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CIMMYT Report On WHEAT IMPROVEMENT 1974

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

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15 days post emerge
(31/2-4 leaf stage of wheat)
plus 2 kg/ha a.i. Dosanex
32 days post emerge
(6-7 tillers of wheat)
.4 2 Kg/ha a.i. Tribunil
19 days post emerge
(41/2 leaf stage of wheat)
.5 4 Kg/ha a.i. Dosanex
21 days post emerge
(5 leaf stage of wheat)
.6 2 Kg/ha a.i. Dosanex plus
0.25 kg/ha a.i. Bromoxynil (tank mix)
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(6-7 tillers stage of wheat)

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1.0

CIMMYT – INIA

Wheat Improvement Base Program

Trials in Mexico permit selection for improved material with broad resistance to disease; and selection of high-yielding, widely adapted varieties.

1.1 Introduction

The first half of the 1970's was characterized by shifting economic, climatic and population forces that had a drastic effect on many of the developing countries. Policy makers in these countries sought increased agricultural production to provide for a greater degree of self sufficiency. Belatedly, they looked to research to provide some answers. This search was reflected in greater demands placed on the International Centers for assistance in developing national research capabilities.

CIMMYT, as one of the Centers, began to receive requests from many countries that formerly grew few, if any, of the crops that CIMMYT deals with. In large part, this increased interest in food production stemmed from: (1)the world-wide shortages of 1972-73 and resultant high costs of imported food; (2) the energy crisis and spiralling fertilizer prices and (3) the attention focused on problems-solving efforts such as the World Food Conference in Rome.

It is ironic that the same forces that jolted the world's economies also weakened many of the traditional sources of aid; so that cutbacks were felt by many of the private foundations that were early leaders in food production assistance. Government aid agencies also were forced to reassess their involvement, and some reduced their direct hire staff in favor of contract services. In turn, these reductions placed more pressure on the International Centers to provide additional services.

The Wheat Improvement Report for 1974 reflects CIMMYT's response to these appeals. In content and format, it shows a sharper focus on national program needs. A total of 17 countries are represented in Latin America, in Africa and the Near East, and in Asia and the Pacific. Yet, these are only 17 of the 72 countries to whom the wheat program sends its international nurseries.

These country reports reflect different program strategies, different stages of development, and a wide range of human, physical and technological resources. They offer first hand accounts of the dynamics of world agriculture, and of the ever expanding exchange of information and technical expertise. They also illustrate how the work done at the CIMMYT base in Mexico interrelates with that of National Programs. CIMMYT's work would be only minimally effective without the close collaboration and cooperation of the National Programs and their research scientists; the inter-active network provides for nation-to-nation assistance on a global basis.

Editor's Note:
Modifications in the content and form of this 1974 Wheat report stem directly from program expansion in recent years. These changes allow documentation of work in national programs and in farmers' fields throughout the world. Style, organization, and layout are designed for readers with a technical background --strongly weighted for scientists in national programs. The aim is to provide a straight-forward, heavily tabular format that is organized for field and reference use.

For reporting purposes, the global network of wheat improvement work is divided into four basic units: the CIMMYT-INIA Base Program, followed by national program reports from Latin America; from Africa and the Near East; and from Asia and the Pacific.

1.2 Bread Wheat

1.2.1 INTRODUCTION

Nurseries at Cd. Obregon, Mexico developed well during 1973 and 1974 and a successful artificial epidemic of leaf and stem rust was established, facilitating good selection. Leaf rust races pathogenic on Yecora 70, Cajeme 71 and INIA 66 and Potam 70 were predominant, but no infection was found on the two new varieties, Jupateco 73 and Torim 73, in the adult stage in the field. An important finding was that virulence genes in the population of leaf rust could attack Jupateco 73 and Samaca 68 in the seedling stage; but these races failed to infect these varieties in the field--indicating that they have adult plant resistance. There appears to be no major shift in the virulence pattern in stem rust.

A natural epidemic of stripe rust, possibly derived from the inoculum collected at Toluca, also occurred at CIANO (Cd. Obregon). It became very severe, especially on some spring x winter F_1's, and on such varieties as Yecora 70 and Jupateco 73. In the 1974 summer nursery at Toluca, the spectrum of virulence was similar to that of 1973. Varieties such as Yecora 70, Jupateco 73, Tanori 71 and Mengavi 8156 (R) showed susceptibility, with different levels of severity. A group of advanced lines from the cross /(Tob-B. Man. x Bb/Cal) S x/ became susceptible to stripe rust for the first time at Toluca, indicating some shift in the virulence pattern of this organism.

1.2.2 BREEDING

During the year, more than 1,700 advanced lines were yield tested at Cd. Obregón and 400 of these were selected for superior yield, rust resistance and suitable agronomic characteristics for inclusion in the Eight International Bread Wheat Screening Nursery. Some of the more outstanding lines are listed in Table 1.2.A.

The advanced lines Kal-Bb II 26992-30M-1Y-1M-3Y-OM and Meng-8156, H 223-64-1Y-6c-1Y-1C-4Y-3C-2B-10GY were recommended to INIA for possible release in Mexico. Kal-Bb is a triple dwarf similar to Yecora 70 in yield potential, but is resistant to leaf rust. Meng-8156 is a one-gene dwarf with red grain; it has a good level of resistance to stem and leaf rust and moderate susceptibility to stripe, and is later maturing than Siete Cerros. In addition to the above two lines, five other lines have shown high yields over three years (including 1973-74): Jupateco "S", 30842-58R-1M-4Y-0M; Hopps-Ron x Kal CM8874-K-1M-1Y-0M; Canario "S" = (HK-28MA x Rfn2-908/Fn) Yr70CM2097-31M-1Y-1M-4Y-0M; Canario "S"= idem CM3097-31M-1Y-2M-1Y-0M; Cno "S"-Pj62 x Gallo 30793-1M-2R-2M-0R.

The advanced lines of Moncho sibs (We-Gto x Kal-Bb) Pichihuila sibs (Cno "S"-Gallo x Kal-Bb); Pavon sibs (Vcn x Cno "S"-7G/Kal-Bb); Emu sibs (Tob "S"-Npo x No 66-Era/Bb-Gallo); and INIA "S"- Soty x Czho (for which a large number of sisters were included) were found to be resistant to all three rusts at Yaqui and have shown high yield performance. Some of these lines were also reported to have Septoria tolerance in Algeria; their high yield, combined with disease resistance, makes this group very valuable as germplasm to test for wider adaptation. The crosses Moncho "S"'s, Emu "S"'s and Pavon "S"'s were found to be resistant to stripe rust in Ecuador under heavy epidemic conditions. Because of their height, these lines are not suitable for irrigated farming (105-110 cms).

The yields of the lines shown in Table 1.2.A (from irrigated experimental trials during 1973-74 at CIANO, where yield is accentuated) range from 6.5-9.0 tons/ha. Four hundred (400) of the best lines entered the 8th IBWSN. Height of these lines varied from 70-110 cms and flowering and maturity characteristics were extremely variable. These lines represented a total of 207 crosses.

The Bread Wheat Crossing Block (CB) is systematically organized in groups with different characteristics, using information collected from the various National Programs. The CIMMYT 1973-74 CB was distributed to 40 cooperators as the First International Bread Wheat Crossing Block. The aim is to gather agronomic and pathologic information that will assist CIMMYT in reassessing the value of the CB entries so that continued suitable modification can be made.

At CIANO, 3,297 single cross F_1's of spring x spring varieties were grown in 1973-74, and were used largely for double and triple cross production. These F_1's, were mostly used to inter-cross with F_1's of spring x winter crosses. Of the 3,297 F_1's, 1,933 were discarded due to poor agronomic response or disease susceptibility. The remainder were harvested as F_2 bulks, which were then classified for suitability for irrigated or rainfed conditions. Height and potential disease resistance were used as characteristics to further divide these populations. For example, those F_1's having parentage involving

Septoria and rust resistance were 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 (and much of this group is grown under irrigated conditions.) On this basis, 549 F_1's were chosen as bulks to be sent for selection in irrigated areas, and 813 F_1's to rainfed areas. Each of the two groups were distributed to more than 75 locations, including all continents where wheat is grown. Such distribution maximizes the efficiency of selection for desirable plants in these populations.

1.2.3 THE 8156 MULTILINE

The varieties derived from cross 8156 are characterized by high yield potential and unusually wide adaptation. They have been grown on more than 13 million hectares in various countries. It is widely recognized that the use of one variety on large geographical areas presents a potential danger, since a single rust race could cause widespread destruction. Further, aerobiological studies have shown that an epidemiological zone can cover substantial areas. Multi- line research seeks to eliminate this danger so that a variety with such wide popularity and superior performance can continue to provide high yields of grain.

About five years ago, a program was initiated to provide a wide array of resistance in this basic genotype. This included resistances to rust and Septoria (although not necessarily both) in all of the lines. Varieties drawn from U.S.A., Canada, Argentina, Colombia, Ecuador, Kenya, Australia, India, Rhodesia, North Africa and other countries, contributed the resistance that was incorporated.

In 1973, 285 advanced lines of this phenotype were produced, based on about 100 crosses. These were distributed as the First International Multiline (8156) Classification Nursery to more than 20 locations in countries where this variety is well adapted. Preliminary results (Table 1.2.B) show that 27 of these lines combined resistance to the three rusts, powdery mildew, and Septoria (in Lebanon, Pakistan, Egypt, Mexico, Turkey, Ecuador and Iran).

The results from the First International Multiline (8156) Classification Nursery have been very encouraging, and these advanced lines can be recycled in the breeding program to strengthen the multiline project. In the same year (1973), the Second International Multiline (8156) Classification Nursery, comprising 300 advanced lines was distributed from the summer Toluca harvest. The Third International Multiline (8156) Classification Nursery, comprising 257 advanced lines, was made up from the 1973-74 harvest at CIANO. This nursery was distributed to 30 locations to gather agronomic and pathologic data and to provide the cooperators with an opportunity to select suitable lines for their specific needs. Each of the successive nurseries has carried some of the original lines, has discarded some as not fully true to type or because of inadequate disease resistance, and has added new ones. Data are not yet available on the Second and Third Multiline Classification Nurseries.

