz-k4500 L.A.4
	SWO 176-3M-1Y-4Y-1Y-1M-0Y-2Ptz-0Y
46	Tzpp2-Ane x Inia/Jar-kvz
	CM 21335-9Y-3M-1Y-1Y-1Y-0B
67	Pima-Saka
	CM 29480-20Y-4Y-5M-1Y-100B-508Y-0M
222-224	Bobwhite "S"
	CM 33203-K-9M-15Y-1M-4Y-2/3M-0Y
282-288	Sunbird "S"
	CM 34630-D-5M-2/5Y
511-514	C "S"-Ana 75-C "S"-Mus "S"
	CM 44321-A-1Y-2/3M

Barley yellow dwarf virus (BYDV) on wheat and barley, which drew so much attention during 1975-76, has declined to a virtually negligible level. Reductions in the aphid vector population over the past several years is resulting in national programs loosening their vigil. No conclusion has been reached as to why the aphid population went so high during 1975-76, their origin, or what climatic conditions were responsible for their rapid establishment and multiplication. Little improvement in germplasm has been made for resistance to BYDV (due to a lack of appropriate selection pressure), but it is encouraging that natural parasites released for the biological control of aphids have established themselves and survived.

The central valley of Chile (Santiago), provides an excellent testing ground for BYDV screening. A high population of *Rhopalosiphum padi* carrying one of the most severe non-specific PAV strains (Dr. Roger Plumb, *per. comm.*) infected wheat and barley at the tillering/elongation stage during 1980. The severe yellowing that followed caused widespread concern about possible losses. But aphids went into *alade* form in a week's time, thereby allowing the crop to revive, and no reduction in yield or test weight was observed at maturity.

Brazil and Chile have excellent aphid BYDV biological control programs underway. However, large scale field testing through artificial inoculations has yet to be started. A regional collection of lines carrying some resistance to BYDV (or for testing) is being coordinated by EMBRAPA, Brazil.

The spread of root rot diseases in the TRUMAO (volcanic ash) soils of southern Chile may well be a major limiting factor for high yield potential, as well as response to high fertilization. A similar situation, although smaller in magnitude, occurs in the southern part of Brazil, and is forcing farmers to grow a wheat crop only every third or fourth year in both countries.

Field screening for resistance to root rot diseases has been done for two years at the Carillanca and Chillan Experiment Stations of INIA, Chile. Although no evidence of resistance has been observed, clear differences in the performance of various genotypes may be used as an indicator for selection purposes. Date of seeding, soil temperature and humidity, organic matter content, fertilization, and crop sequence are only a few factors affecting this complex plant-pathogen reaction. A group of selected materials is under observation for the second and third consecutive year. Repetition of certain crosses selected at various times out of some 2,000 lines being tested is the only indicator one can use to judge the lines presented in Table 9.

Leaf spot disease caused by *Helminthosporium sativum* was severe again in the wheat growing region of central Brazil. As wheat spreads to this and other warmer non-traditional regions, helminthosporium is likely to become a serious limiting factor for production. Genetic resistance, though scarce, is available, and an effective field screening in hot-spot areas may be useful. Few lines from the first Tropical Helminthosporium Screening Nursery survived in Londrina, Brazil. Those survivors of CIMMYT origin are listed below:

(Bb-Cno x Inia-Soty/Sparrow "S")Pvn "S"	CM 37705
Au-Up 301 x Gallo-SX	CM 31154
Maya 74-Pvn "S"	CM 39426
AfM-Coc 75	CM 37617
C 67-FO 839 x Ti/Maya 74 "S"	CM 37666
Pvn "S"-Ti 71 (Resel)	CM 36520

Powdery mildew (*Erysiphe graminis*) appears in most of the countries each year, but causes no significant damage. Only in Paraguay does its appearance on young seedlings cause some alarm. Ample sources of resistance are available and all that is required is an effective screening to select resistant materials.

TRAINING

The Southern Cone program provided funds for only one in-service trainee (from Paraguay) in wheat breeding. The lack of candidates for in-service training is due to a virtual freeze on new openings in most of the countries in the region. Adopted as a severe economic measure, it is particularly frustrating to those who already have several years of service, and now have no opportunities to improve their careers. The program sponsored five scientists from the region to visit the base program in Mexico. Four additional young scientists were sponsored to spend approximately three months in Mexico to work on bilateral programs with CIMMYT.

REGIONAL VISITS

A total of 184 days (150 outside base and 34 in the interior of Chile) were spent visiting and working with various national programs of the region during 1980. The role of CIMMYT on these regional visits is to provide assistance in whatever way possible, and to help orient the priorities of the national programs. Specific activities include planning certain experiments and hybridization programs, taking notes, selecting segregating populations, and the final analysis of results. This is a continuous process that repeats itself every year, so that local problems can be understood and effective suggestions within the national framework can be made.

SEMINARS AND CONFERENCES

CIMMYT attended the Ninth Pan American Seed Seminar held in Buenos Aires, Argentina, in November, 1980. The objectives were to focus the crop improvement programs on the needs of farmers in developing countries, and to discuss the promises and problems of seed patent rights in Latin America.

The germplasm exchange meeting sponsored by the Southern Cone BID/IICA project during October, 1980, at Passo Fundo, Brazil, was discussed earlier. Regional meetings are an effective tool to bring all concerned and interested parties together to enumerate common problems and to evaluate specific advances.

Table 9. Root rot field screening selections, Carillanca, Chile

Variety, or cross and pedigree	
* Chat"S"	CM 33090-M-4M-2Y-5M-0Y
* Kvz-Cj71	SWM 1430-4Y-3Y-1M-1Y-100B-500Y-0M
* Hork-Tito"S"	CM 32219-6M-1Y-5M-500Y-100B-503Y-0M
* Kvz-Bon /[(21931-Ch53xAn/Gb56) Pj62)Soty_7	CM 33729-A-1M-2Y-1M-3Y-1M-0Y
Sprw"S"-Gjo"S"	CM 35195-1M-3Y-1M-1Y-1B-0Y
Burgus2 x Kal-Bb	SWM 3115-2M-4Y-1M-1Y-1M-1Y-0M
Carp"S"-Bjy"S"	CM 40452-1M-1Y-4M-0Y
(Cndr"S"/I118889-Tpr x C0652643)Nac	CM 43478-B-1Y-3M-2Y-1M-0Y
Vee"S"	CM 33027-F-15M-500Y-0M-107B-0Y
(Sdy/Yd"S" x Bb-Cha)Kal-Bb	CM 41197-C-1M-1Y-2M-1Y-1M-0Y
Hqn x II 50.72-N10B/Blo"S"	SWM 3411-15Y-1M-1Y-4M-0Y
Hqn x II 50.72-N10B/Blo"S"	SWM 3411-15Y-9M-3Y-1M-0Y
Hqn x II 50.72-N10B/Blo"S"	SWM 3411-15Y-9M-3Y-2M-0Y
Kvz-Trm	SWM 3879-9Y-13M-3Y-1M-0Y
Bow"S"	CM 33203-K-9M-23Y-11M-4Y-1M-0Y
Bow"S"	CM 33203-K-9M-24Y-1M-1Y-1M-2Y-0M
Snb"S"	CM 34630-D-5M-5Y-5M-1Y-1M-0Y
Sprw"S"/[Bb x Son-Kl. Rend/Cha)Gb(K)7	CM 32516-31M-2Y-1M-1Y-1M-1Y-0B
Sprw"S"/[Bb x Son-Kl. Rend/Cha)Gb(K)7	CM 32516-31M-2Y-3M-2Y-1M-2Y-0B
Mrs-Mo x Plo	CM 3533-A-1Y-1M-2Y-2M-1Y-0B
Sprw"S"-Bjy"S"	CM 30137-1M-1Y-1M-1Y-1B-1Y-0M

* Selections from second year screening

Southern Cone Agronomy

During 1980, the majority of the Southern Cone agronomy program activities were concentrated in Chile and Argentina. The work consisted of a continuation and intensification of efforts begun in 1979. The priorities of the program are the same as those outlined in the 1979 Annual Wheat Report.

The work schedule was divided into three parts. One third of the time was spent at base working on general problems affecting the region, one third dedicated to fieldwork within Chile, and one third spent on travel and fieldwork within the region.

CHILE

Trials were carried out in three diverse areas of Chile to investigate agronomic constraints on the yield of wheat. The objectives of these trials were:

- To determine the maximum potential yield of wheat in certain selected areas using recommended levels of technology;
- To determine the gap between yields achieved using farmers' present practices and the highest yield possible in their fields after selected production factors are modified;
- To determine how much of this yield gap can be attributed to each of the selected production factors;
- To determine whether the level of the potential yield is satisfactory for the area;
- If it is not, to determine what other factors may be involved in reducing the yield potential; and
- If the potential yield is satisfactory, to determine what package of practices should be extended to the farmer, what the priorities within this package should be, and the interactions among practices within the package.

The factors investigated were herbicide, and nitrogen and phosphorus fertilizer. Each factor was applied at two levels: zero and the recommended rate for maximum yield. This gave rise to a 2^3 factorial as follows:

Farmer check	Farmer and herbicide
N	N and herbicide
P	P and herbicide
NP	NP and herbicide

The experiments were carried out in farmers' fields. All factors, such as the variety planted, land preparation, date of sowing, etc., were under the farmers' control, except for the factors being investigated. As yet, this experiment does not have economic importance, since the objective is only to determine the production factors limiting wheat yield.

