CIMMYT Report On WHEAT IMPROVEMENT 1975

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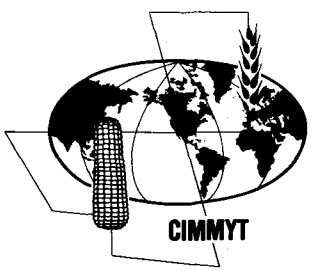
CIMMYT Report On WHEAT IMPROVEMENT 1975

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



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1.0 CIMMYT_ INIA

CIMMYT conducts research at eight sites in Mexico. Four are owned by Mexico's National Agricultural Research Institute (INIA) and four are operated by CIMMYT. Some characteristics of these stations are:

Station	Elevation	Latitude	Hectares used by CIMMYT
CIANO-INIA (Obregon)	Sea level	27°N	130
Los Mochis-INIA	Sea level	25°N	2
Navojoa-INIA	Sea level	27°N	10
Rio Bravo-INIA	Sea level	26°N	1
Poza Rica-CIMMYT	Sea level	20°N	39*
El Batan-CIMMYT	2240m	19°N	44
Toluca-CIMMYT	2640m	19°N	69
Tlaltizapan-CIMMYT	940m	18°N	31*

*twice/year

The Mexican government released three new CIMMYT-INIA bread wheats in 1975. Cocoraque 75, a sister line of Jupateco 73, is more resistant to leaf rust. Salamanca 75 is a soft biscuit-type wheat with good rust resistance. A slightly weak crown root makes Salamanca somewhat susceptible to lodging. Zaragoza 75 is a late maturing one-gene dwarf with red grain, highly resistant to leaf rust but susceptible to stripe rust. All three of the 1975 releases are susceptible to Septoria, but this is not a serious problem in Mexico.

Outside of Mexico, numerous bread wheats of Mexican origin were released in 1975. A partial list is:

Argentina-Precoz Parana INTA, Diamante, Leones INTA.
Cyprus-Jaral 66 "s", Blue Silver, Mexipak.
Guatemala-Maya 75.
Nepal-NL30.
Pakistan-Lyallpur 73, Sandal.
Paraguay-Jacal 66 "s".
South Africa-Sonderend.
Tunisia-Carthage, Dougga.
Turkey-Cumhuriyet, Sakarya (Chanate 2), Jehan, Nuri 70.
USA (Colorado State)-Colano.

In 1975, the Mexican government released Mexicali 75, a new higher yielding durum wheat.

1.1 Introduction

As stated in our last report, the world is awakening to the need for food in the face of the expanding world population. This is reflected in the greater worldwide awareness of the value of food and the greater interest induced by the number of meetings convened to deal with the problem.

Wheat is the major food crop of the world measured either by area sown or size of harvest - 228 million hectares and 355 million tonnes of production in 1975. It is estimated that about 10 per cent of the crop is grown as durum wheat. Barley ranks fourth among the cereals producing 155 million tonnes. Together they make up approximately 16 per cent of the total food supply. Products like milk, fruits, vegetables, melons, roots and tubers contribute about 46 per cent of the gross weight of the world's food supply, but these foodstuffs are high in water content. When they are equated and compared on a dry weight basis with grains, the contribution of wheat and barley to the total dry matter food intake, is much greater. Triticale, a new crop in which CIMMYT has taken a lead, is being grown on a limited acreage and it may be expected to replace much of the rye which is declining in production.

In its limited way CIMMYT continues to contribute to the research on bread and durum wheats, triticale and barley. Details of this work are reported in the following pages. The work CIMMYT does, however, is only as successful as the National Programs are successful. Much of the credit for success so far, has been the result of the contribution of the scientists in the many countries with which CIMMYT has had the good fortune to be associated. The identification of superior materials in many countries and the reporting to CIMMYT, provides the basis for continued improvement in germ plasm which CIMMYT sends back to the cooperating countries.

In 1974, a total of 1210 nurseries were distributed to 83 countries. Of these, only 11 National Program reports are included herein. CIMMYT wishes it could receive highlights of reports from other countries to include as a record of the joint efforts to improve the productivity of cereals. During the course of the year, the new set of nurseries distributed for growing in 1976 represented a modest increase to 1228 nurseries distributed to 90 countries.

This year, forty six in-service trainees took courses in plant breeding, plant pathology, agronomy and cereal chemistry. A large number of visiting scientists spent varying periods with the program.

The climate during the year was, as might be expected, variable from location to location. Although North Africa was well below normal in rainfall, Algeria was able to reach its average production because of improved weed control and use of fertilizers. Tunisia showed a modest gain. In Turkey, an all time production level of 14.7 million tonnes on 9.25 million hectares was achieved. Much of this gain was a direct result of the increased use of fertilizers and herbicides. India continued to produce at near record levels, as also did Nepal.

On balance it might be said that this was a reasonable year for production, but there was little extra grain produced to increase the level of storage needed against emergency periods.

1.2 CIMMYT Wheat Breeding Program

1.2.1 OBJECTIVES AND PHILOSOPHY BEHIND THE SIZE AND NATURE OF SEGREGATING POPULATIONS:

There are many methods of breeding and population handling practised in breeding programs in different parts of the world. The usefulness of these different methods in relation to the programs in which they are used is not questioned here, but their usefulness for the CIMMYT Program is questionable.

The methods used at CIMMYT have proved excellent in achieving the objectives of the program, as demonstrated by the performance of CIMMYT germ plasm and by the world wide release of varieties and germ plasm. Based on its record of achievements, CIMMYT disallows the criticism of its methods now being proposed by scientists, who approach plant breeding primarily from a theoretical basis.

1.2.2 NATURE OF SEGREGATING POPULATIONS

CIMMYT believes that it is not possible to breed cultivars individually adapted to every micro-environment where wheat is grown. Thus, its breeding methodology is geared to produce wheat germ plasm which will be of wide adaptation. The combination of the following characteristics is needed to produce widely adapted varieties of wheat: high yield potential under many growth conditions, semi-dwarf characteristics, disease resistance and daylength insensitivity.

The two following approaches are used to produce cultivars that have wide adaptability and disease resistance:

1 Selection for disease resistance and agronomic types in segregating generation materials at two Mexican locations.

The presently used techniques were developed in the late 1940's by Dr. N. E. Borlaug. He pioneered, on an extensive basis, the growing of two generations of wheat materials per year. This was accomplished by growing the segregating populations during the winter in Mexico at Sonora, (27°N) at sea level under irrigated desert conditions where leaf and stem rusts are endemic.

A second generation is obtained by planting during mid-May in Mexico at Toluca, (19°N) at 2600 meters altitude. The Toluca site is characterized by heavy rainfall and cool temperature throughout the season. Consequently, severe epidemics of stripe rust develop every year. This procedure halves the time necessary to breed new cultivars; moreover, selection in alternate segregating generations under completely contrasting environments (where a genotype must succeed under both conditions if it is to survive), leads to adapted types capable of growing under widely differing conditions. Dr. Borlaug found the resultant wheat lines were photoperiod insensitive because of selection under short day conditions and that they could be grown successfully from Alaska to the tropics, under both irrigation and rainfed conditions.

2 International Testing Program helps to incorporate genetic diversity in the CIMMYT Wheat Program.

Since 1964, the International Spring Wheat Yield Nursery (ISWYN) has provided the vehicle by which the most widely adapted and highest yield potential genotypes available in different countries, can be identified. Presently, these highly adapted cultivars, together with materials selected from other CIMMYT and National Program Nurseries, are used in the CIMMYT Crossing Program to take advantage of more than a decade of world-wide observations in order to provide a dynamic basis of the best germ plasm incorporation into CIMMYT materials.

Genetic research has established that a wheat cultivar tested in many locations, and showing a low coefficient of infection to a disease, often carries a large number of resistant genes. Among international testing programs that help to identify polygenetically resistant parents are the USDA International Spring Wheat Rust Nursery (ISWRN), CIMMYT's International Bread Wheat Screening Nursery (IBWSN), Near East Regional Disease and Insect Screening Nursery (RDISN) and CIMMYT's Latin American Disease and Insect Screening Nursery (LADISN).

These trials serve several purposes: They signal changes in pathogen virulence and they identify varieties with broader resistance which can be added to the Crossing

Program. This is predicated on the principle that a cultivar showing resistance in many parts of the world, is resistant to many virulence factors. Hence, such varieties are likely to carry general or non-specific resistance.

The cooperation of many national programs in testing these materials is of utmost importance. CIMMYT benefits through the identification of genotypes of great value in crosses designed for many national programs. National programs collectively assist one another in obtaining information on varieties to be crossed, and which of their individual varietal entries are most likely to be useful over an extended period of time. Some of these nurseries form a vehicle for widespread distribution of potential varieties or germ plasm.

Using these two broad approaches (described under 1 and 2 above), CIMMYT has achieved spectacular results: Only two cases will be discussed to substantiate these points:-

(1) CIMMYT's International Spring Wheat Yield Nursery has demonstrated that germ plasm developed at CIMMYT or originating elsewhere utilizing CIMMYT materials, is superior in yield performance in most spring wheat growing areas of the world as shown in table 1.2.A.

The 9th ISWYN was tested in 70 locations of the world and at 54 of these locations, a CIMMYT variety appeared as the top yielder. At only 16 locations, were local checks and non-CIMMYT germ plasm able to achieve the top yield performance. Similarly, for the 10th and 11th International Spring Wheat Yield Nurseries from which reports have been received from 72 and 73 world locations, a CIMMYT variety was in the top yield position 50 and 57 times respectively. It should be pointed out that in many cases the local check used was also derived from earlier CIMMYT material. Such a performance strongly suggests that the CIMMYT program is proceeding along successful lines in its present approach.

(2) CIMMYT semi-dwarf cultivars have levels of resistance superior to either land races or locally improved, tall cultivars as shown in table 1.2.B. The data are summarized by zones that are assumed to be epidemiologically dissimilar and measured by average coefficient of infection. The coefficient of infection in the Regional Trap Nursery (RTN) indicates that the local indigenous wheats are all in danger of infection by all three rusts in most regions. The improved tall wheats are also susceptible to attack by the three rusts in a similar fashion. The semi-dwarf wheats on the other hand are relatively resistant in most locations, except in the Indian sub-continent where leaf rust is still a threat.

It is evident from the data in this table that the criticism often directed toward the CIMMYT material viz: that it has endangered production because the improved varieties were susceptible and replaced strongly resistant local varieties, is totally false and such views should be discredited.

1.2.3 POPULATION SIZE IN CIMMYT'S BREAD WHEAT PROGRAM

Keeping in mind that CIMMYT uses two sites for breeding cultivars, at each site more than 1,000 F_2 populations are raised from which are selected rust resistant plants with good agronomic characteristics, which are further tested for quality values.

The F_2 material derived from CIANO, Cd. Obregon, Sonora is distributed to breeders in 80 countries in order that they may choose that which is best suited to their local needs. More than 9,000 F_1 crosses ($\pm$ 6,000 simple crosses and $\pm$ 3,000 top and double crosses) are made each year. Approximately half of these crosses are made in Toluca and the other half at Cd. Obregon. The selection of F_1 material for F_2 bulk is based on their rust resistance, spike fertility, leaf characteristics, and dwarfing. Those F_1 plants exhibiting a height greater than 100 cm and involving a parent having both Septoria and rust resistance, are marked for F_2 bulk to be exploited in dryland areas of the world, such as North Africa, East Africa and South America. In the case of the F_1 crosses with a height less than 100 cm, the F_2 bulk are sent to those areas of the world where irrigated farming is practiced.

Several methods have been suggested for growing F_2 populations. CIMMYT practises a pedigree system since it allows early generation sorting out of such traits as disease resistance, dwarfing, and grain color, etc., which otherwise would be carried over as a mixed population in the bulk system. CIMMYT is fairly convinced, and has scientific data to support the view, that the pedigree system allows the maximum exploitation of the genetic diversity involved in the cross. This is not meant to discredit other systems which might be equally suitable for a particular locality. Our experience dictates that a complex cross may produce several varieties with different patterns of adaptation in the world, and these will be found only through our present system.

Chart 1.2.1 gives in outline the selection and testing system followed by CIMMYT.

In the first sowing of a cross some 250 plants are raised for each of approximately 1,000 F_2 populations. This is large enough as a sample to suggest which F_2 populationshave good plants with regard to disease resistance, dwarfing, leaf cleanliness, and spike fertility. In those populations in which the sample produces a large number of superior segregates, the total reserve seed of that population (which may be 6,000-7,000 plants) is grown in the next crop cycle for exploitation. Those with only a few, are discarded. This produces a marked saving on land area devoted to useless F_2 populations.

Such poor combining crosses, despite the best decision on the parents to be used, backed up by extensive world-wide disease and agronomic data, have been found to be more the rule than ones which have excellent combining ability. The view has often been stated that if CIMMYT studied the parents to a greater degree, it could get along on a few crosses. This is untrue for two reasons. The first as already stated, and the second that it has a world-wide clientele who require a wide array of germ plasm.

Combining ability is an area in plant breeding which has been widely discussed, and measured by several plant breeding institutes before launching a selection program. This may be important, but it is not necessarily required to make breeding advances. Combining ability is the result of interaction of genes for agronomic and pathological characteristics in a given environment. While agronomic traits seem to behave similarly in a given environment from year to year, the disease reactions change with a shift in the virulence factors of the pathogen. This has a disastrous effect on the combining ability value of a cross. In other words, the F_2 population of a cross might be outstanding from both agronomic and disease points of view, and its heritability might be as good in F_3 and F_4. However, in F_5 the value of the cross may be wiped out by a new race of the pathogen which destroys most of the progeny from this cross. This implies that all the time and money spent in studying the combining ability of that cross has come to nought, while an approach using the "eyeball" system is more practical.

One of the criticisms of the CIMMYT program is that it is not using recessive genes because all the susceptible types in the F_1 are thrown away. CIMMYT does not advance highly susceptible F_1 material to the F_2 stage, but it does use them in top and double cross combinations.

The F_3, F_4, F_5, F_6 and F_7 populations are handled in the same way as the F_2 for disease and agronomic characteristics, except that there is more rigorous selection applied amongst the families (sisters) of a population than within the family. Only 5-6 outstanding plants are pulled to advance the generation.

Each individual plant pulled from the field is carefully examined by the pathologist, before it is threshed. More than 100,000 plants are pulled from all generations, and approximately 60,000 are kept after rust examination. These plants are threshed, and the seed from each plant is further examined for size and plumpness. Shrivelled and diseased seeds are discarded. On this basis approximately 30,000 lines are retained for planting in the next cycle at the alternate location. All the entries of F_3 and F_4 are sent to the quality laboratory to be evaluated for gluten strength (Pelshenke value). These values are correlated with the texture of the seed, and for the most part, only low Pelshenke values with soft texture and high Pelshenke values with hard texture, are retained.

From the F_4, F_5, F_6 and F_7 populations, approximately 1,500 entries are cut in bulk for yield tests in the Yaqui Valley at Cd. Obregon. The best entries having good yield potential, disease resistance, and dwarfing are assembled in the form of the International Bread Wheat Screening Nursery which is distributed to more than 150 locations in the world.

Chart 1.2.2 shows the flow of germ plasm between the national and CIMMYT programs. IBWSN provides germ plasm for direct release as varieties in any of the countries or, at the same time it can be used as germ plasm in the crossing programs for generating new variability. The top 25 high yielding advanced lines which have shown suitable agronomic performance and disease resistance, are assembled in an Elite Selection Yield Trial which is grown at 25 selected locations in the major spring wheat producing areas of the world.

In the same way, the Regional Wheat Yield Trial (RWYT) assembled in Egypt by ALAD (Arid Land Agricultural Development), CIMMYT, and FAO is sent out to 25 locations in the Middle East, North and East Africa, and Asia, to determine the yield performance and disease resistance of the selected varieties. Recently a Regional Latin American Wheat Yield Nursery (Ensayos de Rendimiento Cono Sur), was initiated as a joint venture of collaborating programs of the cone countries of South America.

The best performing entries drawn from these various nurseries and many commercial

cultivars drawn from major spring wheat areas of the world, are grown each year as PMI's (International Multiplication Plots) at Cd. Obregon. All these varieties are further evaluated for agronomic characters and disease resistance, and a group of 49 varieties is selected each year and sent out to more than 100 locations throughout the world. This nursery is known as the International Spring Wheat Yield Nursery (ISWYN). It is an important vehicle in the dissemination of the best germ plasm produced in national programs, and at CIMMYT. The ISWYN and IBWSN, ESYT and RWYT, have been helpful in the identification of superior cultivars for many geographical areas of the world.

TABLE 1.2.A Superior cultivars and varieties in world-wide testing.

Nursery	No. of test locations in the world	No. of times CIMMYT germ plasm appears in the first place	No. of times local checks and non-CIMMYT varieties appear in the first place
(1972-73) 9th ISWYN	70	54	16
(1973-74) 10th ISWYN	72	50	22
(1974-75) 11th ISWYN	73	57	16

TABLE 1.2.B A comparison of the average coefficient of rust infection among local, improved tall and dwarf wheat varieties in four geographical regions for the three-year period 1972-1974*.

Variety Group **	Asian Sub-continent	Middle East	North Africa	South Europe	Average
A. Stem rust					
Local	22.35	22.16	15.94	18.67	20.41
Improved tall	8.94	13.19	11.32	11.53	11.57
Dwarf	1.13	4.30	2.95	2.95	3.12
B. Stripe rust					
Local	23.67	18.28	14.61	10.73	15.97
Improved tall	8.07	9.46	5.24	8.23	8.39
Dwarf	4.20	6.39	2.37	2.79	5.62
C. Leaf rust					
Local	36.92	17.34	29.80	21.70	26.11
Improved tall	27.79	14.74	18.40	12.03	18.84
Dwarf	6.32	8.17	5.00	2.33	8.35

* Source: J. M. Prescott, CIMMYT Plant Pathologist, Ankara, Turkey. Personal communication.

**Data based on:
1972 7 local, 12 improved tall, 12 dwarf wheat
1973 7 local, 31 improved tall, 14 dwarf wheat
1974 7 local, 21 improved tall, 15 dwarf wheat

CHART I.2.1 Population Handling in the Bread Wheat Program

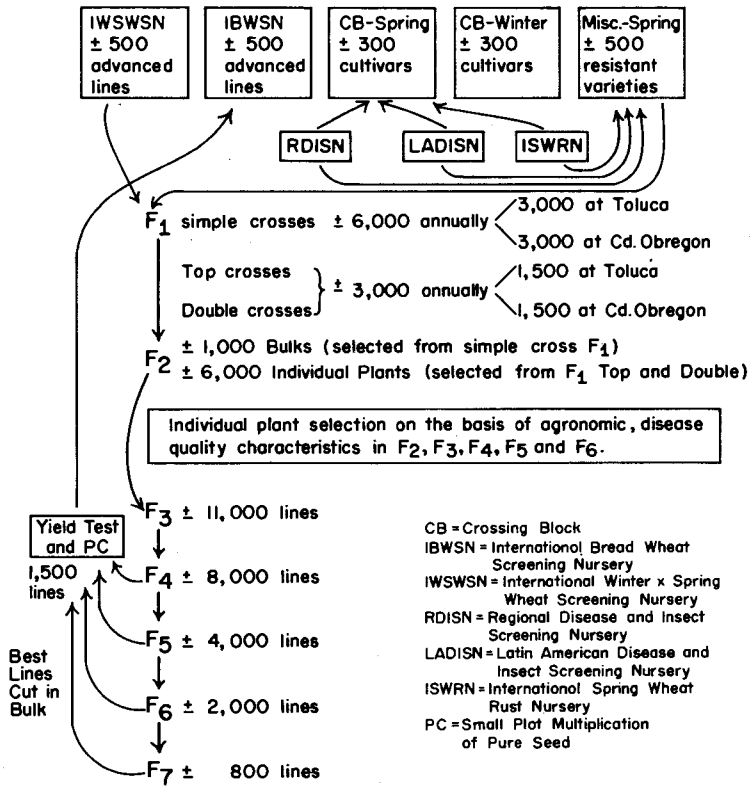
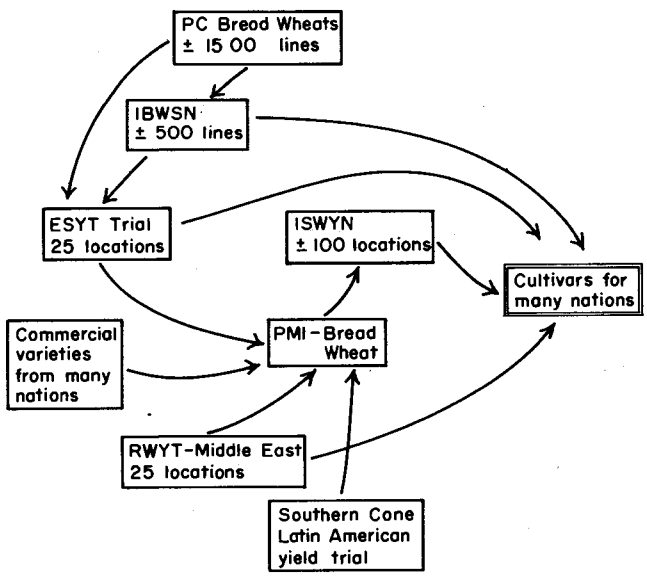


CHART I.2.2 Flow of germ plasm between National and CIMMYT Programs



PC = Small plot multiplication for pure seed
ESYT = Elite Selection Yield Trial (International)
RWYT = Regional Wheat Yield Trial - Middle East
ISWYN = International Spring Wheat Yield Nursery
PMI = International Multiplication Plot

1.3 Bread Wheat

1.3.1 INTRODUCTION

The primary goal of the bread wheat program is to develop varieties that produce stable, high yields under a wide range of environmental conditions. Stability in itself is largely related to resistance to diseases, insensitivity to day lenghts and ability to produce under varying types of moisture conditions.

A wheat variety usually lasts about three to ten years before a new rust race develops which overcomes its resistance. In a few cases, however, varieties have remained resistant for decades although their yield potential is lower than the present day varieties. Yaqui 50 for example, has been resistant to rust for 25 years. Such varieties are being used as parents in the bread wheat program to introduce stable rust resistance in varieties that are already high in yield. Wheats are sown in the winter season at sea level in Cd. Obregón in northwest Mexico and also in the summer, near Toluca at 2600 meters elevation. In 1975, a late frost in Toluca destroyed parts of the summer experiments before they were harvested. However, during the 1974-75 season at Cd. Obregón, the nurseries developed well and an artificial epidemic of leaf and stem rust was established allowing for good selection. The predominant leaf rust races were those able to attack Yecora 70, Cajeme 71, Inia 66 and Potam 70. No infection was found on the two new varieties Jupateco 73 and Torim 73. There was no major shift in the virulence pattern in stem rust.

In the summer nursery at Toluca, the spectrum of virulence in stripe rust was similar to that of 1974. The varieties Yecora 70, Jupateco 73 and Tanori 71 showed different levels of severity of infection to stripe rust. However, because this disease is not important in northwestern Mexico, it is of little importance to Mexican production.

1.3.2 BREEDING

During the winter season at Cd. Obregon more that 1400 advanced lines were yield tested and of these 386 were selected for superior yield, rust resistance and suitable agronomic characters. These were included in the International Bread Wheat Screening Nursery /IBWSN 7. Thirty-one advanced lines showed high yield potential over 2 years and these are shown in table 1.3.A.

In 1975, the Instituto Nacional de Investigaciones Agrícolas (INIA) of Mexico released the following three varieties which had been developed in the CIMMYT program, viz: (1) Jupateco "S" 30842-58R-1M-4Y-0M which was named as Cocoraque 75, (2) Chanate 2, II-26265-22Y-300M-301Y-2M-501Y-500M-0Y which was released as Salamanca 75, and (3) Mengavi 8156 H223-64-1Y-6C-1Y-4Y-3C-1Y-2B-300Y-0Y which was released as Zaragoza 75.

Cocoraque 75 was derived from the cross II 12300 x Lr64 8156/Norteño 67. It is double dwarf, has red grain and tenacious gluten. It has a better level of rust resistance than Jupateco 73, particularly with regards to leaf rust and stripe rust, but it does not measure up to the yield and adaptation of Jupateco 73.

Chanate 2 was derived from the cross Cno"S"-Pj62 x Cno-7C. It is a double dwarf, has red grain and soft gluten strenght. It has a weak crown and is thus susceptible to lodging under high fertility.

Zaragoza 75 was derived from the cross Mengavi-8156. It is late maturing, is a one gene dwarf, has a semi-erect leaf habit and it is highly resistant to leaf rust but is susceptible to stripe rust. It has red grain and soft gluten strenght. This variety was the result of a cross made by Ing. R. Rodríguez of CIMMYT and it was yield tested and put under initial multiplication in the bread wheat program.

Among the advanced lines shown in table 1.3.A is Hork "S", which is from the cross Hopps-Ron x Kal. It is widely adapted. It ranked in the first five in the 11th ISWYN and it has been one of the top yielders in the Yaqui Valley over the past 3 years. It has the phenotype of 8156 and is of the same height, but it combines resistance to all three rusts under Mexican conditions. It has also been reported to be resistant to Septoria tritici in Algeria, and in Pátzcuaro, Mexico. It has red grain and is similar to Super X in industrial quality. It showed resistance to leaf rust in the 22 reporting locations of the 8th IBWSN.

The advanced line known as Cuckoo is derived from the cross 7C-On x INIA-B. Manantial is another high yielding, highly adapted line. It is a one gene dwarf, has white grain and similar industrial quality to that of 7C. This line is highly resistant to leaf rust but moderately susceptible to stripe rust in Mexico. Based on the 6th Regional Wheat

Yield Trial /6RWYT/, this advanced line appeared among the top five high yielding varieties in nine of the 17 locations tested in Asia, the Middle East and Africa.

The advanced line Pollo from the cross Bb-Gallo/Cno-Son64 x Bb is a 2-gene dwarf with a good level of resistance to the 3 rusts in Mexico. It has white grain and its industrial quality is similar to that of Tanori 71.

The advanced lines Emu "S" from the cross Tob "S"-Napo X No66- Era/Bb-Gallo, Pavon "S" from the cross Vcm x Cno "S"-7C/Kal-Bb, and Moncho "S" from the cross Wren-Gto x Kal-Bb carry a very high level of resistance to all three rusts in Mexico. The first is also reported to have stripe rust resistance in Ecuador, while the two latter lines are reported to have a good level of leaf rust resistance in 21 locations of the 8th IBWSN. Preliminary yield data from the 7th and 8th IBWSN indicate that all 3 lines and their various sisters are widely adapted and high yielding in many countries. A summary of the best yielders in the 8th IBWSN, is given in table 1.3.E. Pavon "S" and its sisters are some of the highest yielding advanced lines under Yaqui Valley conditions in Mexico. Both Pavon "S" and Moncho "S" are somewhat late in maturity, are of one gene dwarf height and have white grain.

The advanced line Blue Jay "S" from the cross Tzpp-P1 x 7C is a two-gene dwarf, is early maturing and has resistance to leaf, stem and stripe rust in Mexico. Certain of the sisters have red grain and some have white grain.

The advanced line Osprey "S" from the cross Napo-Cdl x Sam-Tor is a two gene dwarf, has white grain and a good level of resistance to all three rusts in Mexico.

Detailed data from the 8th IBWSN are shown in the following tables: table 1.3.F Septoria resistant lines; table 1.3.G-stripe rust resistant lines; table 1.3.H-leaf rust resistant lines; table 1.3.I-powdery mildew resistant lines.

The Bread Wheat Crossing Block is systematically organized into groups having different characteristics and it uses the information obtained from various national program results collected worldwide. The 1975 Crossing Block was distributed to 40 cooperators. It is hoped that agronomic and pathologic information gathered from these will assist CIMMYT in reassessing the value of the crossing block entries, so that continued modification can be made.

In CIANO, 2660 single cross F_1 material of spring x spring varieties were grown in 1974-75, and used largely for the production of top and double crosses. Of these, 1104 were discarded because of poor agronomic response or disease susceptibility. The remainder were harvested as F_2 bulks. These 1104 were then classified for suitability for irrigated or rainfed conditions. Height and potential disease resistance were used to further divide these populations. For example, that F_1 material having a parentage involving Septoria and rust resistance was sent to North Africa, the Middle East and Latin America, where Septoria is prevalent; those with only rust resistance present in the parentage, were sent to areas where Septoria is not a problem. Most of these locations are primarily under irrigation. On these bases, 481 F_1 crossbreds were selected as bulks to be sent for irrigated conditions, and 679 for rainfed areas. These were distributed to more than 50 locations for each of the two groups, and included all of the continents where wheat is grown. Through this type of distribution the possibilities of selecting the most desirable plants in these populations, is maximized.

1.3.3 THE 8156 MULTILINE

Because of their high yield potential and wide adaptation numerous varieties derived from the cross 8156 have been grown collectively, on more than 13 million hectares in a single year. It is widely recognized that the use of one variety on such a large geographical area presents a potential danger, since the emergence of a single rust race could cause widespread destruction of the crop. Further, it has been demonstrated by aerobiological studies that an epidemiological zone can cover substantial areas. However, a variety with such wide popularity and superior performance could continue to provide high yields of wheat, if this danger could be removed. It is in this context that the multiline can be effective.

About 5 years ago a program was initiated to provide a wide array of resistance in this basic genotype. The sources included resistance to the rusts and Septoria, although not necessarily both, in all of the lines. Varieties which were drawn from the U.S., Canada, Argentina, Colombia, Ecuador, Kenya, Australia, India, Rhodesia, North Africa and other countries, contributed the resistance which has been incorporated.

In 1975, two hundred and fifteen advanced lines were produced and distributed as the 4th International Multiline /8156/ Nursery to more than 30 locations in countries where this variety had been shown to be well adapted. One set was sown in Toluca in 1975 where

some entries were discarded because of their stripe rust susceptibility. One hundred and eleven entries of the 4th nursery, which survived the stripe rust in Toluca, will be individually yield tested in Yaqui in 1975-76 together with 12 different composites. It is hoped that this yield data can be used to form composites for Mexican conditions. In other countries, other combinations will be used so that Multilines of this cross can be composited, according to the needs for specific locations.

In 1974-75, seven different composites were yield tested in Yaqui Valley, and their yield performance is given in table 1.3.B.

It should be noted that individual components, composited to make the above multilines, were of unknown yield potential, many of them being much poorer yielding than Siete Cerros, the check variety. However, the yield performance of the composites were not inferior to the check in some of the cases.

Two of the above composites i.e. 8156 /WBC/-A and 8156 /RBC/-A were sent out in an International Trial, the 5th Elite Selection Yield Trial (ESYT) and their performance in relation to Siete Cerros is shown in table 1.3.C.

The performance of the two composites in certain geographical areas is very encouraging. Because of the presence of different races of rust and differences in yield response to the environment, the components of the composites should be selected under the environmental conditions in which the composite is to be grown. These two composites were also yield tested separately in Cd. Obregon and their performance is presented in table 1.3.D.

It can be seen from table 1.3.C that both of the composites are either at par or better than the commercial varieties being grown.

1.3.4 SPRING AND WINTER WHEAT CROSSES

The crossing of spring by winter wheats offers a real potential for improving both groups. Hybridization between these two seldomly crossed groups of bread wheats, brings together diverse gene pools which can provide yield increases, and can be expected to have complementary advantages for certain other characteristics. In the case of spring wheats, it is anticipated that the winter germ plasm will enhance yield and droughtresistance, and provide additional sources of resistance to such diseases as Septoria, powdery mildew, stripe rust and leaf rust. It can also be expected that a wide range of maturity will be available in segregates from the crosses between these two groups. This range of maturity will provide materials that can be grown under a range of ecological conditions.

On the winter wheat side, the germ plasm from spring wheats will enhance resistance to stem rust and provide a high yield possibility. Also, it will give a range of winter hardiness to spring type wheats for some of the more severe locations in which they are grown. In the 1974-75 season at Toluca, more than 1500 winter wheats collected from the U.S., USSR, Eastern Europe, Western Europe, Turkey, Argentina and Chile were sown during the month of November. Spring wheats were sown at four dates beginning with January 15 and ending at February 15. Crossing was carried out during May and June. Some of the better winter wheats were also sown at Cd. Obregon after vernalization, and were grown under supplementary artificial lighting. Spring x winter crosses are thus made at both locations. The F_1 crosses made at Toluca are grown the following fall at Cd. Obregon in a nursery adjacent to the spring x spring F_1 wheat material. Those made at Cd. Obregon are sown in the Toluca summer nursery, again alongside the spring x spring F_1 crosses. In this manner almost 95 percent of the double cross combinations made, i.e. $F_1 \times F_1$, involved the winter parent.

About 1,900 spring x winter combinations were made in 1975. Crossed seed of each F_1 was sent to the Oregon State University, Corvallis, Oregon, U.S.A., to the Rockefeller Foundation-CIMMYT Program in Turkey and to the Indian Agricultural Research Institute in India. In the 1974-75 season at Cd. Obregon, 998 F_1 of the nearly 1,900 spring x winter crosses made, were sown. Of the 998, some 604 were discarded because of disease susceptibility or extreme lateness. The remaining 394 were harvested in bulk, divided and sent to 100 cooperators world-wide for their selection in F_2.

Another group of 902 spring x winter F_1 crossbreds were sown in Toluca for use in double crossing. Many of these were lost because of early frosts.

Segregates from most of the spring by winter combinations are now only at the F_4 level, and it would be premature to draw specific conclusions on their performance. By 1977, it should be possible to test the agronomic, disease and physiological characteristics of derived lines. However, it is interesting to note that various sisters of the following listed high yielding advanced lines, selected from spring x winter material have been entered in the 9th International Bread Wheat Increasing Nursery for disease and

agronomic evaluation.

Alondra "S" = D6301 - Nai 60 x Wq - RM/Cno^2-Chr.
Huacamayo "S" = Yr x Son 64-NY5207.85/Cno"S"-7C x Gto
Canario "S" = (HK - 38MA x Rfn^2 - 908/Fn)Yr70
Cowbird "S" = K1Atl x Inia - BD(NP876 - Pj62 x Cal/Bb)
Goldfinch "S" = (Kt54$_E$ x Kt54B - Nar59/Drc)8156 - Pj62

1.3.5 SUMMARY

CIMMYT will continue to strengthen the multiline project using the 8156 genotype. Work will also be continued on the development of the Anza multiline in 1976. It is proposed that some 2,000 spring x winter combinations will again be effected so that 1,000 crosses can be grown in each of the two seasons.

The use of identified horizontal resistance sources of rust resistance for incorporation into the germ plasm, will continue in order to obtain greater depth of resistance in the CIMMYT germ plasm. The presence of horizontal resistance cannot be definitely identified with present knowledge at any one location. However, through the use of multilocation testing done by CIMMYT's national cooperators, selection can be made for varieties having widespread geographic resistance in many parts of the world. Many of these will carry to horizontal type of resistance. It is hoped that the magnitude and spectrum of resistance to leaf and stripe rust can be brought to the same level presently achieved in stem rust.

Information derived from the International Nurseries and local screening trials on Septoria resistance in such countries as Algeria, Tunisia, Brazil, Argentina and Mexico, serves to establish which varieties are most suitable for use in the program of increasing resistance. Incorporation of these genes into the CIMMYT germ plasm is vigorously followed, and an increasing number of lines from the program carry adequate resistance in these areas, with the exception of Brazil.

Concerning the development of aluminum toxicity tolerance for Brazil and other countries with a low soil pH, CIMMYT for the past three years, has grown large numbers of F_1 material crossed in Brazil and entered in the Cd. Obregon nursery. These have been crossed with short-statured, disease resistant CIMMYT F_1 material and varieties, in order to incorporate into their material, genes for higher yield potential.

CIMMYT is attempting on a limited scale to produce varieties for the hot and humid tropics. In recent years requests have increased for materials from such regions which grew little or no wheat previously. It is hoped that materials can be produced which can be selected in F_2 and succeeding generations, in such countries as Vietnam, Guyana, Thailand, Indonesia, The Philippines, Zambia, Central America and others. Helminthosporium sativum in addition to the other diseases of wheat, is of overriding importance under such conditions. CIMMYT is using the Poza Rica Nursery in Coastal Mexico for selection of resistant materials. Helminthosporium is severe at that site. CIMMYT has located some sources of resistance and when materials are available, they will be distributed to those countries where this problem occurs.

TABLE 1.3.A Lines showing high yield potential at Cd. Obregon, 1973-74 and 1974-75 seasons.

Variety or cross	Pedigree
Pollo=Bb-Gallo/Cno-Son64 x Bb	II-35129-26Y-2M-1Y-1M-1Y-0M
Emu "S"	CM-8327-C-9M-4Y-3M-0Y
Emu "S"	CM-8327-C-9M-1Y-2M-2Y-1M-0Y
Emu "S"	CM-8327-C-9M-1Y-1M-1Y-1M-0Y
Pavon "S"	CM-8399-D-4M-3Y-0M
Pavon "S"	CM-8399-D-4M-2Y-2M-3Y-1M-0Y
Pavon "S"	CM-8399-D-4M-3Y-1M-1Y-1M-0Y
Pavon "S"	CM-8399-D-4M-3Y-1M-0Y
Pavon "S"	CM-8399-D-4M-3Y-1M-1Y-0M
Hork"S"	CM-8874-K-1M-1Y-1M-1Y-0M(1-356Y)
Blue Jay "S"=Tzpp-PL x 7C	CM-5287-J-1Y-2M-1Y-1M-0Y
Blue Jay "S"	CM-5287-J-1Y-2M-2Y-3M-0Y
Cuckoo=7C-0n x Inia-B.Man	II-28424-8Y-1M-1Y-0M
Moncho "S"	CM-8288-A-3M-1Y-5M-0Y
Moncho "S"	CM-8288-A-3M-2Y-4M-0Y
Tob "S"-Npo x CC-Inia/Cha = Bluetit "S"	CM-5541-C-5Y-1M-1Y-4M-0Y
Osprey "S"=Npo-Cdl x Sam-Tor	CM-8701-A-1M-2Y-1M-0Y
Osprey "S"	CM-8701-A-1M-2Y-3M-0Y
Cowbird"S"=Kl.At1 x Inia-Bb(NP876-Pj62 x Cal/Bb)	CM-16716-M-3M-2Y-1M-0Y
Cowbird "S"	CM-16716-M-3M-2Y-3M-0Y
(Tob-B.Man x Bb/Cd1)SX	CM-8972-F-9M-1Y-1M-1Y-0M
/(S.D.648.5-8156/ChrxSon-Kl.Rend)Bb-Cal/Zbz=Chiroca"S"	CM-8963-A-1M-1Y-1M-5Y-6M-0Y
We x Cno"S"-No66/Zbz=Flicker "S"	CM-8954-B-7M-1Y-1M-1Y-0M
We x Cno"S"-No66/Zbz=Flicker "S"	CM-8954-B-7M-1Y-1M-0Y
Goldfinch=(Kt54E-Kt54B-Nar59/Drc)8156-Pj62	II-23651-E_1
Cha x CC-Inia	CM-1182-OL-1L-OL
(Wal/CC-8156 x Cno)7C	CM-5313-D-1Y-1M-5Y-1M-1Y-0M
We x Cno-Inia	CM-7485-1M-1Y-5M-7Y-0M
Az67-Cd1	CM-7085-37M-2Y-3M-1Y-0M
Wood Pecker = Inia"S"-Npo63 x Cal^2/PV18A-Cno67	CM-15856-6M-5Y-3M-0Y
Cal x Bb-Cno/7C	CM-5345-D-4Y-3M-2Y-4M-0Y

TABLE 1.3.B Yield performance of 7 multi-line composites in comparison to Siete Cerros at Cd. Obregon, 1974-75.

Composite	Yield kg/ha	Yield of Siete Cerros in the same Exp.
8156 (WBC)-A	7913	8376
8156 (WBC)-B	7912	8376
8156 (WBC)-C	7666	7982
8156 (RBC)-A	7723	8376
8156 (RBC)-B	7276	7395
8156 (RBC)-C	8034	8012
8156 (RBC)-E	7740	7516

WBC = White grain brown chaff
RBC = Red grain brown chaff

TABLE 1.3.C Yield of two composites in 15 locations, 1973-74.

Country	Siete Cerros kg/ha	8156 (WBC)-A kg/ha	8156(RBC)-A kg/ha
Chile	1965	2438	1677
Rajasthan (India)	6210	4001	5407
Uttar Pradesh (India)	5136	4348	4400
Sudan	2869	2729	2602
Greece	4608	4390	4690
Peru	3478	3105	3663
Nepal	4933	3865	3918
Iran	5947	6422	6139
Pakistan	3215	3431	3165
Tunisia	5153	5780	5285
Zambia	6930	6397	6872
Ecuador	211	1577	1588
Mexico (Guanajuato)	4472	6356	7019
Mexico (El Batan)	1260	1896	1682
Mexico (CIANO)	8669	8643	9440
Average	4337	4358	4502

TABLE 1.3.D Yield of two composites in comparison to commercial varieties in Yaqui Valley, Cd. Obregon 1974-75.

Varieties and composites	Yield kg/ha
8156 (WBC)-A	8643
8156 (RBC)-A	9440
Siete Cerros	8669
Jupateco 73	9091
Yecora 70	8080
Tanori 71	8539

TABLE 1.3.E High yielding entries of 8th IBWSN appearing frequently in top ten percent at 21 locations.

Entry No.	Cross and Pedigree		Frequency in top 10%
19	Zaragoza 75		9
39	Brochis "S"	CM5872-C-1Y-1M-3Y-0M	8
167	Brochis "S"	CM5872-C-1Y-1M-1Y-3M-0Y	6
68	Moncho "S"	CM8288-A-3M-6Y-5M-0Y	7
108	Moncho "S"	CM8288-A-3M-3Y-6M-1Y-0M	7
114	Moncho "S"	CM8288-A-3M-5Y-14M-1Y-0M	5
115	Moncho "S"	CM8288-A-3M-6Y-5M-2Y-0M	5
143	Chiroca "S"	CM8963-A-1M-1Y-1M-4Y-0M	7
158	Chiroca "S"	CM8963-A-1M-1Y-1M-3Y-0M	5
70	Az67/5812 A1A3-Dan winter x Ron	CM11703-B-1Y-3M-0Y	7
104	Carthage "S" x Kal-Bb	CM7806-15M-2Y-1M-1Y-0M	7
339	Bb-Kal	CM9160-11M-5Y-6M-0Y	7
10	Jupateco 73		6
14	Anza		6
24	$Y50_E$ - Kal^3	II-35188-5M (F_1)-31Y-0M-8M-0Y	6
25	Sapsucker "S"	Br69-1Y-3M-0Y	6
45	Blue Jay "S"	CM5287-J-1Y-2M-2Y-3M-0Y	6
46	Blue Jay "S"	CM5287-J-1Y-2M-1Y-1M-0Y	5
47	Emu "S"	CM8327-C-9M-4Y-4M-0Y	6
281	Emu "S"	CM8327-C-9M-1Y-1M-1Y-0M	5
51	L.V. x Bb-Cno/Kal-Bb	Br71-42-A-1M-1Y-2M-0Y	6
57	Cno-7C x CC-Tob/SD648.5-8156	CM4756-12Y-1M-3Y-0M	6
88	Maya 74 x Soltane "S"-Bb/U.P 301	CM11559-K-5Y-8M-2Y-0M	6
306	Ron-Cha x Bb-Nor67	CM5484-F-5Y-4M-3Y-3M-1Y-0M	6
328	Bb "S" x CC-Inia	30521-20M-2Mch-2Mch-0Mch-0BK	6
8	Cajeme 71		5
15	Inia 66		5
53	Hork "S"	CM8874-K-1M-1Y-0M	5
59	Pavon "S"	CM8399-D-4M-3Y-1M-0Y	5
283	Pavon "S"	CM8399-D-4M-1Y-4M-1Y-0M	5
78	Buho "S"	CM4040-34Y-502M-501Y-0M	5
290	Bolillo "S"	CM8639-K-1M-1Y-3M-4Y-0M	5
294	Cno-Tob "S" x Npo/Bb-Nor 67	CM5221-19Y-0M-0Mch-1Y-0M	5
11	7 Cerros		3

TABLE 1.3.F Entries from 8th IBWSN resistant to Septoria tritici at 6 locations. (Scale 0-9).

Entry No.	Cross and Pedigree	Average in 6 locations.
276	Moncho "S"	
	CM8288-A-3M-5Y-8M-1Y-0M	3.4
108	Moncho "S"	
	CM8288-A-3M-3Y-6M-1Y-0M	3.8
113	Moncho "S"	
	CM8288-A-3M-6Y-2M-1Y-0M	3.7
114	Moncho "S"	
	CM8288-A-3M-5Y-14M-1Y-0M	3.7
117	Moncho "S"	
	CM8288-A-3M-6Y-5M-1Y-0M	3.9
103	Pichihuila "S"	
	CM7652-35M-5Y-3M-3Y-0M	3.3
99	Pichihuila "S"	
	CM7652-35M-3Y-1M-1Y-0M	3.8
83	Grajo "S"	
	CM5816-C-1Y-3M-2Y-500M-0Y	3.2
78	Buho "S"	
	CM4040-34Y-502M-501Y-0M	3.5
54	Pavon "S"	
	CM8399-D-4M-3Y-0M	3.8
74	Ias-Pato ((Cno "S"-Son64/Np880-Pj62 x Cal) We)	
	CM12373-L-3Y-1M-0Y	2.5
164	Chiroca "S"	
	CM8963-A-1M-2Y-6M-1Y-0M	2.8
90	Blue Jay "S"	
	CM5287-J-1Y-2M-1Y-1M-0Y	3.2
363	(WtE-Nar59 x SE/Soty)Cno-8156 x Tob-Cno	
	II 38830-1Y-4M-2Y-1M-1Y-0M	3.5
186	(Cno-7C x CC-Tob/7C) Cno-Chr x Flr-No66	
	CM8607-R-1M-1Y-4M-1Y-0M	3.0
87	(7C/LR 64-Inia x Inia-Bb) Tob-8156	
	CM5349-A-9Y-1M-2Y-500M-0Y	3.6
217	B. Man-7C xCdl	
	CM8186-H-3M-10Y-3M-0Y	3.1
243	NS718 x Meng-8156/Cno "S"-Gallo	
	CM11839-B-1Y-1M-1Y-0M	3.4
31	Bb-Cno x Inia-Soty	
	CM1502-8M-3Y-3M-2Y-0M	3.3
88	Maya 74 x Soltane "S" - Bb/UP 301	
	CM11559-K-5Y-8M-2Y-0M	3.7
190	Cno-7C x CC-Tob/Bb-Cno	
	CM4415-4Y-2M-2Y-1M-1Y-0M	3.6
175	(Tob-CnoxCC-Sx/Az67)Flr-Cno x Yr "S"	
	CM11793-C-2Y-5M-2Y-0M	3.8

TABLE 1.3.G Entries of 8th IBWSN showing resistance to stripe rust at 10 locations

Entry	Variety and Pedigree	Head Infection		Average CI in 10 locations
		Ecuador	Colombia	
69	Emu "S" CM8327-C-9M-2Y-10M-0Y	T	0	1.4
122	Emu "S" CM8327-C-9M-2Y-6M-2Y-0M	0	0	2.4
123	Emu "S" CM8327-C-9M-2Y-8M-3Y-0M	0	0	3.5
121	Emu "S" CM8327-C-9M-2Y-11M-1Y-0M	-	0	4.1
282	Emu "S" CM8327-C-9M-1Y-5M-1Y-0M	0	0	5.2
281	Emu "S" CM8327-C-9M-1Y-1M-1Y-0M	0	0	5.4
245	Emu "S" CM8327-C-9M-4Y-3M-0Y	0	0	5.5
168	Brochis "S" CM5872-B-8Y-1M-2Y-2M-0Y	0	5	3.4
169	Brochis "S" CM5872-B-8Y-1M-2Y-4M-0Y	T	0	4.1
39	Brochis "S" CM5872-C-1Y-1M-3Y-0M	T	0	5.0
385	Brochis "S" CM5872-C-1Y-5M-1Y-0M	T	0	5.9
265	Pichihuila "S" CM7652-1M-1Y-1M-4Y-0M	0	0	1.8
268	Pichihuila "S" CM7652-39M-1Y-1M-4Y-0M	0	0	5.2
236	Alondra "S" CM11683-A-1Y-1M-3Y-0M	0	0	4.9
235	Alondra "S" CM11683-A-1Y-1M-2Y-0M	0	5	5.6
291	Bolillo "S" CM8639-K-1M-1Y-6M-1Y-0M	0	0	1.8
221	Pavon "S" CM8399-D-4M-2Y-1M-0Y	T	0	2.9
57	Cno-7C x CC-Tob/SD 648.5-8156 CM4756-12Y-1M-3Y-0M	0	0	3.3
324	Jar 66-Cno "S" x Cfn-Cno "S" II 26090-10R-2M-3T	0	5	3.4
196	Tob-8156 (R) x Pato (R)/Inia-Tzpp CM5704-D-3Y-1M-2Y-4M-0Y	5	0	3.7
249	Yr "S"/Bb-Cal x 7C-Nad CM12534-G-1Y-1M-2Y-0M	0	0	4.2
35	Inia "S"-On x Inia-Bb CM1607-17M-1Y-1M-1Y-0M	0	5	5.2
104	Carthage "S" x Kal-Bb CM7806-15M-2Y-1M-1Y-0M	0	0	5.7

CI = Coefficient of Infection.

TABLE 1.3.H Entries of 8th IBWSN showing resistance to Leaf rust at 22 locations.

Entry No.	Variety Cross and Pedigree		Average CI in 22 locations
68	Moncho "S"	CM8288-A-3M-6Y-5M-0Y	.2
108	Moncho "S"	CM8288-A-3M-3Y-6M-1Y-0M	.5
110	Moncho "S"	CM8288-A-3M-4Y-5M-2Y-0M	.5
274	Moncho "S"	CM8288-A-3M-4Y-15M-3Y-0M	.5
119	Moncho "S"	CM8288-A-3M-8Y-1M-1Y-0M	.7
112	Moncho "S"	CM8288-A-3M-6Y-2M-2Y-0M	.8
117	Moncho "S"	CM8288-A-3M-6Y-5M-1Y-0M	.8
111	Moncho "S"	CM8288-A-3M-1Y-13M-2Y-0M	.9
113	Moncho "S"	CM8288-A-3M-6Y-2M-1Y-0M	1.0
114	Moncho "S"	CM8288-A-3M-5Y-14M-1Y-0M	1.1
115	Moncho "S"	CM8288-A-3M-6Y-5M-2Y-0M	1.2
118	Moncho "S"	CM8288-A-3M-6Y-4M-1Y-0M	1.2
275	Moncho "S"	CM8288-A-3M-5Y-3M-1Y-0M	1.3
116	Moncho "S"	CM8288-A-3M-6Y-5M-3Y-0M	1.5
276	Moncho "S"	CM8288-A-3M-5Y-8M-1Y-0M	2.2
48	Moncho "S"	CM8288-A-3M-5Y-4M-0Y	2.3
59	Pavon "S"	CM8399-D-4M-3Y-1M-0Y	.9
284	Pavon "S"	CM8399-D-4M-3Y-1M-1Y-0M	.8
283	Pavon "S"	CM8399-D-4M-1Y-4M-1Y-0M	.9
285	Pavon "S"	CM8399-D-4M-4Y-2M-2Y-0M	1.7
71	Pavon "S"	CM8399-D-4M-3Y-0M	2.5
351	Hork "S"	CM8874-K-1M-4Y-1M-1Y-0M	1.0
151	Hork "S"	CM8874-K-1M-1Y-1M-2Y-0M	1.2
150	Hork "S"	CM8874-K-1M-1Y-1M-1Y-0M	2.3
355	Huacamayo "S"	CM8671-B-5M-1Y-2M-1Y-0M	.7
292	Huacamayo "S"	CM8671-B-5M-3Y-2M-4Y-0M	.5
252	Pichihuila "S"	CM7652-17Y-24M-1Y-0M	1.3
78	Buho "S"	CM4040-34Y-502M-501Y-0M	1.8
83	Grajo "S"	CM5816-C-1Y-3M-2Y-500M-0Y	1.8
290	Bolillo "S"	CM8639-K-1M-1Y-3M-4Y-0M	2.3
349	Bb-Kal	CM9160-11M-5Y-5M-2Y-0M	.7
348	Bb-Kal	CM9160-11M-5Y-4M-1Y-0M	.8
350	Bb-Kal	CM9160-11M-5Y-4M-0Y	1.6
339	Bb-Kal	CM9160-11M-5Y-6M-0Y	1.7
193	Cno "S"-Pj 62 x Gallo	II30793-1M-2R-2M-0R	1.6
55	(No 66-Bb/Cno x Nad-Chr "S") 7C	CM5375-F-1Y-1M-1Y-0M	1.6
172	Brochis "S"	CM5872-C-1Y-5M-2Y-2M-0Y	1.3
251	Cno-7C x Bb-Inia	CM7551-22Y-5M-1Y-0M	.8
338	Cal-CC x Son64 - Nr	CM5752-J-8Y-1M-1Y-2M-1Y-0M	.7
336	Pato (R)-Cal/7CxBb-Cno	CM5746-G-3Y-6M-1Y-1M-1Y-0M	.8
337	Pato (R)-Cal/7CxBb-Cno	CM5746-G-3Y-6M-1Y-5M-2Y-0M	.7
194	Tucan "S"	CM2699-12M-1Y-5M-2Y-4M-0Y	1.8
198	CC-We x Yr "S"	CM11530-P-1Y-5M-0Y	1.0
264	Bb-Cal x Pj62	CM7525-33M-5Y-3M-1Y-0M	1.3
91	Cocoraque 75		1.5
105	Npo-Tob "S" x 8156/Kal-Bb	CM7806-15M-2Y-2M-1Y-0M	2.1
143	Chiroca "S" CM8963-A-1M-1Y-1M-4Y-0M		1.8
159	Chiroca "S" CM8963-A-1M-1Y-1M-1Y-0M		2.1
137	Ji/CC x K58N-II44.29	CM14992-1M-1Y-0M	1.6
189	Cno^2-Chr x Tob-8156/Cno "S"-Inia "S" x Bb CM5811-B-1Y-2M-1Y-1M-1Y-0M		2.0
190	Cno-7C x CC-Tcb/Bb-Cno	CM4415-4Y-2M-2Y-1M-1Y-0M	1.3
356	Tp(Cno-No66)^2	CM5527-A-3Y-3M-3Y-1M-1Y-0M	1.9

CI = Coefficient of Infection.

TABLE 1.3.I Entries from 8th IBWSN resistant to powdery mildew at 7 locations. (Scale 0-9).

Entry No.	Variety or Cross and Pedigree	Average in 7 locations
136	CC-Inia "S" x 7C/We CM5430-E-1Y-1M-2Y-1M-1Y-0M	2.14
87	(7C/LR 64-Inia x Inia-Bb) Tob-8156 CM5349-A-9Y-1M-2Y-500M-0Y	2.28
129	Cno-7C x Kal-Bb CM4407-12Y-3M-2Y-1M-1Y-0M	2.42
131	Gto-7C x Bb-Cno CM5278-B-4Y-1M-2Y-1M-1Y-0M	2
137	Ji/CC x K 58N-II 44.29 CM14992-1M-1Y-0M	2.28
189	Cno^2-Chr x Tob-8156/Cno "S"-Inia "S" x Bb CM5811-B-1Y-2M-1Y-1M-1Y-0M	2.28
305	Ron-Cha x Bb-Nor67 CM5484-F-5Y-4M-1Y-1M-1Y-0M	2.57
347	Bb-Kal CM9160-11M-5Y-1M-2Y-0M	2.28
351	Hork "S" CM8874-K-1M-4Y-1M-1Y-0M	2.75

CIMMYT's headquarters at El Batan near Mexico City.

1.4 Durum Wheat

1.4.1 INTRODUCTION

The introduction of new high yielding durum varieties is beginning to increase durum production in the traditional durum areas. Previously, the advent of short, high yielding bread wheats into the traditional durum areas had put durums under hard pressure. Farmers had started to switch to bread wheats, especially where durums had no price advantage to make up for the notoriously lower yields of traditional durums. This situation has begun to change again in some countries, partly as a result of CIMMYT's effort over one decade to improve durum wheat. It has raised the yield potential, increased pest and disease resistance, and provided a wide adaptation to, or even above those of bread wheats.

During the year, a survey was made in 27 countries of the durum production areas and the current use of new high yielding varieties. It showed that the planted area was decreasing in only 4 countries, but seemed to remain stable in 11 countries and to increase in 12 countries. Where the area was decreasing, it was probably due to a further advance of high yielding bread wheats. However where an increase in the durum area was noted, it appeared to be the result of an increasing use of local improved or semi-dwarf high yielding varieties (table 1.4.A). The trend is encouraging, but new high yielding durums are getting into use very slowly, as the table indicates.

In many countries, they still do not contribute to commercial production, or their contribution is small. Assuming that the world's area planted to durum amounts to an extension somewhere around 30 million hectares, the 553,000 ha occupied by high yielding varieties (HYV's), makes up for only 1.8% of this area. More efforts will have to be made by local institutions to make the presently available HYV's popular, and by CIMMYT to provide further improved, better adapted germ plasm.

1.4.2 BREEDING FOR YIELD POTENTIAL AND FERTILITY

It is obvious from the data of this year's yield tests carried out at many locations with the international nurseries, and at Cd. Obregon, North West Mexico, that the new durum variety Mexicali 75, released in Mexico this year has reached the yield potential of the best bread wheats. Mexicali 75 was selected from the cross CM 470 = Gerardo VZ 469 (21563/61=130 Lds), incorporating Italian, Mexican, and USA germ plasm. It is an early maturing one gene dwarf with semi-erect leaves and moderate tillering ability. Its high yield potential is developed especially under good agronomic conditions. It has occupied the number one position in many CIMMYT yield tests in Mexico and in the 6th International Durum Yield Nursery (IDYN).

A number of breeding lines tested in the 74/75 yield trials, appear to have an even more promising yield potential than the newly released variety, Mexicali 75 (table 1.4.B). On the other hand, disease data from these lines reveal their still numerous weaknesses. Another traditional weakness of durums, viz sterility linked with dwarfing, has almost entirely been overcome since the release of Cocorit 71.

Further efforts are necessary to improve fertility. At present, the following simple method for assessing fertility in early generations is being tested. Fertility is expressed in terms of the ratio: grain weight of a random spike sample/total spike weight of that sample. Analyzing only one single cross (about 100 sister lines) in this respect, a high degree of variability was found which can be usefully exploited in selecting the most fertile line, (table 1.4.C). By putting special selection pressure on fertility, it is hoped to progress further towards higher and more stable yields.

Other traits related to yield potential such as short plant stature to prevent lodging, erect leaves, heavy tillering, fertilizer response, etc., continue to be valid breeding objectives for the durums.

1.4.3 DISEASE RESISTANCE

The two crop cycles planted by CIMMYT during the year give breeders the opportunity to screen durum germ plasm for sources of resistance. During the winter cycle at Cd. Obregon, conditions are favorable for leaf and stem rust. However, at this location the current rust races seem to be more virulent on bread wheats than on durums. Therefore, only a moderate disease pressure is observed at Cd. Obregon. A different situation is encounted by durum wheat on the east coast, at Rio Bravo, Tamaulipas. Stem and leaf rust races are extremely virulent on durums and provide a good opportunity to screen for resistant genotypes. In the winter cycle (1975/76), a durum crossing block and a 7th IDSN is

going to be planted and observed at Rio Bravo. In addition, a green-house study with rust spores collected at this location, is planned to be conducted at El Batan during the winter. Data on rust reaction in the seedling stage will be collected and will be available before observations are carried out at Rio Bravo. For the reasons above mentioned, the durum program should become more involved in disease screening at Rio Bravo.

The summer crop at El Batan and Toluca this year suffered a severe stripe rust infection, and good progress could be made with the identification of sources of resistance. In addition, the Toluca Nurseries were again attacked by Fusarium nivale, a fungus which destroys the active green leaf area after flowering. An early infection can destroy the nursery completely, as observed in 1973. Care of this problem is being taken during selection, in order to eliminate the most susceptible lines.

For more than 5 years, a third nursery for disease screening has been planted in the summer cycle 1975 at Patzcuaro. Here, Septoria tritici together with Septoria nodorum and Fusarium roseum spp (head scab) infections are heavy enough to identify the sources of resistance to these diseases. The Patzcuaro nursery which is planted and taken care of by CIMMYT pathologists, was visited twice by durum staff. A selection of lines was made which not only showed resistance after the epidemics had started (1st reading), but also maintained resistance until the end of the crop cycle (2nd reading), (table 1.4.D).

On the whole, the program this year was more aware and made more use than before, of disease data both from the international nurseries (see section on International Cooperation 1.4.7), and from our own Mexican plantings. Using mainly pest and disease data, and also information on grain quality and agronomic traits, CIMMYT's whole parental material was reviewed and put in order. Groups of genotypes with outstanding characteristics for one or another desirable trait, were assembled. Thus, groups with resistance to the rusts, Septoria, powdery mildew, Fusarium and hessian fly as well as sets of types with good grain, high carotene content, high test weight, erect leaves, big heads and dryland types were assembled. This grouping together with a complete list of cross number and entry numbers of nurseries where the crosses are included, helped much to plan and organize the year's crossing program.

1.4.4 COLD AND DROUGHT TOLERANCE

Improving the chances of a durum crop to perform well under suboptimal conditions i.e. to give it a wide adaptation to different types of environments, is a long-term concern of the Durum Breeding Program. Where durums are grown in high elevation areas, like in Turkey, Algeria, and Chile, they must have a certain amount of winter hardiness. CIMMYT has assembled a group of about 150 winter type durum lines which are expected to transfer cold tolerance to spring type germ plasm when crossed with the spring types. The winter type group has been vernalized and planted together with other parental material in Cd. Obregon and, without vernalization, with the winter nurseries in Toluca. It is going to be screened for cold tolerance and used in next cycle's crossing program.

The interspecific crossing program is a different approach towards more cold tolerant durums, which should help to incorporate the cold tolerance of winter type and spring x winter bread wheats into durums.

Drought tolerance depends on various aspects such as the physical situation of the plant, as expressed in its rooting pattern, and also its water economy which is regulated by stomatal openings. Another aspect is crop timing, i.e. the duration of the different growth phases. In this particular case, how much time the crop takes to fill grains after drought stress begins, seems to be important.

The physical criteria are not open to simple assessments by the breeder, whereas notes on crop timing can easily be taken in the field.

At present, the Durum Program is testing a group of more than 50 genotypes, including traditional material and high yielding Mexican dwarfs, under drought conditions. An essential point will be to find the types that show accelerated maturity, i.e. which need comparatively fewer days to fill grain, and also to see how this trait relates to yield when drought is imposed a month or more before flowering. Also, a number of genotypes with special genes for drought resistance might be identified. This will again contribute to creating better adapted germ plasm, and it will make the durum crop more successful in marginal areas.

1.4.5 INTERSPECIFIC CROSSING PROGRAM

Besides exploiting the existing variability in the program's parental material, the international nurseries, the Durum World Collection, and occasional contributions by national programs, CIMMYT has now entered a new field which is the creation of variability through interspecific crossing with hexaploid wheats.

The idea is to make available to the durums, the desirable traits of the best bread wheats, e.g. disease resistance, cold tolerance, fertility, and others, and to incorporate them into the general genetic background of the durums. Major difficulties in this area are incompatibility of types, resulting in extremely poor seed set or complete failure of the cross, and also lethal factors killing F_1 seedlings shortly after germination.

So far, only about 50% of the crosses made, have produced good F_1 material and could be advanced to subsequent generations. The most advanced material is now in F_3, and some promising lines with respect to plant type, disease resistance and fertility are appearing.

During the Mexican summer cycle 1975, several hundred crosses were made between both spring bread wheats and durums, and between bread wheat spring x winter F_1 material and durums, (table 1.4.E). Especially from the latter, it is expected that more cold tolerance will go into the durums.

1.4.6 DURUM QUALITY

Durum grain quality has many definitions, according to the kind of dish which people make from it e.g. flat, unleavened bread in many Near East countries, couscous in North Africa, and chapatis in India. However, on the international market, durum grain quality is determined by its pasta-making properties. So far, CIMMYT durum quality studies have concentrated on this latter aspect, arousing criticism by some durum breeders. George Varughese, for example, emphasizes that the grain characteristics of durums which determine bread-making quality, are different from those for pasta-making. He suggests that more should be done about diversifying durum quality criteria according to the different uses, and that once established, breeders should pay more attention to these criteria.

At present, the Durum Program supported by the laboratory, assembles information on the following characteristics, (See also table 1.4.F):

(1) Kernel size and density

In a routine assessment, kernel size and shape are graded (scale 1 to 3; 1=best and 3=poorest grain). Density is expressed in the test weight (kg/hectoliter).

(2) Vitreousness of kernel

The percentage of non-vitreous yellow berry kernels is estimated in a routine screening.

(3) Pigmentation of grain

The carotenoid content of the grain is determined at CIMMYT's cereal technology laboratory. Carotenoids give the desired yellow color to macaroni. They are still low in concentration in current Mexican lines (2-6 ppm), but a few high pigmentation lines like Gediz have already been obtained.

(4) Macaroni making and color

Our laboratory contains pasta-making equipment (Extruder) which produces macaroni and assesses the properties of the final product. A combined score is used to quantify color and general aspect of macaroni after extruding and drying. Color gets a grade from 1 to 10, with 10 being the best ranking for color. In table 1.4.F, the capital letter after the figure indicates poor (P), regular (R), or good (B) general aspect (rough, intermediate or smooth aspect). A high carotenoid content does not necessarily result in a high macaroni color grade due to the effect of a lipoxidase enzyme which breaks carotenoids down during the pasta-making process, (table 1.4.F example Haurani).

A particular concern of durum breeding at CIMMYT continues to be yellow berry, which is a white mottling of the grain due to a floury endosperm which results in an undesirable aspect of the grain and reduced semolina yield. Besides a wide genetic variation for this character in current durum lines, there exists a strong environmental influence, as experiments conducted by the training section with Cocorit 71, at Cd. Obregon have shown. The amount of yellow berry shown by Cocorit 71 varied greatly according to amount and timing of nitrogen and irrigation. (table 1.4.G and figure 1.4.1).

1.4.7 INTERNATIONAL COOPERATION

The extent of CIMMYT's role in the world-wide distribution of durum germ plasm can be appreciated by the amount of material which was sent out to cooperators in the course of this year. Seven different types of nurseries were prepared and shipped to 47 countries. The nursery with the widest distribution was the International Durum Screening

Nursery (IDSN, 68 sets) followed by the International Durum Yield Nursery (IDYN, 66 sets) and the F_2 irrigated and F_2 dryland sets (44 and 28 sets, respectively). Also a number of Elite Durum Yield Trials (24 sets), Crossing Blocks (16 sets) and F_1 (6 sets) were sent. Data reported from these trials were published in the 1st to 5th IDSN, the 4th and 5th IDYN, and the 1st to 4th EDYT. A preliminary summary of results from the 6th IDSN was prepared and sent to the cooperators. In addition, a detailed account on the durum crop and research, appeared in the publication, CIMMYT TODAY, No. 2 "Durum Wheat: New Age for an Old Crop".

By distributing durum germ plasm, CIMMYT meets the necessities of both the cooperators (who use CIMMYT germ plasm in their national breeding programs and who release varieties), and CIMMYT's own breeding programs, which need the feedback of information and germ plasm for further improvement of its material.

An example of the initial success of this system is given in the map, fig. 1.4.2, and the accompanying identification table 1.4.H. This world map shows where and under which name CIMMYT durum lines have been released as varieties. As already pointed out in the introduction, the distribution of new high yielding semi-dwarfs is still very limited. Farmers often still prefer locally well-known and safe varieties. Our task is therefore to provide lines which can replace Senator Capelli, Hyperounda, Haurani, Mahmoudi, Hedba, Gued Zenati and Kokkini, which are the improved or even unimproved traditional varieties grown in the better North African durum areas. For Turkey's high plateaux, we need semi-winter types able to perform better than Berkmen, 073/44 and 414/44. For the hot, short season durum areas of India, lines are needed to compete with and perform better than Bijaga Yellow.

As data on the performance of CIMMYT germ plasm in the world's major durum areas came pouring in this year, one of the most encouraging results was the clearly established high-yielding ability of the Mexican semi-dwarf durums, headed by Cocorit 71, and recently by Mexicali 75 (Stork "S"),(table 1.4.I). Inquiries were received throughout the year from many countries, including New Zealand, South Africa, Israel, Egypt, Kenya, Yugoslavia and Thailand, for information and seed samples of the new varieties. Several visitors, among them seed officials from Spain and Argentina, have been at CIMMYT's Headquarters and have taken information and seed back to their home countries.

An interesting contribution to our present knowledge on yield levels reached in some of the important durum areas, came from Italy. Yield data were provided by Dr. Zitelli of Instituto Sperimentale per la Cerealicoltura by Drs. Bozzini, Scarascia-Mugnozza and others. Surprisingly enough for the world's No. 1 durum producer, the mean yields reached by the best Italian varieties tested, did not exceed the 4.5 t/ha level (mean of 6 locations, Italian regional durum wheat varieties trials, 1974, but with no Mexican varieties included). Other trials, where Mexican varieties were included, showed that the Mexican semi-dwarfs did at least as good as the best Italian varieties. (The yield level reached 6 t/ha for both Mexican and Italian lines, at one location).

One of the authorities of Italian durum breeding, Dr. G. T. Scarascia-Mugnozza may have had this yield situation in mind when he made the following comment: "I want to emphasize the importance of exploiting much more large segments of the genetic variability present in T. durum and its more closely related species. In general, and especially in the Mediterranean regions, crosses have been carried out inside the same gene pool. To obtain better success, we should avoid the mixing up of the same gene pool, which results in a repetition in the new genotypes of the same advantages or defects of the parental lines".

The question might be asked if the CIMMYT durum program could make a valuable contribution to Italian durum improvement programs. A second question, however, is whether this contribution is desired or not.

Looking at other aspects of our international cooperation, it is clear that CIMMYT also profits from breeding and selection work done abroad. As an example, the CIMMYT cross D-27534=Ld 357_E-Tc^2 x Jo "S" was selected from a screening nursery in Turkey and released as Gediz, a fairly disease-resistant and excellent quality variety. The CIMMYT durum program is using Gediz now for further crossing. Other crosses made at CIMMYT, selected abroad and returned to the CIMMYT durum program came from Argentina (Balcarceo-INTA), Chile (Quilafen) and Italy (the Gerardo lines).

The seeds received by CIMMYT this year consisted of material derived from CIMMYT germ plasm and from non CIMMYT germ plasm. Seed samples came from the USA (new variety candidates Botno, Rugby, Crosby), and from Great Britain (27 winter type durums), and from Israel (one variety). The Near East Nurseries: Regional Crossing Block (RCB), Preliminary Observation Nursery (PON), and the Regional Disease and Insect Screening Nursery (RDISN), composed of both local and CIMMYT lines, arrived in time to be planted

with the winter nurseries at Cd. Obregon.

The exchange of material and information between cooperators and CIMMYT was a decisive help for the creation of new widely adapted, high yielding durums. CIMMYT is sure it can make further progress on this basis.

1.4.8 DURUM IMPROVEMENT IN THE NEAR AND MIDDLE EAST, NORTH AFRICA AND THE EUROPEAN MEDITERRANEAN:

1.4.8.1. Near and Middle East

The countries concerned are Afghanistan, Lebanon, Jordan, Iraq, Iran, Syria and Saudi Arabia. Traditional rainfed durums prevail. Since 1962, some improved Italian germ plasm (Capeiti 8) has been introduced. The distribution of CIMMYT germ plasm began in 1969.

The five best varieties in the First and Second Regional Rainfed Wheat Yield Trials (RfWYT), which were carried out under low fertility conditions were:

1st RfWYT 1972-73		2nd RfWYT 1973-74	
Variety	Grain yield t/ha	Variety	Grain yield t/ha
Capeiti 8	2.09	Cocorit "S"	2.94
Jori C 69	1.86	Gerardo 575	2.77
Haurani 27	1.38	Gerardo 512	2.68
Sen Capelli	1.37	DDw - S 15	2.54
Kyperounda	1.31	Capeiti 8	2.50

Under better agronomic conditions, Jori and Cocorit 71 were the best adapted and highest yielders, as the following results from the 3rd, 4th and 5th Regional Wheat Yield Trials suggest.

Best performers (yield t/ha)

3rd RWYT 1971-72		4th RWYT 1972-73		5th RWYT 1973-74	
Cocorit 71	(4.07)	Cocorit 71	(4.36)	Cocorit	(4.66)
Jori C69	(3.78)	Pelicano	(4.03)	- - -	
Giorgio VZ 300	(3.30)	- - -		- - -	
Inrat 69	(3.25)	- - -		- - -	

In the whole area, Jori C 69 and Cocorit 71 have been the most promising with better agronomic practices. Both are in different stages of seed increase or occupy commercial acreage. The following list shows recently identified, well adapted HYV dwarf durums which are the 10 best from 3rd PON:

Entry No.	Name	Pedigree
12	Cit "S" - Gaviota "S"	CM 9921 - 17 - OY
18	Cr "S" x T. Dic, vern. - G11"S"	CM 199 - 29M-1Y-1M-0Y
9	Maghrebi - H.O.	CM 9772-28M-0Y
26	G11 "S" -Lds-RL3601/Jo "S"	CM 32929-8Y-1M-1Y-2M-0Y
2	DDwarf -S 15 x Cr "S"	D 33312-7Y-3M-1Y-0M
3	DDwarf -S 15 x Cr "S"	D 33312-8Y-4M-2Y-0M
19	Cr "S" - Gs "S"	CM 224-1M-1Y-4M-0Y
29	AA"S" - Plc "S"	D 33041-16Y-3M-2Y-0M
27	21564 - Cr "S"	
47	21563 - gr "S"	LD 31534-3L-OL-1A-0A

Stork CM 470-1M-3Y-0M and Jo"S" - Cr "S" D 27591-5M-3Y-1M were also identified for good yield and grain quality in this region. They were included in the 6th RWYT for further testing.

The major problem of the area is that the new HYV's must show better grain and semolina quality (yellow berry (YB) undesirable) and better disease resistance, mainly to the three rusts. Also, better drought tolerance is required.

Durum figures from individual countries of the area

Country	Durum wheat area ha	Durum Area in % total wheat area	Variety Names and Distribution % Local Types	Promising HYV or lines
AFGHANISTAN	467,000	20	Mouri 80 Local short Durum 10	GVZ 285 5 Jori 2 Creso 1 Anhinga 1
IRAQ	240,000	12	S. Capelli Roshgull Sorgull	Jori
IRAN	488,000	10	?	No HYV in use
JORDAN	190,000	95	Horani Naw 45 Locals 20	F_8-Sel 35
LEBANON	17,000	32	S. Capelli 40 Haurani 25 Locals 30	Jori 5
SAUDI ARABIA	30,000	50	Lokaimy 60 Kolani Herita Kassen, etc.	Jori in seed increase
SYRIA	1,350,000	90	S. Capelli Horani Hamari	Jori in seed increase

1.4.8.2 North Africa

(a) Morocco

Little data are available. The durum area is 3/4 of the total wheat area and Kyperounda and several improved BD-lines are the common varieties. One source reported that Cocorit 71 was going into commercial production in 1975.

(b) Algeria

The most promising durums so far are:

Jori C 69: It was grown during the last three years but will be replaced by Cocorit when seed is available. Its weaknesses are poor disease resistance (chiefly Septoria) and cold tolerance.

Cocorit 71: It continues to yield well in trials, and is more tolerant to Septoria. Its weaknesses are grain quality and high in Yellow Berry (YB).

Inrat 69: It is well adapted and is often used as standard (check). It will be in commercial production within a short time.

Capeiti 8: It yields particularly well in Oran region.

Promising new durum lines in Algeria are Cocorit "S" (later and taller than Cocorit 71, less YB, better adapted to rainfed conditions and high plateau plantings), Anhinga II (lodges, but has high yield, good maturity, height and high grain quality) and Crane B (similar to Cocorit, but better grain quality).

Algeria has started its own durum breeding program during the past growing season. Results from joint Algerian-CIMMYT activities are in sight, as this is indicated in the following seven promising lines and four varieties from the first two years of yield testing.

Name	Redigree	Yield t/ha
D 70-94 (Algerian cross)	D 69.44 x D 69.41	6.4
Cr "S"-F_3Tun x AA "S" 6Fg"S"	CM 10200-2BK-OBK	5.9
Jo "S" - Gs "S" x Gs "S"-AA"S"	CM 9902-5M-2Y-OBK	6.2
Gaviota "S"-Pinguino "S"	CM 10142-39M-OY-OBK	5.7
BY_E-Tc^5 x Gs S	CM 55-50M-2Y-6M-OY-OBK	5.8
G11"S" x T.dic. vern.-G11"S"	CM 86-7M-2Y-6M-0Y-OBK	5.3
21563-AA"S"	D-27625-5M-2Y-2M-2Y-OM-OBK	6.0
Cocorit 71		5.6
Inrat 69		5.6
Capeiti 8		2.9
Bidi 17		4.0

(c) Tunisia

Durums seem better adapted to conditions in the continental area of Tunisia. Possibly moisture and temperature regimes are more favorable, i.e. more durum adequate there, as opposed to the littoral zone. Bread wheats yield higher in the littoral zone.

The most promising durum lines recently identified are D 68-8-6A-3A (a winter type, well adapted to the continental zone, and highest yielder of nine durums in 15 trials on farms in 1974- 75), D 68-8-6A-1A (similar to the above; also high yielding and well adapted to the continental zone), Amal 72, which is Brant S (a high yielding, good quality, Mexican dwarf, which performed yield-wise among the first five in the IDYNs), Inrat 69 (Mahmoudi x Kyperounda, which is now a North African standard variety) and Maghrebi 72 (fairly well adapted, yielded generally less than the first four in the 74-75 farm trials; still promising).

In five years of farm trials, the new HYV durums- Jori, Cocorit 71 and Amal - have been consistently outyielding local improved and unimproved types.