All of the entries of the Third Multiline Classification Nursery will be individually yield tested in 1974-75 at CIANO together with eight different composites ranging from 3 to 13 components. The advanced lines mixed in different composites are listed in Tables 1.2.C and 1.2.D

It is hoped that these preliminary yield data can be used to form final composites for Mexican conditions. In other countries, other combinations will be used so that many multilines of this cross will be composited to meet different country needs.

1.2.4 SPRING X WINTER WHEAT CROSSES

The crossing of spring x winter wheats offers good potential for improving both groups. Intercrossing of these seldom crossed groups of bread wheats bring together two gene pools that may increase yield and also may combine complementarity for certain characteristics.

For spring wheats, it is anticipated that winter germplasm will enhance drought resistance, provide additional sources of resistance to Septoria, and provide enhanced yield due to incorporation of new genes. Further, a wider range of maturity can be evolved to better suit the varieties to the range of ecological conditions under which spring wheat is grown. For winter wheats, germplasm from spring wheats can enhance resistance to the rusts, provide higher yield possibilities, and provide a range of winter hardiness for different areas.

In the 1973-74 season at Toluca, more than 3,477 winter wheat varieties (collected from U.S.A., USSR, Eastern Europe, Western Europe, Turkey and Argentina) were sown in

November. Spring wheats were sown on four dates, beginning January 15. Crossing between the two groups was done in May and June. Some of the better winter wheats also were sown at Ciudad Obregon, after vernalization, and grown under supplementary night lighting. Many spring x winter F_1 crosses are now made in this way at both locations. The F_1 spring x winter crosses made at Toluca are grown the following fall at Ciudad Obregon, alongside the spring x spring F_1's. Crosses made at Ciudad Obregon are sown in the Toluca summer nursery, again with the F_1's of spring x spring. In this way, about 95 percent of the double cross combinations (F_1 x F_1) are made with one winter parent involved.

In the 1973-74 season at Cd. Obregon, 522 F_1 (spring x winter) crosses were sown. Of the total, 207 were discarded because of disease susceptibility or extreme lateness. The remaining 315 were harvested in bulk, divided, and sent to 75 cooperators worldwide.

Another group of 1,000 spring x winter F_1's were planted at Toluca for double crossing there. All of these were lost because of an unusually early September frost shortly after flowering. All spring x winter F_1's are divided in equal parts; one half of the seed of each cross is sent to Oregon State University for use in crossing to winter wheats in their internationally oriented winter wheat program. In 1975, CIMMYT will provide F_1 seed of spring x winter to Turkey and India, also. A list of the outstanding F_1 spring x winter crosses is shown in Table 1.2.E.

Segregants from most of the spring x winter combinations are now only at the F_4 level, and it would be premature to draw specific conclusiones on the performance of these populations. By 1976, it should be possible to test the agronomic, disease and physiological characteristics of derived lines. (However, it is interesting to note that two sister lines of an earlier spring x winter cross (HK-38MA x Rfn2-908/Fn) Yr 70=Canario "S", are now under multiplication for possible release).

1.2.5 SUMMARY

CIMMYT will continue to strengthen the multiline project on the 8156 genotype in 1975.

It is proposed that some 2,000 winter x spring combinations will be made so that about 1,000 crosses can be grown in each of the two seasons.

The use of identified horizontal resistance sources for rust resistance will continue to obtain greater depth and breadth of resistance in CIMMYT germplasm as a whole. The presence of horizontal resistance cannot be definitely established at any one location. However, through multi-location testing and selection, those genotypes resistant in many parts of the world are likely to possess horizontal resistance and, at worst, will be included in such a group of varieties.

Information derived from the international nurseries and local screening trials on *Septoria* resistance in such countries as Algeria, Tunisia, Brazil, Argentina and Mexico, serve to establish those varieties most suitable for use in the continuing crossing program designed to further increase resistance. Incorporation of genes for resistance to *Septoria* in CIMMYT germplasm is being followed vigorously and an increasing number of lines now being selected in the program carry adequate resistance in the geographic areas where this disease is serious.

In the development of aluminum toxicity resistance for Brazil and other countries with low pH soils, CIMMYT's Obregon nursery has grown large numbers of F_1's made in Brazil, for the past two years. These tall aluminum tolerant F_1's have been crossed with short statured, disease resistant CIMMYT F_1's, and with other varieties to incorporate genes for higher yield potential. These are now beginning to produce shorter-statured segregates with good disease resistance and higher yield potential.

On a limited scale, CIMMYT is attempting to produce varieties for the hot to humid tropics, with the aim of producing germplasm in F_2 for selection in countries such as Bangladesh, Vietnam, Guyana, Thailand, Indonesia and countries of Central America. To identify suitable parental materials for crossing, use has been made of the CIMMYT Poza Rica Maize Station in coastal Mexico, where *Helminthosporium* attack is severe, characteristic of humid tropic conditions. This nursery location also serves to identify material adapted to such conditions.

TABLE 1-2-A.- Outstanding Advanced Generation Lines Selected from the 1973-74 Replicated Yield Tests in CIANO. All of these lines have yield potentials of more than 7.5 tons/ha. and are resistant to all three rusts under Mexican conditions. All of these superior lines were incorporated into the 8th. IBWSN.

Entry No. 8th. IBWSN	Cross and Pedigree	Yield Line/highest check	Grain Color	Height
20	Kal-Bb 26992-30M-1Y-1M-3Y-0M	7676/8427 (7c)	2B	E3
21	Kal-Bb 26992-30M-1Y-1M-500Y-0M	7711/7577 (Cj71)	2B	E3
38	Kal-Bb 26992-30M-1Y-1M-1Y-0M	7790/8508 (Jupateco 73)	2B	E3
19	Meng-8156 (R) H225-64-1Y-6c-1Y-1c-4Y-3C-2R-100Y	9108/8427 (7C)	2R	E1
23	Moncho"S" • We-Gto x Kal-Bb CM-8288-A-3M-7Y-0M	8278/8601 Jupateco 73	2 seg.	$E1^-$
48	Moncho"S" • We-Gto x Kal-Bb CM-8288-A-3M-5Y-4M-0Y	7904/8299 Jupateco 73	2B	E1
49	Moncho"S" • We-Gto x Kal-Bb CM8288-A-3M-1Y-5M-3Y-0M	7514/8013 Jupateco 73	2 seg	$E1^-$
112	Moncho"S" • We-Gto x Kal-Bb CM8288-A-3M-6Y-2M-2Y-0M	7519/7667 Jupateco 73	2 seg	$E1^-$
24	Y50E-Kal[3] 35188-5M-(F1)-31Y-0M-8M-0Y	7994/8601 Jupateco 73	1 Red	E_1
26	Y50E-7C x Kal 28875-300Y-14M-1Y-1B	7824/8601 Jupateco 73	2 Red	N^+
53	Hoppe-Bon x Kal CM-8874-K-1M-1Y-0M	7608/7711 (7C)	2 Red	E_1
25	INIA"S"-SOTY x Czho Br-69-1Y-3M-0Y	7872/8601 Jupateco 73	2B	E_1^-
28	INIA"S"-SOTY x Czho Br-69-1Y-3M-7Y-0M	8021/7701 (INIA)	2 Red	E_1^-
30	INIA"S"-SOTY x Czho Br-69-1Y-3M-6Y-0M	7627/7701 (INIA)	2 Red	E_1^-
63	INIA"S"-SOTY x Czho Br-69-1Y-3M-3Y-0M	7519/8346 (Meng-8156)	2 Red	E_1^-
47	EMU"S" • Tob"S"-NpoxNo68-Era/Bb-Gallo CM8327-C-9M-4Y-4M-0Y	7919/8299 Jupateco 73	2 Red	E_1^+

TABLE 1-2-A.- Continuation

Entry No. 8th. IBWSN	Cross and Pedigree	Yield Line/highest check	Grain Color	Height
126	EMU"S" • Tob"S"-NpoxNo68-Era/Bb-Gallo CM8327-C-9M-4Y-3M-0Y	8225/7817 Jupateco 73	2 white	E_2^+
50	Pichihuila "S"• Cno"S"-Gallo x Kal-Bb CM7652-35M-5Y-3M-0Y	7657/8299 Jupateco 73	2B•	E_1^+
39	Brochis "S"•Cno-BbxCd(7c/Lib64-INIA x INIA-Bb) CM5872-C-1Y-1M-3Y-0M	7724/8299 Jupateco	2B	E_2
54	Pavon"S"• Vcm x Cno"S"-7C/Kal-Bb CM8399-D-4M-3Y-0M	7569/7711 (7C)	2B	E_1
59	Pavon "S"•Vcm x Cno"S"-7C/Kal-Bb CM8399-D-4M-3Y-1M-0Y	7542/7810 Jupateco 73	2B	E_1
45	Tzpp-P1 x 7C CM5287-J-1Y-2M-2Y-3M-0Y	8067/8126 Jupateco 73	2B	E_2
46	Tzpp-P1 x 7C CM5287-J-1Y-2M-1Y-1M-0Y	7743/8126 Jupateco 73	2	E_2^+
66	Tzpp-P1 x 7C CM5287-J-1Y-2M-1Y-4M-0Y	7815/8413 Meng-8156	2R	E_2
90	Tzpp-P1 x 7C CM5287-J-1Y-2M-1Y-1M-0Y	7556/7667 Jupateco 73	2	E_2^-
•27	Bb-Gallo/Cno-Son64 x Bb 35129-26Y-2M-1Y-1M-1Y-0M	8209/7701 INIA 66	2B	E_2
29	7C x Tob-Npo CM789-21-1A-2Y-0M	7695/7701 INIA 66	2B	E_2^-
51	L.V. x Bb-Cno/Kal-Bb Br 71-42-A-1M-1Y-2M-0Y	7583/8299 Jupateco 73	2B	E_1^-
52	Cno"S"-Gallo x Bb#4A/K4496 CM11209-F-1Y-4M-0Y	8131/8435 Jupateco 73	2B	E_1
64	Tob"S"-Npo x CC-INIA/Cha CM5541-C-5Y-4M-3Y-3M-0Y	7603/8395 Meng-8156	2	E_2^-
67	Bon x Cno-Son64/Kal-Bb CM8192-C-1M-1Y-1M-0Y	7559/8309 Meng-8156	2B	E_2^-
92	Cno"S"-7CxCno-INIA/Tob CM8380-A-1Y-8M-1Y-0M	7823/7617 Jupateco 73	2R	E_1^+
96	Cno-7CxCC-Tob/Yr"S" CM6540-14M-2Y-3M-1Y-0M	7509/7766 Jupateco 73	2R	E_1
97	Tob-Cno "S" x Pitic62 CM7369-1M-1Y-3M-1Y-0M	7780/8847 Jupateco 73	2B	E_1^+

TABLE 1-2-B.- Entries of First International Multiline (8156) Classification Nursery which were found to be resistant to leaf rust in Lebanon, Pakistan (Lyallpur), Egypt (Sakha), Mexico (El Batan); to stripe rust in Turkey (Izmir), Egypt (Sakha), Ecuador (Santa Catalina), Mexico (Toluca); to stem rust in Egypt (Sakha), Mexico (El Batan); to Powdery mildew in Iran (Gorgan).