This trial was conducted in three areas: the marine terraces of the V and VI Regions, the volcanic soils of the Precordillera of Ñuble, and the red clay soils of the provinces of Malleco and Cautín.

The contribution of each factor tested was calculated, plus the joint contribution of nitrogen and phosphorus. These are shown in Table 1 for the marine terraces of the V and VI Regions. As shown, the major factor is nitrogen, contributing 610 kg/ha to the yield gap of 930 kg/ha. There is also a slight interaction of N x P accounting for 830 kg/ha of the yield gap. Phosphorus on its own contributes very little. Weed control only contributes 20 kg/ha to the yield gap. This is not surprising, since the farmers also applied herbicide and our treatment was applied over theirs. It would therefore seem that the farmers' herbicide treatments are adequate for the weeds encountered. Of the six locations tested, three were planted with old varieties, and three were sown with improved varieties. Thus, it is more instructive to present the data in Table 1 on the basis of the type of variety used. This is done in Table 2.

Although there is obviously a variety x location interaction, the data still retain their validity when interpreted as trends. As can be seen from Table 2, there are large differences between the old and the improved varieties. The potential yield of the new varieties is much higher, 3,780 kg/ha vs. 3,010 kg/ha. The difference in the yield gap is large, 450 kg/ha vs. 1,480 kg/ha, and is due mainly to the greater responsiveness of the new varieties to fertilizer. It is also noteworthy that older varieties yield higher than the improved varieties under present farmer conditions, 2,560 kg/ha vs. 2,300 kg/ha. The main factor contributing to yields in the old varieties is nitrogen, which accounts for 350 kg/ha of the yield gap. The joint contribution of nitrogen and phosphorus is even lower, which shows that phosphorus need not be applied when using the old varieties because they do not have the capacity to respond.

When the improved varieties are used, nitrogen again makes a big contribution to the yield gap, and there is a very large N x P interaction, which accounts for 1,410 kg/ha of the yield gap. It is quite obvious that nitrogen and phosphorus must be applied if the maximum yield levels of the improved varieties are to be reached. The old varieties do not need phosphorus because their potential is below

Table 1. Individual and joint contributions of the factors tested in the Marine Terraces of the V and VI Regions, Chile, 1980-81 (6 locations)

Factors	Kg/ha
Actual Farm Yield	2,430
Potential Farm Yield	3,360
Yield gap	930
Individual Contributions	
Nitrogen	610
Phosphorus	110
Weed Control	20
Joint Contributions	
Nitrogen and Phosphorus	830

Table 2. Individual and joint contributions of the factors tested on old and improved varieties in the Marine Terraces of the V and VI Regions, Chile (1980-81)

	Kg/ha	
	Old Varieties	Improved Varieties
Actual Farm Yield	2,560	2,300
Potential Farm Yield	3,010	3,780
Yield gap	450	1,480
Individual Contribution		
Nitrogen	350	810
Phosphorus	50	170
Weed Control	- 20	70
Joint Contribution		
Nitrogen and Phosphorus	240	1,410

the yield level at which this element becomes a limiting factor.

Similar data are presented in Table 3 for the volcanic soils of the Precordillera of Ñuble to illustrate some further principles. In this case, the most important factor is the joint contribution of nitrogen and phosphorus. Neither one on its own accounts for much of the yield increase. Weed control is important in this area, accounting for 400 kg/ha of the yield gap. The most noticeable thing about these results is the low average yield potential of the area. It is obvious from prior experience in this area that factors other than those tested are limiting. One obvious factor is foot rot (*Gaumannomyces graminis*). The effect of this disease on yields needs to be determined at the farm level.

This was the second year that such trials were conducted in Chile, and much valuable information was collected that will help to further orient both research and extension. In conducting these trials, a number of problems were encountered. In one area (the coastal area of V and VI regions), the production package is deemed adequate, but farmers are not using the required inputs. This is probably due to lack of an extension service, and is being remedied by a vigorous extension-demonstration program by INIA. Other problems have been detected in the area and are being confronted by a renewed program in wheat management research. Some of the management problems under investigation are: the use of minimum tillage to reduce erosion and to permit more timely sowing; the management of a system of pasture legumes-wheat to increase both wheat and livestock production; the use of a wider range of maturities in varieties to give farmers more flexibility in sowing dates. The effect of fungicide on the control of septoria, which is one of the main diseases in this area, will also be investigated.

In the Ñuble area it is quite obvious that the potential yield is low when maximizing the factors that were tested. Therefore, it is necessary for other factors to be evaluated. This will be undertaken with control of foot rot and micronutrient trials. Emphasis will also be placed on the extension of available and proven technology.

ARGENTINA

The main agronomy program activity for 1980 in Argentina was a continued exploration of nutrient deficiencies in wheat production in the Pampa Humeda. The stations involved were Pergamino and Marcos Juarez. In areas represented by the Pergamino Station, the exploration of deficiencies was centered on nitrogen and phosphorus. In the Marcos Juarez area, zinc was also investigated. Unfortunately, results will not be presented from the latter station, since the majority of the 25 experiments sown were lost due to drought and hail damage.

Table 3. Individual and joint contributions of the factors tested in the volcanic soils of the Precordillera of Ñuble, Chile, 1980-81 (10 locations)

Factors	Kg/ha
Actual Farm Yield	1,590
Potential Farm Yield	2,800
Yield gap	1,210
Individual contribution	
Nitrogen	240
Phosphorus	150
Weed control	400
Joint contributions	
Nitrogen and phosphorus	770

In the Pergamino area, nitrogen and phosphorus deficiency is widespread. Twenty-eight experiments were sown and harvested. The response to P (60 kg/ha) as a function of available P (Bray 1) in the soil for this area is shown in Figure 1. A critical level of 13 ppm has been fixed, but much more work needs to be done in this respect. Fertilizer response is affected most by available water in the soil profile at sowing, plus rainfall up to the time of tillering. Given these fertilizer response factors, the region was divided for fertilizer experimentation into three moisture zones: > 300 mm; 220–300 mm; < 220 mm.

The N treatment was 120 kg/ha, the P treatment was 60 kg/ha, and the NP treatment was 120-60. The variety used at all locations was Marco Juarez INTA. From the yield data shown in Table 4, it is apparent that the amount of water available up to tillering had a pronounced effect on the maximum yields. The average yields of the NP treatment ranged from 4,290 kg/ha to 2,950 kg/ha. It appears that in the > 300 mm zone many sites still lack sufficient nitrogen, and that the response to N should therefore be greater. In all zones, there was an N x P interaction, most pronounced in the > 300 mm zone. As is apparent from these data, a response curve for both nitrogen and phosphorus should be defined for each moisture zone, because of different potential yield levels and the different degrees of response and N x P interaction for each zone. Developing these curves will constitute the program of research for the coming year.

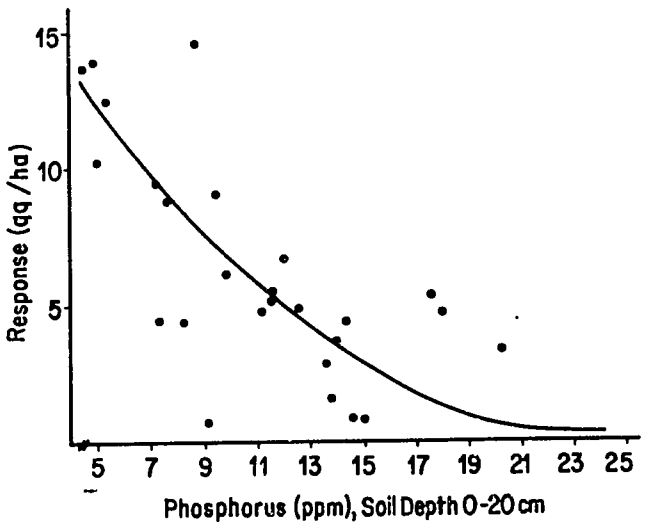


Figure 1. Response to phosporus as a function of available soil phosphorus (1980-81)

Table 4. Average yield (kg/ha) and response levels under various treatments in three different moisture zones in Argentina (1980-81)

Available water at sowing, plus rainfall to tillering (mm)	No. of locations	Yield of check	Yield of NP Treatment	Increase due to NP	Increase due to N alone	Increase due to P alone
> 300	11	2,780	4,290	1,510	590	300
220-300	9	3,180	3,860	680	310	250
< 220	8	2,080	2,950	870	280	380

North and West Africa and Iberia

The CIMMYT North and West Africa and Iberia regional wheat program was initiated in July, 1980. Based in Portugal, this program includes two distinct agroclimatic regions. The first group of countries are located around the Mediterranean Sea, and includes Algeria, Libya, Morocco, Tunisia, Portugal, and Spain. The second group is found on the west coast of Africa, and includes Cameroon, Chad, Ghana, Mali, Mauritania, Niger, Nigeria, Senegal, and Upper Volta. Wheat and barley are the main cereal crops in the region. Table 1 gives the population estimates for the region, and winter cereals area and production.

The basic objective of this regional program is to strengthen national research programs (1) by supplying germplasm, (2) through short term training, (3) by supplying some critical equipment, and (4) through technical consultancy by CIMMYT's regional staff and staff from Mexico. The program also strives to provide an active linkage between the various research programs and institutions of the different countries within the region.