(d) Libya

It is one of the smaller durum producers of North Africa. However, because of massive seed buying from neighbor countries, new HYV durums are in a state of considerable advance. Almost half of the durum area is occupied by local improved and semi-dwarf HYVs. Inrat 69 and Cocorit 71 make up one third of the total durum acreage.

(e) Egypt

There is no commercial durum production to date. The consumption of durum grain in 1973 was 80,000 tonnes. The introduction of CIMMYT durum germ plasm has been slow. Jori and Cocorit 71 are now in seed increase.

The major problems of the area (chiefly Morocco, Algeria and Tunisia), are grain quality, Septoria resistance, cold tolerance for high plateau plantings and drought tolerance for rainfed conditions.

Durum Figures for North Africa

Country	Durum wheat area, ha	Durum area in % total wheat area	Variety Names and Distribution, in % Local Types		Promising HYV or lines	
ALGERIA	1,300,000	62	Bidi Oued Zenati	30 25	Jori Cocorit	10 5
EGYPT	0	0			Jori+Cocorit in seed increase	
MOROCCO	1,375,000	75	Kyperounda BD 3225, BD 2909 BD 1658, etc	50 50	Cocorit	
LIBYA	180,000	70	Mahmoudi	55	Bedri Inrat Cocorit	15 15 15
TUNISIA	817,000	76	Mahmoudi, Chili Roussia, Kokkini		Inrat+Bedri	35

1.4.8.3 European Mediterranean:

(a) Spain

Interest in new durum HYVs from CIMMYT was apparent when two Spanish seed officials visited CIMMYT in June 1975. Jori and Cocorit are being tested and many go to commercial production during the year.

(b) Italy

The most promising lines and varieties, identified in the Italian regional wheat trials in 1974 (six locations) are:

Creso
Rio (Roffi 580)
Sasone (201/P)
Gerardo 529
Tito
Valseva (Gerardo 572)
Valnova (Gerardo 598)
Valgerardo (Gerardo 512)
Valsacco (Gerardo 451)

CIMMYT lines which competed favourably with the above varieties were Tildillo D 28951, Stork CM 470-1M-3Y-OM (=Mexicali 75), Stork "S" CM 470 1M-2Y-OM 21463-AA"S" and D 27625-5M-2Y-2M-1Y-1M-0Y.

(c) Turkey

Uniform spring wheat yield trials have been grown at all major breeding centers (Izmir, Eskesehir, Diyarbakir, Ankara) since 1972-73. The most promising durums, so far identified are Cocorit 71 (local name is Dicle 1) and Ld 357_E-Tc^2 x Jo (local name is Gediz 1).

Gediz 1 yields in Turkey are somewhat above Penjamo 62 and are 80-100% higher than local durums. The advantages of Gediz 1 are stripe rust resistance, higher yield and superiority to Dicle 1 in the coastal area, because of better disease resistance. However, it is moderately susceptible to stem rust and Septoria.

Dicle 1 also has a great yield advantage over local durums to the extent of 30-35%. It outyields Penjamo 62 by 5-10% and Bezostaya by 20-25%. Its advantages are higher yield and slight superiority to Gediz in the South Eastern region where disease pressure is low, but it is moderately susceptible to stripe, stem rust and Septoria.

Dicle 1 sister lines are:

Dicle 2 (27617-18M-6Y-1M-OD)
Dicle 3 (27617-18M-6Y-2D-OD) -higher yielding than Dicle 1
Dicle 4 (27617-9M-5Y-6M-OY) -Better grain, less Yellow Berry than Dicle 1.

Dicle and Gediz were put into commercial production in 1975 and a rapid popularization is expected due to their yield advantage. Other promising lines for the South-Eastern and Coastal areas in Turkey are shown in table 1.4.J.

The major problem in Turkey is that the new HYV's lack resistance to disease, chiefly stem rust, yellow rust and Septoria.

Winter durums are grown on the Anatolian Plateau, in Thrace (European Turkey) and in the Edirne area. Local durums have too little winter-hardiness. Bread wheats like Belal, Bezostaya, 093-44 and 1593/51 are better. Winter durum improvement was undertaken only during the last four years. Recently identified promising durum lines are:

BY_E2 - Tc (II-22252, two sister lines) with high yield potential but insufficient hardiness for more severe areas; 61-130-414/44 (two sister lines) and 61-130-Uveyik 162 (six sister lines).

Promising winter durum lines have been placed under final testing in 1975 for possible release. The major problems of the area are that the new HYV's have still too little winter hardiness to compete with bread wheats and also, more drought tolerance, earlier maturity and disease resistance to yellow rust, stem rust, loose smut and bunt, are required.

In Turkey, durum wheats are grown on 2,200,000 hectares, which is 26% of the total wheat area. Local varieties are Akbasak, Karaculcik, Berkmen, Uveyik 414/44, whilst promising HYV's or lines are Dicle, Gediz and BY_E2, all of which are in seed increase.

Table 1.4.A The present table gives a survey on total wheat production, durum wheat production, and the estimated distribution of high yielding durum varieties

Country	I Total wheat production** x 1000 t	II Durum wheat production x 1000 t	III Durum area + increasing - decreasing o stable	IV Durum area planted to semi-dwarf HYV ha	V Use of semi dwarf HYV in % total Durum area	VI VARIETY NAMES semi-dwarf HYV	VII non-semi dwarf improved*
AFRICA							
Algeria	2600 (72)[b] 1300 (73)[b] 1100 (73)[a]	800 (74)[c]	+	120000 (72)[b] 168000 (74)[d]	15 (72)[h] 20 (74)[d]	Jori Cocorit	Oued Zenati Hedba 3 Bidi 17
Egypt	1800 (73)[b] 1837 (73)[a]	0 (73)[b]	+	in stage of seed increase	less than 1 (73)[b]	Jori Cocorit	
Ethiopia	800 (73)[b] 850 (73)[a]	640 (73)[b] 660 (74)[c]	-	0	0 (75)[h]		
Libya	30 (73)[a]	44 (74)[c]	o	13500 (74)[c.h]	45 (75)[h]	Jori Cocorit	Hamera Mahmoudi Senator Capelli Badri
Morocco	1800 (67-71)[f] 2300 (72)[f] 1897 (73)[a] 900 (73)[b]	1360 (67-71)[f] 1700 (72)[f] 1360 (74)[c] 1600 (75)[d]	-	0 (75)[h]	0 (75)[h]		
Tunisia	690 (73)[a] 885 (73)[b]	640 (73)[b] 520 (74)[c]	+	in stage of seed increase	less than 1 (75)[g]	Jori Cocorit	Inrat 69 Badri
AMERICAS							
Argentina	6500 (73)[a]	600 (74)[c] 800 (75)[d]	o	in stage of seed increase	less than 1 (75)[g]	Balcarceño	Parana Pergamino
Canada	17112 (73)[a]	1500 (74)[c] 2350 (75)[d]	o	0 used in breeding programs	0 (75)[g]	RL 3971 DT 350	Hercules
Chile	747 (73)[a]	400 (75)[d]	+	1	less than 1 (75)[g]	Quilafen	
Mexico	1980 (73)[a]	50 (74)[g]	+	12000 (74)[g]	100 (75)[g]	Cocorit Mexicali	Tehuacan
USA	46577 (73)[a]	2300 (74)[c] 3325 (75)[d]	+	10000 (74)[g]	1.5 (75)[g]	Cocorit Mexicali Produra	Leeds Wells

Table 1.4.A (continued)

ASIA							
Afghanistan	3300 (73)[a]	840 (74)[c]	-	0	0 (75)[g]		
Cyprus	10 (73)[a]	45 (74)[c]	o	3000	10 (75)[h]	Jori	Kyperounda
India	24900 (73)[a]	2750 (74)[c]	+	in stage of	less than	HD 4502	NP 401
	24500 (73)[b]			seed increase	1 (75)[g]		Macs 9
Iran	4500 (73)[b]	430 (74)[c]	-	0	0 (75)[h]		
	4600 (73)[a]						
Iraq	957 (73)[a]	270 (74)[c]	+	200000 (72)[e]	10 to (75)[h]	Jori	
				150000 (73)[e]	20 (72)[e]		
Jordan	38 (73)[a]	140 (74)[c]	o	150 (75)[g]	less than	Jori	Deir Alla
					1 (75)[g]		Hourani
Lebanon	30 (73)[a]	20 (74)[c]	+	10000 (75)[g]	5 (75)[h]	Jori	Haurani
Saudi Arabia	150 (73)[a]	40 (74)[c]	+	1000 (75)[g]	less than	Jori	Hinta-
					1 (75)[g]		Madini
Syria	593 (73)[a]	750 (74)[c]	o	5000 (75)[g]	less than	Jori	
		840 (75)[d]			1 (75)[g]		
Turkey	10080 (73)[a]	2400 (74)[c]	o	10000 (75)[g]	less than	Jori	Akbasak
	9000 (73)[b]	4000 (75)[d]			1 (75)[g]	Cocorit (=Dicle)	
						Gediz	Karakulcik
EUROPE							
France	17792 (73)[a]	440 (74)[c]	+	0 (75)[g]	0 (75)[g]		
		500 (75)[d]					
Greece	1659 (73)[a]	430 (74)[c]	o	0 (75)[g]	0 (75)[g]		
Italy	8898 (73)[a]	2730 (74)[c]	o	In stage of	less than	Gerardos	Capeiti 8
		2900 (75)[d]		seed increase	1 (75)[g]		
Portugal	489 (73)[a]	15 (74)[c]	o	0 (75)[g]	0 (75)[g]		
Spain	3915 (73)[a]	26 (74)[c]	+	In stage of	less than	Cocorit	
				seed increase	1 (75)[g]	Mexicali	
USSR	109608 (73)[a]	1500 (74)[c]	o	1	1		
		8000 (75)[d]					

* The area planted to these varieties is not included in figures of column IV and V.
** The figure in brackets indicates the year when the estimation was done, the small letter indicates the source of information.

Sources

a FAO Production Yearbook 1973.
b CIMMYT Annual Report 1973.
c CIMMYT Today No. 2 Durum wheat: New Age for an Old Crop.
d Produktie durumtarwe in Italie en de wereld. Bureau Landbouwraad, Rome 1975.
e Development and Spread of HYV's of Wheat and Rice in the less Developed Nations. Economic Research Service USDA in Cooperation with US Agency for International Development. Washington, D.C. July 1974.
f Proceedings of the Wheat, Triticale and Barley Seminar at CIMMYT. El Batan, January 22-26, 1973.
g Personal communication by Dr. G. Kingma, CIMMYT Durum Program. El Batán, December, 1975.
h Needs of Durum Wheat in the North African and Near and Middle East Region, by Dr. George Varughese. Third Regional Wheat Workshop Tunis, April 28-May 2, 1975.

TABLE 1.4.B Yield, agronomic data, and disease reaction of superior Durum lines. Yield data show means of 13 yield tests at Cd. Obregón, Mexico, 1975-75.

Variety or line and pedigree	Yield kg/ha	Check yield Mexicali 75	Height cm	Days to Maturity	Disease reaction					
					Stem rust	Leaf rust	Stripe rust	Septoria (leaf blotch)	Fusarium (head scab)	E. graminis (powdery mildew)
Gta x 21563-AA CM 10143-6M-3Y-1M-2Y	9044	8548	105	140	MS	TR	S	4-5	2	1-2
Avetoro D 32864-7Y-2M-2Y-4M-OY	8760	8548	100	140	-	0	MS-S	5-6	2	2
BY$_E$-Tc x ZBW/Cp-ST464xCr)Pic CM^{E}17799-A-9M-1Y-OM	8755	8674	95	140	-	TR	MS	2	2	2-3
21563-AA x Fg CM9799-126M-1M-5Y	8619	8548	95	136	-	0	MS	5	2	1-2
Hercules-Gta x King Fisher CD 1247-D-2Y-OM	8427	7938	95	141	-	0	R	4-5	1	-
Ato x AA-Pic CD 1859-12Y	8303	7938	90	138	-	TR	MS	4-5	2	-
Mca x 21563-AA/Pg-Fg CM14646-C-1Y-1M-1Y-OM	8240	6941	90	137	MS	0	MR	7	2	2-3
Rabi-31810 CM 10172-37M-OY-4Y	8232	7938	80	133	0	TR	MS	6-7	3	-
Durum Dwarf-S15-Cr D33312-7Y-2M-1Y-OM	8210	8276	95	140	R	TR	MR	-	-	-
Mexicali "S" CM 470-1M-2Y-OM	8066	8276	95	130	TR	TR	MR	4	2	-

TABLE 1.4.C Range of fertility indices of 8 example lines from cross CD-4404 = /(T.dur T. sph. ram - G11 "S" x Mariza Sadoro/AA "S") Stork "S"/ Chap-21563, and two check varieties. Fertility based on a random 50 spikes sample per sister line.

Pedigree of sister line	Origin MV -75	Grain weight g	Spike weight g	Fertility* index
CD 4404-B-1Y	F3 03513	65.6	105.5	0.62
CD 4404-R-5Y	F3 03607	59.9	99.7	0.60
CD 4404-G-6Y	F3 03537	53.1	102.0	0.52
CD 4404-M-1Y	F3 03579	53.5	109.6	0.49
CD 4404-J-16Y	F3 03572	41.9	97.3	0.43
CD 4404-1-3Y	F3 03554	33.4	92.2	0.36
CD 4404-1-1Y	F3 03552	21.2	69.5	0.31
CD 4404-H-7Y	F3 03549	10.4	83.1	0.13
Jori 69	-	35.6	94.7	0.38
Mengavi 8156	-	47.5	92.2	0.51

* Fertility index = grain weight/spike weight
MV-75 = Mexican Summer Cycle 1975

TABLE 1.4.D Durum lines with outstanding disease resistance characteristics as identified in NW-Mexico (74-75), Toluca (74-75) and Patzcuaro (1975).

Name and Pedigree	Stem rust	Leaf rust	Stripe rust	Septoria 1st reading	ssp(0-9) 2nd reading	Fusarium 1st reading	ssp(0-9) 2nd reading
Parana 66/270	0	TR	5R	0	2	2	2
65150-Leeds D-68112	0	TR	5MR	0	1	1	3
Snipe "S" CM 13414-1Y-2M-0Y	0	0	TR	0	0	0	2
D Dwarf-515 x Cr D 33312-8Y-4M-2Y-0M	TR	TR	TR	1	3	2	3
BY_E2-Tc^5 D 21276-3Y-6Y-3Y-2M-0Y-1D-0H	0	TR	5 R	1	2	3	4
Lyperonnda-Yrellourico	0	TR	TR-5MS	0	1	1	2
Flamingo "S" D-27582-8M-1Y-5M-2Y-1M-0Y	0	TR	TR	1	3	3	4
Tildillo 28951-3Y-3M-4Y-0M-12T	0	TR	-	1	3	3	3

Table 1.4.E Interspecific crosses made during the 1975 crop cycle. Two examples of good and bad combiners are given for bread wheat Spring x Winter F_1 material x Durums, and current spring bread wheats x durums.

Bread wheat parent (female)	X	Durum parent (male)	Number of seeds obtained from 3 emasculated spikes
S x W F_1 x Spring Durum			
Hg-Son64 x 1150-18 Vg10 x Cbo "S"-Gallo "S"	X	Mexicali 75	45
Bezostaja-2B x Ron#2	X	Mexicali 75	19
T. aestivum x Kal-Bb	X	Ibis	68
Pj62-Ha/$\overline{V}$ /Rsh(LR64-Son64 x Sk)3	X	Ibis	23
Spring Bread Wheat x Spring Durum			
Cuo "S"-Gallo"S"	X	Jaafari	54
Huacamayo "S"	X	Jaafari	22
7C-On x Inia-B-Man	X	Stk "S"-Chap-21563	58
Tucan "S"	X	Stk "S"-Chap-21563	25

Good Bread Wheat combiners were: Cno"S"-Gallo"S", Kal-Bb, Cno"S"-Gallo"S" x Bb# 4A x Kenya 4426, Tob"S"-Cal, Bucky, Fury-7C

TABLE 1.4.F Durum grain quality of some advanced lines and varieties. Seed grade, yellow berry percentage, test weight, pigmentation, macaroni color and total protein. Grain harvested at Cd. Obregon, 1974-75.

Name and pedigree	Seed grade	Yellow berry or black point	Test weight kg/hl	Pigmentation grain carotenoids ppm	Macaroni color(CM) (1-10,P,R,B)	Total protein %
Cr"S"-Gs"S" CM 224-1M-1Y-2M-0Y	2+	0	81.15	3.4	CM 1 R	10.8
Flamingo"S" D 27582-8M-1Y-5M-2Y-1M-0Y	3	Traces black point	83.05	3.1	CM 2 P	12.0
Cormorant "S" CM 299-49Y-4M-3Y-0M	1-	0	82.62	3.5	CM 7 R	10.8
Gediz D 27534-1M-1Y-1M-0Y	1-	0	83.85	6.7	CM 9 B	10.9
Haurani	2	0	81.92	7.9	CM 4 B	13.5
Quilafen	1-	0	81.05	9.0	CM10 R	12.0
Mexicali 75	2-	Traces Yellow berry black point	78.50	5.8	CM 6 R	10.3

TABLE 1.4.G Influence of N-level and frequency of irrigation on grain yield and amount of yellow berry of Cocorit 71. (one single N-application at planting).

N-Dose (kg/ha)	Grain yield t/ha (two irrigations)	Yellow berry	Grain yield t/ha (five irrigations)	Yellow berry
0	2.3	High	4.0	High
60	3.0	Low	5.9	High
120	3.3	Low	7.7	High
240	3.0	Very low	7.3	Very low

TABLE 1.4.H Identification Table for Durum varieties.

Country of release	Local name	Cross and Pedigree	CIMMYT name
Algeria	Jori	BY^{2}_{E}-TcxTac$_{E}$-Tc^{3} D21570-9M-6R-1M	Albatross, Jori
	Cocorit	RA_{E}-Tc^{4}xStw63/AA"S" D 27617-18M-6Y-OM	Cisne, Cocorit
Argentina	Balcarceño INTA	-	Balcarceño INTA
Chile	Quilafen	Ld 357$_{E}$-Tc^{2} D14540-1C-1Y-1C	Quilafen
Iraq	Jori	BY^{2}_{E}-Tc x Tac$_{E}$-Tc^{3} D 21570-9M-6R-1M	Albatross, Jori
Italy	Gerardo	Cp x Yuma x Giorgio	Gerardo
Lebanon	Jori	BY^{2}_{E}-Tc x Tac$_{E}$-Tc^{3} D 21570-9M-6R-1M	Albatross, Jori
Mexico	Jori 69	BY^{2}_{E}-Tc x Tac$_{E}$-Tc^{3} D 21570-9M-6R-1M	Albatross, Jori
	Cocorit 71	RA_{E}-Tc^{4} x Stw63/AA"S" D 27617-18M-6Y-OM	Cisne, Cocorit 71
	Mexicali 75	Gdo VZ 469(21563/60-130-Lds) CM 470-1M-3Y-OM	Stork, Mexicali
Saudi Arabia	Jori	BY^{2}_{E}-Tc x Tac$_{E}$-Tc^{3} D 21570-9M-6R-1M	Albatross, Jori
Syria	Jori	BY^{2}_{E}-Tc x Tac$_{E}$-Tc^{3} D 21570-9M-6R-1M	Albatross, Jori
Tunisia	Amal	Belle-Tc^{2}xZBW/TM$_{E}$-Tc^{2}xZBW D 24102	Brant
	Maghrebi	G11"S"/Br180-LkxGz-61-130 D 26842-21Y-3M-OY	Maghrebi
	Dicle	RA_{E}-Tc^{4}xStw63/AA"S" D 27617-18M-6Y-OM	Cisne, Cocorit 71
	Gediz	Ld357$_{E}$-Tc^{2} x Jo"S" D 27534	Gediz
USA	Cocorit 71	TA_{E}-Tc^{4}xStw63/AA"S" D 27617-18M-6Y-OM	Cisne, Cocorit 71
	Produra	G11"S"/BY_{E}^{2}-Tc D 25609-1M-2M-OY	Pelicano

TABLE 1.4.I Summary of results from the 4th to 6th IDYN. Names, pedigrees, mean yields, and location frequency of the five top yielders.

	Rank	Name and Pedigree	Mean yield kg/ha	Frequency of locations where the line was among the 5 highest yielders
4th IDYN 1972-73 (38 locations)	1	Cocorit 71	4190	28
	2	Anhinga D 22234-52M-3Y-1M-OY	3923	18
	3	Cajeme 71	3842	15
	4	Brant"S" D24102-9Y-3M-OY	3745	12
	5	Crane B D23055-56M-5Y-1M-OY	3723	14
5th IDYN 1973-74 (41 locations)	1	Cocorit 71	3636	21
	2	Brant"S" D24102-9Y-3M-OY	3557	20
	3	Anhinga D22234-52M-3Y-1M-OY	3518	17
	4	Local check	3503	21
	5	Cajeme 71	3488	19
6th IDYN 1974-75 (28 locations)	1	Jupateco 73	5083	17
	2	Stork "S" CM470-1M-3Y-OM	5073	19
	3	Cocorit 71	4833	12
	4	Brant "S" D24102-10Y-3M-100Y-OM	4599	10
	5	Crane "S" D23055-33M-1R-3M-OY	4524	8

TABLE 1.4.J Disease Reaction of Promising Durum Lines at Izmer, Turkey 1975.

Variety	Pedigree	P.s.%	Reaction to P.g.t%	Septoria (1-9)
61-130-LdsxG11"S"/AA"S"	CM498-1s-0s	60S	20MS	7
Jo "S"-Cr"S"	27591-5M-3Y-1M-OY	0	80S	8
Cr"S"-Gs"S"	CM224-49M-1Y-1M-OY	20S	60S	8
Pinguino "S"	28984-52Y-2M-500Y-OM	0	20MS	4
Pinguino "S"	28984-62Y-2M-1S-2S-0S	0	20MS	6
USA IVA-Ci"S"	CM9628-2S-0S	1-S	15MS	8
Plc"S"-Jo"S"	D31769-4M-2S-0S	10MS	70S	8
21564-AA"S" (DBuckxD#2E-Tc^2/LK)	28951-3Y-3M-4Y-OM	15S	10MR	8
AA"S"	22234-52M-3Y-1M-OY	80S	15MS	8
Gaviota "S"	31725-3M-8Y-1M-0Y	0	20MR	8
AA"S"-Cr"S" x Ci"S"	CM10187-15S-0S	20S	40MS	6
Flamingo "S"	27582-8M-13Y-1M-OY	15MS	5MS	4
$LD357_E$-Tc^2xAI"S"(Gediz I"S")	D27534-13M-4Y-1M-OY	5S	90S	5
" "	D27534-3M-1Y-2M-OY	10S	90S	8
" "	D27534-14M-1Y-8M-OY	20S	10MR	8
" "	D27534-14M-1Y-4M-1S-0S	10S	60S	8

P.s. - Puccinia striiformis
P.g.t. - Puccinia graminis tritici

FIGURE 1.4.1 The influence of nitrogen rate and timing on grain yield and yellow berry percentage of Cocorit 71 at Cd. Obregon, 1973-74. Split nitrogen application at planting and early boot stages; high initial soil nitrogen; five irrigations.

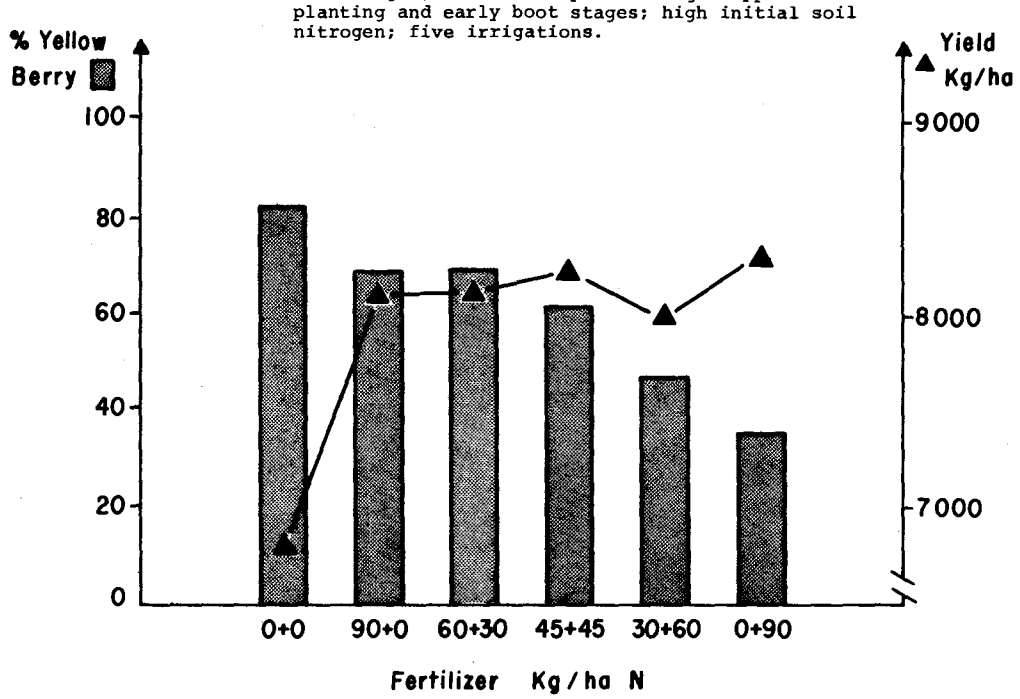
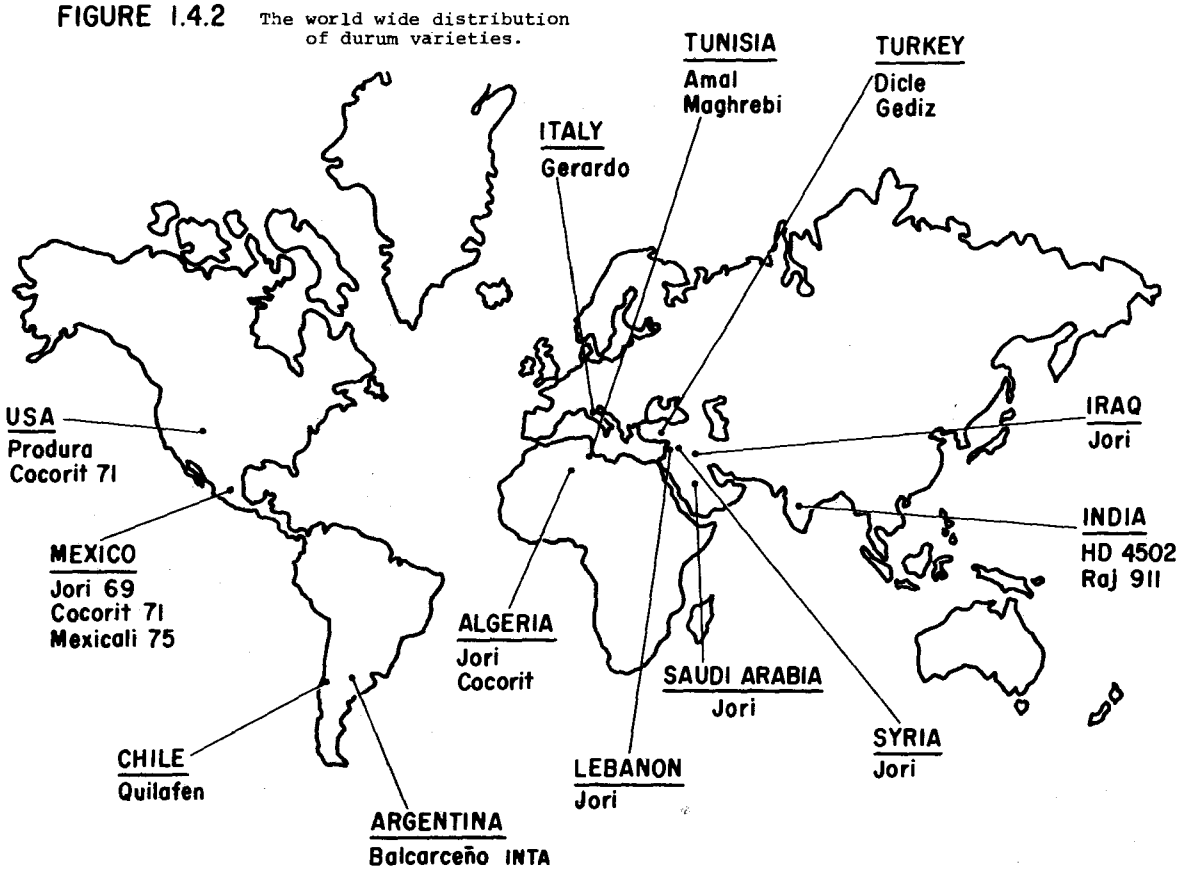


FIGURE 1.4.2 The world wide distribution of durum varieties.



1.5 Barley

1.5.1 INTRODUCTION

Barley is the fourth crop of the world in area sown, being surpassed only by wheat, rice and corn (table 1.5.A). According to the latest reports, it is grown on 87,712,000 hectares, giving a total production of 168,749,000 tonnes. The area where barley forms a primary food source is quite broad. It includes parts of the countries of North Africa, Ethiopia, the Middle East, India, Nepal, Korea, Eastern and Northern Europe and the Andean countries of South America.

Traditionally, barley has been grown under rainfed conditions and mainly on impoverished soils, although there are some areas where it is cropped under irrigation and moderately high fertilization. However, irrigation, fertilization and proper cultural practices are either not available, nor known in most of the areas where barley is cultivated. Consequently, yields are low.

Barley has been a traditional feed source for animals, and more than half the total production is used for this purpose. Due to its physical and chemical properties, it has also been the principal source of malt for use in the brewing and distilling industries. As a human food, barley has been used on a more modest scale, e.g. as cereal breakfasts, soups, couscous, bulgar, bread, cookies and so forth, either alone or in mixtures with such cereals as wheat, rye or rice.

Since the area devoted to production of barley for human consumption is primarily subsistence farming, virtually no research has been devoted to its improvement as compared with such cash crops as wheat, rice, and corn.

In 1972, CIMMYT undertook to try to remedy this situation, deeming it necessary to assist some of the world's poorest fed people. In addition to providing improvement for humans, lines could be expected to arise with similar advantages for animal feeds. There is less likelihood, however, that lines suitable for malting will come out of this program, since the requirements are quite different. The program is now in its third year and has grown steadily since its inception.

1.5.2 NEW DEVELOPMENTS

During 1975, several important steps were taken. In the first three years the principal thrust of the program was directed toward the formation of improved types with better agronomy that could be more readily manipulated in the crossing program. Presently, many of the desirable characters have been assembled in improved genotypes which are now in the crossing block. In several instances, the original donor varieties have been retired and replaced by improved lines. On this basis, more than 40 percent of the crossing block is now composed of improved lines generated within the program. These include lines with wide adaptation, better straw strength, earliness, resistance to some of the diseases, higher yield potential, higher quality, and also the naked kernel in improved agronomic types. Now, the aim of the program is to intercross and combine the desirable characters, which are present in reasonable agronomic types.

Although further improvement can be achieved, several lines have already been distributed to cooperating countries, either in the form of yield trials or as screening nurseries. CIMMYT crossing blocks have also been distributed.

1.5.3 BARLEY IMPROVEMENT PROGRAM HIGHLIGHTS AT CIMMYT

1.5.3.1 Crossing Program

The number of progenitors in the crossing block has been growing steadily. They have now been strengthened as indicated by the introduction of improved lines from the selections in the breeding program. Increasing emphasis is being given to three and four-way crosses because the desired characters can be combined more rapidly. As in other CIMMYT improvement programs, many of the crossbreds produced have been used only for obtaining F_1 material for later use in multiple crosses. In very specific instances, e.g. quality, crosses have been made within segregating lines.

In 1975, the modified clipping method of emasculation was used in which the glumes and anthers are cut off simultaneously, leaving a cup into which pollen can be placed for

pollination. This has allowed the program to perform a greater number of crosses than previously, but emasculation must be made carefully at the correct stage. Using this approach more than two thousand single crosses and more than eight hundred three and four-way crosses were made in 1975.

In CIMMYT's other crop programs, the number of plants grown in the segregating generations was reduced in order to accommodate the large number of crosses. After selection, all of the reserve seed of outstanding populations are regrown in the following cycle in larger plots in order to exploit the superior populations. The same approach is followed in barley.

1.5.3.2 Adaptation

The selection of the existing lines has been done alternatively under two different environmental conditions for several generations in succeeding cycles. It is felt, therefore, that judging from the experience in the other crops a considerable degree of adaptation has already been built into these lines. These two types of environments are: (1) Sea level desert production under irrigation and with high levels of fertility, in Northwestern Mexico during the winter. (2) High altitude humid production in a more southerly latitude near Mexico City under rainfed conditions, with heavy disease epidemics in the summer season.

1.5.3.3 Disease Resistance

Much effort has been directed to locating reliable sources of resistance to many barley diseases. Numerous sources have been pin-pointed and are being used in combination with other characters.

During the summer cycle a severe epidemic of scald (Rhynchosporium secalis) enabled good selection to be made for resistance to this disease. In the last two cycles, other diseases have been only lightly present in the summer nursery and little or no selection has been made against them. However, it is assumed that some of the selected lines carry a certain degree of resistance since they were crossed to genotypes which had been selected in areas where these diseases are endemic.

Very useful information has been obtained from the USDA, the Regional Disease and Insect Screening Nursery grown in the Middle East, the Regional Crossing Block and the Preliminary Observation Nursery distributed by the staff of the Arid Lands Agricultural Development Program based in Beirut. These data have been collected by barley scientists in cooperating countries. In addition, a good deal of information has been gathered by CIMMYT staff members travelling in other countries.

In table 1.5.B, crosses having a parent with a high degree of resistance to scald are listed. It may be seen that the sources of resistance are distributed among several parental genotypes. Whether these genes are different or not must be determined, but the important fact is that segregates of these crosses with stood the attack of an extremely severe epidemic of this disease.

1.5.3.4 Lodging

Considerable progress has been made in the development of lines with good straw strength. These have been tested under high fertility and irrigation at Obregon where they demonstrated a high degree of resistance to lodging. Good combinations of straw strength and good crown strength have been located in lines from Minnesota crossed with lines from the INIA program of Mexico, as well as with some of the Egyptian types. Dwarf types with good straw and yield potential for use in areas of high fertility, have been developed using some of the dwarf mutants developed earlier in India as parent donors.

1.5.3.5 Quality

Three years ago when the CIMMYT program was initiated, a number of crosses were made in an attempt to incorporate quality genes into the breeding lines. Currently more than 40 percent of the segregating material involves, in one way or another, parents which carry genes for protein quality. Previously only the variety Hyproly was being used as a source for the high lysine in protein. Now the Danish mutant Risø 1508 is also being used extensively in crosses.

There have been some difficulties in obtaining plump grains and high lysine at the same time, but there are now many instances in which this linkage has been broken. These lines have been included in the crossing block or they have been used directly as parents in the crosses. Crosses involving both Hiproly and the recent Risø mutant 1508

with varieties having large and plump kernels, such as those found in Mariout types and its derivatives, have proved to be good combiners for eliminating grain shrivelling.

1.5.3.6 Earliness

As has been pointed out in earlier reports, one of the aims of the program has been to develop lines with a short growing cycle for cultivation in areas with a short rainfall period. Such lines would also fit into the cropping pattern areas with long winters and, consequently, short growing cycles. Improved lines carrying genes for earliness have been obtained and they are now being tested in yield trials. The main source of earliness used has been the variety Early Russian which, from an agronomic standpoint, is a very poor type.

It is not expected that the yields of lines selected from these crosses will compete with those of varieties with a normal growing cycle. However, they indeed represent an advance in the sense that they will produce some grain under conditions where the season is so short that normal cycle varieties cannot be grown. In the present growing cycle, these lines are being grown in experiments which are designed to determine whether or not it is possible to get a crop with one or two irrigations, or for that matter, one or two rains.

1.5.3.7 Hull-less Types

Since the program is primarily designed to obtain lines of barley suitable for human consumption, the absence of hulls will facilitate their utilization. A second advantage of having naked grains, is that many of the nutrients such as vitamins and minerals which are present in the pericarp, are not lost as is the case in the pearling process. The number of crosses involving naked types has gradually increased.

Good lines have been obtained from crosses with such naked-kernelled parents as Godiva, IB 65, and a series of lines introduced from Nepal and Ethiopia. Many of the advanced lines currently being tested in the yield trials have naked kernels, and a number of them have been shown to carry increased lysine quality as well. These lines have been distributed to cooperating countries in the regular nurseries.

1.5.3.8 Nursery Testing and Distribution

A series of yield trials were grown for the first time at Cd. Obregon, using selections made at El Batan, Mexico. Several bread and durum wheats as well as triticale and commercial barley varieties were included as checks in these trials. The results are presented in table 1.5.C and they show that in almost all the trials, the CIMMYT barley lines were top yielders. However, it should be pointed out that these trials are grown under optimal conditions of fertility and irrigation, and for this reason may only approximate the relative performance under poor soils and dryland conditions. Nevertheless, in the country trials there is ample opportunity to assess their yield potential.

Using the top yielding lines of these trials, an Elite Yield Trial was assembled for the first time. This was distributed to 30 CIMMYT cooperators in 22 countries. This trial is currently being grown and hopefully data will be returned by the spring of 1976.

In addition to this Elite Yield Trial, a set of the 3rd Screening Nursery (IBON) was prepared using the lines that went into the yield trials at Cd. Obregon. A total of 45 sets was sent to 37 countries. In addition to these two trials, 28 sets of F2 bulks and 31 sets of the barley crossing block were distributed in 23 and 27 countries respectively.

These nurseries have been grown at the same time in several other locations in Mexico in cooperation with the National Institute of Agricultural Research (INIA). These areas represent a wide array of conditions, and should provide information on their performance in a broad environmental background.

TABLE 1.5.A World production of cereals 1973.

Cereal	Area (ha)
Wheat	222,268,000
Rice	134,163,000
Corn	110,924,000
Barley	87,712,000

TABLE 1.5.B Selected crosses from F_2 Barley population carrying resistance to scald (*Rhynchosporium secalis*).

	Cross	Pedigree
1.	Porvenir-Benton	CMB74A-29
2.	Porvenir-Gaines	CMB74A-30
3.	Celaya-Chevron CI 1111	CMB74A-38
4.	Zoapila-NP106	CMB74A-47
5.	Zoapila-CI 12168	CMB74A-49
6.	Zoapila-CI 3087	CMB74A-50
7.	Mezquite-Athenais	CMB74A-58
8.	Dwgl-Api^3 x Ahor 353/70	CMB74A-69
9.	/(CN100-DC23/Fun x Fun^2)Tra/70/2283	CMB74A-80
10.	Por-U.Sask.1800 x Benton	CMB74A-126
11.	Apan-Russian Line x Conquest	CMB74A-155
12.	Apan-Russian Line x CI-14064	CMB74A-157
13.	Apan-Russian Line x Tokak Mutant	CMB74A-159
14.	Manker-Athenais	CMB74A-333
15.	Bonanza-Godiva	CMB74A-354
16.	Junior-DL71	CMB74A-381
17.	Trebi-11012-2	CMB74A-385
18.	OB114- 4-Tanekase 105	CMB74A-397
19.	Cq-Jubilee x Rod 589	CMB74A-409
20.	FB/Obs/E/72 x Dwgl-Api^3	CMB74A-414
21.	FB/Obs/E/72 x Apan-Dwarf II-1Y	CMB74A-420
22.	Tia 111-Utah Hulless x Zoapila	CMB74A-421
23.	Minn 907-YKD9	CMB74A-444
24.	Minn 906-Godiva	CMB74A-459
25.	Minn 906-B855.13	CMB74A-460
26.	Atlas 46 - IB65	CMB74A-478
27.	Atlas 46 - 10985.1	CMB74A-479
28.	11016.2 - Ahor 2194/70	CMB74A-560

TABLE 1.5.C Results of Preliminary Barley Yield Trials grown at Cd. Obregon, Sonora-Mexico during 1974-75 cycle*.

No.of Trial	Variety or Cross	Pedigree	Origin	Yield kg/ha
I	Galt x Dwg1-Api[3]	CMB72A-63-5B-1Y-0B	CIMMYT	6988
	Manker (Barley check)		Minnesota	6816
	CM67-EB489-2-15-5 x CM67-U.Sask 1800	CMB72A-149-I-2B-3Y-0B	CIMMYT	6721
	CM67 (Barley check)		California	6066
	Beacon (Barley check)		North Dakota	5533
	Apizaco (Barley check)		Mexico (INIA)	4900
	Porvenir (Barley check)		Mexico (INIA)	6385
II	CM67-U. Sask 1800 x Pro -CM67	CMB72A-160-I-1B-1Y-0B	CIMMYT	7130
	Ds[2]-Apro x CM67 (CM67/Apro x Sv02109-Mari)	CMB72A-190-B-1B-1Y-0B	CIMMYT	6530
	CM67-U. Sask 1800 x Pro-CM67	CMB72A-160-H-4B-1Y-0B	CIMMYT	6250
	Arivat (Barley check)		USA	5258
	Bussell (Barley check)		Australia	5136
	W.W.Tellus (Barley check)		Sweden	4258
	Coho (Barley check)		Europe	3858
	Weihenstephan (Barley check)		Germany	3258
III	Por-U. Sask 1766	CMB72-76-6Y-1B-2Y-0B	CIMMYT	7313
	Por-U. Sask 1766	CMB72-76-6Y-1B-1Y-0B	CIMMYT	7093
	CM67-Sv. Mona	CMB72-41-29Y-4B-1Y-0B	CIMMYT	6810
	Sv. Mona (Barley check)		Sweden	4843
	Navojoa (Triticale check)		CIMMYT	5800
	Jupateco (Bread wheat check)		CIMMYT	5944
	Zoapila (Barley check)		Mexico (INIA)	5505
	Puebla (Barley check)		Mexico (INIA)	6805
IV	Por-U. Sask 1766	CMB72-76-6Y-3B-1Y-0B	CIMMYT	7711
	Minn. 126 - CM67	CMB72-189-11Y-3B-1Y-0B	CIMMYT	7251
	Minn. 126 - CM67	CMB72-189-29Y-1B-1Y-0B	CIMMYT	6105
	Porvenir (Barley check)		Mexico (INIA)	6046
	Piri (Barley check)		Europe	5360
	Celaya (Barley check)		Mexico (INIA)	5900
	Yoreme (Triticale check)		CIMMYT	4868
	Yecora 70 (Bread wheat check)		CIMMYT	5591
V	Stork "S" (Durum check)	CM470-1M-3Y-0M	CIMMYT	7422
	SD 607-CM67	CMB72-202-11Y-1B-1Y-0B	CIMMYT	7016
	SD 607-CM67	CMB72-202-22Y-1B-1Y-0B	CIMMYT	6501
	Apizaco (Barley check)		Mexico (INIA)	5271
	Bacum (Triticale check)		CIMMYT	4016
	Cocorit 71 (Durum check)		CIMMYT	6463
	Kristina (Barley check)		Europe	6101
VI	Puebla (Barley check)		Mexico (INIA)	6950
	H269	-1Y-1B-1Y-0B	CIMMYT	6621
	H269	-1Y-1B-2Y-0B	CIMMYT	6396
	Mazurka (Barley check)		Europe	5233
	Apan-Russian Line (Barley check)		CIMMYT	4601
	Zoapila		Mexico (INIA)	6055
	Porvenir		Mexico (INIA)	6116
VII	Api-CM67	CMB72-60-500Y-502B-500Y-0B	CIMMYT	6191
	Manker (Barley check)		USA (Minnesota)	5993
	Api-CM67	CMB72-60-500Y-502B-500Y-0B	CIMMYT	5826
	Coho (Barley check)		Europe	4043
	Apizaco (Barley check)		Mexico (INIA)	5826
	Super precoz (Barley check)		USSR	4300
	M66-95 (Barley check)		USA (Minnesota)	4168
	Iris (Barley check)		USA	5100
VIII	H252	-500Y-501B-500Y-0B	CIMMYT	6175
	H251	-500Y-501B-500Y-0B	CIMMYT	6121
	U. Sask 1766-Api	CMB72-183-502Y-501B-500Y-0B	CIMMYT	6088
	Apan-Russian Line (Barley check)		CIMMYT	5425
	Navojoa (Triticale check)		CIMMYT	5601
	Super precoz (Barley check)		USSR	3733
	N.W.C.L. (Barley check)		Australia	4435

* Fertilization = 120 Kg N and 60 Kg P_2O_5 No. of irrigations = 4

1.6 Triticale

1.6.1 INTRODUCTION

Triticale research is completing its first decade at CIMMYT. It can be truly said to have achieved successes beyond what might be expected in the development of a new crop. It has now achieved the status of an incipient commercial crop, with the potential for providing significant contributions to world food supplies. Already it has established its superiority in certain conditions over wheat, outyielding the latter in such locations as those with acid soils or at high altitudes. In figure 1.6.1 is shown the marked gains in yield of triticales in recent years.

1.6.2 CREATION OF GENETIC VARIABILITY

1.6.2.1 Developing New Primary Triticales

The number of new primary triticales available has been substantially increased since 1974 when the techniques of embryo culture and colchicine treatments were improved.

In table 1.6.A is shown the number of new amphiploids that had been produced to the end of 1975. All wheat-rye hybrids cultures from crosses during 1973-74 and sown in Toluca were killed by a severe frost on September 8 and 9 of 1974.

1.6.2.2 Winter Triticale

This program was undertaken during 1972-73 with three major objectives:

1. To increase the genetic variability in spring triticales by utilizing the germ plasm available in winter triticales and even more importantly, to tap the variability of winter ryes and wheats.

2. To develop triticale germ plasm suitable for low temperature winter areas and to obtain a variation in available maturity classes.

3. To identify triticale types that could be used for dual purposes, i.e., production of forage and grain, or completely as forage types.

Selections from the winter nursery grown in Toluca during 1974-75 were sent to 12 cooperators. These were varieties which were selected as a crossing block of winter materials. They were grown in the Americas and Europe for observation and possible use in crossing programs. This nursery provides a good opportunity for other scientists to make winter x spring triticale crosses and to separate true winter types from facultative types. Toluca does not provide the severe climate for such a separation but it does serve the purpose of a screening ground for different diseases and pre-harvest sprouting. All of the selections from 1973-74 were grown under severe cold conditions at the University of Guelph in Canada. The very few plants which survived were selections previously made at Michigan State University. These selections will be entered in the Toluca nursery for 1975-76.

1.6.3 BREEDING FOR INCREASED YIELD, QUALITY AND ADAPTATION POTENTIAL

1.6.3.1 Yield Improvement

Grain yield in triticales has improved steadily under Mexican and international conditions. With the introduction of dwarfing genes and better fertility, yields of the top triticale lines in Mexico are nearly equal to those of wheat checks.

During 1974-75, approximately 900 advanced lines were included in the replicated yield tests at Sonora.

Heavy rains at seeding time resulted in poor seed bed preparation, which in turn gave poor germination. This was compensated for by the increased tillering observed during the season. About 260 lines in this group were selected on their high yield performance and entered in the Seventh International Triticale Screening Nursery. A summary of the selected top yielding lines at Cd. Obregon is given in table 1.6.B.

In most of the experiments, the difference between the top triticale line and the best check, was of the order of ± 300 kg/ha on a 7.5 tonnes/ha average base. This is indicative of the yield potential and competitive abilities of the triticales under well-

managed, highly-fertilized and irrigated conditions. A large number of the new lines are short-strawed, responsive to fertilizer, and resistant to lodging. However, at very high levels of N fertilization, there is still a tendency to lodge in the high-yielding strains, with the exception of Beagle which can withstand applications of 300 kg/ha N. Excessive N application also causes an unwarranted delay in maturity of triticales which as a group, mature about one week later than similar classes of bread wheat.

When triticales are tested in the summer in the high valleys of Mexico,in the States of Mexico and Tlaxcala, they show marked superiority to most wheats. In part, this can be attributed to their better ability to withstand cool temperatures, diseases and relatively poorer soils. In the current year, however, a severe frost at the soft dough stage of grain development, killed many of the segregating populations and yield trials.

Results from other high valley areas, where the national extension staff of Mexico conducted trials and demonstrations, were favourable. One of the new lines known as Bacum, which is among the earliest of present lines, has been particularly promising. It is currently being widely tested in the State of Michoacan, Mexico.

In the outreach program, Arabian, Navojoa and Bacum looked promising in the Mediterranean - Middle East - area, with yields exceeding those of one bread wheat (Cajeme 71) and one durum (Cocorit 71), as shown in table 1.6.C.

1.6.3.2 International Testing Progress

The first set of the International Triticale Yield Nursery (ITYN) and International Triticale Screening Nursery (ITSN) were first circulated on a limited scale in 1969. The triticale lines under test were comparatively low yielding and were narrow in their adaptation. In the period 1969-1974 the breeding program was expanded in size, genetic variability was increased and international testing was increased. As a complement to these nurseries, early generation segregating materials and a set of winter triticales have been sent to cooperators since 1973. The latter material can be used to select for specifically adapted material, which CIMMYT then recombines to build up wider adaptation.

Good progress was made in achieving increased fertility, dwarfing was introduced and the germ plasm markedly widened through the synthesis of new amphiploids and introduced material.

Newer triticale strains, identified for their high yield potential in Mexico, were included in recent international nurseries. These have shown a remarkable increase in average yield each year in an increasing range of environments, as indicated in figures 1.6.1 and 1.6.2. The wheat checks used were those which are currently the high yielding varieties of bread and durum wheats in Mexico.

At the same time, the use of better adapted dwarf Mexican wheats in building new triticales has slowly changed the adaptation picture (table 1.6.D). It will be observed that the average number of locations at which a triticale line ranked among the top five, increased from 11 to 21 percent in five years. Of greater significance is the percent of locations where a triticale line outyielded the best check. The figure rose from less than one percent in 1969 to nearly 12 percent in 1974.

Specific areas where triticales perform better than wheat are being identified. Some of the characteristics of these regions are grouped as follows:-

1. High Elevation Regions

Reports from many countries support the view that triticales give superior yield performance at high elevations, due mainly to their resistance to existing diseases and their ability to tolerate low temperatures. Such locations are:

(1) Northwestern hills of India - Resistance to bunt and stripe rust; better tolerance to cold and to acid soils.

(2) Ethiopia - Better resistance to stem and leaf rust and Septoria leaf blotch.

(3) Kenya - Better resistance to stem and stripe rust.

(4) Colombia and Ecuador - Better resistance to stripe rust and better tolerance to acid soils.

(5) Central Plateau of Mexico - More productive growth under low night temperatures

and more resistance to stripe rust. It is also considered that triticales make better use of nutrients in these infertile soils. On a three hectare farm near Sanctorum, Tlaxcala, 3.5 tonnes/ha of triticale were produced as opposed to 1.5 t/ha with barley. In the Toluca Valley, however, many strains were severely infested with leaf blotches and head blights.

2. Sandy Soils

Much of the triticale area of Europe is sandy. In Hungary, Spain and Sweden, triticales have substantially replaced rye in sandy soil areas. In Mexico triticale experiments over the past three years on a limited scale in Huamantla, a sandy soil area of the high plateau in Tlaxcala, have outyielded wheat varieties by a substantial margin, even where frost damaged the crop.

3. Acid Soils

There are many areas of the world that are covered by soils with a low pH, which is associated with the presence of toxic levels of aluminum. Brazil, for example, has very large areas of such soils on which wheat is very poorly adapted. Triticale shows a much better performance, due to the rye gene in its composition. The best yielding triticales yield three times as much as the best commercial wheat varieties. This is demonstrated in table 1.6.E.

A similar advantage in favour of triticales has been observed in Sierra Tarasca (Michoacan) Mexico, where soils contain high levels of iron and are somewhat low in pH. Some lines perform better in the Mediterranean region. Earlier lines showed distinct sterility and hence poor yields. The triticales listed in table 1.6.F have shown not only resistance to prevalent diseases, but they have also overcome the sterility barrier.

The following countries are currently growing or considering growing triticales commercially:-

1. Ethiopia: It has a large national triticale testing program which has been conducted over the past several years. Very useful information on adaptability, disease spectrum and possible commercialization has been collected. From the last year's testing program, the following lines have been selected and considered for further testing and release:

Armadillo "S" X308-6Y-2M-100Y-8B-ON

Armadillo "S" X308-7Y-4M-100Y-100M-OY

Badger "S" 68-B-10B-ON

In addition, the new line Bacum X 2831 has been shown to be superior in yield and disease resistance, and it is being rapidly multiplied.

2. India: Triticale research has been added to the National Wheat Coordinated Program at four primary centers viz., Pantnagar in Uttar Pradesh (International Development Research Center, (IDRC) assisted, Canada), Ludhiana in Punjab (PL480 assisted), New Delhi and Inchore in Madhya Pradesh. Breeding and agronomy programs are advanced at the two first centers. Here yield advantages of up to 13 percent were observed in the high hills of the Himalayas using older lines. Nine new lines were identified in 1974-75 which were superior in yield to the widely grown Kalyansona wheat variety, both at lower and higher elevations of northwest India.

These were:

Variety	Yield (q/ha)
1. TL 15	26.79
2. Maya II- Arm "S" X 2808-38N-3M-3N-OM	26.14
3. TL 24	25.75
4. V4DL	25.68
5. Navojoa "S" X 2808-38N-3M-6N-4M-OY	25.30
6. DTS 138	25.03
7. TL 29	24.67
8. TL 4	24.65
9. Navojoa "S" X 2808-38N-3M-3N-5M-OY	24.24
Kalyansona)	24.01
Sonalike) wheat checks	23.03
Himani (Rec. variety))	18.86

For 1975-76, approximately 80 farm demonstration trials are planned with four triticale strains, in the upper hills. Small seed packets of triticales will be sold to the farmers for minikit trials in the hills areas. Large multiplications to meet the next year seed requirements are also planned.

3. Kenya: Triticale has given promising results in past years trials. Some were successful under very dry conditions. Two small scale multiplications were done to further test triticales in the country. Resistance to stem and stripe rust are triticale's distinct advantages and in the 6th ITYN, Yoremi 75, Maya I-Arm "S" and Maya II-Arm "S" showed good results. This program is assisted by IDRC (Canada).

4. South Africa: Seed of the two varieties Beesee and Joseph, were multiplied and distributed to farm cooperatives in the Stellesbosch area (Cape Town) in the current year.

5. Brazil: During the past several years, scientists of EMBRAPA at Passo Fundo and FECOTRIGO at Cruz Alta, both in Rio Grande do Sul, have been testing triticales. The soils of the area are acidic with a high concentration of soluble aluminum. Triticales perform better than wheat in such conditions. Most of the present strains are subject to head blight (Gibberella zeae) and seed sprouting at these centers. In spite of this, a significant number outyielded the recommended wheat check by a two to three times factor.

6. Argentina: Triticales are under test in the west Pampas for suitability as a dual purpose crop. Winter pasture is needed and long cycle triticales have been found useful for pasture and later grain production. Older varieties such as Rosner, 6TA203 and 6TA131 are being grown for this purpose. In the Angrul area more than 1,000 hectares of Rosner were grown on commercial farms. New materials, especially spring x winter crosses and semi-winter forage types, are being sent for testing. The selection technique is simple and effective -triticale strains are grown between rye checks, grazing is done and winter survival and grain production are automatically recorded. This system would be very useful for all generations.

7. Chile: A triticale program has been undertaken with Canadian assistance from IDRC. Preliminary results have been encouraging and in certain areas, triticales yielded equally with the bread wheats. Wide testing throughout the country has been undertaken. Some of the selected promising lines are:

Maya II - Arm "S" X 2808-75N-2M-7N-1M-OY
Maya II - Arm "S" X 2808-38N-3M-3N-OM
Maya II - Arm "S" X 2832-29N-6M-5N-OM

8. Mexico: Triticales have performed well in high elevation areas of several states, in addition to good performance in Northwest Mexico. Yoremi 75 was released for commercial production on the basis of test results of the previous years. PRONASE, the national seed multiplication agency has been marketing some seed of this variety. All of the grain produced to the present time, is being consumed at farm level in traditional products. However, there is a growing interest by industry to use it in biscuits, sweet rolls, etc. Mixtures with wheat flour are being tried for use in commercial bread baking.

9. United States of America: Several southern states of the west and east are investigating triticale as a commercial product. Large acreages are now being grown to triticale for use as pasture and feed purposes. Private companies have now entered the field and they are contracting the growing of triticales for use in breakfast foods, hors d'oeuvre type preparations and some in bread. Demand for these products plus such other uses as in the brewing industry, are likely to lead to an increased acreage under triticale. The variety 6TA204 has done well in the west, and 6TA131 in the east.

10. Canada: Very little triticale is grown commercially in Canada and most is used for feed or in the distilling industry. Rosner was the first variety released (1970).

11. Spain: Cachirulo was released commercially some years ago but because of its hard threshing characteristics, it has not been popular. Most of the crop is used for flour in mixtures with wheaten flour to make bread. Some Spanish selections from Mexican material have done very well. These are easy threshing types which have created a real interest in private organizations.

12. Hungary: Triticale has replaced rye on considerable areas in sandy soils. Most of the crop is used for grazing and feed purposes. Early varieties released were known as varieties No. 30, 57 and 64. Recently, a new dwarf variety, Bokolo, has spread over a part of the range.

Several other countries have been following triticales with interest, and in certain regions, yields have exceeded wheat yields. The reasons for the higher yields are often quite different. Some of the countries in an early stage of testing include:

Algeria - The interest is in forage type materials which will grow well under very dry conditions.

Tunisia - Bacum has yielded well and if grain type improves, triticales are likely to move into production.

Colombia - Triticales have outyielded wheats significantly at higher elevations, and wide-scale testing is underway.

Ecuador - Newer triticale lines have shown better fertility, and yield potential and they are being subjected to wider testing.

Venezuela - The varieties Yoremi 75, Bacum, Rahum and Yoco (Re-selection) performe well in the El Valle (Caracas) region. Increased testing is underway.

1.6.3.3 Adaptation

On the basis of partial results obtained from the 6th ITYN, the superior lines are shown in table 1.6.F. Those showing good adaptation from the preliminary results of the 6th ITSN are:

1 Maya II - Arm "S" X 2802-38N-3M-4N-2M-5Y-OM-1Y-OM
2 Maya II - Arm "S" X 2802-37N-3M-1N-3M-4Y-1M-1Y-OM
3 Maya II - Arm "S" X 2802-1N-5M-3N-1M-2Y-OM-2Y-OM
4 Maya II - Arm "S" X 2808-1N-5M-4N-1M-1Y-OM
5 Maya II - Arm "S" X 2802-9N-2M-3N-1M-2Y-3M-1Y-OM
6 Inia-Arm "S" X 1648-5N-1M-2Y-OM
7 Arabian (Re-selection)
8 Siete Cerros (Bread wheat check)

As previously mentioned, figure 1.6.1 shows the increase in adaptation shown year after year by the triticales entering the testing program.

1.6.3.4 Quality

A. Protein Quality

In 1974-75, approximately 3000 triticale samples representing lines from F_5-F_7, plus advanced lines in preliminary or international trials, were tested for protein quality. No samples were submitted from the summer cycle because of the frost damage.

A wide range of protein per cent was observed in most of the material. The gradual lowering of protein quality as seed type has improved, which has been observed in other years, appears to be stabilizing. The range of protein in materials analyzed is shown in table 1.6.G.

A simple technique for screening large numbers of lines is being utilized to test for protein and lysine quantity. The dye binding capacity technique (DBC) is used to identify lines with high levels of protein and/or lysine. Protein content is determined on those with high DBC levels. By adjusting for protein level, those lines with high lysine are then located. There seems to be no inverse correlation of lysine content and grain plumpness.

Some of the lines identified have 4.0 percent or more lysine in the protein (table 1.6.H). It is difficult to analyze the large numbers of samples submitted in a short period of time, so that results can be known before crossing is done in the next cycle. An attempt is being made to determine whether or not the quality index, i.e. DBC value divided by protein content will provide a meaningful relationship with protein quality. At present, however, CIMMYT is still unsure as to what controls the biological value or growth in animals. Work on this aspect is reported elsewhere.

B. Industrial Quality

Improvements in seed plumpness and density, have been slow. This directly relates to yield and industrial quality. However, triticale strains with 75-76 kg/hl test weight have been identified and are being used for further improvement. Similar increases have been found for flour extraction.

The number of lines being tested for quality has increased substantially. Various products are being made from triticale flour, and the different lines are under test for bread making using normal and modified baking procedures. Most triticales have relatively weak gluten, but some make very satisfactory bread.

A group of 33 high test weight lines were tested for industrial quality and the results for the best ten are presented in table 1.6.I. It may be noted that line 6016 shows a loaf volume of 785 cc and that flour recovery on 6021 reached 69.0 percent, not far off the 71 percent common with wheat varieties.

TABLE 1.6.A New primary triticales developed at CIMMYT, 1973-75.

CYCLE	HEXAPLOIDS			OCTOPLOIDS	
	Embryos excised	Number of crosses		Number of crosses	
		Represented	Doubled	Treated	Doubled
CIANO 1973	1900	176	36 (1200*)	---	---
El Batan 1973	2100	205	64 (2000*)	159	31
CIANO 1974	2050	206	killed by frost	158 (400**)	killed by frost
CIANO 1975	1676	175	31	230	21
El Batan 1975	1205	124	40	46	8

* Total number of seeds obtained from colchicine treated hybrids.

** Total number of plants treated with colchicine representing only a part of the total number of F1 hybrid seed produced.

All wheat-rye hybrids cultured from crosses during 1973-74 and planted in Toluca were killed by a severe frost on September 8 and 9, 1974.

TABLE 1.6.B Selected triticale lines from yield tests grown at Cd. Obregon, 1974-75.

Variety	Name	Yield kg/ha	Test Weight kg/hl	Height cm	Stem Rust	Leaf Rust
102	Maya II - Arm "S"	7929	69.4	E_1	0	TR-20MR
103	Maya II - Arm "S"	7909	65.0	E_1	0	TR-5R
215	Inia - Rye x Arm "S"	7879	71.2	N+	0	10-30MR
305	FS 1045	8050	73.2	A	0	10MR
311	IA - Bush	7914	74.3	E_1 -	0	TR-10MR
426	Beagle "S"	7583	65.8	A	0	5-20MR-MS
527	FS 1897	7541	72.3	E_1 -	0	TR
608	Maya I - Arm "S"	7872	75.5	N	0	TR
730	Navojoa	7561	72.7	E_1 -	0	TR
825	FS 282	7235	72.8	N	0	TR-20MR
1216	Lince	7247	70.9	N	0	TR
2007	M_2A-1A	7533	72.8	A	0	TR-5MR
2117	Mapache "S"	7259	70.8	N+	0	TR-10MR
2326	Beagle "S"	7420	69.6	A	0	10-20MR-MS
2402	Octo Bulk-Bush	7185	74.4	E_1	0	TR
2504	Octo O.C. - Agrotriticum	7328	69.7	N+	0	TR
2829	Koala "S"	7669	69.7	N+	0	TR
3009	Bacum	7205	72.5	E_1 -	0	TR
3013	Maya II - Arm "S"	7510	71.3	E_1 -	0	TR
3211	Maya II - Arm "S"	7405	72.9	N+	0	TR
3227	1A - ITA	7882	67.7	E_1 -	0	TR

Standard Checks:-

		Average	Range
Cinnamon	(Tcl)	5763	4950-6691
Siete Cerros	(BW)	7051	6610-7558
Jupateco	(BW)	7638	6633-8556
Cocorit	(DW)	7162	6010-7857
Mexicali	(DW)	7679	6877-8830

Legend:-

BW = Bread wheat
DW = Durum wheat
Tcl = Triticale

A = Very tall
E_1 = One gene height
N = Normal height

TABLE 1.6.C Triticale lines adapted to the Mediterranean Region.

	Egypt	Tunisia	Greece	Spain	Cyprus	Iran	Lebanon	Lebanon Tel Amara	Turkey	Average
Navojoa"S"	7061**	4167*	6120**	1789**	1425	4044**	3000*	2937*	1992**	3615**
Arabian"S"	6162	3813*	4860**	2389**	1814**	6133**	2823*	2271	1853**	3579**
Arabian	6472*	4047*	5478**	2225**	1414	6144**	3530**	2814*	1826**	3772**
Setter	5794	3627*	4435**	2175**	1473	6066**	2988*	2888*	1770**	3468**
Bacum	7461**	4213**	4981**	2238**	1233	5066**	2680*	2555*	1298**	3525**
Rahum "S"	6449*	3567*	3866**	2163**	1822**	6044**	2770*	2987*	1728**	3488**
Cajeme 71	6399	4207	3680	1594**	1673	2911	3193	3480	1013	3127
Cocorit 71	6855	2547	3502	1505	1492	3899	2673	2419	840	2859

* Better than one check

** Better than both checks

Cajeme 71 = Bread Wheat

Cocorit 71 = Durum Wheat

TABLE 1.6.D Yield performance of triticales compared with wheat check varieties in the International Triticale Yield Nursery.

	1st ITYN 1969-70	2nd ITYN 1970-71	3rd ITYN 1971-72	4th ITYN 1972-73	5th ITYN 1973-74
No. of locations tested	38	17	26	25	47
Av. per cent of locations with a triticale line among the top 5	11.3	13.8	16.3	18.2	21.0
Per cent of locations where a triticale outyielded the best wheat check	0.82	4.04	5.85	7.20	11.6

TABLE 1.6.E Performance of triticales in Rio Grande do Sul (Brasil).

Year of test	Best Triticale	Yield % of IAS 52 **	Yield % of IAS 59 **
1970	Armadillo 4	100.33	
1971	Arm"S" PPV 21	270.37	
1972	Badger 118		190.36
1973	Inia-Arm "S"		146.72
1974	Arabian		165.03
1975*	FW 121-Prol x Cin		364.41

* Results of 6th ITSN grown at Cruz Alta (R.S)**=wheat varieties

TABLE 1.6.F Triticale lines with superior yield in the 6th ITYN.

Line or Cross	Total No. of Locations = 34	
	Av.Yield kg/ha	No.of times in top 20%
Maya 11-Arm "S"		
X2802-F-12M-1N-1M-0Y	4735	16
Rahum	4520	13
Beagle	4350	12
F.S. 1897	4272	10
Inia Arm "S"		
X1648-8N-3M-0Y	4364	10
Arabian	4485	9
Navojoa	4355	9
Bacum	4348	8
Yoreme-Tc 75	4271	8

TABLE 1.6.G Range of protein per cent in triticale materials tested in 1974-75.

	Protein per cent		
	High	Low	Average
Crossing block	16.8	11.1	13.9
Preliminary yield trial	17.4	12.2	13.8
7th ITSN	14.5	10.9	12.7
F_5	16.0	11.2	13.6
F_6	15.9	10.8	13.3
F_7	14.5	11.6	13.0

TABLE 1.6.H Lines of triticale with high lysine values, 1974-75.

	DBC for 60 mg protein	Protein	Lysine
Maya II-Arm "S" X2802-28N-2M-ON	43	13.2	4.04
Maya II-Arm "S" X2802-41N-1M-2N-2M-2Y	48	11.4	4.06
Maya II-Arm "S" X2802-58N-2M-ON	51	11.3	4.37
IRA X2142-1N-1M-7N-2M-4Y	55	12.0	4.36
Inia-Arm "S" X1648-0N-4M-0Y	45	13.1	4.03
M_2A - IRA X8244F-1Y-1M-1Y-1Y	52	12.9	4.0
BgC/IRA^3-Bush x Cin X11325-C-3M-100Y	47	12.9	4.0

TABLE 1.6.I Quality characteristics of selected triticale lines, 1974-75.

Lab. No.	Strain	Test Wt. kg/hl	PK Min.	Flour %	Protein %	Sediment cc	Bread Vol.cc
6003	M_2A	75.5	37	68.3	10.0	17	555
6006	FS 1150	75.0	39	60.7	10.7	19	630
6007	Bvr-Tobi x Ars/Cin	75.5	37	64.8	10.2	17	625
6012	E_3-Arm "S"	74.9	33	59.3	10.4	19	675
6016	D6654/Ant/ 573	74.3	55	57.2	11.0	21	785
6017	FS 714	76.2	31	61.2	9.9	17	650
6021	FS 3927	75.4	27	69.0	11.4	15	475
6023	FS 3927	74.1	29	65.0	10.7	15	590
6025	M_2A2	74.6	40	64.1	10.5	20	700
6030	FS 1150	74.1	38	57.8	10.4	20	665

Figure I.6.I YIELD RESULTS FROM SUCCESSIVE INTERNATIONAL TRITICALE YIELD NURSERIES

Note: Advance of yields relative to check wheat varieties

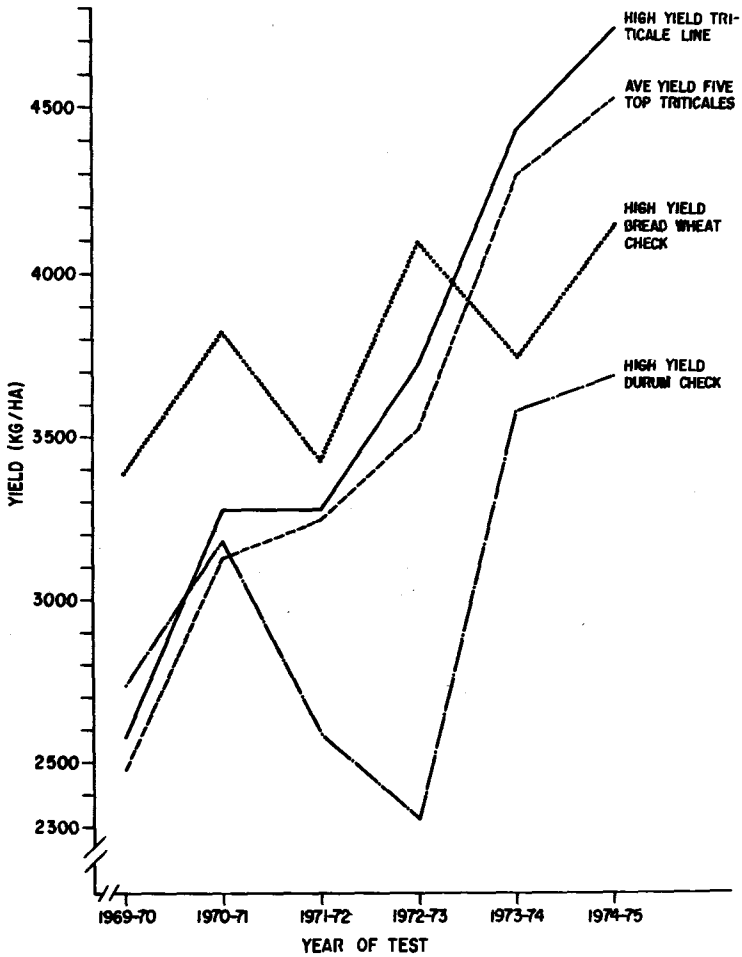
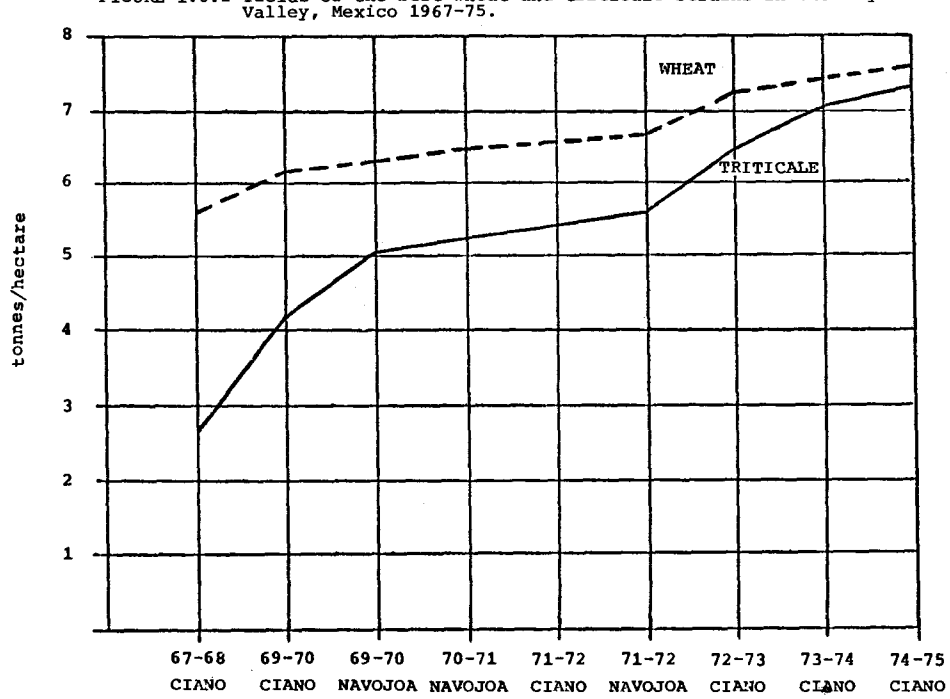


FIGURE 1.6.2 Yields of the best wheat and triticale strains in the Yaqui Valley, Mexico 1967-75.



1.7 Agronomy

1.7.1 INTRODUCTION

The agronomy program was conducted during most of the 1974-75 winter and summer cycle of 1975. During the winter cycle the trials were grown under irrigated conditions at CIANO, Cd. Obregon, and in the summer at Toluca and El Batan stations.

Off-station testing of triticale, bread wheats, durum and barleys was conducted during both of these seasons. In the winter, the trials were sown in the Yaqui Valley in Sonora and in the summer in the states of Mexico, Hidalgo and Tlaxcala.

During the winter, emphasis was placed on development of agronomic practices for triticale along with work on nitrogen use and chemical weed control. Summer work was primarily concerned with herbicide work at the El Batan and Toluca Stations.

1975 was a good year for wheat in the Yaqui Valley. The average yield for the valley was 5.1 tonnes per hectare (un-official). Weather conditions were excellent but sowing was delayed until late November and early December. In fact some of the wheat was not sown until December 20th because of heavy rains in early November. This led to planting in a poorly prepared seedbed because of the heavy clay soil type. As a result, stands looked poor initially but this may not have affected the yield due to wheat's ability to tiller in this environment. In CIMMYT tests it is usual to find in spacing and density studies that if the number of plants per square meter does not fall below 80, the yield is not affected. The early rain also provided some advantage, since one generation of weeds was destroyed. This was particularly important in the case of wild oats which were under better control than normal, during the growing season.

The period from December through May was one of the coolest on record, hence, the delay in seeding actually proved advantageous in regard to yield. Dr. Fischer's date of seeding experiment showed that the optimum seeding date was early December. Even where sowing was done at December 31st the yield was not depressed significantly. This was a result of the particularly cool spring. Temperature data are shown in table 1.7.A. Solar radiation was about average.

A considerable number of trials were conducted and these will be treated in the following sections under groups as off-station trials, nitrogen trials and herbicide trials.

1.7.2 OFF-STATION TRIALS

The objectives of these trials were:

1. To introduce new triticale varieties to the farmer
2. To determine how triticales perform under farm conditions. All plots are grown under actual farm management and much can be learned about the crop under the farmers' own practices.
3. To use the off-station test as a training tool. Trainees participate in sowing, harvesting, and maintenance of plots during the season.

There were five locations used within the Yaqui Valley and each of these was representative of the different types of soils encountered in the irrigated areas of the valley. One of the locations was characterized by having a salt problem which affected the germination in the trial. Some differential sensitivity was noted among the varieties in terms of germination. The most sensitive seemed to be the triticale line Bacum and the durum variety Stork, now known as Mexicali 75. Because of the very variable germination, this trial was lost.

Seedbeds for these trials in general were poorly prepared and as a result, stands were poor initially but improved as the season progressed. Triticale stands were much inferior to those shown by bread wheat, probably due to poor seedling vigor and because some of the seed came from frosted plots grown at Huamantla in the previous year.

However, it is true that nothing short of excellent seedbed preparation is needed for triticale. The poor initial growth of triticales is inclined to make stands look ragged in the beginning. What role the shrivelled seed plays in germination is not known, but it is hoped that as plumper seeded varieties are produced, better stands and better seedling vigor will be obtained.

The same type of problem as that encountered last year was present in the summer cycle in Tlaxcala where stands were uneven. Wherever there were low spots in the field or the seedbed preparation was poor, triticale plant numbers fell off quite rapidly despite the fact that this seed was well developed and came from the Yaqui 74-75 plots.

1.7.3 DATES OF SOWING

Treatments in the dates of sowing trials were sown between December 1 and December 16. This is the time when the largest percentage of the farmers sow wheat in the Yaqui Valley, and the sites chosen were typical viz., following soybeans, cotton and fallow. Fertility levels were high, ranging from about 140-200 kg N/ha. Phosphorus was applied at 100 kg/ha. This was Triple Super at all locations, which gave 46 kg P_2O_5/ha as an application dose. None of the sites were treated with herbicides, since all were essentially weed-free. The few weeds which grew in triticale plots were pulled hy hand. Plots of the usual type used by CIMMYT, i.e. 50 meters long approximately and one drill width i.e. 2.70 meters wide. Harvest was effected with a Hege combine in which a 1.25 meter cut was taken from the center of each plot. The yield which was judged at 12 percent moisture, is presented in table 1.7.B for the different varieties.

On the average, the bread wheat variety Jupateco and the durum variety Stork gave superior yield to triticales in these trials. On the basis of the trial conducted, these two wheats respectively, yielded 0.5 to 1.0 tonnes more than the triticales.

Certain of the triticales tested have a high potential for yield in the absence of lodging. Such varieties are Bacum and Beagle. Rahum gave consistently low yields despite its other advantages in terms of emergence and seedling vigor. The yields of Navojoa and Yoreme were similar. Lodging is not a factor in any of these two varieties, thus their yields were a reflection of the yield potential of the site. In all cases they were consistently lower in yield than either Jupateco or Stork, and in most cases this yield difference was significant.