Entry No.	Pedigree and Cross	Grain type	Height
15	Hopps-Ron x Kal CM-8874-K-1M-3Y-2M-0Y	2 Red	E1 +
38	We x Cno "S" - Gallo/Sx CM8953-B-1M-1Y-4M-0Y	2 Red	E1
45	[(SD648-5-8156/Chr x Son64-K1-Rend) Bb-Cal]/ Zbz CM-8963-A-1M-1Y-7M-0Y	2 White	N
56	(Tob-B.man x Bb/Cdl) Sx CM8972-F-1M-13Y-2M-0Y	2 Red	N
67	Tob "S" - 8156 X CC-INIA CM1208-1Y-6M-2Y-3M-0Y	2 White	E2
81	Cno-7C x CC-Tob/Sd648.5-8156 CM4756-12Y-1M-3Y-3M-0Y	2 Red	E1 +
96	Bb-Nor67 x Tob-8156/Ron CM5456-G-1Y-1M-1Y-1M-0Y	2 Red	E2
99	Cfn-Cno "S" x Ron/Bb-Nor67 CM5463-D-1Y-1M-1Y-3M-0Y	2 White	E1
108	Bb-Cno x Rfn-Cdl CM5597-C-4Y-1M-1Y-1M-0Y	2 Red	E1 +
137	Bb x CC-Cno^2/Tob-8156 x Bb CM5793-G-8Y-1M-1Y-1M-0Y	2 Red	E2
146	Brochis "S" CM5872-B-8Y-1M-2Y-4M-0Y	2 Red	E1 +
148	Brochis "S" CM5872-C-1Y-1M-1Y-3M-0Y	2 Red	E1
152	Brochis "S" CM5872-C-1Y-1M-3Y-2M-0Y	2 B	E1 +
154	Brochis "S" CM5872-C-1Y-5M-1Y-2M-0Y	2 Red	E1
156	Brochis "S" CM5872-C-1Y-5M-2Y-1M-0Y	2 White	E1
157	Brochis "S" CM5872-C-1Y-5M-2Y-2M-0Y	2 White	E1
164	7c/Cno-Chr x On CM794-1M-1Y-1M-3Y-1M-0Y	2 White	E2
173	Cno-7c x CC-Tob/Bb-Nor CM1671-30M-1Y-4M-3Y-3M-0Y	2 White	E2
174	Cno-7C x CC-Tob/Bb-Nor CM1671-30M-1Y-4M-4Y-1M-0Y	2 Red	E2
175	Cno-7c x CC-Tob/Bb-Nor CM1671-30M-1Y-4M-4Y-2M-0Y	2 White	E2
189	Tob "S"-8156 x CC-INIA CM1208-1Y-4M-3Y-2M-0Y	2 White	E3$^-$
192	Tob "S"-3156 x CC-INIA CM1208-9Y-6M-2Y-1M-0Y	2 White	E3
253	We x Cno-INIA CM7585-1M-2Y-1M-0Y	2 Red	E2
256	B.Man-7C x Cdl CM8186-B-6M-5Y-3M-0Y	2 White	E2
277	Cno "S"-Cdl x 7C CM8974-J-5M-1Y-0M	2 White	E1 +
282	Brochis "S" CM5872-C-1Y-1M-3Y-0M	2 White	E1
284	Cno-7C x CC-Tob/Bb-Nor67 CM1671-30M-1Y-4M-2Y-0Y	2 Red	E2$^-$

TABLE 1.2.C.- Entries in The 2nd. International Multiline (8156) Classification Nursery (WBC) • White Grain Brown Chaff.

		Cross	Pedigree
		A. COMPOSITE	
3rd ML-	9	Ron-Cha x Bb-Nor67	CM-5484-F-5Y-4M-2Y-1M-0Y
	81	Cno-7C x CC-Tob/Bb-Nor67	CM-1671-30M-1Y-4M-3Y-3M-0Y
	69	CC-Inia x 7C/We	CM-5430-E-1Y-1M-2Y-1M-1Y-0M
	74	(Cno"S"/Tob-CC x Pato) Kal	CM-16493-B-1M-2Y-0M
	93	CC-Kal (Az x Nad-Lib64/Bb)	CM-11663-E-1Y-1M-1Y-0M
	118	We x Cno"S"-No 66/Zbz	CM-8954-B-7M-1Y-1M-1Y-0M
	130	(We/Lib-Inia x Inia-Bb)7C x Tob-Cno"S"	CM-8625-E-1M-4Y-1M-0M
	157	Cno-Bb x Cdl(7C/Lib-Inia x Inia-Bb)	CM-5872-C-1Y-5M-2Y-2M-0Y
	166	Tob-8156 x CC-Inia	CM-1208-1Y-4M-3Y-2M-0Y
	174	Perico"S" • Cal(21931-Ch 53 x Gb^2/5667)Cno-No 66	11-34886-17Y-4M-4Y-1M-3Y-0M
PC -1690 (Y73-74)		(No.66-Bb/Cno x Nad-Chr"S") 7C	CM-5375-F-1Y-1M-1Y-0M
		B. COMPOSITE	
3rd ML-	9	Ron-Cha x Bb-Nor 67	CM-5484-F-5Y-4M-2Y-1M-0Y
	69	CC-Inia x 7C/We	CM-5430-E-1Y-1M-2Y-1M-1Y-0M
	157	Brochis "S"	CM-5872-C-1Y-5M-2Y-2M-0Y
	205	E 4957-KS/KS-72D 3292	
		C. COMPOSITE	
3rd ML-	210	E 6254-KS/KS-72L41	
	207	E 6057-KS/KS-72L27	
	156	Brochis "S"	CM-5872-C-1Y-5M-1Y-3M-0Y
	96	7C x Tob-Cno"S"/Kal	CM-8865-D-4M-1Y-1M-2Y-0M
	77	We x Cno-No66/Zbz	CM-8954-B-7M-1Y-1M-0Y

TABLE 1.2.D.- Entries in the 2nd. International Multiline (8156) Classification Nursery (RBC) • Red Grain, Brown Chaff.

		Cross	Pedigree
		A. COMPOSITE	
3rd ML-	15	Hopps-Ron x Kal	CM-8874-K-1M-1Y-0M
	68	Ron-Tob "S"	CM-7705-3M-1Y-2M-2Y-0M
	82	11-12300-Tob66 x Cno"S"/SX	CM-16045-24M-6Y-0M
	86	Cno-7C x CC-Tob/SD648-5-8156	CM-6756-12Y-1M-3Y-3M-0Y
	92	(Cno-7C x CC-Tob/Cno"S" -No 66)Kal	CM-11377-A-1Y-8M-4Y-0M
	128	(Tob-B.Man x Bb/Cdl)SX	CM-8972-F-9M-1Y-1M-1Y-0M
	132	Npo-Cdl x Zbz	CM-8935-D-5M-3Y-3M-0Y
		Cno-7C x Cno-Inia/SX	CM-8943-F-1M-2Y-5M-0Y
	139	We x Cno"S"-Gallo/SX	CM-8953-E-3M-2Y-1M-0Y
		Vem x Cno"S"-7C	CM-4015-23Y-1M-1Y-2M-0Y
	144	Cno-7C x CC-Tob/S.D. 648.5-8156	CM-4756-12Y-1M-1Y-1M-0Y
	151	Cno-Bb x Cdl(7C/Lib64-Inia x Inia-Bb)	CM-5872-B-8Y-1M-2Y-2M-0Y
	169	Cal x Bb-Cno/7C	CM-5345-D-4Y-3M-2Y-5M-0Y
		B. COMPOSITE	
3rd ML-	15	Hopps-Ron x Kal	CM-8874-K-1M-1Y-0M
	144	Cno-7C x CC-Tob/SD 648.5-8156	CM-4756-12Y-1M-1Y-1M-0Y
	151	Brochis "S" • Cno-Bb x Cdl (7C/Lib64-Inia x Inia-Bb)	CM-5872-B-8Y-1M-2Y-2M-0Y
	169	Cal x Bb-Cno/7C	CM-5345-D-4Y-3M-2Y-5M-0Y
	28	$Y50_E$-Kal^3	35188-5M-(F1)-31Y-0M-17M-0Y
		C. COMPOSITE	
3rd ML-	53	Cal x Bb-Cno/7C	CM-5345-D-4Y-3M-3Y-4M-7Y-0M
	59	Bobito "S"	11-30837-9Y-1M-1Y-2M-1Y-0M
	83	Hopps-Ron x Kal	CM-8874-K-1M-1Y-1M-1Y-0M
	88	Y 50_E-Kal^3	11-35188-5M-(F1)-31Y-0M-8M-0Y
	91	(Cno-7C x CC-Tob/Cno"S" -No) Kal	CM-11377-A-1Y-8M-3Y-0M
		D. COMPOSITE	
3rd ML-	111	Cno-7C x Cno-Inia/SX	CM-8943-F-1M-3Y-5M-1Y-0M
	116	We x Cno"S"-Gallo/SX	CM-8953-B-1M-1Y-2M-1Y-0M
	142	Vem x Cno"S"-7C	CM-4015-23Y-1M-1Y-1M-0Y
	154	Brochis "S"	CM5872-C-1Y-1M-1Y-3M-0Y
	165	$(Cno\text{-}7C)^2$ x CC-Tob	CM-1679-1M-4Y-2M-1Y-1M-0Y
	171	Cal x Bb-Cno/SX	CM-5345-D-4Y-3M-8Y-8M-0Y
	186	We x Cno-Inia	CM-7485-1M-1Y-5M-7Y-0M
		E. COMPOSITE	
3rd ML-	15	Hopps-Ron x Kal	CM-8874-K-1M-1Y-0M
	88	Y50E-Kal^3	35188-5M-(F1)-31Y-0M-8M-0Y
	151	Brochis "S"	CM-5872-B-8Y-1M-2Y-2M-0Y

TABLE 1-2-E.- Spring x Winter F_1 combinations showing outstanding agronomic characteristics and high level of stripe rust resistance (MV-74).