Wheat is a relatively new crop in West Africa. Table 2 gives population estimates and cereal production data for the various countries of this region where wheat can be grown. The cereals production data included in this table are mainly for sorghum, millet, maize, and rice. The area devoted to wheat production is not significant at present. However, the consumption of wheat in this region is very significant, and as a result, many countries are interested in expanding their wheat area.

ALGERIA

Algeria grows an average of about three million hectares of winter cereals. Durum wheat occupies the largest area (47 percent), followed by barley (28 percent), and bread wheat (22 percent). About 3.5 percent of the area is under oats. Algeria's average production of these crops is about 1.8 million metric tons, which constitutes about 72 percent of the national requirements. The crop year 1980-81 can be classified as a better than average year, and as a result, production should also be above average.

The main durum varieties under cultivation are Bidi 17, Qued Zenati, Hebda 3, Mohamed Ben Bachir, and Polonicum LXB. On limited areas, Capeiti, Inrat 69, and Cocorit 71 are grown. The newer varieties of Timgad, Khroub, Tell, Tassili, and Sahel are yet to be cultivated, and are at present at various stages of seed multiplication.

The main bread wheat varieties are Strampelli, Anza, Mahon Demias, and Siete Cerros. The crosses Bb-Kal, NS 14-13 (a Novi Sad selection), and the cross Veery are very promising for the future.

Two local barley varieties, Saida and Tichdrett, are the most important barley varieties now under cultivation. Limited areas of Robur and Ager are also grown.

CIMMYT is very closely associated with the Algerian national program, and had resident staff stationed in Algeria until 1980. More than 50 scientists have received short term training at CIMMYT, and about 15 of these former trainees are at present engaged in post-graduate training at various universities in the USA, France, and Canada, under a special Ford Foundation grant to CIMMYT.

LIBYA

Wheat and barley are the two most important staple crops of Libya. Ninety percent of these two crops is grown under rainfed conditions in the coastal plains and the low mountain ranges of Jebel El-Akhdar and Jebel El-Gharbi. Wheat and barley are also grown in the Kufra and Sarir irrigation projects.

Libya grows an average of about 600,000 ha of wheat and barley each year. The average production under rainfed conditions is about 0.35 t/ha. Under irrigation the yield is about 2 t/ha. CIMMYT's regional staff does not have any personal contact with the Libyan program at this time. However, Libya does receive germplasm from CIMMYT and ICARDA, and Libyan representatives are also invited to the various regional meetings.

MOROCCO

Among the North African countries, Morocco has the greatest potential for winter cereal production. Morocco grows an average of about four million hectares of wheat and barley. Barley is the predominant crop, and occupies about 50 percent of the total crop area. Durum wheats are grown on about 1.5 million hectares, and bread wheats cover about 500,000 hectares. The average yield is above 1.0 t/ha.

The main barley varieties in cultivation are Rabat-071, Merzaga, Tripolis 89, Barlis 628, Brasserie Maroc, and Arig 8. The most promising lines in the program are of Californian origin (USA) and from crosses involving Californian material.

The main durums under cultivation are Kyperounda, Zeramek, Cocorit 71, Hadj Mouline, Oued Zenati, Selbara, and Jori. The cross Bittern is promising and a sister line from this cross will likely be released as a variety in the near future.

The main bread wheats under cultivation are Nasma, Siete Cerros, Potam, Tegyey 32, and Pynite. Except for Pynite, all are high yielding varieties. Two lines, Tegyey 9 and 11, were approved for release in 1981. The lines Tegyey 9, 11, and 32 are all derived from a cross between Siete Cerros and an advanced line of Mara Zerameck.

Four bread wheats are being registered now, and are likely to be released in the near future. They are:

BT 1615= Tob"S"-Napo x CC-INIA/Cha
CM-5541-31Y-0M-Imch-Imch

BT 1618= Bb x Son 64-KI Rend/Bb-Gallo
CM-7935-25K-Imch-2Rt-0Rt

BT 1646= Kal-Bb

BT 1669= Brochis "S"
CM-5872-B-8Y-1M-2Y-3M-0Y

The 1980-81 crop season is anticipated to be one of the worst in history due to the extreme drought during the months of December, January, February, and March. There was some recovery due to late rains, but the damage was extreme and the losses will be great.

TUNISIA

Tunisia grows about 1.5 million hectares of wheat and barley. Of this area, about 900,000 hectares are in the north and about 600,000 hectares are in the central and southern regions. Rainfall in the north is generally above 500mm, and between 200mm and 500mm in the central and southern areas. Rainfall is very erratic in central and southern Tunisia, while in the northern region it is more dependable. Average production of wheat and barley is about one million metric tons. For the 1980-81 crop season, production conditions are excellent in the north, poor in the central region, and very poor in the south.

Durum wheat is the main crop of Tunisia. It occupies about 600,000 hectares in the north and about 200,000 hectares in the central and southern regions. The main varieties in cultivation are Inrat 69, Maghrebi, Badri, and Amal. The older varieties, Chile and Mahmoudi, which were the predominant varieties ten years ago, are now grown on only about 10 to 15 percent of the northern region. During the past two years, Tunisia released two new varieties, Ben Bachir-78 (a Stork sister), and Karim 79 (a Bittern sister), CM-9799-126M-1M-4Y.

Barley is the second most widely grown crop in Tunisia, covering more than 500,000 hectares. Of this, more than 300,000 hectares are grown in the drier zones of

Table 1. Winter cereal area and production, and population estimates for North Africa and Iberia regions

Countries	Population estim. in millions, 1979*	Population estim. in millions, 2000*	Winter cereal area in mill.ha.**	Winter cereal production in mill.t.**
Algeria	19.1	38.4	3.30	1.80
Lybia	2.8	5.7	.56	.20
Morocco	19.4	35.6	4.00	4.20
Tunisia	6.4	9.8	1.50	1.00
Portugal	10.0	11.8	.70	.75
Spain	37.6	44.0	6.19	12.58
Total:	95.3	145.3	16.25	20.53

* Based on World Food System Data Sheet

** Estimated from various sources

central and southern Tunisia. The main varieties are Martin, a six-row variety, and Ceres, a two-row variety. Barley in Tunisia is used as a feed grain, for direct human consumption, for malting, and also as a forage crop.

Tunisia's bread wheat area is about 200,000 hectares. Bread wheats are grown somewhat more in the north, and the main varieties under cultivation are Ariana 66, Dougga, Carthage, and Florence Aurore. During 1980, Tunisia released two new bread wheat varieties:

Tanit 80= Tzpp-PI x 7C(BT-2532)
CM-5287-J-1Y-2M-2Y-2Y-3M-2Y

Salambo 80= Pato x CC-INIA (BT-2528)
CM-1021-14Bj-4Bj

Although Tunisia has some excellent bread wheat varieties under cultivation, the area devoted to this crop during the past few years has been declining. This trend is due to (1) the availability of durum varieties with yield potential equal to the available bread wheats, and (2) because durum wheats receive a higher price.

Nearly 80 percent of northern Tunisia's cropland is devoted to improved varieties. The older varieties are limited to the Kef-Jenduba area, which is the only high elevation area in Tunisia. A new experiment station is under development in this area, and as a result Tunisia will be able to evaluate material adapted to the conditions of this region.

PORTUGAL

In this region, CIMMYT's activities emanate from the National Plant Breeding Station, ELVAS. Nearly all the plant breeding work in Portugal for wheat, barley, and triticale is done on this station.

Portugal grows an average of more than 800,000 hectares of winter cereals, and consumes about 800,000 tons of bread wheat and about 100,000 tons of durum wheat. During the 1976 to 1978 period, the area under production and the yield of cereals declined substantially due to uncertainties in land tenure and changes in manage-

Table 2. Total cereal production and population estimates for the West African region, where wheat can be grown on a limited scale*

Countries	Population estim. in millions, 1979	Population estim. in mill., year 2000	Cereal** production 1,000 metric tons
Cameroon	8.3	13.1	740
Chad	4.4	7.6	606
Ghana	11.3	21.2	601
Mali	6.5	11.6	1,146
Mauritania	1.6	2.9	54
Niger	5.1	9.6	1,317
Nigeria	74.6	148.8	8,426
Senegal	5.5	9.7	540
Upper Volta	6.7	11.8	1,018
Total:	124.0	263.3	14,018

* Based on World Food System Data Sheet

** The main cereals are sorghum, millets, maize and rice. The area of wheat is not significant.

ment style. Currently, area and production are increasing, but Portugal is proposing to join the Common Market, which may again affect the area devoted to cereal production.

Bread wheat is the most important cereal crop in Portugal, occupying about 50 percent of the winter cereal area. It is grown mainly in the districts of Beja, Evora and Portalegre, but is also important in the northeast upland district, Braganca. The main varieties under cultivation are Impeto, Mexicano 1491, Anza, Siete Cerros, and Nazareno Strampelli. Limited areas of Campodoro, Chaimite, Etoile de Choisy, Mara, Mucaba, Tarro, and Xevora are also grown. The main variety grown in the Braganca area is Barbela.

Three new varieties from ELVAS are under registration at present:

Tejo= (21931/Ch53-An x Gb56)An64
Sado= Dougga"S" x S.Son64
Caia= Azteca x Mucaba

The cross Veery has performed well and is likely to be proposed for registration this year.

Only about five percent of the total winter cereal area is devoted to durum wheat, due mainly to the low productivity of local durum varieties and their low support price. Cocorit 71 (of Mexican origin), Timpanas, Faisca, and Faia (all from the National Plant Breeding Station) are now approved for release. The pedigrees of these new varieties are.