1.7.4 NITROGEN TRIALS

In the first of these trials, which was a Nitrogen x Variety trial, 18 varieties were grown which included 10 triticale, 5 bread wheat and 3 durums. The nitrogen levels were 0, 75, 150, 225 and 300 kg/ha. The results of this trial are summarized in figure 1.7.1 which shows the average response of the triticales, bread wheats and durums to the different levels of N. The yield at nil N was quite high -about a 4 tonnes average- even though this crop followed a non-fertilized maize crop which was grown during the summer. Perhaps it would have been better to have grown sorghum to exhaust the soil nitrogen since several forage cuts can be made during the season. The results showed no difference between the response of triticale and bread wheat, to nitrogen. On the average, the durum varieties as a group yielded higher through all levels.

The past season was probably exceptionally favorable for durums. They have large grain size and there was good opportunity for grain filling during the cool maturity period. In figure 1.7.2 the yields for individual varieties viz, bread wheats Jupateco and Yaqui 50; triticales Beagle and Drira, are shown. It has been common to observe that in working with N response, there is usually a "fan effect", that is most varieties perform equally well at low levels of nitrogen but the differences become very apparent as the level of N application increases. This is particularly true when old and new varieties are being compared, and this is seen here in the comparison of Yaqui 50 with the group of new improved ones.

However, when a comparison is made among the improved varieties, there is a different picture. There are quite wide differences between varieties at the nil N level. There is almost a two tonnes difference between the triple dwarf variety Torim, on the one hand, and the one gene dwarf Jupateco bread wheat, and the triticale Drira, on the other. This confirms the past year (73-74) Yaqui results where the same Drira also performed well at nil N. The difference is thought to be due to a greater uptake of N from greater depths because the varieties Jupateco and Drira may have deep rooting systems. This N at depth is an artifact of this environment and may also be true of other irrgiation areas where underground drainage is minimal. The absence of the N effect might also be accounted for by the fact that at the nil N rate, soil N was already very high.

Another aspect of interest is the total dry weight production per hectare. The average response of this factor to N for the three crops is shown in figure 1.7.3. Although the grain yield response of the triticales and bread wheats was similar, their total dry matter production varies considerably at high fertility levels. There is approximately a 2 tonnes/ha difference in favour of triticales at the 300 kg N/ha level. It would appear that triticales in general have a higher potential for production of total dry matter than either the durums or bread wheats. This could very well be a breakthrough from the stand-

point of exploitation for forage. Selection for harvest index within different height classes might have greater potential here than in bread wheat, since the triticales produce two more tonnes of dry matter, and the range of difference would be amplified.

In figure 1.7.4 the total dry matter production as effected by increasing the levels of N for individual varieties shows an interesting relationship. A triticale variety like Drira is able to produce over 20.3 t/ha while Beagle, another triticale, can produce only 18.4 t/ha. The old tall variety of bread wheat, Yaqui 50, has a poor potential for producing dry matter and it appears that such new bread wheat varieties as Jupateco and Torim are as good as, or in most cases, better dry matter producers, than the older varieties.

The higher general levels of dry matter production in triticales is quite exciting and appears well worth exploiting.

The second nitrogen trial was concerned with the source of nitrogen applied. This trial was conducted to test the response of Jupateco to different sources of solid nitrogen fertilizers at varying levels. The sources of nitrogen used were urea, ammonium sulphate, ammonium nitrate and sulfur-coated urea (scu). The dissolution rate of sulfur-coated urea was 20.5 percent when placed in water for seven days. Split applications were compared with one application at sowing time at all levels and for all sources. Split application meant half at sowing time and half at the first extra irrigation, applied 26 days after the emergence of the crop. This corresponded to the beginning of tillering in growth phase. All fertilizers were spread by hand and were then washed into the soil with irrigation water, except in the case of sulfur-coated urea which was raked into the surface, because it floats when irrigation is applied and would float away from the surface.

The grain yield results for the different treatments are shown in table 1.7.C. Urea, ammonium sulfate, ammonium nitrate behaved in a similar manner when applied at sowing time and also when put on in split applications. They were not significantly different from one another at any rate and with either type of application. However, all three fertilizers were consistently superior to sulfur-coated urea. The significance of this difference varied, but it was accentuated further in the split application as would be expected.

In a combination of 24 comparisons at different rates and times of application, SCU was significantly inferior 15 times. Ammonium sulfate was the least consistent of the fertilizers in terms of its superiority. When comparing times of application, that is all applied at sowing versus the split application, the split application was almost always superior. However, only in two cases was the difference significant. The split application was even superior in the case of SCU, except at 160 kg/N/ha. Even greater benefit may be derived from a split application which is delayed until later, for example, the second auxiliary irrigation. This theory should be tested.

The third type of N trial was a manipulation trial. The management of nitrogen fertilizers varies widely from place to place throughout the world, ranging from hand application to machine application. Apart from nitrogen sources, the type of management is also influenced by the extent of knowledge on the fertilizer materials. This experiment was designed to test the relative performance of different nitrogen sources under different management regimes. The level of nitrogen applied was 100 kg/ha.

The six management regimes used were:

1. Broadcast onto dry soil six days before sowing.
2. Worked into dry soil six days before sowing.
3. Broadcast onto wet soils 6 days before sowing.
4. Worked into wet soil six days before sowing.
5. Broadcast onto dry soil at sowing and immediately washed in by irrigation water.
6. Worked into dry soil at sowing time.

The average yields of the three different nitrogen sources averaged over all six management regimes are shown in table 1.7.D. Ammonium nitrate gave significantly better yields than urea at the p=0.05 level, and SCU was significantly inferior to both of the other fertilizers.

Table 1.7.E shows the effect of management on each nitrogen source. For urea, management had no significant effect, although two treatments looked inferior viz., numbers one and five. Therefore, there must have been losses from both broadcast treatments as expected. When urea was broadcast on a wet surface, as in treatment number three, there was no significant yield loss. With ammonium nitrate, again the management did not haveasignificant impact on its effectiveness. In the case of SCU, management again had no effect although treatments that were either broadcast or worked in six days in advance

of sowing, gave better yields but this was not significant.

Ammonium nitrate gave significantly greater yields than urea in two treatments viz, when urea was broadcast six days in advance and broadcast at sowing time. This is due to the fact that volatilization is a factor in urea loss when it is left on the surface of the ground. In all other treatments, these two sources of N behave similarly.

Ammonium nitrate always performed significantly better than SCU except in treatment number four where it was worked into a wet soil six days before sowing. Working into a wet soil in advance of sowing, seems to enhance the performance of SCU. In the other five treatments the range of superiority of ammonium nitrate over SCU in terms of grain yield of Jupateco, was from 1110 to 2120 kg/ha. Urea was significantly superior to SCU in all but two of the treatments viz., number one and number four, where it still showed a trend of higher yield. SCU gave a higher than normal and unexplained yield in the latter case. The superiority of urea in terms of grain yield over SCU in the other four treatments, ranged from 720 to 1550 kg/ha.

The last of the nitrogen experiments was concerned with N application on N deficient plants. This experiment was designed to give answers to a very widespread problem. Many farmers do not apply or may not be able to apply N, either as a full dose or as the second part of the split application, until the plants have undergone stress due to lack of nitrogen. This experiment was set up to determine the effect of length of stress due to lack of nitrogen, on the variety Jupateco. Other fertilizer comparisons were also included and the data are summarized in table 1.7.F.

The N was applied as urea (46% nitrogen). It was broadcast on the soil surface and immediately washed in with irrigation water. When the application of all at sowing time is compared with the split application, the split application was significantly better at the lower levels of N. Once maximum yield has been reached, differences between timing are no longer significant. This would agree with the data from the N source trial.

The results of the length of stress study show that the plants can be N stressed for long periods of time at the stage of growth from the beginning of tillering to mid-jointing, without suffering any loss of yield. Visual stress began at 28 days after emergence, or the beginning of the tillering phase. Application at this stage brought the yield up to the level of 200 kg/N at sowing, where adequate N and maximum yield are assumed. An application at 43 days, i.e. 15 days after stress initiation, had the same effect. The surprising result in this trial was the application at 57 days or i.e. a 29 days post stress application. This application raised the yield to 8760 kg/ha as compared to 7600 kg/ha for the 200 kg/N applied at sowing treatment. The difference was highly significant and it is surprising and difficult to explain. However, looking at the components of yield, some trends appeared to emerge.

The harvest index is shown in table 1.7.G. The harvest index in the late applications was raised significantly compared to the earlier applications.

Spikelet fertility in the 57 days after emergence appplication was significantly increased and these data are shown in table 1.7.H. It would appear that a high availability of N is necessary in the period just preceding anthesis. This nitrogen would be supplied in the 57 day application and it may have caused the increase of spikelet fertility and the resultant increased yield.

1.7.5 SPACING AND DENSITY TRIAL

This trial was conducted to test the effects of different spacings and densities on three high yielding triticale varieties viz., Yoreme, Bacum, and Beagle using one dwarf bread wheat variety (Torim), as the check. The yield results are presented in table 1.7.I. The lodging score for the same treatment and varieties were also determined where the percent of the plot area lodged x Sin θ (where θ is the angle to the vertical of lodging) is presented in table 1.7.J.

In the case of Yoreme, with a height of 110 cm the highest yield was given at the 45 cm spacing x 80 kg seed rate treatment. However, this yield is only significantly greater than one other treatment, that of the 15 cm x 160 kg rate, where the reduction in yield was due to lodging.

Lodging was quite severe in the case of Bacum with a height of 120 cm where all the treatments lodged. The highest yield was given by the 15 cm x 40 kg treatment and this was significantly greater than any of the other treatments. This highest yield also coincides with the lowest lodging score. Beagle with a height of 130 cm, gave its highest yield at the 30 cm x 80 kg treatment. This yield was significantly greater than only two other treatments, namely the 15 x 160 and 30 x 160 treatments. The significant reduc-

tion in yield of the 15 cm x 160 kg treatment is thought to have been due to lodging, while the reduction in the 30 cm x 160 kg treatment cannot be explained as no lodging occurred.

In the case of the dwarf wheat variety Torim with a height of 65 cm, the highest yield was given in the 15 cm x 80 kg treatment. This was significantly greater than two others, namely the 30 cm x 80 kg and the 45 cm x 40 kg treatments. In the case of the latter, the reduction in yield is thought to have been due to poor light reception by the dwarf variety at this wide spacing and low density. The dwarf variety yielded consistently higher at the narrow spacing of 15 cm.

In the summary then, triticales in the height range of 110 - 130 cm and in the absence of lodging, are not affected by a wide range of spacing and density treatments under the high fertility conditions encountered in the Yaqui valley. Lodging consistently reduced yield. In the case of the dwarf wheat where no lodging occurred, wide spacing reduced yield. In this case, the narrow spacing of 15 cm with a medium seed rate i.e. 80 kg/ha to a high seed rate i.e. 160 kg/ha, gave the best results.

1.7.6 WILD OATS REMOVAL STUDY

Wild oats (Avena fatua) is a major weed problem in many wheat growing areas of the world causing a large reduction in yields. Due to an irregular dormancy pattern, this weed is very hard to control once an infestation has been established since seed for one year, may carry over and sprout irregularly during the next five or six years. A number of herbicides have been identified which are able to control this weed. Their properties and their methods of application vary greatly. Methods of application vary from pre-planting incorporation to early post emergence, and to mid tillering spray applications. The effectiveness of any one of these methods of application depends on the environment. The economics of application must be considered since some of these compounds are very expensive. Therefore, it is important to know when wild oat competition begins to reduce yields during the crop cycle since this is a determining factor in selecting the herbicide to be used. For this reason, the effect of varying lengths of weed competition on four crops, triticale, bread wheat, durum, and barley using the varieties Yoreme, Jupateco, Cocorit and Celaya, respectively, was studied.

The yield figures are presented in table 1.7.K. Crop losses, due to wild oats, can be seen in this table. After 114 days of competition, yield losses were 4790 kg/ha, 4070 kg/ha, 2880 kg/ha, and 1200 kg/ha for Cocorit, Yoreme, Jupateco and Celaya respectively. Wild oat plant density was 48 plants per sq. meter. As may be seen from the reduction in yield figures, there was a wide range in the competitive ability of the four crops. Yoreme, the triticale variety may have been at a disadvantage since it had a low plant emergence, namely 71 plants/m^2. The emergence of the other crops was as follows: Jupateco 129 plants/m^2, Celaya 135/m^2 and Cocorit 95/m^2.

The effect of the duration of competition is different and it also depends on the crop. In the case of Yoreme, competition did not have a significant effect until the 44 to 58 day interval. There was no significant reduction in yield in Jupateco and Cocorit until the 58-78 day interval. Barley was not significantly affected by competition until late in the season i.e. 104-114 days. On the basis of these experiments, carried out under high fertility and high wild oat competition, a reduction in yield due to wild oat infestation is not a factor until at least 44 days after emergence. The earliest showing of yield reduction was in the triticale variety Yoreme, This is the stage of mid tillering and it is also the latest that any herbicide would be applied to give effective weed control.

Another problem is determining the methods of control, is the severity of the infestation and the effect of this infestation on yield. An experiment was conducted to determine the effect of increasing the density of wild oats on the yield of four crops viz., triticale, bread wheat, durum wheat and barley, using the varieties Yoreme, Jupateco, Anhinga, and Celaya respectively. The yield data are presented in table 1.7.L. Yield losses at an infestation of 115 plants/m^2 were as follows:

Yoreme 5190 kg/ha, Jupateco 4160 kg/ha, Anhinga, 2560 kg/ha and Celaya 990 kg/ha.

These figures show a very wide range in the competitive ability of the crops used. Again the triticale was placed at a disadvantage due to low germination, namely 66 plants/m^2. The germination figures for the other crops are quite similar and are as follows: Jupateco 127 plants/m^2, Anhinga 112 plants/m^2, Celaya 137 plants/m^2.

Another measure of the competitive ability of the different crops is the panicle production of the wild oat plant in the different crops. These data are presented in table 1.7. M for the different crops at a wild oats density of 115 plants/m^2. There

was a considerable range in panicle production in the four crops, proceeding from 4.4 panicles per plant in the triticale, to 0.3 panicles per plant in barley. It can be assumed from these figures that barley actually killed quite a large number of wild oat plants that germinated, because of its strong competition. This is due to the rapid development of the barley plant which covers the ground and prevents the penetration of the light to such slower growing plants as wild oats.

Another measure of competition is seen in table 1.7.L. It shows the number of wild oat plants it takes to reduce yield significantly in any one of the four crops. In the case of Yoreme, this was 21 wild oat plant/m^2, Jupateco bread wheat 27 plants/m^2, Anhinga durum wheat 45 plants/m^2, and Celaya barley 78 plants/m^2.

Another important feature of table 1.7.L is the competitive ability of the durum wheat Anhinga, as compared with Jupateco, the bread wheat. In the wild oat removal study, Jupateco was superior to the durum Cocorit. It is thought that the height, 125 cm as compared with 120 cm for Jupateco and 100 cm for Cocorit makes Anhinga more competitive.

A few important points arise in the competition data which should be taken into account in production agronomy. Firstly, the variability that exists in competitive ability of crops or varieties should be exploited when dealing with weedy situations. Also, weeds may be kept to a minimum by the inclusion of a competitive crop in a rotation, wherever this is feasible. When breeding for situations where weeds are a problem, due to an inherently poor farming system, the breeder should keep certain characteristics in mind such as early vigorous growth and certain height, for example no shorter than a one gene dwarf.

1.7.7 WILD OATS CONTROL

The data for the wild oat control study are presented in table 1.7.N. Jupateco was used as the variety under test and there were 36 treatments in all. Weed control was expressed on the scale of 0-10 with 0 = no control, and 10 = complete control. The wild oat population (72 plants/m^2), was sufficient to decrease the yield significantly. The non weeded check yielded 3970 kg/ha as compared with 5900 kg/ha for the hand-weeded check. In this experiment there were many different products used at various dates and rates. Carbyne (Barban) gave significantly higher yields than the non-weeded check, although the weed control was not deemed to be satisfactory. The best weed control for this product was scale 7.0. In this treatment the application rate was 5 liters of Carbyne product/hectare applied at 18 days post emergence (3-35 leaves). The lack of control given by Carbyne was also shown in the yields from this treatment, as they were never as good as those from the hand weeded check.

Dicuran also gave very poor control of wild oats and this was reflected in the low yields recorded from the application of this product. In only one case (2.0 kg a.i/ha at 30 days post emergence) was the yield significantly greater than the non weeded check. Yields were never as good as the hand weeded check.

Although control was satisfactory (scale 8.0) with a 0.5 kg/ha a.i. application of Sencor, the yield was very low being only 3410 kg/ha. This low yield was the result of the high phytotoxicity of this product. Therefore Sencor cannot be recommended for application on spring wheats.

Dosanex at a higher rate of 0.5 kg/ha a.i. gave satisfactory control of wild oats, and this was reflected in the good yield obtained. The best date for application of this material seems to be at 30 days post emergence, or 5.5 leaf stage of wheat. When applied at 4.0 kg/ha a.i. at this date, weed control was rated at 8.3 and the yield was 6230 kg/ha. This material shows good promise because of its wide range of weed control destroying most broadleaves as well as grassy species.

WL 29761 (Mataven or Super Suffix) gave a control rating of 10.0 at both dates and both rates of application. However, the best yields were received from the 30 day application. Yields were excellent then, being 6810 kg/ha and 7010 kg/ha at the 0.45 kg/ha a.i. and 0.60 kg/ha a.i. rates, respectively. Although control was also complete with WL 29761 at the 43 days post emergence application, yields were considerably lower. It is thought that the following reason is responsible for the low yields. From data obtained in other competition studies between wild oats and wheats, it was found that severe competition begins at about 40 days after emergence. The mode of action WL 29761 is not to kill the plant outright but to dwarf it and leave it to be shaded out by the wheat as it grows. Therefore, wild oats treated with WL 29761 would be competing with the crop for several days after application. For this reason yield may be suspected to be reduced and the same is also true for Suffix. Although control is satisfactory for this product at the 43 days post emergence application, yields were surprisingly low. One kg/ha a.i. of Suffix seems to be adequate for satisfactory control of wild oats in this environment.

Excellent control was also obtained with applications of Finaven at 0.5 kg/ha a.i. and 1.0 kg/ha a.i. at 30 days after emergence i.e. the 5 1/2 leaf stage of wheat. This was reflected in high yields, which were 6030 kg/ha and 7090 kg/ha, respectively. Good control was also obtained with these applications at the 43 days post emergence stage i.e., the 7 1/2 leaf stage of wheat. The yields were 6310 kg/ha and 6460 kg/ha at the 0.5 kg/ha a.i. and 1.0 kg/ha a.i., respectively. Applications of CGA 18'731 gave unsatisfactory results. Applications of WL 29226 also gave low yields. This was due to high phytotoxicity of this product which was reflected in poor emergence of the crop combined with almost no control of wild oats.

1.7.8 PHALARIS MINOR CONTROL

The data from the control study on Phalaris minor are presented in table 1.7.0. Jupateco was the wheat variety used and 24 herbicidal treatments were used. Weed control is expressed on a scale of 0-10 with 0=no control and 10=complete control. Phytotoxicity is also expressed on a similar scale with 0=no damage, and 10=complete kill of the plant. The population of Phalaris (110 plants/m^2) was not sufficient to depress yields significantly. The yield of the non weeded check was 6690 kg/ha compared with 6970 kg/ha for the hand weeded check. TOK E-25 gave unsatisfactory control of Phalaris when applied as a pre-emerge. When applied at a rate of 15 liters/hectare of commercial material, a control rating of 5 was obtained.

Dicuran when applied at 2 kg/ha a.i. at 18 days post emergence gave satisfactory control, and the very good yield of 7310 kg/ha. This product when applied post-emergence is combination with pre-emerge application of TOK E-25 also gave excellent results. In this case, the control rating was 9.0 and yield was 6870 kg/ha.

Dosanex when applied at 4 kg/ha a.i. at 30 days post-emergence i.e., 5.5 leaf stage, also gave good results. The control rating was 9.3 and the yield 7240 kg/ha. The earlier applications of Dosanex while giving control of Phalaris also gave low yields. The effectiveness of this product is very much controlled by irrigation timing. A later application of Dosanex, i.e. one liter at 55 days post-emerge, gave lower weed control ratings and lower yields. The onset of the competitive effect of the weeds may have already begun at this stage.

CGA 18'731 when applied at 1 kg/ha a.i. and 2 kg/ha a.i. at 40 days post-emerge, i.e. the 7 leaf stage, gave weed control ratings of 8.7 and 9.1 respectively. Very good control was not reflected in higher yields. It is difficult to explain this effect since phytotoxicity was minimal. The application of WL 29226 pre-emerge, gave a low yield due to the high phytotoxicity plus a poor control of Phalaris.

Sencor gave excellent control of Phalaris but phytotoxicity was also high, although the 0.25 kg/ha a.i. application gave a yield of 7220 kg/ha. However due to crop phytotoxicity, this product cannot be recommeded for wheat in this environment.

The two most promising products which were identified in this trial were Dosanex and Dicuran. When applied at 30 days post-emerge Dosanex at 4 kg/ha a.i. gave excellent results as did Dicuran when applied at 18 days post-emerge at a rate of 2 kg/ha a.i.

1.7.9 WILD OATS CONTROL IN BARLEY

The data from the wild oat control study in barley are presented in table 1.7.P. Apizaco was used as the test barley variety. Six treatments were applied. Weed control again is expressed on a scale of 0-10 and phytotoxicity on a similar scale. The wild oat population 64 plants/m^2 was sufficient to decrease the yield significantly. The non weeded check yielded 3300 kg/ha in comparison to 4570 kg/ha for the hand weeded check. Barnon performed best when applied at 2 kg/ha a.i. at 40 days post-emerge giving a wild oat control rating of 8.7 and a yield of 4790 kg/ha. Later application were not as effective, probably because of the onset of competition from the wild oats at an earlier stage.

1.7.10 HERBICIDE SCREENING TRIAL

A non replicated herbicide screening trial was carried out at the Toluca nursery using 30 barley lines, 50 triticale, 50 durums, and 100 bread wheats. On these were imposed six herbicide treatments which showed promise for use in the CIMMYT nursery. Two check untreated plots were included for each line. Notes were taken on phytotoxicity and readings were made on the scale of 0-10 with 0=no suppression and 10=total kill of crop plants. The check varieties included in every 20 plots, were Yoreme a triticale, Jupatec 73 a bread wheat, and Cocorit 71 a durum.

The herbicide treatments were as follows:

1. Tribunil: 1 kg/ha a.i. at 17 days post-emergence at the 3.0-3.5 leaf stage.

2. Dosanex: 2kg/ha a.i. at 17 days post-emergence at the 3.0-3.5 leaf stage.

3. Faneron: 1 kg/ha a.i. at 17 days post-emergence at the 3.0-3.5 leaf stage.

4. Baneron: 1 kg/ha commercial product, at 20 days post-emergence at the 3.5-4.0 leaf stage.

5. Brominal: 0.48 kg/ha a.i. at 26 days post-emergence, at the 4.5-5.0 leaf stage.

6. Basagran:2kg/ha a.i., 34 days post-emergence at mid tillering stage.

The results were as follows:

1.7.10.1 Tribunil

This chemical showed high phytotoxicity in barley with an average score of 2.9 and a range from 1 to 7. The damage was too severe for this chemical to be used in future on barley. The average phytotoxicity reading in triticale was 0.4. Most lines gave a 0 reading with only three lines giving as high a reading as 2. This product therefore, looks suitable for use on triticales.

In the durum wheat lines, phytotoxicity was higher than in triticales with an average of 1.1. Most lines showed some phytotoxicity with a few lines being as high as 5 and 6. This herbicide can not be recommended for post-emergence with durum wheats. On bread wheats, phytotoxicity was only slight. Because only six lines out of 100 showed any phytotoxicity, this product is considered suitable for use on bread wheats.

1.7.10.2 Dosanex

It was quite phytotoxic to barley giving an average reading of 2.2. The range of phytotoxicity was somewhat lower than that for Tribunil, ranging from 0 to 4. This herbicide is not considered suitable for application on barley.

The average phytotoxicity reading on triticale was 0.5. Most lines that were injured gave a phytotoxicity reading no higher than 1. This product would appear to be suitable for triticales.

In durum wheat, the average phytotoxicity reading was 0.6 and most lines showed some phytotoxicity. Only one line gave a reading of 2.0 and another a reading of 4.0. All other lines showed a phytotoxicity reading of only 1. It considered that this chemical is suitable for use on durums.

Phytotoxicity was low on bread wheats with an average of 0.4. Most lines had 0 toxicity. This product looks very good for use with bread wheats.

1.7.10.3 Faneron

This product showed high phytotoxicity on all crops, with average readings of 4.7, 2.8, 4.0 and 2.7 on barley, triticale, durum, and bread wheats respectively. Because of the high phytotoxicity, Faneron cannot be recommended on these crops under Toluca conditions.

1.7.10.4 Baneron

Because of its high phytotoxicity readings of 2.5, 1.6, 2.0, and 1.6 on barley, triticale, durum and bread wheats respectively, this product cannot be recommended for use under this conditions.

1.7.10.5 Brominal

It gave an average reading of 0.5 on barley. One line gave a reading of 3 while two lines gave a reading of 2. The remainder were 1 and 0. The chemical appears suitable for barley, and no phytotoxicity was observed on triticale, bread wheats or durums. Thus, it is considered suitable for use with all crops.

1.7.10.6 Basagran

This product showed no phytotoxicity on any crop and is suitable for application over a wide range of barley, bread wheats, durums and triticales.

1.7.10.7 Weed control with chemicals

The weeds found in Toluca were primarily Brassica campestris, Commelina coelestis, Malvastrum peruvianum, Galinsoga ciliata and Poa annua. Notes were taken on weed control in the evaluation trial of the preceding section on August 15, 1975 about 8 weeks after the earlier application (17 days post-emergence). The following is a summary of the weed control with the various chemicals.

Tribunil - It gave excellent control of all broadleaves; some Poa annua began to come back late in the season but there was still 90 percent control of this grassy weed.

Dosanex - It had the same effect as Tribunil on the broadleaves. This product gave more consistent and seemingly longer control than Tribunil on Poa annua.

Brominal - It left some Galinsoga ciliata and Commelina coelestis coming back at the time of evaluation. Commelina may be resistant to this product, and further research is required thereon. As expected, there was no control of Poa annua. The type of control given by Brominal is not satisfactory under Toluca conditions.

Basagran - Gave consistently good control of broadleaves, but no control of Poa annua.

Baneron - and Faneron gave excellent control of all broadleaved weeds, and both controlled Poa annua.

1.7.11 WEED CONTROL TRIALS AT EL BATAN SUMMER 1975

A number of products were applied at different dates and different rates for weed control at El Batan. The crop varieties used were Yoreme triticale, Jupateco bread wheat, and Cocorit durum wheat. There was very little phytotoxicity with any of the products used, so no report is given for this characteristic. Yields are not reported as there was an outbreak of take all, Ophiobolus graminis, in the plots and this made yield interpretation meaningless. The most common weeds in El Batan were Amaranthus hybridus Galisoga ciliata, Commelina coelestis and Tithenia tubaeformis. Also present but in much smaller amounts were Portulaca oleracea, Ipomea purpurea, Anoda hastata and Lopezia racemosa. The degrees of control on the main weeds only are reported here as the control of the others was difficult to score because of the small numbers present.

The results of these trials are presented in table 1.7.Q. It can be seen that Amaranthus hybridus is difficult to control and very few products gave satisfactory control of it. The most promising herbicides were 2,4-D, which gave 100 percent control and Brominal at 0.48 kg/ha a.i., which gave 90-92 percent control. This latter treatment looks the most promising for application to nursery material at El Batan since it also gives satisfactory control of all weed species encountered. No phytotoxicity was noted for the wheat plants over a wide range of germ plasm.

Tribunil and Dosanex do not appear to be satisfactory under this environment because of poor control of Amaranthus hybridus. Dosanex is also weak in its control of Commelina coelestis. Faneron gives poor control of Amaranthus hybridus but is excellent on the other weeds. Baneron at 1.0 kg/ha at 17 days after emergence also gave excellent control of all species. Basagran and MCPA gave good control except for an almost complete failure to control Galisoga ciliata. Brominal must be applied at the high rate 0.48 kg/ha a.i. for satisfactory control of different weeds species. Brominal and MCPA applied at the early dates, 17 days after emergence, also gave satisfactory weed control. When applied at 1.0 kg/ka a.i., 2,4-D also gave excellent control. MCPA, even when applied at 0.48 kg/ha a.i., does not provide good weed control due primarily to the resistance of Amaranthus hybridus and Galisoga ciliata.

Amaranthus hybridus was also fairly resistant to CGA 18'731 which gave only 57 percent control at 2.0 kg/ha a.i. Brominal and CGA 18'731 combined well since Brominal controlled Amaranthus hybridus. Except for this weed, Faneron and Tribunol gave good control.

1.7.12 WEED CONTROL TRIALS AT TOLUCA SUMMER 1975

The same type of weed control trials were conducted in Toluca. Yields are not reported since early frost made yield interpretation difficult. The most common weeds in Toluca were Malvastrum peruvianum, Brassica campestris, Cucumis sativa, Commelina sativa, Galisoga ciliata and one grass species, Poa annua. The results of weed control are presented in table 1.7.R.

It will be seen that many products showed good control of weeds at Toluca. The most promising of these are Tribunil and Dosanex since they give good control at low rates of application i.e 1.0 kg/ha a.i. and 2.0 kg/ha a.i. respectively. At these rates there is little phytotoxicity over wide ranges of germ plasm. At present, Tribunil is recommended for use in the CIMMYT breeding nursery in Toluca, at a rate of 1 kg/ha a.i., 20 days after emergence. Faneron also gives good control except that it showed phytotoxicity

levels in the screening trial. Basagran gave poor control for most of the weeds, but it may give better control if applied earlier when the weeds are small. From previous experience, it is known that Basagran will not control grasses such as Poa annua and it also shows poor control of Galinsoga ciliata.

For satisfactory control of broad leaves in this environment, Brominal must be used at the high rate 0.48 kg/ha a.i. but does not control grasses, which are important in Toluca. The effectiveness of Brominal and MCPA falls off rapidly with date of application, as may be seen when the 27 and 42 days application are compared. This is true of most herbicides in this environment. The weeds develop rapidly and become resistant. The ineffectiveness of 2,4-D is believed to be due to its late application at 42 days, although in other environments this would appear to be the best date for application of this chemical.

1.7.13 OFF-STATION TRIALS IN THE STATES OF MEXICO, HIDALGO AND TLAXCALA, SUMMER 1975

The objectives of these off-station trials are threefold:

1. To obtain relevant data on the performance of the best triticale lines arising out of the CIMMYT program. Triticale is a new cereal and although much has been said and written about it, very little is known about its performance under farm conditions. Over the last two years, CIMMYT has conducted agronomic tests both on and off stations. However, the bulk of this work was done under adequate moisture and soil fertility conditions in the Yaqui Valley, State of Sonora. From these tests, it was seen that the agronomic management of triticales was quite similar to that for wheat, although there are some important differences between the two crops.

From a yield view point, triticales under these irrigated high fertility conditions, were shown to be quite competitive with the bread wheats. This program continues and in fact has been expanded in Sonora. However, to add to these data, it was considered worthwhile to test the triticales under more marginal conditions such as drought, limited soil tillage, and in small farm areas at higher altitudes, where early frost and other agronomic limiting factors such as weeds and diseases are present. These trials were designed to determine more about the agronomic factors which would be of greater importance in these conditions, i.e., variety, fertilizer, herbicide, etc., and how these inputs should be managed.

2. It was considered that this framework of off-station trials could be used to train production agronomists from developing countries. Everyone is aware of the shortage of properly trained agronomists in most of the developing nations. CIMMYT considers that this is one of its prime objectives and should remain so, although it realizes its inadequacy in handling all of the training that is required. The types of trials devised in this program are considered to be a good training ground for production agronomists. These trials take the trainees away from the 10 m^2 plots of the experiment station. Instead the trainee operates in the farm field where problems can be observed and discussed. Also the trainees can examine the techniques of management by the farmer. From these he can learn to identify those practices which the farmer is doing incorrectly, and he may have some suggestions for inproving the farmers' agronomic practices. The trainee is in the center of a production area where he is exposed to farming each day in driving through the country. This provides him with a general picture of production practices and problems.

3. While Mexico and CIMMYT have not entered into a formal agreement with regard to research programs, it is obvious that the informal cooperation of CIMMYT and INIA has been a major factor in the high production of the wheat growing areas of the Northwest of Mexico. The impact of this program is well documented and has been felt in many parts of the developed and developing countries of the world.

CIMMYT also recognizes that right on the doorstep of its headquarters, there is an area which may be helped, namely the cereals producing area of the central plateau of Mexico. This area is characterized by subsistence farming where farm size is small and where there is a real challenge for the extension service to put new technology into the production field. Improved technology is available and it can be applied immediately with small modifications to any particular situation. Therefore, CIMMYT felt that through a demonstration program in conjunction with the extension service of SAG, it could help the region by showing new technology to the farmers. The design of the demonstrations should be simple, be easily understood by the farmers, and provide the greatest amount of knowledge in the shortest possible time. In other words, recommendations for a production program for the area would be the prime objective, and time is an important factor. The design of research is simple and it is conducted in a thorough manner by the researchers with the proper collection of only the necessary, but required data.

A demonstration program was designed at six sites in the states of Mexico, Tlax-

cala and Hidalgo. The sites were at Tizayuca in Hidalgo; San Vicente, Chicoloapan and San Pablo Ixayoc in the State of Mexico; and Quaula, Sanctorum and Huamantla in Tlaxcala. The sites at Tizayuca, San Vicente, San Pablo and Quaula were identified by the extension service. The other two sites were arranged through personal contacts by CIMMYT staff with the farmers. Al experiments were sown with the drill, with the exception of the San Pablo site which was sown by hand and seed was then incorporated with a spike-tooth harrow. A variety demonstration was put in at each site using the best agronomic practices, which included seeds, good seed bed preparation (two diskings and levelling), and high soil fertility with 120 kg N and 60 kg P_2O_5, applied broadcast at sowing time, and incorporated in the soil. The source of N was urea (46% N). The source of phosphorus was Triple Super phosphate (46% P_2O_5). Weed control was obtained through the use of chemicals. Tribunil was applied at the rate of 1 kg/ha a.i. at 20-25 days after seeding on all wheat and triticale varieties. The barley was sprayed with a mixture of MCPA 0.24 kg/ha a.i. and Basagran 1.0 kg/ha a.i. at about 30 days after seeding. These treatments all achieved excellent weed control at all of the sites. The plot size was 50 meters long by one drill width of 2.70 m.

Five triticale lines were tested at each location. Local checks were Puebla, a barley recommended for the area by INIA, and Cleopatra bread wheat released specifically for dryland production, by INIA. At three of the locations, three of the advanced lines from the CIMMYT bread wheat program were also included while at two locations one advanced line from the CIMMYT barley program was included. Two replications were sown at each location. Harvesting was completed with a small plot thresher except at San Pablo where three quadrats were cut by hand from each plot. Where harvesting was done by machine, a 1.5 meter strip was cut through the length of each plot. This overcame border effects, while at the same time it gave a large plot size of 70 m^2 approximately. Grain was weighed in the field.

Trials with N were conducted at two locations, Quaula and Sanctorum, while herbicide trials were conducted at Tizayuca, Quaula, Sanctorum, and San Vicente. The herbicide trials screened a number of products and combination of products for possible use in the area. These data could then be used for further testing of a smaller number of products from which farmer recommendations could be made. Sowings were completed between May 28 and June 6. All sites were harvested with the exception of Quaula, where severe frost damage occurred late in September. The barley variety Puebla escaped the frost and was harvested before that date at this site. However, damage was almost complete on the bread wheats and triticales, and they were not harvested.

The results of the variety trials are presented in table 1.7.S. The triticale varieties were Navojoa, Beagle, Rajum, Yoreme and Bacum. Cleopatra is a bread wheat released for dryland conditions by INIA. Tzpp-Pal-7C, Moncho and Pavon are advanced bread wheat lines from the CIMMYT program. Puebla is a barley variety released for the area by INIA while PC91 is an advanced barley line from the CIMMYT program. An examination of the average location yield provides an indication of the potential production of the area, which is 2000-3000 kg/ha under optimum management conditions. Only minimal meteorological data on the season were available and this needs to be improved.

In regard to individual varieties, Cleopatra looks extremely promising for the area. At Tizayuca and San Vicente it ranked in first place, while in Sanctorum and San Pablo it was second. It was third in Huamantla. This is very interesting since this variety was selected specifically for dryland conditions by INIA. It significantly outyielded the barley variety Puebla in three out of five locations. The average yield across the five locations was 3470 kg/ha compared to 2680 kg/ha for Puebla.

The most interesting triticale variety is Yoreme since this has been certified for commercial production in Mexico. It yielded 4430 kg/ha in Sanctorum and was ranked in first place, while at Tizayuca and San Vicente it occupied second position. In comparison with barley, it outyielded Puebla significantly in only one location, Sanctorum, while Puebla outyielded Yoreme significantly in Huamantla. The average yield for the five locations was 2930 kg/ha for Yoreme as compared with 2680 kg/ha for Puebla.

Another triticale line showing promise is Bacum. It outyielded Puebla significantly in one of the locations at Sanctorum. Its average yield was 3230 kg/ha as compared to 2680 for Puebla. The other triticale line, Rahum, showed some promise, also yielding on the average 2890 kg/ha which is slightly higher than barley. The two remaining triticale lines Navojoa and Beagle did not appear promising, having yields of only 2550 and 2280 kg/ha, respectively.

One of the greatest problems with the triticale lines available for this particular area is their lateness in relation to early frosts being a limiting production factor. The early maturity of barley reduces this risk and makes it very attractive for cultivation. All of the late varieties of triticales such as Beagle were damaged by frost

at all locations, while the crop was completely lost to frost at Quaula where frost hit on September 24. Here, barley escaped the frost and Puebla yielded 3970 kg/ha. However, early plantings of triticale varieties such as Bacum and Yoreme are likely to escape frost. Nevertheless, the search for early triticale types for this season's environment should continue.

The new bread wheat lines from the CIMMYT program did not show exceptional promise, with exception of Pavon at Sanctorum where it yielded 4060 kg/ha. Again earlier varieties would be better for this environment. The CIMMYT barley line PC91 did not yield well at the two locations in which it was tested.

As a general summation of the year's work from the view point of the three objectives set up for the program, the results were good. In respect of screening materials for the area, the method appears quite satisfactory. It has shown clearly in one year what types of materials fit the season. From the satisfactory performance of the bread wheat variety Cleopatra, more emphasis will be given in future to the testing of INIA varieties bred for short season dryland conditions. Triticales also have a future, although the search will have to be intensified for earlier maturity. However, Yoreme which has already been released by the INIA program, should do well where early frosts are rare, if planted between May 15 and June 1st. Bacum and Rahum also are possibilities.

A discussion is not presented on the N and herbicide trials conducted. They were exploratory in nature and will be continued in future with appropriate modifications. These trials when properly designed with the needs of the area in mind should yield worthwhile information for use by the extension service. Experimentation is also proposed for studying cultural practices in the area as well as differences in sowing techniques.

Sowing techniques within the region range from sowing by drill to broadcasting by hand followed by incorporating with a disk. Land preparation is also quite variable and deserves future attention.

From the training viewpoint, it was considered that the season was very successful and very effective training was accomplished. The training officers of CIMMYT would like to continue training in this way. Incorporation of Mexican trainees would be most desirable, since their familiarity with the area, language and culture would be beneficial to the trainees from other countries. They would also act as a liaison between CIMMYT and the Mexican Extension Service. Their residency with the other trainees in El Batan will increase communication between the two organizations. Also the benefit for the Mexican trainees would be great since they would be trained in and made very familiar with an area in which they would later work.

Insofar as the third objective of the program is concerned i.e. improving the lot of the farmer in the area, very little can be said about this now, since the effects are felt in the longer term. However, there was great interest shown within the ejidos involved. The farmers in general expressed the opinion that they would like to see a return of experimentation in their area in the next year. It is hoped that CIMMYT's experimentation will improve and will answer some of the more relevant questions pertaining to cereal production. This research must be simply designed, ask the relevant questions and give the answer in the shortest possible time. Time is precious for any production program.

Field days were organized by the extension service at five locations. While the attendance was satisfactory, it is hoped that it will be improved in the future. Greater familiarity with people and the area by all the people involved in the project, would automatically lead to an improvement in this sector. Great interest was shown on the part of the farmers and a notable feature of all field days, was the interchange of ideas between the farmers and the extension people. A discussion of the results of the trials in Sanctorum was held in that ejido between ejidatarios, farmers and two CIMMYT staff members. Again it is felt that much was learned on both sides through this type of contact.

Table 1.7.A. Temperature Data 1974-75 at Cd. Obregon, Sonora.

Month	Temperature in °C			
	Mean Max		Mean Min	
	74-75	Long Term	74-75	Long Term
Nov.	27.4	28.9	11.8	11.6
Dec.	22.9	24.1	5.8	8.4
Jan.	23.1	23.2	5.7	6.7
Feb.	23.6	24.7	5.7	6.8
Mar.	25.8	27.1	7.6	8.2
Apr.	28.3	31.2	7.1	10.3
May	32.6	34.4	11.0	13.9

Table 1.7.B Yields of varieties (t/ha) in farm trials sown from December 1-16, 1974-75 at Cd. Obregon.

	PARADA	GARCIA	KARAM	AMAYA	AVE.
Bacum (Tcl)	6.7	5.6	6.1	7.2	6.4
Stork (Durum)	6.0	5.8	7.7	7.2	6.8
Beagle (Tcl)	6.1	4.9	7.2	6.1	6.1
Rahum (Tcl)	5.8	5.6	6.2	6.5	6.0
Jupateco (Bread)	6.4	6.3	7.3	7.4	6.9
Navojoa (Tcl)	5.7	5.5	7.2	6.5	6.2
Yoreme (Tcl)	5.7	5.7	7.3	6.6	6.3
$L.S.D._{0.05}$	0.4	0.4	0.6	0.5	

Tcl = Triticale

Table 1.7.C Grain yields in kg/ha (12% moisture) at different levels of N and from different sources of N. 1974-75, Cd. Obregon.

N Rate (kg/ha)	Urea	$(NH_4)_2SO_4$	NH_4NO_3	SCU
0	2970	3950	3950	3760
40	4180	4930	4540	3840
20 + 20*	5270	5090	5230	4300
80	5830	5250	5940	4850
40 + 40	6400	6000	6720	5250
120	6940	6710	6800	5750
60 + 60	6930	7150	7120	5980
160	7020	6480	7080	6360
80 + 80	6680	7380	7160	5920

* Split application = Half at sowing, half at 26 days postemerge (beginning of tillering).

$L.S.D._{0.05}$ (within sources) = 810

$L.S.D._{0.05}$ (among sources) = 920

SCU = sulphur coated urea

Table 1.7.D Average yield of Jupateco wheat for three different nitrogen sources at 100 kg/N/ha over six management regimes. Cd.Obregon, 1974-75.

N. source	Yield (kg/ha)
Nil N (check)	3890
Urea	6570
Amm. Nitrate	7030
SCU* (20.5% in 7 days)	5600
$L.S.D._{0.05}$	400

* SCU = sulphur coated urea

Table 1.7.E Yield of Jupateco wheat for three different nitrogen sources at 100 kg N/ha over six management regimes. Cd. Obregon, 1974-75.

Treatment	Subtreatment	Yield kg/ha
Broadcast into dry soil six days before sowing	Urea	6050
	NH_4NO_3	7248
	SCU	5650
Worked into dry soil six days before sowing	Urea	6890
	NH_4NO_3	6760
	SCU	5650
Broadcast onto wet soil six days before sowing	Urea	6970
	NH_4NO_3	7030
	SCU	5470
Worked into wet soil six days before sowing	Urea	6610
	NH_4NO_3	6640
	SCU	6200
Broadcast onto dry soil at sowing and immediately worked in by irrigation water	Urea	6050
	NH_4NO_3	7070
	SCU	5330
Worked into dry soil at sowing time	Urea	6860
	NH_4NO_3	7430
	SCU	5310

SCU= sulphur coated urea

Table 1.7.F Grain yield (12% moisture) of Jupateco wheat under different N levels and different lengths of N deficiency stress.

	Treatment	Yield (kg/ha)
1.	Nil N	4300
2.	200 kg N (sowing)	7600
3.	100 kg N (sowing) + 100 kg N (28 days post)	7240
4.	100 kg N (sowing)	5870
5.	50 kg N (sowing) 50 kg N (28 days post)	6610
6.	200 kg N (14 days postemerge)	7390
7.	200 kg N (18 days postemerge)	7470
8.	200 kg N (43 days postemerge)	7500
9.	200 kg N (57 days postemerge)	8760
10.	200 kg N (75 days postemerge)	5330

Table 1.7.G Harvest index of Jupateco wheat under different N levels and different lengths of N deficiency stress.

Treatment	Harvest index
1. Nil N	42.01
2. 200 kg N (sowing)	39.30
3. 100 kg N (sowing) + 100 kg N (28 days postemerge)	40.84
4. 100 kg N (sowing)	41.70
5. 50 kg N (sowing) + 50 kg N (28 days postemerge)	40.68
6. 200 kg N (14 days postemerge)	38.40
7. 200 kg N (28 days postemerge)	40.08
8. 200 kg N (43 days postemerge)	41.60
9. 200 kg N (57 days postemerge)	51.84
10. 200 kg N (75 days postemerge)	52.70

$L.S.D._{0.05} = 5.26$

Table 1.7.H Grains per central spikelet of Jupateco wheat under different N levels and different lengths of N deficiency stress.

Treatment	Grains/central spikelet
1. Nil N	1.85
2. 200 kg N (sowing)	2.29
3. 100 kg N (sowing + 100 kg N (28 days postemerge)	2.04
4. 100 kg N (sowing)	2.03
5. 50 kg N (sowing) + kg N (28 days postemerge)	2.09
6. 200 kg N (14 days postemerge)	2.15
7. 200 kg N (28 days postemerge)	2.34
8. 200 kg N (43 days postemerge)	2.73
9. 200 kg N (57 days postemerge)	3.40
10. 200 kg (75 days postemerge)	3.39

$L.S.D._{0.05} = 0.80$

Table 1.7.I Yield results (kg/ha) in a spacing and density trial of three triticale varieties and one bread wheat variety (Torim) at Cd. Obregon, 1974-75.

Treatment	Yoreme	Bacum	Beagle	Torim
15 cm x 40 kg	7570	8480	7320	7580
15 cm x 80 kg	7660	7150	7430	7950
15 cm x 160 kg	7460	7320	7150	7920
30 cm x 40 kg	7680	7100	7580	7330
30 cm x 80 kg	7710	7720	7840	7060
30 cm x 160 kg	8100	6880	6930	7570
45 cm x 40 kg	7690	7410	7290	6970
45 cm x 80 kg	8190	7690	7260	7610
45 cm x 160 kg	7580	7580	7560	7160

$L.S.D._{0.05}$ within main treatment = 635 kg/ha

Table 1.7.J Effect of spacing and density treatment on the lodging score of three high yielding triticale varieties and one dwarf wheat variety (Torim), 74-75.

Treatment	Lodging score			
	Yoreme	Bacum	Beagle	Torim
15 cm x 40 kg	0	17.5	0	0
15 cm x 80 kg	12.5	48.9	0	0
15 cm x 160 kg	15.5	58.3	14.6	0
30 cm x 40 kg	0	36.4	0	0
30 cm x 80 kg	0	26.7	0	0
30 cm x 160 kg	13.3	27.2	0	0
45 cm x 40 kg	0	23.8	0	0
45 cm x 80 kg	0	22.8	0	0
45 cm x 160 kg	14.6	38.6	3.8	0

Table 1.7.K Yield (kg/ha) of four crops under varying lengths of competition from wild oats (Avena fatua).

Treatment	Yoreme (T)	Jupateco (B.W.)	Cocorit (D)	Celaya (B)
1. Handweeded check	5600	7460	7490	5120
2. Weeds removed 17 days post-emerge	6400	6870	7290	4350
3. Weeds removed 31 days post-emerge	6270	7210	7500	5330
4. Weeds removed 44 days post-emerge	6240	7110	7120	5490
5. Weeds removed 58 days post-emerge	5100	6990	6940	5140
6. Weeds removed 78 days post-emerge	4060	5480	5580	4770
7. Weeds removed 88 days post-emerge	3000	5220	4700	4240
8. Weeds removed 100 days post-emerge	1910	4690	4110	5080
9. Weeds removed 106 days post-emerge	2650	5170	4020	4420
10. Weeds removed 114 days post-emerge	1530	4580	2700	3920

L.S.D.$_{0.05}$ within varieties = 1040 kg/ha
T = triticale, B.W. = Bread wheat, D = Durum, B = Barley
Wild Oat Density = 48 plants/m^2

Table 1.7.L Yield (kg/ha) of four crops under varying densities of Wild Oats (Avena fatua).

Treatment (Wild Oat Density)	Yoreme (T)	Jupateco (B.W.)	Anhinga (D)	Celaya (B)
0 plants/m^2	6380	7450	6500	5240
21 plants/m^2	5340	6910	6270	5250
27 plants/m^2	3930	5510	6080	5260
45 plants/m^2	3120	5920	5280	5100
78 plants/m^2	1820	5270	5620	4030
115 plants/m^2	1190	3290	3940	4250

L.S.D.$_{0.05}$ within varieties = 720 kg/ha
T = Triticale, B.W. = Bread Wheat, D = Durum Wheat, B = Barley

Table 1.7.M Number of wild oat panicles per m^2 in four crops at harvest each having an initial density of 115 wild oat plants/m^2.

Crop	Wild Oat Panicles/m^2	Panicles/Wild Oat plant
Yoreme (T)	503	4.4
Jupateco (B.W.)	343	3.0
Anhinga (D)	273	2.4
Celaya (B)	36	0.3

T = Triticale, B.W. = Bread Wheat, D = Durum wheat, B = Barley

Table 1.7.N Effect of different herbicides on Wild Oat (Avena fatua) control and the yields of the bread wheat variety Jupateco, 1974-75.

Compound	Rate/ha	Days post-emerge	Stage of Wheat	Weed Control	Yield kg/ha
1. Nonweeded check	-	-	-	-	3970
2. Handweeded check	-	-	-	10	5900
3. Carbyne	3 lts c.m.*	11	2 1.	4.3	5570
4. Carbyne	5 lgs c.m.	11	2 1.	5.3	5230
5. Carbyne	3 lts c.m.	18	3-3 1/2	5.3	5180
6. Carbyne	5 lts c.m.	18	3-3 1/2 1	7.0	5410
7. Dicuran	1 kg a.i.**	18	3-3 1/2 1	3.0	4640
8. Dicuran	2 kg a.i.	18	3-3 1/2 1	3.7	4600
9. Sencor	0.25 kg a.i.	18	3-3 1/2 1	5.7	4400
10. Sencor	0.5 kg a.i.	18	3-3 1/2 1	8.0	3410
11. Dosanex	2 kg a.i.	18	3-3 1/2 1	4.3	5130
12. Dosanex	4 kg a.i.	18	3-3 1/2 1	7.7	5810
13. WL 29761	0.45 kg a.i.	30	5 1/2 1	10.0	6810
14. WL 29761	0.6 kg a.i.	30	5 1/2 1	10.0	7010
15. Finaven	0.5 kg a.i.	30	5 1/2 1	9.0	6030
16. Finaven	1.0 kg a.i.	30	5 1/2 1	10.0	7090
17. C.G.A. 18'731	1.0 kg a.i.	30	5 1/2 1	3.3	4310
18. C.G.A. 18'731	2.0 kg a.i.	30	5 1/2 1	6.7	5540
19. Dosanex	2.0 kg a.i.	30	5 1/2 1	5.0	5000
20. Dosanex	4.0 kg a.i.	30	5 1/2 1	8.3	6230
21. Dicuran	1.0 kg a.i.	30	5 1/2 1	5.0	5000
22. Dicuran	2.0 kg a.i.	30	5 1/2 1	5.3	5080
23. WL 29761	0.4-5 kg a.i.	43	4 1/2 1	10.0	5360
24. WL 29761	0.6 kg a.i.	43	4 1/2 1	10.0	5820
25. Finaven	0.5 kg a.i.	43	7 1/2 1	9.0	6310
26. Finaven	1.0 kg a.i.	43	7 1/2 1	10.0	6460
27. Suffix	1.0 kg a.i.	43	7 1/2 1	8.3	5580
28. Suffix	2.0 kg a.i.	43	7 1/2 1	9.0	4610
29. C.G.A. 18'731	1.0 kg a.i.	43	7 1/2 1	4.0	4160
30. C.G.A. 18'731	2.0 kg a.i.	43	7 1/2 1	6.0	5420
31. Dicuran	1.0 kg a.i.	43	7 1/2 1	2.7	3800
32. Dicuran	2.0 kg a.i.	43	7 1/2 1	5.7	4480
33. WL 29226	1 kg a.i.	-	Preemerge	0	2370
34. WL 29226	2 kg a.i.	-	Preemerge	0	2270
35. WL 29226	3 kg a.i.	-	Preemerge	0	3130
36. WL 29226	4 kg a.i.	-	Preemerge	0	2690
			L.S.D.$_{0.05}$		1040

* c.m. - commercial material
** a.i. - active ingredient

Table 1.7.O Effect of different herbicides on canary grass (Phalaris minor) control, phytotoxicity and the yields of the bread wheat variety Jupateco, 1974-75.

Compound	Rate/ha	Days Post Emerge	Stage of Wheat	Phyto-toxicity	Weed control	Yield kg/ha
1. Nonweeded check	-	-	-	0	0	6690
2. Handweeded check	-	-	-	0	10.0	6970
3. TOK E 25	10 lt c.m.*	-	Preemerge	0.7	2.7	6310
4. TOK E 25	15 lt c.m.	-	Preemerge	0	5.0	6810
5. Dicuran	1 kg a.i. **	18	3-3 1/2 1	0	7.0	5040
6. Dicuran	2 kg a.i.	18	3-3 1/2 1	0	7.7	7310
7. Dosanex	2 kg a.i.	18	3-3 1/2 1	0	8.0	5860
8. Dosanex	4 kg a.i.	18	3-3 1/2 1	0	10.0	5750
9. TOK E 25 + Dosanex	10 lt c.m. + 2 kg a.i.	Dos-18	TOK Preemerge Dos-3 1/2 1	0	9.7	7020
10. TOK E 25 + Dosanex	10 lt c.m. + 4 kg a.i.	Dos-18	TOK Preemerge Dos-3 1/2 1	0.7	9.3	7020
11. TOK E 25 + Dicuran	10 lt c.m. + 1 kg a.i.	Dic-18	TOK Preemerge Dic-3 1/2 1	0.3	5.0	6650
12. TOK E 25 + Dicuran	10 lt c.m. + 2 kg a.i.	Dic-18	TOK Preemerge Dic-3 1/2 1	0	9.0	6870
13. C.G.A. 18'731	1 kg a.i.	40	7 1.	0	8.7	6250
14. C.G.A. 18'731	2 kg a.i.	40	7 1.	0.3	9.7	5950
15. WL 29226	1 kg a.i.	-	Preemerge	4.0	3.3	6040
16. WL 29226	2 kg a.i.	-	Preemerge	7.7	0	4770
17. WL 29226 + Dosanex	1 kg a.i. + 2 kg a.i.	Dos-18	WL-Preemerge Dos 3-3 1/2 1	4.0	5.7	6080
18. WL 29226 + Dicuran	1 kg a.i. + 1 kg a.i.	Dic-18	WL-Preemerge Dos-3-3 1/2 1	4.3	3.7	6020
19. Dosanex	2 kg a.i.	30	5 1/2 1	0	7.0	6830
20. Dosanex	4 kg a.i.	30	5 1/2 1	0	9.3	7240
21. Dosanex	2 kg a.i.	55	2nd node	0	7.3	5940
22. Dosanex	4 kg a.i.	55	2nd node	0	7.3	5520
23. Sencor	0.25 kg a.i.	18	3 1/2 1	2.3	8.0	7220
24. Sencor	0.5 kg a.i.	18	3 1/2 1	8.7	10.0	4340
			$L.S.D._{0.05}$	0.9	2.0	1570

* c.m. - commercial material
** a.i. - active ingredient

Table 1.7.P Effect of Barnon on Wild Oat (Ayenua fatua) control, phytotoxicity and the yield of the barley variety Apizaco, 1974-75.

Compound	Rate/ha	Day Postemerge	Stage of Barley	Weed Control	Phyto-toxicity	Yield kg/ha
Nonweeded						3300
Handweeded						4570
Barnon	1 kg a.i.	40	7 leaf	7.0	0	3970
Barnon	2 kg a.i.	40	7 leaf	8.7	0	4790
Barnon	1 kg a.i.	54	2 nodes	7.7	0	4390
Barnon	2 kg a.i.	54	2 nodes	9.0	0	3600
			$L.S.D._{0.05}$	1.0		850

Table 1.7.Q Weed control (%) by different herbicides at different dates and rates at El Batan Station, Summer 1975.

Product	Rate kg/ha a.i.	Application Date	DAE*	Stage of Wheat	Weed control (%) Amaranthus hybridus	Galinsoga ciliata	Tithonia tubaeformis	Commelina coelestis
Tribunil	1		17	4.5 leaves	13	43	66	57
Tribunil	2		17	4.5 leaves	30	76	93	86
Dosanex	2		17	4.5 leaves	43	73	77	10
Dosanex	4		17	4.5 leaves	27	80	56	43
San 7104	1.6		32	1 node	27	10	67	23
San 7104	3.2		32	1 node	27	40	100	93
Faneron	1		17	4.5 leaves	50	100	100	100
Faneron	2		17	4.5 leaves	56	100	100	100
Baneron	0.5		17	4.5 leaves	73	86	77	70
Baneron	1.0		17	4.5 leaves	70	97	100	100
Baneron	0.5		27	6.5 leaves	20	60	83	76
Baneron	1.0		27	6.5 leaves	83	70	77	100
Basagran + Tribunil	(2.0+0.5)		17	4.5 leaves	33	53	100	77
Basagran + Tribunil	(2.0+1.0)		17	4.5 leaves	57	60	100	83
Basagran + MCPA	2.0+0.24		27	6.5 leaves	87	17	100	53
Basagran + MCPA	2.0+0.48		27	6.5 leaves	90	0	100	70
Brominal	0.24		17	4.5 leaves	40	87	93	90
Brominal	0.48		17	4.5 leaves	92	100	100	100
Brominal + MCPA	0.24+0.24		17	4.5 leaves	67	100	93	100
Brominal + MCPA	0.24+0.24		28	6.5 leaves	70	73	93	43
2,4-D	0.5		38	1 node	27	33	100	67
2,4-D	1.0		38	1 node	100	70	100	80
MCPA	0.24		27	6.5 leaves	33	0	50	60
MCPA	0.48		27	6.5 leaves	43	17	100	60
C.G.A 18'731	1.0		17	4.5 leaves	43	100	83	60
C.G.A 18'731	2.0		17	4.5 leaves	57	100	93	93
C.G.A + Brominal	1.0+0.24		17	4.5 leaves	93	100	93	100
Faneron + Tribunil	0.5+0.5		17	4.5 leaves	50	90	77	90

* DAE = Days after emergence of crop

Table 1.7.K Weed control (%) by different herbicides at different dates and rates at Toluca Station, Summer 1975.

Product	Rate kg/ha a.i.	Application Date	DAE*	Stage of Wheat	Weed control (%) Malvastrum peruvianum	Brassica campestris	Cucumis sativa	Commelina coelestis	Galinsoga ciliata	Poa annua
Tribunil	1.0		17	4.5 leaves	100	100	100	100	100	100
Tribunil	2.0		17	4.5 leaves	100	100	100	100	100	100
Dosanex	2.0		17	4.5 leaves	100	100	100	100	100	100
Dosanex	4.0		17	4.5 leaves	100	100	100	100	100	100
San 7104	1.6		17	4.5 leaves	67	87	100	100	100	50
San 7104	3.2		17	4.5 leaves	100	100	100	100	100	100
Faneron	1.0		17	4.5 leaves	93	100	100	100	100	100
Faneron	2.0		17	4.5 leaves	100	100	100	100	100	57
Baneron	0.5		26	6.5 leaves	7	87	100	100	100	60
Baneron	1.0		26	6.5 leaves	50	67	100	83	90	77
Baneron	0.5		42	1 node	0	57	93	70	70	60
Baneron	1.0		42	1 node	43	7	83	77	67	67
Basagran + Tribunil	(2.0+0.5)		42	1 node	93	93	87	33	23	80
Basagran + Tribunil	(2.0+1.0)		42	1 node	100	93	83	93	57	50
Basagran	1.0		42	1st node	33	33	33	0	0	0
Basagran	2.0		42	1st node	33	33	17	0	0	0
Brominal	0.24		17	4.5 leaves	27	93	100	90	100	0
Brominal	0.48		17	4.5 leaves	83	100	100	97	100	0
Brominal + MCPA	0.24+0.24		27	6.5 leaves	100	77	67	63	77	0
Brominal + MCPA	0.24+0.24		42	1st node	30	10	57	17	23	0
2,4-D	0.5		42	1st node	0	0	0	0	0	0
2,4-D	1.0		42	1st node	0	0	0	0	0	0
MCPA	0.24		27	6.5 leaves	100	93	50	33	0	0
MCPA	0.48		27	6.5 leaves	100	97	50	67	40	0
C.G.A.	1.0		17	4.5 leaves	100	27	100	100	100	100
C.G.A.	2.0		17	4.5 leaves	67	40	67	67	67	67
C.G.A. + Brominal	1.0+0.24		17	4.5 leaves	100	100	100	100	100	100
Faneron + Tribunil	0.5+0.5		27	6.5 leaves	43	17	100	93	60	50

*DAE = Days after crop emergence

Table 1.7.S Variety trial results (kg/ha), five locations, Summer 1975.

Location	Tizayuca	San Vicente	San Pablo	Sanctorum	Huamantla	Ave.
Variety						
Navojoa (T)	1630	2680	1940	4030	2470	2550
Beagle (T)	1930	2470	2010	3120	1850	2280
Rahum (T)	1500	3360	2190	4010	3400	2890
Yoreme (T)	2090	3690	1340	4430	3080	2930
Bacum (T)	1870	3530	2490	3980	4260	3230
Puebla (B)	2010	2490	2760	2270	3880	2680
Cleopatra (B.W.)	2960	4220	2650	4070	3450	3470
TZPP-PAL-7C (B.W.)				3170	3300	
Moncho (B.W.)				3750	2670	
Pavon (B.W.)				4060	2670	
PC91 (B)				2770	2450	
Ave Location Yd	2000	3210	2200	3600	3040	
L.S.D. 0.05	510	1290	1540	440	410	

T = Triticale, B = Barley, B.W. = Bread Wheat

Drs. R.G. Anderson and M.M. Kohli (from CIMMYT) confer with colleagues at Passo Fundo, Rio Grande do Sul, Brazil on the effects of aluminum toxicity in wheat.

FIGURE 1.7.1 The average yield response of ten triticales, three durums and three bread wheats to five levels of N, at Cd. Obregon 1974-75.

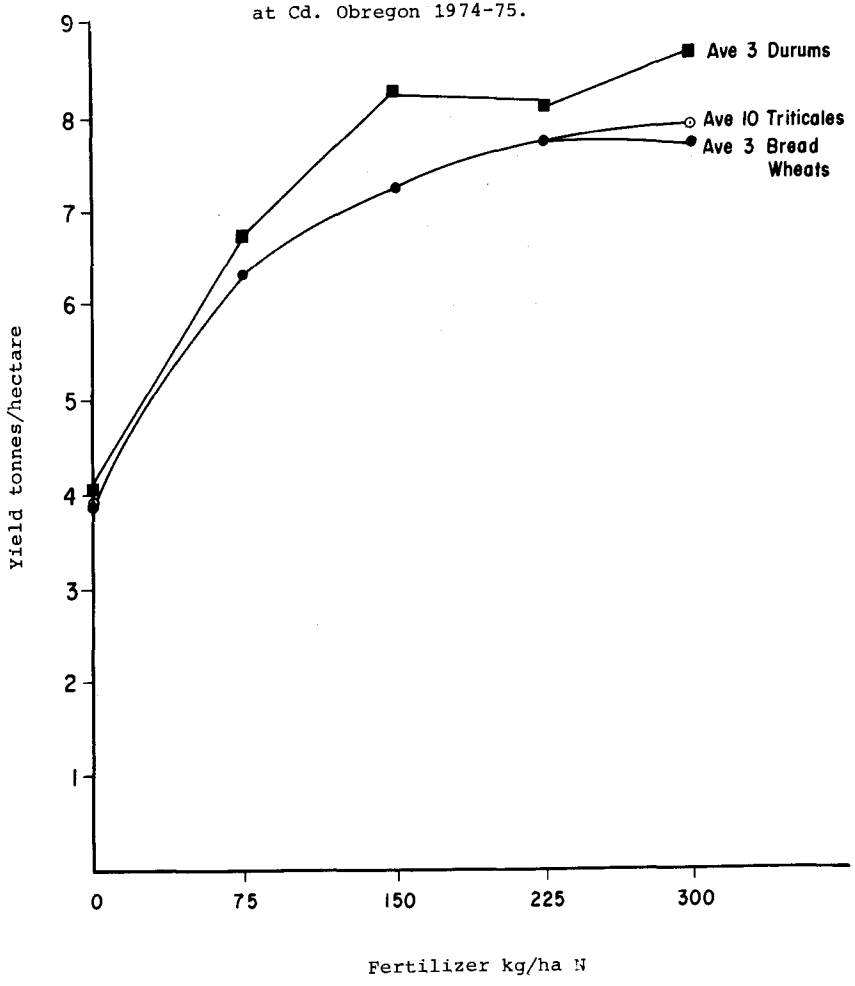


FIGURE 1.7.2 The yield response of two triticale and three bread wheat varieties to five levels of N, at Cd. Obregon 1974-75.

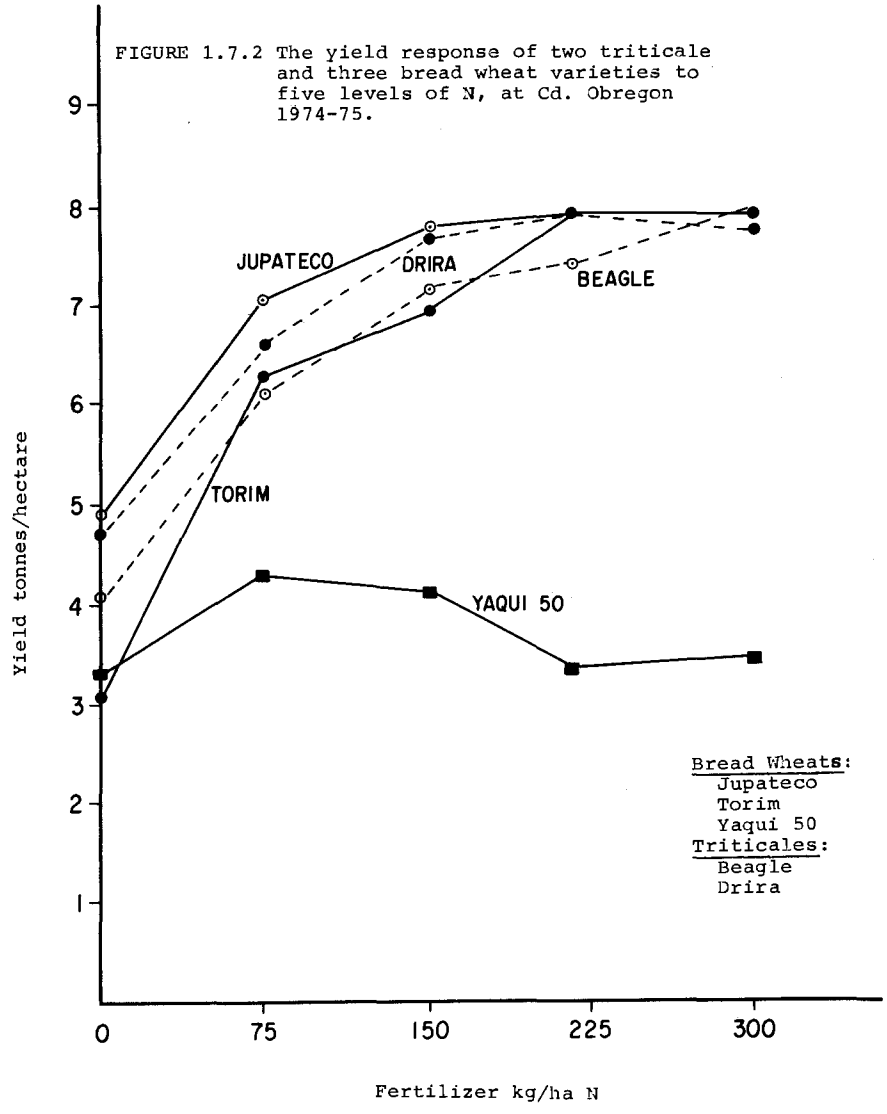


FIGURE 1.7.3 The effect of N level on total dry weight production of plant and grain - averaged results for ten triticale, two durum and three bread wheat varieties in an experiment grown at Cd. Obregon, 1974-75.

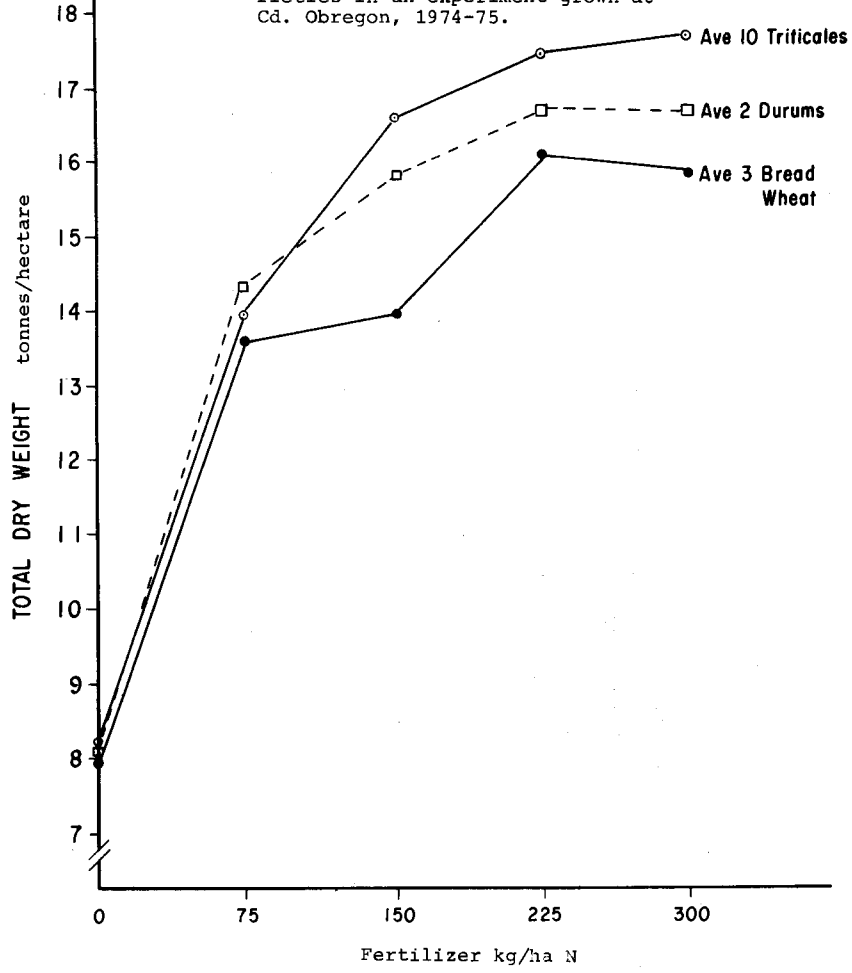
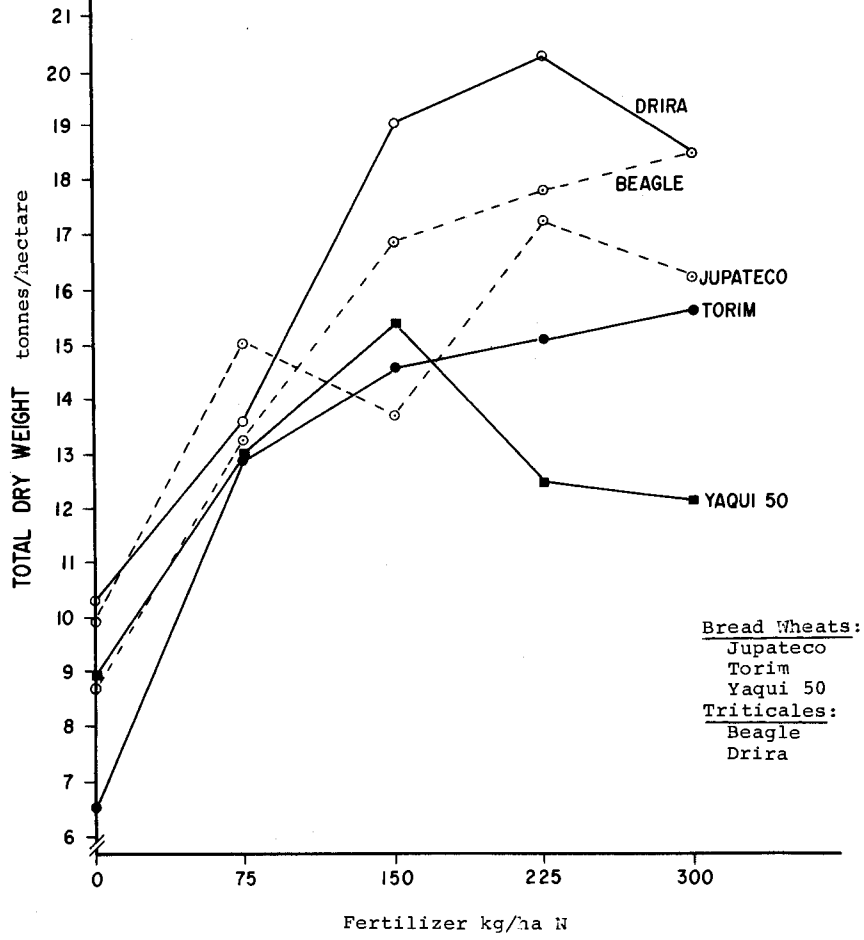


FIGURE 1.7.4 The effect of N level on total dry weight production of plant and grain for individual varieties of triticale and bread wheat in an experiment at Cd. Obregon, 1974-75.



1.8 Physiology

1.8.1 INTRODUCTION

The wheat physiology program in the Yaqui Valley, 1974-75 season, concentrated on four areas of particular interest, viz., yield potential assessment; environmental and plant manipulation; leaf angle and yield potential; and simulated drought studies. The work on yield potential under optimum conditions, namely high fertility, irrigation with lodging and disease control, continued with greater emphasis being placed on the relationship between growth and yield in the crop situation and under spaced plant conditions. Environmental and plant manipulation was continued but a wider range of varieties were included in shading trials to augment the previous data obtained from Yecora 70, a triple-dwarf, early maturing variety. Simulated drought trials were conducted including a detailed study of two wheat and two barley varieties by Mr. Fran Bidinger, a Cornell University Ph.D. student, and a comparative study of 54 diverse genotypes of which 18 were studied in more detail by Srita. M. E. Sanchez of the National Agricultural University, Chapingo.

The terminal drought treatment used is the most feasible under Yaqui Valley conditions. Soil moisture retention is high, thus increasing the difficulty of producing short-term stress and early seasonal rainfall is very often encountered. CIMMYT production trainees conducted two irrigation trials designed to answer questions relevant to the program. Eight yield trials of near-isogenic populations selective for differences in leaf angle were conducted for the first time. The results from the season's work appear encouraging but did not give definitive answers. Studies on the adaptability of spring wheat genotypes to a wide range of growing conditions and altitudes at the same latitude, were continued by Mr. David Midmore, a Ph.D. student from Reading University. These were conducted at Poza Rica, Tlaltizapan, El Batan and Toluca. The study was terminated during the year and it will be reported fully in Mr. Midmore's thesis.

All grain yields in this sections are expressed on a 12 per cent moisture basis and unless otherwise stated, they are taken from plant samples with the border effects removed.

1.8.2 YIELD POTENTIAL ASSESSMENT

Weather conditions at CIANO in the 1974-75 season were very favorable as shown in table 1.8.A. Although the usual heavy rains in the first weeks of November delayed most plantings until late November or early December, the subsequent period up to May and particularly during April, was very cool. Hence the delay in seeding actually proved advantageous for yield potential in that a greater part of the growth took place under conditions of high radiation.

The exceptionally high yields obtained with all materials were a reflection of the favorable season. Yecora 70, seeded in trials in late November and early December, gave a mean yield of 9.07 tonnes/hectare as an average of seven trials and in the absence of disease. This compared with yields of between 6.41 t/ha and 7.95 t/ha in the preceding four seasons. This large fluctuation is adequately explained by the relatively small changes in temperature and radiation between January and April.

The primary study of yield potential included 48 genotypes comprising bread wheats, durum wheats and triticales. It was designed to measure yield under optimum conditions and to study possible selection criteria for yield. Grain yields in the trial were excellent with the semi-erect bread wheat, Fiserect 3, yielding 9.63 t/ha, followed by Mexicali 75 (Stork "S") with a yield of 9.52 t/ha. The cool season was reflected in the favorable yield of the later maturing genotypes which normally run into hot weather before their potential is realized. Yield was closely related to harvest index, (the ratio of grain dry matter to total above-ground dry matter) with an r value of 0.66**, and also to grain number per unit area, with an r value = 0.64**. Leaf permeability, a measure of stomatal aperture, was measured with the simple air flow porometer and it was recorded at regular intervals throughout the season. Significant differences were shown to be consistent over time between the genotypes under test. Moreover, leaf permeability showed a highly significant positive correlation with grain yield, with an r value of 0.47** and as such, shows promise as a potential selection criterion. The technique is simple and four readings a minute are possible.