♀ (Winter wheat)	♂ (Spring wheat)
Triticum aestivum (Rumania)	Jupateco 73, Cno "S" - Gallo, Mochis 73, Perico, Tito "S", Rigo "S", Cno-7C x Torim "S"
Bezostaya 2B	Jupateco 73, Perico, Cno "S" - Gallo
Bezostaya 1	Ron#2, Cno "S"-Gallo, Perico "S", Gallo
Lilifen	Pichihuila "S", Emu "S", Cno "S" - Pj62 x Gallo, Rigo "S", Mochis 73, Erection RGA, Cno "S" - Gallo/ Kal-Bb x 7C-Nad63.
Son 64-SS[2]	Jupateco 73 "S", Bb-Kal, Cha#2, CC-Inia"S" x Cal, Pichihuila "S", Ti, Bb-Gallo, Cal, Fury, Cno "S"- Gallo, Mochis 73, Perico, Grajo "S", Hork, Eagle, Roque "S"- Soty, Carpintero
Yamhill	Hork, Jupateco 73"S", WW15/Bb-On x Ji
(CD-P101 x Gne/P101)Drc	Emu"S", Jupateco "S", Sparrow "S", Hork Bobito "S"
Roedel-Swgon 92	Bb-Gallo, Gallo, Cno "S"-Gallo, Cno-Pj62, Buho, Cno-7C
Roussalka	Pichihuila "S", Cha#2, Torim 73, Cno "S"-Gallo, Fury
S13-Aobakamoughi	Cno "S"-Gallo, CC-Inia "S" x Cal, Jupateco 73, Gallo, Fury, Mochis 73, Tanori 71, Perico "S"
Poncheau	Bobito "S", Jupateco "S", K1-Bb, Emu "S", Sparrow "S", Hork
[Pch(Kt54A-N10B x Kt54B)Nar59] (Kt54A-N10B x Kt54B)Nar59-Hn1V	Erection RAF, Chanate#2, Bb-Cno/Nad-Chr x Sr, Pichihuila "S", Emu "S", Bolillo "S"
Hn1V(Kt54A-N10B x Kt54B/Nar59)	7C x Tob-Npo, Hork, Cno "S"-Gallo x Bb-Inia, Tito "S", Moncho "S", Bobito "S", Brochis "S"
Marne Deprez-Poncheau	Fury x Cno "S"-No66, Pj62-Cal, ZZ"S", Gto-7C x Bb-Cno, Cal Lu, Kal-Bb x Cj71"S"
Cleo-Pch	Kal-Bb, Pavon "S", Emu "S", Sparrow "S", Kal-Bb x Cj71"S", M. Plm x Cno "S" - 7C/CC, Canario "S", Hork
CD-Pch	Emu"S", Pichihuila, Brochis "S", Buho, Fury x Cno "S" -No66, Choli, Gto-7C x Bb-Cno, Trifon "S", Alondra "S"
Fortunata[2] - CI 13170	Cno "S"-Gallo, CC-Inia x Cal, Fury x Cno "S" - Cal x Nad, Cal-Pj62, Tob66-B. Man x Bb, Pichihuila "S"
Capitole	Pichihuila "S", Fury, Erection RGA, K.M12 x Kal-Bb

TABLE 1-2-E.- Continuation.

♀ (Winter wheat)	♂ (Spring wheat)
Hq-Son64 x 11-50-18-Vg10	Pichihuila "S", Cno "S"-Pj62 x Gallo, Hork
MD-Vg 8316	TL365A.34-SX x CC, WW15/Bb-On x Ji, Bobito
Cadet	Bobito "S", Kal-Bbx Cj71 "S", Hork, Zopilote "S"
Cleo-Pch	Pichinuila "S", Sparrow "S", Jupateco 73"S"
Pch(Kt54A-N10B x Kt48 B/Nar59)	Zopilote "S", Rq"S"-Soty, WW15, AFM
Sava	Yecora 70, Torim 73, Tanori 71
55-1744	No66-WS 1657 x Kal-Bb, Jupateco 73"S", Zopilote M. Plm x Cno "S"-7C/CC, TL365A.34-5X x CC
Ymh-Jar66	Emu "S", Bobito "S", Tito "S", W.Ring-We x Ron
Brevor	S948.Al-Sta. Elena[5], Topo "S"-Nar59, Perico "S"
Libelula	Cno "S"-Gallo, CC-Inia x Cal, S948.Al-Cno "S"[2] x Cno FG7[4]
Marzatto	Roque 73, Mochis 73, Tanori 71
Maris Nimrod	Perico, Grajo "S", Pichón, Kal-Ska x Cno "S" - Inia "S"/ Cno-Chr
Joss Cambier	Pichihuila "S", Moncho "S", Bolillo "S", Emu "S"
Pumafen	Cno "S"-Gallo, Cno "S"-7C x Tgn, Erection RAF
F.Aur[2]/SK"S"-CD x Pch	Hork, Tucan "S", Era x Cno-7C, Son-K1.Rend x Ceo-CC/ Tob
NS 732	Bb-CC x Ron, CC-Inia "S" x Cal
Aurora	Cno "S"-Gallo, (Cha x Meng-8156/Cno "S"-Gallo) Emeck
Car 58.182-Drc	Grajo "S", Bb/Pato x Inia-Npo, Cal-Pj62
63.189.66.7-Hys "S"	Emu "S", Sparrow "S", Hork
ND-P101	Roque 73, Zopilote "S", Yr x Son-NY5207.85/Cno "S"- 7C x Gto
Pj62-Hn1V	Ron#2, Cno "S" - Gallo, Mochis 73
Riebesel 4751	Moncho "S", Hork, Bobito "S"
Car 284	Pichihuila "S", Bb/Pato x Inia-Npo
EL-CD[2]	Cno "S"(Arg), Erection RGA, Grajo "S"
Kavkaz	CIANO 67, Chanate#2
Splendeur	Torim 73, Jupateco 73

TABLE 1.2.F.- Recently named Bread Wheat Varieties and lines. (Spring types)

Name	Abbrev.	Cross	Pedigree	Year	Country
Alondra"S"	Ald	D6301-Nai60xWq-RM/Cno^2-Chr	CM-11683-A-1Y-1M-2Y-0M	1974	Mexico
Anahuac F75	Ana	II12300-LR64Ax8156/Inia68	II-30842-5"S"-3M-2T-0R	1975	Mexico
Anza	Anza	LR-N10B x An_E^3	II-8739-4R-1M-1R	1973	California
Arz	Arz	Mayo 54$_E$-LRxTac"S"(LR64 x Tzpp-Y54)	II-21419-288	1973	Lebanon
Bet Dagan		(Yaktana x Norin10-B-21) Florence Aurore	V-238-8828(131,133)	1971	Israel
Bluebird 4A	Bb4A	Cno"S" x Son-K1Rend/8156	II-23584-26Y-2M-3Y-1M-0Y	1969	Mexico
Bobito"S"	Bbt	Cno-8156xTob-Cno/Inia"S"-II20350	II-38837-9Y-2M-1Y-5M-0Y	1974	Mexico
Bolillo"S"	Blo	Pi62-Gallo/NrxFlr-Cno	CM-8639-K-1M-1Y-500M-502Y-0M	1974	Mexico
Brochis"S"	Bch	Cno-BbxCd1(7C/Lib64 Inia x Inia-Bb)	CM-5872-C-1Y-1M-3Y-0M	1974	Mexico
Bucky	By	Nar59-Pj62/PixK1.AtlxNapo 63	II-21386-15E-5E-4E	1973	Ecuador
Buho	Buho	Sr70/Lib64-Inia x Inia - Bb	CM-4040-34Y-502M-501Y-0M	1973	Mexico
Buitre	Bui	L.S.3.1-Pi62 x Inia/CC-Inia	II-28867-300Y-302M-0Y	1971	Mexico
Calandria	Cld	Cheg-GtoxJar"S"/K1. Rend-Son64	HM1023-6P-2B-13P 2B-1T-0P-0Y	1973	Mexico
Calden Inta		Cheq285-Gto/Son64-Tzpp x Nai60	H856-30J-2J-1B-6B-By	1974	Argentina
Calidad	Cal	Tzpp-Son64/LR64A-Tzppx An_E	II-22429	1969	Mexico
Cajeme 71	Cj71	Cno "S"xSon64-K1. Rend/8156	II-23584-26Y-2M-0Y-3Y-1M	1971	Mexico
Canario "S"	Can	(HN-38MA x Rfn^2-908/Fn) Yr70	CM-2097-31M-1Y-1M 4Y-0M	1974	Mexico
Cardenal	Cdl	Meng-8156xJar"S"/8156	II-27105	1970	Mexico
Carpintero	Carp	Rq"S"-Pal#2/K1.Pet-Raf x SX	II-30724-1C-2C-4C-0C	1973	Mexico
Carthage		Napo-Tob"S" x 8156	II-28071-7M-3Y-7M-0Y	1974	Tunisia
Carazinho	Czho	Frontana x Colorista Sel. Trigo Col. Roxo			Brazil
Centrifen	Ctfn	Y53-N10B x LR^2			Chile
Chanate # 2 (=Salamanca 75)	Cha#2	Cno"S"-Pj62 x Cno-7C	II-26265-22Y-300M-301Y-2M-501Y-500M-0Y	1971	Mexico
Chapingo		F_2 Bulk selected under dry conditions	INIA	1974	Mexico
Cigueña	Cgn	Son64"x Tzpp-Y54/An64A	II-21406-6-2-300Y-301M-0Y	1971	Mexico
Choli	Cl	(21931/Ch53-LR64^{2}x8156) Nar59"S"	II-21515-1P-1P-3P	1973	Ecuador
Chorcha	Cho	(Tzpp-Son64 x Nar59)(LR64-Son64 x Napo 63)$_2$	II-25499-6M-1R	1973	Ecuador
Cleopatra		/Bb(Inia"S"-Napo)^{2}x II-20356/ T_2	CF283-30R-3M-0T	1974	Mexico
Cocoraque 75		Jupateco "S"	II-30842-58R	1975	Mexico
Condor		WW15^2/F 62-Gb56xTzpp-Nai60	WW31*WW15xWW80 (UQ1 15)	1974	Australia
Coqueña	Coq	Pato B(Jar-Napo/LR64xTzpp-An_E)	CM-1020-500M-500Y-500B-0Y	1973	Mexico
Corre Caminos	CC	Son64-Y50$_E$x Gabo)	II-19792-2M-7T-1C-3T-100M-0Y	1971	Mexico
Cuervo	Cvo	CI7800-BrxTzpp-Son64A	F67-2789-5P-2C-0C-0M	1973	Mexico
Diamante INTA		Son64A-TzppxNai60/Narino59	II-21872-9T-2B-3T-2B	1974	Argentina
Dougga		K1.Pet-Raf x 8156^2(R)	II-23997-4Y-100M-300Y	1974	Tunisia