Timpanas= Gerardo 469-Gr"S"
CM-362-21M-2Y-7M-0Y
Faisca= Ovi-Capelli
Faia= Preto Amarelo-Ovi x Mex D

These new varieties yield on a par with the available bread wheats, and since the price of durum wheats has recently been increased to a level higher than bread wheats, the area under durum production will probably increase in the future.

Triticales do very well in the acidic soils of the northeastern area of Portugal, and the variety Beagle is one of the best performers. In the southern part of the country there are also some acidic soils, and here too, triticales do very well. The triticales approved for cultivation are Armadillo, Beagle, Bacurn, Arabian, and Mapache. The demand for triticales is high, but the area cultivated is negligible at present due to a lack of seed. Triticales are in demand because they generally give higher yields and their price is similar to that of wheat. Triticale should become an important crop in Portugal in the near future.

Barley currently occupies about 100,000 nectares, and is mainly used as a feed grain and for malting. The main varieties in cultivation are Beka, Union, Arivat, Carina, and Iris. Rebeca, a new variety bred by ELVAS, is approved for release. The following varieties from ELVAS are now under registration:

Enxara = CM-67-U.Sask 1744,
CMB72-45-19Y-2B-2Y-1B-1Y-0B
Camponesa= Por-U.Sask 1766,
CMB72-76-6Y-3B-1Y-0B

SPAIN

Spain has the largest area under wheat and barley, and also the highest yields in the region. The average area sown to wheat and barley is about six million hectares, and production is normally about 12 million metric tons. In 1979-80, Spain harvested a record crop of 14.5 million tons. However, the 1980-81 season was extremely dry in the Andaluzian and Extremadura regions, and unusually dry in the Ebro, Duero, and Central regions. Since these regions grow late varieties, the late rains they received have helped, and the Duero and Central regions will have an above average crop from this harvest.

Table 3 lists the varieties recommended for the different regions of Spain. In the Duero and Central regions, winter or semiwinter varieties are needed, while the Ebro, Andaluzian, and Extremadura regions grow spring varieties.

Barley is the major winter cereal grown in Spain, and covers slightly more than 50 percent of the total winter cereal area. The area devoted to bread wheats is over 2.5 million hectares, while the area given to durum is usually below 100,000 hectares.

The spring wheat area of Spain is at present primarily sown to three varieties: Anza, Cajeme, and Yecora. Anza occupies an alarming proportion of this area. Rapid introduction of more varieties with diverse resistance should be a high priority if disease epidemics are to be avoided.

In 1980, CIMMYT signed a special agreement with the Government of Spain to help INIA of Spain expand its efforts in wheat, barley and triticale research. INIA has recently submitted twenty-four advanced lines of bread wheat and a few lines of durum and triticale for varietal registration. Table 4 gives the list of bread wheat varieties registered during 1980-81. All of these lines may not come into full production, but they are potential varieties. The main objective of INIA in registering all these lines is to block private seed companies from registering any advanced material from International Agricultural Research Centers, thereby obtaining undue credit and money.

PERFORMANCE OF IBWSN, IDSN, AND ITSN IN THE NORTH AFRICAN AND IBERIAN REGIONS 1980–81

Outstanding lines from the IBWSN, IDSN, and ITSN are listed in Tables 5, 6, and 7. These lines were selected on the basis of observations at a minimum of five locations. The production problems at various locations were different: Sevilla had heavy stripe rust; Cordoba had excellent mildew development; Elvas had good BYDV

Table 3. Varietal recommendations for Spain, by region

Region	Bread wheat	Durum wheat	Barley
Ebro region	Anza	Abadia	Albacete
	Aragon 3		Alpha
			Hop
			Secal 1
			Tina
			Zaphir
Duero region	Alcazar	Abadia	Egea
	Almirante	Cocorit 70	Ribera
	Bastion		
	Boulmiche		
	Talento		
Central region	Bastion	Abadia	Abel
	Castan	Cocorit 70	Albacete
	Mahisa 13		Alpha
	Boulmiche		Precoce-de-Peuple
	Partizanka		
Andaluzia and Extremadura regions	Anza	Mexicali 71	Abacus
	Cajeme 71	Cocorit 70	Bolare
	Yecora 70	Crane	Hassan
	Castan	Esquilache	Georgia
	Marca		Logra

development; Guich, Morocco, was very dry; Beja, Tunisia, had no diseases but had excellent plant development. The lines listed in Tables 5, 6, and 7 performed well in at least three of the five locations. The lines marked with an asterisk were either selected in more than three locations, or they performed exceptionally well in at least two locations.

Table 4. New bread wheat varieties registered in Spain, 1980-81

1 - Ajalvir	Myna"S" SWM-4589-7Y-1M-3Y-0M
2 - Albares	Myna"S" SWM-4589-7Y-8M-1Y-0M
3 - Albarracin	Car 422-Ana 75 SWM-4616-2Y-20M-1Y-0Y
4 - Algete	Chukar"S" CM-20769-A-8Y-1M-2Y-5M
5 - Algora	Pewee"S" CM-31630-I-1Y-2M-4Y-0M
6 - Almoguera	Pewee"S" CM-31630-I-1Y-2M-5Y-0M
7 - Alovera	Buckbuck CM-31678-R-4Y-2M-15Y-0M
8 - Anchucha	Buckbuck CM-31678-R-4Y-2M-15Y-2M-1Y-0B
9 - Arganda	Veery"S" CM-33027-F-12M-1Y-6M-0Y
10 - Armuña	Veery"S" CM-33027-F-3M-1Y-0M
11 - Auñon	Koel"S" CM-34574-F-1M-2Y-0M
12 - Atienza	Vulture"S" CM-36064-A-1M-1Y-0M
13 - Azuqueca	Thrush"S" 34742-E-2M-8Y-2M-1Y-0M
14 - Cordoba	Chanate No.2
15 - Roda	Bb-Kal CM-9160-11M-5Y-5M-2Y-0M
16 - Chiclana	Bluejay"S" CM-5287-J-1Y-2M-2Y-3M-0Y
17 - Palencia	INIA"S" - Napo II 32801-100R-102R-101M-100R-0S
18 - Lora	Cgñ/Pato x Bb-Cno CM-10712-1Y-1M-7Y-1M-1Y-0M
19 - Sagra	Pavon"S" CM-8399-D-4M-2Y-2M-3Y-1M-0Y
20 - Villamarta	Pavon"S" CM-8399-D-4M-3Y-3M-1Y-0M
21 - Nambroca	We x Cno-INIA CM-7585-1M-1Y-2M-1Y-0M
22 - Sevilla	Como"S" CM-4756-12Y-1M-1Y-0M
23 - Loja	Cgñ/Pato x Bb-Cno CM-10712-1Y-1M-6Y-1M-1Y-0M
24 - Villanueva	Brochis"S" CM-6872-B-8Y-1M-2Y-4M-0M

WEST AFRICA

In this region, wheat is presently grown in limited areas in Cameroon, Chad, Mali, Mauritania, Niger, Nigeria, Senegal, and Upper Volta. The northern parts of Ghana may also be able to grow wheat. With the exception of Cameroon, wheat is grown under irrigation from about November 15 to the first of March. The soils are generally a very heavy clay, with very low water infiltration. The wheat season is short, evapotranspiration is high, and the date of planting and water management are critical to obtaining a successful crop. Among the West African countries, Nigeria has the maximum production potential and the largest area of wheat. The predominant varieties under cultivation are Siete Cerros and its derivatives, and Anza also does very well. There are currently no major wheat diseases in any of these countries.

In Cameroon, wheat is now grown in the High Plateau region near N'Gaoundere. The soils are highly acidic, so liming with rock phosphate and using soybeans and maize as green manure are common cultural practices. The rainy season is from March to October, and this area receives about 1,500 mm per year. The coolest season is from November to February, but this is also the driest season. Wheat is therefore grown in this region as a rainfed crop from about the 15th of August to early January. The early part of the wheat cycle is relatively warm with high humidity and rain. Septoria, helminthosporium, and fusarium are major disease problems. The varieties grown at present Jupateco, Chris-Senegal, and Sonalika—do not have good resistance to any of these diseases, so the crop is protected by fungicidal application, resulting in high costs of production.

Triticales perform quite well in this part of Cameroon, and it is hoped that their production will increase in the future. Also, wheat lines from the Aluminium Screening Nursery performed very well during 1980.

The demand for wheat in West Africa is great and is is on the increase. As a result, many governments in the region enthusiastically support the expansion of wheat production. However, training sufficient manpower to conduct production agronomy research and extension activities, the availability of inputs during critical periods, and marketing, are the major constraints to increasing wheat production in this part of the world.