Leaf photosynthesis measurements were made in the field each week from early February to mid-April over all genotypes. A 30 second exposure to $^{14}CO2$ in a circular cuvette was employed, followed by freezing the exposed tissue for digestion and counting. These measurements were undertaken by Mr. Fran Bidinger in the laboratories at Cornell University. The instrument used also included a resistance porometer which records an

estimate of stomatal aperture, based on relative humidity change. Initial results show a good correlation of r=0.27** between grain yield and mean photosynthetic rate over the season. Also, there was a significant correlation between yield and the mean value photosynthetic rate as determined by four readings before anthesis (r=0.22*) and the mean of the readings in the first four weeks after anthesis (r=0.24*). On only three occasions were the photosynthetic rates recorded on any one day, significantly correlated with yield. Two of these were obtained shortly before anthesis during the period of the most rapid ear growth, and the other was obtained during the period of rapid grain growth. Results from the resistance porometer were less encouraging than those from the airflow porometer. On three occasions significant correlations were obtained between leaf resistance and grain yield. However, the mean over the season was not significantly correlated with yield, and only the mean value for the first four weeks after anthesis, showed a significant correlation of r=0.26*.

The differences between the results and the correlations obtained with the air flow and resistance porometers, are probably the result of one or both of two differences between the methods. The resistance porometer gives a measure of stomatal aperture on one surface only - in this case, the adaxial surface. It is more sensitive when leaf resistance is high, whilst the air-flow porometer gives a measure of stomatal aperture on whichever surface the stomata are more closed, and it is more sensitive when leaf resistance is low.

The same genotypes in the above trial were also grown under spaced plant conditions to simulate the stand in a planting of early segregating generations in the breeding programs. The purpose of this experiment was to see which traits, when measured on spaced plants, best predicted the genotype's yielding ability in large plots at commercial densities. Table 1.8.B sumarizes the correlation coefficients obtained between the trait in spaced plants and the same trait in the large plots, together with its correlation with large plot grain yields.

The pattern which emerged confirmed to a large degree the results from previous seasons. Although there were usually significant correlations between the same trait or component measured on spaced plants and in a plot (full stand), grain yield was an exception. Once again, this demonstrated that plant grain yield is a poor predictor of grain yields in large plots. The harvest index of the spaced plants showed the best correlation with plot grain yield, followed by plant height and, in this season, by maturity date. Harvest index itself is no doubt correlated strongly with plant height. However, harvest index prediction of yield was closer than achieved using height, showing that the index is a more reliable selection criterion for yield, than is height. When only the 30 short bread wheats were considered, the spike number per plant also gave a useful correlation with crop yield.

When all traits measured on the spaced plants were considered in a multiple regression analysis, the mode which best predicted yield was made up of harvest index, spikelets per spike which is negative, kernel weight, days to maturity and grain filling days (negative). In the case of the 30 semi-dwarf bread wheats, the best model included harvest index, grains per central spikelet which were negative, and ear emergence date.

A preliminary study showed that harvest index measurements on field dried plants were sufficiently precise for selection, but they took two to three times as long as visual plant selection. The next project will undertake selection in segregating populations, using harvest index in order to decide whether any gain in selection precision will outweigh the reduced number of plants that can be selected.

Another trial designed to evaluate the errors accumulated in plot yields when the guard rows are not removed, showed that in plots where borders were not removed, the tall varieties were favoured. This was not unexpected. The ratio of yield of a tall to a short variety was up to 12 per cent higher in unbordered plots than ones in which borders were removed. This was primarily the result of differences in light competition, but there was evidence that taller varieties showed a relative advantage at the ends of the plots as well. As borders are not removed from the breeders' yield trials at CIMMYT, it has been suggested that as a first step, lines of the same height class should be put into the same trials. A further assessment should be made at the end of the next season of the errors incurred by harvesting complete plots in the absence of interplot light competition.

1.8.3 ENVIRONMENTAL AND PLANT MANIPULATION

Shading studies in past seasons have shown two marked periods in the crop cycle, when shading reduced grain yield. The first period covered the month prior to anthesis, 60 to 90 days in Yecora 70, and it was evident in each of the seasons tested. The second period was during the grain filling stage but this varied according to the season. When the season was cool and there was a long grain filling period, the effect was small or of

no account.

A more intense study of the first and most critical period was conducted in the 1974-75 season on Yecora 70. Continuous shading of the crop showed that reductions in light at 13 per cent and 33 per cent reduced grain yield by 11 and 15 percent respectively. However, 33 per cent shading from 62 to 83 days had no effect on grain yield or grain number, although the total dry matter production over the 21 day period was reduced by 35 per cent in relation to the control. Sixty six per cent shading for the same period reduced yield and grain number by 18 and 25 per cent respectively. Seventy two per cent shading for a 7 day period from 71 to 78 days had a similar effect. The crop appears to be able to buffer itself against short periods of reduced growth and reduced levels of incoming radiation of up to 33 per cent. Together with the observation of an accumulation of soluble sugars in control crop stems in the pre-anthesis period, the results suggest that there may be some factor other than radiation limiting grain number during this phase.

In another shading trial, the effect of eight 28 day periods of 55 per cent shade on the yield and components of 12 diverse genotypes was examined. The pattern of effect on grain yield of most varieties was similar to that described earlier for Yecora 70. However, some varieties demonstrated different patterns of sensitivity. The grain number of erect RAF was sensitive to shading over a much longer period than other varieties. Another erect line, Fiserect 4A, was very sensitive to preanthesis shading, but shading after anthesis had very little effect on kernel weight or yield. On the other hand, Cocorit 71 showed very little sensitivity to shading before anthesis. Further work is required to evaluate whether the differences observed here can be usefully related to physiological traits other than the rate of development.

When early and late maturing Mexican varieties are compared, most of the extra time taken to reach maturity by the latter varieties is the result of the increased duration of the true vegetative phase which occurs before spike initiation. Previous results showed that crop yield is very insensitive to environmental manipulation in the vegetative stage, and that the crop would benefit more from a longer spike development phase. Studies are in progress this season to test this hypothesis before looking for genetic material more sensitive to environment after, rather than before, spike initiation.

Six hour photoperiod extensions were given to plots of Yecora 70 for 14 day periods from 21 to 104 days. Results were confused by the developmental acceleration of photoperiod, but there were significant reductions in yield caused by short periods of long days up to ear emergence. Yields were significantly lower when the crop was exposed to long days prior to anthesis, and marginally lower when the day length extensions were provided in the 49 to 66 day period, as compared with those treatments which received long days prior to 49 days. This effect was caused by a greater reduction in grain number than was observed in other treatments. The results are encouraging since it appears that there is a photoperiodic sensitivity after the onset of the reproductive phase, but the results should be confirmed before screening genetic material for greater sensitivity in the reproductive as compared with the vegetative phase.

1.8.4 LEAF ANGLE AND YIELD POTENTIAL

Eight yield trials were conducted using near isogenic populations resulting from crosses between sources of erect leaf character and several commercial varieties. The populations were primarily F3 bulks but little segregation was evident. Disease was not controlled in these trials and heavy outbreaks of leaf rust on susceptible lines, hampered the evaluation of the results. Among the near isogenic lines of some wheat crosses (RAF x Yecora, RAF x INIA and RAF x Nadadores), the leaf angle was positively correlated with yield, with the higher yields being given by plants having the more erect leaves. However, in the progeny of most crosses there was no evidence of this correlation.

When there was a significant effect of leaf angle, it was accompanied by an increase in grain number and a decrease in kernel weight as leaves showed a greater degree of erectness. It is not known whether these associations represent causal linkage of characters coming from the common parent, viz., erect RAF,which has a high grain number and low kernel weight, or whether they reflect underlying physiologic relationships. The durum population study showed an inverse relationship between yield and leaf angle. Yield was lower in the populations with erect leaves, probably because the increase in grain number observed in the bread wheats was not present in the durums.

The usefulness of the erect leaf character has not been fully evaluated and at least one more season's yield trial with disease control will be necessary to establish whether or not this characteristic is beneficial.

1.8.5 GENOTYPIC COMPARISONS UNDER SIMULATED LATE DROUGHT CONDITIONS

An intensive study of two bread wheats and two barley varieties was conducted by Mr. Francis Bidinger as a part of his Ph.D. thesis. The study was designated to study the striking advantages shown by barley under drought conditions observed in the trials at CIANO during the previous season. However, the difference in grain yield under drought of the two barley varieties (mean of 3.76 t/ha) and the two bread wheats (3.7 t/ha) was small and could be accounted for by the following two factors. The barleys reached anthesis one to two weeks earlier than the bread wheats, thereby tending to avoid the drought, and the barley yields include the weight of the hull. Many measurements including leaf permeability, water potential, the uptake of labelled carbon dioxide ($^{14}C02$) and the translocation patterns were studied and they will be presented in Mr. Bidinger's thesis.

A set of 54 diverse genotypes was studied in another trial under control and with three late drought treatments. Although the most severe drought treatment received its final irrigation at 21 days after planting, and the least drought treatment was irrigated at 51 days, there were no significant differences between the drought treatments in either grain yield or any of the normal components of yield. Therefore, all results represent a mean of the three drought levels. Control yields were lower in this trial than in others with a mean of 5.78 t/ha as N was withheld so as to reduce early vegetative growth in the drought treatments.

The top four yielding varieties under drought, were two barley varieties (the weights include hull), that is WI2198 (3.51 t/ha), and CM67 (3.08 t/ha) and two bread wheats viz., Zacatecas (2.93 t/ha) and Cleopatra (3.11 t/ha). Both of the varieties of bread wheat were developed by INIA in Mexico specifically for dryland conditions. Gabo, an Australian line reputed to have drought tolerance, gave the sixth highest yield (2.89 t/ha). Other high yielding lines under drought were Tanori (2.91 t/ha), Penjamo (2.84 t/ha), CIANO (2.83 t/ha), Nainari (2.78 t/ha), and T64-2-W, a tall late bread wheat (2.78 t/ha). A helpful picture of the general performance of major groups of varieties is presented in table 1.8.C.

Differences between height groups of the dwarf wheats in the controlled crop were small and opposite to those recorded in the more intensively managed trials. Under drought, differences between all the groups were small with only the old durums and triticales being markedly lower than the other groups. Over several seasons, it had been noted that the highest yields under drought in the bread wheats were found in the single and two gene dwarfs although this year, with the more severe drought, some tall bread wheats, for example Gabo and Nainari, did very well.

A large amount of additional data was collected in this trial, viz., yield components, leaf area changes, leaf water potential and leaf permeability. Under drought, harvest index gave the best correlation with plot yields with a $r=0.83^{**}$, followed by grain number, correlation of $r=0.78^{**}$, total field weight $r=0.48^{**}$ and an inverse correlation with anthesis date of $r=-0.40^{**}$. It was interesting to note that although drought was most severe after anthesis, yield was not correlated at all with kernel weight, showing an r value of 0.04. Measurements of water potential and leaf permeability were confusing and yielded no significant correlations with yield under drought conditions. However, on a more restrictive set of 18 genotypes, there was a positive correlation between yield and permeability under drought conditions of $r=0.59^{**}$.

The same genotypes grown in the above trial were also grown as spaced plants under well watered and drought conditions in order to observe possible correlations between the spaced plant characteristics and the plot yield under drought, with a view to seeing whether this might be used as a selection criterion. When all measured characters on the spaced plants were put into a multiple regression, the best predictor of droughted plot yield over all genotypes included plant harvest index, spike number and grain number; the latter being negative, measured on droughted plants with a $r^2=0.42$. The best predictor of drought plot yield based on results from well watered plants was made up from the plant harvest index and grains per spikelet with $r^2=0.33$. However, when only the semi-dwarf bread wheats were considered, the results were discouraging. The best model from well watered plants consisted only of a negative correlation with maturity of $r^2=0.23$, while that based on droughted plants showed only two with an effect viz: maturity (negative), and plant grain dry weight with $r^2=0.23$.

1.8.6 YIELD POTENTIAL UNDER LOW LATITUDE CONDITIONS

The trials were carried out by Mr. David Midmore at the four sites noted earlier, Poza Rica, Tlaltizapan, El Batan and Toluca to study the adaptability of spring wheat and triticale genotypes to a range of differing growing temperatures. Late January seedings yielded a mean of 0.84 t/ha at Poza Rica, reflecting the severe disease problems, primarily

Helminthosporium sativum, at that site. Yields of similar plantings at Tlaltizapan, El Batan, and Toluca were 5.54, 5.48, and 6.5 t/ha respectively on the basis of the experimental yields.

At these three sites, there was very little difference in solar radiation but the mean temperatures at Tlaltizapan were 7 to 10°C higher than at El Batan and 9 to 13°C higher than Toluca. In the light of these temperatures it is surprising that yields were as high as those measured in Tlaltizapan. It would appear that as long as radiation is adequate, temperature has only a marginal effect on yield. Results from these trials have not been fully analyzed but are presented fully in Mr. Midmore's Ph.D. thesis in the El Batan Library.

TABLE 1.8.A Summary of weather data in wheat season 1974-75 at CIANO, Ciudad Obregon, Sonora, Mexico. Wheat Physiology. Met. Stn.

Month	Temperature °C				Rainfall mm		Evaporation+ mm		Solar Radn. cal. cm^{-2} day^{-1}	
	Mean Max		Mean Min							
	74-75	long* term	74-75	long* term	74-75	long* term	74-75	long** term	74-75	long** term
Nov	27.4	28.9	11.8	11.6	108	13		4.2	316	343
Dec	22.9	24.1	5.8	8.4	2	18	4.0	3.4	291	290
Jan	23.1	23.2	5.7	6.7	3	14	3.5	3.1	313	312
Feb	23.6	24.7	5.7	6.8	1	8	3.9	3.7	405	399
Mar	25.8	27.1	7.6	8.2	0	3	4.9	5.2	495	512
Apl	28.3	31.2	7.1	10.3	0	1	7.0	7.5	557	594
May	32.6	34.4	11.0	13.9	0	0			620	615

+ USWB Class A Pan * 1960-1975 (15 year) ** 1970-1975

TABLE 1.8.B Simple correlation coefficients between (a) the same trait measured in spaced plants and large plots and (b) the trait measured on spaced plants and grain yield of large plots.

Spaced Plant Trait	All Genotypes (n=48)		Short Bread Wheats (n=30)	
	a	b	a	b
Grain dry wt.	0.15	0.15	0.23	0.23
Total dry wt.	0.51**	-0.09	0.52**	0.09
Harvest index	0.82**	0.50**	0.80**	0.40*
Grain number	0.33*	0.05	0.37*	0.32
Kernel wt.	0.86**	0.15	0.80**	-0.14
Spike number+	0.73**	0.10	0.67**	0.43*
Spikelets/spike	0.91**	0.00	0.77**	0.26
Grains/spikelet	0.45**	-0.01	0.48**	-0.20
Height	0.98**	-0.40**	-	-0.42*
Ear emerg.date	-	0.33*	-	0.64**
Maturity date	-	0.45**	-	0.50**
Leaf permeability	0.85**	0.25	0.87**	0.48**

+ = Measured per plant on the spaced plants, and per unit area in the large plots.

* = P.F. 5% ** = P.F. 1%

TABLE 1.8.C Summary of yield data under well watered and late drought conditions, with lines grouped into classes.

Genotypes + (n)	Well watered			Drought
	Height(cm)	Anthesis	Yield(t/ha)	Yield(t/ha)
Tall BW (8)	120	92	5.01	2.52
E_1 BW (11)	101	90	6.23	2.60
E_2 BW (9)	94	90	6.17	2.57
E_3 BW (6)	63	88	5.89	2.44
Old D (4)	111	93	5.33	2.02
Modern D (2)	94	90	7.20	2.53
Triticales (7)	119	92	6.01	2.00
Barleys (6)	101	81	5.06	2.53

+ BW=bread wheats; D=durums; (n)=number in each group

E_1 = Single dwarf, E_2 = Double dwarf, E_3 = Triple dwarf

Dr. J.P. Srivastava discusses with Dr. Imam the effect of salt concentration on wheat, at the research station near Khartoum, Sudan.

1.9 Basic Germ Plasm Improvement

1.9.1 INTRODUCTION

The program for improvement of basic germ plasm is concerned with work leading to the production of parental lines having some specific characters, principally for use later in the conventional breeding programs of bread wheats, durums, and triticales. The different aspects characterizing the work have been outlined previously, so the present report will deal primarily with the results which have achieved and which have been applied in the conventional programs.

1.9.2 CHARACTERS UNDER STUDY

1.9.2.1 Dwarfness

During the winter of 1974-75, various uniform lines were obtained with dwarfness contributed from S-948-A1 and from Tom Thumb which possess good grain. Thus, it can be said that the phase of the work of tranfering dwarfness from these two wheat varieties to lines with good agronomic characteristics has been completed. This was accomplished primarily by backcrossing and these lines can be used as parents in the bread wheat improvement program. In order to evaluate these lines, they were divided into four groups and sown in yield trials. The results of these trials are summarized in the following paragraphs.

In a Dwarf Wheat Yield Trial known as Experiment II-DMB, 21 isogenic lines which are very similar in appearance to the variety Ciano 67, were grown with check varieties including Ciano 67. In addition to recording their yields, data were also taken on the following characters in order to determine the effect on yield of height, number of tillers/m^2, spikes/m^2, spikelets per spike ($^e/_E$), grains/spike ($^G/_E$), grains/spikelet ($^G/_e$), spikelets/m^2 ($^e/_{m^2}$), grains/m^2 ($^G/_{m^2}$), volume and weight of 1000 grains, and hectolitre weight.

In table 1.9.A the data are shown for this experiment in which dwarf Ciano lines are compared with Ciano. In summary, the similarities and differences from Ciano 67 in the experiment were:-

1. All had similar vegetative cycles ranging from equal to Ciano, to three days later flowering.
2. All were shorter in height.
3. All had higher yields.
4. All had a greater number of tillers/m^2.
5. All had a greater number of spikes/m^2.
6. All had a greater number of spikelets/spike.
7. All but one had a greater number of grains/spike.
8. Thirteen lines had more grains per spikelet, one equal to and eight had less grains per spikelet than Ciano.
9. All had a greater number of spikelets/m^2.
10. All had a greater number of grains/m^2.
11. All lines had a lower 1000 grain weight.
12. All were lower in grain volume of 1000 grains.
13. One line was higher, but 20 lines were below in hectolitre weight.

It seems evident that the shortening of straw resulted in an increased tillering capacity, which gave rise to a greater number of spikes per unit area. Spikelets per spike were also increased and in some cases, grains per spikelet were also considerably greater in number. All of these were reflected in higher grain production per unit area.

On the other hand, it is clear that the size and weight of the grain was reduced, but these reductions were more than compensated for by the number of grains produced, thereby resulting in greater yields from the new lines than obtained with Ciano. In particular, the lines identified as varieties No. 43 and 50 gave yields statistically equal to the check varieties, Jupateco 73, Torim 73 and Super X. This is of special interest in that the high quality of Ciano has been combined with high yield.

In table 1.9.B the performance is shown of dwarf wheat materials of the cross H283-70, which represents isogenic lines of Inia 66 with dwarfness contributed from Tom Thumb and resistance to leaf rust derived from Chris. These derived lines showed a similar behavior to that shown by the Ciano 67 derived lines. In this case the dwarf $E3^{+}$ lines yielded more than the recurrent parent Inia 67 and as much as Jupateco 73 and Super X.

Perhaps the most outstanding case of the effect of dwarfness on yield, can be seen in table 1.9.C which shows nine isogenic lines of Santa Elena with the dwarfness of S-948-A1. All of these lines yielded much more than Santa Elena and eight of them were superior in yield to Jupateco 73, Super X, Torim 73 and Yecora 70, which without doubt are four of the highest yielding commercial varieties.

In Experiment V-DMB, viz table 1.9.D, wheats with dwarfness derived from different origins, were grown. In general, the shortening of the straw again resulted in a considerable increase in grain production. In this experiment the most interesting material was that derived from Chris and Nariño 59, particularly from the standpoint of the rust resistance possessed by these two varieties.

The results obtained from shortening the height of the straw in Ciano 67, Inia 66, Santa Elena, Chris and Nariño 59 show that within certain limits, yield can be increased if the straw is shortened to the point where the other factors of yield can be expressed. At the same time, the results suggest that in old varieties which have been eliminated because of lodging problems, there can exist genes for yield which should be incorporated into modern short-strawed varieties.

The observations made from these four trials serve as a basis for selecting the best lines. Thirty of these were entered into the bread wheat improvement program. These are listed in table 1.9.E. This material together with other advanced lines were tested at El Batan during the 1975 summer. Those which show better performance will be included again in yield trials and observed during the 1975-76 winter season.

In addition, lines are being improved using a new source of dwarfness called Hisumi. When vernalized and grown under the conditions of the Yaqui Valley in Sonora, it is a variety with a water habit and a height of 40-50 cm. By the winter of 1975-76, CIMMYT will have F-4 lines of simple crosses of Hisumi with Chris, Tezanos pintos precoz and Jupateco 73 in which the dwarfness of Hisumi will have been combined with the spring habit of the aforementioned varieties. However, this material is somewhat susceptible to rusts, and also the grain and agronomic type of the plants is not entirely satisfactory.

1.9.2.2 Branched Heads

In the improvement of wheats with branched heads, the ramification is reduced but does not totally disappear when such wheats are grown under conditions of complete competition. Because they always produce a larger number of spikelets and florets per spike, there are a larger number of sites in which to put more grains. This characteristic on its own is not actually of very great importance. However, it may lead to greater efficiency in growing plants since there will be proportionately more space in which plants can grow to give a larger number of grains. Ramification could be a means to this end.

From the point of view of increasing plant productivity, the ramified spike, as is the case in normal spikes with a greater number of flowers per spike, could be used to detect or identify some wheats which potentially have a higher capacity to yield than they are able to express, because of a limitation of flowers or spaces in which to develop more grains.

Most of the work was done on the improvement of the fertility and grain in these ramified-spiked wheats during recent years. CIMMYT produced lines which showed sufficient improvement in these two aspects and which were suitable for yield testing. In the 1973-74 season a yield trial was grown which included ramified bread wheats (Rah) and ramified durums (Rad). The results of the testing for the better ones together with those obtained in a 1974-75 trial are reported in table number 1.9.F.

It can be seen that M Reo x II 8156 $(R)^{4}$, a ramified bread wheat, yielded a little more than Super X and Jupateco 73. It showed no statistical difference from Stork "S" and Cocorit 71, which are two high yielding conventional durum varieties. It is clear

that M Reo x II 8156 (R)^4 yielded significantly more than the ramified bread wheats tested in 1973-74. This superiority can be attributed to the greater number of spikes, the satisfactory fertility (G/e) and in particular, the better hectolitre weight which can be taken as an indication that the grain is plump. Without much doubt, there is in this line a combination of the ramified characteristic with fertility and good grain. If the ramification of the head is limited, it is evident that the fertility and grain will be improved in this type of wheat.

The ramified durum wheats (Rad) have also achieved improved yield as can be seen in the case of line H391.71A-9B-4$_Y$-2B-2$_Y$-OB in table 1.9.F. It reached a yield similar to Cocorit 71 and the grain which was produced under Ciano conditions, was similar to Cocorit 71. This represents a marked advance over the ramified durums first developed from primary crosses involving the original sources of ramification. The hectolitre weight of this line is similar to that of Stork "S" and Cocorit 71, and it is superior to the hectolitre weight of the lines tested in 1973-74. These results are an indication of the improvement achieved in ramified durum wheats.

1.9.2.3 Quality

In the summer of 1974 work was initiated which was designed to develop progenitors with better quantity and quality of protein in bread wheats. The following sources of quality have been used - Nap Hal, Frondosa PI 106505.8.1, Kenya Governor, Pioneer CI 4324, Mahratta CI 8500, K338-Lemki^3 CI 13271, Cedar PI 93984, Kenya C10863 PI 117623, Mestaner x KC.60.4809-3A PI 202800, Buitre "S" and LS.3.1 - Pi62.

As indicated previously, these wheats have unfavourable agronomic characteristics which make them difficult to use for quality in the conventional wheat breeding program. Therefore, this developmental work consists of transferring the quality present in the material, to wheats with agronomic characteristics which permit their easy handling in the program of bread wheat improvement.

To achieve this objective, a work plan was designed around the following principal points:

1. Crossing the quality sources with lines and varieties possessing good agronomic type.

2. Individual selection in the field of segregates showing better agronomic characteristics.

3. Laboratory tests to determine which segregates possess the desired quality.

4. Carrying the better lines to the advanced generations. New crosses will be made with good agronomic types in order to initiate a new cycle of selection for agronomic type and quality.

Following this general scheme, lines were produced with a high protein content and good agronomic types. Nine of these lines also possess a good index of protein quality, according to preliminary data reported from the protein quality laboratory.

Table 1.9.G lists the selections which combined quality and improved agronomic type. Some of them produced good grain under the conditions of growth at El Batan. It is clear from the table, that all the lines have acceptable height and earliness; however, other characteristics such as rust resistance and grain plumpness are not as good as in Ciano 67. It may be concluded that it is possible to increase considerably the quantity of protein, and possibly also its quality, even though the latter may be marginal.

1.9.3 WIDE CROSSES

During the 1974-75 winter and 1975 summer,work was continued on the wide cross project. In this period, more than 5000 spikes were treated with different doses of EACA (Epsilon Amino-N, Caproic Acid), which were then emasculated and later pollinated with pollen of different genera. This procedure was followed to achieve the following crosses:

Wheat with barley	Rye with oats
Wheat with oats	Barley with oats
Rye with barley	

The embryos which formed in the 1974-75 cycle were taken to Kansas State University by Dr. Bates. According to a personal communication from Dr. Bates, all the material died - apparently as the result of a too drastic effect of the EACA treatment. For this reason, during the summer of 1975, the treatment time with EACA will be reduced.

Last summer, like previous cycles, crosses were effected on both treated and untreated spikes. These were harvested 20-25 days after pollination and sent to the laboratory, where the embryos were cultured on a special medium.

From the embryos collected, some plants were obtained which were studied to determine their chromosome constitution and to see whether they really were intergeneric crosses. In this respect, Dr. Thomas considered that some of these plants were truly intergeneric crosses.

In addition, other genera of grasses have been studied for possible inclusion in the wide cross project. It is considered that Elymus and Agropyron are very interesting, and possibly by the winter of 1975-76 some new crosses with these genera can be attempted by CIMMYT.

International nurseries ready for dispatch from CIMMYT's headquarters, El Batan, near Mexico City.

TABLE 1.9.A Dwarf wheat yield trial. Data from Experiment II-DMB grown at Cd. Obregon in the winter, 1974-75.

Yield Rank	Variety or Cross	Pedigree	Days to Flower	Height cm	Yield kg/ha	Tillers /m²	Spikes /m²	e/E	G/E	G/e	e/m²	G/m²	Weight of 1000 grains (g)	Volume of 1000 grains (cc)	Hecto litre weight (kg)	Variety No.
1	Jupateco 73		89	103	7958*	449	430	17.32	45.82	2.64*	7448	19703	44.8	55	84.3	27
2	S948A1-Cno"S"xCno67[6]	CMH72A.429-11B-3Y-0B	85	68	7458	531	523	17.24	37.32	2.16	9017	19518	41.4	53	82.2	50
3	Super X		94	103	7250	392	365	19.13*	49.85*	2.60	6982	18195	42.3	52	83.5	29
4	S948A1-Cno"S"²xCno67[3]	H569.71-3Y-3B-0Y-1B-0Y	84	70	7000	497	485	16.87	35.72	2.11	8182	17324	45.1	56	83.4	43
5	Torim 73		86	73	6938	440	426	17.74	42.46	2.39	7557	18088	48.4	59*	84.3	28
6	S948A1-Cno"S"²xCno67[3]	H570.71-3Y-3B-0Y-2B-0Y	84	70	6938	491	472	16.79	33.91	2.01	7925	16006	45.9	57	83.4	35
7	S948A1-Cno"S"²xCno67[4]	H499.71A-7B-3Y-1B-0Y	84	65	6875	543	514	17.41	34.55	1.98	8948	17759	44.0	55	82.8	41
8	S948A1-Cno"S"²xCno67[3]	H569.71-3Y-4B-2Y-1B-0Y	84	70	6833	561	540	17.67	34.93	1.97	9542	18862	42.9	53	83.5	42
9	S948A1-Cno"S"²xCno67[5]	CMH72.381-10Y-1B-0Y	84	70	6750	527	513	17.56	36.22	2.06	9008	18581	45.8	56	83.3	45
10	S948A1-Cno"S"[4]	H471.71A-12B-3Y-1B-0Y	83	65	6625	494	479	16.20	35.40	2.18	7760	16957	42.4	53	83.3	46
11	S948A1-Cno"S"²xCno67[3]	H569.71-3Y-4B-0Y	84	70	6604	595*	576*	18.02	34.24	1.90	10380*	19722*	42.7	52	83.9	31
12	S948A1-Cno"S"²xCno67[4]	H499.71A-3B-0Y-2B-0Y	87	68	6542	511	503	16.48	32.19	1.95	8289	16192	42.6	53	83.3	37
13	S948A1-Cno"S"²xCno67[4]	H499.71A-2B-5Y-2B-0Y	86	70	6542	569	557	16.60	31.54	1.90	9246	17568	40.4	50	83.1	39
14	S948A1-Cno"S"²xCno67[5]	CMH72.381-4Y-1B-0Y	85	68	6417	475	463	17.92	35.17	1.96	8297	16284	44.6	55	83.9	44
15	S948A1-Cno"S"²xCno67[3]	H570.71-4Y-1B-0Y	84	70	6417	530	505	16.64	28.07	1.68	8403	14175	45.4	56	83.7	32
16	S948A1-Cno"S"²xCno67[4]	H499.71A-7B-1Y-1B-0Y	84	68	6250	487	473	17.05	32.89	1.92	8065	15557	43.9	55	83.6	40
17	S948A1-Cno"S"²xCno67[4]	H499.71A-3B-0Y-1B-0Y	86	70	6167	519	509	16.80	32.35	1.92	8551	16466	43.4	54	83.2	36
18	S948A1-Cno"S"²xCno67[4]	H499.71A-1B-0Y	84	68	6146	539	525	16.49	29.43	1.78	8657	15451	43.2	53	84.2	33
19	S948A1-Cno"S"²xCno67[4]	H499.71A-2B-5Y-1B-0Y	85	68	6042	541	526	15.73	28.35	1.80	8274	14912	44.0	54	83.7	38
20	S948A1-Cno"S"²xCno67[3]	H569.71-1Y-10B-0Y	82	70	6000	488	473	16.91	34.29	2.02	7998	16219	42.1	52	83.6	30
21	S948A1-Cno"S"²xCno67[4]	H499.71A-3B-0Y	87	70	6000	551	529	17.40	31.87	1.83	9204	16859	42.9	53	83.2	34
22	S948A1-Cno"S"[5]	CMH72.331-1Y-2B-0Y	84	65	5917	530	516	16.06	30.28	1.88	8287	15624	44.5	55	83.8	48
23	S948A1-Cno"S"[5]	CMH72.331-1Y-1B-0Y	85	68	5667	532	513	15.33	29.93	1.95	7864	15354	44.3	55	83.7	47
24	S948A1-Cno"S"[5]	CMH72.331-1Y-1B-1Y-0B	83	65	5667	560	546	15.71	29.26	1.86	8578	15976	42.4	53	83.5	49
25	CIANO F67		83	100	5625	467	460	14.78	29.18	1.97	6799	13423	48.5*	58	84.1	26
		DMS 5%			991.00			1.33	5.19							
		DMS 1%			1314.66			1.76	6.89							

Abbreviations E = Spike e = Spikelet G = Grains * = Highest Value

TABLE 1.9.B Performance of dwarf wheats in Experiment III-DMB, grown at Cd. Obregon in the winter, 1974-75.

Yield Rank	1974-75 Var.Nc.	Variety or Cross	Pedigree	Yield kg/ha	Days to Flower	Height cm	Stem Rust	Leaf Rust
1	52	Jup 73		7500	89	100	0	10-20R-MR
2	58	(ChrisxTth-Son64/Chris)Inia66^3	H283.70-3Y-2B-1Y-4B-1Y-2B-0Y	7479	89	70	0	5-20MS-MR
3	54	SX		7458	93	100	5-10MR-MS-S	20MR-R
4	55	Cj71		7208	94	80	0	20-30MS-MR
5	59	(ChrisxTth-Son64/Chris)Inia66^3	H283.70-3Y-2B-1Y-4B-4Y-2B-0Y	7208	88	70	0	10-30MS-MR
6	53	Torim 73		7146	87	75	TR	10-30MS-S
7	71	S948A1-Hua R^3	H478.71A-7B-2Y-1B-0Y	7146	91	95	5-10MR-MS-S	5-10MR-MS
8	60	(ChrxTth-Son64/Chr)Inia66^3	H283.70-3Y-2B-1Y-4B-5Y-1B-0Y	7000	89	70	0	20-MR-MS
9	57	(ChrisxTth-Son64/Chris)Inia66^3	H283.70-3Y-1B-2Y-1B-4Y-1B-0Y	6958	88	70	0	10-30MS-S
10	61	(ChrisxTth-Son64/Chris)Inia66^3	H283.70-3Y-2B-1Y-4B-7Y-1B-0Y	6938	90	65	0	20-30MS
11	64	TacxTth-Son64/Spre^5	H550.71-4Y-2B-1Y-2B-0Y	6500	78	90	10-30MR-MS-S	10R-MR
12	68	TacxTth-Son64/Spre^5	H550.71-14Y-7B-0Y	6479	80	90	5-30MR-MS-S	20-30MS-S
13	56	(ChrisxTth-Son64/Chris)Inia66^3	H283.70-3Y-1B-2Y-8B-1Y-1B-0Y	6417	80	65	0	10-20MR-MS
14	70	Hua Rojo		6354	91	Alto	20-30MS-S	10-20MS-S
15	66	TacxTth-Son64/Spre^5	H550.71-14Y-7B-1Y-1B-0Y	6333	76	85	5-10R-MR-MS	10-20MS-MR
16	63	TacxTth-Son64/Spre^5	H550.71-14Y-6B-0Y-3B-0Y	6313	76	80	20-30MS-MR	10-20MS-S
17	51	Inia 66		6271	87	105	TR	20-30MS-S
18	67	TacxTth-Son64/Spre^4	H280.70A-1B-2Y-2B-2Y-1B-0Y	6250	81	85	5-10MR-MS-S	10R
19	72	S948A1-Hua R^2	H544.71-7Y-3B-2Y-2B-0Y	6250	88	85	10-20MR-MS-S	5-10MR-MS
20	65	TacxTth-Son64/Spre^5	H550.71-14Y-6B-1Y-1B-0Y	6188	78	90	20-30MR-MS-S	20-30MS-S
21	75	Cno F67		6000	84	95	5-10MR-MS-S	10-30MS
22	69	TacxTth-Son64/Spre^5	H550.71-14Y-6Y-0Y	5833	80	90	20-30MR-MS-S	10-20MS-S
23	73	S948A1-Hua R^2	H544.71-12Y-5B-2Y-1B-0Y	5042	89	95	5MR-R	TMR
24	74	S948A1-Hua R^2	H544.71-12Y-5B-2Y-2B-0Y	4729	90	100	10-30MR-MS	TMR
25	62	S precoz		4625	73	115	0	5-10MR-MS

CV = 8.8

DMS 5% = 802.83 kg/ha

DMS 1% = 1065.16 kg/ha

TABLE 1.9.C Performance of dwarf wheats in Experiment IV-DMB grown at Cd. Obregon in the winter, 1974-75.

Yield Rank	1974-75 Var.No.	Variety or Cross	Pedigree	Yield kg/ha	Days to Flower-ing	Height cm	Stem Rust	Leaf Rust
1	81	S948A1-Sta Elena[7]	CMH72.380-12Y-1B-0Y	8479	89	95	0	T5MR
2	82	S948A1-Sta Elena[6]	H498.71A-17B-2Y-1B-0Y	8104	89	95	TR	20-30R-MR
3	88	S948A1-Sta Elena[7]	CMH72A.390-2B-1Y-0B	7979	89	85	0	20R-MR
4	86	S948A1-Sta Elena[5]	H567.71-6Y-1B-0Y	7917	89	85	TMR	5R-MR
5	84	S948A1-Sta Elena[5]	H567.71-6Y-1B-1Y-1B-0Y	7875	89	85	5R-MR	5R
6	83	S948A1-Sta Elena[5]	H567.71-2Y-2B-2Y-1B-0Y	7833	88	90	5-10R	10-20R-MR
7	87	S948A1-Sta Elena[7]	CMH72A.390-1B-1Y-0B	7771	91	85	0	TR
8	80	S948A1-Sta Elena[7]	CMH72,380-4Y-3B-0Y	7729	89	90	TR	40MR-MS
9	77	Jup 73		7604	88	100	0	TR
10	93	H285.70-Tob66	H411.71A-1B-4Y-1B-0Y	7479	89	100	T5R	20-30MR-MS
11	78	Torim 73		7417	87	75	T5MS-MR	5-20MS-MR
12	79	SX		7271	93	95	TMS-MR	40-50MS-MR
13	97	Yec F70(B)		7250	88	75	10MR	60S-MS
14	91	H285.70-Tob66	H411.71A-1B-7Y-2B-0Y	7104	92	95	5-10R	10-20MR-R
15	85	S948A1-Sta Elena[5]	H567.71-8Y-3B-0Y	6854	93	60	0	5MR-R
16	96	H285.70-Tob66	H411.71A-1B-6Y-4B-0Y	6854	88	95	30-40R	40-50MS
17	92	H285.70-Tob66	H411.71A-1B-1Y-1B-0Y	6792	90	95	0	T5MR
18	94	H285.70-Tob66	H411.71A-1B-5Y-1B-0Y	6708	89	90	0	T10MR
19	95	H285.70-Tob66	H411.71A-1B-6Y-1B-0Y	6708	89	95	10MR-R	30MR-MS
20	99	Spre-S948A1xSpre/Lundi[4]	H494.71A-3B-3Y-1B-0Y	6667	86	70	TMS	10-20MR-MS
21	98	H285.70-Yec70	CMH72.420-2Y-1B-0Y	6479	-	70	0	10-20MR-MS
22	89	Tob66		6458	88	105	5-10R	10-20MS-MR
23	100	Arm"S"-H170.68A	H622.71-12Y-4B-5Y-1B-0Y	6396	82	100	0	40MS-S
24	90	Tor"S"-Tob66	H472.71-8Y-4B-1Y-2B-0Y	5875	88	65	0	10-20MS-MR
25	76	Sta Elena		5583	89	alto	0	30-40R-MR

CV=9.7

DMS 5% = 986.66 kg/ha

DMS 1% = 1309.00 kg/ha

TABLE 1.9.D Performance of dwarf wheats in Experiment V-DMB, grown at Cd. Obregon in the winter, 1974-75.

Yield Rank	1974-75	Variety or Cross	Pedigree	Yield kg/ha	Days to Flowering	Height cm	Stem Rust	Leaf Rust
1	120	Meng-II8156(R)	H223.64-1Y-6C-1Y-1C-4Y 3C-1Y-2B-300Y-0Y	7875	96	85	0	30R
2	112	Nad63xTth-Son64/Nad63[3]	H270.70A-3B-1Y-2B-3Y-2B-0Y	7625	96	65	TMS	TMR
3	121	SX		7625	91	100	10-20MS-MR	20-30R-MR
4	124	Cj71		7458	90	80	0	20MS
5	118	Saric F70-1B		7375	90	75	0	30-40MS
6	116	Topo"S"-Nar59	H485.71-4Y-6B-2Y-1B-0Y	7000	90	60	0	20MS-MR
7	113	Nad63xTth-Son64/Nad63[3]	H270.70A-3B-1Y-2B-0Y	6583	96	65	TMS	10MR-MS
8	117	Nar59 x Cno"S"-Gallo	CMH 73.939-6Y-0B	6500	83	95	5R	5MR-R
9	123	Jup 73		6417	84	100	TMR	10R/30S-MS
10	102	Chris-S948A1xChris[5]	CMH73.489-2Y-0B	6271	-	100	TMS	5-10MR-MS
11	110	Nad 63		6063	-	115	TMR-R	TMS
12	106	Chris-S948A1xChris[5]	CMH72A.309-5B-4Y-0B	6021	-	100	5MS-MR	10MR
13	115	Topo"S"-Nar59	H485.71-4Y-2B-3Y-1B-0Y	6021	87	60	0	40-50MS
14	122	Chris-S948A1xChris[4]/Sx[2]	CMH73.475-9Y-0B	6021	93	100	TMS	40-60MS-S
15	108	S948A1-Crim[4]	H474.71A-7B-1Y-1B-0Y	5979	90	90	TMR-MS	20R-MR
16	119	Tor"S"-Saric F70	H488.71A-4B-1Y-1B-0Y	5813	96	45	0	10-30MS-S
17	103	Chris-S948A1xChris[5]	CMH73.489-5Y-0B	5771	-	100	0	10MR
18	109	S948A1-Crim[4]	H474.71A-7B-1Y-1B-0Y	5750	92	80	0	T10MS
19	105	Chris-S948A1xChris[5]	CMH72A.309-5B-3Y-0B	5604	-	100	0	10-30MR-MS
20	111	Nad63xTth-Son64/Nad63[4]	H553.71-1Y-2B-1Y-1B-0Y	5604	95	60	0	5MR-MS
21	104	Chris-S948A1xChris[5]	CMH72A.309-1B-1Y-0B	5188	-	100	TR	10-20MS
22	125	CnoF67		5167	81	95	T5MS-MR	10MR-MS
23	114	Nar 59	Nar 59-100Y	4375	90	Alto	0	5-10MS-MR
24	107	Crim		4333	96	Alto	0	40-50MS-MR
25	101	Chris		3542	96	Alto	T5MS	20-40MS-MR

CV=5.9 DMS 5% = 509.66 kg/ha
1% = 676.16 kg/ha

TABLE 1.9.E Material entered in the bread wheat improvement program, 1974-75.

	Cross	Pedigree	Origin 1974-75
1	S948A1-Cno"S"^{2} x Cno67^{3}	H570.71-3Y-3B-0Y-2B-0Y	V-35
2	S948A1-Cno"S"^{2} x Cno67^{3}	H569.71-3Y-4B-2Y-1B-0Y	V-42
3	S948A1-Cno"S"^{2} x Cno67^{3}	H569.71-3Y-3B-0Y-1B-0Y	V-43
4	S948A1-Cno"S"^{2} x Cno67^{4}	H499-71A-7B-3Y-1B-0Y	V-41
5	S948A1-Cno"S"^{2} x Cno67^{5}	CMH72.381-10Y-1B-0Y	V-45
6	S948A1-Cno"S"^{2} x Cno67^{6}	CMH72A.429-11B-3Y-0B	V-50
7	Tac x Tth-Son64/SP^{5}	H550.71-14Y-6B-0Y-3B-0Y	V-63
8	Tac x Tth-Son64/SP^{5}	H550.71- 4Y-2B-1Y-2B-0Y	V-64
9	Tac x Tth-Son64/SP^{5}	H550.71-14Y-7B-1Y-1B-0Y	V-66
10	Tac x Tth-Son64/SP^{5}	H550.71-14Y-7B-0Y	V-68
11	(ChrxTth-Son64/Chr) Inia66^{3}	H283.70-3Y-2B-1Y-4B-1Y-2B-0Y	V-58
12	(ChrxTth-Son64/Chr) Inia66^{3}	H283.70-3Y-2B-1Y-4B-4Y-2B-0Y	V-59
13	(ChrxTth-Son64/Chr) Inia66^{3}	H283.70-3Y-2B-1Y-4B-5Y-1B-0Y	V-60
14	S948A1-Sta Elena^{5}	H567.71-2Y-2B-2Y-1B-0Y	V-83
15	S948A1-Sta Elena^{5}	H567.71-6Y-1B-1Y-1B-0Y	V-84
16	S948A1-Sta Elena^{5}	H567.71-6Y-1B-0Y	V-86
17	S948A1-Sta Elena^{6}	H498.71A-17B-2Y-1B-0Y	V-82
18	S948A1-Sta Elena^{7}	CMH72.380-4Y-3B-0Y	V-80
19	S948A1-Sta Elena^{7}	CMH72.380-12Y-1B-0Y	V-81
20	S948A1-Sta Elena^{7}	CMH72A.390-1B-1Y-0B	V-87
21	S948A1-Sta Elena^{7}	CMH72A.390-2B-1Y-0B	V-88
22	H285.70-Tob66	H411.71A-1B-4Y-1B-0Y	V-93
23	Nad63xTth-Son64/Nad63^{3}	H270.70A-3B-1Y-2B-3Y-2B-0Y	V-112
24	Chr-S948A1 x Chr^{5}	CMH73.489-2Y-0B	V-102
25	Chr-S948A1 x Chr^{5}	CMH73.489-5Y-0B	V-103
26	Chr-S948A1 x Chr^{5}	CMH72A.309-5B-4Y-0B	V-106
27	Topo"S"-Nar 59	H485.71-4Y-6B-2Y-1B-0Y	V-116
28	Nar59 x Cno"S"-Gallo	CMH73.939-6Y-0B	V-117
29	S948A1-Crim^{4}	H474.71A-6B-1Y-1B-0Y	V-108
30	S948A1-Crim^{4}	H474.71A-7B-1Y-1B-0Y	V-109

Ing. M. Galvez, Lic. C. Limon and Dr. M.M. Kohli appraise the good growth of triticale in Tlaxcala, Mexico.

TABLE 1.9.F Yield and some yield components of branch headed wheats tested at Cd. Obregon during the winter cycles 1973-74 and 1974-75.

	Variety or Cross		Pedigree	Yield kg/ha		E/m^2		e/E		G/E		G/e		G/m^2		Weight of 1000 grains (g)		Volume of 1000 grains (cc)		Hectolitre Weight (kg)	
				73-74	74-75	73-74	74-75	73-74	74-75	73-74	74-75	73-74	74-75	73-74	74-75	73-74	74-75	73-74	74-75	73-74	74-75
1	Stork "S"		CM-470-1M-2Y-0M		8542		357		18.7		43.0		2.29		15355		62.5		76.0		83.8
2	Cocorit 71			6700	8271	332	324	18.6	21.2	44.2	47.8	1.62	2.24	14685	15494	55.0	55.9	70.0	69.0	81.2	82.9
3	H251.68A-Cr"S"x Rad2"S"-Rad3"S"	Rad	H391.71A-9B-4Y-2B-2Y-0B		7938		269		26.4		52.8		1.99		14217		55.4		68.0		83.6
4	M.Reo-II8156 (R)[4]	Rah	CMH72A-127-3B-3Y-0B		7771		442		20.9		46.3		2.21		20500		37.7		46.0		85.4
5	Rad3"S"-H251.69A	Rad	H193.70-4Y-1B-1Y-7B-2Y-1B-0Y		7729		258		40.7		58.0		1.42		14982		56.2		71.0		77.4
6	Super X			6296	7646	355	351	17.5	19.1	50.2	52.9	2.45	2.76	17856	18592	39.0	44.8	52.5	55.0	80.4	83.9
7	Rad3"S"-H251.69A	Rad	H193.70-4Y-1B-1Y-2B-1Y-1B-0Y		7542		278		42.5		58.8		1.38		16366		57.8		74.0		78.3
8	Rad3"S"-H251.69A	Rad	H193.70-5Y-4B-1Y-0B	5533	7354	283	301	34.9	33.4	56.9	62.2	2.00	1.86	16122	18746	42.7	46.1	60.0	58.0	76.3	79.0
9	Rad3"S"-H251.69A	Rad	H193.70-4Y-2B-1Y-0B	5521	7208	265	286	40.6	52.8	49.7	62.4	2.06	1.18	13179	17852	50.5	46.6	67.5	61.0	79.2	79.0
10	Rad3"S"-H251.69A	Rad	H193.70-5Y-4B-3Y-3B-1Y-1B-0Y		7000		321		31.3		47.7		1.53		15321		47.9		61.0		80.3
11	Cajeme 71			6596	6979	370	392	17.9	19.7	39.7	41.1	2.37	2.08	14689	16123	48.2	50.0	62.5	62.0	81.6	82.7
12	M.Reo-No66[2]	Rah	H155.70-2Y-5B-7Y-0B	6013	6646	373	405	21.9	22.8	48.7	48.2	2.55	2.11	18165	19545	37.0	37.3	50.0	48.0	79.6	80.7
13	H251.69A-Cr"S"x Rad2"S"-Rad3"S"	Rad	H391.71A-9B-4Y-2B-3Y-0B		6625		253		25.6		56.0		2.18		14168		55.1		68.0		81.2
14	M.Reo-No66[2]	Rah	H155.70-2Y-5B-4Y-0B	6158	6521	350	346	20.3	23.1	48.2	49.1	1.22	2.12	16893	17006	39.2	39.2	53.0	50.0	79.5	80.4
15	M.Reo-No66[2]	Rah	H155.70-2Y-7B-2Y-0B	6092	6396	372	383	18.8	23.7	46.1	46.0	1.63	1.93	17174	17626	37.2	37.5	50.0	47.0	80.9	82.2
16	Noroeste 66			6033	6354	313	355	17.4	19.0	40.9	41.2	2.37	2.16	12802	14626	47.7	46.2	59.2	56.0	81.4	82.9
	D.M.S. 5 %			581	881																
	D.M.S. 1 %			772	1169																

Abbreviations: E = Spikes e = Spikelets G = Grains Rad = Ramified durum wheats Rah = Ramified bread wheats

TABLE 1.9.G Lines selected at El Batan, summer 1975, which combined both high quality and improved agronomic types, compared with the variety Ciano 67.

Row No.	Line	Pedigree	% Protein	DBC Protein	Index of Quality	Days to Flowering	Height cm
E-294	Ron#2-Fnd^2	CMH74.879-1Y-1B	15.6			70	80
E-295	Ron#2-Fnd^2	CMH74.879-1Y-2B	16.3			70	80
E-296	Ron#2-Fnd^2	CMH74.879-1Y-3B	16.0			70	80
E-297	Ron#2-Fnd^2	CMH74.879-1Y-4B	15.4			70	80
E-512	Fnd-CnoF67^2	CMH73A.630-3B-1Y-1B	15.7			69	75
E-615	BB#7-NapHal/MahrattaxCno"S"-Gllo	CMH73A.497-4B-1Y-1B	15.6	39	4.1	62	65
E-616	BB#7-NapHal/MahrattaxCno"S"-Gllo	CMH73A.497-4B-2Y-1B	15.9			69	70
E-617	BB#7-NapHal/MahrattaxCno"S"-Gllo	CMH73A.497-5B-1Y-1B	16.0			62	70
E-618	BB#7-NapHal/MahrattaxCno"S"-Gllo	CMH73A.497-5B-1Y-2B	15.6			62	70
E-621	BB#7-NapHal/MahrattaxCno"S"-Gllo	CMH73A.497-5B-3Y-1B	17.6	35	3.9	66	65
E-622	BB#7-NapHal/MahrattaxCno"S"-Gllo	CMH73A.497-5B-3Y-2B	18.6			66	65
E-623	BB#7-NapHal/MahrattaxCno"S"-Gllo	CMH73A.497-5B-3Y-3B	17.5			66	65
E-636	Cal-NapHalxCal"S"	CMH73A.498-22B-2Y-1B	17.2			62	70
E-637	Cal-NapHalxCal"S"	CMH73A.498-22B-2Y-2B	15.6	37	3.9	62	70
E-638	Cal-NapHalxCal"S"	CMH73A.498-22B-2Y-3B	16.4			62	70
E-643	Cal-NapHalxRon#2-NapHal^2	CMH73A.502-4B-1Y-1B	18.1	35	4.0	64	80
E-644	Cal-NapHalxRon#2-NapHal^2	CMH73A.502-4B-1Y-2B	17.6	35	4.3	64	80
E-645	Cal-NapHalxRon#2-NapHal^2	CMH73A.502-4B-4Y-1B	18.6			66	65
E-709	H546.71-Samaca	CMH73.562-7Y-2B-1Y-1B	15.4			65	65
E-710	H546.71-Samaca	CMH73.562-7Y-4B-1Y-1B	15.6			66	70
E-711	H546.71-Samaca	CMH73.562-7Y-4B-1Y-2B	15.5			66	70
E-712	H546.71-Samaca	CMH73.562-7Y-3B-1Y-1B	16.2			64	65
E-714	H546.71-Samaca	CMH73.562-7Y-3B-1Y-3B	15.7	40	4.1	64	65
E-752	K.GovxCno"S"-Gllo	CMH73.993-2Y-1B-1Y-1B	15.8			70	75
E-753	K.GovxCno"S"-Gllo	CMH73.993-2Y-1B-3Y-1B	15.7			70	75
E-754	K.GovxCno"S"-Gllo	CMH73.993-2Y-7B-1Y-1B	16.1			66	65
E-756	K.GovxCno"S"-Gllo	CMH73.993-2Y-7B-5Y-1B	15.3			68	70
E-773	CnoF67-NapHal	CMH72A.484-2B-11Y-4B-2Y-1B	17.2			68	65
E-774	CnoF67-NapHal	CMH72A.484-2B-11Y-4B-2Y-2B	17.3			68	65
E-775	CnoF67-NapHal	CMH72A.484-2B-11Y-4B-2Y-3B	16.9			68	65
E-776	CnoF67-Naphal	CMH72A.484-6B-11Y-5B-2Y-1B	16.8	36	3.8	66	80
E-777	CnoF67-NapHal	CMH72A.484-6B-11Y-5B-2Y-2B	17.6			66	80
E-781	CnoF67-NapHal	CMH72A.484-11B-1Y-4B-6Y-1B	15.4	38	3.8	66	60
E-782	CnoF67-NapHal	CMH72A.484-11B-1Y-4B-6Y-2B	15.4	40	4.0	66	60
	Cno F67		14.8	37	3.6	64	75

DBC = Dye Binding Capacity.

1.10 International Nurseries

In 1975, cooperating scientists planted 1228 trials of wheat, triticale and barley according to the distribution shown in table 1.10.A. All told, this program involved 27 different nurseries in 90 countries which are listed in table 1.10.B.

The CIMMYT International Nurseries Program is designed to disseminate germ plasm and to identify high yielding, disease and insect resistant varieties which possess broad adaptability. It also serves as a channel for the exchange of germ plasm for other national programs.

TABLE 1.10.A Number of entries per nursery and distribution of each nursery, 1975.

Nursery	Entries per nursery	North America	Latin America	Europe	Africa	Middle East	East Asia and Oceania
		Bread Wheat					
Crossing block	239	3	6	1	3	5	11
F_2 irrigated	482	1	10	2	6	8	17
F_2 dryland	480	4	16	3	9	3	13
F_2 spring x winter	394	7	16	7	10	7	21
Int. Bread Wheat Screening	386	8	36	15	37	16	36
Int. Spring Wheat Yield	50	14	20	18	22	11	22
Multiline	215	1	2	4	7	4	9
Int. Septoria Observation	213	7	12	5	8	2	3
F_1	756	1	0	-	-	1	1
		Durum					
Crossing block	128	1	3	1	1	6	4
F_2 irrigated	89	2	10	9	8	11	4
F_2 dryland	76	2	4	6	7	15	3
Int. Durum Screening	289	2	12	12	16	12	11
Int. Durum Yield	25	7	12	15	13	5	7
Elite Durum Yield	25	1	5	4	7	6	3
F_1	-	1	-	-	2	2	1
		Triticale					
Crossing block	264	2	2	-	2	1	3
F_2 irrigated	204	6	9	6	5	3	12
F_2 dryland	425	8	8	9	6	2	12
F_2 spring x winter	82	9	6	12	3	1	10
Int. Triticale Screening	300	4	31	21	24	10	22
Int. Triticale Yield	25	11	12	15	18	6	19
Triticale Disease Resistance	102	1	3	1	2	-	1
		Barley					
Crossing block	361	1	5	7	5	6	5
F_2	202	1	8	5	5	3	6
Int. Barley Observation	250	-	11	5	9	8	8
Exp. Barley Yield	25	1	6	2	7	5	7
Total		106	265	185	242	159	271

TABLE 1.10.B Bread wheat, durum, triticale, and barley nurseries distributed by the International Nurseries Program, 1975.

Country	Bread Wheat	Durum	Triti-cale	Barley	Country	Bread Wheat	Durum	Triti-cale	Barley
North America	46	16	41	3	Chad	2	1	–	–
Canada	12	3	16	2	Egypt	10	4	2	3
USA	34	13	25	1	Ethiopia	10	8	11	1
Latin America	118	46	71	30	Ghana	2	–	1	–
Argentina	22	23	13	3	Kenya	5	9	6	2
Bolivia	4	–	13	3	Lesotho	1	–	1	–
Brazil	24	4	13	1	Malagasy	1	–	–	–
Chile	10	5	9	4	Malawi	2	–	–	–
Colombia	2	–	2	–	Mali	1	1	–	–
Costa Rica	1	–	1	–	Morocco	1	1	1	1
Cuba	1	–	1	–	Nigeria	5	3	2	2
Ecuador	6	2	4	4	Rhodesia	4	1	5	1
Guatemala	7	–	3	1	Senegal	2	–	2	–
Guyana	1	–	–	–	Somalia	4	2	2	2
Honduras	2	–	1	–	South Africa	14	3	5	4
Mexico	16	9	8	9	Sudan	6	–	3	–
Nicaragua	3	–	3	–	Tanzania	4	–	2	–
Paraguay	5	–	2	1	Tunisia	8	7	2	4
Peru	9	3	7	3	Uganda	1	–	–	–
Uruguay	3	–	1	–	Zaire	2	–	1	–
Venezuela	2	–	1	–	Zambia	2	–	2	–
Europe	55	47	64	19	Middle East	57	57	23	22
Albania	–	3	1	–	Cyprus	5	4	1	1
Austria	1	3	–	–	Iran	8	–	3	2
Bulgaria	1	–	2	–	Iraq	8	7	1	3
Czechoslovakia	1	–	1	–	Israel	5	3	2	–
Denmark	–	–	–	4	Jordan	4	8	4	3
England	5	1	3	2	Lebanon	9	9	6	4
Finland	1	–	1	–	Libya	2	4	1	1
France	3	11	7	–	Saudi Arabia	1	2	–	1
W. Germany	3	1	1	2	Syria	4	6	3	2
Greece	2	2	2	–	Turkey	9	10	2	3
Hungary	3	–	5	2	N. Yemen	1	2	–	1
Ireland	1	–	1	–	S. Yemen	1	2	–	1
Italy	1	9	–	–	East Asia and Oceania	133	33	79	26
Malta	1	1	–	–	Afghanistan	7	1	2	1
Netherlands	4	1	3	1	Bangladesh	6	–	4	3
Norway	–	–	1	–	China	19	2	5	2
Poland	4	5	5	–	India	41	17	35	6
Portugal	1	–	2	–	Indonesia	1	–	–	–
Rumania	5	1	4	–	Japan	3	–	1	1
Russia	5	4	5	–	S. Korea	6	–	3	4
Spain	5	2	9	6	Nepal	8	–	4	1
Sweden	–	–	6	–	Pakistan	27	9	19	7
Switzerland	1	–	3	–	Thailand	1	1	1	–
Yugoslavia	7	3	3	2	Australia	12	1	5	1
Africa	102	54	60	26	New Zealand	2	2	–	–
Algeria	12	13	10	5	Total	511	253	339	126
Cameroon	3	1	2	1					

1.11 Training

1.11.1 IN-SERVICE TRAINING

Forty-six young men and women underwent CIMMYT regular in-service training in 1975. They participated in the four regular courses, viz., breeding, agronomy, cereal technology and pathology. Trainee participation over the past six years is outlined in table 1.11.A

The number of trainees who have received wheat in-service training at CIMMYT since the inception of the program in 1960,are listed by country in table 1.11.B. Trainees in 1975 were supported by over nine different sponsors as shown in table 1.11.C.

1.11.2 TRAINING OF MEXICAN NATIONALS

For the first time a young scientist from the Mexican Extension Service joined the formal in-service training program. This does not truly reflect CIMMYT's contribution to our host country, since most of the training in Mexico does not appear on the training program charts. Over many years, CIMMYT has employed young Mexican scientists for two years after graduation as research assistants. They work in the programs and most of them go on to further studies for a Master of Science degree. After graduation a few have returned to work with CIMMYT, some have continued on to Ph.D. level, but many have returned to work in the Mexican Research Service (INIA), or with private companies. Several of CIMMYT's senior Mexican staff first entered as new graduates. The program has assisted Mexico with some of its training needs.

In the case of the trainee from the Mexican Extension Service, this arrangement works very well with our new production training which is being conducted in the El Batan area. Now CIMMYT training and Mexico's extension service are complementary, with each assisting the other.

1.11.3 WHEAT PRODUCTION TRAINING SITE CHANGE-OVER

The wheat production training site was changed from CIANO in Northern Mexico to the El Batan headquarters of CIMMYT, with training being given in the environment of the Central Plateau. This move was taken to improve the production training program in the following ways:

1. To conduct the applied research in a rainfed environment.

2. To conduct the training in an area with a similar level of technology to that existing in most of the trainees' countries.

3. To complete all crop operations in a time sequence that would allow trainees from most northern hemisphere wheat growing zones, to return to their countries before fall sowing time. This seems particularly important in order to ensure that the trainee will not lose a growing season in his own country. Under this arrangement he will begin his season directly after his return from CIMMYT, when he will be freshly motivated to move directly into his national program.

4. To utilize fully the physical facilities at El Batan in the training program. Some activities can be combined with the maize production program at El Batan, to give a somewhat broader experience.

The one drawback (which was foreseen) is the limited experience received by the trainee in irrigated agriculture which exists in some of their home countries. In an attempt to overcome this, a short period has been scheduled at the onset of the program in Cd. Obregon. Other trips are conducted to irrigated areas of the Central Plateau.

1.11.4 PRODUCTION TRAINING STRATEGY

The overall objectives have not changed from those stated in previous reports. However, because of the change in training site, certain objectives will receive greater stress. Learning by doing will meet a harder challenge as trainees participate in the development of the parts of the package of practices for wheat, triticale and barley under the very variable growing conditions of Mexico's Central Plateau.

They will carry out the demonstrations in collaboration with the Mexican Extension Service and with assistance from CIMMYT's agronomy program. As in the past, some basic

courses will be given but the greater part of the trainees' time will be spent at farm sites, putting together the parts of the basic agronomic practices that will increase farm incomes and crop yields.

1.11.5 THE TRAINEE AND AGRONOMIC DECISION MAKING

Production trainees began their work by identifying the limiting factors for small grain production in the areas near El Batan. They then designed and managed a complete set of applied research trials at six locations in farm fields with sufficient scope on which to base the development of a package of practices and to make recommendations. In addition each trainee had an agronomic trial at El Batan, (tables 1.11.D and 1.11.E).

Strategies and recommendations based on the farm results will be elaborated and refined in the next season. The on-farm variety trials provide an example of the decision-making process by the trainees, (table 1.11.F). The trainees made the folowing observations:-

1. Both wheat and triticale had some advantages over the traditional crop barley.

2. The best yielding triticale variety (Bacum) was not the one released by the National Mexican Seed Certification Agency viz., PRONASE.

3. From the results at Santorum (table 1.11.F), it appears that triticale possesses a yield/economic advantage (3885 kg/ha) over barley (2520 kg/ha).

One trainee, Julio Peña, using data from Santorum, attempted to answer the economic questions by using an analytical procedure from the new economics training manual, viz., "From Agronomic Data to Farmer Recommendations", which was prepared by the Economics Department at CIMMYT. He concluded that both wheat and triticale were competitive with barley on the basis of the one year's results. However, other agro/climatic relationships exist and the trainee identified rainfall distribution and days from flowering to maturity, as probable complicating factors. This viewpoint was based on frost injury to some of the triticales because of their late maturity.

A clarification of this year's conclusions will be a part of the 1976 trainee trials. Specifically, more varietal testing in more agro-climatic zones with associated economic studies are planned. This will be done in two steps:

(1) Twenty-five to 30 triticale lines will be screened to identify those having a short vegetative cycle (60-65 days to flowering), and a short ripening period. The triticales will be tested at two locations. (2) This will be followed by including the best yielding varieties and lines in the 1977 trials.

This kind of decision-making on the part of the trainee provides a learning opportunity evolving from the trainee participation in on-farm applied research.

1.11.6 TRAINING THE FUTURE TRAINERS

This concept is receiving its first real test in wheat production training. In 1976, Ecuador will organize and carry forward a production course using the three men who undertook the trainee course in 1975, at CIMMYT-Mexico. Together with part-time help from CIMMYT, these three trainers, will use a model similar to CIMMYT's production course to train extension and research personnel for the Andean wheat growing region of Ecuador.

1.11.7 NATIONAL TRAINING PLANS

CIMMYT is still encouraging National Programs to formalize their own research, training goals and objectives in order to help them identify their priorities, develop staff and training plans and to clarify the role of the national training and academic institutions in providing the required people. This will allow a clearer identification of their needs.

A national training plan in developing countries is essential before men are sent to CIMMYT for training as "trainers". Without such a plan, the training is fruitless.

In this regard, although it is not CIMMYT's direct responsibility, a national training plan for advanced degrees to man the national institutions, is also needed in most countries. Efforts should be made by the countries to draw up such a plan and to provide budgeted financing to put it into effect.

1.11.8 WHEAT TEAM FIELD NOTES

Issues of Wheat Team Field notes were distributed to about 600 cooperators to maintain contact and to exchange research information with past trainees.

TABLE 1.11.A Wheat trainees in specialized courses 1970-75.

Course	1970	1971	1972	1973	1974	1975	Total
Breeding	30	22	18	23	20	16	129
Production	6	7	10	14	17	22	76
Cereal Technology	4	1	2	4	2	5	18
Pathology	-	2	5	6	3	3	19
Seed Production	-	-	3	-	-	-	3
Total	40	32	38	47	42	46	245

TABLE 1.11.B Wheat in-service trainees 1960-75 by countries and regions.

Region and country	1975	1960-75
North Africa and Near East	13	181
Afghanistan		18
Algeria	5	32
Cyprus		2
Egypt	1	9
Iran	1	12
Iraq		7
Jordan	1	6
Lebanon	1	5
Libya		7
Morocco		17
Saudi Arabia	1	2
Syria		5
Tunisia	1	21
Turkey	2	35
Yemen		3
Tropical Africa	10	33
Ethiopia	1	8
Kenya	2	5
Madagascar		1
Nigeria	7	11
Somalia		1
Sudan		4
Tanzania		3
South and East Asia	8	61
Bangladesh	3	11
India	2	6
Korea		5
Nepal	2	5
Pakistan	1	33
Philippines		1
Latin America	11	74
Argentina		18
Bolivia		2
Brazil		15
Chile	4	9
Colombia		3
Dom.Rep.	1	1
Ecuador	4	11
Guatemala		4
Mexico	1	1
Paraguay		2
Peru	1	6
Uruguay		2
Other	3	15
France	1	1
Hungary		1
Poland		2
Portugal		1
Rumania		2
Spain		2
USSR		3
USA	2	3
Totals	46	364

TABLE 1.11.C The origin of financial support for wheat trainees, 1975.

Trainees by Sponsor	Months
Ford Foundation	45.1 months
US AID	25.1
Rockefeller Foundation	14.5
BID	30.7
IITA Nigeria	34.8
IDRC	17.3
CIMMYT core	27.3
Government of Mexico	0
Saudi Arabia	5.6
Iran	8.3
Self or Commercially sponsored	
USA	2.3
France	6.9
Peru	3.0
Total	220.9 months 1975

TABLE 1.11.D Summary of trainees and their agronomic experiment reports 1975.

Shettima Abba, Nigeria - Crop and Nitrogen Responses in Farmer Fields.

Ali Imam, Bangladesh - Effects of Nitrogen, Phosphorus, Potassium and Micronutrients on Yield of Apizaco Barley.

Abdullahi Jahun, Nigeria - The Effects of Herbicide on Different Weeds in Triticales.

Abdullahi Maikano, Nigeria - Effect of Row Spacing and Seeding Density on Yield of Triticale and Bread Wheat.

Julio Ivan Peña Peña, Dominican Republic - Effects of Seeding Depth on Growth of Triticales.

Yusufu Sandamu, Nigeria - Variety Tests in Farmer Fields + Barley Variety Response to Nitrogen Rates and Time of Application.

Esref Yucelygit, Turkey - Effect of Date of Planting on the Yield of Triticale, Wheat and Barley.

TABLE 1.11.E The number, type and location of statistically and economically interpreted trials conducted by each trainee.

	Number of Trials	Type
Ali Imam, Bangladesh	1	Variety Trial *
	1	Fertilizer Trial +
Esref Yucelygit, Turkey	1	Date of Seeding *
	2	Herbicide +
Shettima Abba, Nigeria	1	Fertilizer x Crop *
	1	Fertilizer x Crop +
Abdullahi Jahun, Nigeria	2	Herbicide +
	1	Variety Trial +
Abdullahi Maikano, Nigeria	1	Density Trial *
	1	Variety Trial +
Yusufu Sandamu, Nigeria	1	Fertilizer x Application x Crop*
	1	Variety Trial +
Julio Ivan Peña Peña, Dominican Republic	1	Depth Seeding *
	1	Fertilizer Trial +

* = Off Station - Applied Research

+ = On Station - Applied Research

TABLE 1.11.F The results of on-farm variety grain yield (kg/ha) demonstration trials at four locations in the Central Plateau of Mexico, 1975.

Leader		Yusufu Sandamu		Ali Imam		Abdullahi Jahun		Abdullahi Maikano		Average
Location		San Vicente		San Pablo		Santorum		Tizayuca		
Experiment No.	Crop	919	DMR .05	915	DMR .05	910	DMR .05	920	DMR .05	Overall
A. Navojoa	Tcl	2680	bc	1940		4030		1620	F	2570
B. Beagle	Tcl	2470	bc	2010		3120		1930	C	2630
C. Rahum	Tcl	3360	ab	2190		4010		1620	F	2790
D. Yoreme	Tcl	3690	ab	1340		4430		2090	B	2890
E. Bacum	Tcl	3530	ab	2490		3980		1870	D	2970
F. Puebla	Bar	2490	c	2760		2270		1830	E	2090
G. Cleopatra	Wh	4220	a	2650		4070		2960	A	3480
H. PC - 91	Bar					2770				2770
I. Pavon	Wh					4060				4060
J. Moncho	Wh					3750				3750
K. TZPP-Pal-7c	Wh					3170				3170
CV %		16.84		2.471		26.3		9.4		
LSD .01		1152		NS						
.05		7610		NS						

N.B. The 5th off station of Quaula was not included because the trial was frosted, hence there was no harvest.

LEGEND

Bar = Barley
Tcl = Triticale
Wh = Wheat

DMR = Duncan's Multiple Range
NS = Not Significant
CV = Coefficient of Variation

1.12 Wheat Quality

The protein quality laboratory and the plant nutrition laboratory provide assistance in the evaluation of materials for the maize, wheat, barley, triticale and sorghum research programs.

1.12.1 PROTEIN QUALITY LABORATORY

1.12.1.1 Evaluation of Protein

In the evaluation of protein quality of wheat, barley and triticale, the DBC (dye binding capacity) procedure was followed. The micro Kjeldahl method was used to determine the protein content of the materials. All analysis are done on an individual plant basis.

The DBC was performed on constant weight samples of 200 mg. and micro Kjeldahl determinations were made on all samples above the DBC mean. The high DBC values obtained are due to a combination of high protein quantity and the presence of a high content of basic amino acids. The DBC value alone does not indicate whether one or both are responsible for the high level observed. Thus the protein content is obtained from the Kjeldahl determination, and the DBC is corrected to a constant protein level. The resulting DBC values which are still high, are selected for their presumed good protein quality (high basic amino acid content). Using the aforementioned procedure, 5320 barley samples from F_3 to F_7 generations, 3000 triticales and 1500 wheat samples were analyzed.

1.12.1.2 Nutrition Studies

CIMMYT has no facilities for conducting animal assays to evaluate the nutritional quality of grain of selected advanced materials under development. Instead, CIMMYT supplies samples of grain to established nutrition researchers in Guatemala, Mexico and Denmark for biological assays using the rat as the test animal.

Ten cereal samples were sent to INCAP, (the Institute of Nutrition for Central America and Panama), in Guatemala to be evaluated for nutritional quality. Diets were prepared at eight per cent protein levels using the cereal as the only source of protein. As check references, casein diets at 8 and 10 per cent protein levels were used. The test period took 28 days and each group included 8 animals - 4 males and 4 females. Results are shown in table 1.12.A.

Protein intake and weight gain were measured to calculate the Protein Efficiency Ratios (PER). The report received by CIMMYT shows data on PER and their standard errors, as well as individual responses, separately for males and females. The rats were sufficiently sensitive to detect differences within the group of maize samples, within the triticales and between them and the wheat check, Yecora. All triticales were superior to Yecora.

Sixteen triticale samples were sent to INIP, (the Instituto Nacional de Investigaciones Pecuarias), in Mexico. Rats were fed diets with triticale as the only protein source. In one set of trials, diets were not supplemented and in the other, lysine was added to a level which should provide the requirements for growing rats. The principal parameter was weight gain, but relative growth was calculated and the growth of the animals were considered with the best triticale (i.e. No. 12089), at 100 per cent. The results are shown in table 1.12.B. In the INIP report the following points are made:

(a) In both trials the differences in growth between triticale lines were not significant.

(b) When weight gain was correlated with the lysine content of the samples (unsupplemented trials), there was no significant difference between triticale lines.

(c) Similar results were obtained where animals were fed with triticale samples supplemented with lysine; however, the weight gain was superior when compared with the unsupplemented trials.

Dr. Shimada with his group is also interested in studies on insects as possible experimental animals for protein evaluation. They are conducting preliminary research on larvae of the confused flour beetle and have used the triticale line material, as the experimental base.

Dr. B. O. Eggum of Denmark who offered to collaborate with CIMMYT, evaluated seven maize and triticale samples. He provided data on TD (true digestibility), BV (biological value), and NPU (net protein utilization), which are presented in table 1.12.C. The TD of wheat and maize protein has been reported in the literature at about 90 per cent. The TD of cereal protein from CIMMYT is shown in the table, to be 90-94 per cent so that only about 6-10 per cent of the N passed non utilized through the animals. The most interesting value is the BV, because it reflects protein quality. Differences were shown for maize samples. The triticale samples tendered to be similar. NPU reflects the N retention by the animal. It is the product of TD and BV expressed in percentage. The high NPU values of about 70 for maize with improved quality, and 62 to 65 for triticale are a consequence of both high TD and high BV.

CIMMYT appreciates very much the work of the three mentioned laboratories and the responsible scientists - Dr. R. Bressani, Dr. A. S. Shimada and Dr. B. O. Eggum.

TABLE 1.12.A Evaluation of cereal grain samples for nutritional quality by INCAP, Guatemala.

INCAP No.	Sample	CIMMYT Lab.No.	Pedigree	Protein %	Lysine %	*INCAP (Guat.) PER	** INIP (Mexico) without add. Lysine	with Lysine
14593	Maize	14358	Composite White (H.E.)	9.7	3.9	2.22		
594	Maize	14360	Composite Yellow (H.E.)	9.6	3.8	2.14		
595	Maize	14359	Composite K	10.4	3.1	2.25		
596	Maize	14361	Veracruz 181...0_2,(H.E.)	9.4	4.0	2.41		
597	Maize	14357	Tuxpeño x La Posta 0_2	8.7	4.6	2.41		
598	Wheat	14352	Yecora Y/73-74	11.5	2.9	1.27		
599	Triticale	14353	Navojoa Y/73-74	12.2	3.7	1.71		
14000	Triticale	14354	Maya Arm.SS (12081)	10.8	4.0	2.00	95	96
601	Triticale	14355	Triticale (12084)	12.0	3.3	1.90	100	100
602	Triticale	14356	Triticale (12087)	13.4	3.3	1.75	80	88
			Triticale 12070	14.0	4.0		86	86
			Triticale 12077	10.2	3.2		80	97
			Triticale 12078	13.8	3.6		91	91
			Casein 8 %			2.86		
			Casein 10 %			2.81		

* INCAP diets were prepared at 8% protein level. Four male and four female rats per trial.
** INIP only, reported that it had compared the growth of animals with Triticale 12084, as 100%.
PER = Protein Efficiency Ratio.
INIP = Instituto Nacional de Investigaciones Pecuarias.
INCAP = Instituto de Nutricion de Centroamerica y Panama.

TABLE 1.12.B Protein evaluation with rats by Dr. Shimada, INIP, Mexico.

Sample	CIMMYT Lab.No.	Protein %	Lysine % in Protein	Relative* Growth %
Triticale	12068	13.6	3.7	90
Triticale	12071	14.4	2.9	85
Triticale	12072	11.6	3.6	91
Triticale	12073	14.7	3.4	79
Triticale	12075	13.6	3.4	96
Triticale	12082	11.7	3.5	76
Triticale	12083	12.9	3.3	82
Triticale	12085	13.1	3.7	77
Triticale	12089	13.9	3.2	100
Triticale	12096	13.2	3.5	84

* The parameters were weight gain and feed conversion, but only relative growth is reported. Growth of animals with triticale 12089 = 100%.

TABLE 1.12.C Protein evaluation with rats* by Dr. Eggum, Copenhagen.

Sample	CIMMYT Lab.No.	Pedigree	Protein %	Tryptophan %	Lysine %	Parameters** TD	BV	NPU
Maize	13493	CIMMYT Comp. (Normal)	10.2	.47	2.5	93.9-0.8	60.6-1.2	56.9-1.5
Maize	13488	White Comp.0_20_2(Opaque)	10.6	.87	4.0	93.2-0.6	75.6-0.2	70.4-0.3
Maize	13496	Thai 0_20_2 Comp.(Opaque)	9.9	1.02	4.4	92.4-1.2	77.5-1.3	71.6-1.5
Maize	13497	Thai 0_20_2 Comp.(Modif.)	9.6	.81	4.0	93.4-0.7	74.8-1.2	69.9-0.6
Triticale	12069		13.7		3.8	91.0-0.6	67.9-0.6	61.8-0.8
Triticale	12074		14.1		3.5	92.7-1.3	67.9-1.3	63.0-1.3
Triticale	12080		11.1		3.2	89.8-0.7	72.6-0.9	65.1-0.9

* Five animals per diet.
** TD = True Digestibility.
BV = Biological Value.
NPU = Net Protein Utilization.