TABLE 1.2.F.- Continuation

Name	Abbrev.	Cross	Pedigree	Year	Country
Eagle			Timopheevi parent		Australia
Egret		WW15xHeron	WW16	1974	Australia
Emek 112		Florence Aurore x Yt-N10B21	V238-6843	1972 ?	Israel
Emu"S"	Emu	Tob"S"-Napo x No66-Era/Bb-Gallo	CM-8327-C-9M-4Y-3M-0Y	1974	Mexico
Endor 331		Florence Aurore x Yt-N10B21	V 238	1972 ?	Israel
Era	Era	Complex cross:Tc,Supreza, FKN,Mida,K117A,Pembina, K58N,Lee	Minn II-62-64	1972	U.S.A.
Erect RGA		Tzpp-Son x Napo/Tob-8156	CM-1162-21-1A-1Y-0M	1973	Mexico
Erect Raf		Tzzp-Son x Napo/Tob-8156	CM-1162-21-1A-2Y-0M	1973	Mexico
Fath	Fath	Cno "S"-Gallo	II-27829-19Y-2M-5Y-1M-0Y	1973	Tunisia
Fisrerect#4A		Meng-8156R/Tob-Cfn x Bb	CM-6531-250M-6Y-2Bf-0Yf	1973	Mexico
Fletcher	Flr	Sister of Era		1972	U.S.A.
Gallo	Gallo	Wt_E-Nar59 x StaE/Jar "S"	II-22529		Mexico
Gavilán	Gv	Cno"S"-No66 x CC-Inia 66	II-34167-91Y-6M-0Y-502M-0Y	1973	Mexico
Grajo	Gjo	Tob-Cno"S"xTob-8156/Cal x Bb-Cno	CM-5816-C-1Y-3M-4Y-500M-0Y	1973	Mexico
Hira	Hira	HD1941*E5477-Son64	E5477 * Pi"S"	1971	India
Hork	Hork	Hopps-Robin x Kalyan	CM-8874	1974	Mexico
Huacamayo "S"	Huac	NY5207.05/Cno"S"-7C x Gto-Yr x Son	CM-8671-B-5M-1Y-2M-2Y-0M	1974	Mexico
Jilguero	Jl	Cno-7C x Cno - Pj62	II-25917	1971	Mexico
Jupateco 73	Jup	II-12300 x LR64-8156/Nor67	II-30842-31R-2M-2Y-0M	1973	Mexico
Kalyan	Kal	See Kalyansona			
Kalyansona	Kal	Penjamo 62"S"-Gabo 55	II-8156-S227	1967	India
Khushal 69		(21931-Ch53 x An"S"/Y50) C271	PK-037-17P-3K-2F	1969	Pakistan
Kite		Eagle BC x Mex.semidwarf	DARP*Dw.Agropyron Res.from Falcon		Australia
Kourifla 73		See Jupateco			
Lakhish		(Yaktana x Norin 10-B21) Florence Aurore	V238-8828(211,212)	1970 ?	Israel
Lapacho		Ciano 67"S"		1974	Argentina
Lechuza	Lza	Tob-8156 x CC-Inia/Jaral"S"	CM-5629-A-1Y-1M-0M1F-1Y	1973	Mexico
Leones INTA		Son64-Tzpp x Nai60*Jaral"S" (C)	II-18889-1R-3C-1T-2B-0J	1974	Argentina
Lyallpur 73		Bb - Norteño 67	II-27100-307M-100A-0A	1974	Pakistan
Maghreb 73		My54E-LR x II490/LR64 x Tzpp-Y54	II-21419-288 (See Arz)	1974	Morocco
Maya 74		Cno"S" - Gallo		1974	Guatemala
Marcos Juárez INTA-MJ		K1.Rend-Son 64	II-19975-86Y-1J-6Y-1J-4Y-1J-0B	1971	Argentina
Mexifen	Mef	Son64 x SkE-AnE	II-18703-17M-2R-3C		Chile
Mexicani	Mxc	LR-N10B x AnE^3	II-8739-4R-1M-1R	1971	Sudan
Mochis 73		Son 64-K1.Rend. x Bb"S"	II-26502-8Y-9M-1T-1M-5S-0M	1973	Mexico

TABLE 1.2.F.- Continuation.

Name	Abbrev.	Cross	Pedigree	Year	Country
Mocho"S"	Mon	Wren-Gto x Kal-Bb	CM-8288-A-3M-6Y-5M-1Y-0M	1974	Mexico
Narro	Narro	Bb x Inia-Napo/20350	II-38620-102"S"-1M-6R-0M	1974	Mexico
Novafen	Nfn	Rbh^2(Fn/K-N x N10B)	Ch10503-2P-3P-6P-1P	1971	Chile
Nuri 70	Nuri	Cno"S"x Son-Kl.Rend/8156	II-23584-15Y-6M-0Y	1970	Mexico
Oxley		Sister of Condor	UQ139	1974	Australia
Paloma	PL	Pato/LR64-Son64 x Napo	II-25499-100M-300Y-300M	1972	Mexico
Pari 73	Pari	Cno"S"x Son-Kl.Rend/8156	II-23584-303M-0Y-11A-1A-1436	1973	Pakistan
Pavon "S"	Pavon	Vcm x Cno"S"-7C/Kal-Bb	CM-8399-D-4M-3Y-1M-0Y	1974	Mexico
Perico	Pco	[Cal(21931-Ch53 x Gb^2/5667)] Cno-No 66	II-34886-17Y-4M-5Y-0M	1973	Mexico
Puthwar		114B35-Nadadores 63	V1102	1974	Pakistan
Pichihuila	Pci	Cno"S"-Gallo x Kal-Bb	CM-7652-15Y-500M-0Y	1973	Mexico
Pichinchi	Pin	(Son64-Sk$_E^6$/An$_E^3$ x My54E-An"S"-Fl.)Tiba	II-21263-2E-5E	1973	Ecuador
Pichón	Pch	Napo63 x Tzpp-Son64/8156(R)	II-28071-7M-3Y-5M-1Y-0M	1973	Mexico
Precoz Parana INTA	PPI	Son 64A-Knott#2	II-18893-12P-3B-3P-1B-1T	1971	Argentina
Prospur		Napo x Tzpp-Son 64A		1974	California
Protor		Tob-Cno"S"	II-24906-30M-3Y-3M-0Y	1974	California
Quelele	Ql	Wt$_E$-Nar59 x Tzpp-Wt$_E^3$		1973	Ecuador
RBC Comp		8156 Multiline Composite	Red grain Brown Chaff	1974	Mexico
Rigo "S"	Rigo	Sr-Bon(36896-Cj54^{2}x Yt54A/CC$_E$8156 x Cno)	CM-8510-H-7M-1Y-2M-3Y-0M	1974	Mexico
Robin #2		Jar^2"S" x Meng -8156	II-26787-300Y-300M-302Y-2M-500Y-1B	1971	Mexico
Roque 66	Rq66	Son 64A x Sk$_E$-An$_E$	II-18883-6M-6R-11C-1Y	1966	Mexico
Saka	Saka	8156-Nad x Bb(Son64-Kl.Rend/Cno-Chr x Bb	CM-5826-F-6Y-500M-503Y-0M	1973	Mexico
Salamanca 75		See Chanate # 2		1975	Mexico
Samaca 68	Sam	Bza x Africa Mayo^2	II-13022-9B-1T-2B-1T	1968	Colombia
Sandal 73		See Pari 73	II-23584-17Y-1A-0A	1973	Pakistan
Saric 70		Bluebird 3	II-23584-26Y-2M-2Y	1970	Mexico
SD 648-5		Sel. Mkwazine by Olesen			Rhodesia
Soltane		Son 64-Kl.Rend	II-19975-68Y-1Y-6Y-1J-3Y (BT2296)	1972	Tunisia
Soty		Son - Tzpp x Y54	II-18888	1960	Mexico
Sparrow "S"		(Rn-Md x K117A/Cobh^2) Son-Kl.Rend/Cno"S"x LR64^2-Son64	CM-2182-5M-1Y-2M-3Y-0M	1974	Mexico
Super X	Sx	Pcnjaino 62"S" x Gabo 55	II-8156-1M-2R-4M	1966	Mexico
Tala	Tala	Son-Kl.Rend x Massaux 5		1974	Argentina
Tanori 71	Tl	Son 64 x Cno-Inia	II-25717-11Y-3M-1Y	1971	Mexico
Tarnab 73		Nal"S"-CR151 x S948 -Mxp65	PK3563-4A-0A-0G-0 Aut	1973	Pakistan
Tecolote	Tl	E4830/C303 x M5392/666.5		1973	India ?