Table 5. Outstanding lines of the 4th IBWSN in the North African and Iberian regions

Entry No.	Cross and pedigree
1	Wrm x Kal-BB SWM-1445-8Y-2M-500Y-518M-501Y-503M-500Y-0Y
20	Tzpp^2-Ane x INIA/Jar-Kvz CM-21335-9Y-3M-1Y-1Y-1Y-0B
25	Hork"S"-Coc CM-28242-1M-1Y-1M-1Y-0Y
30	Titmouse"S" CM-30136-3Y-1Y-0M-100B-0Y
48	PV18A-Cno x Hork"S" CM-32151-3M-500Y-501M-500Y-501M-0Y
49	Pheasant"S" CM-32418-1M-1Y-6M-1Y-1M-0Y
53	Pvn"S" (Pato (R)-Cal/7C x Bb-Cno) CM-32535-4M-1Y-1M-1Y-1M-0Y
58	Veery"S" CM-33027-F-3M-3Y-1M-0Y
63	Veery"S" CM-33027-F-12M-1Y-1M-1Y-2M-0Y
64*	Veery"S" CM-33027-F-12M-1Y-3M-0Y
68	Veery"S" CM-33027-F-12M-1Y-4M-2Y-2M-0Y
69	Veery"S" CM-33027-F-12M-1Y-6M-0Y

Table 5. (continued)

Entry No.	Cross and pedigree
77*	Veery"S" CM-33027-F-15M-500Y-0M-75B-0Y
84	Veery"S" CM-33027-F-15M-500Y-0M-110B-0Y
85	Veery"S" CM-33027-F-15M-500Y-0M-126B-0Y
102	Anza
120	Ti-Tob x Ald"S" CM-33217-Q-4M-1Y-0M-118B-0Y
121	Ti-Tob x Ald"S" CM-33217-Q-4M-1Y-0M-157B-0Y
126*	Junco"S" CM-33483-C-7M-1Y-0M-3B-0Y
127	Junco"S" CM-33483-C-7M-1Y-0M-5B-0Y
128*	Junco"S" CM-33483-C-7M-1Y-0M-7B-0Y
137	Hahn"S" CM-33682-L-1Y-1Y-1M-3Y-100B-505Y-0M
139	Hahn"S" CM-33682-L-1Y-1Y-4M-4Y-100B-501Y-500B-0Y
140	Hahn"S" CM-33682-L-1Y-1Y-4M-4Y-100B-502Y-0M
183	/Jup(7C-Pato(B)/Lr64-INIA x INIA-Bb)/Ana CM-37760-C-21Y-2M-1Y-3M-9Y-0M
186*	Dove"S" CM-38199-A-1Y-9M-1Y-0M
189	Hork"S"-Ymh x Kal-Bb CM-38212-I-7Y-2M-1Y-3M-1Y-0M
190	Hork"S"-Ymh x Kal-Bb CM-38212-I-7Y-2M-1Y-3M-2Y-0M
193*	Maya-Nac. CM-39424-1Y-1M-1Y-1M-3Y-0B
224*	Nkt"S" CM-40454-11M-4Y-2M-1Y-0M
226*	Nkt"S" CM-40454-33Y-4M-1Y-0M
227	Nkt"S" CM-40454-38M-4Y-1M-0Y
237	Yd"S"-Bjy"S" CM-40456-12Y-1M-2Y-1M-0Y
269	Dga-Bjy"S" CM-40610-22Y-1M-2Y-3M-0Y
270*	Dga-Bjy"S" CM-40610-22Y-1M-3Y-1M-1Y-0B
272	Dga-Bjy"S" CM-40610-25Y-3M-3Y-1M-1Y-0B

Table 5. (continued)

Entry No.	Cross and pedigree
276	Dga-Bjy"S" CM-40610-25Y-3M-3Y-4M-2Y-0B
293	Him-Coc x Nac. CM-41195-A-13M-2Y-3M-1Y-0M
294	Him-Coc x Nac. CM-41195-A-13M-2Y-3M-1Y-1M-0Y
313	Mn.72131-Pvn"S" CM-42402-30Y-1M-1Y-1M-2Y-0B
314	Mn.72131-Pvn"S" CM-42402-30Y-1M-1Y-3M-1Y-0B
316	(Tzppxlrn46-Cno/I164.27) Jar-CnoxCfn-Cno/Sr CM-42425-7Y-3M-1Y-1M-0Y
324	Hork"S"-Gjo"S" CM-42844-27Y-3M-2Y-1M-1Y-0B
358	Cmt-Yr x Mon"S" CM-43405-A-2Y-1M-1Y-1M-1Y-0B
360	Cmt-Yr x Mon"S" CM-43405-A-2Y-1M-5Y-1M-2Y-0B
362	Mrs x Kal-Bb/Azt CM-43429-H-1Y-1M-1Y-1M-1Y-0B
363	Mrs x Kal-Bb/Azt CM-43429-H-1Y-1M-2Y-1M-0Y
364*	Mrs x Kal-Bb/Azt CM-43429-H-1Y-1M-2Y-3M-1Y-0B
366	Cmt-Coc x Plo CM-43473-J-1Y-1M-5Y-2M-2Y-0B
374	Mrs-Mo x Plo CM-43533-M-1Y-2M-1Y-1M-0Y
379	Jup-Emu"S" x Gjo"S" CM-43598-11-1Y-2M-1Y-1M-1Y-0B
408	Kvz-Trm x Ptm-Ana CM-43903-H-4Y-1M-1Y-3M-1Y-0B
409	Kvz-Trm x Ptm-Ana CM-43903-H-4Y-1M-1Y-3M-2Y-0B
416	Kvz-Trm x Ptm-Ana CM-43903-H-4Y-2M-1Y-2M-2Y-0B

Table 6. Outstanding lines of the 1980-81 IDSN in the North African and Iberian regions

Entry No.	Cross and pedigree
11	Yav"S" CM-9799-126M-1M-3Y-0Y-1B
19	Dack"S" CM-13919-11Y-2M-2Y-0Y-0KE-1B
34	Win"S" CM-18577-11Y-6Y-2Y-0Y
36	Win"S" CM-18577-11Y-7Y-1Y-1M-0Y-0KE
53	S.15-Cr"S"/Cit"S"-Aa"S" x Fg"S" CD-7443-11Y-4M-0Y
81	Teal"S"-Win"S" x Gad"S" CD-16467-A-5M-1Y-2M-0Y
83*	Teal"S"-Win"S" x Gad"S" CD-16467-A-11M-4Y-1M-1Y-1M-0Y
85	Win"S"-USA.02237 x Gad"S" CD-16559-C-7M-2Y-2M-1Y-0M
116	Shwa"S"-Bit"S" CD-20626-5M-2Y-1M-0Y
138	Kif"S" CM-14662-D-14Y-3M-1Y-1Y-0Y
144*	Win"S" CM-18577-11Y-6Y-2Y-0Y-13B-0Y
154	Ente"S"-Mexi"S" CD-8153-12M-3Y-1M-2Y-1M-0Y
169*	Stil"S" CD-16677-A-2M-3Y-1M-3Y-0M
191	Shwa"S" x Cit.71-Gta"S" CD-25987-2M-2Y-0Y
206*	Shwa"S" -Yav"S" CD-23184-3Y-3M-1Y-0Y
209	Waha"S" -Yav"S" CD-23582-7Y-8M-1Y-0Y
225	Yav"S" -Corm"S" x Shwa"S" CD-22356-B-10M-1Y-1M-1Y-0Y
230	Ful"S" - Gta"S" x Kif"S" CD-16791-E-9M-4Y-6M-1Y-2M-1Y-0Y

Table 7. Outstanding lines of the 1980-81 ITSN in the North African and Iberian regions

Entry No.	Cross and pedigree
2	Caborca 79
11	M2A-IA-X-12665-11Y-3Y-9M-1Y-1M-100Y-0M
28	Topo 1419
62	Chiva''S'' X-24551-8Y-3M-1Y-0M
63	Bvr''S''-Abn''R'' X-24560-9Y-3M-1Y-0M
67	Abn-Sapsucker''S'' X-25449-1B-3Y-2B-0Y
70	Ira-Kal x Abn X-25697-B-1Y-1B-1Y-1B-1Y-0B
74	Bgl''S''-Addax X-27407-1H-1Y-1M-1Y-1M-0Y
84	M2A-Mia X-27947-22M-1Y-0M
94	Nv-M2A(2) x Ia X-29426-D-2M-1Y-1M-1Y-1M-0Y
109	M2A-Anza X-30276-3B-14Y-4B-1Y-1B-0Y
110	Rm''S''-Bza x Cml X-30386-A-1M-1Y-1M-1Y-1M-0Y
122	Bcm''S''-Ia X-31186-6Y-4M-1Y-2M-0Y
143	Ptr''R''-Addax X-31729-B-1Y-1M-1Y-1M-0Y
159	Rm-Mat-Canada 42 X-32761-6Y-1B-3Y-1B-0Y
170	W74-103-Addax/Bgl''S'' X-33470-C-1Y-5M-1Y-0M
177*	Nacozari 76
182	Panther''R''-Rm X-34816-500Y-502M-500Y-503B-0Y
219	Panther''S''-Mia X-36471-22M-2Y-2M-0Y
242	Panda''R''-Abn X-36518-57H-6Y-2M-0Y
248	Panda''R''-Ye X-36521-30H-2Y-2M-0M
259	Arm''S''105-Bgl x M2A(2)/YE TC75 X-38108-A-1M-1Y-1M-0Y
273	Ia-Kla x Cal/Bgl B-199
274	Ia-Kla x Cal/Bgl B-199
276*	Beagle
277	Ia-Kla x Cal/Bgl B-199
285	(Cml-Pato x Kiss Dwf/Bgl)Bgl Bb-823

Eastern and Southern Africa

Many countries in eastern and southern Africa continue to express strong interest in exploring the production potential of new varieties of wheat, barley and triticale. Regional program activities in 1980 centered around the screening and distribution of the latest germplasm via regional and international nurseries. This horizontal transfer of new technology was efficiently utilized in many national programs. Regular contact with CIMMYT regional staff helped to maintain continuity in those national programs still lacking in senior scientific staff and/or government support.