1.13 Regional Winter Cereal Activities

1.13.1 INTRODUCTION

The Ford Foundation's Arid Lands Development (ALAD) Winter Cereals Program completed its crop year activities in the Bekaa Valley of Lebanon working jointly with the Lebanese National Wheat Program located at Tel Amara. Regional Nurseries were prepared for the 1975/76 crop season and dispatched from Beirut in September. Due to civil strife in Lebanon, staff members' families were shifted to Cairo, Egypt, for the period of instability. Because of the uncertainties in the Lebanese situation, plans were made to duplicate all possible nursery and germ plasm in Egypt. Arrangements were made with the Government of Egypt for land and assistance at Sakha Experiment Station. Sowings were completed at Sakha and, despite the difficulties in Lebanon, most of the germ plasm was also successfully planted at Tel Amara and Kfardane.

The ALAD Winter Cereals Program duties are under the direction of Dr. J. P. Srivastava, the Ford Foundation Wheat Breeder in cooperation with Dr. Y. Klaimi, Head of Plant Breeding, Agricultural Research Institute, Tel Amara, Lebanon.

The ALAD Program works jointly with the International Maize and Wheat Improvement Center's (CIMMYT) Regional activities. These activities are focused on the regional disease surveillance and monitoring efforts. This work has been integrated with the ALAD program efforts and CIMMYT's international program operations based out of Mexico. The CIMMYT regional activities have been under the direction of Dr. Eugene E. Saari, with assistance from Dr. J. M. Prescott, who is assigned to the Rockefeller/CIMMYT Wheat Improvement Program in Turkey.

In addition, ALAD's Winter Cereals Program has worked closely with the FAO Cereal Project based in Cairo, Egypt, and the Field Crops Division of the Arab Arid Zone and Dryland Research Center (ACSAD) based in Damascus, Syria. The FAO cereal improvement work has been under the guidance of Dr. Abdul Hafiz. Recently, FAO has engaged Dr. Y. Klaimi from Lebanon to work regionally in the winter cereals, and his operational base will be Baghdad, Iraq.

OBJECTIVES

The principal goal of the ALAD Program is to help national programs in the region to identify superior varieties and germ plasm through broad scale testing throughout the region.

The germ plasm involved represents wheat lines and varieties developed or selected by the national programs in the region, CIMMYT, or selections identified by the Regional staff. There is also a continuing effort to identify and develop special germ plasm and superior sources of disease resistance. This supports national program efforts as well as providing CIMMYT with a feed-back mechanism of information and materials for its activities in germ plasm development.

The specific objectives of regional work are:-

1. To identify varieties with wide adaptability, superior yield and disease resistance.
2. To identify factors which limit wheat production.
3. To identify germ plasm which will satisfy special production situations.
4. To continue to identify and broaden the disease resistance base.
5. To develop disease surveillance and monitoring which helps national programs to adequately assess epidemic disease potentials.
6. To act as a center for the exchange of material and information between national programs of the area.
7. To assist in the additional training needs of national programs.
8. To assist national programs in utilizing summer nursery facilities in Kenya.
9. To provide CIMMYT with outreach and backstopping activities.

1.13.2 SUMMARY OF REGIONAL ACTIVITIES

1.13.2.1 Wheat

The Regional Wheat Yield Trial (RWYT) data was received from 17 of the 33 locations by nursery preparation time. The top seven varieties in the regional yield nursery are given in table 1.13.A.

The top ranking variety was 7C-OnxInia-B.Man which was also a top yielder in the 1973/74 regional wheat yield trial. The Agricultural Research Institute in Lebanon has named this line Haramoun. In addition, the Institute named the line (Kt54-N10B-21-10) Kt54B-Nai 54 x Drc)8156 x Pj62 as Sannine which did well in Lebanon. Sal-Seaf-P106-19 was named Baalbeck which has done well in the Rainfed Wheat Yield Trial. The variety Baalbeck was released for the rainfed conditions in Lebanon.

The stem rust resistance of the top five varieties appears to be at adequate levels, and leaf rust resistance is superior to Mexipak. The calculation of an average Coefficient of Infection (ACI) above 10.0 should not be considered a safe level or a level which can control rust infection for any extended period of time. With the exception of $LR64^2$-Son64 x CC/Ska, all of the top varieties should be carefully evaluated in areas where yellow rust represents a high epidemic potential.

Arz ($My54_E$-LR x H490(LR64 x Tzpp-Y54)), identified through the regional trials as a high yielding amber grained variety with superior rust resistance as compared to Mexipak, is being multiplied in Pakistan, Saudi Arabia, Iraq, Egypt and Lebanon.

The highest yielding durum in the RWYT was Stork'S'. The Mexican national wheat program has recently released a Stork line, viz., Mexicali 75, for commercial production. It is a widely adaptable line and appears superior to Cocorit and Jori in yield, grain size, lustre and color.

The data from the Regional Barley and Rainfed Wheat Yield Trial are presently being analyzed by the FAO Cairo office.

The level of rust resistance of most of the lines selected was superior with some exceptions. The lines with a high ACI should be carefully evaluated in those areas where the individual rusts are a problem.

The most promising lines from the Preliminary Observation Nursery with seventeen stations reporting, are listed in table 1.13.B. The increasing concern regarding the lower rainfed wheat areas led to the initiation of the Regional Rainfed Wheat Yield Trial in 1972/73. In the past the Preliminary Observation Nursery (PON) has contained a section which was designated as rainfed types. However, experience indicated that this group was never singled out and as a result it was usually sown in the irrigated plots. In order to increase the rainfed selection possibilities, it was decided that a separate rainfed PON was justified. This nursery was organized for the first time in 1975/76. In the 1974/75 PON section for rainfed observations, information was received from 16 locations. In table 1.13.C the selections noted as outstanding or equal to Mexipak by cooperators, has been summarized.

In general the rust infection levels in the rainfed are lower than under irrigated conditions, reflecting the environmental effect on rust development. The notable exception is the much higher level of stem rust on Mexipak in the rainfed section. It appears that the rainfed section was sown at geographically different locations from the irrigated section, and stem rust was an important factor at some of the locations.

Results from the durum PON indicate a number of lines considered as equal to or better than Jori 69 and Cocorit in appearance. However the check variety Haurani 27 was noted by only a few cooperators as being equal to these varieties. As a check variety repeated throughout the nursery it was noted 5 to 6 times except when its position occurred in row one, where it was noted 10 times as promising. This no doubt is a reflection of the border effect on the first row of the nursery. The top durum selections are noted in table 1.13.D.

The rust reactions were extremely variable, and judgements regarding their relative resistance or susceptibility should be made with caution. The general mean average rust infection of the best breadwheat varieties continues to remain low, indicating that the overall resistance base of the durum wheats needs further improvement, especially with stem rust.

Quality has not been analyzed except for grain size and color. Hopefully this additional information can be incorporated in the future.

1.13.2.2 Barley

In the Barley PON, Beecher is used as a check. This variety has been doing well throughout most of the Region and has been one of the top yielders in the Regional Barley Yield Trial over the past two years. Only two varieties - Iris and Aramir were noted by cooperators more often than Beecher as outstanding lines.

The best PON barley lines in appearance are given in table 1.13.E. The rust data have not been provided because all varieties are relatively susceptible. Stem rust values are low and the basic reason for this is the early maturity and therefore escape from infection.

1.13.2.3 Summer Nursery

This year the Kenya summer nursery was in operation for those cooperators wishing either to advance segregating lines or to obtain information on resistance to rust. This year segregating material was received from Algeria, Cyprus, Lebanon, Pakistan and Tunisia. Advanced lines for information on rust resistance were received from Algeria, Egypt, Jordan, Lebanon and Tunisia. In addition, many regional selections were included in the summer nursery. Seed from the segregating populations was harvested and returned to the cooperators in time for all fall sowing. For those only wishing data, results were returned on the rust development observed at Njoro. Lebanon barley germ plasm comprising 2,200 lines was screened for disease resistance at Njoro and Molo. This collection was also screened by Dr. R. W. Stubbs against virulent races of stripe rust under glasshouse conditions. Seeds of resistant lines can be supplied upon request.

1.13.2.4 Multilines

The identification of the 8156 multiline components with resistance to the three rusts continued and a number of the components were identified. A list of the best lines from the standpoint of resistance was circulated to cooperators. There still needs to be a careful evaluation of the agronomic characters locally, in order to determine which component would be suitable for blending into a composite.

Last year's yield trials with the 8156 multiline components identified from the 1973/74 multilines supplied by CIMMYT were disappointing. The composite blends did not yield well compared to the check variety Mexipak. A few of the individual components did well as straight line varieties. It seems that until enough individual high yielding components are identified, the constitution of a high yielding composite blend will not be possible. Until this happens, the multiline composite variety will not compete with the straight line variety.

1.13.2.5 Triticale

A few triticale lines selected from CIMMYT nurseries were included in the 1974-75 regional nurseries. Plant growth of triticale lines was impressive at most of the locations and disease resistance was superior to wheat lines. However, all the lines suffered from poor grain development. In the 1975/76 Rainfed PON section, about 50 triticale lines have been included for wider testing in the region.

1.13.2.6 Regional Nurseries.

From the disease screening work done through the Regional Disease and Insect Screening Nursery (RDISN) the best sources of resistance to the various diseases are circulated into the Regional Crossing Block. The data concerning each entry is provided in the Crossing Block book to help cooperators. Those varieties identified as promising in agronomic type and possessing adequate levels of resistance, are promoted from the RDISN to the PON and from the PON to the RWYT. In this way a continual flow of the superior wheats for both yield and disease resistance can be maintained.

1.13.2.7 General

The surveillance program which monitors changes in the cereal rusts which may affect commercial production operates through the use of the Regional Disease Trap Nursery system. The data have been under review and will be analyzed in depth by Dr. Prescott in Ankara, Turkey. In addition to the field response data which are the principal responsibility of the CIMMYT pathologists in the region, the glasshouse analysis of the rust cultures for virulence spectrums are carried out by cooperators. The yellow rust analysis is done by Dr. R. W. Stubbs, the Netherlands; stem rust by Dr. A. H. Kamel, Egypt; and leaf rust by Dr. M. Boskovic, Yugoslavia. The identification of virulence spectrums should help us understand more precisely the magnitude and potentials which confront us in our efforts to develop wheat varieties possessing a longer and more useful resistance base.

The basic structure of the Regional Nurseries prepared for the 1975/76 wheat season remained the same. In some cases where national programs have a more limited interest, the PON and RCB are divided so that each country receives only the material that it specifically requests.

During the season Drs. E. E. Saari and J. P. Srivastava visited most of the national programs in the region, working closely with the local scientists.

A number of distinguished visitors spent time with the ALAD Program. This year, trainees from the following countries spent some time working in the fields at Tel Amara: 2 from Iran, 2 from Jordan, 2 from Syria, 2 from Cyprus, 2 from Egypt, 2 from Saudi Arabia and 1 from Kenya.

A number of conferences and workshops were attended during the year. The more important ones were the International Winter Wheat Conference, Zagreb; the International Barley Genetics Congress, Munich; the Mediterranean Phytopathological Congress, Zadar; the First Turkish Phytopathological Congress, Izmir; the First Bangladesh Wheat Workshop, Dacca and the Third Regional Wheat Workshop, Tunis.

TABLE 1.13.A The top seven ranking wheat varieties in the Regional Wheat Yield Trial, 1974-75.[1]

Rank	Variety/Cross	Av. Yield kg/ha	Freq[2]	Rust ACI[3] YR	LR	SR	Grain Color
1	7C-OnxInia-B. Man	4,728	9	17.8	10.3	8.6	A
2	Mexipak	4,619	4	21.3	43.0	5.9	A
3	Dougga 74=Kl. Pet. Raf x8156[2]	4,555	7	18.1	24.4	8.5	R ?
4	Tob-7C	4,545	4	14.9	12.3	0.8	R
5	LR64[2]-Son64xCC/Ska	4,495	5	6.2	8.3	2.6	R
6	Stork'S'	4,454	4	15.7	19.0	5.0	A
7	Sparrow	4,454	4	15.2	2.8	4.2	W

Based on seventeen stations reporting.

Freq = Frequency with which the variety was in the top 5 group out of 17 locations.

Rust ACI = Average coefficient of rust infection (values below 10 considered adequate resistance).

TABLE 1.13.B Lines from the Preliminary Observation Nursery most frequently rated as outstanding in appearance by cooperators, (Seventeen stations reporting).

PON No.	Variety / Cross	No. Locations noted	Rust A C I		
			YR	LR	SR
14	Bb(S64-An64xNad/Jar'S')	10	5.1	3.4	0
15	(21931/Ch53-AnxGb56)An64	10	5.0	15.1	14.8
29	Cno-7CxCC-Tob/Bb-Nor67	10	17.0	9.6	14.3
25	(We/Lib64-IniaxInia-Bb)7Cx Tob-Cno	9	3.9	22.1	1.6
27	Tob^2-7C	9	15.1	1.8	1.6
53	ChL-Inia'S'	9	3.9	13.6	15.0
98	S-227xFAO-215	9	38.3	12.8	9.6
5	G156(LR64A^{2}xTzpp-AnE)	8	38.0	10.8	4.3
16	(HK-38MAxRfn^2-908/fn)Yr70	8	15.0	3.8	6.6
26	Cno-7CxCno-Inia/Kal	8	15.7	1.3	2.9
28	Tob-8156xCC-Inia'S'/Bb-7C	8	6.1	0.8	2.6
35	AdeG/FrxFn-YxCofndw-Nar59	8	15.4	32.7	6.3
48	Cno-Son64x7C	8	6.7	24.0	2.9
51	12300-TDOxJar66xPak20	8	1.3	2.8	1.3
57	Th6-KfxLee-Kf/Tpn	8	13.7	0	0.2
77	12300xLR64-8156/Nor67	8	27.2	11.4	4.2
85	7CxNor67	8	21.1	3.2	0
105	Cal-CCxTob66	8	12.9	15.0	13.2
106	Cal-CCxTob66	8	25.9	21.3	19.8
134	CC-Inia(S64-KttxKl. Pet. Raf)	8	0.4	1.2	0.2
139	Tob'S'-NPxCC-Inia/Ch	8	32.0	6.0	14.2
170	G155xNai60	8	11.4	54.0	6.5
*	Mexipak Check	5-7	53.7	49.7	4.2
			16.7	14.2	6.4

YR=Yellow Rust LR=Leaf Rust SR=Stem Rust

TABLE 1.13.C Rainfed PON selections noted as equal or superior to Medipak, (16 locations reporting).

Row No.	Variety / Cross	Locations Noted	Rust A C I YR	LR	SR
26	K338-Et de Ch x Koudiet	8	0.1	16.2	22.0
34	Puthwar 'S'	8	9.8	6.2	2.3
27	Greece-0893	7	0	5.1	4.0
13	Bb-Pismarz/S64 x Tzpp-Nai60	6	0	2.0	0
21	(MexH44-Mg/Coll'S'}1B-4(B-3} x Cno-7C	6	0	15.2	12.7
28	Ska x Son-Kl.Rend	6	1.0	0.1	0
31	Fn-Md x K117A/Cofn^2}Son-Kl.Rend/ Cno'S' x LR64^2-Son64=Sparrow	6	8.3	5.0	0
Check*	Mexipak	6-7	11.5	26.8	22.3

*Repeating check - noted as outstanding differentially in the nursery depending upon the row.

YR = Yellow Rust LR = Leaf Rust SR = Stem Rust

TABLE 1.13.D Durum PON entries most frequently noted by cooperators as superior in appearance.

Row No.	Variety / Cross	Locations noted	Rust A C I YR	LR	SR
6	D.Dwarf 5-15xCr'S'(164)	8	30.7	10.8	20.0
53	D. Dwarf 5-15xCr'S'(8y)	8	1.6	4.6	22.6
4	Jo'S'-Cr'S'	7	0.3	7.4	6.4
5	AA'S'-Plc'S'	7	33.4	7.4	21.5
8	Stork 'S'	7	7.8	3.3	17.9
27	Polycross	7	46.7	2.2	3.7
28	Gerardo VZ469(21563/61-130x 60-115)	7	20.1	5.0	9.3
37	F-9	7	5.7	7.6	22.6
42	Cn'S'xT.dicVern.-Gll'S'	7	1.3	18.7	19.0
	Checks				
	Haurani 27*	5-6	42.6	17.6	36.4
	Jori C69	4-7	11.2	8.1	7.4
	Average		18.3	8.4	17.0

*Haurani was noted 10 times for its superiority in the row 1 position, but was eliminated because it represented a border effect.

TABLE 1.13.E Barley PON entries most often selected by cooperators as outstanding in appearance 1974-75.

Row	Variety / Cross	No. Locations noted
82	Iris	12
85	Aramir	12
19	Numar	10
21	WI 2127	10
4	2762xBeecher(2L)	9
6	2762xBeecher(6L)	8
11	EsperancexTwo Row(8L)	8
65	Orge Tichedrett 3270	8
73	Plata x Sv. Mari	8
Check*	Beecher	7-11

Tunisian seed production experts on study tour in Canada and the U.S.A., inspect seed cleaning equipment.

2.0

Africa and Near East

To irrigate their small holding, an Egyptian farmer and his wife lift water with an Archimedes' screw.

2.1 Algeria*

2.1.1 INTRODUCTION

Algeria grows an average of nearly 3 million hectares of winter cereals. In adverse years some of the area is not harvested. The area distribution among the cereals is approximately 43 per cent durum wheat, 29 per cent bread wheat, 25 per cent barley and 3 per cent oats (table 2.1.A).

The need for cereals at a minimum requirement level of 200 kg per capita is about 3 million tonnes. Average production is about 1.6 million tonnes, hence there is normally a shortage of nearly 1 1/2 million tonnes/year. The formation of the "Project Céréales" in 1970, and the government's strategy of increasing inputs of fertilizer and introducing high yielding varieties, was meant to rectify the shortage in production.

At present more than 60 per cent of the bread wheat area and 15 per cent of the durum area is under high yield varieties. No change has occurred in the varietal pattern for barley and oats. During previous years, the introduction of the high yielding varieties led to a gradual shift of per cent area for the different cereals. Bread wheats gained about 14 per cent from the durums, which in turn replaced barley area. The changes are evident in table 2.1.A.

Since the year 1971, climatic conditions for cereal production in Algeria have been highly unfavourable, except in 1972 when a record crop of 2.35 million tonnes was harvested. The average yields of the four cereals for the past four years are calculated as a percentage of the 1951-70 average in table 2.1.A. It is interesting to note that even under these adverse conditions, bread wheats suffered less than the three related crops. Two major factors were responsible - bread wheats normally are grown in the best agro-climatic zones and secondly, a high proportion of the crop is under high yielding varieties.

Table 2.1.B shows the evolution of fertilizer usage in Algeria. It is evident that fertilizer use has risen dramatically. The prices of fertilizer, (table 2.1.C), are highly subsidized in Algeria while the price of cereals is kept at a comparatively high level, (table 2.1.D).

The cereal growing regions are normally divided into three zones - littoral (plain), sub-littoral (hilly) and high plateau. From a crop improvement standpoint, the latter two can be grouped together and they constitute 85-90 per cent of the cereal lands. The agro-climatic conditions for the littoral zone are normally good. The sub-littoral and high plateau areas vary from 600 to 1200 meters elevation and receive 250 to 650 mm of rain. Snow, late frost and early dry hot winds (sirocco) are typical of the region.

The climatic patterns for the regions of Algeria for 1974-75 crop season are given in table 2.1.E. Only 35 per cent of the area had a reasonable chance for production and for the remainder, the chances were poor. However, for the last development phase, conditions were good for crop development. As a result, production stayed close to average.

Although climatic factors were unfavourable, this alone cannot account for the low production considering the supply of inputs and available price incentives. Weeds are the next major contributing problem, and their effect is accentuated in years of adverse climate. Poor land management and inadequacy of good quality seeds are other responsible factors.

Because of the dry conditions, rusts and Septoria damage were minimal in the past year. In order of importance the diseases normally present are: Septoria, stripe rust, stem rust, leaf rust and mildew. Large areas of the high plateau and sub-littoral zones of the western region were subject to attacks of "Punaise". Several species exist but the most common was Aelia germari.

2.1.2 CEREAL BREEDING AND TESTING

2.1.2.1 Bread Wheats

Initial trials during the late sixties showed the good adaptation of Mexican wheats to Algerian conditions. This prompted the Ministry of Agriculture to introduce Inia 66, Tabari 66, and Siete Cerros. The breeding program was also activated during this period, to assess more germ plasm as well as to develop varieties, which are more adapted to Algerian conditions.

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* CIMMYT assists the Ministry of Agriculture and Agrarian Reform in its research and training programs through the assignment of CIMMYT scientists. The CIMMYT involvement is financed through a grant from the Ford Foundation.

Strampelli, an Italian variety, showed excellent adaptation and yield. It is now moving into production. This variety has a good level of tolerance to Septoria, but it is susceptible to leaf and stem rust which may preclude its widespread use.

Some of the more promising lines and varieties in advanced yield trials are reported in table 2.1.F. Anza (= Mexicani) is the best among this group. The crosses Napo 63-Tob "S" x 8156 (R), Cal/Cno "S" x LR64^2-Son 64, Mexicano 1481 and Chanate #2 are also outstanding and are being considered for varietal release.

Promising lines and varieties in the second year trials are shown in table 2.1.G. Condor, UQ105, a variety of Australian origin is outstanding. This is a cross derivative of Anza, which is now under multiplication in Algeria. Under normal conditions, varieties of medium or medium late maturity should do well. However, in the last two crop seasons, conditions were more conducive for favoring development of early varieties. Thus, it is too early to judge how these varieties will perform ultimately.

Results for the best yielding lines of the first year trials are presented in table 2.1.H. The best lines are from the Emu, Moncho, and Bobito crosses. PV18A-Cno x Provence is also promising.

2.1.2.2 Durum Wheats

Durum wheat occupies about 43 per cent of the total cereal area or about 61 per cent of the total wheat area. It is grown principally in the sub-littoral and high plateau areas. The agro-climatic conditions of these areas are highly variable so that varieties must have high yield stability to buffer themselves under adverse conditions. Predominant varieties are Bidi 17, Hebda 3 and Oued Zenati. Polonicum x Z.B., although a variety of more recent origin, can be classed in this group.

Table 2.1.I shows the performance of some of the better known durum varieties of the past three crop seasons. Nearly all the exotic varieties yielded more than the local varieties. Cocorit is well adapted with a high stability of yield. However, it carries a high yellowberry percentage which makes it difficult to spread into wide cultivation. Mexicali, Anhinga and Gerardo 512, the first two from CIMMYT and the latter from Italy, are close to Cocorit in yield potential, but they are much superior in resistance to yellowberry. These three are potential varieties. Capeiti and Inrat 69 are highly unstable.

Some of the promising lines and varieties in the advanced yield trials, are reported in table 2.1.J. The lines D.durum S.15-Cr "S"; Cr "S" - Gs "S" x Parana 66/270 and Gerardo 469-Gr "S", gave excellent yields over the past two seasons. However, they have little advantage over Cocorit or other varieties under advance testing. They are unlikely to be released, but will be used as parents in the crossing program.

Priority has been placed on durum wheats in the breeding program, because of the importance of this crop in Algeria and the need to supplement breeding work being done elsewhere. Extensive hybridization work was initiated two seasons ago and the first segregating populations resulting from these efforts, will be grown in 1975-76. Collections of varieties have been made from different parts of the world and assessed for suitability. Excellent germ plasm is now available for crossing.

2.1.2.3 Barley

It occupies 25 per cent of the cereal area of the country. Since the introduction of high yielding bread wheat varieties, the durum crop began to take over former barley areas resulting in a reduction of about 12 per cent in the barley acreage. Barley is normally grown in the drier areas.

Most of the disease problems such as Rhyncosporium, Helminthosporium, Erysiphe and Puccinia hordei are common in Algeria.

The local varieties, Saida and Tichedrett are well adapted and have good yield potential. Robur and Bérénice, both of French origin, are under advanced testing and performed well, as shown in table 2.1.K. In addition, Zemyr, Alger 48, Delisa, Strain 205, Beraç and Clipper are performing well.

2.1.2.4 Triticale

Triticale testing was initiated four years ago. The program handles screening nurseries, segregating material and yield trials.

The general observation to this time is that, under optimal conditions, a few triticales consistently outyielded the best bread wheats. Also, they perform equally well

when the initial establishment of the crop is good. But if conditions are unfavorable in the initial stages of crop development, their performance is usually bad. This can be associated with poor seed type. Nearly all the triticales under test in Algeria have inferior seed. Irrespective of the general-trend-observations reported above, many selections from the cross Maya II - Arm "S", are doing well (table 2.1.K). In addition, (Inia-Rye)^2 Arm "S" 2146-3N-6N-6N-1M-3Y-OM and FS 1240 also gave acceptable levels of yield under adverse conditions in the last cycle of trials.

2.1.3 PRODUCTION RESEARCH

2.1.3.1 Varietal Evaluation at the Farm Level

Advanced field plot variety trials involving 41 varieties of bread wheat, durum wheat and barley were harvested at 11 locations in three regions, (table 2.1.L). The trials were grown on Domaine farms and comprised new selections and introduced varieties. Recommended varieties were used as checks. Additional information on the varietal response is obtained in these trials under farm conditions of land preparation, weed populations and rotation patterns. The plot size was either 30 or 50 meters long by 2.5 meters wide, in two or three replications. Seeding, fertilizing, spraying and harvesting were all done with field size equipment.

The results of these trials are presented in tables 2.1.L, 2.1.M and 2.1.N for the more promising varieties.

Weed competition especially wild oats, rye grass, Phalaris sp., brome grass and a wide variety of broad-leaved weeds was a contributing factor in variety response. Barley was much more competitive than wheat. This was primarily the result of the rapid early growth and heavy tillering, all of which reduced weed growth. The taller varieties, especially the durums, were more competitive. This confirms the previous observations on plant height and early tillering capacity with respect to weed competition.

In the central and western regions, drought was serious in the early part of the season. This delayed emergence and tillering. Stripe rust at one location reduced yields of Siete Cerros, Jupateco and certain other varieties. The length of maturation period also affected yield. Because of the late start, varieties and species with short maturation showed a yield advantage. This was expressed in the higher barley yields, particularly in the Western Region. The excellent yield of the bread wheat, Mahon Démias, in the eastern and central regions was a further expression of short maturation advantage, which should form a major selection criterion for wheat varieties in North Africa, since a short period of favorable weather after flowering is common there.

The results in these field trials over past years, indicate that a plant type is needed with a maximum height of 100 cm, early vigorous growth and tillering, a relatively long vegetative stage, an intermediate flowering date and a relatively short period of maturation.

Too early heading will result in frost damage, but too late will result in heat damage. Mahon Démias is a local variety with many of these characters, but it is too tall and it has too weak straw for it to yield above 3 t/ha. A variety with the same characteristics plus 100 cm height and good straw strength, would yield well under ideal conditions and also under drought stress and weed competition situations, which are common to this region.

The best yielding bread wheats, Zambezi, Anza, Strampelli, Jupateco and Mexicano 1481 are all either short or of intermediate height, have medium to late maturity and usually have early vigorous growth.

The durum varieties Cisne "S", Anhinga I and II and Kyperounda are all medium to tall varieties, which are medium late in maturity and have high tillering capacity. Cocorit was the only short-strawed variety showing promise. Other short-strawed durums appeared to lack drought tolerance and competitive ability for weeds. Most are also early maturing. The average yield of durum wheat varieties is shown in table 2.1.M.

The most promising bread wheat is Anza, with good Septoria tolerance, rust resistance, high yield potential and medium maturity. Cisne "S" and the two Anhingas were the best among the durum prospects.

Only scattered data were available from the eastern barley trials, because of poor weather, (table 2.1.N). Hence, only the west and central regions are reported. Barley averaged 165 per cent in yield by comparison with wheat in these regions. Zemyr, Maguelone and Ager were superior to local varieties. Zemyr is a relatively short-strawed two-row barley.

2.1.3.2 Herbicide Trials

Five herbicide trials were applied with ground sprayers, and two by air in the central regions. Data on the efficacy of herbicides were collected for all trials, but yield data for only two trials could be obtained.

Suffix was applied by aerial and ground application in the El Khemis region. One trial was almost lost to drought, and the other was heavily damaged by birds and uneven application of fertilizer. These factors had a greater effect on yield than did the herbicide. Suffix applied at 6 liters of product per hectare both by air and surface application, reduced wild oat populations and seed set, but it did not completely control all wild oats. Combinations of Suffix with MCPA controlled broad leaf weeds,but wild oat control was less than with Suffix alone. By increasing the dose rate to 9 liters per hectare with 600 gm of MCPA, both wild oats and broad-leaved weeds were effectively controlled. Wild oat heads were reduced from over 200 per square meter to less than 15, on the average. Very little oat seed was produced in the surviving heads.

The effect of Suffix application in 1972-73 on wild oat populations following a year of fallow, was also studied. Wild oat heads was reduced from 60 per square meter on the untreated area, to 7 on the treated. This reduction in wild oats by Suffix on the following wheat crop, suggests more studies are needed to verify and evaluate the residual effect of grassy weed control.

2.1.4 ANNUAL FORAGE LEGUMES IN CROP ROTATION

2.1.4.1 Introduction

The season 1974-75 was the second year of the introduction of annual forage legume species into the crop rotation work of Algeria.

Adaptation trials in 1973-74 showed that the Australian cultivars Jemalong (Medicago truncatula) and Harbinger (Medicago littoralis) are well suited to lower altitude regions. Snail medic (Medicago scutellata) also appeared promising.

The season 1974-75 was the first opportunity to follow the effect of a previous medic year on wheat yields in the following year. In general, yields were disappointingly low. This was primarily due to prolific weed growth in the wheat crop following medic, because of a lack of comprehension of the value of grazing techniques coupled with a very late finishing season in 1973-74, when weeds were allowed to grow unchecked in the medic and as a result, set large amounts of seed.

Lessons learned from that first season were applied to the grazing management in 1974-75, and fields were left relatively weed-free at the end of the season. A number of points were identified in 1973-74 which required elucidation. Seeding depth was responsible for some complete failures in that year, and there was uncertainty as to the rate of fertilizer to be applied and quantity of seed to be sown. Optimum seeding dates had to be established.

This year the research program into the annual forage legume system in Algeria, concentrated on these parameters. Varietal trials were also continued throughout the agricultural region.

2.1.4.2 Date of Seeding

Three date of seeding trials were sown. However, due to very adverse conditions on the high plateau at Saida, plant survival at all three dates was essentially zero. At Tafaroui in the littoral, in the subsequent seed production (table 2.1.O) there were no significant differences caused by seeding as late as November 14 (actually germination was not complete until mid-February), although a difference in forage production was observed in the early spring (table 2.1.P). These results, however, must be considered within the framework of existing climatic conditions and the weed populations.

The Medicago establishment was greatest with the first date of seeding. However, this medic was under severe moisture stress during 10 weeks of very dry weather because of a very heavy weed population. Thus the medic population was reduced so that no significant differences were observed between the three dates with respect to plant numbers. As might be expected, no differences were found in seed production (the most important factor to be considered in the establishment year).

The question is raised as to what would be the situation if the climate were more favorable and the weed populations were lower? It may be possible that the results from Sfisef (600 meters altitude) would be a reflection of this condition (table 2.1.P). Weed

populations were lower and the climate was more favorable at Sfisef. Thus the growing season for the earlier seeding dates was effectively longer. Medicago populations were not reduced in the period through March. Significant differences were shown in forage and seed yields between early and late seeding as seen in table 2.1.P. Thus if the weed population is known to be high (or if it is known that sheep for grazing the weed growth will not be available at the right time), it appears wise to wait for a weed germination following the early rains, and then kill the weeds during seedbed preparation and sow the Medicago pasture.

2.1.4.3 Rate of Phosphate

In the two trials conducted, no response to phosphate was shown (tables 2.1.Q and 2.1.R) except for seed production at Tafaroui. Although statistically significant, this result is in some doubt because there is no obvious reason for it. Normally a phosphate response is obvious in forage yield differences. A difference in seed yields with phosphate treatments would then be explicable.

The lack of response results can be attributed to high residual levels of P_2O_5 on state farms (Domaines). This lack of P_2O_5 response has also been reported for Tunisia under similar conditions. Continuation of this experiment over a number of years may give a better understanding of longevity of residual P_2O_5.

In the absence of a soil testing service, it would be wise to assume that the soil will be responsive. Phosphate would be applied each year because superior medic growth has been shown to result from annual P_2O_5 applications over that obtained in a system, where all the phosphate is applied in the cereal cropping year. The P_2O_5 applied to regenerating stands of medic should be applied as near as possible to the seasonal break, thereby allowing an early stimulation of the annual legume, which would then offer greater competition with the weeds of the pasture.

2.1.4.4 Seeding Rate

The over-riding objective in the initial seeding of an annual forage legume into a wheat rotation, is to obtain the highest possible seed yields as a reservoir for following years. It is obvious that seed rate has an effect on early season forage yields due to plant density (tables 2.1.S, 2.1.T and 2.1.U) but this effect decreased later in the growing season (table 2.1.T). The seed yields show no significant differences between 12 and 24 kg/ha seeding rates at both sites where yields were determined (tables 2.1.S and 2.1.T). In fact at Sfisef with a normal growing season, there were no significant differences between the three rates used.

At Tafaroui, where conditions were more adverse (i.e. the growing season was shorter), there was a significant difference between the 6 and 12 kg/ha seeding rates, (table 2.1.S). Given a normal season there, it is likely that even 6 kg/ha would result in a maximum seed yield in the case of Jemalong at lower altitudes. In the case of Harbinger, circumstantial evidence from the phosphate and seeding depth trials at Sfisef indicate that a plant population of 100-120 plants /square meter is the maximum that could be supported under this year's conditions. This probably is true also for most years. Thus, a pasture seeding rate of 12 kg/ha for Harbinger could be considered wasteful of seed. However, if seedbeds are poorly prepared and where weed populations are known to be high, the larger seeding rates are likely to be justified.

2.1.4.5 Depth of Seeding

Results from these trials appear in tables 2.1.V and 2.1.W. It appears that seeding depth for Jemalong and Harbinger should be about 1.5 cm for greatest efficiency of seed use. At Sfisef, other factors affected seed yields in the trial (survival populations between treatments showed no differences leading to no significant differences in seed yield).

When seed is broadcast on the surface, about half of it is lost in some way, e.g. desiccation of the radicle on the surface after germination or consumption by birds and mice, etc. When seeding is done below 1.5 cm, the establishment is again impaired. Snail medic, which has a very much larger seed, exhibits a greater tolerance to excessive seeding depth. This is responsible in part, for its success in Algeria.

2.1.4.6 Legume Variety Trials

The cultivars Jemalong, Harbinger, and Snail performed well at low elevation sites (e.g. tables 2.1.X and 2.1.Y). Snail is outstanding in spring forage production while all three produce reasonable quantities in the critical autumn-winter "feed trough". Theoretically, Paragosa (Medicago rugosa) should be well suited to the heavy clay soils of Algeria. However, because it has a specific rhizobial requirement, it rarely nodulates without inoculation. Unfortunately, the inoculum is not available in Algeria.

Clare (Trifolium subterraneum) also requires inoculation on most soils. It is doubtful whether cultivars which require inoculum, will be of widespread importance in the forseeable future in Algeria.

For the high plateau, Jemalong is the most successful (table 2.1.Z) but even it is not promising. Some reports indicate Snail is well-suited to the high plateau country. It has reasonable cold tolerance but it is generally less so than Jemalong. Snail sets what appears to be large quantities of seed, but many of the pods are barren. In addition, its forage production in these cold high altitude areas is quite poor.

With regard to the hard-seed breakdown of the cultivars under test, Harbinger and Jemalong exhibit very little breakdown over the summer (table 2.1.AA). However, the amount of seed available for germination in October is acceptable. The hard-seed breakdown curve of Snail more closely approximates the ideal curve. The breakdown curve of Paragosa is dangerously high, and this variety is also extremely prone to germinating in periods which are climatically similar to the beginning of the season so that false starts followed by desiccations occur. For this reason regeneration is not always reliable. Jemalong, Harbinger and Snail, therefore, appear to be the best among the commercial varieties of Medicago for introduction into Algeria, at least for lower altitudes. The potential of other Australian cultivars of Medicago truncatula, such as Cyprus and Borung, and also that of the Algerian selected ecotypes remains to be seen. At present, 600 lines of indigenous Medicago are under evaluation at Algiers. In addition, a number of short season Australian cultivars will be screened during the next crop cycle.

2.1.4.7 Herbicide Applications to Medicago

Algeria wishes to commence local seed production of Medicago immediately. There is a large weed problem in much of the agricultural area, particularly in the case of grassy weeds. It is expected, therefore, that for serious seed production, chemical herbicides will be required. Table 2.1.BB shows the effect of using two chemicals, Treflan^{R} (Trifluralin) and Avadex^{R} (Di-allate), on subsequent seed production by the medic. Results are encouraging for the use of herbicides as a tool in seed production fields.

2.1.4.8 Insect Damage

Two insects could become increasingly important as Medicago areas are expanded.

1. A species of Sitona which can cause significant reductions in plant establishment through eating emerging cotyledons.

2. A pod boring insect (probably genus Etiella) was most obvious at Sfisef, and it was also present at other locations. It appeared to prefer Harbinger, where 15 per cent of pods were found to be devoid of seed. All introduced and indigenous cultivars were attacked by this insect.

TABLE 2.1.A Evolution of area, production and yields of cereals in Algeria.

	Years	Durum wheat		Bread wheat		Barley		Oats		Total
		Area / Produc.	% Total	Area / Produc.	% Total	Area / Produc.	% Total	Area / Produc.	% Total	
Area 1000 ha	1951-1970	1200	44	420	15	1000	37	100	4	2720
	1971-1974	1153	43	748	29	645	25	70	3	2616
	% shift		-1		+14		-12		-1	
Production 1000 q	1951-1970	7700	42	3200	18	6600	36	700	4	18,200
	1971-1974	6400	41	5325	34	3675	23	375	2	15,775
	% shift		-1		+16		-13		-2	
yield q/ha	1951-1970	6.4		7.6		6.6		7.0		6.7
	1971-1974	5.6		7.1		5.7		5.4		6.0
	1971-1974 yields shown as a % of 1951-1970 yields	88		93		86		77		90

q = quintal = 100 kilograms

TABLE 2.1.B Evolution of fertilizer use in Algeria*.

Years	N	P	K	Total
1970-1971	34,773	41,657	15,727	92,157
1973-1974	100,000	90,000	40,000	230,000

* About 55 per cent is used for winter cereals, except potash which is not used for the cereals. All the figures are in tonnes.

TABLE 2.1.C Fertilizer prices in Algeria.

Type of Fertilizer	Price/q (Algerian Dinars)
Ammonium Nitrate (33.5% N)	34.90
TSP (Super 46%)	46.10
DAP (Diam.phos.-18%N, 46%P_2O_5)	62.20
Urea (46% N)	46.10

$1.00 US dollar = 4.00 Algerian dinars. q=quintal=100 kg

TABLE 2.1.D Cereal prices in Algeria. (Algerian Dinars/q).

Crops	Price up to 1972-1973	Price 1973-1974	Price 1974-1975
Bread wheat	44.00	48.00	58.50
Durum wheat	53.00	54.00	63.78
Barley	31.70	31.70	40.70
Oats	30.20	30.20	35.20
Forage	?	22.00?	25.00

$ 1.00 US dollar = 4.00 Algerian dinars

TABLE 2.1.E Climatic conditions in the Algerian cereal belts in the 1974-75 crop season.

		West		Central		East		% Cereal Area
			% Cereal Area		% Cereal Area		% Cereal Area	
Littoral or Plain	I	VP	5	F	2	F	5	12
	II	VP		P		VP		
	III	G		G		G		
Sub-littoral or Hilly	I	P	15	P	10	P	18	43
	II	F		P		P		
	III	G		G		G		
High Plateau	I	P	20	P	15	F	10	45
	II	F		F		VP		
	III	G		F		G		
	% Cereal Area		40		27		33	100

I = Seeding to Tillering
II = Tillering to Heading
III = Heading to Ripe

VP = Very Poor
P = Poor
F = Fair
G = Good

TABLE 2.1.F Performance of the most promising bread wheat lines and varieties in the advanced trials in comparison to the standard varieties.

Varieties	1973-1974			1974-1975		
	yield	rank	%7C	yield	rank	% 7C
(21931/Ch-An x Gb)An	36.92	10.3	100	44.74	5.0	104
Np63-Tob"S" x 8156(R) 28071-7M-3Y-7M-0Y	41.77	8.0	97	44.62	8.5	104
Cal/Cno"S" x LR64^2-Son64 27169-48M-1Y-1M-0Y	38.50	7.3	104	44.57	6.8	104
Marco Juarez INTA	37.71	7.3	102	43.89	9.5	102
Soltane	33.98	10.3	96	42.48	15.0	95*
Siete Cerros (=7C)	35.52	6.7	100	43.00	9.5	100
Anza	38.96	2.7	110	46.51	5.5	104*
Strampelli	36.88	5.0	104	44.74	7.8	100
Mexicano-1481	33.89	10.7	105	44.26	9.3	99*
Chanate # 2	35.03	6.0	109	45.92	13.8	103*

* % Strampelli

TABLE 2.1.G Promising bread wheat lines and varieties in the second year trials.

	Varieties	1973-1974			1974-1975		
		yield	average rank	% highest check	yield	average rank	% highest check
324	Tzpp-Son64 x Np/Cno"S"-Inia"S" 34002-2 Mch-4MK-0Mch	41.86	12.5	94	43.74	3.7	100
325	HD832-Nor/Cno"S"-Cal x Nad CM-5618-G-7Y-0M	47.23	2.5	106	41.70	3.0	95
391	/(U-SK x S.Past)Mara/ Cno"S"-Inia"S" 31356-2M-1Mch-2-2Mch-0Mch	52.10	2.0x	108	49.98	4.0	95
396	Cal x Cno-8156^2 30027-5TU-1MB-1BK-0BK	44.99	13.5	94	52.61	1.5	100
421	Ptf x 4777^2(Fr-K58/N10B) A3704-5P-1P-3P-0BK	43.15	6.5	96	51.74	5.0	100
426	Bt(Son64-An64 x Nad/Jar"S") 34795-5Y-1M-3Y-0M	45.65	6.0	102	54.59	5.3	101
448	UQ 105	72.19	1.0x	114	55.38	4.0	102
438	Sparrow"S" CM-2182-5M-1Y-2M-3Y-0M	58.33	1.0x	112	52.32	9.7	96
453	7C-on x Inia-B.Man	56.63	7.0x	89	52.65	4.3	98
457	Jupateco-73	41.63	17.0x	80	52.37	6.3	97
	7C (=Siete Cerros)	39.91*	11.8	--	48.79**	5.8	--
	Strampelli	43.96*	5.4	--	49.27**	3.8	--

* Average of 31 first year trials ** Average of 18 second year trials
x Based on one location

TABLE 2.1.H Promising lines and varieties of the first year trials.

V. No.	Cross	Yield q/ha	Average rank	% highest check
4	EMU"S" CM-8327-C-9M-1Y-0M	53.49	2.3	105
6	MONCHO"S" CM-8288-A-3M-7Y-0M	54.22	4.7	106
32	Cno"S"-Gallo x Bb # 4A/K4496 CM-11909-F-1Y-4M-0Y	53.32	3.5	95
68	PV-18A-Cno67 x Provence Tu-87-2BK-0BK	55.68	4.0	104
67	Tob x CC-Pato/Soltane Tu-245-1BK-0BK	53.29	3.5	99
76	/(Cno.Nad x Chris"S"/So64-Kl.Rend x Bb)/ /(Cno-Chris x on/Gallo)(Cno-Son x Cno-Inia)/ CM-15774-8Bj	63.54	3.5	98
111	(Rfn^2-908/Fn x GZ139-GB1360.3228) Cllfn^3 A 6842-6P-1P-1P-3P	62.47	5.5	95
106	Tob"S"-Np x CC-Inia/Cha CM-5541-34Y-0M-OMch-4BK	61.54	6.5	93
147	Cno"S"-Cal x Y50$_E$-Kal CM-16219-4SB-0SB	59.88	4.5	90
146	Pato-on x Cno"S"-Gallo CM-16216-3SB-0SB	60.69	4.0	91
153	Bobito"S" 388837-1Y-2M-1Y-0Y-0AL	81.36**	1.0	113
	7C (=Siete Cerros)*	60.10	4.8	--
	Strampelli*	60.15	3.8	--

*Average of 15 trials. **Only one location.

TABLE 2.1.I Average performance of some of the important durum varieties in Algeria during 1973-1975.

	1972-1973			1973-1974			1975-1976			Average
	e yield	e rank	% cit*	e yield	e rank	% cit	e yield	e rank	% cit	%over cit
Cocorit	25.58	5.8	100	33.85	--	100	33.88	7.8	100	100
Mexicali	--	--	--	53.08	8.0	96	45.29	9.0	102	99**
Anhinga	25.60	5.2	95	52.48	9.0	95	33.34	6.5	101	97
Gerardo 512	--	--	--	35.05	8.7	86	34.49	8.3	99	93**
Capeiti	24.20	5.9	95	29.92	--	88	28.32	16.5	84	89
Inrat 69	19.75	12.3	77	30.74	--	91	28.55	19.1	84	84
Polonicum ZB	21.71	8.0	85	29.50	--	87	22.08	20.5	67	80
Bidi 17	20.84	10.4	82	25.60	--	76	22.70	20.1	67	75

* cit = Cocorit ** Only two years

TABLE 2.1.J Some of the promising durum lines in the yield trials.

	1973-1974			1974-1975			%
	yield	rank	%cit	yield	rank	%cit	Average
Jo"S"-Cr"S" x Flg"S" DM-71-249	40.06	10.0	92	47.42	3.0	107	100
Cr"S"-F3 Tu x AA"S"/Flg"S" CM-10200-2BK	42.49	7.7	97	47.39	3.5	107	102
Pg"S"-31810 CM-10071-2M-0Y	55.28	5.0	100	46.34	6.0	104	102
Gt"S"-Pg"S" CM-10142-39M-0Y	57.45	4.0	104	47.30	4.0	107	106
D.durum S. 15-Cr"S"	61.63	1.0	111	46.61	4.5	107	109
Cr"S"-Gs"S" x Parana 66/270	56.43	9.0	102	46.32	5.5	106	104
Cr"S"-Gs"S"	57.70	6.0	104	46.97	4.5	108	106
Gerardo 469-Gr"S"	60.78	3.0	109	48.30	5.0	111	110
21563-AA"S" 27625-5M-2Y-2M-2Y-0M	38.01	3.5	100	35.38	3.8	102	101
Maghrebi	30.06	--	93	34.35	6.8	104	99
Gerardo 525	35.84	7.3	88	36.24	5.3	104	96
Georgio 653	37.85	5.3	93	34.17	9.0	104	99
Georgio 532	37.32	4.7	92	34.07	8.8	103	98
Georgio 449	36.49	6.7	90	34.05	5.3	103	97

cit = Cocorit

TABLE 2.1.K Performance of barley varieties Robur and Bérénice and triticale Maya II-Arm "S" in comparison to the wheat and local durum and barley varieties.

V. No.	Variety	yield average 3 stations	average rank	% Bidi 17	% Saida	% Strampelli
715	Strampelli (BW)	50.14	3.3	193	116	100
725	Siete Cerros (BW)	48.35	4.7	187	112	96
721	Bidi 17 (Local DW)	25.93	24.7	100	60	52
719	Robur (Barley)	50.45	4.3	195	117	101
723	Bérénice (Barley)	46.25	8.3	178	107	92
720	Saida (Local Barley)	43.29	10.3	167	100	86
707	Maya II-Arm"S" (Tcl)	48.20	4.7	186	111	96

BW = Bread Wheat DW = Durum Wheat Tcl = Triticale

TABLE 2.1.L Average yields of bread wheats grown in eleven locations in three regions of Algeria under farm conditions.

Variety	Yield q/ha				%
	West	Central	East	Average	Siete Cerros
Zambezi	26.0	17.5	23.2*	21.8	125
Anza	25.4	17.1	26.2	22.7	119
Jupateco	25.6	13.6	23.9	20.7	109
Strampelli	21.9	13.9	25.7	20.4	107
Mexicano 1481	22.5	16.4	30.8*	24.0	107
Siete Cerros	22.8	14.4	21.0	19.1	100
Hazera	24.1	13.8	20.7	19.1	100
Soltane	22.4	12.6	18.2*	17.2	99
Potam"S"	24.0	12.8	16.5*	17.2	97
Cinnamon (Tcl)	19.2	11.2	16.2	16.9	80
Mahon Démias**	----	19.2	21.2	20.2	114

* Only 3 of 4 locations, and 10 of 11 in all regions.
** Not grown in western region - 7 locations total.
Tcl=Triticale variety.
Averages are weighted according to the number of trials in each region.

TABLE 2.1.M Average yields of durum wheat varieties grown in 11 locations in three regions under farm conditions.

Variety	Yield q/ha				%
	West	Central	East	Average	Oued Zenati
Cisne "S"	27.1	15.2*	22.3*	21.5	127
Anhinga I	25.4	15.3	19.1	19.6	120
Kyperounda	29.7	14.5	16.7	19.5	119
Anhinga II	26.4	14.7	18.2	19.2	118
Cocorit	23.7	14.0	15.8*	17.5	114
Crane "S" A	21.7	13.1	21.5*	18.4	111
Crane "S" B	23.6	12.9	19.1	18.1	111
Jori"S" x Crane"S"	21.8	14.0	18.2	17.6	108
Durtal	23.8	12.2	17.5	17.3	106
Oued Zenati	20.9	11.9	17.4	16.3	100
Inrat 69**	24.2	--	11.3*	17.7	100

* Grown in 3 of 4 trials in the region.
** Not grown in central region, 6 trials only.
Averages are weighted according to the number of trials in each region.

TABLE 2.1.N Average yields of barley varieties grown in 7 locations in two regions in field plots.

Variety	Yield q/ha				% Check
	West		Central	Average	
Zemyr		48.8	22.5	35.7	121
Ager		42.6	24.1	33.4	113
Maguelone		42.1	24.5*	33.3	113
Bérénice		42.6	21.5	32.1	108
Clipper		42.3	19.6	31.0	105
Checks	Saida	34.6	Tichedrett 24.5	29.6	100

* Grown in 3 of 4 locations.
Averages are weighted according to the number of trials in each region.

TABLE 2.1.O Date of seeding trial, Tafaroui, 1974-1975. (Means of three replicates)

Seeding date	10-10-1975	29-10-75	14-11-75	Comments
Establishment (plants/m^2)	118.7	94.0	87.7	Least Sig.Diff. (5%) = 21.4
Survival (plants/m^2)	78.0	96.0	87.7	Survival counts taken at time of establishment counts for third date. N.S.D.between plant numbers at that time.Difference between survival and establishment in Date 1 significant.
Forage Production (tonnes/ha F.W.)				No significant difference between Dates 1 and 2.
Medicago	12.0	12.5	2.0*	
Weeds	7.0	8.6	4.0*	* Visually estimated
Seed Production (kg seed/ha)	284.5	271.3	211.4	No Sig.Difference (5%)

TABLE 2.1.P Date of seeding trial, Sfisef, 1974-1975. (Means of three replicates)

Seeding date	21-10-1975	31-10-75	25-11-75	Comments
Establishment (plants/m^2)	151.3	116.7	102.3	Least Sig.Diff.(5%)=29.7
Forage Production (tonnes/ha F.W.)				
Medicago	23.5	21.4	13.8	L.S.D. (5%) = 7.17
Weeds	5.7	5.1	5.7	No Significant Difference
Seed Production (kg seed/ha)	541.5	450.2	388.6	L.S.D. (5%) =86.4

TABLE 2.1.Q Phosphate application rate trial, Tafaroui, 1974-1975.
(Means of three replicates)

P_2O_5Rate (kg/ha)	0	22.5	45	90	Comments
Establishment (plants/m^2)	115.7	112.3	117.0	120.0	No Sig. Diff.
Survival (plants/m^2)	114.3	107.0	112.7	106.7	N.S.D. in plant population N.S.D. between establishment and survival
Flowering (3-3-1975) (flowers/m^2)	9.7	8.7	10.7	8.7	No Sig.Diff.
Forage Production (tonnes/ha F.W.)					
Medicago	14.4	14.0	16.4	17.1	No Sig.Diff.
Weeds	10.6	14.7	10.9	12.5	No Sig.Diff.
Seed Production (kg seed/ha)	139.5	243.7	225.7	216.5	L.S.D. (5%) = 44.4

TABLE 2.1.R Phosphate application rate trial, Sfisef, 1974-1975.
(Means of three replicates)

P_2O_5Rate (kg/ha)	0	22.5	45	90	Comments
Establishment (plants/m^2)	185.7	179.7	173.7	184.3	N.S.D.
Survival (plants/m^2)	133.0	119.3	120.7	122.0	N.S.D.
Forage Production (tonnes/ha F.W.)					
Medicago	26.0	27.3	27.4	23.4	N.S.D.
Weeds	6.0	6.4	5.9	8.1	N.S.D.
Seed Production (kg seed/ha)	494.5	507.3	517.3	479.0	N.S.D.

TABLE 2.1.S Seeding rate trial, Tafaroui, 1974-1975.
(Means of three replicates)

Seeding Rate (kg/ha)	6	12	24	Comments
Establishment (plants/m^2)	51.7	84.3	172.0	L.S.D. (5%)=22.2
Forage Production (tonnes/ha F.W.)				
Medicago	11.0	18.3	21.4	L.S.D. (5%)= 6.6
Weeds	18.2	10.3	7.0	L.S.D. (5%)= 5.1
Seed Production (kg seed/ha)	102.4	211.3	214.6	L.S.D. (5%)=45.8

TABLE 2.1.T Seeding rate trial, Sfisef, 1974-1975.
(Means of three replicates)

Seeding Rate (kg/ha)	6	12	24	Comments
Establishment (plants/m^2)	58.3	131.3	221.0	L.S.D. (5%)=72.7
Forage Production[1] (tonnes/ha F.W.)				
Medicago	6.4	17.5	25.6	L.S.D. (5%)= 5.6
Weeds	6.5	4.3	4.9	N.S.D.
Forage Production[2] tonnes/ha F.W.)				
Medicago	21.1	33.6	35.4	L.S.D. (5%)= 9.4
Weeds	19.1	15.7	8.6	L.S.D. (5%)= 4.6
Seed Production (kg seed/ha)	255.4	308.4	292.8	N.S.D.

(1) Cut 18-4-1975 (2) Cut 23-5-1975

TABLE 2.1.U Seeding rate trial, Wagran, 1974-1975.
(Means of three replicates)

Seeding Rate (kg/ha)	6	12	24	Comments
Establishment (plants/m^2)	13.3	95.3	184.3	L.S.D. (5%)=10.7
Forage Production (tonnes/ha F.W.)				N.S.D. between Medicago yields from 12 and 24 kg/ha but trend is apparent
Medicago	trace	4.5	8.3	
Weeds	25.6	21.6	17.2	N.S.D.

TABLE 2.1.V Depth of seeding trial, Tafaroui, 1974-1975.
(Means of three replicates)

Seeding Depth	Surface	1.5 cm	4.0 cm	Comments
Establishment (plants/m^2)	47.7	95.3	78.7	L.S.D. (5%)=41.2
Forage Production (tonnes/ha F.W.)				
Medicago	11.8	17.2	15.1	N.S.D.
Weeds	11.7	12.1	11.8	N.S.D.
Seed Production (kg seed/ha)	144.4	229.4	232.8	L.S.D. (5%)=56.2

TABLE 2.1.W Depth of seeding trial, Sfisef, 1974-1975.
(Means of three replicates)

Seeding Depth	Surface	1.5 cm	4.0 cm	Comments
Establishment (plants/m^2)	97.3	197.0	156.7	L.S.D. (5%)=52.4
Survival (plants/m^2)	102.7	116.7	130.6	N.S.D.
Forage Production (tonnes/ha F.W.)				
Medicago	17.6	14.9	16.9	N.S.D.
Weeds	6.7	7.9	7.1	N.S.D.
Seed Production (kg seed/ha)	446.3	469.5	439.8	N.S.D.

TABLE 2.1.X Legume variety trial results, Tafaroui, 1974-1975.
(Means of three replicates)

Variety	Harbinger	Snail	Jemalong	Paragosa	Clare	Comments
Establishment (plants/m^2)	80.3	19.7	85.7	6.7	29.0	L.S.D. (5%)=12.0
Forage Production (tonnes/ha F.W.)						Analyses with Clare deleted)
Medic/Clover	13.3	14.0	17.4	3.2	trace	L.S.D. (5%)= 3.9
Weeds	11.0	14.9	7.9	17.2	19.5	L.S.D. (5%)= 5.9
Seed Production (kg seed/ha)	108.3	251.7	218.0	58.7	--	L.S.D. (5%)=45.0

TABLE 2.1.Y Legume variety trial results, Sfisef, 1974-1975.
(Means of three replicates)

	Harbinger	Snail	Jemalong	Paragosa	Clare	Comments
Establishment (plants/m^2)	101.3	52.3	102.3	18.0	64.0	L.S.D. (5%)=32.3
Forage Production (tonnes/ha F.W.)						Analyses with Clare deleted
Medic/Clover	13.8	14.4	13.8	1.4	trace	L.S.D. (5%)= 6.0
Weeds	4.9	4.1	5.7	10.6	6.2	N.S.D.
Forage Production (tonnes/ha F.W.)						Analyses with Clare deleted
Medic/Clover	31.9	48.7	29.8	8.8	trace	L.S.D. (5%)=15.2
Weeds	15.2	22.1	10.7	17.8	24.0	L.S.D. (5%)= 5.9
Seed Production (kg seed/ha)	450.9	634.6	387.8	352.6	--	N.S.D.

TABLE 2.1.Z Legume variety trial results, Wagram, 1974-1975.
(Means of three replicates)

	Harbinger	Snail	Jemalong	Paragosa	Clare	Comments
Establishment (plants/m^2)	58.0 (16.0)	25.0 (37.8)	76.0 (30.7)	0 (0)	20.3 (19.0)	Figures in brackets are % establishment
Forage Production (visual estimation)	3.8	1.3	10	0	0	Forage visually rated against Jemalong = 10

TABLE 2.1.AA Medicago hard-seed breakdown, July-October, Tafaroui, 1975.
(Percent Hard Seed)

	July	August	September	October
Harbinger	86.8	86.8	85.0	85.2
Snail	87.0	83.4	80.6	76.3
Jemalong	92.3	89.2	88.9	87.6
Paragosa	82.4	77.1	67.3	50.4

TABLE 2.1.BB Herbicide applications to Medicago trials, Tafaroui,1974-1975.

	Establishment (Medic/m^2)	Establishment (Weeds/m^2)	Seed Yield (kg seed/ha)
No Herbicide	55	91	189.4
+ Avadex	50	79	265.1
+ Treflan	52	16	339.6
+ Avadex + Treflan	30	7	368.1

2.2 Cyprus

2.2.1 INTRODUCTION

The total area sown to wheat and barley is about 150,000 hectares. These two crops are grown in approximately equal proportions and only under rainfed conditions. Accordingly, yields are mainly determined by the amount of available water which is seldom sufficient for high yields. Thus grain yields seldom exceed 4 tonnes/hectare (t/ha). Rainfall in 1974-75 was about average in most areas, but it was poorly distributed. The grain filling period from March to April was very dry causing significant losses in yield. Yields varied from 1 to 3 t/ha, with barley giving higher yields than wheat.

Cereals are fertilized with 40 kg/ha N and 35 kg/ha P_2O_5. Although there is no shortage of fertilizer, the limiting factor in their use is the low and uneven distribution of rainfall. Fertilizer is not subsidized and the present prices are 210 mils (0.54 $U.S.) per kg N and 229 mils (0.58 $U.S.) per kg P_2O_5. There is no shortage of fertilizer.

Cereal diseases have not been serious at any time over the last seven years. This may have been the result of the marked changes in genetic material grown in the Middle East after CIMMYT varieties were introduced. However, Septoria is a new disease in Cyprus. It is now becoming increasingly significant.

2.2.2 BARLEY

All barley grown in Cyprus is of the 6-row type and is used for feed purposes. The Greek variety Athenais replaced all the old varieties because of its high and stable yields. A new variety Attiki, with similar yield but having better rust resistance, was released in 1973. All other introduced varieties from many International Nurseries failed to outyield Athenais.

A breeding program initiated in 1968 was directed toward producing new barley varieties which are early maturing and drought resistant. Special emphasis is being placed on nutritional improvement and disease and lodging resistance. Hooded barleys suitable for use as hay forage are being developed. Very early genotypes were selected from the cross Mari x Athenais which reach heading 30 days earlier than Athenais and are earlier than the early parent Mari. Early genotypes were also selected from a composite cross known as CCXXI. These lines are currently under test under rainfed conditions at different sowing dates. Athenais was crossed with Hyproly (CI 3947) and other high protein, high-lysine lines. The F3 lines were screened in 1975 and the best lines will be evaluated in 1975/76. Selected mutants in M4-M6 will be screened in 1975/76.

Material with several promising agronomic characters from over 200 crosses, is being screened.

2.2.3 DURUM WHEAT.

Durum wheat is used for bread and pastry. The area under Kyperounda, Psathas and Tripolitico, the traditional varieties, is being reduced as Capeiti 8 is expanding. The Mexican varieties Jori C69 and RAE Tc^2 x Stw 63/AA"S" (Cocorit "S") were released for cultivation in 1975/76. The varieties Jori C69, Cocorit 71 and Cocorit "S" (above), outyielded Kyperounda by 10, 29 and 32 per cent respectively.

The aim of hybridization and introduction of segregating populations is to select high yielding, early maturing, lodging resistant and good pasta quality varieties. Selected varieties are crossed with the local varieties, some of which produce high quality grain. Several new lines selected from the segregating populations gave very good results in preliminary screening. The most promising lines are listed in table 2.2.A.

2.2.4 BREAD WHEAT

Before 1967, bread wheats were not grown on a significant scale. The Mexican variety Pitic 62 was released that year and due to its high yield, the area rapidly increased. However, because of its low baking quality, it is now being replaced by varieties with better baking strength. A sister line of Jaral 66 was introduced in 1973 and its area is expanding. Mexipak 69 and Blue Silver (=Sonalika) which have better milling and baking properties than Pitic, were released in 1975.

Crosses in bread wheat are limited in number in Cyprus because the program is

concentrated around the more important cereals, viz., durum wheat and barley. However, large numbers of segregating populations are introduced from CIMMYT, ALAD and FAO for selection under limited rainfall. Some of the selected lines are now in F6 and they appear very promising for both high yield and good baking strength. The most promising are shown in table 2.2.B.

2.2.5 AGRONOMY

The Cyprus Agricultural Research Institute is conducting an experimental program to determine whether fallow can be replaced profitably by a leguminous crop, and whether fallow is necessary in the low rainfall cereal growing area.

The program comprises two types of rotation trials:

(a) Introduction of common vetch (Vicia sativa) and a short-term subterranean clover ley (Trifolium subterraneum var. Clare) into a wheat rotation.

(b) Introduction of woollypod vetch (Vicia dasycarpa) and forage barley into a grain barley rotation

The first of these trials was initiated in 1963/64 in the Northern part of Cyprus under 400-600 mm of rainfall. It was planned to run for 12 years. The trial compares five rotations -- Continuous wheat, wheat-fallow, wheat-vetch, two years of wheat and two years of subclover ley and three years of wheat with three years of subclover ley.

The results are consistent showing that wheat following three years of subclover ley produced the highest yield as shown in table 2.2.C. This is probably a result of soil enrichment with N.

New trials were initiated in 1974, which compare the following rotations:

Grain barley continuous; grain barley-fallow; two years grain barley-fallow; grain barley-forage barley; two years grain barley-forage barley; grain barley-woollypod vetch (Vicia dasycarpa var. Lara); two years grain barley- woollypod vetch.

Trials aimed at determining the most effective and economic method of seed bed preparation by comparing the number and time of ploughings during the fallow year, have been conducted since 1964. It was found that two cultivations, one in autumn and one in spring, produced a better seed bed for the following crop. The timing of the spring cultivation is the more critical. It should achieve proper weed control and create soil conditions which will promote soil conservation and the maximum intake of fall moisture. The results from these trials are given in table 2.2.D.

In order to investigate the effect of using the chisel plow in dryland farming and to compare it with other types of soil cultivation implements, a series of trials were recently undertaken. The implements used were the chisel, moldboard, subsoiler, line cultivator and disc plow. All of these practices are being compared with no tillage or minimum tillage methods. This work is still in progress.

An experiment was conducted at ten sites on methods of sowing cereals in dryland conditions using the conventional and deep-furrow drills. The results are shown in table 2.2.E which suggests that the conventional drill is more effective. However, the deep furrow drill could be more effective in years of below average rainfall.

Fertilizer experiments conducted over the past eight years have demonstrated that 40 kg/ha N (half at sowing, half as topdress at tillering) is adequate for barley (var. Athenais) and for Kyperounda, a tall durum wheat variety. However, for the bread wheat Pitic 62, 80 kg/ha N gave better results. A response to phosphorus is encountered only in dry seasons. However, since rainfall cannot be predicted at sowing time, phosphorus is always applied at about 35 kg/ha P_2O_5. The farmers have applied a complex fertilizer 14-22-0 for many years. More recently 16-20-0 and 20-20-0 at sowing, coupled with a top-dressing of nitrochalk and to a lesser extent urea, have been used.

The fact that a relatively low N rate will produce up to 4 t/ha of grain, probably means that N applied during drier years, remains in the soil unused and is then taken up by the following crop. This was shown in 1974 when although relatively high grain yields of wheat and barley were obtained (4 t/ha), there was no response from freshly applied N. Presumably the N applied in 1973, a drought year, was still available in the soil.

2.2.6 PEST CONTROL

A spray treatment of BHC applied during the growing season or as a soil treatment

at time of sowing, was effective against larvae of the cereal leaf miner Syringopais temperatella, Lederer, which is severe in Cyprus. Parathion, fenitrothion, diazinon, chloropyriphos, mevinphos and an endrin dicrotophos mixture were all effective as spray treatments. Trichloronate and carbofuran were effective as soil applications. A single deep plowing in summer was not effective in controlling the larvae. Early stage larvae were more susceptible than late stage larvae to the insecticides. A significant correlation was established between larval population and loss in grain yield. BHC spray applied early in the growing period tended to increase yield over late applications.

Following an earlier survey on insect species and grain weight losses carried out in Cyprus, a considerable amount of field and laboratory work was done to find efficient means of controlling stored grain insects. Malathion, is widely used as a grain protectant and as a store disinfectant in Cyprus. Other low mammalian toxic organophosphorus insecticides found to be suitable for such use include pirimiphos-methyl, phoxim, fenitrothion, tetrachlorvinphos and bromophos. Aluminum phosphide applied as phostoxin tablets was also found to be very effective against stored grain pests.

Tests to establish the susceptibility of different wheat varieties to Rhyzopertha dominica F. (lesser grain borer) showed that the most susceptible in order were Hazera 2152, Blue Silver, Mexipak 69, Pitic 62 and Capeiti 8. The most resistant were Tobari 66, Safed Lerma and Kyperounda.

2.2.7 WEED CONTROL

In 1974, wild oat control trials were laid out in wheat and barley. The post emergence herbicides benzoylpropethyl and difenzoquat were applied with satisfactory results, on several varieties of wheat, when the wild oats ranged from the three leaf to the late tillering stages. No adverse effects on wheat were observed. Benzoylpropethyl was applied at 170 and 200 gm a.i. per donum, and difenzoquat at 100 and 134 gm a.i. per donum.

In barley, only difenzoquat was used and at the same rates as in wheat. The results were satisfactory with no crop damage.

TABLE 2.2.A Promising durum wheat lines in Cyprus 1974-75.

1. Cr^2-B.Bd (BY^2_E-Tc) (BY^2_E-Tc x Tgl_E-Tc^3)
   1CM 593-OL-6A-OA
2. (BY^2_E-Tc x TAC_E-Tc^3) (BY^2_E-Tc)^2 Z.-B. x W.
   1D 31539-3L-OA-1A-OA
3. (BY^2_E-Tc x TAC_E-Tc^3) (Ld 357_E-Tc^2)
   (TM_E x Tc^2)-Z.-B. x W.) 1D 31541-1L-OL-3A-OA
4. (BY^2_E-Tc x TAC_E-Tc^3) x Jori "S"
   1D 31546-5L-OL-4A-OA
5. Jori "S" x BY_E-Tc^5 1D 31561-5L-OL-4A-OA
6. (TM_E-Tc^2)(Z.-B. x W.)(BY^2_E-Tc x TAC_E-Tc^3)Jori "S"
7. Anhinga "S" - Volunteer 1D 31728-3L-OL-1A-OA
8. Brant "S"-Zenati Bouteille 1D 31834-1L-OL-3A-OA
9. (BY^2_E-Tc x TAC_E-Tc^3) (BY^2_E-Tc)^2 Z.-B. x W.
   1D 31543-7L-OL-5A-OA
10. Brant "S" - Jori "S" 1D 31695-1L-OL-4A-OA

TABLE 2.2.B The most promising bread wheat lines in Cyprus tests, 1974-75.

1.	Tob 66 x Hqn - ICM753-0CM-1A-2A-0A
2.	II60-147 (Aust)/Cno-Chris x ON-CM 898-0CM-1A-1A-0A
3.	Bb x Tob 66 - ICM 1547-0CM-2A-2A-0A
4.	Chris ($LR64^2$-Son 64/Son 64-$Y50_E$ x Gto) Tob.66-NP832-ICM2239-0CM-3A-2A-0A
5	Cno-Pj62 x Jar "S"-ICM 1540 - OCM - 1A - 4A - OA
6.	Inia "S" (36896-Cj54 x Y54/5840)MP33 -I x 8-1A-0A
7.	Inia "S" - Napo 63 x Nor 67 - JPK 6155-OL-1A-0A
8.	Bb x Tox-Cno- ICM 1561-OL-2A-0A
9.	Tc-Inia x Col - I 3985-1A-0A
10.	Tob-8156R x LW/Chr-Sr -I 4098-1A-0A

TABLE 2.2.C The influence of rotation on grain yield of Kyperounda wheat.

Rotation	Average yield (kg/ha) for 1965-74
Wheat continuous	792
Wheat after fallow	1,095
Wheat after vetch	1,406
Wheat after a 2-year subclover ley	1,783
Second wheat year after a 2-year subclover ley	1,413
Wheat after a 3-year subclover ley	2,086
Second wheat year after a 3-year subclover ley	1,576
Third wheat year after a 3-year subclover ley	1,354

TABLE 2.2.D The influence of the number and timing of plowings on the average grain yield of Athenais barley from seven locations in Cyprus during 1966-1971.

Treatment	Yield (kg/ha)
one Ploughing (Spring)	3,122
Two Ploughings (Autumn and Spring)	3,540
Three Ploughings (Autumn, early and late Spring)	3,196

TABLE 2.2.E The effect of the different methods of seeding on the average grain yield of Athenais barley from ten locations during 1967-74.

Treatment	Seed Rate kg/ha	Yield kg/ha
Conventional Drill 13 rows - 18 cm spacing	86	2,644
Deep-furrow Drill 16 rows - 20 cm spacing	86	2,390
Deep-furrow Drill 8 rows - 40 cm spacing	86	2,509
Deep-furrow Drill 8 rows - 40 cm spacing	57.5	2,323
Deep-furrow Drill 8 rows - 40 cm spacing	43	1,972

Dr. Frank Zillinsky from CIMMYT, Mexico, discussing triticale problems with Dr. M. Oggema, Director of the National Plant Breeding Station, Njoro, Kenya and members of his staff.

2.3 Iraq

Wheat was grown on 1,407,650 hectares in 1974-75 giving a production of 845,400 tonnes with an average yield of 600.4 kg/ha. Barley occupied 567,300 hectares with a production of 437,000 tonnes and a yield of 770.4 kg/ha.

Low and erratic distribution of rainfall in the major wheat and barley growing dry farming areas of the north and certain unavoidable problems, were the principal causes of reduced area and reduction in production and average yields. Under irrigation and in high rainfall areas, yields up to 1.7 t/ha were harvested.

Rains in general were deficient and the climate was drier than usual. Average rainfall in the low rainfall belt of Talafar amounted to 257 mm as against a normal fall of 350 mm. Protracted drought towards the grain filling and maturity period adversely affected yields especially in Neneva, the province with the largest area under wheat.

In the irrigated and high rainfall areas, high yielding varieties (HYV's) now occupy 80 percent of the wheat area and about 30 percent of the barley. These areas are increasing but in the low rainfall areas, mainly local varieties are still grown.

Under irrigation and high rainfall conditions, fertilizer use is expanding but under low rainfall conditions its use has been negligible so far. Current Iraqi dinar (ID) prices of fertilizer are:

Ammonium sulfate	ID 21/tonne
Urea	ID 34/tonne
Triple superphosphate	ID 160/tonne

The Government has provided a 50 percent subsidy for next year's crop to encourage fertilizer use and as a result sales have risen.

The recommended doses for HYV's, such as Mexipak, are 120 kg N + 40 kg P_2O_5 on irrigated land and 120 kg N + 80 kg P on high rainfall areas. Fertilizers are not used nor recommended on barley.

Shortage of irrigation water and non-availability of adequate quantities of seed of HYV's pose problems in wheat and barley expansion. During deficient rainfall years the area under the crops fall very low, especially under rainfed culture.

Mexipak, INIA 66 and Jori 69 varieties of wheat, and Numar and Arivat varieties of barley remained popular during the year. The new varieties Abu-Ghraib-1, Abu-Ghraib-2, Nuri 70 and Arz of bread wheat, and Cocorit 71 and V0029 of durum wheat, and Giza 120 of barley are all under increase.

The most promising lines of wheat and barley identified during the period were:

1. Bread Wheat: Cno-Gallo, Bb-INIA, HD832-Bb, Kal-FAO Mex 2 x Ajeeba x Mex 2, 17a-Son 64, and 7C-On x INIA-B.Mon.

2. Durum Wheat: Crane "S", (BY_E^2-Tc) (Tac-Tc) Als, Cocorit "S", Apollo.

3. Barley: V. Well, Arivat x Local, Plat x Su.Mari, Magnific, Starin 205 and Line 257/14.

During the years when rainfall is deficient, insect and disease problems are low and such was the case this year. In areas of high rainfall, covered smut and leaf rust caused some damage.

The government has been impressed with the performance of high yielding varieties when they are correctly grown. On the basis of these results, a pilot project will be launched for 1975-76. In it, about 30,000 hectares of wheat and 7000 hectares of barley will be sown under Government supervision using a complete package of practices -- good land preparation, improved seed of HYV's, adequate fertilizer use and chemical weed control. Both irrigated areas and an additional 7500 hectares in rainfed areas will be sown.

2.4 Nigeria

The total acre of wheat in Nigeria is about 12,000 acres (4800 ha) of which about 70 percent is grown under irrigation on large irrigation schemes, and 30 percent on fodamas (residual moisture on river flats and swamps). Barley is practically not grown, there being perhaps only 100 acres (40 hectares) in small lots on small farms. No triticale is currently grown.

Wheat yields are in the 2.5 tonnes/hectare (t/ha) range in the irrigated areas, although yields as high as 4.75 t/ha have been harvested. On the fodamas (small farms) the wheat yields vary from 0-0.75 t/ha. In the irrigated areas, poor management accounts for reduced yields. Barley yields in the test plots, are equal to wheat. In the yield trials, as much as six t/ha have been grown.

In Nigeria, wheat is sown during November or early December and harvested in late February or in March. The length of season which depends largely on the sowing date, varies from 100-120 days. There is no rainfall throughout the growing period, but sunshine insolation is reduced during December to January by the "Harmattan" wind blown dust from the Sahara. Maximum temperatures are 32-35°C in November, 30-32°C in December and January and 30-35°C in February. Minimum temperatures for the same months are 15-17°C, 12-14°C and 14-17°C respectively. The onset of the Harmattan (hot wind from the desert) marks the beginning of the "cool" season and this may occur anytime from late October to early December. Mid-November is normally the best time for sowing.

The high yielding varieties comprised about 33 per cent of production in 1974-75. They are expected to exceed 70 percent in 1975-76. Indus 66 and Siete Cerros are the principal varieties with Inia 66 likely to be recommended in coming years for the region south of Lake Chad. Its yields are inferior to Indus 66 by about 5-10 per cent, but the bread quality is superior.

No fertilizer is used on the fodamas. On the irrigation schemes its use is variable (from 0-200 kg/ha), with the average probably being less than 100 kg. The type of fertilizer used is affected by its availability. Fertilization ranges from top dressing with superphosphate only, to applying N only, all at sowing. Fertilizers are subsidized by the government, but the supply does not meet the demand. Other constraints include the problems of obtaining credit, and the supply logistics. The recommended fertilizer practice is to apply a basal application of superphosphate to the seed bed, and to apply N as a split application. The second N is applied three weeks after sowing.

The principal problems restricting further wheat expansion are the difficulties of establishing, maintaining and expanding irrigation schemes. The lack of trained personnel and insufficient planning, plus the lack of coordination of tractor hire units (which do almost all the cultivation with the irrigation sections), result in much reduced yields.

Dam construction is proceeding. Developments are planned for 300,000 acres (121,500 ha) in South Lake Chad State, more than 200,000 acres (81,000 ha) in Kano State, slightly less in the North West State and a number of small schemes in North Central State. Kano State is behind schedule. It is reported that about 10-20 per cent is in operation and in the other proposed schemes, work is only in the initial stages. There are no marketing arrangements for surplus wheat and this acts as a disincentive.

The newest varieties released are Indus 66 for South Lake Chad region and Siete Cerros in Kano State. Inia 66 is also being multiplied in South Lake Chad at a pilot farm. In 1971, (Lee-N10B)Gb 55) Gb 56 and Sonora 63 were released for Northern Nigeria.