TABLE 1.2.F.- Continuation.

Name	Abbrev.	Cross	Pedigree	Year	Country
Tito"S"	Tito	Chr-Vcm x Kal-Bb	CM-8212-D-4M-0Y-0M-4M-5Y-4M-10Y	1974	Mexico
Toluca F 73		Inia"S"-Napo63 x Cno 67	II-28036-111M-1R-2M-1T-0M	1973	Mexico
Toquifen	Tqfn	(908$_F$Fn)^2-P4160xYt54-N10B-C14^2	Ch7817-3P-4P-1P-2P-1P	1969	Chile
Tordo	Tor	Nal60 x TT-Son64/LR64-Son64	H244.67-1Y-6B	1971	Mexico
Torim 73	Torim	Bb - Inia	II-26501-1T-7M-0Y-55Y-0M	1973	Mexico
Trifon "S"	Trif	[(Y48 x K58-N/Fr-KAD)Gb] Coutiches	F$_4$-5Y-0M-2Y	1974	Mexico
Tucan "S"	Tucan	Bb-Tob(Cno-No 66/C273 x NP875-E853.5.8)	CM-2609-12M-1Y-5M-2Y-4M-0Y	1974	Mexico
Tutuli	Tll	(Md/N-K117AxFr.KAD/Gb)Fr-KAD/Gb	II-19154-1E-1E-1E-1E	1973	Ecuador
II-20350		LR-Cj60 [(Rew-HxN/S211)E-K]		?	Mexico
Vicam 71	Vcm	Inia"S" - Napo 63	II-22398-39M-1R-0Y-101M-0Y	1971	Mexico
Wared		Sister of Era		1974	Washington
WBC Comp		Multiline 8156 Comp	White Seed Brown Chaff	1973	Mexico
Wren	We	Y50$_E$ - 8156 x Kalyan	II-28895-300Y-304M-0Y	1971	Mexico
Yecora 70	Yr70	Bluebird 2	II-23584-26Y-2M-1Y-0M	1970	Mexico
Zacatecas		Nor67 (Cno"S"-Jaral/Y50$_E$-Cno"S" On)	II-30861-1R-104M-109S-101M-0R	1974	Mexico
Zaragoza 75		Meng - 8156	H223-6Y-1Y-6E-1Y-1C-4Y-3C	1975	Mexico
Zambezi	Zbz	8156 x Lee- ND74	ND74 = ND4/Lee/Mida ND4=Thatcher x K338AC	?	Rhodesia
Zipa 68	Zipa	F-Y48 x Af M^2	II-12924-20B-3T-2B-1T	1968	Colombia
Zopilote "S"	Zp	Son$_2$64A-Sk$_E^6$/An$_E^3$-M/Rw^2-Bra^2	II-20911-2E-8E-2E	1973	Ecuador

1.3 Durum Wheat

1.3.1 INTRODUCTION

Durum wheat is a major food crop in most countries around the Mediterranean Basin. It also is important in East Africa, the Near and Middle East, India, the USSR, and some areas of the Americas. Worldwide, an estimated 30 million metric tons a year of durum grain is produced on 27.3 million hectares. Only a small part of this amount enters the international market and is used for pasta production. The larger part is consumed by the producers for different types of bread and for local dishes (couscous, bulgur and chapatis). Table 1.3.A shows area, production, and yield data of some major durum areas.

Traditionally, the durum species has been grown as a rainfed crop. Water supply, temperature regime and other environmental factors usually are inadequate during at least a part of the growth stage of the crop. Frequently very low levels of management are applied to durums in the traditional durum areas. Finally, the traditional varieties (with low yield potential due to lodging and disease susceptibility) still prevail in many countries where durums are a major crop. These factors may account for the low productivity of the crop that is indicated in Table 1.3.A

Focusing on the above problems, the CIMMYT durum wheat breeding program initiated as an independent international program within CIMMYT in 1968, aimed at assembling, screening and exploiting the genetic variability contained within the durum species. The central idea has been to create improved germ plasm combining high grain yield potential, wide adaptation, broad disease resistance to the major diseases, drought tolerance, and acceptable quality. The improved germ plasm obtained after the first years of breeding efforts has been made available quickly to all national programs concerned with improving durums.

1.3.2 MAJOR ACCOMPLISHMENTS: TO 1974

1.3.2.1 Widening the Gene Pool Base

At the onset of this international breeding program, it was clear that first priorities were: a wider genetic variability and broader disease resistance. The early phases of this breeding program were directed at these two objectives. A durum germ plasm bank was assembled using the USDA durum world collection, as well as germ plasm supplied by the National Programs of all countries where this crop is grown. From this bank, durums were screened for resistance to diseases such as stem and stripe rust, Septoria sp., mildew, and fusarium. This work continues, in collaboration with the National Programs of Algeria, Tunisia, Turkey, Ethiopia, and (with the assistance of Dr. G. Saari, CIMMYT's regional pathologist) Lebanon. Sources of resistance to all major durum diseases have been identified, and now are used in breeding program of more than 5000 crosses a year. However, CIMMYT breeders do not anticipate production of a line or variety with resistance to all major diseases. If one should be developed, its resistance would be only transitory. New biologic forms of the pathogens are arising continually to frustrate the development of such a universally resistant type. Thus, selection for resistance to the most important diseases is attempted on a regional scale, rather than on a worldwide basis.

1.3.2.2 Breeding for Yield and Adaptation

Considerable gains have been made in increasing the yield potential of durums; a major proportion of the success is due to the improvement of both plant type and head fertility. The first short durums had some degree of sterility that was detrimental to yield, however current yields are much improved. Table 1.3.B shows the gain in yield potential of the newest durum varieties in comparison to older selections. In wide adaptability, the new durum germplasm compare favorably with bread wheats. This can be seen by comparing the performance of different durum lines against the bread wheat control as charted for the various International Durum Yield Nurseries shown in Fig. 1.3.A. Nonetheless, CIMMYT breeders are aware that a great deal more work would be required to transfer this breadth of adaptability to most breeding materials, and to a range of maturity classes that would fit in various farming conditions.

1.3.2.3 Shortening the Time of Maturity in Durums

In an International Breeding Program such as CIMMYT's the advanced breeding materials should represent a continuous range of maturity classes; from the very late to the very early maturing. CIMMYT breeders feel that one special type of maturity is of extraordinary importance in view of the large area which would benefit from it. All Mediterranean countries need varieties which possess a relatively long period from seed germination to

flowering -- but which will also mature as quickly as possible after heading, because hot winds and drought in those countries threaten any crop with a prolonged grain filling stage. CIMMYT has made crosses to obtain such varieties and the F_1 and F_2 seed is being sent to Algeria, Tunisia, Turkey, Lebanon and Ethiopia for screening under the local conditions. Table 1.3.C compares the maturity of this germ plasm with that of slower maturing varieties.

1.3.2.4 Breeding for Disease Resistance

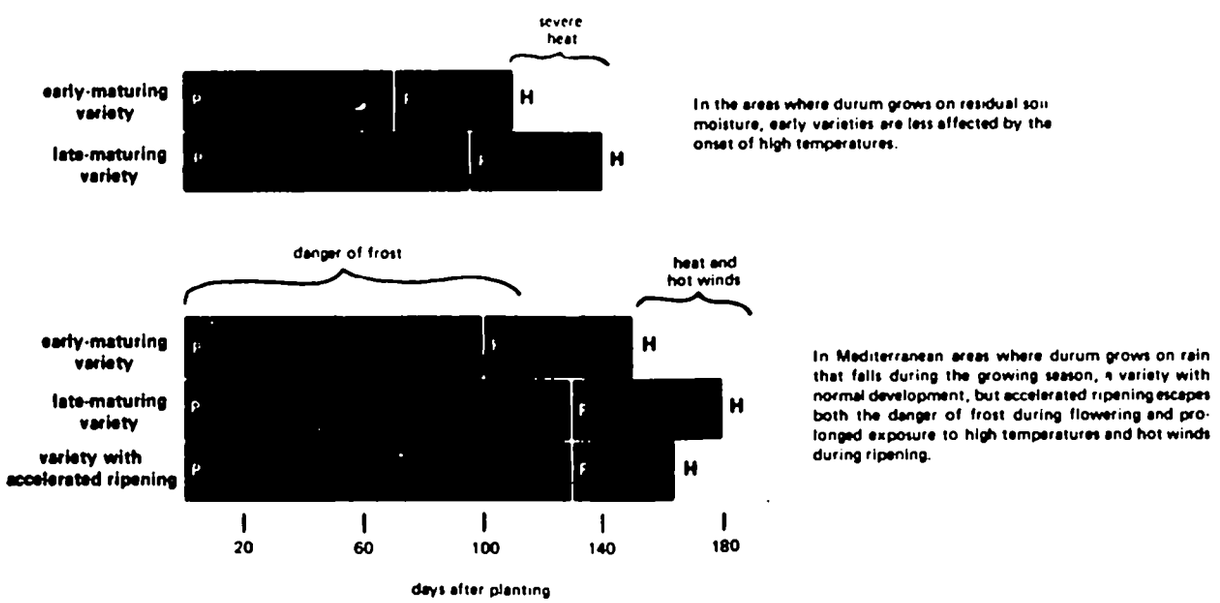
Resistance to major diseases seem to be a necessary condition for stabilizing crop yield. Unfortunately for the breeder, the pathogenic populations are so diverse and changeable that no durum variety can be expected to prove resistant under all climatic conditions, nor to be resistant for any great length of time. Hence, CIMMYT's strategy in its international nurseries has been to identify those genotypes possessing the broadest disease resistance and to breed these into high-yielding, improved germ plasm. It is hoped that some of this resistance might be a combination of both specific and general resistance, thus enhancing the protection against the pathogenic population. In practice, selection for resistance is done on a regional basis; using as a source germ plasm the segregating populations which CIMMYT distributes to National Programs on a worldwide scale. Attention is focused primarily on controling diseases caused by stem and stripe rust, Septoria tritici, powdery mildew, and fusarium, which are the most serious hazards to wheat production. Table 1.3.D is a summary list of the more outstanding lines for disease resistance.