The major disease problems in the region for which screening is done include the three rusts, *Helminthosporium sativum, H. tritici-repentis,* and *Septoria* species. Some screening is also done (in Zambia) for powdery mildew resistance. The initial screening work with wheat, triticale, barley and oats is done at the National Plant Breeding Station (NPBS), Njoro, Kenya. Table 1 provides a summary of the nurseries planted at the NPBS and an indication of the selection pressure placed on the entries grown.

Disease screening is accomplished in a three stage process. New germplasm is first screened in one or more introduction nurseries. This material comes from a variety of sources, both from within and without the region. After the introductory season, repeat nurseries are grown. All selections from the introduction nurseries are grouped by crop (as indicated in Table 1), and these new nurseries are grown in the second season. This repeat observation of each selected line provides an opportunity to confirm disease evaluations. A larger plot can be grown of the selected entries, which helps in the comparison of plant types and the evaluation of uniformity within the rows. This enables a further reduction in the number of lines ultimately destined for regional screening. In the Njoro OS 79-80 Repeat Nursery, for example, 139 breadwheats were selected from 665 entries. Similar reductions in numbers were possible in repeat nurseries for durum wheat and triticale. From the repeat nurseries, entries move on to regional screening.

This process of making introductions, moving to repeat nurseries and then on to regional screening is fast and avoids much unnecessary duplication. Promising lines identified in these nurseries are planted in larger multiplication plots to produce sufficient seed for replicated yield trials, or for preliminary yield trials in Kenya.

SCREENING NURSERY FOR THE AFRICAN COOPERATIVE WHEAT YIELD TRIAL (SNACWYT)

In early 1980, the 3rd SNACWYT was distributed to 21 countries. Material selected in Kenya over two to three seasons was used for this regional evaluation. Disease pressure at the NPBS is primarily for stem and stripe rust; therefore, lines with resistance to these two rusts are selected and included in the SNACWYT. Those crosses with Kavkaz in the pedigree were often identified in the introduction and repeat nurseries as superior under Kenya highland conditions. Thus, of the 111 breadwheat entries in the 3rd SNACWYT, at least 55 have Kavkaz or a related parent in their pedigrees. Table 2 lists the best entries identified in the 3rd SNACWYT following field inspection in Rwanda, South Tanzania, Ethiopia, North Tanzania, and at two sites in Kenya. In late 1980, the 4th SNACYT (for 1981) was assembled using results from the 1980 repeat nursery at Njoro, Kenya. The lines selected for the 4th SNACWYT included many crosses between spring and winter wheats, which means that over half of the breadwheats in this regional nursery now carry Kavkaz or related parentage in their pedigrees. Such outstanding crosses as Kavkaz-Cigueña, Veery, and Bobwhite were included.

The triticales in the 4th SNACWYT were screened for at least two seasons at the NPBS. Some 90 lines, selected from repeat nurseries in 1980 and from multiplication plots at Njoro, were tested for their bushel weight. Only those entries with test weights of 56 pounds per bushel or above were kept for distribution in the SNACWYT. Many entries with Panda (=Maya II-Armadillo x Camel) as a parent were included.

Durum entries in the 4th SNACWYT consisted of stem rust resistant lines from Ethiopia and reselections in Kenya from Mexican, Turkish, and other crosses. Distribution of durum wheat in the regional nurseries is much less extensive than bread wheat and triticale, because many national programs do not work on durums. The 4th SNACWYT was expanded to include 225 breadwheats, 47 durums and 49 triticales. While it is probable that the number of sets distributed each year will continue to increase, further expansion in the size of the SNACWYT is not forseen in the near future.

Table 1. A summary of nurseries planted in 1980 in the CIMMYT/NPBS regional program.

Nursery	Number of Entries					Number of Selections.				
	Bread wheat	Durum	Triticale	Barley	Oats	Bread wheat	Durum	Triticale	Barley	Oats
Njoro OS 1979-80	4440	2468	1591	1791	-	1070	652	739	228	-
Njoro MS 80	7455	1634	1186	385	575	764	123	106	85	73
Njoro F_2 1980	1687	766	741	1120	-	120	-	-	-	-
Njoro NEN 1980	1544	1738	200	442	-	235	95	19	51	-
Total	15126	6606	3718	3738	575	2189	870	864	364	73
Percent selected						14.47	13.17	23.24	9.74	12.7
Mau Narok 1980	426	-	-	-	-					
Molo 1980	2472	-	86	-	-					
Njoro OS 1980-81	3441	827	1032	37	-					
	6339	827	1118	37	-					

Table 2. Best Bread wheat, triticale, durum and oats lines in the Third Screening Nursery for the African Cooperative Wheat Yield Trial (1980)

Entry No.	Variety or cross	Pedigree
Bread wheat		
5	Aurora-Maya 74	SWM4065-1Y-1M-4Y-0M
10	M nivet	CM37705-K-2Y-7M-1Y-0M
13	Chat	CM33090-N-1M-6Y-0M
15	Kavkaz-Jaral	SE 372-3S-5S-2S-0S
19	Kinglet	CM33089-W-3M-7Y-1M-0Y
24	Sunbird	CM34630-D-5M-5Y-3M-1Y-0M
33	Veery	CM33027-F-12M-1Y-4M-0Y
34	Veery	CM33027-F-12M-1Y-9M-0Y
46	Bobwhite	CM33203-K-9M-9Y-4M-4M-0M
50	Bobwhite	CM33203-K-9M-24Y-1M-1Y-0M
74	CNT-8	Brazil
99	Aurora-TobxGrajo	CM30833-N-2Y-2M-2Y-2M-0Y
107	Fury-Kal^2	CMH73A-599-2B-1Y-1B-1Y-1B-500Y-0M
Triticale		
117	Ocelot	X12677-56Y-3Y-0M
144	BglxIRA-Bgl	X22548-2Ke-1Ke-0Ke
148	FS 3268	3M-0Y
153	CmlxCno-Gallo	X17077-2M-0Y
161	Masa Mex-Kenya	Acc 3833-59-4
162	Masa Mex-Kenya	Acc 3833-67-1
Durum		
171	Cit-Fg	CD3568-8Y-2M-0Y-0Ke
176	Champala-Booby	CM16886-15L-2L-1ke-5Ke-0Ke
178	Yellowlegs	CM17142-8M-3Y-1M-0Y-0Ke
179	Heron	CM17747-C-1M-4Y-0Ke
181	Mallard	CD3909-12Y-0M-0Ke
193	G11^2-Tdic.VernumxJaafari	CD11597-1ke-0Ke
Oats		
198	Ken631/M720183	8Ke-0Ke
201	PR76xCAN615	3Ke-1Ke-0Ke
208	X3308-1xCAN615	-1Ke-14Ke-0Ke

AFRICAN COOPERATIVE WHEAT YIELD TRIAL (ACWYT)

Results obtained from the regional screening nursery, SNACWYT, are used in preparing the regional yield trial, ACWYT. In 1980, the 4th ACWYT was planted at 14 locations in 7 countries. A preliminary summary of yield rankings is presented in Table 3. The two highest yielding entries were Triticale 65 and Beaver-armadillo. These ranked at the top at each of the seven locations reporting so far, and this confirms results of earlier regional trials in which the triticales dominated. In South Tanzania, the test weights of these two triticales were 68 kg/ha and 71 kg/ha respectively. Bread wheats varied from 76 kg/ha to 81 kg/ha in this location.

In the 5th ACWYT, prepared in late 1980, these two triticales have been included again, as well as Ocelot-(M2A-1A). Entries that were repeated in the 5th ACWYT included K. Fahari, Aurora-Maya, and Chat. Other entries were identified through the SNACWYTs of earlier years, or through other tests in various countries.

Table 3. Preliminary summary of the Fourth African Cooperative Wheat Yield Trial, ranking for yield

	Location						
Line or cross	Kenya	Southern Tanzania	Botswana	Zambia	Zaire	Ethiopia	Uganda
K. Fahari		4		5			
Kavco			5				
Bvr-Arm	1	2	2	1	3	2	1
Kinglet		3					
P 66/253			3				
R 233"S"	4						
Sajame	3			3	4	3	3
Harrier							
Au-Maya				4			
Musala					5		
Weci	5		4			4	4
Chat	6				2	5	
Jup-Ald							
Tcl 65	2	1	1	2	1	1	5
Mwewe							
Check		5					2
		Tai					

INTERNATIONAL YIELD TRIALS

In May, 1980, four international yield trials (16th ISWYN, 1st ESWYT, 11th IDYN, 11th ITYN) received from CIMMYT, Mexico, were planted at Njoro, Kenya. Due to dry conditions in June, such insects as semi-loopers and army worms caused damage. Spraying for these insects resulted in good control, but also some phytotoxicity.