The most promising lines in 1974-75 included Y50 - Kal^3, Pj62-Gb55 x Nai 60, Jupateco 73, Inia 66, Pi62 - Frond/pi62 - Mazee x Mxp from 11th ISWYN, Tanori 71, Kal-Son x Tob/Inia - Cno x Cal, Zambezi, Bb4 "S" (=Cajeme "S"), 12300 x LR64 - 8156/Noc 67 (=Cocoraque "S") and Pj62 (Inia "S"/Tob-Ofn x Bb) Cal from 10th ISWYN, 7th IBWSN and 8th IBWSN.

Others were: Pj62; 7C; Super x (=Indus 66); Inia "S" - Soty x Czho; Cno-Bb x Cal; Canario "S"; CC-Cno^2 x Tof - Cno "S"; Npo-Tob "S" x 8156/Kal-Bb; Vic x Cno "S" - 7C/Kal-Bb; Cal-CC x Son/Nr; Vic x Cno "S" - 7C/Kal - Bb and Sr-Bon.

A number of the triticales under test were high yielding but the grain was very poor. The most promising barley varieties under test were from NEDECO (previous consultants on the Kano River Project). These included Angwar, Tern, Triumph, Claudia, Zephyr and Diva.

Nigeria Breweries is underwriting a preliminary malting barley program to be conducted by the Institute of Agricultural Research.

There were no rusts during 1974-75 and their occurrence is very rare. Foot rot pathogens - Helminthosporium and Fusaria are potentially important on irrigation schemes and under rainfed culture on the Jos Plateau, where waterlogging is important and production potential questionable during the May-September wet season. Black point sometimes occurs.

In summary, it would appear that with good management and adoption of experiences at the research level, four t/ha of wheat could be very feasible, with better farmers achieving five t/ha. The limits of high temperature and short season on yield potential cannot be defined, since water management problems prevent a direct assessment. Date of sowing and rates of fertilizer application are critical, particularly on the upland soils of low fertility (Lake Chad region has heavy clay).

Mr. Omar A. Ameen inspects a crop of Cocorit 71 wheat at the Abu Ghraib Experiment Station near Baghdad, Iraq.

2.5 Saudi Arabia

Durum wheat has been grown in the Kingdom of Saudi Arabia for centuries. Agricultural statistics show that for the period 1960-61 to 1965- 6 the total area sown to wheat was 71,961 hectares (719,611 donums). This is about 75 percent of the total area sown to winter crops or 16 per cent of the total cropped area. Virtually the only variety grown was Sonia, a native durum.

Wheat is considered to be one of the most important crops of the Kingdom and it is sown under both irrigated and rainfed conditions. Much of the area is sown to the low yielding local variety which should be replaced. The method of planting should also be improved to make wheat production economic. Local wheat production is insufficient for the country's consumption and it is necessary to import most of the wheat and flour from outside sources.

Because of the increased world demand for wheat and the fall in production which occurred in 1972, prices rose rapidly. Exporting countries had reduced stockpiles, fertilizer prices rose and shipping costs increased. The result was a near tripling of the price which had been obtained in early 1972. Thus, it was considered essential that local wheat production should be fostered in the country.

The Ministry took steps to develop agricultural production in general, and grain production in particular. A short four-year production program was undertaken in 1971/72 to promote the sowing of Mexipak, and to show farmers the best way to sow. Also the program aimed to provide technical and financial support, using the training farms for demonstration and seed production.

In the first year, at no charge to the farmers, the Ministry provided experts, equipment, seeds and fertilizer. They also conducted the work on the training farms. Loans were made available to be repaid after harvest. Also, the farmers were instructed on the need to use the right proportions of fertilizer on Super X, the variety being grown (it was known as Mexipak but actually it was the red sister).

The results of the first year, 1971-71, were as follows:

Average yields were raised to 512 kg/donum (5.12 tonnes/hectare) in Derat and Durma, 394 kg/donum in Kharag and El Delm and 306 kg/donum at El Kosseim. In the process, pure seed was produced for use in the next year. Saudi technicians were trained in the use of modern agricultural equipment and the maintenance of seed purity. The training farm demonstrations convinced the farmers of the value of high yielding varieties and the use of fertilizers, as well as proper employment of irrigation to conserve water.

In the second year, 1972-73 the Ministry continued to extend its technical and financial services and it distributed N and P fertilizers to farms of Wadi El Dawasser. Further sowing of Mexipak as a rainfed wheat, was undertaken in Abha and El Taif. The area was increased in the second year from 570 to 1450 donums and average yields were 397 kg/donum. Forty farms were included. About two tonnes of clean seed was available for planting in the following year. Mexipak appeared promising on the rainfed areas.

Following the same procedure in the third year, 1973-74, the average yield rose to 443 kg/donum and the area was increased to 1820 donums. Yields were generally high in the farm field. The area which was provided with seed and technical supervision, was 1224 donums. In the fourth year, 1974-75, the average yield was 347 kg/donum on 96 training farms covering 2448 donums. The total area sown to Mexipak was 60,000 donums (5,500 ha).

In 1974-75, several varieties in the Sixth Regional Yield Trial looked promising. These included Awand, 5331 x Norteño, Mexipak 65, /(Kt54-N10B) Kt54B - Nai 54D/ (8156-Pj62 LR64-Son64 x CC/Ska and Carthage. In the Sixth International Durum Yield Nursery, Stork "S", Brant "S", Crane "S", Gs "S" (D-Buck x TM_E - Tc/LK), Cocorit 71 and Jori 69 were the top yielders, ranging from 5.3 to 6.7 tonnes/hectare (t/ha). This compares with 2.5 t/ha using the local variety Lokainy.

In the National bread wheat trial the better varieties were: Kal x FA0215-1-2, Supe X, Vican 71, Arz, Awand, (Son 64-C271 x 53-588-Andes/Pi) LR64, Pak 20 x HD832, Bawuk and Tanori. Yields ranged from 5.9 to 6.9 t/ha compared to the local Hista Medini at 3.9 t/ha. In the National durum trial, 21563-Gn"S", Gerardo VZ469-AA "S", 21563-JO "S", D. dwarf S15-Cr"S" and Jori 69 were the top five in yield. Their yields ranged from 5.7 to 6.4 t/ha compared to Lokairy at 3.4 t/ha.

In another trial conducted at five locations with eight varieties, Bartouk, Arz, Super X, and Kal-FA0215-1-2 Occupied the first four positions with yields from 3.7 to 4.4 t/ha as compared with the local check at 3.1 t/ha. In a similar trial with durums, Cocorit 71, Cisne "S" and Crane "S" occupied the first four positions with yields from 3.6 to 3.8 t/ha against the local check at 2.6 t/ha.

In sowing date trials, it was concluded that Super X and Jori 69 were best sown on December 1, with an earlier sowing at November 15 being the second best. Later sowings rapidly reduced yields. In an N trial there was some evidence of the advisability of splitting the N application at sowing, instead of applying all of it at once. This might be expected under the lighter soils at the experiment site.

In barley, Briggs, Beecher, So 02012 x US43, and Gazeh 68 x 70 were superior in yield to the local check. In the Regional trial, L272/3-4 and L 272/7/1 from Egypt, Trischedrilt from Algeria, Line 257/14 and Giza 121 held the first five positions.

In Algeria, Mr. L. Hachemi, Director of Research, discusses disease problems with Mr. Kebabsa, Director of Guelma Station, and his colleagues.

2.6 South Africa

The breeding and selection program for the irrigation areas of South Africa is reported from the Roodeplaat Research Station, Department of Agricultural Technical Services at Lynn East, Pretoria.

2.6.1 BREAD WHEAT BREEDING AND SELECTION.

The aims of the 1973 program were (1) to solve specific South African problems concerning yield potential, disease resistance, agronomic characteristics and quality; and (2) to maintain a local source of knowledge in this field.

During the 1973 season, 284 successful crosses were made. In the segregating generations 7880 single plants and lines were selected of which 494 were transferred to the Bread Wheat Evaluation Nursery 1974. Also from the Bread Wheat Late Entries and the Bread Wheat Isolation Nursery, 7 lines were transferred to the Bread Wheat Evaluation Nursery.

For the Bread Wheat Yield Trial 1974, 83 lines were selected of which 42 came from the Bread Wheat Evaluation Nursery 1973, 2 from the yield trial 1973, 26 from the 6th International Bread Wheat Screening Nursery and 13 from the 9th International Bread Wheat Yield Nursery.

The 6th International Bread Wheat Screening Nursery (6th IBWSN) and the 9th International Spring Wheat Yield Nursery (9th ISWYN), which were received from CIMMYT, were planted at Roodeplaat. Twenty grains of each line in the 9th ISWYN were also planted at Maktini for rust evaluation.

In the breeding work, about 80 per cent of the parental lines used, were taken from the following CIMMYT programs: 3rd and 4th ISN, 5th IBWSN and the 7th ISWYN.

2.6.2 BREAD WHEAT YIELD TRIALS.

Promising bread wheat lines of sufficient uniformity from the breeding and selection section, from the international nurseries and yield trials and from other sources were included in the Bread Wheat Yield Trial. This trial was planted over a wide range of localities in the Republic of South Africa and some localities outside South Africa. During selection, special attention was paid to a wide adaptation to the various localities with regards to climatological conditions and different agronomic practices. Characteristics like high yield combined with a good resistance against diseases (specially rusts), quality and desirable agronomical properties were emphasized.

The lines selected for the 1973 Bread Wheat Yield Trial were sown in randomized blocks with 4 replicates. The number of entries per trial was 25, including 3 standard cultivars. In all, four trials per locality were sown, indicated as 1973 BWYT, I, II, III and IV. The standard cultivars in each trial were Inia and T4 as constant standards plus a local standard. Plots consisted of 3 rows each 0.3m apart and 5m long.

Lines exceeding the experimental average by 1 1/2 standard error on two localities or the best standard line at 3 localities selected for the first time were transferred to the 1974 BWYT. Lines exceeding these criteria for the second time are transferred to the Bread Wheat Elite Trial.

The names and pedigrees of the entries in the yield trials, and their destiny are shown in tables 2.6.A, 2.6.B, 2.6.C and 2.6.D. The yields, size of standard error, least significant difference, and coefficient of variation of these trials are reported in tables 2.6.E, 2.6.F, 2.6.G and 2.6.H. Disease data on stem and leaf rust, mildew, wheat stunt, barley yellow dwarf virus and loose smut are reported in tables 2.6.I, 2.6.J, 2.6.K and 2.6.L. The results from quality testing for grain, flour, dough and baking characteristics are presented in tables 2.6.M, 2.6.N, 2.6.O and 2.6.P.

2.6.3 BREAD WHEAT ELITE TRIALS.

In the 1973 Bread Wheat Elite Trial 7 lines and Inia, T4 and Zambesi as standard cultivars were sown in a replicated trial consisting of 3 randomized blocks. Plots consisted of 6 row strips, with rows 0.3m apart and 15m long. The main purpose of this trial was seed increases of the elite lines, comparison with standard cultivars under semi-commercial circumstances and testing of the elite lines on localities that were unable to handle a full scale Bread Wheat Yield Trial.

Material, which consistently shows good characteristics is submitted for release to the Wheat Action Committee of the Department of Agricultural Technical Services and the Wheat Grading Committee of the South African Agricultural Union. The first committee judges the agronomic and the second the quality characteristics. The Wheat Control Board is responsible for the seed increases after a cultivar is declared acceptable for release. The Department of Agricultural Technical Services also undertakes a certain amount of propagation of seed from cultivars that are released. These plantings are regularly inspected by the Wheat Control Board.

The trials, which were planted at four localities in the Transvaal, received high levels of nitrogen (90-110 kg N/ha) to aim for high production yields. The irrigation treatments given were also aimed at high yield levels.

The seven outstanding lines being seed increased and under consideration for release were as follows:

Name of line	Pedigree	Proposed name after release
Bb No. 2	23584-26y-2m-1y-0m	Aerie
Inia 66/P4160	109-12m-1A-0G	Elize
23584 x Cno'S'-Son 64	28146-10y-0m	Heléne
Tokwe x Jaral 66	153-29m-1A-0G	Bonnie
Ciano 'S'(Inia'S')^2	II-23959-13T-4M-3Y-0M	Gail
(564-Y50$_E^5$ x Gto) Inia'S'	23528-7M-1T-1M-8Y-0M	Elrina
Bb No.4	23584-15y-6M-4M-0M	Gerda

A comprehensive report on the agronomic and quality characteristics over 3 years of testing were submitted during 1974 to the Wheat Action Committee and the Wheat Grading Committee, where Aerie, Elize and Helene were accepted for release.

2.6.4 DURUM WHEAT TRIALS

To 1973, the annual consumption of durum wheats in South Africa varied from 19000 - 23000 tonnes. An evaluation program for durum wheats is considered necessary to make the Republic independent of world markets, specially in times of world shortages and high prices.

In 1973, the 4th and 5th International Durum Yield Nurseries (IDYN) were received from CIMMYT. In the 4th IDYN, 11 lines exceeded the experimental average and 7 of these were transferred to the 1974 Durum Elite Trial. All of the 11 lines were transferred to the 1974 Durum Yield Trial. The 5th IDYN trial was severely damaged by birds, and could only be used for seed increases for replanting in 1974.

Yield and agronomic data of the lines which exceeded the experimental average in the 4th IDYN are shown in table 2.6.Q.

2.6.5 BISCUIT WHEAT YIELD TRIALS

The annual consumption of biscuit wheat in South Africa to 1973 amounted to 20,000 tonnes and a program was commenced to produce a suitable biscuit wheat cultivar.

Biscuit wheat material was planted at Roodeplaat and Glen. Of the 26 lines tested, four showed some promise, and one - Springfield - showed excellent promise as a biscuit wheat cultivar in South Africa. The agronomic data and yields of the lines tested are reported in table 2.6.R.

2.6.6 TRITICALE YIELD TRIALS

Triticale material totalling 108 lines in the 4th International Triticale Screening Nursery from CIMMYT was evaluated in single rows at Roodeplaat. The twenty best yielding lines which are shown in table 2.6.S, together with their agronomic characteristics, were transferred to the 1974 Triticale Yield Trial for nationwide testing. Thirteen lines outyielded Inia.

TABLE 2.6.A 1973 BREAD WHEAT YIELD TRIAL I. LIST OF LINES

CULTIVAR NO.	NAME OF CULTIVAR	PEDIGREE	DESTINY OF LINE
1.	Inia 66 (standard)		
2.	Bb 4 A (R)	23584-26y-2m-3y-1m-0y	1,2
3.	Cajeme 'S'	23584-26y-2m-3y-2m-0y-300m	1
4.	Bb x Inia	26591-1t-7m-0m-39y-0m	4
5.	Yecora 'S'	23584-26y-2m-0m-43y-0m-48y-0m	1
6.	Bluebird	23584-26y-2n-3y-1m-40y-105m-0m	1
7.	Yecora 'S'	23584-26y-2m-1y-0m-(1-5y)-47y-0m	1
8.	Cajeme 71		1,2
9.	Yecora 'S'	23584-26y-2m-1y-0m-2y-0m	4
10.	Cajeme 'S'	23584-26y-2n-3y-2m-0y-1m-0m	1
11.	Cajeme 'S'	23584-26y-2m-3y-2m-0y-300m	1
12.	Wit Zambezi		4
13.	T4 (standard)		
14.	Ciano 'S' x Inia 'S'^{2}	II 23959-27t-11m-5y-0m	4
15.	Bb-Nor 67	27100-278m-1y-6m-0y	4
16.	Inia 67-Cal(Inia S/864	28647-67y-1m-0y	4
17.	Napo-Tob 'S' x 8156 (R)	28071-7m-3y-5m-1y-0m	4
18.	Bb-Nor 67	27100-110m-1y-3m-0y	4
19.	Bb-Nor 67	27100-110m-3y-4m-0y	1
20.	Tob-P'due x CnO	24277-20y-4m-0y	4
21.	LR 64'-564xCC/Cno-Chris		1
22.	Zambezi		4
23.	Bb x Cno ((LR64/S64 x SKE-Ane)Cno)	CM 1503-20m-0y	4
24.	Inia 'S' On x Inia-Bb	CM 1607-7m-0y	1
25.	Local check		

1. To 1974 Bread Wheat Yield Trial
2. To 1974 Bread Wheat Elite Trial II
3. To 1974 Bread Wheat Elite Trial I
4. Rejected.

TABLE 2.6.B 1973 BREAD WHEAT YIELD TRIAL II. LIST OF LINES

CULTIVAR NO.	NAME OF CULTIVAR	PEDIGREE	DESTINY OF LINE
26.	Inia (standard)		
27.	Cno'S' -No66(resel)	27811-2y-1m-1y-1m-0y	4
28.	Inia x Bb	21478-7y-9m-0y	1,2
29.	Ciano 'S' x 8156 (B)	25332-6m-3r-11m-4y-0m	4
30.	Bb x Cno-S0n 64	28146-10y-1m-2y-0m	1
31.	P.V. 18A - Cno 67	27893 - 20y-8m-4y-0m	4
32.	Inia-Cal(Inia'S'/S64Y50^{3}xGlo)	28647-67y-1m-1y-0m	4
33.	K-F4-16		4
34.	Kalyan x Bb	26992-30m-300y-300m-501y-500m-0y	4
35.	Cno 'S' -Bj 67	27939-18m-1m-1y-1m-0y	4
36.	Cno 'S' x Bb	26939-89m-1y-4m-0y	1,2
37.	Bb no. 3 - Sarie 70	23584-2y-2m-2y-0m	4
38.	T4 (standaard)		
39.	Bb no. 2	23584-26y-2m-1y-0m	3
40.	23584 x Inia 66	26591-1t-17m-0y	1
41.	Cno 'S' x Inia 'S'^{2}	II 23595-13t-4m-3y-0m	3
42.	Bb no. 1	23584-15y-6m-0y	4
43.	Bb no. 4	23584-26y-2m-3y-2m-0y	1,2
44.	Mtelikwe		4
45.	Devuli		4
46.	Inia'S' x Napo 63		4
47.	7 Cerros		
48.	Cno^2 (S64-K1 Rend)	II 23584-5y-6m-0y	4
49.	23584 x Cno 'S' - S64	28146-10y-0m	3
50.	Local check		

1. To 1974 Bread Wheat Yield Trial
2. To 1974 Bread Wheat Elite Trial II
3. To 1974 Bread Wheat Elite Trial I
4. Rejected

TABLE 2.6.C 1973 BREAD WHEAT YIELD TRIAL III. LIST OF LINES

CULTIVAR NO.	NAME OF CULTIVAR	PEDIGREE	DESTINY OF LINES
51.	Inia 66 (standard)		
52.	S64-Y50^5 x Gto /Inia	23528-7m-1y-1m-8y-0m	3
53.	Yecora 'S' (B)	23584-26y-2m-1y-0m-86-0m	1
54.	Yecora 'S'	23584-26y-2m-1y-0m-89y	1,2
55.	Bb no. 4 A(R)	23584-26y-2m-3y-1m-0y	1,2
56.	Yecora ISI (R)	23584-26y-2m-1y-0m(6-10y)	4
57.	Ciano 'S' - Gallo	27829-19y-2m-0y	4
58.	Yecora 70		3
59.	Cno-7 Cerros x Cno-Pj 62	25917-7y-6m-1y-0m	4
60.	(LR x Nor 10B) An^{1}e^1 'S'/Lundi		1
61.	T-K-Y50/Inia 66		4
62..	Tob x 8156 (R)		4
63.	T4 (standard		
64.	Son 64 x K1 Rend	II 19975-68g-1j-1b-10y-0y	4
65.	(Cno'S' x S64-K1 Rend)8156	II 23584-15y-6m-0y-0m	4
66.	Cno'S' Inia 'S'^{2}		4
67.	Inia x 23584	II 26478-7y-10m-0y	1,2
68.	23584 x Tob 66	II 26595-8y-1m-0y	1,2
69.	Cno-Inia x Calidad	27224-36m-1y-0m	1
70.	23584-Inia 66 x Cal	27237-68m-1y-0m	1,2
71.	Cno 'S' x No		4
72.	Tob 66 x Cno 'S'	24908-30m-3y-3m-0y	1
73.	Cno c No. 66	25111-6m-7y-3m-0y	4
74.	Wit Zambezi		4
75.	Local check		

1. To 1974 Bread Wheat Yield Trial
2. To 1974 Bread Wheat Elite Trial II
3. To 1974 Bread Wheat Elite Trial I
4. Rejected

TABLE 2.6.D 1973 BREAD WHEAT YIELD TRIAL IV. LIST OF LINES

CULTIVAR NO.	NAME OF CULTIVAR	PEDIGREE	DESTINY OF LINE
76.	Inia 66 (standard)		
77.	LR 64A II-50-25 SK	161-2m-1a-0g	4
78.	Tokwe x Jaral 66	153-29m-1m-0g	3
79.	Inia 66/P4160	109-12m-1a-0g	3
80.	K1 Rend-S64[2] x Inia 'S'/Cno'S'	24970-29m-3y-2m-0y	4
81.	Inia 'S' x Napo 63		4
82.	Hira	H.D. 1941-/ES 477x S64	4
83.	Jaral 'S'/Lee -SK Mara		4
84.	Pitic 62		4
85.	LR 64 - N 10B - An_e[3]		4
86.	Mexico no. 120		1
87.	Hazera 2152		5
88.	T4 (standard)		
89.	Chhoti-Lerma	15929-1m-4r-2m	1
90.	Jaral 'S'	18889-6t-2t-2b-1t-1t	4
91.	Mexicano 1481		4
92.	Sanalika		4
93.	Kalyansona		1
94.	Bb no. 5		4
95.	Sekel		4
96.	Nana		4
97.	Muthi		4
98.	Tokwe		4
99.	41A (Rhod)		4
100.	Local check		

1. To 1974 Bread Wheat Yield Trial
2. To 1974 Bread Wheat Elite Trial II
3. To 1974 Bread Wheat Elite Trial I
4. Rejected.

TABLE 2.6.E YIELDS AT VARIOUS LOCALITIES OF THE LINES AND CULTIVARS INCLUDED IN THE 1973 BREAD WHEAT YIELD TRIAL I.

CULT. NO.	ROODEPLAAT		LOSKOP		VAALHARTS		SANDVET		MAKATINI		KOKSTAD		DÖHNE		GROOTFONTEIN		OUDTSHOORN		HARDAP		MAHANENE		MOCAMBIQUE	
	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.
1	3551	0	6864	1	4733	0	5111	0	4587	7	4614	0	3793	0	5471	0	3749	0	4140	0	2191	0	3120	
2	3782	0	6873	1	5536	0	5277	0	2753	0	5694	0	4453	1	5578	0	4060	0	4487	0	2202	0	2167	
3	3664	1	6670	0	5044	0	5553	1	1827	0	6154	1	5127	4	5558	0	4811	1	4160	0	1556	0	2082	
4	3795	0	6297	0	5667	1	5444	1	3013	0	5814	0	5200	4	5009	0	3993	0	4427	0	2024	0	2922	
5	3611	0	6519	0	6214	3	5499	1	2360	0	6000	1	4907	3	6026	2	4567	1	4214	0	2351	0	2052	
6	3964	1	6662	0	5133	0	5499	1	1993	0	4940	0	4100	0	6173	2	4164	0	4620	1	1778	0	1771	
7	3840	0	7113	1	6444	3	5555	1	2113	0	6827	3	4787	2	5636	0	3878	0	3874	0	2273	0	2212	
8	3789	0	6982	1	5511	0	5611	2	2140	0	4714	0	4020	0	5120	0	4387	0	2813	0	1349	0	2258	
9	3953	1	6619	0	5089	0	5277	0	4260	6	5760	0	4507	1	4960	0	3571	0	3220	0	2507	0	3089	
10	3453	0	6964	1	5955	2	5833	3	2360	0	6234	1	4953	3	6062	2	3660	0	3287	0	1969	0	2276	
11	3460	0	6666	1	5778	1	5388	0	1460	0	5800	0	4373	0	5191	0	4647	1	4467	0	1544	0	1747	
12	3889	1	6786	0	6000	2	5388	0	2893	0	6240	1	3193	0	5693	1	4651	1	4534	1	3296	2	2356	
13	3951	1	6755	0	6667	4	5555	1	1933	0	6874	3	3580	0	5080	0	4476	0	4074	0	2144	0	1991	
14	-	-	5831	0	4333	0	5000	0	3427	2	5014	0	3687	0	4318	0	3640	0	3153	0	2222	0	3347	
15	3284	0	6179	0	4622	0	4944	0	3180	1	5587	0	3980	0	4491	0	3482	0	3980	0	2480	0	2660	
16	3386	0	6810	0	5556	0	5444	1	4474	7	5387	0	3747	0	5164	0	3864	0	4340	0	1902	0	2224	
17	2937	0	5811	0	4200	0	4722	0	3027	0	4847	0	3693	0	5376	0	4160	0	4154	0	2036	1	2307	
18	3811	0	6373	0	4556	0	4944	0	2953	0	4927	0	3947	0	4869	0	3451	0	3587	0	1678	0	2840	
19	3462	0	5931	0	5333	0	5555	1	2860	0	5494	0	4020	3	5102	0	3733	0	4134	0	2213	0	2644	
20	3757	0	6282	0	5000	0	5277	0	3927	4	5440	0	3687	0	5331	0	3913	0	4167	0	2402	0	2700	
21	3571	0	6713	0	6067	2	4833	0	3293	0	5707	0	4180	0	5655	1	4498	0	4327	0	2522	0	2027	
22	3760	0	6626	0	5955	2	5444	1	2627	0	6574	2	3653	0	6097	2	4560	1	5107	2	3318	2	2240	
23	3626	0	5944	0	4889	0	4500	0	2993	0	4720	0	3460	0	4807	0	3991	0	3714	0	2673	1	2209	
24	3804	0	6157	0	3978	0	4944	0	3740	3	4567	0	4540	1	5202	0	4000	0	3694	0	3224	2	3082	
25	3973	1	6784	0	5689	1	5277	0	2560	0	5720	0	4140	0	5004	0	3880	0	4620	1	2542	0	2560	
Exp. ave. (kg/ha)	3671		6539		5377		5275		2910		5587		4185		5316		4072		4052		2291		2507	
L.S.D. (kg/ha)	217		344		329		177		247		420		236		368		506		512		416			
C.V. %	10		9		11		6		15		13		10		12		22		22		32		7	
S.E. (kg/ha)	184		300		289		156		213		366		207		322		442		443		364		186	

1 S.E. = Standard error of mean.

Yields exceeding the experimental average by at least one standard error, are underlined.

TABLE 2.6.F YIELDS AT VARIOUS LOCALITIES OF THE LINES AND CULTIVARS INCLUDED IN THE 1973 BREAD WHEAT YIELD TRIAL II.

CULT. NO.	ROODEPLAAT		LOSKOP		VAALHARTS		SANDVET		MAKATINI		KOKSTAD		DÖHNE		GROOTFONTEIN		OUDTSHOORN		HARDAP		MAHANENE		MOCAMBIQUE	
	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.
26	4035	0	6853	2	4844	0	5222	1	4120	2	5694	0	3533	0	5069	0	5100	1	3694	0	2291	0	2942	
27	3580	0	5699	0	5356	0	4722	0	4107	2	5940	0	4353	1	4611	0	4789	0	4254	0	1778	0	2292	
28	4188	1	7035	2	5289	0	5000	0	3507	0	4834	0	4173	1	4922	0	5209	1	4107	0	1931	0	2361	
29	3560	0	6108	0	5333	0	4166	0	4394	3	4080	0	3720	0	5226	1	4316	0	3960	0	1822	0	2464	
30	4464	3	6266	0	5511	0	5388	2	2860	0	5167	0	4440	2	5399	1	5258	1	3674	0	2762	1	2724	
31	4406	2	6190	0	5244	0	4722	0	3727	0	5554	0	3733	0	5089	0	4440	0	4027	0	1644	0	2808	
32	4226	1	6710	1	5889	1	5222	1	4420	3	6200	1	3753	0	4280	0	4789	0	4314	0	2064	0	2454	
33	-	-	6162	0	5111	0	4444	0	4007	1	5667	0	3520	0	4524	0	4962	0	4127	0	1787	0	2469	
34	4157	1	6777	1	6133	1	5444	2	3667	0	5774	0	3893	0	4960	0	4531	0	4180	0	2489	1	2441	
35	3795	0	6131	0	5889	1	4555	0	4127	2	5887	0	3360	0	4869	0	4409	0	3793	0	1811	0	2167	
36	4020	0	6199	0	4111	0	4444	0	4580	3	5594	0	3680	0	5116	0	5116	1	4014	0	1718	0	2627	
37	3680	0	6628	1	6333	2	4500	0	2060	0	5480	0	3960	0	4960	0	4855	0	5287	2	2084	0	1821	
38	4568	3	6950	2	7444	5	5889	4	2373	0	6747	2	4073	0	4964	0	4762	0	5233	2	1951	0	2073	
39	4044	0	6642	1	5667	0	4535	0	3994	1	5387	0	4720	3	4784	0	3311	2	4174	0	2000	0	2271	
40	3997	0	6024	0	5444	0	4833	0	3980	1	6020	0	4560	2	4960	0	5247	1	3740	0	2022	0	2162	
41	3620	0	6124	0	4111	0	4388	0	3934	1	5314	0	3320	0	4533	0	4171	0	3807	0	1524	0	2703	
42	3500	0	6402	0	5755	0	4944	0	3947	1	6080	1	4747	3	4564	0	4769	0	4514	0	2464	0	2633	
43	3597	0	6799	1	5222	0	5111	1	2387	0	6227	1	4447	2	4551	0	4602	0	4700	1	1911	0	1732	
44	3406	0	5699	0	5511	0	3944	0	2047	0	5147	0	4213	1	4862	0	5051	1	4154	0	2798	1	1368	
45	3904	0	6244	0	6533	3	5611	3	3514	0	6327	1	3587	0	5286	1	4427	0	4354	0	2696	1	2429	
46	4255	1	6462	0	5289	0	5388	2	3720	0	6140	1	4007	0	4929	0	4636	0	3527	0	2476	0	2399	
47	3711	0	6639	1	6578	3	5999	4	2200	0	5680	0	2987	0	4987	0	4447	0	3880	0	3076	2	2583	
48	3517	0	4711	0	4000	0	2944	0	4100	2	4167	0	2873	0	4287	0	4242	0	3293	0	1884	0	2239	
49	5373	2	6637	1	4067	0	5000	0	2807	0	5374	0	4160	1	5144	0	4989	0	3007	0	2620	1	2637	
50	3606	0	5724	0	6355	2	5277	1	2727	0	5774	0	4040	0	4658	0	4113	0	3420	0	2307	1	2281	
Exp. ave. (kg/ha)	3926		6313		5479		4869		3494		5667		3917		4862		4740		4047		2164		2363	
L.S.D. (kg/ha)	202		301		393		284		327		500		280		335		260		586		264		-	
C.V. %	9		8		13		10		16		16		13		12		10		25		29		9	
S.E. (kg/ha)	177		262		344		244		287		433		247		293		263		512		913		220	

1 S.E. = Standard error of mean.

Yields exceeding the experimental average by at least one standard error, are underlined.

TABLE 2.6.G YIELDS AT VARIOUS LOCALITIES OF THE LINES AND CULTIVARS INCLUDED IN THE 1973 BREAD WHEAT YIELD TRIAL III.

CULT. NO.	ROODEPLAAT		LOSKOP		VAALHARTS		SANDVET		MAKATINI		KOKSTAD		DÖHNE		GROOTFONTEIN		OUDTSHOORN		HARDAP		MAHANENE		MOCAMBIQUE	
	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.
51	3593	0	6146	0	5022	0	5111	0	4320	2	5254	0	4313	1	4818	0	4667	0	4534	0	2078	0	3167	
52	3817	1	6546	0	5089	0	5277	1	3860	1	6535	1	4453	1	5047	0	5082	1	4674	0	2200	0	2788	
53	3700	1	6564	0	6289	2	4722	0	4034	1	6520	1	4773	3	2738	0	5111	1	4040	0	2076	0	2977	
54	1529	0	8375	0	5644	0	4500	0	4527	3	6860	2	4327	1	4609	0	5149	1	3920	0	2222	0	2653	
55	3491	0	7002	2	6111	1	5666	3	2367	0	6120	0	4987	5	4602	0	5236	1	4820	0	2620	0	2148	
56	3377	0	6586	0	6111	1	4838	0	3814	1	6807	2	4247	0	5666	2	4807	1	4460	0	1684	0	2506	
57	3291	0	6349	0	5844	0	5055	0	3727	0	5874	0	3740	0	4571	0	4956	1	3907	0	2298	0	3021	
58	3353	0	6508	0	6178	1	5000	0	3207	0	6500	1	4573	2	5124	0	4391	0	4960	1	2213	0	2348	
59	3622	0	7053	2	6844	5	5166	0	2647	0	5627	0	3367	0	4820	0	4251	0	4120	0	2318	0	2447	
60	3833	1	6764	1	7444	8	5909	5	1780	0	6607	2	3767	0	5388	1	4304	0	5267	1	2100	0	2514	
61	3766	1	6386	0	6289	2	4500	0	4474	3	5880	0	4453	1	4753	0	4387	0	4460	0	1821	0	2700	
62	3520	0	6824	1	6778	4	5222	1	3700	0	6174	1	4427	1	4671	0	4533	0	4220	0	2469	0	2443	
63	3644	1	7137	2	7622	9	6111	6	3013	0	6887	2	3900	0	4360	0	4942	1	5934	3	2840	0	2197	
64	3286	0	6066	0	5622	0	4777	0	4167	2	5700	0	3720	0	4638	0	4213	0	4240	0	2118	0	2816	
65	3526	0	6213	0	6000	0	4838	0	3814	1	5954	0	3767	0	4469	0	4680	0	4534	0	4351	0	2409	
66	3571	0	6219	0	5133	0	5055	0	4027	1	5034	0	3640	0	5051	0	3649	0	4127	0	2642	0	2714	
67	3620	0	5788	0	4889	0	4388	0	4074	1	4090	0	3967	0	4873	0	4209	0	3660	0	3067	1	2266	
68	3266	0	6497	0	6178	1	4888	0	3080	0	5974	0	4847	4	5116	0	4169	0	4280	0	2691	0	2350	
69	2742	0	6015	0	5800	0	4388	0	3734	0	6140	0	4500	2	5027	0	4313	0	4547	0	3156	1	2282	
70	3389	0	6479	0	5089	0	4722	0	3720	0	5154	0	4367	1	5417	2	4353	0	3987	0	2678	0	2733	
71	2802	0	6433	0	5622	0	5055	0	2920	0	5154	0	4300	1	5173	0	4333	0	3987	0	2153	0	2471	
72	2911	0	6382	0	5867	0	4777	0	3427	0	5247	0	4113	0	5333	1	4151	0	4194	0	3507	2	2398	
73	3175	0	5971	0	3911	0	4611	0	3954	1	5160	0	3647	0	5235	1	4247	0	4074	0	2196	0	2703	
74	3575	0	6633	0	6400	2	5277	1	2520	0	6220	0	3480	0	5173	0	5251	1	3660	0	2998	1	2235	
75	3335	0	6691	0	6667	4	5388	2	2893	0	4740	0	3600	0	3413	0	4327	0	4407	0	2398	0	2310	
Exp. ave. (kg/ha)	3424		6465		5933		5035		3514		5894		4131		4883		4549		4361		2436		2543	
L.S.D. (kg£ha)	241		673		200		207		340		393		193		151		432		532		540		-	
C.V. %	12		7		6		7		17		12		8		11		17		21		39		9	
S.E. (kg/ha)	207		236		178		178		300		347		167		267		378		466		473		219	

1. S.E. = Standard error of mean

Yields exceeding the experimental average by at least one standard error, are underlined.

TABLE 2.6.H YIELDS AT VARIOUS LOCALITIES OF THE LINES AND CULTIVARS INCLUDED IN THE 1973 BREAD WHEAT YIELD TRIAL IV.

CULT. NO.	ROODEPLAAT				VAALHARTS		SANDVET		MAKATINI		KOKSTAD		DEHNE		GROOTFONTEIN		OUDTSHOORN		HARDAP		MAHANENE		MOCAMBIQUE	
	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.	YIELD	S.E.
76	4395	1	6697	0	4800	0	5222	0	3760	4	3820	0	3647	1	4624	1	4007	0	4220	0	1742	0	2924	
77	3975	0	6319	0	5200	0	4722	0	3460	2	4560	0	3573	0	4238	0	4336	0	4634	0	2000	0	2686	
78	4037	0	6797	1	5778	0	5388	0	3834	4	6220	1	3907	2	4506	1	4856	1	5207	0	2044	0	2296	
79	4362	1	6882	1	5000	0	5222	0	3747	4	4247	0	3180	0	4531	1	4238	0	4640	0	1753	0	2743	
80	3984	0	6566	0	5556	0	5333	0	3554	3	4507	0	3767	1	4240	0	4280	0	4814	0	1976	0	2317	
81	4337	1	6779	1	4889	0	5000	0	3940	4	4167	0	3513	0	4453	1	4398	0	3587	0	1231	0	2952	
82	4091	0	6062	0	6289	0	3722	0	2253	0	4707	0	2380	0	4033	0	4556	0	3754	0	1511	0	2065	
83	3626	0	5831	0	4889	0	4055	0	2807	0	4600	0	3693	0	3840	0	4544	0	4620	0	1578	0	1831	
84	3244	0	5151	0	7333	5	5944	3	1467	0	4460	0	3220	0	5614	5	4640	0	5074	0	1498	0	1987	
85	3840	0	7321	3	7511	5	5944	3	1727	0	5440	0	3280	0	5048	3	4960	2	4814	0	1876	0	2353	
86	4051	0	6382	1	5511	0	5277	0	1173	0	5374	0	2447	0	3480	0	3664	0	5954	2	2058	0	1564	
87	4200	0	6919	1	6622	2	5166	0	2580	0	5420	0	3227	0	4300	0	4980	2	5647	2	2414	2	2389	
88	4535	4	7281	3	8067	8	6166	4	1527	0	6734	2	3000	0	4508	1	4447	0	6594	4	2087	0	2432	
89	3662	0	6848	1	6511	1	5777	2	3267	2	6354	1	3093	2	4320	0	5091	2	5614	1	2118	0	2598	
90	4040	0	6802	1	7400	5	5611	2	1427	0	6174	1	3153	0	4404	0	4471	0	5354	1	1911	0	1521	
91	4351	1	5671	0	7844	7	6666	7	1527	0	5294	0	3220	0	4171	0	4284	0	4820	0	2084	0	2103	
92	3809	0	6248	0	5111	0	5333	0	3920	4	5647	0	4240	3	4316	0	4782	1	4334	0	2067	0	5222	
93	4800	3	6655	0	7333	3	6333	5	2847	0	6314	1	3207	0	4760	2	4513	0	5540	1	2333	2	2568	
94	3411	0	5655	0	4800	0	4055	0	3367	2	5374	0	4493	4	2884	0	3976	0	4494	0	2062	0	2579	
95	3875	0	6279	0	5778	0	4666	0	3400	2	5860	0	3753	1	3658	0	4471	0	4434	0	2078	0	2428	
96	3437	0	5914	0	4644	0	2722	0	3307	2	3740	0	2380	0	3669	0	3709	0	4447	0	1813	0	1998	
97	3637	0	6046	0	5333	0	4166	0	3173	1	5140	0	4540	4	3424	0	4184	0	4754	0	2109	0	2453	
98	3715	0	5638	0	5733	0	4833	0	2067	0	5880	0	3293	0	2873	0	3673	0	4574	0	1951	0	1855	
99	4177	0	6968	1	7667	6	6388	5	2833	0	6040	1	3353	0	4929	2	4967	2	5300	1	1831	0	2523	
100	4104	0	6135	0	6955	3	6277	5	3213	1	4967	0	3220	0	3584		4153	0	4354	0	1829	0	2339	
Exp. ave. (kg/ha)	4000		6440		6089		5200		2807		5200		3403		4178		4407		4863		1919		2333	
L.S.D. (kg/ha)	232		311		280		220		253		680		193		304		296		453		232		-	
C.V. %	10		85		8		7		16		23		14		13		12		16		20		10	
S.E. (kg/ha)	203		273		244		200		227		593		240		267		259		393		202		227	

1. S.E. = Standard error of mean

Yields exceeding the experimental average by at least one standard error are underlined.

TABLE 2.6.I DISEASE RESISTANCE OBSERVED IN THE 1973 BREAD WHEAT YIELD TRIAL I.

CULT. NO.	VAALHARTS MILDEW %	VAALHARTS WHEAT STUNT	MAKATINI LEAF RUST	MAKATINI STEM RUST	DIHNE LEAF RUST %	DIHNE STEM RUST %	OUDTSHOORN B.Y.D.[1]	OUDTSHOORN LEAF RUST	OUDTSHOORN STEM RUST	MAHANENG LOOSE = SMUT
1.	20	Fairly resistant	995	105	80	20	X	0	0	0
2.	10	Fairly resistant	80ms-s	10ms	90	30		0	0	1
3.	0	Resistant	99ms-s	25ms	30	0		0	0	0
4.	20	Fairly resistant	65r-mr	5s	0	0		0	0	10
5.	10	Fairly resistant	99s	10s	30	0	X	0	0	0
6.	0	Resistant	99s-ms	ts	30	0	X	0	0	0
7.	10	Fairly resistant	99ms-s	5ms	70	0		0	0	0
8.	10	Fairly resistant	80ms-s	25s	0	0		0	0	0
9.	10	Fairly resistant	99s	5ms	90	0		0	0	2
10.	0	Resistant	99s-ms	5ms	0	0	X	0	0	0
11.	10	Fairly resistant	99ms	5ms	10	0	X	0	0	0
12.	10	Fairly resistant	99s	5s	90	20		25s	0	0
13.	0	Resistant	99s-ms	99s	90	90		25mr	0	0
14.	20	Fairly resistant	99s	255-ms	0	0		0	0	5
15.	10	Fairly resistant	99s	5ms	5	0		0	0	3
16.	10	Fairly resistant	40ms	255ms	0	20	X	0	0	2
17.	20	Fairly resistant	40r-mr	5s	90	0		0	0	3
18.	10	Fairly resistant	40ms	10ms	5	0		0	0	4
19.	10	Fairly resistant	25ms	tms	40	0		0	0	6
20.	10	Fairly resistant	99s	40s	50	30	X	0	0	4
21.	10	Fairly resistant	99s-ms	0,10s	40	0	X	0	0	5
22.	10	Fairly resistant	99s	ts	80	10		45s	0	0
23.	20	Fairly resistant	65s	5ms-s	40	0		0	0	2
24.	10	Fairly resistant	65s-ms	55	0	5		0	0	17
25.	0	Resistant	99s	10s	0	10		0	0	0

= Barley

1. B.Y.D.= Yellow Dwarf virus
2. Total number of infected ears observed in the four replicates.

TABLE 2.6.J DISEASE RESISTANCE OBSERVED IN THE 1973 BREAD WHEAT YIELD TRIAL II.

CULT. NO.	VAALHARTS MILDEW %	VAALHARTS WHEAT STUNT	MAKATINI LEAF RUST	MAKATINI STEM RUST	DÖHNE LEAF RUST %	DÖHNE STEM RUST %	OUDTSHOORN B.Y.D.[1]	OUDTSHOORN LEAF RUST	OUDTSHOORN STEM RUST	MAJANENE LOOSE S. SMUT
26.	10	Fairly Resistant	99s	5ms	100	0		0	0	0
27.	20	Fairly Resistant	25ms-mr	5r-ms	0	0		0	0	6
28.	10	Fairly Resistant	25ms	25s	50	0		0	0	9
29.	10	Fairly Resistant	80mr	25s	0	0	X	0	0	1
30.	10	Fairly Resistant	25s	10s	0(90)	0(90)		0	0	0
31.	10	Fairly Resistant	65ms	10s	0	0		0	0	1
32.	20	Fairly Resistant	25ms-s	5s	0	0		0	0	4
33.	20	Fairly Resistant	40mr-ms	0	20	0		0	0	9
34.	20	Fairly Resistant	25mr-r	0	0	10		0	0	4
35.	10	Fairly Resistant	25r-mr	0	10	0		0	0	0
36.	10	Fairly Resistant	65ms-s	5s	0	10	XX	0	0	2
37.	10	Fairly Resistant	99s	tms	20	0		0	0	0
38.	10	Resistant	99ms-mr	99s	80	90		45mr	0	0
39.	10	Fairly Resistant	99ms	tms	80	0	X	0	0	5
40.	10	Fairly Resistant	50mr-ms	10s-ms	0	0	X	0	0	11
41.	10	Fairly Resistant	40ms-mr	10ms	0	0	X	0	0	1
42.	10	Fairly Resistant	65ms-s	40s-ms	100	100		25mr	0	6
43.	10	Fairly Resistant	65ms-s	5s	70	0		0	0	3
44.	10	Fairly Resistant	99s	10s	100	0		10s	10s	0
45.	10	Fairly Resistant	99ms-s	80s	100	90		25mr	0	3
46.	10	Fairly Resistant	99s	40s	90	80		0	0	2
47.	10	Fairly Resistant	99ms	65s	100	100		25mr	0	0
48.	10	Fairly Resistant	99s	tms	35	20		0	0	0
49.	10	Fairly Resistant	25ms	20ms	0	0		0	0	2
50.	0	Resistant	99s	5ms	0	0		0	0	0

1. B.Y.D. = Barley Yellow Dwarf virus
2. Total number of infected ears observed in the four replicates

TABLE 2.6.K DISEASE RESISTANCE OBSERVED IN THE 1973 BREAD WHEAT YIELD TRIAL III.

CULT. NO.	VAALHARTS MILDEW %	VAALHARTS WHEAT STUNT	MAKATINI LEAF RUST	MAKATINI STEM RUST	DÖHNE LEAF RUST %	DÖHNE STEM RUST %	OUDTSHOORN B.Y.D.[1]	OUDTSHOORN LEAF RUST	OUDTSHOORN STEM RUST	MANANFING LOOSE S. SMUT
51.	10	Fairly Resistant	99s	5ms	80	0		0	0	0
52.	10	Fairly Resistant	25ms-s	tms	30	0		0	0	4
53.	10	Fairly Resistant	80ms-s	99s	100	0		0	0	0
54.	20	Fairly Resistant	65ms	10s	90	0		0	0	3
55.	10	Resistant	99ms-s	5ms	70	0		0	0	0
56.	10	Fairly Resistant	99ms	25s	70	0		0	0	2
57.	10	Fairly Resistant	25mr-r	5ms	0	0		0	0	1
58.	10	Fairly Resistant	65s-ms	tms	75	0		0	0	4
59.	10	Resistant	25mr-r	tms	0	0		0	0	0
60.	0	Fairly Resistant	80ms-s	99s	90	90		0	0	0
61.	20	Fairly Resistant	99s	10s	90	5		10s	0	4
62.	10	Fairly Resistant	40ms	25ms	0	0		0	0	0
63.	10	Resistant	65s-ms	65s	100	90		tmr	0	0
64.	10	Fairly Resistant	65ms	105	5	0		0	0	2
65.	10	Fairly Resistant	25ms	25s	20	0		0	0	3
66.	10	Fairly Resistant	99s	ts	70	0		0	0	0
67.	10	Fairly Resistant	25ms	5s	0	0		0	0	7
68.	0	Fairly Resistant	65ms-0	50s	70	0		0	0	6
69.	10	Resistant	25ms	10s	0	0		0	0	0
70.	10	Fairly Resistant	80mr-ms	10s	60	0		0	0	0
71.	20	Fairly Resistant	50ms-s	20s	80	0		0	0	0
72.	10	Fairly Resistant	10vr-ms	10s	0	0		0	0	0
73.	10	Fairly Resistant	25ms	20s-ms	60	0		0	0	0
74.	10	Fairly Resistant	99s	40s	90	80		50s	0	0
75.	10	Resistant	99s	5s	40	0		0	0	0

1. B.Y.D.= Barley Yellow Dwarf Virus
2. Total numbers of infected ears observed in the four replicates.

TABLE 2.6.L DISEASE RESISTANCE OBSERVED IN THE 1973 BREAD WHEAT YIELD TRIAL IV.

CULT. NO.	VAALHARTS MILDEW %	VAALHARTS WHEAT STUNT	MAKATINI LEAF RUST	MAKATINI STEM RUST	DUHNE LEAF RUST %	DUHNE STEM RUST %	OUDTSHOORN B.Y.D.1	OUDTSHOORN LEAF RUST	OUDTSHOORN STEM RUST	MAHANENE LOOSE SMUT 2
76.	10	Fairly Resistent	99s	25s-ms	80	20		0	0	0
77.	10		99s	5ms	65	0		0	0	0
78.	20	Fairly Resistent	99rr-ms	65s	70	0		0	0	0
79.	10	Fairly Resistent	99s	10s	70	0		0	0	5
80.	10	Fairly Resistent	65r-mr	5ms	20	0		0	0	38
81.	10	Fairly Resistent	65ms-mr	10ms	60	0	X	0	0	0
82.	10	Resistent	99vr-ms	50s	100	65		75s	0	1
83.	0	Resistent	99s	0	90	30		45s	0	0
84.	10	Fairly Resistent	99s	99s	90	80		0	0	2
85.	0	Fairly Resistant	99s-ms	99s	100	90		10mr	0	0
86.	10	Resistant	99s	99s	100	100	X	0	0	3
87.	0	Resistant	80ms-mr	80s	100	90		45s	0	0
88.	0	Resistant	99ms-mr	99s	100	100		0	0	0
89.	10	Fairly Resistant	65mr-ms	10s-ms	0	0		0	0	2
90.	0	Fairly Resistant	99s	65s	100	80		45s	0	0
91.	10	Fairly Resistant	99s	60s	90	60		50s	0	2
92.	30	Susceptible	65ms	65s	70	60		0	0	0
93.	10	Fairly Resistant	99ms-s	65s	100	90		0	0	0
94.	10	Fairly Resistant	20ms	20ms	50	0		0	0	1
95.	20	Fairly Resistant	99s	40s	90	60		0	0	0
96.	10	Fairly Resistant	10ms	65s	30	5		0	0	0
97.	20	Fairly Resistant	99ms-s	25s	90	10		0	0	0
98.	20	Fairly Resistant	80ms	10s	70	20		0	0	0
99.	10	Fairly Resistant	99s	10s	90	40		50s	0	0
100.	10	Fairly Resistant	99s	tms	0	0		0	0	0

1. B.Y.D. = Barley Yellow Dwarf virus
2. Total number of infected ears observed in the four replications.

TABLE 2.6.M BAKING QUALITY AND TEST WEIGHTS OBSERVED IN THE 1973 BREAD WHEAT YIELD TRIAL I.

	WHEAT (GRAINS)	FLOUR			BAKING TEST		TEST WEIGHTS (KG/HA)								
CULTIVAR NO.	EXTRACTION %	PROTEIEN %	DOUGH CHARACTERISTICS	MIXOGRAM	VOLUME CC	POINTS %	LOSKOP	ROODE-PLAAT	VAAL-HARTS	SAND-VET	MAKA-TINI	DOHNE	GROOT-FONTEIN	OUDTS-HOORN	HARDAP
1	77,8	13,8	Normal	medium	675	55	80,0	77	78,5	73,5	79,1	77,4	82	83	77
2	76,6	13,8	Normal	weak	650	55	77,5	75	77,5	75,5	71,8	74	79	81,7	75
3	75,8	13,2	Normal	Medium-strong	550	56	75,5	76	78,5	77	-	77	80	83	76,5
4	74,2	14,0	Normal	Medium-strong	525	54	79,0	75,5	78,5	76,5	75,5	75	80	82,5	77,5
5.	76,5	13,1	Normal	strong	540	51	77,5	75	80	78	70,5	73,5	80	82,5	77
6.	75,6	13,4	Normal	Medium-strong	550	55	74,5	73,5	78,5	75,5	-	76	80,5	81,5	75,5
7.	75,1	13,1	Strong	Strong	500	48	78,0	75,5	80	77,5	73	73,5	80	81	77
8.	75,1	12,6	Strong	Medium-strong	475	47	77,5	75,5	78,5	77	-	75	78,5	81	75,4
9.	79,4	13,2	Normal	Medium-strong	650	62	79,5	76,5	78,5	75,5	77,3	76	80	80,5	75,8
10.	76,0	12,6	Strong	Medium-strong	455	41	78,0	74	78,5	76	70,6	75,5	80	81,7	76
11.	75,2	13,5	Normal	Strong	525	47	77,5	74,5	78,5	76	-	77	79,5	82,5	76,5
12.	72,9	12,7	Strong	Medium-strong	505	49	79,0	77	80	75,5	75,5	74,5	79,5	81,5	78,5
13.	75,6	11,5	Normal	Weak-medium	555	52	77,0	77,5	78,5	78,5	76	71,5	79,5	81,5	78
14.	74,0	15,7	Normal	Medium	575	54	77,0	-	80	77,5	74,5	74,0	79,5	82,5	77
15.	76,0	13,6	Strong	Medium	580	50	79,5	77	78,5	75	76,2	77,4	80,5	81	76,5
16.	73,9	13,4	Sticky	Medium	580	56	79,5	76	77,5	76	79,2	76,1	78,5	81,5	75,5
17.	74,9	13,6	Normal	Medium-strong	600	55	77,5	76	78,5	73,5	79,5	77,1	81,5	83,5	79
18.	75,5	13,5	Normal	Weak-medium	590	59	77,5	76,5	78,5	73,5	77,5	75,0	80,5	81	76,5
19.	74,7	14,4	Normal	Medium	610	53	77,5	77	78,5	76,5	73,8	77	80,5	83	76,5
20.	74,1	14,8	Normal	Medium-strong	590	54	77,0	76	80	76	78,7	70,0	81	81,5	77
21.	75,1	13,2	Strong	Medium	610	58	79,0	76,5	80	75	76,3	78,6	81	83	78
22.	72,8	13,3	Strong	Strong	510	49	77,5	76	78,5	74	74,7	73,5	79,5	81,5	78
23.	74,8	15,8	Normal	Strong	585	52	78,5	75,5	78,5	75	79	76,5	80	82,5	78
24.	74,9	13,8	Strong	Medium	602	56	78,0	76	76	75	78,6	76,5	81,5	83	77,5
25.	72,2	13,5	Strong	Medium	550	52	79,0	76	80	74	76,5	77,4	77,5	81	80,5

TABLE 2.6.N BAKING QUALITY AND TEST WEIGHTS OBSERVED IN THE 1973 BREAD WHEAT YIELD TRIAL II.

	WHEAT (GRAINS)	FLOUR			BAKING TEST		TEST WEIGHTS (KG/HA)								
CULTIVAR NO.	EXTRACTION %	PROTEIEN %	DOUGH CHARACTERISTICS	MIXOGRAM	VOLUME CC	POINTS %	LOSKOP	ROODE-PLAAT	VAAL-HARTS	SAND VET	MAKA-TINI	DÖHNE	GROOT-FONTEIN	OUDTS-HOORN	HARDAP
26	75,3	13,9	Strong	Medium-strong	61,0	59	80,0	27,0	78,5	77,0	78,3	79,5	80,0	82,5	78,0
27	74,9	14,4	Strong	Medium-strong	585	55	79,0	75,5	80,0	78,5	79,0	77,0	79,5	81,5	79,0
28	75,4	13,8	Strong	Medium	562	54	79,5	77,0	78,5	75,0	79,7	78,0	79,5	82,5	78,0
29	75,8	14,5	Strong	Medium	560	53	79,5	76,0	78,5	76,0	80,7	77,0	81,5	82,5	78,5
30	76,3	12,8	Normal	Weak-medium	510	50	79,0	76,5	80,0	78,5	78,5	77,0	80,0	82,5	78,0
31	74,7	13,9	Strong	Medium	560	53	79,0	75,5	78,5	78,5	78,8	80,0	80,5	81,0	78,0
32	75,4	13,3	Normal	Medium	525	51	79,3	76,0	78,5	77,0	78,6	75,0	75,5	80,5	77,0
33	74,9	13,4	Normal	Medium	585	55	80,0	-	78,5	75,0	75,8	80,0	80,0	81,0	77,5
34	73,1	14,3	Strong	Medium	600	57	78,0	76,0	78,5	78,5	79,5	78,5	81,0	80,5	79,0
35	77,5	15,3	Normal	Medium-strong	610	59	79,0	75,5	80,0	77,5	77,1	80,0	80,5	82,5	78,5
36	75,8	12,7	Strong	Weak	490	48	76,5	75,5	78,5	76,0	78,7	79,0	79,5	81,5	77,5
37	73,8	13,2	Strong	Medium-strong	425	48	78,0	72,5	78,5	76,0	73,0	76,1	78,5	80,0	77,5
38	75,9	1,15	Strong	Weak	550	52	80,0	77,5	78,5	79,0	75,8	73,9	79,0	80,0	79,5
39	75,8	12,6	Strong	Medium	475	49	77,0	74,0	77,5	77,2	77,5	77,5	78,0	80,0	78,5
40	75,8	12,5	Normal	Medium	490	52	78,5	77,5	75,0	77,2	77,0	79,0	79,0	81,0	78,5
41	74,5	13,8	Normal	Weak-medium	575	54	77,5	74,0	77,5	75,0	74,0	76,0	79,5	77,5	77,5
42	76,5	13,5	Normal	Weak-medium	545	51	79,5	77,0	80,0	77,0	79,0	80,0	82,5	82,5	80,0
43	76,8	14,1	Normal	Strong	570	53	79,0	74,5	78,5	78,0	71,1	76,5	77,5	80,0	77,5
44	74,1	14,8	Normal	Medium	620	58	77,5	74,0	77,5	72,5	69,5	76,5	81,5	80,0	78,0
45	73,6	12,2	Normal	Medium	565	52	78,0	75,0	78,5	75,5	74,5	72,5	79,0	79,5	78,5
46	73,0	12,6	Normal	Weak-medium	585	50	76,5	73,0	74,5	75,1	72,4	80,0	80,0	77,5	77,5
47	74,7	11,6	Strong	Medium	550	53	77,5	75,0	78,5	75,5	74,2	72,5	79,5	80,5	78,5
48	76,3	14,1	Normal	Medium	505	60	73,5	74,0	78,5	77,5	73,5	78,5	81,5	76,5	76,5
49	77,8	13,5	Normal	Medium-weak	660	58	78,5	78,0	80,0	78,5	79,2	77,5	79,0	82,5	77,5
50	73,8	14,5	Strong	Strong	635	54	76,5	73,5	78,5	74,5	74,3	77,4	78,0	78,0	81,5

TABLE 2.6.0 BAKING QUALITY AND TEST WEIGHTS OBSERVED IN THE 1973 BREAD WHEAT YIELD TRIAL III.

	WHEAT (GAINS)	FLOUR			BAKING TEST		TEST WEIGHTS (KG/HA)								
CULTIVAR NO.	EXTRACTION %	PROTEIEN %	DOUGH CHARACTERISTICS	MIXOGRAM	VOLUME CC	POINTS %	LOSKOP	ROODE-PLAAT	VAAL-HARTS	SAND-VET	MAKA-TINI	DOHNE	GROOT-FONTEIN	OUDTS-HOORN	HARDAP
51	75,3	14,4	Normal	Medium	675	65	80,0	76,0	78,5	76,5	80,1	81,0	80,0	83,0	78,0
52	74,3	13,4	Normal	Medium	655	59	78,0	74,0	78,5	77,5	77,7	74,5	81,0	83,0	76,5
53	77,0	12,3	Strong	Medium	655	55	77,0	73,5	78,5	77,5	77,3	75,5	81,5	82,5	78,0
54	77,8	13,3	Normal	Medium	665	52	77,0	-	78,5	77,5	76,8	80,0	78,5	82,5	76,5
55	76,8	12,8	Normal	Medium	655	52	76,5	72,0	77,5	75,0	78,5	77,5	81,5	76,0	76,0
56	73,5	12,5	Normal	Medium	585	49	77,0	74,0	78,5	76,0	77,3	78,1	79,0	83 0	77,5
57	74,3	14,5	Normal	Medium	54,5	49	77,5	75,0	80,0	77,5	78,5	79,5	81,5	77,5	77,5
58	76,6	13,5	Strong	Medium-strong	560	58	77,5	72,5	77,5	77,5	78,1	77,5	79,0	82,5	77,5
59	73,9	12,9	Strong	Medium-strong	490	44	76,0	72,0	77,5	77,0	71,6	75,5	78,5	80,0	75,5
60	76,5	1,15	Normal	Medium	510	48	80,0	74,0	78,5	79,0	72,0	74,5	79,5	81,0	79,0
61	74,0	11,3	Normal	Medium	665	65	80,0	75,5	80,0	77,5	80,5	82,5	80,5	83,0	80,0
62	72,5	12,4	Normal	Medium	545	44	79,0	74,0	80,0	76,5	77,3	76,5	80,0	82,5	78,5
63	77,4	11,5	Strong	Weak	445	40	81,0	75,0	78,5	79,0	78,0	70,5	79,5	82,5	79,5
64	72,5	12,5	Strong	Medium-strong	525	51	79,0	74,0	78,5	76,0	76,0	77,5	80,0	81,5	77,0
65	77,1	14,8	Strong	Medium	565	56	78,5	75,0	78,5	77,6	77,6	78,5	80,5	81,7	79,5
66	76,9	12,5	Strong	Medium-strong	600	62	79,0	74,5	78,5	76,5	81,3	81,0	81,0	83,5	78,5
67	76,8	12,6	Strong9	Medium	590	55	79,0	80,0	77,5	80,8	77,0	81,5	82,4	82,4	78,5
68	78,4	13,8	Normal	Medium	610	60	79,0	73,0	78,5	77,5	77,3	75,0	79,5	81,5	77,0
69	76,1	13,8	Normal	Medium	645	53	80,5	76,0	80,0	78,5	80,69	82,0	83,0	83,5	79,5
70	75,9	13,9	Strong	Medium	760	50	80,0	75,0	78,5	77,5	80,7	78,5	81,5	83,5	78,5
71	76,6	14,2	Normal	Weak-medium	700	49	79,5	74,0	77,5	78,0	77,6	79,0	80,0	82,5	78,0
72	77,2	13,7	Normal	Medium	735	55	80,0	75,5	78,5	76,8	76,8	81,5	82,5	82,5	77,0
73	77,0	13,6	Normal	Weak	630	54	79,0	75,5	80,0	77,5	79,8	80,5	82,0	83,0	79,5
74	72,7	11,8	Normal	Medium	570	49	79,5	75,0	80,0	77,0	75,1	75,5	80,0	82,5	78,5
75	72,8	14,1	Normal	Medium	620	76,5	73,0	78,5	76,5	74,5	75,1	77,0	77,0	81,0	80,5

TABLE 2.6.P BAKING QUALITY AND TEST WEIGHTS OBSERVED IN THE 1973 BREAD WHEAT YIELD TRIAL IV.

	WHEAT GRIANS	FLOOR			Baking test		TEST WEIGHTS (KG/HA)								
CULTIVAR NO.	EXTRACTION %	PROTEIEN %	DOUGH CHARACTERISTICS	MIXOGRAM	VOLUME CC	POINTS %	LOSKOP	ROODE-PLAAT	VAAL-HARTS	SAND-VET	MAKA-TINI	DöHNE	GROOT-FONTEIN	OUDTS-HOORN	HARDAP
76	74,0	13,1	Normal	Medium	680	57	79,0	75,7	78,5	73,5	80,5	80,5	81,5	81,5	77,8
77	74,4	14,5	Normal	Medium	760	57	78,5	74,2	75	73,5	81,3	79,9	81	83	76,5
78	74,2	14,0	Normal	Strong	680	50	78,0	74,7	77,5	77,8	78,5	81	79	79	76,5
79	67,8	14,1	Normal-sticky	Weak	690	54	80,5	76	77,5	73,5	80,2	81	81	81,5	76,5
80	74,6	14,6	Normal	Weak-medium	650	46	77,0	73	77,5	74	78,1	78,5	78,5	81	75,5
81	68,8	13,0	Normal	Weak	760	51	77,3	70,7	75	73	78,5	75,0	79,5	80	74,5
82	76,1	13,6	Strong	Medium	620	52	76,0	71,3	75	76	73	74,5	77,5	79,	76,5
83	74,6	15,9	Strong	Medium	660	48	75,5	70,2	73,6	72	72,7	73,5	77	79	75,8
84	66,6	13,0	Sticky	Weak	575	41	70,5	66,6	73,5	73	-	68	78	76,5	74,5
85	78,2	1,15	Sticky	Weak	525	41	80,3	73,5	76	78	76,5	73,5	80	81	75
86	68,1	12,0	Very sticky	Weak	495	30	77,5	71	73,5	74,5	-	70,5	75,5	77,5	75,5
87	71,9	12,4	Very sticky	Weak	590	59	76,0	71,7	73,5	70	72,1	76,5	78	79	77,5
88	76,7	11,2	Very sticky	Weak	550	35	80,5	74	78,5	-	73,5	80	80	77	78,5
89	72,0	11,8	Very sticky	Weak	600	44	80,0	74,5	80	76,5	78,6	77,5	80	81,5	78
90	75,5	12,9	Normal	Weak-medium	550	78,0	73,2	76	76,5	-	72,8	77,5	78,5	78,5	75
91	73,4	13,3	Sticky	Weak	625	51	78,0	71,5	77,5	73,5	80	69,5	76,5	79,5	72,5
92	77,5	12,8	Sticky and very sticky	Weak	605	34	76,0	74,5	75	80,2	77	78,5	81	76	76
93	75,2	12,4	Normal	Weak-medium	590	45	79,0	74,2	78,5	76	73,7	75	79,5	80	76,5
94	74,3	13,4	Strong	Weak	700	47	78,0	74	75	75	77,6	79,5	76	81,4	75,5
95	77,5	12,6	Normal	Weak	625	50	79,0	72,3	77,5	74,5	76	77,5	80	80	76,5
96	77,0	13,6	Strong	Medium	600	43	76,5	73,5	77,5	73	77,5	78,5	78	80,5	76,5
97	73,6	14,2	Normal	Medium	630	53	78,5	74,5	75	75,5	77,2	75,5	81	77	77
98	73,3	13,8	Strong	Medium	515	75,5	70	73,5	72,5	-	70	71,5	75	75	72,5
99	75,8	12,8	Strong	Medium	465	43	78,5	75	80	77,5	73,5	75	80	81	77,5
100	77,0	14,4	Normal	Medium-strong	650	56	78,0	71,7	78,5	76	75,6	76,5	80	79,7	

TABLE 2.6.Q YIELD AND AGRONOMIC DATA OF THE LINES EXCEEDING THE EXPERIMENTAL AVERAGE IN THE 4th INTERNATIONAL DURUM YIELD NURSERY.

Cult. no.	Name of line or cultivar	Yield (Kg/ha)		Agronomic Characteristics Roodeplaat						Destiny
		Glen	Roodeplaat	Days to flowering	Days to maturity	Height cm.	Lodging %	Test weight Kg/hl	Weight of 1000grains	
3	Caperti	5000	3134	96	136	103	54	70,8	37	1974 DYT, DET
4	Jori C-69	4714	3540	98	139	81	0	74,3	40,5	1974 DYT, DET
6	Brant - S	5321	3298	95	140	75	0	71	38	1974 DYT
11	Cocorit - 71	5714	4011	97	139	91	0	74	38	1974 DYT, DET
12	Cocorit - S	5929	3873	103	140	104	0	78	43	1974 DYT, DET
14	Gerardo 574	4929	3536	98	141	80	0	73	37,3	1974 DYT
15	D - 6647	5196	4114	107	143	87	0	76	32	1974 DYT, DET
16	Gansa - S	4404	3504	102	140	89	0	73,3	51	1974 DYT
17	Quilafen	3518	4530	104	141	91	0	75,5	39	1974 DYT
18	Parana 66/270	3750	3920	104	146	88	0	74	39	1974 DYT, DET
21	T. Dic. Ver. G11-S	-	3936	100	139	83	0	76,5	34	1974 DYT, DET
25	T4 (Bread wheat control)	5643	3820	96	143	79	0	76	26	-
	Experimental average	-	3567							
	L.S.D. (Kg/ha)	-	246							
	C. V. %	-	12							
	Standard error (Kg/ha)	-	249							

TABLE 2.6.R BISCUIT WHEAT ISOLATION NURSERY AT ROODEPLAAT AND GLEN. AGRONOMIC AND YIELD DATA DETERMINATION.

Cult. no.	Name of Cultivar	Pedigree	Roodeplaat Agronomic Characteristics				Glen	Origin	Baking Quality			Destiny
			Days to Flowering	Days to Maturity	Height cm.	Lodging %	Yield Kg/ha		Proteien %	Grain Score (10)	Score x	
7	Queen Fan		laat	145	110	0	2732	South Africa	14,4	0	R	1974 Bis WYT
10	Coutiches		144	laat	-	-	-	France	-	-	-	1974 Bis WEN
13	Florence Aurore		94	131	110	50	2049	France	16,1	0	R	1974 Bis WYT
14	Potam = Inia'S'-Napo 63	II-22402-6M-4y -1m-1y-0m	92	133	75	0	-	Mexico	12,0	0	R	1974 Bis WYT
16	C-271-WtExSon 64		91	134	87	0	-	Mexico	-	-	-	1974 Bis WEN
17	Bb #4 A 'S'	23584-26y-2m-3y -1m-0y-(1-2y)0y	96	136	62	0	-	Mexico	13,9	0	R	1974 Bis WYT
18	Chhoti Lerma		95	136	80	0	-	Mexico	12,8	0	R	1974 Bis WYT
19	Bb - Cha	34330-500y-500B - 0y	92	131	77	0	-	Mexico	-	-	-	1974 Bis WEN
20	(21943/Ch53-LR64^{3} x 8156 x Nar 59'S)	II-21515-1P-1P 3P	98	133	87	0	-	Mexico	-	-	-	1974 Bis WEN
21	Tob'S'-NPxCno-Son 64/ Cal-Ska	35058-26y-3m-2y-0m.	91	132	85	0	-	Mexico	-	-	-	1974 Bis WEN
22	Bb - Pj62	30598-6I-3y-1m-1y-0m	91	133	62	0	-	Mexico	-	-	-	1974 Bis WYT
23	Tob'S'-NPxCC-Inia/Cha	CM5541-20y-1m-0y	92	131	80	0	-	Mexico	-	-	-	1974 Bis WEN
24	Norteno 67 = LR64xS64	19008-52m-6y-3m 2y	92	131	90	0	-	Mexico	-	-	-	1974 Bis WEN
25	Sonalika		91	131	85	0	-	Mexico	13,6	0,5	P	1974 Bis WYT
32	Lemhi 62	CI 13435	laat	137	112	0	2914		12,9	0,5	P	1974 Bis WYT
33	Twin	CI 14588	laat	146	87	0	4599		12,2	1	P	1974 Bis WYT
34	Springfield	CI 14589	laat	146	90	0	4326		11,8	2	A	1974 Bis WYT
35	Nugaines	-	laat	laat	-	-	4417	U.S.A.	11,8	0	R	1974 Bis WYT
36	Springfield	-	laat	146	100	0	3916	U.S.A.	11,6	2	A	1974 Bis WYT
37	Lemhi 66	-	-	150	-	-	3005	U.S.A.	12,8	0	R	1974 Bis WYT
38	Hyslop	-	laat	142	110	0	4781	U.S.A.	13,3	0	R	1974 Bis WYT
39	Sprague	-	laat	laat	-	-	3689	U.S.A.	12,5	0	R	1974 Bis WYT
40	Idaed	-	laat	laat	-	-	2869	U.S.A.	13,1	0	R	1974 Bis WYT
41	Marfed	-	98	136	105	40	3370	U.S.A.	13,6	0	R	1974 Bis WYT
42	Paha	-	laat	142	105	40	4144	U.S.A.	13,9	0	R	1974 Bis WYT
43	Yamhill	-	140	laat	-	-	3825	U.S.A.	13,1	0,5	P	1974 Bis WYT
-	T4	-	-	-	-	-	3370	South Africa	-	-	-	-

x R = Rejected
P = Promising
A = Acceptable

TABLE 2.6.S 4th INTERNATIONAL TRITICALE SCREENING NURSERY. YIELD AND AGRONOMIC DATA OF THE TWENTY LINES IN THE NURSERY.

Cult. no.	Name of Cultivar	Pedigree	Rank	Yield Kg/ha	Agronomic Characteristics			
					Days to flowering	Days to maturity	Height cms.	Lodging %
29	Maya II x Arm 'S'	x-2802-38N-2M-12N-0M	1	5233	102	147	93	0
47	Inia x Arm 'S'	-	2	5227	99	140	105	0
31	Maya II x Arm 'S'	x-2802-38N-5M-8N-0M	3	5087	101	147	97	10
41	(Inia-Rye)^{s} x Arm	x-2145-2N-9M-3N-0M	4	5033	97	138	105	50
67	Maya II x Arm 'S'	x-2832-29N-5M-1N-0M	5	4893	95	139	95	5
27	Maya II x Arm 'S'	x-2802-1N-2M-4N-0M	6	4767	100	143	100	0
88	Inia x Arm 'S'	8195-2N-0M	7	4740	100	139	95	0
38	(Inia - Rye)^{s} x Arm	x-2144-12N-2M-2N-0M	8	4733	100	143	100	25
56	Maya II x Arm 'S'	x-2802-37N-4M-1N-0M	9	4680	96	142	115	0
64	Maya II x Arm 'S'	x-2832-24N-6M-6N-0M	10	4633	91	138	105	20
30	Maya II x Arm 'S'	x-2802-38N-2M-13N-0M	11	4620	102	147	91	0
92	Inia x Arm 'S'	OMA	12	4547	97	136	100	40
58	(Inia x Rye)^{s} x Arm 'S'	x-2152-4N-1M-1N-0M	13	4440	96	138	110	0
62	Maya II x Arm 'S'	x-2802-75N-1M-2N-0M	14	4413	91	138	95	0
79	Inia x Arm 'S'	1731-5N-0M	15	4360	92	138	110	60
35	Maya II x Arm 'S'	x-2802-64N-3M-9N-0M	16	4347	99	145	85	0
86	Beaver x Arm 'S'	x-2747-8M-7N-0M	17	4280	95	137	115	0
55	Cocorit	-	18	4273	98	142	92	0
77	Inia x Arm 'S'	1731-2N-0M	19	4213	97	138	110	40
17	Inia x Arm 'S'	x-2802-38N-1M-7N-0M	20	4180	100	143	85	0
52	Inia	-	-	4400	89	131	85	0

2.7 Tunisia

2.7.1 INTRODUCTION

The variability of the Tunisian rainfall pattern is a factor of major importance in planning and interpreting agricultural programs in the country. Seasons vary from one another and it is not uncommon to have greater differences at a site from season to season than between sites in a single season. Variability exists with respect to total rainfall in the growing season, the onset and length of the growing season, the distribution of rain and the occurrence of stress periods.

High summer temperatures occur and frost or hail can damage cereal crops in a haphazard manner, but it is the rainfall pattern which dominates agricultural production. For this reason a number of season's data are required to establish sound conclusions and then review a single season's data on the basis of similar earlier experience.

In the past season 1974-75, total rainfall was inferior to the sixty year mean, ranging from 53 percent at Thala in the west to 93 per cent at Borj el Amri just West of Tunis. Two widely separated stations out of a total of 13 stations, registered rainfall equal to the average. The overall mean rainfall was 83 per cent of normal.

In the early part of the season, moisture was adequate in most areas to allow good seed bed preparation. December and January, normally the wettest months, were unusually dry and soil reserves were not built. This shortage was not reflected in greatly reduced yields but it did reduce the effectiveness of some of the soil active herbicides and it discouraged farmers from using both herbicides and topdressing. Subsequent rainfall was well distributed, however, and good responses were obtained to applied nitrogen. Grain filling was good.

The dry period mentioned above led to a low incidence of leaf diseases and as a result, production was not affected in the country. Septoria did not develop and the rusts, mildew and Ophiobolus were reported in only minor degree. Damage from insects was minor as is normally the case. The nematode, Heterodera avenae continued to cause problems in areas where rotations are limited.

Although very marked progress has been made in weed control by both cultural and chemical means, weeds are still the principal limiting factor in production. The grassy weeds in particular had good opportunity to compete with the wheat crop.

National production was up over the previous year despite the deficient rainfall. A good deal of this increase can be attributed to the effect of cereal improvement progress, particularly in the popularizing of much improved agronomic practices.

2.7.2 PLANT IMPROVEMENT

2.7.2.1 Varietal Improvement

As intimated, climatic conditions were fairly good for crop development at the experiment stations. The main cereal breeding work is conducted at the Béja Station about 100 km north west of Tunis. Additional test sites are located at Tunis, Bour Bia, Mateur, Bou Salem and Krib, i.e., all are located in the northern one-fifth of the country.

The breeding nursery at Béja was subjected to an artificial epidemic of stem rust using inoculum collected in the previous season. Since most of the collections had been made on durum wheats, the epidemic was good in durums but there was little pathogenicity on the bread wheats. Stripe rust occurred naturally and gave good differentiation. Siete Cerros and many of its derivatives showed heavy attack.

All segregating populations and observation nurseries were inoculated for Septoria by spreading chopped up straw which had been collected the previous year. Normally this produces a good infection, but the dry weather precluded its establishment in this season.

2.7.2.1A Bread Wheat

Performance of the Tunisian bread wheat varieties during the past season as well as their average performance in the past four years based on microplant yield trials, are given in table 2.7.A. It is evident that the newer varieties are superior in yield to the older ones. Also their resistance to Septoria and rust are better than Florence Aurore or

* CIMMYT assists the Ministry of Agriculture in its research and training programs through the assignment of CIMMYT scientists. The CIMMYT involvement is financed by a grant from the Ford Foundation.

Inia, the two most widely grown cultivars.

In all, 125 varieties were tested in second and third year trials. Of these the best five are listed in table 2.7.B. Yields are expressed as a percentage of Soltane. It is not known whether any of these will be competitive with the recently released varieties Dougga and Carthage. First year trials showed a similar trend with 13 of 100 varieties promoted to the next cycle of testing.

The ten best lines of the 600 lines listed in the preliminary yield trials are shown in table 2.7.C, some of which appear very promising. No crossing program was undertaken in 1974-75 since segregating material from CIMMYT appears adequate and covers a wide range of variation. Over 4,000 single plants were selected from F_2 populations in the field. Of these, 2116 were advanced to F_3 after selecting for seed type and quality.