1.3.2.5 Other Strategies of the Durum Program

Work continues on the incorporation of some winter hardiness into durums. For this purpose, over 250 durum winter types were vernalized; and will be crossed during the spring of 1975. Also, in 1974, more than 3200 F_1 seed crosses were distributed to National Programs in Algeria, Ethiopia, Lebanon, Mexico, Tunisia and Turkey. The strategy is to distribute a wealth of germ plasm in the F_1 generation to those countries having the expertise to fully exploit the genetic variability of this species.

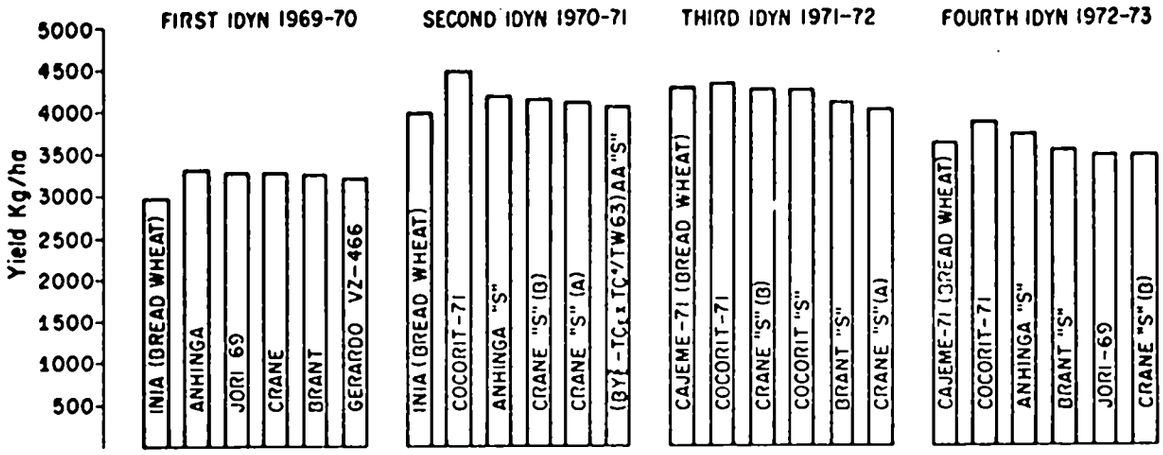
1.3.2.6 Frost Damage to the Durum Summer Nursery

During the summer of 1974, an early killing frost struck the high Valley of Toluca. This frost completely destroyed the nursery; not a single plant was saved. The breeding program was set back one crop season, and it was necessary to use the reserve seed to prepare the Winter Nursery. Fortunately, before this disaster, the nursery had been evaluated for stripe rust resistance, and the breeders could discriminate and discard susceptible families from the reserve seed. CIMMYT breeders noted that the early generation material - F_1 Top and Double Crosses, were complete losses. (These crosses will be made again during the spring of 1975.)



Schematic example of the advantages of durums with early maturity or accelerated ripening in certain areas. (P = planting; F = flowering; H = harvest).

Fig. 1.3.A. MEAN OVERALL LOCATIONS FOR YIELD OF BEST FIVE VARIETIES AND BREAD WHEAT CONTROL IN THE INTERNATIONAL DURUM YIELD NURSERY (IDYN)



T. 1.3.A Area planted to durum wheat, durum production and mean yield of durum wheat in the worlds major durum areas*.

Region	Area x 1000 ha	Production x 1000 t	Yield t/ha
East Africa	1,000	700	0.70
North Africa	3,600	2,700	0.75
Near and Middle East	5,000	4,900	0.98
USSR	6,400	8,000	1.25
European Mediterranean	2,000	3,100	1.55
USA and Canada	2,850	5,700	2.00
India	2,750	2,100	0.75
Others	3,700	2,800	0.75
WORLD	27,300	30,000	1.10

* Sources a) Durum Wheat: New age for an old crop
CIMMYT Today No. 2

b) Produktie durumtarwe in Italie en de wereld
Bureau Landbouwraad, Rome 1975

TABLE 1.3.B.- Yield improvement at different stages of the durum breeding program in Mexico. Data from yield trials at CIANO experimental station.

Variety	Height	Year released	Yield Kg/ha
Tehuacan 60	Tall	1960	4200
Oviachic 65	One gene dwarf	1965	7000
Chapala 67	One gene dwarf	1967	7000
Jori 69	One gene dwarf	1969	7700
Cocorit 71	One gene dwarf	1971	8300
Stork "S" (Proposed for release)	One gene dwarf	1975	8600

TABLE 1.3.C.- A comparison of durum varieties with a short post-heading maturity period against longer maturing varieties. Data from CIANO 1972-73, 1973-74.

Variety	Height	Origin	Days to heading	Days from heading to maturity
GROUP 1 (Fast maturing varieties. 50 days or less after heading)				
Cín-Mca x Cr"S"	Tall	Mexico	113	39
Bo "S"-Castelnuovo	Medium tall	Mexico	111	39
Pl - 264440	Tall	Greece	110	40
Stork "S"	One gene dwarf	Mexico	82	50
Pl - 306656	Tall	France	82	50
80/57	Tall	Unknown	83	50
Cocorit	One gene dwarf	Mexico	86	50
Gaza 277	Tall	Australia	86	50
Candeal 11	Tall	Chile	100	50
GROUP 2 (Slow maturing varieties. 55 days or more after heading)				
D-67-2-12A-7A-0A	Medium tall	Tunisia	81	57
Zenati Bouteille	Tall	Algeria	80	57
Biskri Bouteille	Tall	Algeria	85	57
D-56-27 A	Medium tall	Tunisia	80	58
Mariza Sadovo	Tall	U.S.S.R.	86	58
Flamingo "S"	One gene dwarf	Mexico	92	60
Cr "S" - Gs "S"	One gene dwarf	Mexico	90	64
Maghrebi - Gaviota	One gene dwarf	Mexico	90	74

T.1.3.D Selected durum varieties used in the breeding program as sources of disease resistance. Data taken from ADISN 1971-72, 1972-73 and 3rd RCB 1972-73

Variety or cross	Genealogy	Origin	Stem rust reaction: South Asia	West Asia	East Africa	North Africa
Hercules		Canada	MR	R	S	R
Durum var. 24		Unknown	MR	R	MR	R
Tehuacan 60		Mexico	MR	MR	S	MR
Jori 69		Mexico	MR	R	MS	S
Cocorit 71		Mexico	MR	MR	S	MR
Anhinga "S"	22234-52M-3Y-1M-0Y	Mexico	MR	MR	S	MR
Flamingo "S"	27582-9M-8Y-1M-0Y	Mexico	R	R	MS	R
Flamingo "S"	27582-8M-13Y-2M-0Y	Mexico	MR	R	S	R
D.dwarf S.15 x Cr"S"	33312-7Y-2M-1Y-0M	Mexico	MR	MR	S	MR
Maghrebi		Tunisia	R	R	MS	R
Wells		USA	R	R	MS	R
Leeds		USA	R	R	MR	R
Ward		USA	R	R	MR	R
			Stripe rust reaction			
Zenati-Boutellis		Algeria	R	R	MR	R
Senator Capelli		Italy	-	MR	R	R
Tehuacan 60		Mexico	-	MR	R	R
Jori 69		Mexico	-	R	R	MR
Cocorit 71		Mexico	MS	MS	MR	R
Flamingo "S"	27582-8M-13Y-2M-0Y	Mexico	-	S	MR	R
Flamingo "S"	27582-18M-12Y-5M-500Y	Mexico	R	R	R	R
Flamingo "S"	27582-9M-8Y-1M-0Y	Mexico	R	R	R	R
Cr"S"-Gs"S"	28980-28Y-13M-500	Mexico	R	MS	R	R
Crane "S"	23055-56M-1Y-1M-0Y	Mexico	R	R	MR	R
Gaviota "S"	31725-3M-8Y-1M-0Y	Mexico	MR	R	MR	R
Maghrebi		Tunisia	R	R	R	R
			Septoria tritici reaction			
INRAT 69		Tunisia	-	MR	MR	R
T.turgidum		Unknown	-	R	MS	R
Durum var. 24		Unknown	-	R	MR	R
Gerardo 512		Italy	-	R	MS	R
Gerardo 466		Italy	-	R	S	R
61-130 x Lds		USA	-	MS	MS	-
Leeds		USA	-	-	-	R
Boobi "S"	21263-5Y-1Y-2Y-3M-2Y-102M	Mexico	-	R	MS	R
Cr"S"-Gs"S"	28980-28Y-13M-500Y	Mexico	-	R	MS	R
Gaviota	31725-40M-3Y-13Y-0M	Mexico	-	R	S	R
Pelicano	25609-2M-1Y-1M	Mexico	-	R	S	R
Anhinga	22234-52M-3Y-1M-0Y	Mexico	-	R	S	S
Flamingo	27582-8M-13Y-2M-0Y	Mexico	-	R	S	MS
			Powdery mildew reaction			
Tehuacan 60		Mexico	-	R	-	R
Chapala 67		Mexico	-	R	-	R
Pelicano "S"	25609-2M-1Y-1M	Mexico	-	R	-	MR
Jaafari		USSR	-	R	-	-
Durum var. 24		Unknown	-	R	-	R
INRAT 69		Tunisia	-	R	-	R
Maghrebi		Tunisia	-	R	-	R
Senator capelli		Italy	-	R	-	R
Capeiti		Italy	-	MR	-	R
Gerardo 466		Italy	-	R	-	MR
Hercules		Canada	-	R	-	R
Wells		USA	-	R	-	R
Leeds		USA	-	R	-	R
61-130 x Lds		USA	-	R	-	MR
			Fusarium reaction			
			France	Poland		
T. turgidum		Unknown	R	-		
Maghrebi		Tunisia	S	MS		
Lakota		USA	S	R		
Cr"S"-Plc"S"	31724-33M-0Y-0M	Mexico	MS	-		

TABLE 1.3.E.- Recently named Durum Wheat Varieties and lines.