Table 4 presents the top yielding entries from these trials. Among the bread wheats two selections of Veery were excellent in yield, above 4 tons per hectare. Compared to earlier years, yields were generally somewhat low, undoubtedly due to the late planting, insect damage, and dry periods in June, July, and August. It is noteworthy that Veery was slightly above the yield of Mapache triticale in

Table 4. Top Yielding Entries in International Yield Trials at Njoro, Kenya, 1980

Entry Number	16th ISWYN	Yield t/ha	Entry Number	1st ESWYT	Yield t/ha
6	Veery F-12M-1Y-6M-0Y	4.34	8	Dove	4.32
48	Heima-Cocx Bjy	4.01	21	Veery F-12M-1Y-4M-0Y	4.12
24	Kl.Chamaco	4.00	16	Kocl	4.10
8	Zaraguro	3.97	23	Pavon 76	4.02
18	Tesia T 79	3.95	11	Jup-ZpxCoc	3.90
36	Antizana	3.87	9	Drongo	3.87
12	Romi	3.78	6	Pewee	3.87
16	Alondra	3.77	25	Buckbuck	3.81
33	HD 2172	3.72	15	Sunbird	3.81
14	Inia/Son64-P4160ExSon64	3.72	17	Junco	3.72
			24	Buckbuck	3.72
	11th IDYN			11th ITYN	
48	Nacozari 76 BW	3.18	21	Tigre	4.24
49	Mapache Tcl	2.73	5	Bison	4.19
17	Avocet	2.71	17	Beaguelita	4.10
47	Pavon 76	2.64	1	Mapache	4.06
41	D 6811	2.56	3	Caborca	3.99
46	Mexicali 75	2.53	25	Tcl 65	3.94

the last two years. In trials at other locations, such as South Tanzania and North Zambia, triticales and Veery were also among the best yielders.

In the 11th ITYN (Table 4) the highest yield was obtained from Tigre (entry 21), which was also very high in test weight (above the standard for rye). Mapache was very high in yield, but it had a test weight almost ten percent below Tigre (=M2A-MIA).

INTRODUCTION NURSERIES FOR 1980

CIMMYT and ICARDA provided the bulk of the introductions in 1980, and data was returned to these Centers for summary and analysis. Some of the preliminary data from these nurseries, however, are presented in Tables 5, 6, and 7; Table 5 reports durum lines showing resistance to stem rust, based on data from Njoro; Table 6 provides a listing of triticale lines possessing resistance to stem rust, also based on data from Njoro; Table 7 reports new crosses demonstrating resistance to stripe rust at Molo, Kenya. It should be noted that the Veery lines are being attacked on the leaves, and that while some other lines are showing resistance to stripe rust (leaf), they are subject to ear infection (eg. Giza 155).

NEAR EAST NURSERY FOR 1980

Over the past eight years, breeders in the Near East have sent their new germplasm to East Africa for additional disease screening and to accelerate its advancement via off-season planting. In 1980, the Near East nursery was composed of 13 subsets (nurseries) from a variety of locations, containing a total of 3,944 entries. Table 8 provides a listing of these nurseries, by origin, and an

Table 5. Durums from Mexico (CB-D) that are resistant or moderately resistant to stem rust (1979-80)

Entry No.			Stem Rust Score 5/8	18/8
01	Barrigon Yaqui		TS	0
029	Gdo Vz 447		5MS	5S-MS
031	Durum Variety 24		TS	0
033	Inrat 69		0	5MS
049	Ente	CM32-7M-1Y-1M	5S	5S-MS
055	Cr S-P66/270	CD745-7Y-0Y	0	5S
056	Ruff-Fg	CM9880-25M-1Y-1M-1Y	0	TMS-S
058	E3728-CpE^{3}xGz-4777^{2}E	A4050-5P-2P-3B	TMS	TMS
059	E3728-CpE^{3}xGz/CpE^{3}GzxTc60	A4090-17P-2P-1P-1B	5MS	5MS
063	Tunisian Durum 7		0	0
065	P66/253		5S	5MS-S
0108	BD1645		0	0
0125	Yel	CM17142-8M-3Y-1Y-0Y	0	5S-MS
0144	PgxRuff-Fg	CD8942-32M-1Y-5M-3Y-0M	0	5S
0169	Njoro 227		0	TS

indication of selection pressure. Weather conditions were ideally suited for selection of lines tolerant of dought and resistant to stem and stripe rust. About 10 percent of the lines were harvested, based on selection for rust resistance and vigor under moisture stress.

REGIONAL WORKSHOPS

Two workshops were held in the region during 1980. The first, a Symposium on Wheat and Triticale, was organized by the Institute of Agronomical Studies in Rwanda (ISAR) and held in Gisenyi, Rwanda. Sponsor-

Table 6. Lines of best resistance (0 score) from the Triticale Disease Resistance Nursery, Njoro, Kenya (1979-80)

Entry No.	Line	Cross/Pedrigree
19	KLA	X2091-1M-0N
21	KLA"S"	-
22	$(IR)^2$Arm x 310/32	X8534-A-3Y-1M-0Y
36	$M2A^2$	X8276-A-100Y-0M
37	M2A-Cml	2N-0M-2Y-0M
42	FS 477	X7243-8M-3Y-6M-0Y
44	M2A-ARS	MT190-8W-2W-0N
46	Leo 7	X8208-G-1Y-2M-3Y-0Y
47	M2A-Canada-Terrier	X8536-A-4Y-2M-1Y-0Y
49	M2A-IRA	X16014-3Y-4B-2N-5M-0Y
54	Drira-M2A	TG3
55	M2Ax1517 $(Inia\text{-}Guarda)^2$	X15583-4M-0Y
56	Ita-Leo-M2A	X12257-3Y-4B-2N-3M-0Y
57	IA-IraxBui=RAM	X2802-9N-2M-3N-1M-3Y-1M-1Y-0M
64	M2A=Angora"R"	
66	MA 105	X22427-101Y-2M-2Y-0M
67	Beaguelita	X16723-6Y-1Y-1M-0Y
68	Oct-Hexaxlra	X16378-2Y-0B-1Y-0M
72	M2A-UP301-XBgl	X14536-26Y-100Y-12M-0Y
73	Bgc-Ti71	X11100-A-12M-100Y-0Y
74	Cin-M2A	TG3
75	M2Ax1517$(Inia\text{-}Guarda)^2$	X12725-E-1Y-1Y-7M-0Y
81	M2A-Kla	X12845-12Y-7Y-1M-0Y
83	M2A-FS722	X12257-2N-0M
85	RAM	

Table 7. Bread wheat crosses with low stripe rust infection, Molo, Kenya, 1980

Variety or cross	Pedigree
Lfn-Mz(4777/ReixY-Kt) Maya	SWM4743-14Y-8M-3Y-3M-0Y
Lfn-MZ(4777/ReixY-Kt) Maya	SWM4743-19Y-2M-1Y-1M-0Y
Bobwhite	CM33203-K-9M-19Y-3M-3Y-0M
Sunbird	CM34630-D-5M-5Y-5M-1Y-1M-0Y
AgMxKal-Bb	CM35082-1M-3Y-4M-1Y-1B-0Y
Jup 73-Emu	CM36869-17Y-8M-3Y-2M-1Y-0M
Emu-MildressxKal-Bb	CM38199-F-2Y-3M-1Y-1M-0Y
Bon-Yr70/TaestxKal-Bb	CM41860-A-5M-1Y-1M-2Y-0M
Bon-Yr70/TaestxKal-Bb	CM41860-A-5M-2Y-1M-1Y-0M
Bon-Yr70/TaestxKal-Bb	CM41860-A-5M-2Y-2M-1Y-0M
Condor S-Ana75 x Condor-Mus	CM44321-A-1Y-2M-2Y-0M
Car422-Anahuac75	SWM-4610-10Y-4M-1Y-1M-1Y-0M
Inia-On x Inia-Bb/Bjy	CM30142-7Y-1M-1Y-1M-1Y-0M
Jup-Ald	CM36867-18Y-19M-2Y-1M-1Y-0M
Fath-Coc75	CM36896-27Y-1M-2Y-3M-1Y-0M
Jup-ZpxCoc75	CM37614-B-14Y-6M-3Y-1M-1Y-0M
((HnIV(Kt54A-N10BxKt54B/Nar59)) Bjy) Ald	CM41219-I-1M-1Y-2M-2Y-2Y-0M
Burgas Sort 12-13xKal-Bb	SWM3115-2M-4Y-1M-2Y-1M-2Y-0M
Roussalka-K4527 LD5DI(Yr/Bb-Calx7C-Nad)	CM33393-E-2M-2Y-7M-4Y-1M-1Y-0M
Pima77xRg-Soty/Siskin-Paron	CM34709-Q-2M-2Y-10M-1Y-2M-1Y-0M
Bobwhite	CM33203-K-9M-10Y-1M-5Y-0M-2Ptz-0Y
PCh-Maya 74	CM39442-7M-1Y-3M-1Y-1M-0Y-1Ptz-0Y
Kal-Bb-Toquifen	CM40229-13M-6Y-3M-2Y-1M-0Y-1Ptz-0Y
Mochis 73-TjB 259.69xParon	CM43363-DD-2Y-1M-3Y-5M-0Y-1Ptz-0Y
Golden Valley-Azt67xMus	CM41287-I-8M-1Y-1M-1Y-2M-0Y-0Ptz
Golden Valley-Azt67xMus	CM41287-I-8M-1Y-1M-2Y-2M-0Y-0Ptz
Golden Valley-Azt67xMus	CM41287-I-8M-1Y-1M-3Y-3M-0Y-3Ptz
Golden Valley-Azt67xMus	CM41287-I-8M-1Y-2M-3Y-3M-0Y-0Ptz
Golden Valley-Azt67xMus	CM41287-I-8M-2Y-2M-2Y-2M-0Y-0Ptz
Kvz-BunhoxPj62-Maya74"S"	CM33593-C-4M-1Y-8M-500Y-100B-500Y-501B-0Y-1Ptz-0Y
Pato-OnxMaya74/Pichiuila	CM40737-6Y-2M-3Y-4M-0Y-2Ptz-0Y

ship by the International Development Research Center (IDRC), Canada, made it possible to invite participants from Burundi, Kenya, Malawi, Mexico, Tanzania, Zaire and Zambia. A large group of Rwandese agricultural engineers also participated. The focus of the symposium was the promising production potential of wheat and triticale in the region. Based on the data provided, participants called for greater cooperation and interaction among national programs to (1) raise the general level and quality of regional research, and (2) facilitate the exchange of germplasm.