A few of the best crosses in advanced generations are:

$Y50_E$ - Kal^3 x Cal	CM21648	Bon x $Y50_E$ - Kal^3	CM21446
Cno^2 - chr. x Az 67	CM21818	Cha x Jar	CM7576
Cha # 2 x Cno "S"-Gallo	CM21716		

2.7.2.1B Durum Wheat

Durum wheats of CIMMYT origin continued to give high yield performance. However, among the top yielders a lack of adequate disease resistance, earliness, too short straw and a tendency to yellowberry, places some restriction on their use as direct introductions. The two new varieties Maghrebi and Amel of Mexican origin did well and are under seed multiplication. Inrat 69 and Badri are grown widely and were partially responsible for the good harvest of 1975.

The durum program is under rapid expansion both in evaluating germ plasm and in using those selected as parents in crosses to the high yielding base varieties. The best F_2 obtained in 1974-75 was D68-5 x Flamingo "S". Crosses in the advanced generations which are very promising include D67-2 x Jo"S" - Cr"S" D71-223, Giorgio 565-Maghrebi D71-297 and Leeds mutant x Gaviota "S" D71-549.

The expanded program is just underway and it will be some time before it can be assessed.

2.7.2.1C Summer Nursery

The program has made full use of the summer nursery facilities being arranged by CIMMYT through the courtesy of the Kenya Government. During the past season, 30 spikes from each of the best F_2 populations and two spikes from each of the advanced generation lines of both bread and durum wheats, were sent to the summer nursery. In this way it is hoped to advance the material by one generation, and at the same time, to discard lines which are most susceptible to disease conditions at the Njoro Station in Kenya. It is felt that this approach will increase the productivity of the program and thereby shorten the generation time required to obtain new varieties.

2.7.2.1D Development of Personnel

Development and training of personnel for the section continued to progress rapidly (table 2.7.D). The Tunisian program is well equipped with trained people to carry out its research needs.

2.7.2.2 Varietal Testing on Farms

2.7.2.2A Wheat

The program of simultaneous varietal evaluation and demonstration on farms was conducted as in previous years. Plots were 5x40 meters in two replications. Project equipment was used for pre-sowing cultivation and N application, final seed bed tillage, seeding and weed spraying. Where possible, harvest was done by the grower's combine. Plots used for seed increase were harvested with the plot harvester of the Project. The fertilizer applications were 22 kg P_2O_5/ha applied with the seed and usually 45 kg P_2O_5/ha had already been applied by the grower. A total of 90-100 kg N/ha was used at most sites, which was split more or less equally between preseeding and the tillering stage. A total of 66-78 kg N/ha was used at a few sites where the yield potential was limited. The seeding rate was 100 kg/ha for bread and 120 kg/ha for durum wheats. Seeding started on November 15 in the continental (interior) zone. It was completed at all sites by December 11. At most sites

13 varieties were tested. All 15 seeded variety trials were harvested. Good yields were obtained despite rainfall shortage.

As in previous years, the varieties responded differently in the two climatic zones of the Northern wheat growing region (table 2.7.E). Soltane continued to perform well in the littoral but was somewhat less well adapted in the continental area. Florence Aurore yielded less than Soltane in both regions. Ariana 66 performed well in the continental zone and was about equal to Soltane in the littoral. Carthage and Dougga showed almost identical yield patterns to Ariana 66. Siete Cerros gave equal yield to Ariana in the continental but was lower in yield in the littoral. Fath, an early, large seeded, low tillering variety was essentially equal to Soltane in the littoral but was very poor in the continental zone. It is felt that better results might be achieved through using higher seed rates up to 150 kg/ha to overcome the paucity of plants because of the larger seed, and to provide more plants to offset less tillering.

In the durums, Inrat 69 outyielded Badri, an earlier variety, by a small margin, and its yield in the continental area was lower. Amal 72 continued to outyield Inrat 69 under both conditions. Maghrebi 72 gave slightly higher yields under littoral conditions but fell below Inrat in the continental. The D68 numbered varieties were somewhat late, but they outyielded Inrat 69 in both conditions, being about equal to Amal in performance. Chili an unimproved cultivar, performed well in the continental region and it can continue as a wheat variety there. Mahmoudi, the old variety which has been largely replaced by Inrat, gave a low yield as did D77 when tested in the littoral.

Adaptation of varieties to the two zones is indicated by the five year averages of yield as shown in table 2.7.F. Soltane 72 was the outstanding variety in the littoral zone but it was outyielded by Ariana 66 and Siete Cerros in the continental. Susceptibility to Septoria was the chief drawback of Siete Cerros in the littoral. Poor tolerance to saturated soil may have been another factor. The low yields of traditonal durums in the littoral zone was probably due to lodging as a result of the applications of 70-100 kg N/ha coupled with good moisture conditions. Ariana 66, Siete Cerros, Soltane 66 and the new durums appear to be equally productive in the continental zone.

Inia 66 seems relatively poorly adapted to the continental zone and its yield seems somewhat unstable. This appears from year to year and in trial to trial variations not accounted for by Septoria attack. In the 1974-75 season, Inia 66 produced the top yield in 5 of 11 trials. In only one trial was it average, in yield. In the other trials it was relatively low. It gave the highest yield of 54.9 q/ha recorded from any trial, in the one grown at Beja. Dougga at Mateur gave the second highest at 52.4 q/ha. Soltane's highest yield was 50.7 q/ha at Beja.

What are the characteristics which make Soltane 72 more valuable to Tunisian farmers than Inia 66? A comparison of the two varieties is made to suggest selection criteria for obtaining varieties with adaptation to rainfed intermediate technology conditions.

Soltane 72 has more tillers than Inia 66, which because of its earliness will begin stem elongation in unseasonably warm weather. It also tillers poorly in saturated soils. Soltane will compete more effectively with weeds than Inia, particularly the broad leaved weeds, and this is probably due to its more profuse tillering. The prostrate habit of Soltane in its early growth may also be a factor. Inia is considered to be less able to endure saturated soil conditions, turning yellow before other varieties. Because of its earliness, yields are often damaged by birds.

In rainfed agriculture, the evolution of varieties and the timing of farming operations are largely determined by the prevailing climate. Usually there is a specific time of planting, which leads to maximum probability of a good stand with minimum risk of drought or excessive rain. New varieties, therefore, need to be tried to fit such conditions. Amal 72, Maghrebi 72 and Badri are similar in maturity to Inia 66, but they appear to act differently in relation to the environment, possibly because of the basic differences in the durums. Tunisian workers believe that a somewhat later maturity in Inia would lead to less frost and bird damage and less susceptibility to factors interfering with tillering. (Editor's note - The Tunisian program should undoubtedly grow varieties other than Inia 66 if this is a poor type. There appears little reason to maintain it in production if it is not liked). The question is asked whether CIMMYT should alter its breeding objectives for maximum yield and stability under intermediate technology. The answer of course, is that the National Programs are responsible for selecting from the many types provided, those which fit their needs.

2.7.2.2B Barley

In preceding years, Ceres and Martin, two barley varieties grown in Tunisia, have

been included with wheat in varietal demonstrations in localities where barley is important. Because a barley breeding program has been established within the Project, separate barley variety demonstration trials were grown this year. Trial techniques were similar to wheat, except that 50 kg N/ha were used in place of 70-100 kg/ha as in wheat. Four trials were seeded and three were harvested.

Yields of Ceres and Martin were comparable with the best of the newer varieties (table 2.7.G). The good yields of Gem, WI2197, Ager and Manon recommend their further testing. WI 2197, a two row variety, is very early and this may allow it to escape drought under desert conditions. Early varieties are important also in case of delayed planting.

The varieties Mardu, Pella, Ager and Gepsi grew with a winter habit pattern of development, yet they were not adapted in the continental climate zone. Their poor performance may have been related to the low water holding capacity of the soil at the test site, rather than to cold temperature. Soil moisture may have been depleted before the plant developed because of its winter habit. The two durum wheats with semi-winter habit viz., D68-8-6A-1A and D68-8-6A-3A were well adapted to the soil and temperature conditions in this zone as noted in table 2.7.E.

In future, the inclusion of Soltane 72, Inrat 69 and a triticale variety as checks in the barley trial is being considered in order to compare economic returns from the different crops.

2.7.2.3 Seed Production and Technology

Successful seed progress does not suddenly appear. Several components are required and most of these must be built indigenously.

The primary units functioning in successful seed programs include:

1. Crops research and development
2. First stages of seed multiplication
3. Seed production, processing, storage, distribution and marketing.
4. Seed quality control
5. Extension or advisory services.

The Tunisian seed program includes most of these components. The emphasis by Government and CIMMYT has been to strengthen each segment and to help assure good coordination around these components. Components and their function are illustrated in figure 2.7.1.

2.7.2.3A Crops Research and Development

Much of the CIMMYT effort has been devoted as explained in previous sections, to strengthening this part of the program. The activities associated with the Technical Division of the Office of Cereals and those with the Genetics Laboratory of INRAT are the primary aspects of the program. Having a strong dynamic crops research and development program is basic to any seed multiplication effort.

2.7.2.3B First Stages of Seed Multiplication

INRAT (Institut National de la Recherche Agronomique), figure 2.7.1, is responsible for maintenance and multiplication of breeders seed. It cooperates with COSEM (Coopérative Centrale de Semences) and CCSPS (Coopérative Centrale de Semences et Plants Séléctionnés). Techniques to increase the rate of seed increase, to reduce frequency of multiplications and to provide for better storage have been primary points of emphasis in strengthening this activity. COSEM and CCSPS contract for the production of the next stage of seed multiplication - basic seed - with their respective seed multipliers. Assistance in this aspect has been provided through quality control activities. However, consideration has also been given and proposals have been made for meeting the longer term basic seed needs of crops other than cereals.

2.7.2.3C Production, Processing, Storage, Distribution and Marketing

Commercial seed production and processing of cereal seeds is primarily the responsibility of COSEM and CCSPS. Both seed cooperatives have improved their facilities

to increase operational efficiency of their processing plants and to place greater emphasis on quality control. Both organizations have materially increased their amount of seed multiplied as shown in figure 2.7.2.

Approximately, 92 per cent of seed processed by COSEM and CCSPS was distributed by the 34 Office of Cereals distribution centres in 1974. These centres provide seed on a subsidized exchange basis for grain supplied to them through a credit program or by direct sale. Most of the seed marketed through the Office of Cereals is on an exchange basis. Limited storage space at the centres has restricted their ability to stock seed early. COSEM has had a shortage of bagged seed storage space for seed ready for distribution. The request made to COSEM and CCSPS for seed, sometimes arrive late and seed deliv eries are delayed.

Discussions and written proposals have been made to help identify ways of overcoming these problems. COSEM is building a new seed storage facility and seed processing timing has been improved. The Office of Cereals is attempting to place requests earlier and attempts are being made to increase credit availability for seed purchase. The amount of "selected seed" distributed increased from 89,000 quintals in 1973 to 126,000 quintals in 1974. More seed of new improved varieties is being produced each year as shown in figure 2.7.3. Of the seed production area harvested in 1975, 73 per cent was that of the newer improved varieties.

2.7.2.3D Seed Quality Control

The Ministry of Agriculture has established a seed testing laboratory, planted purity control plots and developed proposed legislation. Field inspections were made by two teams with representatives of INRAT and the Technical Division of Office of Cereals. Seed samples were collected from processed seed of COSEM and CCSPS and tested for germination and physical purity (The Federal Republic of West Germany provided plant facilities and technical assistance on these program aspects).

With respect to improvements in seed legislation and seed certification procedures, assistance was provided. Seed sampling triers (tubes) were made locally, and relevant information prepared from other programs was translated into French in cooperation with the Technical Division of the Office of Cereals and the Seed Testing Laboratory. A seed survey was organized to gain more information on the quality of seed being used by farmers. This survey also provided a double check on the quality of "Selected Seed" distributed. On this basis it has been possible to assess the suitability of proposed standards in seed legislation. Slides were prepared to strengthen the laboratory education capacity. Recent publications on seed production and technology were provided to the libraries of the Seed Testing Laboratory and INRAT, as well as to the Office of Cereals, COSEM and CCSPS.

2.7.2.3E Extension and Advisory Services

Strong educational programs are an essential feature of successful seed programs. The project's extension activities include practical demonstrations, field days, personal contacts with farmers and a careful monitoring of input supplies. The 14 mobile extension technicians collected the 120 wheat seed survey samples referred to earlier. Further details of extension will be provided later.

2.7.2.3F Other Supporting Activities

In addition to activities in support of specific segments of the seed program, the following other activities were assisted in support of the total program.

At the request of the Ministry of Agriculture, a twenty-four day tour of selected seed locations in North America was arranged. The four participants included a representative from INRAT, from the Seed Regulation and Certification Section, CCSPS and COSEM.

A Regional Wheat Workshop concentrating on one section on seed production in Tunisia, was held at Tunis.

A paper dealing with "Personnel Development and Training", was prepared. Included were staff needs and ways to meet the training needs.

2.7.3 WEED CONTROL

2.7.3.1 Introduction

The total weed control program consists of demonstrating improved tillage and herbicide practices and experimentation to develop better recommendations. Progress in applied research has aided extension's efforts and accelerated on farm change. Weeds are

a greater yield loss factor in Tunis than any other factor, with yields often being reduced by half.

More than three quarters of the weed loss is due to grassy weeds such as wild oats (Avena sterilis), ryegrass (Lolium rigida) and canary grass (Phalaris paradoxa, P. truncata, and P. brachystachus). There are many broad-leaved weed species of economic importance, but in total their effect on yield is less than one quarter.

For many years 2,4-D has been used on about 100,000 hectares. In 1973-74 this rose to 135,000 hectares and in 1974-75 to 144,000 hectares. Important progress has been made in the adoption of grassy weed herbicides. The figures are 4,000 hectares treated in 1973-74 and 16,500 hectares in 1974-75. This progress has resulted from applied research teamwork involving several agencies concerned with weed control in Tunisia, and financial support supplied by Government. Herbicides were subsidized by 50 percent and producers were supplied loans with which to buy.

The supply of herbicides in Tunisia has been satisfactory. The main limiting factor in their use has been inadequate promotion, distribution, and technical services from the company suppliers. Extremely dry weather during December and January probably reduced the use of new herbicides by one-half of that which would have been used had conditions been more favourable.

2.7.3.2 Tillage Practices

The importance of improved tillage practices is stressed in extension. Every variety demonstration trial is also a demonstration of recommended seed bed preparation. Extra tillage operations are done by the grower if needed, and pre-seeding harrowing is always done by the team using Project equipment. The failure to remove all established or germinated weeds before seeding has been a major problem on farms in Tunisia. However, great improvement has occurred especially on the more progressive farms. In extension work, stress on seed bed preparation should continue especially on the less progressive farms. In addition, more extension effort should be directed towards practices and cropping systems which reduce the level of weed infestation in fields used for wheat. This includes the use of herbicides. Reduction of grass weed infestation is especially important because of the high yield loss and high cost of herbicides for these weeds. Most broad-leaved weed problems have been overcome by good seed bed preparation, if two or three shallow cultivations are accomplished after the fall rains have started. Preseeding tillage practices however, have not prevented high yield loss from the grass weeds.

2.7.3.3 Applied Research on Herbicide Use

An experimental program using herbicides has been conducted for five years. Originally the objective was to avoid phytotoxicity as a result of 2,4-D application, to develop alternative methods for broad-leaf weed control and to develop methods for grass weed control. As these objectives have been accomplished, new problems and opportunities appear.

Nine types of trials were conducted and all told, 45 trials were conducted. Yield data were obtained for all but two sites.

Type I - To evaluate promising herbicide treatments - 23 treatments, 5 trials.

Type II - To evaluate sensitivity of important and new cereal varieties to certain herbicide treatments - 7 herbicide treatments on 11 wheat varieties, 2 trials; 3 herbicide treatments on 10 barley varieties, 4 trials.

Type III - Demonstration and evaluation of 2,4-D and Suffix applications at three different stages of wheat development, 5 trials.

Type IV - At variety trial sites, demonstration and evaluation of 10 recommended herbicide treatments, 12 trials.

Type V - Influence of time of application on effectiveness of canary grass treatments - 3 to 12 treatments, 4 trials.

Type VI - Influence of plant N status on sensitivity of wheat and weeds to 6 herbicide treatments, 5 trials.

Type VII - Influence of TOK dosage and volume of spray on treatments of Dicuran or Dosanex mixed with TOK - 4 dosages of TOK, 2 spray volumes, 6 trials.

Type VIII - A special trial of mixtures of Certrol H with Dicuran or Dosanex, and a mixture of Dicuran and Dosanex.

Type IX - Special trial of use of Dicuran and Dosanex in the wheat-medicago system.

The results of the applied research program are discussed below in terms of the information developed rather than the type of trial.

2.7.3.3A Suppression of Wild Oats by 2,4-D

In each of the past four years, yield increase as a result of 2,4-D application has been greater at sites with high wild oat infestations than at sites with high broad-leaf weed infestations (table 2.7.H). Averaged over all trials, yield increase was 2.6 quintals/ha at sites with more than 20 wild oat panicles per square meter than at sites with less than this number. In these same trials there was no difference in yield between trials with more or less than 45 percent of soil surface covered with broad-leaved weeds. These are the weed infestation reference points above which a herbicide application is considered profitable. The lack of a yield advantage with high broad-leaf weed infestations is due to the masking effect of the 2,4-D on wild oats. If the wild oat population is high, broad leaf weeds are suppressed and their soil coverage is usually less than 45 per cent. Yet at these sites, yield increase tends to be high as a result of wild oat suppression by 2,4-D.

In addition to yield data, a number of observations indicate wild oat suppression by 2,4-D. A typical harmful effect of 2,4-D on the grass family when sprayed at the incorrect time is the rolling and fusing of the leaf edges known as "onion leaf". Both in plots and growers' fields, severe onion leaf is commonly seen in wild oats but not on wheat when sprayed at the same time. Also the flowering parts of wild oats are often affected by 2,4-D. The symptoms include restricted emergence of the panicle from the boot, distorted panicles, reduced number of florets and sterile florets, especially at the panicle base. Seed production in these ways may be reduced by 90 per cent.

Each year in routine percentage control observations the effect of 2,4-D on wild oats was noted but little importance was given to it since the view accepted was that there was no effect. In 1974-75 the per cent control of wild oats by 2,4-D applied at beginning of jointing was rated at 26 per cent in the 5 type 1 trials; 12 per cent in the 14 type IV and 14 per cent in the 5 type III trials. In the type III trials, it was observed that 50 per cent control was achieved at the 4.5 leaf stage versus 14 per cent control from a beginning-of-jointing stage application and only 6 per cent control when sprayed at the boot stage. These above ground observed effects give wheat an advantage in its capture of light, and the reduction in wild oat seed production has a big advantage in succeeding years.

There are indications that the use of 2,4-D gives wheat an advantage in the crucial grain filling period when water is required at a higher level. Rapid extraction of soil moisture by heavy wild oat infestations often results in lodging of both the oats and wheat. This appears to result from sudden loss of turgor pressure. Lodging always appears to be less in the treated plots.

One of the reasons for the differential effect of 2,4-D on wheat and oats, is the less advanced growth stage of the latter when the application is made, particularly when germinated wild oats were removed at seeding time. After seeding, rains normally bring up other wild oats over an extended period making these latter emerged plants even more vulnerable.

Avena sterilis the commonest wild oat of Tunisia, is more susceptible to 2,4-D than A. fatua or other Avena spp. Plant roots are more sensitive to such auxin type materials such as 2,4-D than are the above ground parts, and this may be a factor in the observed results in the case of A. sterilis.

It is suggested that research is needed to maximize selectivity between wheat and the wild oats. Time of application, dosage, formulation, wheat variety etc. need study. Immediate gains are possible with early 2,4-D application where wild oats are present, especially with durum wheat which appears quite tolerant even if the high price of grass control chemicals preclude their use. Sites with heavy wild oat populations tend to be highly productive so that returns from control measures are also high. Based on yield results from five years of experiments, 2,4-D should be used at such locations.

2.7.3.3B Factors Influencing Yield Loss from Weeds

Yield loss due to weeds varies widely from year to year, and moisture stress is a key reason. If severe, as a result of extraction by weeds, the losses are large. However, when rainfall is adequate for both wheat and weeds throughout the season, yield losses are low.

In Tunisia, highest yield losses often occur in years with very wet winters, when the wheat suffers much more from soil saturation than from grassy weeds, particularly wild

oats and canary grass. Phalaris paradoxa,grows taller than short strawed wheats in saturated soils, but only half as tall under drought. After a very wet winter, hot dry spring winds place high stress on the shallow-rooted, crowded wheat crop. Such conditions occur at least one year in three in Tunisia and high yield losses are seen in those years. Since broad-leaved weeds often mature before the stress period, the grassy weeds are greater in their effect.

As available N increases, grassy weeds become more of a problem so that control methods are essential as the soil fertility is increased. Yield loss to such weeds is about proportional to per cent infestation - at 10 wild oat plants/m^2, there is a 10 per cent loss; at 30, a 20 per cent loss; at 50, a 30 per cent loss which eventually levels out at about 45 per cent loss.

Tentative standards which have been established as a guide in deciding whether or not to make a herbicide application, are:- wild oats, 10-20 panicles/m^2; rye grass 50-60 spikes/m^2; canary grass 30-40 spikes/m^2 and for broad-leaved weeds, 25-50 per cent soil surface covered. The decision must be taken long before weeds have reached the heading stage or maximum soil coverage, so the grower must use early observations plus experience to estimate weed damage, if herbicide is not applied.

The variety of wheat due to seedling vigour and height has an influence on yield loss. Differences were observed in the current year, with varieties selected in Tunisia being better competitors e.g.Florence Aurore, Ariana 66, Mahmoudi, Inrat 69, and Badri were somewhat better. Inia 66, Soltane 72 and Siete Cerros had intermediate competitive ability although Inia was less so in wet winters where broad leaved weeds were predominant. The late durums D68-8-6A-1A and D68-8-6A-3A produced a dense leaf cover at the soil surface and stem growth is delayed and short. These two varieties competed poorly against grass weeds, but did well against broad leaved weeds.

The key issue in deciding whether or not to apply herbicide, is predicting the loss of weeds. Most factors are known and can be estimated. Weather records should be used in conjunction.

2.7.3.3C Herbicide Phytotoxicity

2.7.3.3Ca Wheat

Type II trials are conducted each year to determine whether promising or recommended herbicide treatments are safe to apply on wheat varieties used in Tunisia. In assessing herbicide damage, weed free sites are necessary for reliable measurements of yield losses.

The two sites used this year were not totally weed free and loss of yield due to toxicity, tended to be obscured by weed control benefits, but there was variation in the ability of specific herbicides to control a particular infestation. Yield response of bread and durum wheats appeared to differ. Chandor and Tok Ultra tended to be better with durums, while Ipuron was better with bread wheats and Printan affected both equally. Certrol H was less damaging on the bread wheats and Actril M gave variable results. Mataven (Super Suffix) was less phytotoxic on durums than on bread wheats.

There were indications of varietal differences within species. Ariana 66 was susceptible to damage from Printan and Actril M, Soltane to Actril M, Dougga to Chandor and Inrat to Ipuron, Certrol H and Actril M.

In a special trial, the mixing of herbicides increased phytotoxicity. At standard doses, combining Certrol H with Dicuran or Dosanex resulted in high toxicity. A combined Dicuran at 1.2 kg/ha and Dosanex at 2.4 kg/ha resulted in both increased toxicity and increased weed control, as compared with Dosanex at 4 kg/ha. Herbicide mixtures offer the possibility of reducing costs while increasing effect. However, thorough testing is needed to avoid phytotoxic problems.

High wind velocity during herbicide application tends to increase both weed control and crop phytotoxicity. This was obvious in variety trials where Dicuron or Dosanex were applied in wind velocities above 25 km/hr. In these trials increase in foliar absorption caused severe early chlorosis and stunting of wheat, but recovery was good. Nevertheless, the application of substituted ureas should not be made in winds over 20 km/hr.

2.7.3.3Cb Barley

Ten barley varieties were tested for sensitivity to three wild oat control herbicides in each of four trials. These were Barnon - new and designed for barley, Mataven - a new material for use on wheat, and Suffix - now used on wheat in Tunisia with good results. None of the varieties were sensitive to Barnon, but wild oat control was unsatisfactory because of dry conditions in these trials. Both Mataven and Suffix were phytotoxic

and do not appear useful to barley. However, the variety Pella was only slightly affected by either material and Martin was only slightly affected by Suffix. The varieties Gem, Martin and Manon appeared to have individual plants with genetic resistance to Mataven i.e. these appeared heterogeneous.

2.7.3.3D Weed Control Performance

Weed control performance of each herbicide is evaluated by estimating the reduction of weed competition as a result of the application. For broad leaves this is a comparison of soil surface covered, and for grass weeds it is the number of inflorescences/m^2. A rating is thus obtained for each species in each plot and it is expressed as per cent control. Major points of interest based on average weed control ratings of five Type I and two Type II trials are the following:

(i) Rating for 2,4-D on wild oats was 26 per cent. At four of the five sites, wild oats were growing vigorously when sprayed, so they were probably more sensitive to the herbicide.

(ii) There was little loss in effect by reducing the dosage of Certrol H and Quinerexone from 3.5 to 2.5 kg product/ha. The dose should be reduced accordingly, to reduce expenditure and the danger of phytotoxicity.

(iii) Fair control of Phalaris paradoxa was obtained by pre-emergence treatment with Tok Ultra. This was the case under very dry conditions and it may be expected that control would be good in normal rainfall.

(iv) Good grass weed control including Phalaris was obtained with Ipuron. Its poor control of broad-leaves suggests that this material should be mixed with other herbicides to obtain reliable broad-spectrum activity.

(v) Dicuran and Dosanex in spite of a lack of rainfall following application, gave satisfactory control.

(vi) The near failure of Tok wettable powder in the control of Phalaris in mixtures with Dicuran and Dosanex, was probably the result of no rainfall after treatment.

(vii) In high infestations of wild oats, Mataven gave better control than Suffix.

(viii) A spray volume of 400 l/ha tended to be more effective than 100 l/ha with Dicuran + Tok, but not with Dosanex + Tok probably resulting from the greater solubility of Dosanex.

(ix) In general, control results paralleled those of preceding years.

Average weed control ratings from 14 Type IV trials showed the following highlights:

(i) The percentage wild oat control by 2,4-D was only half that in Type I trials. Sensitivity was likely reduced by less vigorous growth conditions under the dryer soil and the absence of late emerging plants, which are more vulnerable in the earlier growth stage.

(ii) The lower moisture in Type IV trials resulted in less effectiveness of Dicuran and Dosanex on wild oats and rye grass than in Type I. Broad-leaf control was also inferior.

(iii) Separate applications of 2,4-D and Suffix did not reduce the effectiveness of the control on wild oats, whereas it did when Suffix was combined with MCPP ester or MCPA potassium salt.

(iv) As in Type I trials, general results closely paralleled previous experience.

2.7.3.3E Yield Performance of Herbicide Treatments

Promising herbicides were evaluated in 5 Type I trials. The particularly high yields in these trials were due primarily to the control of heavy wild oat infestations at three of the sites.

The good yield performance under Ipuron which gave the highest yield at Le Kef, resulted from good control of both wild oats and Phalaris. It also controls rye grass and it can be satisfactorily mixed with other materials. Mataven alone and with MCPP gave better results than Suffix. Both materials need further study. The trials also confirmed the superior average performance of Dosanex.

2.7.3.3F Timing 2,4-D and Suffix Application

Type III trials were designed to determine the optimum timing for 2,4-D and Suffix, and the factors involved. Spraying bread wheat at the 4.5 leaf stage with 2,4-D usually resulted in a loss of 2-3 q/ha because of phytotoxicity. In 1974-5 weed control, the benefits tended to obscure the loss but furnished valuable information on the influence of timing on the suppression of wild oats by the use of 2,4-D.

Wild oat control from 2,4-D improved from 14 to 52 per cent by spraying at the 4.5 leaf stage rather than at jointing, but phytotoxicity increased. Results suggest that in durum where this phytotoxicity is not apparent, 2,4-D should be applied at the 4.5 leaf stage.

Boot or flag leaf application of 2,4-D reduced yields by about 4 q/ha in earlier tests, but this year only at Mateur was a loss this high encountered.

As in the past, the 4.5 leaf stage application of Suffix resulted in less control of wild oats but a trend to high yield. This suggests that such fast acting chemicals as Mataven should be tested for time of application. As in the case of 2,4-D this year's application of Suffix at the boot stage was not as damaging as in previous years.

2.7.3.3G Control of Canary Grass (Phalaris)

The important species of canary grass as earlier stated, are Phalaris brachystachus, P. paradoxa and P. truncata. Canary grass has wide distribution and dense populations are often associated with high infestations of wild oats or rye grass, which tend to suppress canary grass. When these wild oats or rye grass infestations are controlled by a herbicide which has no effect on canary grass, there is a dramatic increase in canary grass infestation. Thus if the herbicide program does not include control of canary grass, this problem could rapidly be as damaging as wild oats and rye grass combined. A high priority has been placed on canary grass control.

In trials using Tok at 2 kg/ha in combination with Dicuran and Dosanex, the effectiveness of treatments for canary grass was controlled more by rainfall than by growth stage. Yield results from these trials do not indicate a "best timing" based on stage of development of canary grass, but they do indicate that phytotoxicity may be expected from Dicuran, Dosanex and the new chemical Ipuron applied at early jointing.

In contrast with the poor and unreliable canary grass control performance of post emergence Tok, the performance of Ipuron was good, as well as consistent.

A second set of trials using Tok + Dicuran or Dosanex compared volumes of 100 l/ha using 2 kg of chemical, with 400 l/ha at rates of 0,1.5,2.0 and 3.0 kg/ha. The control level tended to increase with dosage. The larger quantity of water tended to be better. These advantages may not apply if rainfall follows application.

The most encouraging result from the 1974-5 experiments on canary grass control was the effectiveness of Ipuron, and work on dosage and mixtures should have high priority. Tok Ultra effectiveness and some activity from Mataven are also encouraging. The shallow depth of germination and root prolification of canary grass may increase its vulnerability to soil active herbicides. Further screening of promising materials is justified.

2.7.3.3H Dicuran and Dosanex Performance and Nitrogen Application

It was hoped that more reliable weed control by Dicuran and Dosanex could be achieved at lower cost and risk of phytotoxicity by changing the N level of wheat and weeds. The time of application of N was altered for the tillering stage. No differences were observed for either weed control or phytotoxicity, and this approach is unlikely to yield results. Yield differences observed with different timing of N applications are probably due more to nutrition than herbicidal effect.

Results from the six herbicide treatments reconfirm the recommendations. At recommended doses of Dicuran and Dosanex, slight but tolerable toxicity occurred, but at double the dose the toxicity was too great to be accepted. Rye grass was well controlled by both. There was practically no control of wild oats at half dosage, control was poor at the recommended dose and it was good at the double dosages. A lack of rainfall following treatment explains the poor wild oat control at the normal dose. The consistent yield advantage of plots with Dosanex, is probably the better wild oat control.

2.7.3.3I Profit from Herbicide Use

Based on the average of 16 trials, profits from herbicide application were favourable in 1974-5 and they were: 8.210 Dinars/ha ($21.60) with 2,4-D; 17.630 Dinars/ha($46.39)

with Suffix; and 30.700 Dinars/ha ($80.79) with Dosanex (table 2.7.I). This economic performance is surprising considering the conditions viz., herbicide applications on all trials whether needed or not, recommended cultural practices including seed bed preparation applied in all trials, based on results from Soltane (which competes well with weeds) and a rainfall pattern not associated with high returns from herbicide use. Lack of rain in December and January reduced the effectiveness of the substituted ureas, and only a few sites were affected by the saturated soil problem which increases yield loss due to grassy weeds, as discussed earlier. Canary grass competition was minimal due to generally dry conditions.

The profit from herbicide application at the three sites with high wild oat infestation, was quite outstanding - 26.510 D/ha ($69.76) with 2,4-D; 67.000 D/ha ($176.32) with Suffix and 104.510 D/ha ($275.03) with Dosanex (table 2.7.I).

These results would suggest that splitting hairs over whether or not herbicide will pay, is an improfitable exercise in Tunisian conditions. With the proper choice of treatment and application technique, which assures correct and uniform dosage, there is little chance of losing money even if the government subsidy of half the herbicide price as applied in Tunisia, were not provided.

2.7.4 FERTILIZER STUDIES

In 1974-75 the distribution of rainfall had an effect on the fertilizer in two ways. Up to January each rainfall was in light showers and was patchy in distribution. There were periods of good weather and wind, and moisture did not accumulate in the soil. The distribution during the rest of the season was near ideal and wheat responded favourably to N application. The trials at Thala and Fahs suffered drought because rains were delayed to early February. Grassy weeds were a problem but weed control work could be carried through. Although some disease was present, there was no serious effect on yield. The trial at Borj el Amri was damaged by insects. There was some lodging at Beja. Hail caused damage estimated at 10-15 percent in the trial at Bon Arada and Medjiz el Bob.

2.7.4.1 Rate and Timing of N Application

Demonstrations and experiments were conducted using rate and time of application of N studies. The traditional technique and present recommendations were compared. The varieties Soltane, Inrat 69 and in one case Maghrebi, were used. The average yield for bread wheat varied from 17 q/ha at Kairouan to 58.4 q/ha at Thala and 25.7 q/ha at Bon Arada. Yields were good despite below average rainfall. Statistical analyses of the data revealed that the yield differences due to rate of applied N were highly significant in one, and not significant in three experiments. The effect of time of application on yield was only significant in one case, and the lack of differences appeared to be related to the cultural treatments in the preceding year.

There were three experiments conducted to study in detail, the fertilizer needs of certain of the newly released varieties to establish response to heavy rates of N. Average yields obtained were as follows:

Beja - 50.1 q/ha; variety Amel (highest plot 58.7)

Borj el Amri - 26.9 q/ha; variety Inrat 69 (highest plot 31.8)

Fahs - 24.9 q/ha; variety Soltane 72 (highest plot 31.7)

The differences between rates of N at the first two sites were highly significant at .01 and at the third at the .05 level. Split applications gave higher yields (1/2 seeding, 1/2 tillering) but were not significant over the full amount at seeding. Response to different rates were dependent on soil moisture and the preceding crop. The wheat at Beja had been preceded by a grain legume and rates above 33 kg/ha did not increase yield. Hectolitre and 1,000 grain weight were not affected by the treatment.

Soil moisture and crop rotation again affected the response of wheat to N application. In regions with a near annual rainfall of 500 mm or less, the optimum rate is between 45 and 67 kg/ha and for regions above this, it is 90-100 kg/ha. The rates may be halved when wheat follows a grain legume, sugar beet or green manure crop but they should be increased if wheat follows a cereal.

2.7.4.2 Forms of N Fertilizer

Sulfur coated urea, a new form of N fertilizer, was tested for the first time. It is a slow release form and it overcomes some of the deficiencies of other forms, e.g. the risk of volatilization of urea or the risk of leaching as with ammonium nitrate. The forms were compared at Borj el Amri and Mateur.

No differences were detected between the forms at either site. The three forms when applied at planting time gave the same yields. Sulfur coated urea was at least as efficient as other sources, but it is premature to draw definite conclusions after only one season when the new form depends on soil moisture to enter the soil solution in the dissolved form. Unquestionably, rainfall in the autumn had an effect and it must be followed for several seasons.

Five rates were used and there was some interaction of form and rate at one site where 45 kg/ha of urea gave a response equivalent to 90 kg/ha ammonium nitrate. Sulfur coated urea produced the best hectolitre and 1000 grain weights. The new source is economically competitive and it reduces cost, since it can be applied all at seeding.

2.7.4.3 The Interaction of Varieties and Rates of N

In 1974-75 two experiments were grown, one using durums at Beja and the other with bread wheats at Borj el Amri. The wheat varieties used were Amel, Inrat, Maghrebi and Mahmoudi (durum) and Soltane, Dougga, Carthage and Florence Aurore (bread wheats). Five N rates were applied. Increasing rates significantly increased yield, but there was little interaction of rate x variety.

Compared with the traditional durum Mahmoudi, the new varieties have good potential - Amel 38.2 q/ha; Inrat 69, 37.5; Maghrebi 34.5; and Mahmoudi 27.6 q/ha. Amel and Maghrebi showed 20-30 per cent lodging at as low as 33 kg/ha. The bread wheat trial had some insect damage but nevertheless the new varieties showed a marked increase of potential over Florence Aurore, whose only advantage lay in its good grain weight.

2.7.4.4 Fertilizer Requirements of Barley

To begin the study of needs of certain new varieties of barley which are normally grown in drier parts of the country, an experiment was established at Fahs with six new varieties - Martin, Gem, Delisa, WI 2197, Manon and Gypsy (all introduced from other countries), and different levels of N.

Increasing the fertilizer rate had a highly significant effect on yield, but there was little difference between varieties. Average yield was 27.8 q/ha. Maximum yields were obtained at 67 kg/ha and no lodging was observed up to this level. Manon and Delisa showed excellent kernel weight. At least 33 kg N/ha seems to be justified at sites below 500 mm rainfall.

2.7.4.5 Phosphate

Fifteen demonstrations were placed adjacent to other trials to assess the effect of superphosphate (45 per cent P_2O_5). Wide variations were observed. Since farms are in the habit of applying phosphate on a regular basis the nil plot application was not really representative of the country as a whole.

2.7.4.6 Conclusions

Results led to the following recommendations:

(a) Nitrogen remains the essential fertility element limiting production and the rate of application is dependent on rainfall. Above 500 mm rainfall, at least 45 kg N/ha should be applied at seeding and 33-45 kg N/ha at tillering, depending on moisture availability. In a less fertile situation, 67 kg N/ha should be applied. When rainfall is 500 mm or less, the total application may not exceed 45 kg N/ha, which is divided between seeding and tillering. In a dry year, the second application may be omitted.

(b) Urea is usually cheaper than other forms such as ammonium nitrate, and it can be used at seeding without risk, although it should be incorporated with harrows to avoid losses due to volatilization. It should not be used at tillering, but be replaced by ammonium nitrate.

(c) On barley, 33 kg N/ha split between seeding and tillering, should be used in areas of 400 and 500 mm rainfall.

2.7.5 CROP ROTATION PROGRAM

The object of work in the rotation section is to contribute to the improvement of cereal production in Tunisia by establishing a system of land use which is more productive and less exploitive than the fallow-wheat biennial rotation. The latter is widely used but it leads to the depletion of soil fertility, through using up organic matter and it restricts animal production.

In previous reports the principles of the annual Medicago-wheat system have been described. To be successful the system must allow the yield of cereals to be at least as high as that using the best available recommendations, while supporting greater animal production.

From its initiation in 1971-72, the program has followed a specific orientation. Essentially it has been an attempt to fit the widely established system of Australia, to Tunisian conditions. The eventual aim is to establish an area on commercial farms, both state and private, functioning as the rotation should work. An area of about 5000 hectares is considered sufficiently large to act as a spring board for future expansion, once the value has been tested economically and technically, and to provide sites for research to be conducted.

In the preliminary stages, answers were sought for simple but important questions to see how the system could be adapted to Tunisia, and in the same period to train a small nucleus of Tunisian scientists in the technology, and also to determine the likelihood of success of introducing the system.

In the third phase, activity could be expanded and more detailed complementary research be conducted on animal carrying capacities and the integration of the wheat, pasture and animal relationships. Much of the expansion will be a matter of extension with simpler adaptive research. To avoid delay in its extension, commercial production of seed was instituted early in the program, and a systematic collection and evaluation of native Medicago materials was undertaken in order to locate varieties for areas where the currently available ones are not suitable.

The program in 1974-75 with results and progress, are discussed in this report in three categories:

(a) Experiments and demonstrations established in the first phase of the program.

(b) The extension activity in establishing the commercial areas.

(c) Seed production and assessment of indigenous materials.

2.7.5.1 Experiments and Demonstrations

Rotation experiments were established at three sites in 1971-2. The treatments, each with several replicates, were as follows:

	Treatments					
Year	1	2	3	4	5	6
1971-72	M	-	-	-	-	-
1972-73	W	M	-	W	F	-
1973-74	M	W	M	F	W	F
1974-75	W	M	W	W	F	W
1975-76	M	W	M	F	W	F
1976-77	W	M	W	W	F	W

W = wheat; M = medic; F = fallow

The wheat following medic is grown with minimal cultivation following autumn rains and it receives no N. Wheat following fallow is sown into a seed bed whose preparation begins in the previous spring, and with the quantity of N normally recommended in the area. Similar treatments were started in each of the three successive years to provide a buffer against an unusual year which could affect initial establishment of the medic. As it turned out, medic was established each year. The simple aim was to see how many cycles of rotation would be necessary to produce yields of wheat in the medic-wheat rotation equal to those with the fallow-wheat system. This year is important in that wheat follows medic in the first and second cycles.

Summary of Results at Three Sites: (Mean yield q/ha).

Treatment	St.Cyprien	Smindja	Teboursouk
Wheat after medic 1st cycle	19.5	16.5	18.5
Wheat after medic 2nd cycle	18.0	19.1	23.2
Fallow	22.6	20.1	24.7

The above are mean plot yields. It is not possible to detect significant differences because of variation in yields, but the trends are predictable except at St. Cyprien where it was expected that the first cycle should have yielded less than the second.

2.7.5.1A Interaction of Annual Legume Varieties with Locations

Two experiments were established on widely differing sites to observe the performance of a carefully selected group of cultivars imported as commercial varieties from Australia, where their performance is well known. It was desirable to establish if the same pattern of productivity would occur in Tunisia. Varieties were planted both with and without rhizobial inoculum.

The varieties used were as follows:

Jemalong, Medicago truncatula, is widely regarded as being adaptable to a wide range of environments. It has good early winter vigour, which is an advantage both for livestock and weed competition. Seed yields are good even in drier areas. Maturity is mid season and it can be expected to commence flowering in mid to late March, when moisture is normally adequate and temperatures are moderate.

Cyprus, M. truncatula, is similar to Jemalong in many ways but it is considerably earlier maturing. If flowers 3-4 weeks earlier in early to mid February, and it produces seed under adverse conditions. It requires only a 3 month growing season.

Harbinger, M. littoralis, is a different species with some important differences from the truncatula varieties. It is deeper rooting and therefore is better adapted to sandy soils. It has the same maturity as Cyprus and it has good early vigour and herbage production, and it sets seed easily. It requires only a 3 month growing season and it functions on as low as 300 mm of rain. It grows on the same soils as truncatula varieties, but does better on sandy alkaline soils. It can use natural bacteria and does well with little nodulation.

Paragosa, M. rugosa, is highly productive in the proper location but it is less widely adapted. It does well if the annual rainfall is over 350 mm. Its growing season approaches five months. It is good in heavy alkaline soils, particularly the grey brown soil group. It requires a specific strain of rhizobium to effect nodulation. Sometimes nodules form but they will not fix N. It has a high degree of hard seed breakdown to assist in regeneration. This is a good feature but sometimes it causes loss of regeneration as a result of a false start brought on by peculiar climatic conditions, such as an early season rain without later support from additional rain.

Clare, Trifolium subterraneum. Most of the commercial cultivars of subterranean clover belong to the subspecies subterraneum, but Clare belongs to the subspecies branch, calycinum, whose members are knownto tolerate slight alkalinity in high lime. It excels in areas of more than 450 mm rainfall with a long growing season, but must be regarded as the only sub clover likely to perform well in the wheat belt of Tunisia.

The two sites, viz St. Cyprien and Smindja, were different in soil texture and structure, as well as in average annual rainfall. Both were low in fertility and had a similar degree of weed infestation. St. Cyprien represents the heavy clay loam and Smindja, sandy loam. Rainfall at St. Cyprien is about 450 mm and Smindja 350 mm. Ryegrass is the principal weed at the former and broad-leaves at the latter, although some ryegrass is also present. Experiments were established in 1971-72 with the aforementioned five cultivars.

At St. Cyprien all varieties were established and persisted, but Paragosa and Clare began with a sparse population which increased in the second and third years. At Smindja, Paragosa and Clare failed to establish, but Cyprus and Jemalong were established and persisted moderately well. Harbinger was clearly the best.

The performances of the different cultivars were as expected. At neither site

was there an appreciable difference between inoculated and non inoculated plots, except that in the first year at St. Cyprien, Paragosa and Clare appeared poorer when not inoculated with Rhizobia, but this could not be measured.

In 1974-75, these plots were sown to Soltane wheat using an autumn preparation with adequate superphosphate and no N nor herbicide. The yield results which describe the effectiveness of the legume cultivars are as follows:

Treatments	Wheat Yields in q/ha With Inoculum	Without Inoculum	Variety Mean
St. Cyprien			
Jemalong	23.9	28.3	26.2
Harbinger	21.1	26.3	23.7
Paragosa	26.3	24.3	25.3
Cyprus	25.3	27.5	26.4
Clare	25.5	24.1	25.0
LSD			NSD
Smindja			
Jemalong**	16.1	16.2	16.1
Harbinger	23.3	25.3	24.3
Paragosa*	11.1	12.1	11.6
Cyprus**	15.1	14.2	14.6
Clare*	8.3	11.4	9.8
LSD			5% 3.9 1% 4.2

* no legume in pasture ** mediocre legume in pasture

At St. Cyprien the yield of Soltane wheat on fallow using N fertilizer and chemical weed control was 22.6 q/ha, and at Smindja 20.1 q/ha.

The question of the effectiveness of a variety to adapt to the environment is difficult to define although the characteristics of each are described above. Each was chosen initially because of different characters and different responses to locality features. Harbinger could have been expected to be adapted to Smindja. Earliness was not the only feature leading to adaptation there, since the variety Cyprus is just as early. The answer can be found in the reflection of N accretion shown by the cereal yields since top growth adds little to the N available. But its top growth was also best, - again reflecting superior below ground development.

At St. Cyprien each of the cultivars had an opportunity to increase in density over the pasture period, and each contributed to soil fertility in a similar fashion. Had a crop been taken after one year of pasture, the differences in favour of Jemalong, Cyprus and Harbinger would have been expected. This was not a part of the plan since the longer period before cropping was intended to give a variety, which may be slow to establish, but is subsequently aggressive, a chance to develop.

The relationship with the rhizobia is vital. Without proper inoculation and function of the bacteria, the legume is ineffective in building organic N. For the sake of forage production on weed competition, there are more effective forage plants. The experiments described set out to establish whether indigenous or natural rhizobia existed and would be effective.

The results indicated that natural rhizobia of the proper strains to produce adequate N, were present. Theorically there are superior strains of rhizobia which can be isolated which will fix more N, but none of these have been known to persist in the soil to the exclusion of the less efficient ones already present. In Tunisia where abundant indigenous varieties of Medicago varieties exist with adequate nodules, it can be assumed that the natural rhizobia will form the basis of commercializing the system, and only those varieties that function with them, will be useful.

In the period of the experiments, there were 25 demonstrations in which either Harbinger or Jemalong were sown and about 4000 commercial plantings were also made. None failed because of poor nodulation. It can be safely stated, therefore, that varieties exist or can be found to fit the major locations of the wheat region of northern Tunisia.

2.7.5.1B Use of Phosphate at Establishment

The sensitivity of annual forage legumes to phosphate deficiency and their response to applied phosphate, is well known. Application on initial establishment may be

reflected in greater density, vigour and seed set in the first year, and this goes on through the life of the pasture. Two experiments were established beside the variety experiments at Smindja and St. Cyprien to measure whether this effect applied. Each was a randomized block with four levels of P_2O_5 in the year of establishment i.e., 0, 22, 45 and 67 kg P_2O_5/ha, grown in four replications. In subsequent years, the treatments each received uniform applications of 45 kg P_2O_5/ha. The mean yields of wheat at the two sites were as follows:

Treatment kg/ha P_2O_5	St. Cyprien (Jemalong)	Smindja (Harbinger)
0	18.7	17.2
22	19.7	17.7.
45	19.2	18.7
67	19.2	18.7.
LSD	NSD	NSD

There were no visible differences either in the year of establishment or in subsequent years. Obviously these sites had large residual reserves of P_2O_5, which is common on better farms in Northern Tunisia. Most early results of fertilizer trials have borne this out in previous years.

Australian workers have reported substantial responses to P_2O_5 in the year of establishment, in both Medicago and sub-clover and in some cases could directly relate N accretion to units of P_2O_5 applied. There have been sufficient examples of response however, in newly established and regenerating stands of medic, to warrant a continuance of the recommendation of the 45 kg/ha application at the time of establishment. In areas where there has been no history of addition of P_2O_5 to the wheat crop, its use is mandatory.

2.7.5.1C Field Measurement of N Accretion

In the second phase of the program, it is planned to set out each year a series of experiments on commercial wheat crops, which follow a year of medic pasture. These are designed to measure the build up of soil fertility, particularly N. An initial experiment was conducted in 1974-75 to test the method. A field that had been previously planted to medic at St. Cyprien, and then had been sown to wheat as a normal commercial operation, was chosen as the site. Five treatments of applied N fertilizer were used viz., 0,22,45,67 and 90kg/ha in three replications. Planting was late and the plant density was sparse. These factors reduced the yields, but the results were interesting as indicated by the following:

Treatments (kg N/ha)	Yield q/ha
0	14.5
22	14.3
45	14.3
67	17.3
90	14.2
LSD	NSD

The apparent response to 67 units could not be interpreted, and there is a need for greater replication in future work.

2.7.5.2 Establishment of Commercial Areas

The creation of the rotation in a number of fields on commercial farms, both state owned and in the private sector, is the major goal in the short term. This is essential if the system is to be assessed for suitability and usefulness. Preliminary experimental work was aimed at achievement of this goal.

Based on the extent of the wheat area in Tunisia and its location, it was decided that 5000 hectares would be adequate for the purpose and it would provide the nucleus for rapid subsequent expansion. The plan envisaged to provide seed, was determined in the following way:

Year	Tonnes	Hectares to sow
1	5	500
2	5	500
3	30	3000
4	30	3000

The smaller scale plantings in the first two years were in a sense exploratory, to give an appreciation of the problems of seed sale and distribution. Supervision of planting, advice on management, causes of wastage and an early estimate of the likelihood of success could all be studied.

This year was the third year of the plan, and it was the year in which a large area was sown following the experience of the two earlier years. It was clear that this plan covering a total of 7000 hectares, would in spite of a few failing fields, be capable of providing over the 5000 ha. Wastage from early plantings was reduced. Failures were rarely the result of technology, but were from a change in purpose of certain state farms. In the year, data were collected from six farms which had grown wheat following the very first plantings of medic, and where there was a comparable crop of wheat sown after fallow.

The data were reported at the Third Regional Wheat Workshop, Tunis, 1975 and are reproduced below:

Farm Region	Variety	Application kg N/ha	Area ha	After Medic		After Fallow	
				No. Culti-vations	Wheat Yield q/ha	No. Culti-vations	Wheat Yield q/ha
1. Tunis	D5825	66	40	3	14	4	12
2. Fahs	Mahmoudi	33	15	4	10	5	9
3. Fahs	Ariana 66	50	10	3	32	5	26
4. Gaafour	F. Aurore	33	5	3	17	5	16
5. Gaafour	D5825	33	4	2	21	4	21
6. El Aroussa	Inia	36	5	4	22	5	22

No differences in yield are shown by these data due to moisture storage under fallow, a reduction in number of cultivations and little else. The farmer's normal fertilizer strategy was applied to both fields. He may have been able to use less on the crop following medic, although he is strongly advised to use some in the first cycle after cropping.

The problems of supervising planting and management are great, and in Tunisia this responsibility must be placed with the extension workers. For this year the program of plantings was managed by holding regional field days preceding plantings. A strong link was observed between success and the amount of attention given to farmers and to farm managers. Sowing does not present many problems. The two principal areas of concern are the grazing of fields to get the maximum benefit in animal production and weed control, and the preparation of land in autumn for the subsequent crop.

2.7.5.3 Seed Production and Seed Characteristics

Yield and seed coat characters of seed are important factors in the suitability of a variety. The ability to produce large quantities of seed with a tolerable pattern of seed coat development and breakdown of hardness, is important.

Both these areas were examined in the season. Field sampling produced pod yields of the following order which indicates the level that might be expected from various areas.

Seed Production Results

Area	Kg pods/ha	kg seed/ha	Variety	
St. Cyprien	1790	286	Jemalong	1st year
Teboursouk	1013	162	Jemalong	1st year
Goubellat	300	48	Jemalong	2nd year
Goubellat	520	83	Jemalong	Regeneration
Smindja	1133	334	Harbinger	1st year
Siliana	1287	373	Harbinger	1st year
Enfidaville	200	58	Harbinger	1st year

These yields are derived as the mean of a number of samples taken from within a square meter quadrat. Pod yields are easily made. Determining the seed yield is obtained by examining the rates of seed to pod weight in a number of samples. Therefore 100 pods were weighed, the seeds were removed and weighed, and the percentage calculated. The results showed that Jemalong (16 samples) had a 16 per cent mean seed weight with a range of (7-27) and Harbinger (14 samples) showed a 29 per cent mean seed weight (range 22-36). On this basis, seed yields can be calculated approximately from the samples as shown.

Initial indications of hard seed percentage were obtained from 30 field collections and these are listed in table 1.7.J which also shows the variation among samples.

The hard seed coat character which is so important to allow pasture to regenerate spontaneously after the crop of wheat, does reflect the climatic conditions in the spring when the seed is maturing. Hence the differences between the two varieties is due to the fact that Harbinger was grown in the drier regions rather than the differences between varieties.

2.7.5.4 Evaluation of Indigenous Cultivars

Tunisia, as well as other countries of North Africa, is rich in native Medicago material and as a result should provide cultivars for areas where there is no suitable commercial material. The process of collection and evaluation is a long one. This was begun in the summer of 1974 with a collection made by Mathieson of South Australia. This material, and material from other sources, was grown in pots this year to increase seed. The seed from this is destined for row plantings next year.

The collection planted in pots comprised 250 collections of the following:

Medicago truncatula	M. tornata
M. obicularis	Several Trifolium spp.
M.polymorpha	Hippocrepis spp.
M.ciliaris	Astragulus spp.
M.littoralis x truncatula	Scorpiniris spp.
M.minima	

2.7.6 EXTENSION

Extension activities which are an integral part of the project, continued fully under Tunisian leadership. The 14 mobile technicians take the research results to the farmers and many of these young men received wheat production training at CIMMYT. Two engineers are providing leadership in the program.

A package of recommended practices was developed early in the program. This package is continually updated as new research uncovers new approaches. Recommendation of the variety to use, proper date and rate of seeding, amount and time of fertilizer application and the most effective weed control practices, are integral parts of the package.

The extension program has been very effective in encouraging use of the high yielding varieties and in making farmers aware of the new techniques.

This has been done by the use of:

(a) Practical Demonstrations - These were conducted on 65 farm fields. They provided an opportunity to show a high yield variety in comparison with the farmer's traditional variety. Additionally, sections of the plot were given the recommended dose of N and compared with no N. Chemical weed control was also demonstrated. The average economic value of the yield increases in these plots is shown in tables 2.7.K and 2.7.L.

(b) Farmers' Meetings - Several different kinds of meetings were held with farmers as shown in table 2.7.M. These were arranged in large and small groups to stress particular kinds of information at different times during the season. Practical demonstrations were employed. Also the projects package of variety, fertilizer, weed control and rotational trials were used for demonstrations.

(c) Mass Media - Radio and television appearances were made by Project scientists. Activities were based on timeliness and were used as a supplement to the field demonstration program.

(d) Input Supplies - Seeds, fertilizers and weedicides were supplied by the Office of Cereals CCGG and COCEBLE distribution centres. Project personnel were not directly involved, but they monitored and anticipated needs as well as advised farmers where supplies were available.

The success of the extension activities and the Project's work is reflected in the use of new varieties, fertilizers and weedicides. Changes in the use of new high yielding varieties are illustrated in figures 4 and 5. Figure 6 illustrates changes in the use of fertilizer.

About 100,000 hectares have been sprayed with 2,4-D for several years. However, the area covered in 1974-5 was 144,000 hectares. The effect of new grassy weed herbicides is now beginning to be seen. In 1973-74, these were used on 4,000 hectares and this year on 16,500 hectares.

The use of these inputs ultimately affects yields. Cereal production has nearly doubled since the advent of the project and the 1974-75 crop of 1,300,000 tonnes was the largest ever recorded. Tunisian farmers are responding to the new cereal technology.

TABLE 2.7.A Experiment Station performance of the Tunisian Bread Wheat Varieties. (Average of 1974-5 trials and four year average).

Variety	1974-5 q/ha	% FA	4 year average	% FA
Florence Aurore	38.17	100	35.32	100
Ariana	44.55	117	42.07	119
Inia	46.30	121	42.54	120
Soltane	48.70	128	45.50	129
Carthage	49.96	131	47.93	136
Dougga	53.61	141	49.99	142
Fath*	51.71	136	46.70	132

* Only 3 years average FA = Florence Aurore

TABLE 2.7.B Best yielding lines of the advanced yield trials.

V. No.	Cross and Pedigree	Yield q/ha	% Soltane
V. 113	No.66-Cno"S" x Jar 66 27343-$_2$R-3M-3T	55.2	110
V. 118	On x Son64-Kl.Rend/Cal 31206-1Tu-2MB-OBj	52.4	105
V. 212	Pato x CC-Inia CM-1021-7MB-13Bj-OBj	53.3	107
V. 310	Tob"S"-Np x CC-Inia/Cha CM-5541-34Y-OM-OMch-OBj	53.0	114
V. 305	Bb"S"-Nar"S" 30857-7Bj-2Bj-2Bj-OBj	50.6	109

TABLE 2.7.C The Ten Most Promising Crosses in the Preliminary Yield Trials, 1974-75.

V. No.	Pedigree	Yield in Comparison to the Highest Check	% of the Highest Check
E.P. 103	INIA x 169-Provence T 71-191-8Bj-2Bj	64.2/59.2 Dougga	109
EP.124	HD 1799-Kal T 71-92-7Bj-9Bj	65.5/59.2 Dougga	111
EP.135	Kal-Cal"S" T 71-29-34Bj-5Bj	60.7/59.2 Dougga	103
EP.317	ANZA-Tzpp CM-6438-2Bj-7Bj	60.0/58.9 7 C	102
EP.409	(Eb/Yt_E-$Y50_E$ x 5661) Era-Bj66 CM 7690-1Bj-9Bj	60.7/56 9 Fath	107
EP.411	Cno"S"-Jar x Tzpp-Son64^2/Wren CM 7812-1Bj-3Bj	59.8/56 9 Fath	105
EP.507	7C - Pato CM 790-11MB-6Bj-10Bj	63.6/60.7 Crt.	105
EP.535	Pato x CC-Inia CM-1021-7MB-14Bj-12Bj	64.3/60.7 Crt.	106
EP.1110	Cal-CC x Son64-Nr CM 5752-H-3Y-CM-CMch-2Bj	60.8/57.3 Crt.	106
EP.1113	MEX 1481 x Tob-8156/Tob-Cno"S" x 7C CM-5891-A-CM-CMch-7Bj	62.3/57.3 Crt	109

TABLE 2.7.D Development of Personnel in the Tunisian Program.

	Ph.D.	M.Sc.	B.S.
Plant Breeding	3(1)	1(2)	2(3)
Plant Pathology	1	1	-
Cereal Technology	-	-	1
Total	4	2	3

(1) One person due to return in 1976
(2) One due to return in 1975
(3) One due to go for M.Sc.degree in 1975

TABLE 2.7.E Average Yield (q/ha) in 15 Varietal Trials on Farms in Two Climatic Zones in Northern Tunisia, 1974-5.

Variety	No. of Locations*		Average Yield (q/ha)		% Test Variety Littoral Zone**	Yield Cont. Zone
	Littoral Zone	Continental Zone	Littoral Zone	Continental Zone		
Bread Wheat						
Florence Aurore	11	4	33.3	24.0	87.2	97.2
Inia 66	11	0	35.6	-	93.2	-
Ariana 66	11	4	37.1	27.6	97.1	111.7
Soltane 72	11	4	38.2	24.7	100.0	100.0
Carthage 74	11	4	37.3	27.9	97.6	113.0
Dougga 74	11	4	36.7	27.8	96.1	112.6
Siete Cerros	3	4	30.7	27.6	80.4	111.7
Fath	5	2	37.6	12.0	98.4	48.6
Durum Wheat						
Inrat 69	11	4	30.9	24.3	100.0	100.0
Badri	11	4	29.7	21.8	96.1	89.7
Amal 72	11	2	35.7	28.8	115.5	118.5
Maghrebi 72	11	4	32.4	22.2	104.9	91.4
D 68-8-6A-1A	9	4	34.8	26.6	112.6	109.5
D 68-8-6A-3A	9	4	35.7	28.0	115.5	115.2
Chili	0	3	-	25.5	-	104.9
Mahmoudi	2	0	19.4	-	62.8	-
D 77	2	0	21.2	-	68.6	-

* Littoral zone sites: Mateur, Utique, Mornagia, Fahs, Mograne, Béja, Oud Zarga, Madjez, Teboursouk, Bousalem, Bou Arada; Continental zone sites: Le Kef Sers, Thala, Robaa.

**Per cent based only on trials which contained both the test variety and the variety being compared, therefore does not always correspond with yield comparisons based on averages from all trials.

Test varieties: bread wheat = Soltane 72; durum wheat = Inrat 69

TABLE 2.7.F Average of Yearly Yield Performance in Two Climatic Zones* of Wheat Varieties Tested for Five Years on Farms in Northern Tunisia, 1970-1 to 1974-5.

Variety	Total No. Trials		Average Yield (q/ha)		%Soltane**/Yield	
	Littoral Zone	Continental Zone	Littoral Zone	Continental Zone	Littoral Zone	Cont. Zone
Bread Wheat						
Florence Aurore	61	19	29.3	23.0	79.6	87.1
Inia 66	61	15***	33.7	24.2***	91.6	91.7
Ariana 66	46	18	35.1	27.2	95.4	103.0
Soltane 72	61	20	36.8	26.4	100.0	100.0
Siete Cerros	29	17	34.9	27.4	94.8	103.8
Durum Wheats						
Traditional durums****	31	12	22.5	20.8	61.1	78.8
Inrat 69	56	19	29.9	24.3	81.3	92.0
Badri	60	18	30.0	24.2	81.5	91.7
New durums*****	58	11	33.7	27.7	91.6	104.9

* Sites in Zone of Continental Climate: LeKef, Tajerouine, Thala, Sers, Siliana and Robaa. Remainder of sites used were in the Littoral zone.

** % based only on trials which contained both Soltane and the variety being compared; therefore does not always correspond with average yields from all trials.

*** Does not include 1974-5. Inia 66 discontinued in Continental Zone due to poor performance.

**** Roussia, Mahmoudi, Syndiouk, Mahmoudi, D77, D177, and Chili, the variety used in the Continental Zone since 1973-4.

*****1970-1 = Jori; 1971-2 = Cocorit; following years = Amal 72 .

TABLE 2.7.G Yield (q/ha) of 10 Barley Varieties in Three Farm Demonstrations in Northern Tunisia, 1974-5.

Variety	Location of trial			Average yield
	Mornagia	El Akhouat	Sers	3 trials
Ceres	32.0	18.7	31.8	27.5
Martin	34.0	19.6	32.0	28.5
Delisa	23.0	16.8	34.6	24.8
Gem	23.7	28.5	36.2	29.5
W1 2197	-	31.0	24.8	31.7*
Mardu	35.3	16.0	9.9	20.4
Pella	32.0	18.0	17.2	22.4
Ager	42.7	22.0	20.2	28.3
Gepsi	34.7	23.2	16.1	24.7
Manon	35.3	21.2	29.2	28.6
LSD 1%	10.1	N.S.	6.5	-

* Adjusted for missing value.

TABLE 2.7.H The average yield response (q/ha) from the application of 2,4-D on high and low infestations* of wild oats and broad leaves, in all Type I and Type IV trials, 1970-71 to 1974-75.

	Average q/ha gain or loss in yield. (The number of trials, averaged, is shown in brackets)							
	Wild Oats				Broad Leaf Weeds			
	Less than 20		More than 20		Less than 45		More than 45	
1970-71 **			1.4	(2)	1.4	(2)		
1971-72 **	-0.8	(6)	0.7	(3)	-0.1	(6)	-0.3	(3)
1972-73	0.1	(4)	2.5	(8)	2.3	(5)	1.1	(7)
1973-74	0.0	(14)	2.8	(8)	1.0	(14)	1.1	(8)
1974-75	0.5	(11)	3.8	(5)	1.3	(12)	2.3	(4)
Av.yield gain,all trials	0.0	(35)	2.6	(26)	1.1	(39)	1.1	(22)
Weed density effect			2.6				0.0	
Av.yield gain,last 3 years	0.2	(29)	2.9	(21)	1.3	(31)	1.4	(19)
Weed density effect			2.7				0.1	

* Wild oats, more or less than 20 panicles/m^2; broad leaf weeds more or less than 45 per cent of soil surface covered.

** 2,4-D applied too early; yield loss of 2-3 q/ha, variety Inia 66. No apparent loss in other years, variety Soltane 72.

TABLE 2.7.I Average increase in yield, value of yield increase and net profit per hectare in all Type I and Type IV trials and in trials with high wild oats infestation,1974-5. (One dinar = 2.63 U.S.dollars.)

Weed infestation controlled	Broad leaves[1]	Wild oats	Most weeds[2]
Herbicide used	2,4-D[1]	Suffix	Dosanex
Amount of product used/ha	1.3 liters	6.0 liters	4.0 kg
Cost of application D/ha[3]	2.160	8.600	8.950
All trials[4], Av. of 16			
Yield increase q/ha	1.7	4.3	6.5
Value of yield increase D/ha[5]	10.370	26.230	39.650
Net profit, D/ha	8.210	17.630	30.700
Trials with high wild oats infestation[6], Av. of 3			
Yield increase, q/ha	4.7	12.4	18.6
Value of yield increase, D/ha	28.670	75.640	113.460
Net profit D/ha	26.510	67.040	104.510

1. Includes some yield benefit from suppression of wild oats.
2. Canary grass is not controlled by Dosanex but caused little damage in 1974-75 due to poor development as a result of the dry Dec.-Jan.
3. Includes application (1.250 D/ha), plus growers cost of herbicide, viz:- 2,4-D 0.700D/1, Suffix 1.225D/1, Dosanex 1.925D/kg (Govt. subsidy pays half of the price).
4. Does not include one trial and part of another oversprayed with 2,4-D.
5. Bread wheat at 6.100D/quintal.
6. These three trials had over 100 panicles/m^2; all other trials had less than 25/m^2.

TABLE 2.7.J Per cent of Hard Seeds Found in Field Collections of Jemalong and Harbinger Medics.

Variety Jemalong		Variety Harbinger	
Sample No.	Hard seed %	Sample No.	Hard seed %
	First year seed		First year seed
1	70	1	74
2	93	2	70
3	87	3	63
4	61	4	66
5	67	5	46
6	76	6	58
7	69	7	64
8	67	8	61
9	66	9	61
10	74	10	59
11	68	11	60
12	69	12	48
13	96		58
Mean	74	Mean	61
After 2 years pasture		After 2 years pasture	
14	95	13	68
15	71		
After regeneration		After burning	
16	97	15	52
17	94		(36% dead seed)

TABLE 2.7.K Average Results of Practical Demonstrations - Bread Wheat.

Varieties	No Nitrogen				Recommended Nitrogen(1)			
	Av. Yield q/ha	Diff. in Yield*	% of Florence Aurore	Dinar Val. of the Diff.(2)	Av. Yield q/ha	Diff. in Yield*	% of Florence Aurore	Dinar Val. of the Diff.(2)
Soltane	20.7	3.6	120.7	18.460	28.2	7.0	133.3	36.608
Inia	24.5	7.4	142.9	38.120	29.4	8.2	139.0	42.848
Ariana 66	25.5	8.4	149.4	43.940	27.7	6.5	130.9	33.956
Siete Cerros	14.3	-2.8	-83.1	14.560	25.0	3.9	118.3	20.124
Florence Aurore	17.1	-	100.0	-	21.1	-	100.0	-

(1) 67 kg N/ha. (2) Dinar price per quintal = 5.300 D. * = Compared with Florence Aurore.

TABLE 2.7.L Average Results of Practical Demonstrations - Durum Wheat.

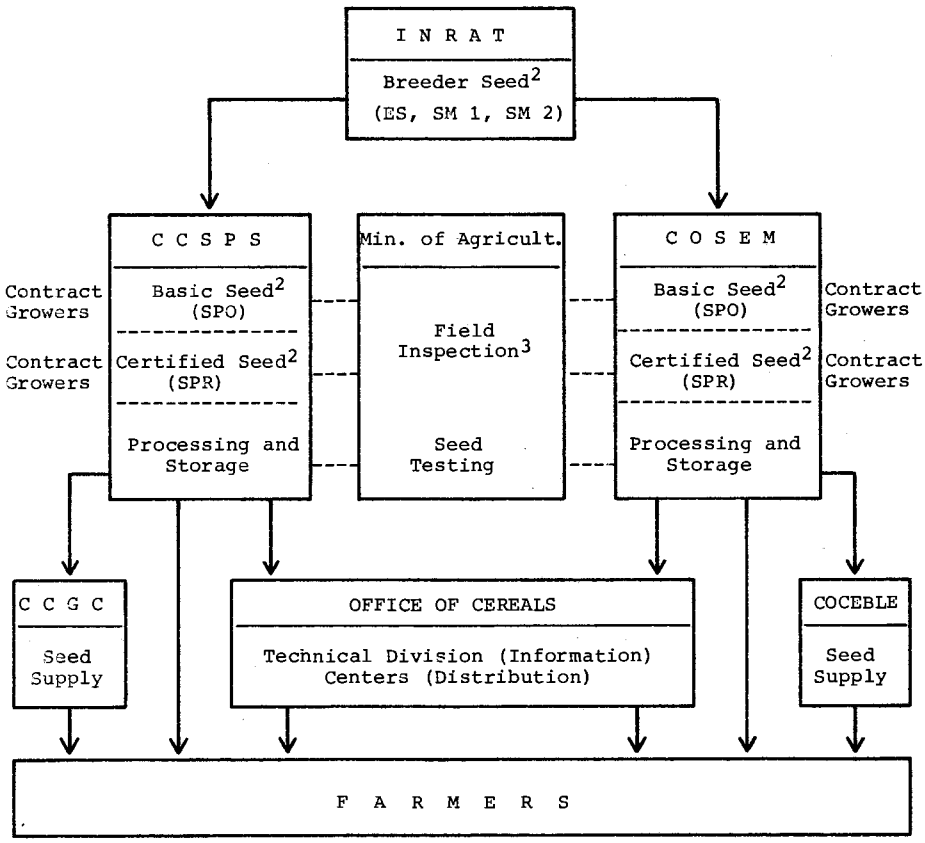
Varieties	No Nitrogen				Recommended Nitrogen(1)			
	Av. Yield q/ha	Diff. in Yield*	% of Mahmoudi	Dinar Val. of the Diff.(2)	Av. Yield q/ha	Diff. in Yield*	% of Mahmoudi	Dinar Val. of the Diff.(2)
Inrat 69	18.5	2.4	114.9	14.880	24.9	6.2	132.2	38.502
Badri	16.4	0.3	101.8	1.798	23.7	5.0	126.5	30.814
Amel 72	17.3	1.2	107.3	7.254	21.4	2.7	114.6	16.368
Chili	13.2	-2.9	81.7	-18.290	16.7	-2.0	88.1	-12.524
Mahmoudi	16.1	-	-	-	18.7	-	-	-

(1) 67 kg N/ha. (2) Dinar price per quintal = 6.300 D. * = Compared with Mahmoudi.

TABLE 2.7.M Details of Farmer Meetings.

Weed Control Meetings		Extension Days		Local Meetings	
Number	Participants	Number	Participants	Number	Participants
9	236	8	1,018	56	699

FIGURE 2.7.1 The components and their function in the Tunisian Seed Program.



1. Complete names of each organization are as follows:
   INRAT - Institut National de la Recherche Agronomique
   CCSPS - Coopérative Centrale de Semences & Plants Séléctionnés
   COSEM - Coopérative Centrale de Semences
   CCGC - Coopérative Centrale des Grandes Cultures
   COCEBLE- Coopérative Centrale de Blé

2. Terms used in proposed legislation:
   ES = Head Rows
   SM1 and SM2 = Bulk Increases
   SPO = Original Basic Seed
   SPR = Reproduction of Basic Seed

3. Inspection made by teams from INRAT, the Office of Cereals and the Seed Control Laboratory.

FIGURE 2.7.2 Hectares of wheat seed production by COSEM and CCSPS compared

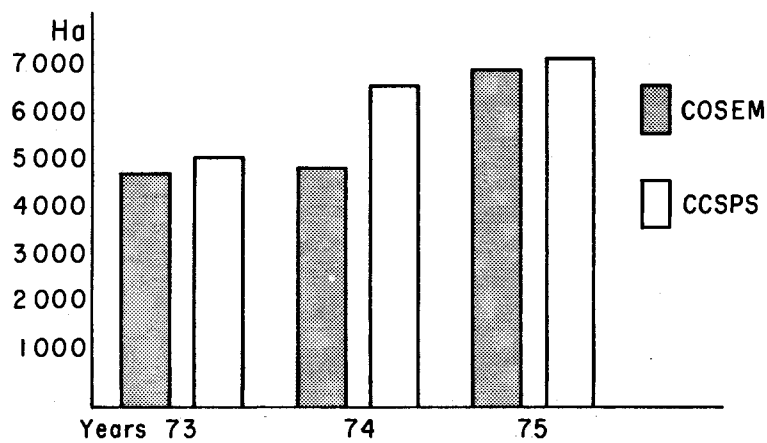


FIGURE 2.7.3 Wheat seed production of newer and traditional varieties compared

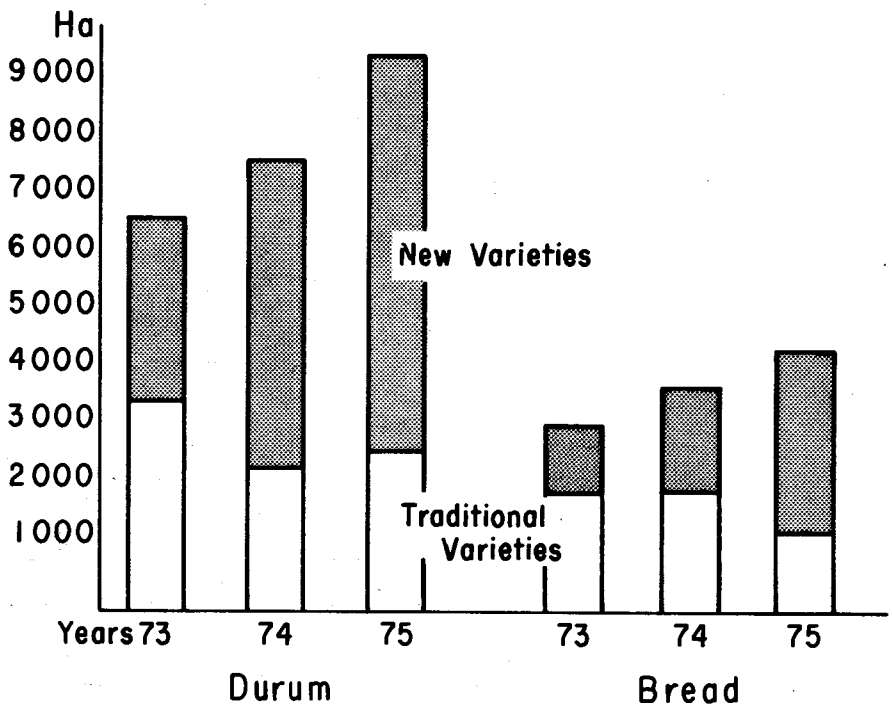


FIGURE 2.7.4. Comparison of new durum wheat varieties used, with total wheat area seeded in North Tunisia

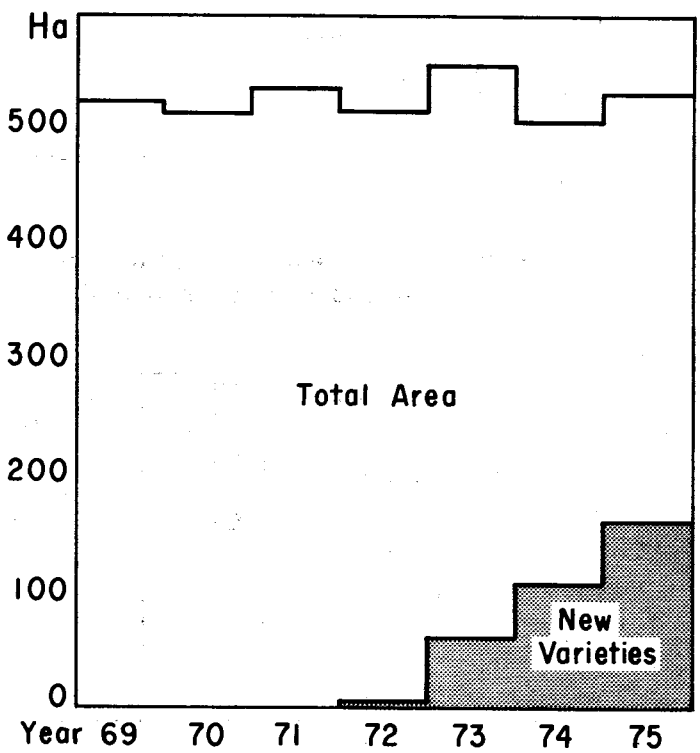


FIGURE 2.7.5. Comparison of new bread wheat varieties used, with total wheat area seeded in North Tunisia

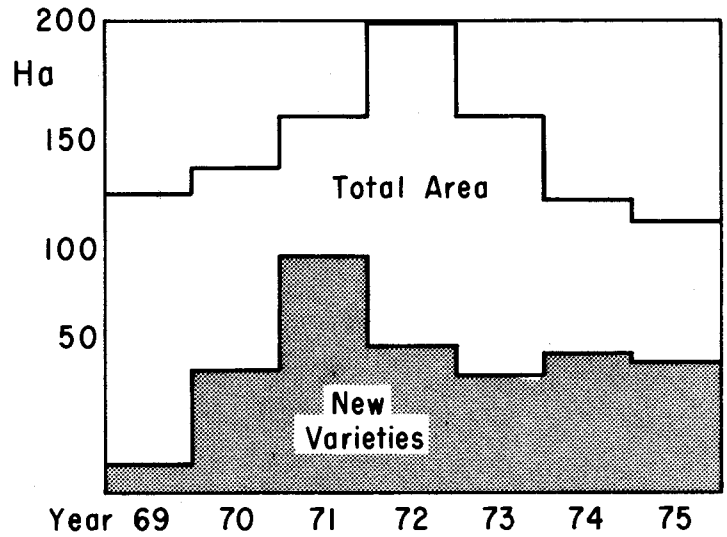
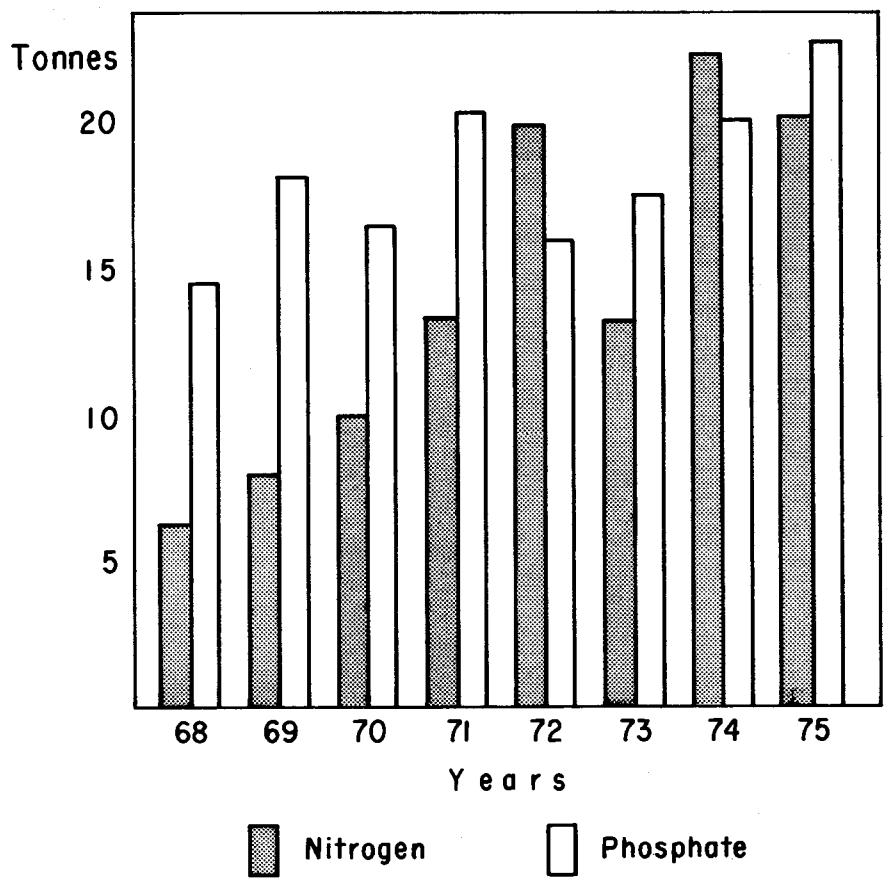


FIGURE 2.7.6. Increased use of actual nitrogen and phosphate



2.8 Turkey

2.8.1 INTRODUCTION

In 1975 Turkey harvested its largest wheat crop - 14.75 million tonnes from 9.25 million hectares for an average yield of 1590 kg/ha. The previous highest yield year was 1971 when production reached 13.5 million tonnes from 8.7 million hectares with an average yield of 1552 kg/ha. Barley production in 1975 was also a new high --- 4.5 million tonnes from approximately 2.7 million hectares, giving an average yield of 1670 kg/ha. This production increase in 1975 was a result of improved technology --- adoption of new varieties and improved cultural practices --- and, perhaps more important, very good rainfall in the spring months. In the coastal areas higher production was partly the result of some shifting from cotton production to wheat. The lower price of cotton and the higher price of wheat plus labor shortages and cotton insect problems, prompted this shift away from cotton. In Thrace the wheat area increased at the expense of sunflowers. This was a result of the national price structure of the two commodities.

This excellent 1975 crop will provide Turkey with all her domestic requirements for the next year and will help re-build her carry-over stocks to a comfortable level. While no wheat exports are being considered, it is quite likely that Turkey will be in a position to export some barley in the coming year. Production probably will continue to climb in the coming years as improved technology spreads, and is encouraged by a generous floor price set by the Turkish Government.

Preliminary results from a CIMMYT sponsored survey of the major wheat production areas of Turkey indicate that new varieties have played a major role in increasing production. These data show that high-yielding varieties in 1971-72 were planted on 97% of the wheat area in Çukurova (mostly Penjamo 62) and 79% of the area in Thrace (mostly Bezostaya). In the Aegean area and in the South Marmara area 35% and 40%, respectively, of the wheat areas were planted to high-yielding varieties (mostly Mexican or Italian varieties).

The Wheat Research and Training Project, cooperatively with the Ankara Province Agricultural Extension Service and the Oregon State University/AID team, conducted a successful demonstration project in 1975. Based on the results of agronomic research conducted since 1970, a series of practices was recommended to the Extension Service which was guaranteed to produce twice the national average yield,provided there was no drought. This set of practices was designed to utilize only tillage equipment and other inputs already available in Turkey. The demonstration project was aimed to convince government officials that yields can be raised significantly and that a nation-wide production campaign can be initiated immediately.

The average yield from the demonstration fields was 2530 kg/ha and the national average yield over the last five years was 1420 kg/ha. The following table gives the yield results of the demonstration fields.

Village	Yield kg/ha		Per Cent Increase
	Demonstration	Other Farmers	Over Other Farmers
1	3250	2300	41
2	2940	2100	40
3	2930	-	-
4	2880	1240	132
5	2800	2350	19
6	2280	1600	42
7	2280	1750	30
8	2080	1830	14
9	2070	1650	25
10	1820	1500	22
Ave.	2530	1810	40

* CIMMYT assists the Ministry of Agriculture in its research and training programs through the assignment of CIMMYT scientists. The CIMMYT involvement is financed by a grant from the Rockefeller Foundation.

Production costs, gross income and profits from some of the demonstration plots and from some nearby farmers who were not in the demonstration program, were calculated. These results are summarized in the following table.

Village	Production Costs TL/ha*		Value of Crop TL/ha			
	Demonstration	Other Farmers	Demonstration	Other Farmers	Extra Profit from Package	Ratio of Increased Benefit to Increased Cost
1	2220	1820	7250	5620	1230	4.1 : 1
2	2400	2420	5720	4630	1110	Increase of 1120TL with cost saving of 20TL.
3	2340	1970	5180	4760	50	1.1 : 1
4	2260	1400	6240	4260	1120	2.3 : 1
5	2350	1930	8630	4810	3400	9.1 : 1
6	2460	1890	9300	3320	5410	10.5 : 1
7	2130	1440	7800	5230	1880	3.7 : 1
Ave.	2310	1840	7160	4660	2030	5.3 : 1

* The current exchange rate is TL 15 = U.S. $1. (TL = Turkish lira).

As the Wheat Research and Training Project matures and national scientists assume more of the leadership, some changes in external assistance have been made. In 1975, the Oregon State University/AID team completed their contract period and ended their work in Turkey. Their assistance was instrumental in training Turkish scientists and in assisting the Turkish Wheat Research and Training Project to establish adaptive research trials on farmer's fields, in initiating weed control research, and in the formation of a national wheat extension team. It is hoped that the research they initiated will form the foundation for an intensive wheat production program by the Government of Turkey.

Because Turkish national scientists have now assumed the leadership for the pathology research in the Wheat Research and Training Project, in 1976 Dr. J. M. Prescott will devote a larger percentage of his efforts to CIMMYT's regional activities.

2.8.2 PATHOLOGY

In the fall of 1974 very little disease was observed in commercial wheat plantings throughout the country; however, by mid-April 1975 the disease situation had changed and in most fields stripe rust, leaf rust, stem rust and/or septoria leaf blotch could be found. This was true for the Central Plateau (particularly the eastern portion), the Aegean, and the Mediterranean regions of Turkey. As the season progressed, the stripe rust situation on the Central Plateau approached epidemic levels and considerable loss in production resulted. Loss estimates for the eastern portion of this region ranged from 0-100% for individual fields with about 20% considered average for the region as a whole. In the Aegean region stem rust caused considerable damage to the late maturing varieties. Stripe rust and septoria leaf blotch were also present but not severe. In the Mediterranean region the incidence of disease was above normal with stripe rust, stem rust, and septoria leaf blotch the principal diseases. In the South Marmera and Thrace regions, leaf rust became moderately severe and caused some damage. The disease incidence in the remaining wheat growing areas was slightly below normal. Overall the incidence of diseases in Turkey for the 1974-75 crop year was higher than average.

A conservative estimate of the overall loss in production attributed to common bunt, loose smut, the three rusts, and septoria leaf blotch is 10-15 per cent. Total production for 1974-75 was reported to be 14.75 million tonnes of wheat. Even with a conservative loss estimate of 10%, this equates to about 1.5 million tonnes of wheat lost to diseases. At current prices, this is approximately 3.75 billion Turkish liras or 250 million US dollars. It is clear that 1974-75 was a costly year for Turkey with respect to wheat diseases.

These figures indicate the need for higher levels of disease resistance of commercial varieties grown in Turkey. The varieties released in 1975 have much better disease resistance than the older varieties and should contribute to stabilizing production.

In 1975 three Turkish scientists returned to the Wheat Research and Training Project after completing graduate programs in the United States. They have been assigned to the research stations at Ankara, Adapazari, and Edirne. At the present time, there are

two scientists with Ph.D. degrees, four with M.S. degrees, and four with B.S. degrees working in pathology in the Wheat Improvement and Training Project.

New and continuing pathology research efforts in Turkey include the following:

(a) Race and virulence analysis of the rusts.

(b) Creation of artificial epidemics of the rusts in nurseries to aid selection.

(c) National disease surveillance program.

(d) Screening breeding material for resistance to common bunt, loose smut, Cercosporella root rot, powdery mildew and Septoria leaf blotch.

(e) Distribution of nurseries to monitor the disease situation.

(f) Screening for adult plant or horizontal resistance to stripe rust.

(g) Studies for the affects of the rusts on leaf and root development.

The regional disease surveillance program, begun in 1971, was continued in 1974-75. During this year the Regional Disease Trap Nursery (RDTN) was sent to 200 cooperators in 45 countries. The results of the RDTN, coupled with those from the Regional Disease and Insect Screening Nursery are being used to locate and map the distribution and movement of virulence genes within the region, to observe changes in these virulence genes within the region, to provide information to the regional countries about potential disease problems and possible necessary variety changes, and to support and assist the national wheat improvement programs' pathology groups within the region.

2.8.3 VARIETAL IMPROVEMENT

2.8.3.1 Spring Wheat Improvement

At the end of the 1974-75 season, the spring wheat breeding stations jointly recommended the release of the seven new spring wheat varieties shown in table 2.8.A. Included in the group are five bread wheat varieties (Cumhuriyet 75, Sakarya 75, Ceyhan 75, Ulucak 75 and Nuri 70) and two durum wheats (Gediz 75 and Dicle 74). Dicle 74 had been previously recommended for the south eastern region of Turkey.

A total of 36 tonnes of elite seed of Cumhuriyet 75, Sakarya 75, Ceyhan 75, Nuri 70 and Gediz 75 were distributed in the various spring wheat regions before the 1975-76 season. All of these varieties and Ulucak 75 will be extensively multiplied in the 1975-76 season.

These varieties are expected to make a significant impact on wheat production in all of the spring wheat areas of Turkey. In three years of extensive trials, the varieties have proved to be superior to Penjamo 62 in yield and disease resistance.

Cumhuriyet 75 is particularly promising in the Aegean and Mediterranean regions and this variety will likely be readily adopted by the farmers because of its combination of excellent yield and large, white seed. Sakarya 75 is widely adapted but is particularly promising for the drier spring wheat regions and as a variety for late seeding. Gediz 75 and Dicle 74 are both semidwarf durums which should quickly replace the tall, native durums currently being grown. Gediz 75 is being recommended for the areas with good rainfall and Dicle 74, although widely adapted, is being recommended primarily for the drier regions in the southeast because of its lack of good grain characteristics when grown under high rainfall conditions.

In the southeastern region of Turkey, Dicle 74 continued its excellent performance record. In the last four years, it has consistently outyielded the native durum varieties by 30-50% and the recommended bread wheat varieties, Penjamo 62 and Bezostaya, by 10-20%. Since Dicle 74 was first recommended in this region, the breeding station at Diyarbakir has been responsible for its seed multiplication and distribution. In the past year the station produced 135 tonnes of elite seed. Fifty tonnes of this seed were distributed to the farmers for the 1975-76 crop season, and the remaining 85 tonnes were used for further multiplication.

The adoption of Dicle 74 by the farmers of this region is almost assured. The southeastern region of Turkey is historically a durum growing region but in the last few years high yielding bread wheats such as Penjamo 62 and Bezostaya have been replacing a large portion of the native durums. Because of its high yield potential and wide adaptation, Dicle 74 should reverse this trend in a short time.

There are several other promising durum lines which are entering the final stages of evaluation in this region. Several of the Flamingo and Stork sibs are promising, especially Stork "S" CM470-1M-2Y-0M. Also many selections from the cross (Z-B x Lak - 60-120 / G11"S") Cit "S" (CM9757) were outstanding in this year's trials. All of these lines will be evaluated in regional trials during the 1975-76 season.

Of the new bread wheat varieties, Sakarya 75 is the most promising in this region. It has good drought tolerance and is relatively early in maturity, factors which are important in this region. Another bread wheat line (T54-01-25-3-7 x 7 Cerros), derived from a spring x winter cross, has shown excellent yield potential in the last two years. It will undergo final evaluation and small scale multiplication during the 1975-76 season.

2.8.3.2 Winter Wheat Improvement

Bezostaya, first introduced into Thrace (the European part of Turkey) in 1968, now occupies approximately 85% of the total wheat area. It is well adapted and has been largely responsible for the significant increase in average yield per hectare in this region in the last few years. Etoile de Choisy was recommended two years ago and is now being grown on a limited area, but it will not replace a significant proportion of the Bezostaya area because of its relatively poor seed characteristics and late maturity.

At the end of the 1974-75 season the breeding station for this region, at Edirne, tentatively named four new lines:

Meriç	T54-01-25-3-7 x 7 Cerros	M6418-6-3A-101A-1A-0A
Kirkpinar	Hyslop "S" - 7 Cerros	
Tunca	Fata Sel.185 - 1 x 61-130-Lds	C27-16
Serhat	Hipro II - 21263 (Durum)	D69002-0W

They are selections from spring x winter crosses and have been tested extensively for the last two years. Meriç and Kirkpinar have consistently outyielded Bezostaya by 10-15%. Tunca and Serhat, new durum lines, have consistently outyielded the local durums by 10-20% and are equal to Bezostaya in yield potential. Small quantities of Meriç will be distributed to farmers in the 1975-76 season and all lines will be submitted to the National Variety Testing Institute for final evaluation.

The breeding station for the northern Marmara region, at Istanbul, has submitted two durum lines to the National Variety Testing Institute for final evaluation. The lines, a sister of Gediz 75 (Selection No. 68722-2) and Ganzo sib (Selection No. 69102), are spring types. They will be evaluated for the more moderate region surrounding the Marmara Sea.

The Agricultural Faculty of the University of Ankara released three new winter wheat varieties this past year. The new varieties Tosun 21, Tosun 22, and Tosun 144 were named after their developer, Dr. Osman Tosun. These new varieties are semidwarf types and are the first Turkish-bred semidwarf wheat varieties released in Turkey.

The breeding stations at Eskisehir and Ankara are responsible for developing winter wheat varieties for more than four million hectares in the Central Plateau. In the past year, Eskisehir submitted eight new lines to the National Variety Testing Institute. Two of the lines were for evaluation under rainfed conditions and six under irrigated conditions. The amount of irrigated wheat area is limited but there is a growing need for well adapted varieties for these conditions.

The two lines for rainfed conditions, /¯(K58-N/Cnn-Tm x Mi-Hope) Pn-Cnn_7 Yektay, P558-2-1, and Menkemen"S" - Mayo 48 x 4/11/Yayla 305, P227-23, were widely tested in 1974-75. Both lines displayed good adaptation and yield potential, but P227-23 was so exceptional at all locations that it has been submitted jointly by Ankara and Eskisehir. This line will be seeded in several demonstration plots in 1975-76 and will be multiplied for distribution.

The winter wheat program at Ankara submitted eight new lines for evaluation; four were bread wheats and four were durum wheats (table 2.8.B). Over the last three years, the Ankara station has now submitted a total of 10 durum lines and 5 bread wheats to the National Variety Testing Institute. Also, several lines from each of the following 9 crosses are promising and these will be further evaluated in the 1975-76 season:

M374 (Local) x 7 Cerros	61-130-414/44
T54-01-25-3-7 (Local) x 7 Cerros	Berkmen "S"-128-13
21183-C0652643 x Lcr - KS82136	Berkmen - Oviachic
Nad x Tmp - C112406	61-130-Uveyik 162
(Vil 53 - Atl 66/Fn x K58-N) P14-P101	

All of these are spring x winter crosses which have been made in Turkey, Oregon, or Colorado. These lines and others mentioned are the first representatives of the extensive spring x winter wheat effort begun in various places in the late 1960's and early 1970's to combine the best attributes of both wheat groups.

In the 1975-76 season, the most promising winter wheat lines will be seeded in demonstration plots in farmer's fields throughout the Central Plateau. The demonstrations will include the native and recommended varieties and will consist of one or more drill strips of each variety and line. The larger plots are preferred by farmers for their evaluation and the large plots will also serve for multiplication and dissemination of the lines. A combination of data from yield trials and demonstrations at many locations will quickly identify the best adapted lines for the Central Plateau.

The various winter wheat breeding stations of Turkey organized and distributed a section of the 1974-75 International Winter x Spring Wheat Screening Nursery (IWSWSN) to eight locations in Turkey and seventeen other countries. In 1975-76, Turkey will not distribute any portion of the IWSWSN; instead it will be distributed completely by the winter x spring wheat breeding program at Oregon State University. An observation nursery of the best winter wheat lines from all stations will be grown cooperatively at several locations in Turkey and, hopefully, the best lines from this nursery will be submitted for inclusion in the IWSWSN.

2.8.4 AGRICULTURAL ECONOMICS

A series of cultural practices which can substantially increase Turkish wheat production has been defined by the Wheat Research and Training Project. An economic evaluation of the results of the first year of farmer demonstrations suggests that the improved technology is far more profitable to the farmer and to the nation than traditional systems.*

The problem now is to implement the improved system rapidly within the constraints imposed by the socio-economic conditions and by Turkish institutional capabilities. The task of the economist is to work with the biological scientists to shape the technology to suit local conditions and to identify barriers to adoption which could be removed by policy actions.

A series of studies, mostly with Turkish collaborators, has been designed to shed light on the "fit" between the technology and the local environment. One study already completed on chemical weed control** concludes that this element of the package, even when used alone, is highly profitable and could serve as the "leading edge" in introducing the full package. Its benefits are fairly widely known, it requires no major change in the cycle of farm operations, it is applicable to all size farms, and a large-scale campaign is administratively and financially feasible. Moreover, experimental data suggest that if the entire package were to be applied, but without weed control, results might be no better than using no package at all, due to profuse weed growth. Effective weed control is absolutely essential to the success of the package. In any incremental adoption of the separate elements of the package, weed control should come first.

Another project underway is a comprehensive survey study of Anatolian wheat farming practices and wheat farm resources. To complement a baseline survey done with CIMMYT's cooperation in 1973, another survey planned for 1976 will give an idea of how rapidly changes are occurring and what factors appear to accelerate or retard the adoption of new practices. This survey will also give insights into the effectiveness of input delivery systems (including the delivery of technical information) and on the functioning of the contract services market. It will also provide some information on how accessible the improved technology is to small farmers. Out of these studies should come policy

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* Farmer Demonstrations of Improved Dryland Wheat Production System: Preliminary Report, Wheat Research & Training Project. November 17, 1975.

** An Economic Analysis of the Benefits of Chemical Weed Control on Wheat in Anatolia: Dr. Charles K. Mann, Wheat Research & Training Project. December 2, 1975.

recommendations on how the introduction of the technology could be accelerated and made as suitable as possible to existing conditions.

It is expected that the various cooperative research projects will be useful in formulating measures to facilitate rapid adoption of improved technology by all sizes of farms with a minimum of adverse side-effects. With emerging issues defined in advance, a more coherent set of policies can be formulated.

Turkey has the potential to be a major wheat producer and the analytical talent to design sound policies to realize that potential, if this talent can be brought to bear on the issues. It is hoped that the Wheat Research and Training Project can make a useful contribution not only in this area of wheat production, but also in the development of Turkey's analytical resources.

2.8.5 AGRONOMY

The agronomy staff of the Wheat Research and Training Project increased in number with the return of four master degree students --- three with degrees in soil science, one with a degree in crop science; and one with a degree in weed science. This staff increase plus the termination of the USAID/Oregon State University contract initiated a new agronomy research program at Eskişehir and the incorporation of research, that was begun by the Oregon State University team, into the research of the Wheat Research and Training Project.

An agronomy research program at Eskişehir was commenced to study the higher rainfall (450-650 mm) transitional areas which border the Anatolian Plateau. Other agronomic research is being conducted at Ankara and Diyarbakir. The research at Ankara, in the Anatolian Plateau and Diyarbakir, in southeastern Turkey, has been involved with tillage management during the fallow season and with agronomic trials designed to define the cultural techniques for maximum wheat production under their respective climatic conditions. The research at Eskişehir will investigate cultural techniques for the transitional areas and various cropping cycles that may be practical under the higher rainfall conditions.

With the departure of the Oregon State University team, Turkish scientists assumed full leadership of the adaptive tillage research, the weed research and demonstration program, and the wheat production training program. The adaptive tillage research will continue in five provinces on the Anatolian Plateau. The objective of these trials is to test under farmer conditions, a set of tillage combinations which have been identified through research on experiment stations as improved systems. Advanced cultural techniques such as fertilizer usage and herbicide application were also incorporated into these adaptive research trials. This research has generated considerable farmer interest and is an effective way of conveying new management techniques to farmers.

Weed control research has shown increases in yields ranging up to a 50% increase, depending on various factors. A factor of major importance has been the timing of the herbicide application. A large proportion of the herbicide used by farmers is applied very late, sometimes after heading of the wheat crop. By this time, the weeds have reached an advanced stage of maturity and in many cases have already set seed. Herbicide application at this time gives only a slight improvement in yield. On the other hand, herbicide application at the correct period in the spring with a properly operating and calibrated sprayer may give yield increases up to 50%, depending on weed population intensities. The weed research program will place more emphasis on demonstration trials and will work again in close association with extension personnel.

The success of the agronomic research program is best exemplified by the data from the adaptive research trials. The average yield of these trials for the 1975 harvest was 3.12 t/ha whereas average yields from adjacent farmer fields was 1.22 t/ha. Over the three year period 1973-75 the adaptive research trials averaged 2.15 t/ha compared with 1.08 t/ha for adjacent farmer fields. This is a yield increase of 99%.

A training manual has been prepared by Mr. F. V. Pumphrey of the USAID/OSU wheat production team to assist in the production training program of the Wheat Research and Training Center. The manual has been translated into Turkish, a training officer from the Wheat Research and Training Center has been appointed, and it is anticipated that a formal training schedule will be launched soon.

2.8.6 EXPERIMENT STATION OPERATIONS

In 1975 a Turkish scientist was assigned as Experiment Station Manager at Ankara. A new 400 hectare tract of land near Ankara is being developed into a modern field laboratory. Plans also call for the construction of a supplementary irrigation system and for building a farm management center.

2.8.7 WHEAT BREEDING RESULTS SUMMARY, TURKEY 1974-75

2.8.7.1 Spring Wheat Regions (Izmir, Adana, Antalya, Samsun)

2.8.7.1A New Spring Wheat Varieties:

Tentative Name	Cross	Pedigree
Cumhuriyet 75	Ciguena"S"	21406-6-2-300Y-0S
Sakarya 75	Chanate	26265-22Y-300M-301Y-2M-501Y-0S
Ulucak 75	Cno'S'-Gallo	27829-13Y-3M-0Y
Ceyhan 75	Robin	26787-300Y-300M-302Y-3M-0Y
Gediz 75	$LD857_E$-Tc^2 x Jo"S"	27534-1M-1Y-1M-0Y
Nuri 70	Bb#1	

2.8.7.1B Promising Spring Wheat Lines

Ulucak 75-2	Cno"S"-Gallo	27829-19Y-2M-3Y-0M
Ulucak 75-5	Cno"S"-Gallo	27829-19Y-3M-5Y-0M
Seyhan 5	$Y50_E$ - Kal^3	35188-5M-31Y-0M
-	Cno'S'-Gallo x Bb-Ron	CM7753-502S-0S

2.8.7.1C Distribution (tonnes) of New Spring Wheat Varieties

	Region			
Variety	Aegean & South Marmara	Mediterranean	Black Sea & North Marmara	Total
Cumhuriyet 75	14.5	6.0	1.2	21.7
Sakarya 75	4.0	0.3	0.75	5.0
Ceyhan 75	2.3	0.3	0.4	3.0
Nuri 70	2.4	2.4	-	4.8
Gediz 75	0.8	0.1	-	0.9
T o t a l	24.0	9.0	2.4	35.4

2.8.7.2 Southeast Turkey (Diyarbakir Region)

Dicle 74 or Dicle I (= Cocorit 71) - 50 tonnes were distributed to farmers in 1975 and 85 tonnes were seeded for further multiplication. Dicle IV (27617-9M-5Y-5M-0Y) may be considered for release because it has better seed characteristics than Dicle I, but no better yielding, in fact, slightly less. Dicle III (27617-18M-6Y-2D-0D) has been considered for release, but is not better than Dicle I. Sakarya 75 has done very well throughout this region. Most of the other Chanate Sibs, also do well.

Promising bread wheat lines are Kop = 754-01-25-3-7 (Local) x 7C (M6418-6-3A-101A-1A-0A), Cajeme 71 (which has done very well in experimental plots but is too short for general use throughout the region at this time) and HD832-Bb (27047-51M-2Y-1M-0Y).

Promising durum wheat lines are Stork S (CM470-1M-2Y-0M), the best of three; Stork S (CM470-1M-3Y-0M) and Stork S (CM470-1M-4Y-0M). Gediz 75 and sister lines do reasonably well but are somewhat lower yielding than Dicle. Several lines from the cross (Z-B x Lak - 60 - 120 / G11"S") Cit'S', CM9757 are also promising.

The average yield figures of check varieties in all yield trials at Diyarbakir are shown on the next page:

Variety	Bread Wheat Trials (tonnes/hectare)	Durum Wheat Trials (tonnes/hectare)
Dicle 74	5.87	5.74
Penjamo 62	5.98	5.73
Cajeme 71	5.85	-
Bezostaya	5.04	-
Penjamo 62	5.71	-
Dicle III	-	5.57
Bagacak (Local)	-	3.44
Akbasak (Local)	-	3.62

2.8.7.3 Southern Marmara Region (Adapazari)

Cumhuriyet 75 and Sakarya 75 do very well in this region, but Dicle 74 and Gediz 75 do not perform very well here. This region grows little durum wheat. The most promising crosses are (Tob - B Man x Bb / Cd1) S x (CM 8972); Cno - Bb x Cal (7 C / Lib 64 - Inia x Inia - Bb) (CM 5872); Cno'S' - Pj 62 x Gallo (30793-1M-2R-2M-0R). Cno"S" - Gallo lines do reasonably well, and $Y50_E$ - Kal^3 lines yield very well.

2.8.7.4 Northern Marmara Region (Istanbul)

Ganzo sib (Local Sel. 69102) and a Gediz 75 sib (Local Sel. 68722-2) have been submitted to the National Variety Testing Institute for final evaluation. Gediz 75 sib may actually be Gediz 75. Promising bread wheat lines are T54-01-25-3-7 x 7 Cerros which has done quite well and is probably the same line as in Diyarbakir (the cross was made in Ankara in 1968) and several lines from the cross Kosemeloz 1718 (a local winter wheat) x 7 Cerros, a cross which was made in Edirne about 1970. Promising durum wheats are several lines from the cross Kunduru (Local Winter) x (Cp_E - Gz x Tc^3 / BY_E^2 - Tc). Gediz 75 and sister lines do quite well.

2.8.7.5 Thrace (Edirne)

The new varieties submitted to the National Variety Testing Institute are:

1. Meric = T54-01-25-3-7 x 7 Cerros. This is the same line as from Diyarbakir and probably Istanbul. This line must have good adaptation. Many selections were made from this cross, but generally the lines had insufficient winter-hardiness for the Central Plateau. Small amounts of seed were given to 20 farmers in 1975. This variety is quite promising for this region.

2. Kirkpinar = Hyslop'S' - 7 Cerros. This variety was originally selected as an F_3 bulk at OSU and was brought to Turkey in 1971. It has good yield potential and white seed but is somewhat late. (OSU=Oregon State University).

3. Tunca (Durum) = Fata Sel. 185-1 x 61-130-Lds, C27-16. It is 15-20% higher yielding than the local durums and equal to Bezostaya.

4. Serhat (Durum) = Hipro II - 21263 (Durum), D69002-0M. This cross was made by Rupert at Davis. It was originally selected as an F_3 bulk at Oregon State University and was brought to Turkey in 1971. It has good yield potential but is slightly later than the local varieties.

5. Etoile de Choisy was recommended a couple of years ago. It is currently grown on a limited area but it may never occupy an extensive area because of its late maturity and poor seed characteristics.

Promising bread wheats are (1) Tob'S'-8156 (R), 23439-4A-2A-1A-0A, a line which has yielded well in the last 2 years but there is some doubt on its winterhardiness; (2) several lines from the cross MD-$P101^2$, i.e. Hyslop sibs have excellent yield potential but are quite late. They also are susceptible to Puccinia graminis tritici. Hyslop itself is also good; (3) several lines from Pakistan probably lack winterhardiness; (4) a few lines from the cross CD-P101 x Drc / Hys'S'; (5) several excellent yielding late lines from the cross Ymh x Hyslop; (6) many lines from the cross Kosemelez 1718 x 7 Cerros. This cross was also good at Istanbul. These lines are F_5'S'; (7) and a few lines with the general pedigree: Pacific NW variety x Mexican spring.

A promising durum wheat is 61-130-Akbasak 253/39 which is a cross made in Ankara. Several lines from this cross are also promising in Ankara.

2.8.7.6 Western Transitional Zone (Eskisehir)

New lines submitted to National Variety Testing Institute were: (1) /(K58-N/Cnn-Tm x Mi-Hope) Pn-Cnn/ Ykt, P558-21-1. It gave a good yield performance in the Eskisehir region, but it was only fair on the Central Plateau. It has fair winterhardiness; (2)Menk 'S' - Hy48 x 4/11/Yayla 305, P227-23, a line submitted jointly by Ankara and Eskisehir. It had excellent yield in both regions, is quite early, reasonably short, has good white seed, and is widely adapted. It is likely to be a good variety for the Central Plateau; (3) six lines were submitted for evaluation under irrigated conditions.

Other lines which showed promise are (1) M374(local) x Super X which has good yield and adaptation but may lack winterhardiness. There are many lines from this cross; (2) Fata Sel. 185-1 x 61-130-Lds, which is the same line as the new durum variety Tunca in Edirne; (3) and 61-130-Kunduru 414/44 (Durum). This cross was made in Ankara where many lines are also being evaluated.

Bolal continued to perform very well in the Western Transitional Zone.

2.8.7.7 Central Plateau (Ankara)

Lines submitted to National Variety Testing Institute were:

1. Bread Wheats.

(1) Fr - Tm x Tx 580 - 405 / 908 - Fn M6405-12-6A-1A-2A-0A

(2) Fr - Tm x Tx 580 - 405 / 908 - Fn M6405-2-1A-101A-1A-0A

These two lines are being called Erciyes sibs. They are very early types, have good, red seed, fair yield potential, and only adequate winterhardiness.

(3) Scout^5 - Agent, 68F6674 from Colorado. Many lines from this cross are doing well, and this is probably the best one. It is a little later in maturity than desired but it has good yield potential and good adaptation.

(4) /(N10B / 27 - 15 x Rio - Rex) P101/ Yayla 305, P149-7. This cross was made at Eskisehir and it has done reasonably well in the Plateau. It has excellent white seed and it is quite tall.

2. Durum Wheats.

(1) 61-130-Uveyik 162 (local) (D03-41A-1A-0A)

(2) Uveyik 162 - 61 - 130 (D04-17A-3A-0A)

(3) Uveyik 162 - 61 - 130 (D04-16A-4A-0A)

The lines from these reciprocal crosses are very promising. Many sister lines are also being evaluated but these three are the most advanced. Most lines are intermediate in height and have good to excellent yield. This cross is giving some of the best levels of winterhardiness among the durums.

(4) 1224/1 is a local selection which has shown good yield potential. It is intermediate in height and has good adaptation.

3. Promising Bread Wheats.

(1) M374 - SX. There are many lines from this cross (M6545) and they all have red seed, intermediate height and moderate winterhardiness.

(2) 21183-C0652543 x Lcr - K562136(Colorado cross) Dr. J.R.Welsh will release two new HRWW varieties from this cross. It is quite promising on the Plateau. The most promising line is C0725061 but several lines are just entering advanced trials. All lines are semidwarf types.

(3) Nad 63 x Tmp - C112406. There are some excellent types but the lines have only fair seed. They may not be sufficiently good to become a variety but three lines have proved to be excellent combiners and have been used extensively in the crossing program.

(4) (Vi153 - Atl 66 / Fn x K58 - M) P14 - P101. All lines have excellent white grain and fair to adequate winterhardiness. Yield potential is generally good but most lines are still heterogenous.

(5) One T54-01-25-3-7 x 7 Cerros line is very promising for the transitional zones but lacks winterhardiness for the Central Plateau.

(6) Many lines from the Spring x Winter program at Colorado State University.

(7) Several lines from the HRWW programs in Nebraska and Oklahoma.

(8) Russel 1714. Unknown origin. In preliminary testing it was promising.

Promising materials are in the F_2, F_3, F_4, and are selections from Spring x Winter and Spring x Winter x Winter crosses.

4. Promising Durum Wheats.

(1) Uveyik 162 x 61-130. There are many outstanding lines from this cross and its reciprocal. At least one and probably several new varieties will be obtained from them.

(2) Berkmen Sib x 128-13 (local) D02-7-1A-1A-1A-0A. This line has excellent potential and is a semi dwarf. It should be released as a new durum variety soon.

(3) Berk - Oviachic (Cross D07). There are several promising lines from this cross, both short and tall types.

(4) 073/44 - Oviachic (Cross D08). These are quite promising types with fair to good winterhardiness.

(5) Many lines from the cross 61-130-Telamara have useful winterhardiness.

It is considered that the durum material in the program will supply good durum varieties for Turkey for at least the next 10 years.

TABLE 2.8.A New Wheat Varieties Recommended for the Spring Wheat Regions of Turkey.

Tentative Name	Cross	Pedigree
Cumhuriyet 75	Ciguana "S"	21406-6-2-300Y-0S
Sakarya 75	Chanate	26265-22Y-300M-301Y-2M-501Y-0S
Ulucak 75	Cno "S" - Gallo	27829-13Y-3M-0Y
Ceyhan 75	Robin	26787-300Y-300M-302Y-3M-0Y
Nuri 70	Bluebird #1	
Gediz 75	$LD357_E$-Tc^2 x Jo"S"	27534-1M-1Y-1M-0Y
Dicle 74	Cocorit 71	

TABLE 2.8.B Lines Submitted to the National Variety Testing Institute During 1974-75.

Cross	Pedigree
Bread Wheats:	
Fr-Tm x Tx 580-405/968-Fn = Erciyes	M6405-12-6A-1A-2A-0A
Fr-Tm x Tx 580-405/908-Fn = Erciyes	M6405-2-1A-101A-1A-0A
$Scout^5$ - Ag	68 F 6674
/(N10B/27-15 x Rio-Rex)P101/ Yayla 305	P149-7
Durum Wheats:	
61-130-Uveyik 162	D03-41A-1A-0A
Uveyik 162-61-130	D04-17A-3A-0A
Uveyik 162-61-130	D04-16A-4A-0A
1224/1	

3.0

Asia and Pacific

Farmers and their children in a good crop of Sonalika wheat near Dattanagar, Bangladesh.

3.1 Afghanistan

3.1.1 INTRODUCTION

Wheat is the principal cultivated crop in Afghanistan. Approximately 3,500,000 acres (1,400,000 ha) are irrigated. The area under rainfed culture can rise as high as 10,600,000 acres (4,240,000 ha), but this area is very variable and in any one year its extent will depend on moisture at sowing time and the expected price. The average yield of the improved wheats is about 3.5 tonnes per hectare (t/ha) while the local varieties give 1.5 t/ha on irrigation. On the rainfed areas, yields are about 0.525 t/ha.

Because of their high yield per unit area, the improved varieties provide a significant part of the total grain production, but they occupy only 15-20 per cent of the irrigated acreage. This low adoption is considered due to such factors as:- the lack of an adequate seed production program to produce quality seed; an inadequate credit system to provide farmers with capital to purchase inputs; insufficient knowledge regarding the use of fertilizers and improved cultural practices; lack of chemicals for seed treatment to be provided to the farmer on credit and, trained personnel inadequacy particularly a cereal plant pathologist and a seed technologist.

3.1.2 CEREAL VARIETIES

Cherab 70 and Bakhtar, both spring wheats with Mexican germ plasm, were released as commercial varieties for growing in the Eastern and Northern Provinces. They are taking over area from Mexipak which has become susceptible to the rusts. Bolal and Martonvasar, two lines from the Nebraska International Winter Wheat Trial, showed broad adaptation and high yield potential among the winter wheat lines and varieties. HD832, Mexipak 15-4, C271 and Strampelli have been top yielders among spring wheat lines and varieties over the past three years.

In the past year, growing conditions were good with above average precipitation as snow and rain. In spite of this, such diseases as the rusts, mildew, smut and others, were negligible.

Barley is a very important feed crop with an area of approximately 757,000 acres (303,000 ha). The average yield is about 2 t/ha. To date, there are no improved barley varieties.

3.1.3 FERTILIZER USE

The use of commercial fertilizer by Afghan farmers began in the early 1960's in the cotton growing region of the North. With time and effort on the part of Government, farmers were persuaded to use fertilizers on other crops as well. However, in spite of availability of credit for fertilizers, it is estimated that not more than 10 per cent of irrigated wheat farmers are using fertilizers. From the beginning of the campaign to encourage fertilizer use, the Government has provided up to 66 per cent subsidy on fertilizer. Up to 1973, the Extension Department of the Ministry of Agriculture was in charge of supply and sales of fertilizer. After that date, responsibility for distribution was placed with the Afghan Fertilizer Company.

The sales statistics available are as follows:

1973-74	42,000 tonnes
1974-75	62,000 tonnes
1975-76	62,000 tonnes sold in first 10 months. (80,000 projected)

The above fertilizers are comprised primarily of urea and diammonium phosphate (DAP) in a ratio of about 2:1. Most of the fertilizer is used on the wheat crop. The recommended rates are 50 kg urea/jreeb, i.e. 250 kg urea/ha, and 25 kg DAP/jreeb, or 125 kg DAP/ha. Application varies according to farmer preference, his financial status, water availability, etc. It is usually below the recommended level. Up to 1974 all fertilizer used in the country was imported, but now the urea plant at Mazar-i-Sharif is producing more urea than there is domestic demand. DAP, however is still being imported.

The consumer sales price is 570 Afghanis ($9.50 U.S.) per 50 kg bag of DAP and 500 afs ($8.33 U.S.) per 50 kg bag of urea. The level of subsidy varies with the fluctuations of the international market.

As earlier mentioned wheat is the most important cereal crop in Afghanistan. It is imperative that the country be self-sufficient and continue to increase production levels to meet the expanding population. A National Wheat Breeding program is being conducted, aided by international cooperation. This ensures that varieties selected from any source are chosen for their suitability to Afghan conditions.

3.1.4 WINTER WHEAT IMPROVEMENT

The objective of the winter wheat improvement program is to evolve wheats with good winter hardiness, high yielding potential and hard amber grain suitable for bread making. Two approaches have been followed:

1. A crossing block was established to create genetic variability and broaden the genetic base of future genotypes and varieties. Parents from the local winter wheat and exotic germ plasm were selected. In the selection of parents for each cross, precaution is taken that they are genetically diverse and possess complementary characters. In the current year eighty one F1's were planted.

2. During the year two duplicate sets of the locally collected germ plasm of wheat were grown as observation nurseries. These are located in Kabul and Nangerhar provinces and comprised 1230 entries. At Kabul the purpose was to purify and select for winterhardiness, plant height and grain quality. At Nangerhar the aim was to select for grain quality and good phenotype. From the two nurseries, 105 selections were made with good winter hardiness and 105 spring types were also selected. These will be used in crosses in coming years.

Protein analyses were conducted on all local germ plasm using a UDY protein analysis. Atlas 66 was used as the standard with a value of 17.4 per cent. Protein analysis showed that 15 local wheat selections had protein contents from 17.0-20.0 per cent, which is equal to or greater than that of Atlas 66. It is known that protein level is influenced by environmental factors, so that it is felt that three years of data and studies are required to obtain reliable information on protein level. The high protein varieties from local germ plasm will be used as parents in the coming years.

3. Nurseries and trials of winter wheats received from Nebraska and Turkey, were fall sown under two completely different environments at Kabul and Bamiyan Research Stations. The winter wheat trials and nurseries, because of a severe winter and prolonged and unusually early snowfall, provided a good basis for selection for winter hardiness and survival. Bolal and Martonvasar proved particularly hardy. Two spring wheats included as checks did not survive well. Lerma Rojo 64 was severely damaged and Mexipak, although somewhat less affected, was much reduced in stand. Locally adapted winter wheats also withstood the winter climate.

The results of this experiment and others indicate the potential for improvement of winter wheat in Afghanistan. The local wheats are resistant to frost damage or when affected, they have early spring recovery and fast growth. The varieties, however, must have better disease, lodging, and shattering resistance. Some lines have been developed, approaching this desirable combination of characters. Amber grain is preferred and selection is made for the grain type.

3.1.5 SPRING TYPE CEREAL IMPROVEMENT

The aim of the spring wheat improvement is to get early maturing, drought tolerant, fertilizer responsive varieties with field tolerance to stripe rust, septoria, smuts, etc.

The indigenous spring wheats of Afghanistan have excellent grain characteristics. Local germ plasm of spring wheats were grown at Nangerhar Research Station for purification. A crossing block was established there. Selected local germ plasm of spring wheats are used as parents in crosses with exotic selected improved advanced lines and varieties. In 1974-75 approximately 100 crosses were made between local and exotic germ plasm. F1's were sown.

The fall sown bread wheat, durum wheat, barley and triticale improvement program is briefly categorized as follows:

1. Selections are made from nurseries sent by CIMMYT, FAO, ALAD, Nebraska University and various other institutions.

2. Early generation tests are being carried on materials obtained from crosses made at local research stations.

3. Yield trials were conducted on F^4, F^5 and F^6 selections. About 15,000 F2 plants are raised each year and about 10-40 per cent of them are selected for advance to F3.

4. Advanced generations are tested in preliminary yield trials, regional yield trials and a national uniform trial. All are replicated and conducted at 2-6 sites throughout the wheat districts of Afghanistan.

5. Attempts are being made to transfer stripe rust resistance to the commercial cultivars.

6. Research on barley and triticales is primarily centered on the screening of introduced lines or varieties for desirable characters and adaptability.

3.1.6 FERTILIZER AND AGRONOMIC TRIALS

Experiments are listed below which are conducted on fertilizer requirements and other agronomic practices in different wheat growing areas.

(a) Application of different levels of N and P_2O_5.

(b) Date of planting effect on yield potential of new varieties.

(c) Fertilizer levels giving best results on new lines and varieties.

(d) Seed rates for best performance in different varieties, as well as methods of surveying existing practices.

(e) Herbicide trials. In general 2,4D and MCPA have been found useful when applied on time and at the right dose. Weeds are controlled and the crop is not damaged.

(f) Water management and irrigation schedules.

(g) Improved agronomy for rainfed production.

(h) Time of N application using urea, on winter wheats.

Mr. Sohan Pal, Dr. T.P. Singh and Mr. Malik examine a plot of early sown long eared wheat at Pantnagar, India.

3.2 India

3.2.1 INTRODUCTION

CIMMYT wheat and triticale material was assessed in India in the 1974-75 winter planting season by the All India Coordinated Wheat Improvement Project. One of the main objectives of the Project is to enrich the genetic variability of wheat and triticale at each Indian breeding centre. In pursuit of this aim, fixed and segregating wheat and triticale material is obtained annually from international and regional agencies, in the form of yield, observation, screening, crossing block and breeding nurseries.

Depending on the number of sets received of each nursery, the material is supplied to different centres for evaluation and further use. The promising ones which are identified by this multi location testing are further tested in summer nurseries. The most promising lines are fed into the Wheat National Genetic Stock Nursery (for use by all the wheat workers in the country) and into stations and coordinated variety trials.

During 1974-75, the following CIMMYT material was received and supplied to a total of 24 Indian stations:- International Spring Wheat Yield Nursery (ISWYN); Elite Selection Yield Trial (ESYT); multilines; International Bread Wheat Screening Nursery (IBWSN); Crossing Block (CB); International Septoria Observation Nursery (ISEPTON); F2 Bulk Bread Wheat (Irrigated); F2 Bulk Bread Wheat (Rainfed); F2 Spring x Winter Bread Wheats; International Durum Yield Nursery (IDYN); Elite Durum Yield Trial (EDYT); International Durum Screening Nursery (IDSN); Crossing Block (CB); F2 Bulk; International Triticale Yield Nursery (ITYN); International Triticale Screening Nursery (ITSN); Crossing Block (CB); Triticale Durum Rust Nursery (TDRN); and F2 Spring x Winter Triticales.

The results obtained in Yield Nurseries and Observation Nurseries, are presented below.

3.2.2 YIELD NURSERIES 1974-75

3.2.2.1 International Spring Wheat Yield Nursery (ISWYN).

Forty nine varieties were evaluated against a local check variety at Niphad, Powarkheda, Pusa, Delhi, Durgapura and Pantnagar. The sowing dates ranged from November 20, 1974 to December 5, 1974.

The data obtained showed the following varieties gave a promising performance at a number of locations, in order of merit:-

Entry No. 13 = Pj62-Gb55 x Nai 60
No. 48 = Pi62-Frond/Pi 62-Mazde x M x P
No. 11 = Son 64A-TzPP/Nai x St.464-Bza "S"
No. 35 = Soltane No.42 (=Mexican)
No. 7 = Y50E-Kal^3
No. 39 = Giza 155

However, none of these entries has been found suitable for further extensive yield testing because numbers 13, 11, 35 and 7 are all red grained and are susceptible to brown, or brown and yellow rusts, while entry numbers 48 and 39 although being amber grained, are susceptible to three and two rusts respectively.

3.2.2.2 Elite Selection Yield Trial (ESYT).

This trial which was conducted at Durgapura and Pantnagar, consisted of 25 varieties and 2 multilineal composites of 8156 cross derivatives. The yield and other characteristics of promising entries are given in table 3.2.A.

These results showed that entry numbers 12, 13 and 15 in that order gave better overall performance. However entry number 15 in this and other trials, although good yielding and amber grained, was found to be highly susceptible to brown rust. Entry number 3 is red grained and highly susceptible to brown rust. Entry number 17, although amber grained and rust resistant, yielded well at only one location. However, further testing in the 1974-75 ISWYN at six locations showed number 17 to be highly susceptible to yellow rust, and a poor yielder. It was concluded that no variety merited further testing in yield trials.

3.2.2.3 Regional Wheat Yield Trial (RWYT) from Beirut.

Twenty five varieties including the local check Kalyansona were tested in a yield trial conducted at the Punjab Agricultural University, Ludhiana and the results are stated in table 3.2.B.

From these results, it was decided that only entry numbers 20, 23 and 4 would be evaluated critically in 1975-76. They all yielded well, are amber grained and showed a moderate to high degree of resistance to rusts.

3.2.2.4 Rainfed Wheat Yield Trial (RfWYT) from Beirut.

This trial was conducted under low fertility rainfed conditions at Delhi with 25 varieties, including a local check variety. The best yields in quintals/hectare (q/ha) were Sonalika (56), Mexipak (53) and SA42 (49 q/ha). The latter two were much inferior in resistance to rusts than Sonalika. It was considered that no variety was suitable for further yield testing.

3.2.2.5 International Durum Yield Nursery (IDYN).

A series of trials was conducted with 25 varieties including a local check, at Niphad, Vijapur, Indore and Powarkheda. Only at Powarkheda were satisfactory trials grown, and here the local check, Raj 911, outyielded all varieties with 32 q/ha, followed next by Cocorit "S" with 27 q/ha. It was concluded that no variety held promise for further extensive testing in coordinated trials.

3.2.2.6 Elite Durum Yield Trial (EDYT).

This trial with 25 strains including a local check, was laid out at Niphad and Indore. Because it was sown late at both places, valid conclusions could not be drawn. However, the data in table 3.2.C show entry numbers 5, 3 and 19 to possess promising yield and resistance to rusts.

3.2.2.7 International Triticale Yield Nursery (ITYN).

Against a local check, 24 varieties were tested at several locations. Data in respect to entries that did well at more than one location are presented in table 3.2.D. Numbers 11, 17, 1 and 6 gave better or as good a performance at Pantnagar as that of the local check, Sonalika. At Ludhiana, entry numbers 1, 11, 9, 10, 6 and 16 performed better than the check, Kalyansona. At Powarkheda, Siete Cerros was top yielder.

Although numbers 11 and 6 appeared promising, both were highly susceptible to brown rust, and therefore will not be tested in the All India Coordinated trials.

Beagle which is considered to be most promising elsewhere, gave a poor performance under Indian conditions at all locations.

3.2.3 OBSERVATION NURSERIES 1974-75.

The following nurseries were critically evaluated on the basis of one or two unreplicated rows at two or more locations for rust reactions, yield potential, height, maturity, grain characteristics, etc. In 1975-76, the promising ones will become new entries of the Wheat National Genetics Stock Nursery/Triticale Screening Nursery for extensive multi location evaluation to identify superior genetic stocks for use by Indian wheat and triticale breeders.

Promising lines for yield, rust resistance and acceptable grain type will be tested in station trials to feed cooperative multi location yield tests, and in subsequent coordinated variety trials.

3.2.3.1 International Bread Wheat Screening Nursery (IBWSN).

Four hundred entries including checks were evaluated at Pantnagar, Ludhiana, Durgapura, Delhi, Kanpur, Pusa and Powarkheda. The entries with promise for resistance to two or three rusts, yield potential and grain type are shown in table 3.2.E.

3.2.3.2 Preliminary Observation Nursery (PON) from Beirut.

This nursery containing 328 entries was raised at Delhi and Hissar. The most promising entries for rust reactions, grain and important agronomic characteristics are listed in table 3.2.F.

3.2.3.3 International Durum Screening Nursery (IDSN).

The promising entries for yield, grain type and field resistance to rusts in this nursery, which was screened at Indore, Poona and Powarkheda, are shown in table 3.2.G.

3.2.3.4 Crossing Block Durum.

In an evaluation at Indore, the most promising of the 146 entries tested for simultaneous resistance to black and brown rusts were found to be:- Hercules; Rolette; CP x St.464-CPT8A-3470-4p-4p-2p-0Y; Roussia-BD 1419; Anhinga "S" D22234-52M-3Y-1M-0Y; Durum variety 24; Gs"S" - Cr"S" D27676-6M-2Y-0M-500M-0Y and Pg"S" x 31810 CM10071-45M-0Y.

3.2.3.5 International Triticale Screening Nursery (ITSN).

At Pantnagar, Ludhiana, Powarkheda and Kanpur, 300 lines including checks were evaluated for rusts, height, maturity and row yield, etc. Those entries which showed the best overall performance were:-

Entry No.	Variety Name/Parentage	Entry No.	Variety Name/Parentage
3	Maya II - Arm "S"	190	F.S. 2989
9	Maya II - Arm "S"	194	M2A2
12	Maya II - Arm "S"	209	Octo-Hexa
23	Maya II - Arm "S"	210	F.W.121-Prolific x Cin
108	Maya - Arm "S"	217	M2A-Cin
119	Inia-Rye x Arm "S"	229	M2A-Bye x Cin
145	Inia - Arm "S"	249	F2 Bulk 9056
160	Camel "S"	259	IA - Bush
181	F.S. 1534	280	WC - 8744
183	F.S. 1897		

3.2.3.6 Triticale Disease Resistance Nursery (TDRN).

Of the 64 entries evaluated for resistance to brown rust, the following 14 lines showed promise:-

Entry No.	Variety Name/Parentage	Entry No.	Variety Name/Parentage
1	Maya II - Arm "S"	45	(D44-1M-1Y-1M)/(Inia-Rye)^{2}Arm "S"
2	Maya II - Arm "S"	48	(D44-1M-1Y-1M)/(Inia-Rye)^{2}Arm "S"
16	Inia - Arm "S"	49	(D44-1M-1Y-1M)/(Inia-Rye)^{2}Arm "S"
17	Inia - Arm "S"	51	Seed Type 61-1B
27	F.S. 1897-1B	57	Hexaploid from Bulk 1B
28	F.S. 1897-2B	58	Hexaploid from Bulk 1B
44	F.S. 555-2B	59	Hexaploid from Bulk 1B

TABLE 3.2.A Yield (q/ha) and other important characteristics of promising lines in the ESYT at Durgapura and Pantnagar, 1974-75.

Entry No.	Variety/ Parentage	Durgapura Y	Durgapura R	Pantnagar Y	Pantnagar R	Rusts Bl.	Rusts Br.	Rusts Yl.	Grain characteristics Col.	Grain characteristics Tex.	Grain characteristics 1000 Gr.Wt. (gm)
3.	Y50E-Kal^3	55.5	6	44.5	10	TS	60S	0	R	H	32.0
10.	7 Cerros(Check)	59.6	3	47.2	8	0	100S	20S	A	SH	32.0
12.	TzPP-P1 x 7C	61.5	2	51.5	2	0	40S	20S	-	-	32.0
13.	Tanori 71	58.4	4	53.0	1	0	tR	0	R	H	40.0
15.	7C-On x Inia-B Man	62.8	1	47.5	7	0	100S	0	A	H	28.0
16.	Pichuila "S"	46.7	13	48.5	5	0	0	0	A	H	38.0
17.	We-Gto x Kal-Bb	44.7	16	49.0	3	0	0	0	A	H	40.0
18.	2nd 8156(RBC) Composite	51.9	12	44.0	11	0	0	0	A	H	38.0
21.	2nd 8156(WBC) Composite	38.4	21	40.0	16	0	5X	10X	-	-	32.0
23.	Yr x Son 64 x Gto.	39.3	20	49.0	3	0	0	0	R	H	35.0
	Sowing Date	22.11.74		20.11.74							

Y = Yield
R = Rank
Bl= Black
Br = Brown
Yl = Yellow
Col = Color
Tex. = Texture
Gr.Wt. = Grain Weight

TABLE 3.2.B Yield (q/ha) and other important features of the promising entries in the Regional Wheat Trials conducted at Ludhiana, 1974-75.

Entry No.	Variety/ Parentage	Yield	Rank	Rust Reaction Bl.	Br.	Yl.	Height (cm)	Matur- ity	Grain Characters Col.	1000 Gr.Wt.(gm)
1.	7C-On x Inia-B.Man	45.5	8	0	0	20S	93	ML	Amb	32.0
4.	(Kt 54-N10B-21-10) Kt 54B-Nai 540rc P156 x Pj 62	45.5	8	-	-	-	103	ML	Amb	36.0
5.	Kal-Son.64	48.5	5	-	-	50S	104	ML	Amb	30.0
15.	LR 64^2-Son.64 x CC/SKA.	46.8	7	-	-	-	94	ML	Red	36.0
16.	Sal.Seaf.P106-19 x Inia	51.5	2	-	-	10S	102	L	Red	34.0
18.	L1439/4581 x G 156	53.2	1	-	10S	TS	112	E	Amb	50.0
20.	LR 64^2-Son.64 x (Son.64-Y50E x Gto)	49.7	3	-	-	20S	90	ML	Amb	44.0
23.	Carthage 74	48.2	6	-	-	-	87	E	Amb	36.0
24.	Fath 74	49.0	4	-	-	40S	90	ML	Amb	42.0
Local Check, Kalyansona		40.0	-	-	40S	80S	85	ML	Amb	32.0
	Sowing Date	24.11.74								

TABLE 3.2.C Yield (q/ha) and other important characteristics of promising varieties in the EDYT, Niphad and Indore, 1974-75.

Entry No.	Variety/ Parentage	Niphad Y	R	Indore Y	R	Max.Rust Reaction Bl.	Br.	Yl.	Matur -ity	Height (cm)	Grain Characters Col.	Tex.	1000 Gr.Wt.(gm)
3.	Jo"S"(G11"S"/61-130 x IDS)	24.5	2	32.4	11	30S	10S	-	ML	72	A7	H	50.0
5.	Cocorit	27.6	1	41.9	1	10MS	10MS	-	ML	75	A7	H	55.4
13.	LD357E-TC^2x Jo"S"	23.2	7	35.9	3	60S	30S	-	ML	73	A8	H	51.0
14.	LD 21563/LKE-LD 390 x Ch67 Cr"S"-Gs"S"	23.3	6	35.0	4	50S	30S	-	ML	77	A8	H	56.0
16.	Maghbrebi "S"	24.3	3	29.4	16	40S	10S	-	ML	73	-	-	61.0
17.	Cr"S"-Gs"S"	23.8	4	33.5	10	20MS	0	-	ML	80	A7	H	68.0
19.	AA"S"	21.4	13	38.4	2	20MS	20MS	-	ML	81	A7	H	56.0
23.	GTA"S" x 21563-AA"S"	18.7	18	34.3	5	80S	30S	-	ML	62	A7	H	54.0
25.	Local Check: Malavika	21.8	12	-	-	30S	-	-	ML	71	A7	H	42.0
	or Malva Raj	-	-	33.6	9	5MR	30S	-	ML	65	A7	H	54.0

Y = Yield
R = Rank
Bl = Black
Br = Brown
Yl = Yellow
Col = Color
Tex = Texture
Gr.Wt. = Grain Weight

TABLE 3.2.D Yield (q/ha), rank and other traits of promising entries of the ITYN,1974-75.

Entry No.	Variety	Pantnagar Y	R	Delhi Y	R	Ludhiana Y	R	Powarkheda Y	R	Max.brown rust	1000 Gr. Wt. (gm)
1.	Armadillo "S"	32.6	4	26.8	12	31.0	1	20.5	22	100S	46.0
6.	Maya 1-Arm "S"	31.9	5	27.8	10	27.5	5	30.5	4	80S	43.0
10.	Siete Cerros	26.9	17	24.8	18	28.5	3	35.5	1	100S	32.0
9.	Maya II-Arm"S"	28.4	10	30.1	6	28.5	3	21.5	20	100S	43.0
11.	Maya II-Arm"S"	34.9	1	33.6	2	30.5	2	22.5	18	80S	37.0
16.	Inia-Arm"S"	25.9	21	34.2	1	27.5	5	26.5	9	100S	34.0
17.	Inia-Arm"S"	33.7	2	25.8	16	21.5	14	25.5	11	30S	41.0
20.	Tanori 71	27.9	18	28.8	8	24.7	9	31.5	3	5MR	42.0
23.	Beagle	24.5	19	25.9	15	22.8	12	24.5	14	5MR	44.0
25.	Local Check: Sonalika or	33.4	3	-	-	-	-	-	-	40S	52.0
	Hd 1981 or	-	-	17.9	24	-	-	-	-	20S	41.0
	Kalyansona or	-	-	-	-	25.5	8	-	-	50S	40.0
	JNK6T-206B	-	-	-	-	-	-	33.5	2	0	32.0
	Sowing Date	17.11.74		26.11.74		16.11.74		26.11.74			

TABLE 3.2.E Names and parentage of promising entries of the IBWSN, 1974-75.

Entry No.	Variety/Parentage
16	Toluca 73
17	Roque 73
20	Kal-Bb, 26992-30M-1Y-1M-3Y-0M
27	Bb-Gallo/Cno-Son.64 x Bb 35129-26Y-2M-1Y-1M-0M
29	7C-Tob-Npo C 789-21-1A-2Y-0M
32	Sparrow "S"
34	Pato-7C/CC-8156 x Cno "S"
36	Pato(R)-Cal/7C x Bb-Cno.
39	Cno-Bb x Cdl(7C/Lib 64-Inia x Inia-Bb)
44	Cno"S"-7C x Kal. Bb.
49	We-Gto x Kal-Bb.
51	L.V x Bb-Cno/Kal-Bb
57	Cno-7C x CC-Tob/Sd. 648-5-8156
61	Vcm-Cno"S"-7C/Kal-Bb
62	Canario "S"
68	We-Gto x Kal-Bb
79	Pichihuila "S"
85	Pichihuila "S"
91	Jupateco 73"S"
102	Pichihuila "S"
105	Npo-Tob"S" x 8156/Kal-Bb.
108	We-Gto x Kal-Bb.
113	-do-
119	-do-
145	We-Cno "S" - No.66//Zbz
150	Hopps-Ron x Kal.
154	Cno-7C x Cno-Inia/Sx.
155	7C-Tob-Cno"S"/Kal
172	Cno-Bb x Cdl (7C/Lib 64;Inia x Inia-Bb)
212	Cal-CC x Son-Nr.
221	Vcm-Cno"S"-7C/Kal-Bb.
272	Chr-Vcm x Kal-Bb.
277	Cno"S"-Pj 62 x Gallo
297	Fury x Cno"S"-No.66
332	Ron-Cha x Bb-Nor.67
339	Bb-Kal
344	Gallo-Aust II 61.157 x Cno"S",No.66
349	Bb-Kal
350	Bb-Kal
379	Tob"S"-8156 x CC-Inia

TABLE 3.2.F Promising lines from the Preliminary Observation Nursery, 1974-75 on the basis of yield, reaction to rusts and grain characteristics.

Entry No.	Variety/Parentage
BW 5/74*	G 156 x (LR 64^2 x TzPP x AnE)
BW 9/74	Inia"S"-Napo x Tob 66, 27078-8m-1y-1m-0y.
BW 25/74	(We/Lib 64; Inia x Inia x Bb)7C x Tob-Cno"S" CM 8625-G-1m-1y-1m-0y.
BW 28/74	Tob-8156 x CC-Inia"S"/Bb-7C, 5790-K-3y-3m-1y-1m-0y
BW 83/74	Tob 66 x Cno"S"-No.33898-7r-1m-4y-2m-0y
BW 85/74	7C-Nor 67, Cr 3664-2787
BW 177/74	7C-Nor 67, Cr 3664-2765
BW 98/74	S 227 x FAO 215-6L
BW 134/74	CC-Inia (Son 64-Knott 72 x Kl.Pet.Raf)30882-3bj-5bj-5bj-0bj.
BW 136/74	Lundi x CC-Inia, 30946-11tu-1mb-5bj-0bj
BW 147/74	HD 2208
BW 170/74	Giza 156 x Nai 60 L 1569-8091
BW 175/74	(Pi-Gb x Nor x Son 64 x Y54E)Gto)Inia, Cr 3509-2663
BW 178/74	7C-Cno x No.66 CM 3969, Cr 8-3193
RFBW 15/74	Chb"S" (HD 832-6-7 x Y50-Cno/ON)PK 6218-6K-1K-0L
RFBW 18/74	Cno-Chris x On/SKA, C 1178-1K-11K-0L
II Durums	
D3/74	Pelicano"S" D 25609-1m-1y-2m-0y
D5/74	AA"S"-Plc"S" D 33041-16y-3m-2y-0M
D8/74	Stork"S", CM 470-1m-2y-0M
D31/74	(G11"S"-Br 180-LK x Gz 220)21563, AA"S" CM 9976-40M-0Y
D53/74	D.Dwarf 5-15-Cr"S", D 33312-8y-4m-2y-0A
D55/74	(G11"S"/Br 180-LK x Gz 220) Cr"S"(Stw 6-Gold-Ball x Stw^6-Stw^6)
D57/74	Gerado VZ 469-Ptc"S" CM 373-3m-2y-1m-0Y.

* Red Grain BW = Bread Wheats D = Durum Wheats

TABLE 3.2.G Promising lines identified from the IDSN, 1974-75.

Entry No.	Variety/Parentage
21/74	(AA"S"(CPE^3-Gz x TC^3/BYE^2-TC)Fg"S", CM 10162-76M-0Y
29/74	Ld 357E-TC^2 x Jo"S" D 27534-1M-1Y-1M
40/74	Anhinga"S"
56/74	Lds.Mut-Cr"S" CM 18354-1Y
59/74	(21563/61-130 x Lds)Ptl"S" CM 18534-7Y
60/74	Cocorit 71
66/74	(AA"S" x Ld 357E-TC^2/G11"S")Jo"S"-RD 119-2W-4Y x AA"S"
75/74	Tllo"S"-Stork"S"
83/74	Giorgio VZ 394-CR"S" x Lds Mut/Gta"S" CM 19646-A-1Y
118/74	(BYE-TC x Z,B-W/CP-ST 464 x Cr"S")Plc"S" CM 17799-A-9M-1Y
188/74	(G11"S"/BYE^2-TC x Z,B-W) D 21563-Gs"S")GS"S"-Cit CM 14448-C-1Y-1M-2Y.
190/74	Maghrebi"S" x Gs"S"-AA"S"/Gta"S"-Cit"S" CM 14472-B-8Y-1M-1Y
197/74	Maghrebi"S"-Gs"S" x AA"S"(AA"S"(CPE^3-Gz x TC^3/BY^{2}E-TC) x D 21563-AA"S" CM 14473-B-3M-2Y
207/74	AA"S"-Gs"S" x Cit"S"(Jo"S"/Ld 357E-TC^2 x G11"S") T.dic.V.Vernum-G11"S") CM 14582-1M-1Y-1M-4Y
208/74	-do- CM 14582-1m-1Y-3M-1Y
214/74	(AA"S"(CPE^3-Gz x TC^2/BYE^2-TC)Gs"S"-Cr"S") Jo"S"-Cr"S" x 21563-AA"S" CM 14662-A-2Y-1M-2Y
219/74	D 21463-AA"S" x Fg"S" CM 9799-126M-1M-3Y.

3.3 Nepal

The wheat area increased in 1974-75 by approximately 20,000 hectares, rising from 270,000 to 290,000 from last year. Production rose correspondingly from 315,000 tonnes to 332,000 tonnes. However, the average yield fell slightly from 1160 to 1140 kg/ha.

The Agricultural Input Corporation sold nearly 1800 tonnes of wheat seed but in spite of this, there was an acute shortage of seed in the eastern Tarai region. In the central Tarai, supplies exceeded demand and some seed remained unsold. It is therefore necessary to predict seed needs more accurately in order to make distribution more effective.

On the whole the season was favorable for production. Good rainfall occurred at tillering and heading over most of the country. However, a moderate drought occurred at the grain filling stage in the Tarai.

Leaf rust was almost negligible throughout the Tarai and there was little harm. Powdery mildew and bunt caused some losses in the hills.

Sterility was reported from several areas but was confined to small areas. In a variety x fertilizer trial, Tanori 71 was sterile at the low rates of N, but sterility was essentially absent at the higher rates. In the variety x date of sowing trials, there was no definite relationship with sterility.

Seed multiplication was made on 1200 hectares in farmers' fields and about 2500 tonnes were estimated to have been produced.

A ten-day trip was conducted in which Agricultural Development officers of two of the large wheat growing regions visited a number of the research stations and extension areas of the Tarai. In addition to it providing an opportunity for exchange of ideas on the wheat programs, it also revealed that better communication was needed between research and extension workers.

Two young scientists of Nepal were sent to Mexico for three months practical training in wheat breeding and pathology. They returned with self confidence and ready to join in the furthering of the wheat program.

Summer trials are being conducted at different planting dates at Khumuttar, Kakani and Daman to determine whether a second crop can be successfully grown. Preliminary data have indicated the possibility of growing a second crop at Khumuttar and this would be particularly useful for screening for leaf and stem rust. Nepal now grows a National Screening Nursery.

Nepal continues to collaborate with other National and International Programs. CIMMYT, India, FAO and ALAD programs sent nurseries with many valuable materials. A Nepalese scientist attended the Western Wheat Conference in Zagreb, Yugoslavia and others attended the Indian Wheat Workshop.

A decision was taken to establish the wheat breeding central station at Bhairawa, using Khumuttar near Kathmandu as a sub-station. Wheat breeding will also be conducted at Rampur as in the past, since leaf rust development is regularly encountered. It is hoped that good artificial epidemics of rust can be developed at Bhairawa as well. Plans have been laid to set up a crossing block at Bhairawa in the coming year.

Present wheat varieties are considered capable of giving yields of 4 tonnes/hectare (t/ha) as compared with the 1 t/ha average now being harvested by the farmers. Raising the farm yields will require improved levels of inputs and increased extension activity.

In the breeding program a large number of selections were made for yield testing in the country. Some of the promising lines in yield test included NL88, HP1102, NL30, Tanori 71, HD 1982 and Jupateco 73. A number of agronomic trials were conducted at different locations. One experiment using compound fertilizers showed a need for potash in one location in the Tarai. Elsewhere both N and P were required. Response to N varied but in some locations, N gave an increasing response up to 150 kg/ha, falling off with rates above this level.

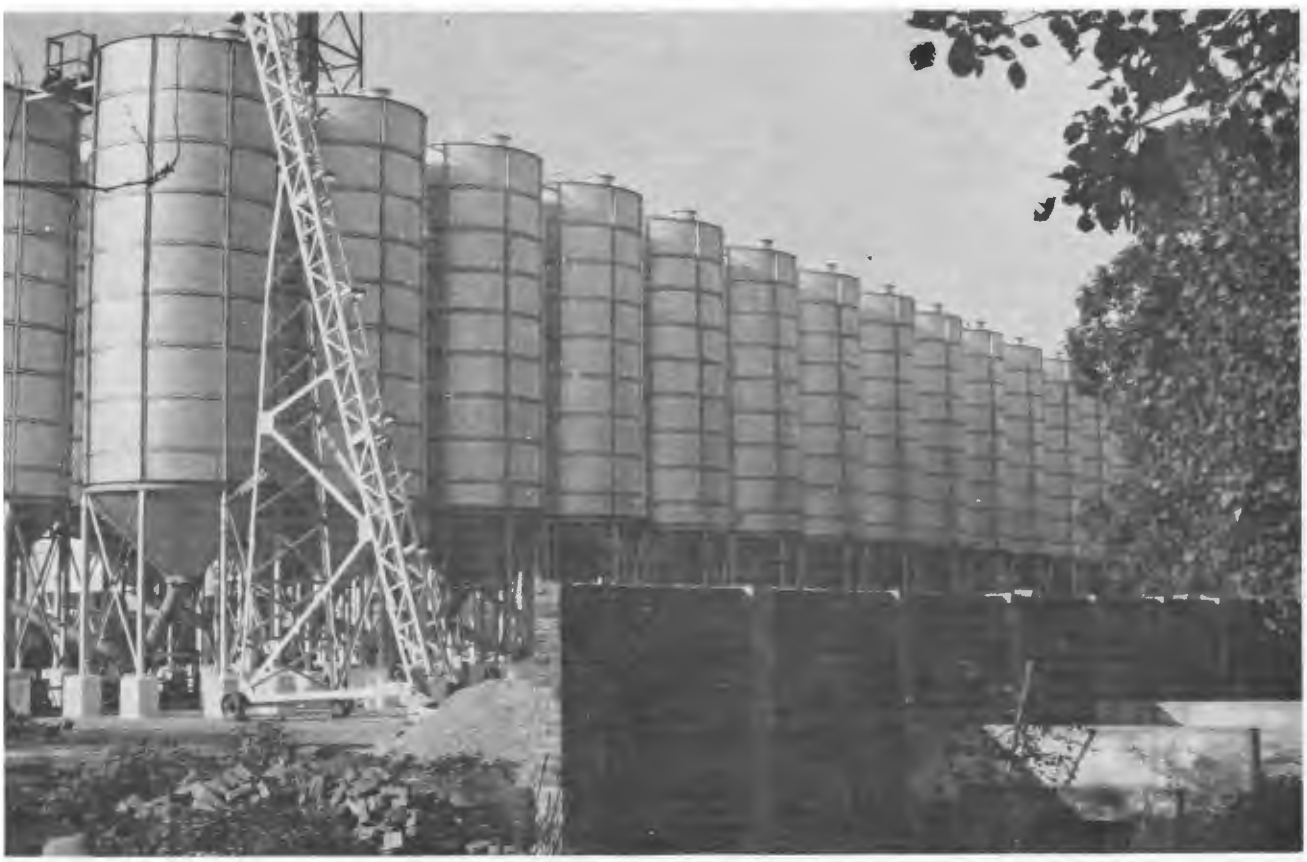
Studies were conducted on N fixation using inoculation with Azotobacter. At two

stations, 12.5 and 28.4 percent yield gains were achieved with inoculation over non-inoculated in combination with an application of 60-60-40 fertilizers. At two other stations, gains were 19.5 and 28.4 per cent at the 0-0-0 fertility level. In most cases, yield gains were obtained through inoculating with Azotobacter, except at higher levels of N above 100 kg/ha. Above this, yields were depressed by inoculation. Although the results were encouraging, several years' results are needed to establish the value of inoculation at the yield differences shown.

Considerable screening of materials was done for the rusts and other diseases. Fungicidal trials were also conducted. A large number of varieties was identified for their freedom from rusts at several locations, but the level of infection as already pointed out was quite low.

In barley, yield trials were conducted at five centres. Among the promising entries were HBL 56, Betzes, CI 10448, Erbet and 60AB2057. Many of the barley varieties exceeded the check in yield and outyielded Sonalika, the wheat check variety. In a preliminary trial grown in the higher hills, the five with highest yield were EB 1054, K6823, HB676, NB6101 and HBL 65. Highest yields among these early varieties ranged as high as 5.7 t/ha.

In triticale, research was confined to the CIMMYT material grown. The 6th International Triticale Yield Nursery was grown at two stations. On an average of the two, 12 triticale lines gave yields superior to the Tanori 71 bread wheat check, all but one were superior to Cocorit 71, and three lines bettered Siete Cerros in a trial of 20 varieties. The yield comparisons were 5.9 t/ha for the highest triticale, 4.6 t/ha for Tanori 71, 4.3 t/ha for Siete Cerros and 4.0 t/ha for Cocorit 71.



The seed storage silos of the Tarai Development Corporation at the G.B. Plant University of Agriculture and Technology, Pantnagar, India.

4.0 Glossary

ACI	Average Coefficient of Rust Infection
ACSAD	Arab Arid Zone and Dryland Research Center
a.i.	active ingredient
ALAD	Arid Lands Agricultural Development
BV	Biological Value
BWYT	Bread Wheat Yield Trial
CB	Crossing Block
CCGG	Coopérative Centrale des Grandes Cultures
CCSPS	Coopérative Centrale de Semences et Plants Séléctionnés
Cd	Ciudad (e.g. Cd. Obregon = City of Obregon)
CI	Coefficient of Infection (Rust)
CIANO	Centro de Investigaciones del Noroeste (Cd. Obregón, México)
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo (International Maize and Wheat Improvement Center)
cm	centimeter
COCEBLE	Coopérative Centrale de Blé
COSEM	Coopérative Centrale de Semences
CRI	Coefficient of Rust Infection
CV	Coefficient of Variation
DAP	Diammonium Phosphate
DBC	Dye Binding Capacity
donum	Equals 0.227 acres = 919 sq. meters
EACA	Epsilon Amino N Caproic Acid
EDYT	Elite Durum Yield Trial
ESYT	Elite Selection Yield Trial
FAO	Food and Agriculture Organization of the United Nations
ha	hectare
hl	hectoliter
HYV's	High Yielding Varieties
IBWIN	International Bread Wheat Increasing Nursery
IBWSN	International Bread Wheat Screening Nursery
IDRC	International Development Research Center (Canada)
IDSN	International Durum Screening Nursery
IDYN	International Durum Yield Nursery
INCAP	Instituto de Nutricion de Centroamerica y Panama (The Institute of Nutrition for Central America and Panama)
INIA	Instituto Nacional de Investigaciones Agrícolas (The Mexican National Institute of Agricultural Research)
INIP	Instituto Nacional de Investigaciones Pecuarias
INRAT	Institut National de la Recherche Agronomique
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
LADISN	Latin American Disease and Insect Screening Nursery
LR	Leaf Rust
LSD	Least Significant Difference
m	meter
m^2	square meter
N	Nitrogen
NPU	Net Protein Utilization
P_2O_5	Oxide of Phosphorus
PER	Protein Efficiency Ratio
Pgt	Puccinia graminis tritici
PMI	International Multiplication Plots
PON	Preliminary Observation Nursery
PRONASE	Productora Nacional de Semillas (The Mexican National Seed Production Agency)
Ps	Puccinia striiformis
q	quintal (=100 kg)
q/ha	quintal/hectare
RCB	Regional Crossing Block
RDISN	Regional Disease and Insect Screening Nursery
RfWYT	Rainfed Wheat Yield Trial
RTN	Regional Trap Nursery

RWYT	Regional Wheat Yield Trial
SAG	Secretaria de Agricultura y Ganadería, México
SCU	Sulphur Coated Urea
SR	Stripe Rust
t	tonne
TD	True Digestibility
TDRN	Triticale Disease Resistance Nursery
t/ha	tonnes/hectare
TL	Turkish Lira
tonne	metric ton (= 1000 kg)
YR	Yellow Rust

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