A second workshop was held in Tananarive, Madagascar. This international colloquial on wheat was organized by the Ministry of Rural Development and the Norwegian Agricultural Development Agency (NORAD). Major discussion points were the role of plant quarantine in international cereal research and the need for applied research in specific areas. Wheat imports continue to increase throughout the region, and the discussions underlined current bottlenecks to improving local production. Reorganization of plant quarantine practices, better coordination of research, establishment of an effective seed organization, and implementation of effective support price policies are required. The workshop succeeded in clarifying and reinforcing these points with the various government agencies represented.

Table 8. Near East Nursery plantings and selection totals at the NPBS, Njoro, Kenya (1980)

Origin of Nursery	No. of Entries	No. of Selections
Advanced lines, Sakha, Egypt	73	9
F_1 hybrids, Sakha, Egypt	268	33
Hybrid seed, Giza, Egypt	40	0
Hybrid seed, Egypt	36	6
Bread wheats F_5, etc., ICARDA	680	69
Durum lines, ICARDA	1703	95
Triticale lines, ICARDA	200	19
Barleys, ICARDA	340	38
Barleys, Cyprus	102	12
Breadwheat Selections, Patzcuaro, Mexico	314	17
Rust resistant breadwheat, Greece	29	0
Helminthosporium lines, Zambia	46	43
Disease Trap Nursery, Ethiopia:		
Breadwheats	58	58
Durums	35	0
Total	3924	399

South and Southeast Asia

The CIMMYT South and Southeast Asia regional program was initiated in 1980 with the appointment of Dr. Eugene E. Saari as regional coordinator of CIMMYT activities. The goal of this program is similar to that of other CIMMYT regional programs: to assist countries in the region (Pakistan, India, Nepal, Bangladesh, Thailand, Burma, Cambodia, Vietnam, and Laos) in increasing yields of wheat, barley, and triticale by strengthening their national crop improvement programs. This effort is based on the free exchange of genetic material (via international nurseries) and technical information within the region, with other regional programs, and with the CIMMYT, Mexico, base program.

Important program objectives include the identification of key factors limiting production in the region, provision of assistance in developing methods and/or information to overcome production problems, and the training of national scientists (at CIMMYT, Mexico, and in regional workshops) so they may effectively participate in the overall development of cereals in the region.

Wheat production in warmer subtropical environments (such as Bangladesh) has risen dramatically in recent years. Special nurseries, designed to develop germplasm more suitable for these areas, are to be implemented via this regional program.

Pakistan

Wheat is the most important crop in Pakistan. It now occupies 6.714 million hectares, of which 5.036 million are irrigated and 1.678 million are rainfed. Barley covers only 170,000 hectares, while triticale continues to generate interest but is not yet produced commercially. The 1980 wheat crop was the largest ever recorded: 10.75 million metric tons, for an average of 1.62 tons per hectare. Continued emphasis on and support for wheat production by the Government of Pakistan, along with favorable weather, resulted in a record crop for the second consecutive year. Even so, Pakistan's rapidly increasing population keeps demand ahead of production.

As in 1979, several factors contributed to the increase in wheat production:

1) The use of fertilizer increased by 45,000 nutrient tons. Nitrogen application rose from 331,000 tons in 1979 to 370,000 tons in 1980. Similar increases were posted in the use of phosphate fertilizer (P_2O_5), which grew from 101,000 tons in 1979 to 160,000 tons in 1980. Zinc, potassium and other elements are seldom applied to wheat, but there is evidence of a zinc deficiency in some areas where rice is produced in the alternate cropping cycle.

2) In 1980, Pakistan again escaped serious disease epidemics in wheat. However, widespread use of varieties with low or moderate resistance to rusts still constitutes a high risk for the country.

3) Financial assistance from the government, particularly to small farmers, increased considerably. More credit was available for seed, fertilizer and machinery.

4) A large program for exchanging improved seed for farmers' seed was carried out.

5) The support price of wheat was increased for the 1980 crop from 46 to 50 Rupees per 40 kgs. This was done prior to seeding time, so farmers knew the guaranteed price and subsequently increased area sown. This price increase coincided with the removal or a decrease in the subsidy allowed on fertilizers.

VARIETAL RELEASE AND DISTRIBUTION PROGRAMS

Four new varieties were released during the 1979-80 season:

	Rust Reaction
Bahawalpur 79 Cno "S"-LR64^2 x Son 64/Son (amb) PK 6149-IB-OB-Kg-OB-pb	10MS 25MS-S
Indus 79 23584 x 15-13-5-Son 64	5MR-MS 10MR
Zamindar 80 Ron-Cno x Bb-Nor 67 CM5484-F-5Y-4M-1Y-1M-1Y-O Qt	5MR 10LM
Khyber 79 Nai "S" 61-6134 x C271/PAK 20	30MS TMR

As new varieties are developed, they are submitted for entry and testing in the National Uniform Wheat Yield Trial (NUWYT). Results in 1980 were recorded from 38 locations. These results guide the Federal Seed Certification Service in the release of new varieties. The following varieties have been recommended for cultivation in Pakistan:

Lyallpur 73	Yecora 70
Sandal	Lu 26
Blue Silver	Pari 73
ARZ	WL 711
Sonalika	Pavon 76

The Cereal Disease Research Institute also conducts trials to determine the reactions of candidate varieties to various diseases. Continuing efforts to strengthen the pathology input in breeding programs are being made.

SUPPORT PROGRAMS

In 1979-80, seven Pakistanis participated in CIMMYT in-service training programs for breeding, pathology, production and cereal technology. A number of Pakistanis are also in advance degree training. CIMMYT also continues to send a large number of nurseries and germplasm to Pakistan to meet the requests of the various Pakistani variety development programs.

Glossary

ACI	Average Coefficient of Rust Infection
ACWYT	African Cooperative Wheat Yield Trial
a.i.	Active ingredient
BWYT	Bread wheat yield trial
BYDV	Barley yellow dwarf virus
CB	Crossing block
cm^3	Cubic centimeter
CI	Coefficient of infection (rust)
CIANO	Centro de Investigaciones Agrícolas del Noroeste (Cd. Obregón, México)
CIMMYT	Centro International de Mejoramiento de Maíz y Trigo (International Maize and Wheat Improvement Center)
cm	Centimeter
CRL	Cereal Rust Laboratory, USDA, St. Paul, Minnesota
CV	Coefficient of variation
EBYT	International Barley Yield Trial
EDYT	Elite Durum Yield Trial
ELAR	Ensayo Latino Americano de las Royas
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária (Brazilian Agency for Agricultural Research)
FAO	Food and Agriculture Organization of the United Nations
g	Gram
ha	Hectare
hl	Hectoliter
HYVs	High yielding varieties
IBON	International Barley Observation Nursery
IBWYN	International Bread Wheat Yield Nursery
IBWSN	International Bread Wheat Screening Nursery
IC	Index of quality
ICARDA	International Center for Agricultural Research in the Dry Areas(Aleppo, Syria)
IDRC	International Development Research Center (Ottawa, Canada)
IDSN	International Durum Screening Nursery
IDYN	International Durum Yield Nursery
INAT	Institut National Agricole Tunisienne
INIA	Instituto Nacional de Investigaciones Agrícolas (The Mexican National Institute of Agricultural Research)
INIAP	Instituto Nacional de Investigaciones Agropecuarias (Ecuador)
IPO	Institut Voor Plantenziektenkundig Onderzoek (Research Institute for Plant Protection, Netherlands)
ISEPTON	International Septoria Observation Nursery
ISWRN	International Spring Wheat Rust Nursery
ISWYN	International Spring Wheat Yield Nursery
ITSN	International Triticale Screening Nursery
ITYN	International Triticale Yield Nursery
IWSWSN	International Winter x Spring Wheat Screening Nursery
kg	Kilogram
kg/ha	Kilogram per hectare

kg/hl	Kilogram per hectoliter
LADISN	Latin American Disease and Insect Screening Nursery
LDC	Less developed countries
LR	Leaf rust
LSD	Least significant difference
m	Meter
m^2	Square meter
PC	Small plot multiplication for pure seed
PER	Protein efficiency ratio
PMC	Small increase plot
PMI	International multiplication plots
ppm	Parts per million
ppt	Parts per thousand
RDISN	Regional Disease and Insect Screening Nursery
RDTN	Regional Disease Trap Nursery
RTN	Regional Trap Nursery
SARWEIN	South African Regional Wheat Evaluation and Improvement Nursery
SNACWYT	Screening Nursery for the African Cooperative Wheat Yield Trial
SR	Stripe rust
t	Ton (= 1000 kg)
TDRN	Triticale Disease Resistance Nursery
t/ha	Tons/hectare
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
VEOLA	Vivero de Enfermedades y Observación de Latino America
YR	Yellow rust
Y78-79	Yaqui, México, 1978-79