Variety name	Abbrev.	Cross	Pedigree	Year of Release	Country of Release
Amal 72	Amal	Brant "S" In Tunisia BD1830	D-24102-4R-4M-0Y	1972	Mexico/ Tunisia
Avetoro	Ato	Jo"S"\Gll "S"/61-130x60-115)	D32864	1972	Mexico
Botno		Sister of Ward			
Creso or Crocso		MaxZxCpB144	Mutant	1973	Italy
Crosby		Ld^2/St464//Leeds	CI17282 (D67-15)	1974	North Dakota
Dicle 74		Cocorit 71		1974	Turkey
Egret					
Gaviota	Gta	Cr"S"(T.pol.185309xTpol$_E$-Tc^2/Gll "S")	D-31725	1972	Mexico
Gediz I					
Hercules		RL3097/RL3304//Stewart/RL3380		1973	Canada
Huevos de Oro	HO	[(Cr"S"/Stw63-GldBall x Stw63) ST464] Mex.Dw.	D28981-14Y-6M-500Y-0M	1974	Mexico
Ibis					
Kingfisher					
Kiwi	Kiwi	Jo"S"(T.Pol185309xT.Pol$_E$-Tc^2/Gll"S") DM69-2	D-31810	1974	Mexico
Maghrebi 72		Gll"S"/Br.180-LkxGz-61.130	D26842-21Y-3M-0Y	1972	Mexico/Tunisia
Maristella		Capeiti x Dauno III		1973	Italy
Meauca	Mca	Stw63(Gll"S"/CI8133-2h-Candealfen$_2$x C8)	D31613	1972	Mexico
Petrel	Ptl	(Ld357$_E$-Tc^2xGll"S"/T.turg.) Cr"S"	CM-601	1972	Mexico
Plover					
Rabicorno	Rabi	AA"S"(CPE-GzxTc^3/BY^2_E-Tc)	D31733	1974	Mexico
Raj 911		[(Yt54-N10BxSt464)Tc^2] Nachitschevanicum	II-20528-4R-1R	1975	India
Rolette		Leeds x PI from Ethiopia	D65-17	1973	U.S.A.
Ruff					
Rugby		Sister of Ward			
Snipe					
Stork	Stk	Gerardo VZ469 (21563/61-130x Leeds)	CM-470	1972	Mexico
Taganrog B.Bal		(Capelli x Candeal Italiano) x (Candeal x Taganrog) (17-12-4)		1963	Argentina
Tildillo	Tilo	21564-AA"S"(D.BuckxD#2$_E$-Tc^2/LK)	D28951	1972	Mexico
Valfiora		Giorgio	GVZ532	1973	Italy
Valsacco		Giorgio	GVZ451	1974	Italy
Valgerardo		Gerardo	GVZ512	1973	Italy
Valgiorgio		Giorgio = Capelli x VZ156	GVZ447	1973	Italy
Valselva		Gerardo	GVZ572	1973	Italy
Valnova		Gerardo	GVZ598	1973	Italy
Ward	Ward	Ld/3/LD357//CI7780/LD362/4 Leeds "S"	CT15892	1973	U.S.A.
Wakooma		Lakota^2 x Pelissier		1973	Canada
D68.11		INRAT 6g x BD 1708-BD141gxBD1705 BD1705			Tunisia

1.4 Barley

1.4.1 INTRODUCTION

The CIMMYT barley program, now in its third year, continues to follow the pattern established earlier in the wheat program. The aim is to develop high yielding widely adapted strains that can be used in barley-producing areas of the world. Emphasis is being placed on improving the agronomic type and the adaptation of the crop, as well as in improvement of nutritional value.

At the beginning of the program in 1972 large numbers of varieties were collected from many countries, including well adapted varieties and strains from Mexico's National Program. Screening and genotypic selection has been conducted on this broadly based genetic material in each subsequent cycle. New strains from national, regional and international programs have been introduced continually; providing a concentration of superior strains with different characteristics in the Crossing Block.

More than 350 lines and varieties are now being used in the Crossing Block, and these have been classified for:2-row or 6-row types,yield potential, disease resistance, earliness, lodging resistance, high-protein, and lysine. Multiple crossing is being used extensively to move the desirable characteristics into superior lines. Single crosses are used only in specific cases.

In the 1973-74 cycle, more than 1200 crosses were grown at Cd. Obregon. More than 400 double crosses and about 200 three-way crosses were also grown. A total of 350 F_2 bulk populations, and more than 1200 individual plant selections made from double and three-way crosses, are being grown in the 1973-1975 cycle.

Early materials are being grown in a special nursery, and lines developed from this nursery will be sent to countries and locations where the growing cycle is short and normal cycle varieties are unadapted because of late maturity. Table 1.4.1 lists the various characteristics and the most promising parents in the CIMMYT Crossing Block.

1.4.2 NEW DEVELOPMENTS

1.4.2.1 Adaptation

One of the great deficiencies in barley has been its lack of wide-adaptation. Materials developed in the initial stages have now been moved through six generations; backward and forward, from near sea level in Northwest Mexico to 2,300 m. a.s.l. on the Central Plateau near Mexico City. Thus, lines have been screened for different climatological and ecological conditions, as well as for different photoperiods and pathological conditions. The winter nursery at Cd. Obregon has provided conditions for selecting superior agronomic types; the summer nursery at El Batan offers excellent conditions for screening for such important barley diseases as powdery mildew, scald, spot blotch, net blotch, loose smut, stem rust, leaf rust, stripe rust, bacterial blight, and barley yellow dwarf.

1.4.2.2 Disease Resistance

During the past two cycles (1973-1974), considerable information has been obtained regarding resistance to particular diseases among the barley materials. In many cases, however, resistance of a variety is masked by susceptibility to other diseases: for example, Rhyncosporium may remove the leaves before leaf rust reaction can be observed. To overcome this masking it is essential that information be gathered from many sites where one disease predominates, to isolate and identify the sources of resistance. In 1973, the first barley disease screening nursery was sent to a number of cooperators in different parts of the world to supply such information. Some results have been received, but increased interchange is essential if the international program is to have its full effect. Cooperators are urged to make a special effort to supply this information as early as possible, to upgrade the quality of the progenitors being used in crossing. Local testing is being used extensively in Mexico at various sites to get this information.

1.4.2.3 Lodging Resistance

On a worldwide basis lodging is one of the principal factors limiting yields of barley. Lines have now been developed with stiff straw and a relatively well anchored crown that allow the plant to stand erect. These lines are now in F_4 and F_5, and will be

tested in 1975 at Cd. Obregon. Varieties with short straw can be used effectively in high rainfall or irrigated areas. Lines with short straw and good agronomic type have been obtained for use in such areas, from mutants developed in India.

1.4.2.4 Nutritional Value

Until the last cycle, the variety known as Hyproly (and crosses derived from it) was the source of the high-protein high-lysine characteristic. This variety has certain problems: it is quite sterile, resulting in the formation of few kernels; is particularly susceptible to most of the foliar diseases; and grain-filling is unsatisfactory. This latter characteristic is transmitted to many of the lines that have high protein. An alternate source of high lysine was developed by Danish scientists and Riso through irradiation of the variety Bomi. This line, known as Mutant 1508, has a higher lysine content (15% above that of Hyproly). Although the protein content is somewhat less in 1508, it remains at an acceptable level of about 12%.

In previous years, only about 20% of the crosses involved parents with high quality; and, as indicated, only a few types were obtained with good quality and acceptable agronomic plant type. Currently, almost 40 % of the crosses involve quality parents.

Agronomic type and grain-filling characteristics in lines derived from 1508 are superior to those from Hyproly. The high lysine character of this mutant is simply inherited and is determined by a single recessive gene. F_3 lines derived from crosses with this mutant are now being grown. Some of these selections have a high DBC value, and a well-developed endosperm.

More than 2000 individual plants, selected from different segregating generations involving either Hyproly or 1508, were tested for DBC value. Among the crosses involving 1508, superior segregates were obtained in crosses with these varieties: Porvenir, Blanco Mariout, Manker, Godiva, line 11012-2 (dwarf Indian mutant), and M66-85 (Minnesota line). Although some of these segregates are not of an ideal type, they represent a distinct advance over the original source variety.

1.4.2.5 Earliness

The growing cycles in many barley production areas are relatively short and many varieties are not adapted to this environment. Crosses have been made with early types and this character has been incorporated in lines. The nurseries for these types are handle conventionally except they are harvested earlier. Lines that have achieved relative homozygosity, which are now in F_5, have been developed. Some of these lines are naked-grained, are resistant to some of the diseases, and are high in protein content.

1.4.2.6 Hull-less Grain

Many of the lines now used for human consumption are of the hulled-grain type. CIMMYT's program has emphasized the introduction of the hull-less character so that pearling the hull from the grain will not be necessary. Normally pearling is done by direct mechanical abrasion or by soaking. Abrasion reduces the protein and food yield through loss of portions of the seed coat; whereas soaking may reduce water soluble proteins responsible for higher nutrition.

1.4.2.7 International Nursery Distribution

In 1973-74, for the first time, CIMMYT has distributed a wide range of materials derived from the barley program. These lines are being tested in 35 countries. A total of 78 sets of nurseries were distributed: including crossing blocks, F_2 bulks, and screening nurseries. Field notes on general performance and disease reactions are expected in the spring of 1975. Local testing within Mexico continues in close cooperation with the National Institute of Agricultural Research (INIA), using their local station system. The first yield tests from advanced lines were sown in the Cd. Obregon station in the fall of 1974, and should indicate yield potential in the derived lines.

TABLE 1.4.A.- Varieties and Lines of Barley used for the introduction of desirable characters in the CIMMYT program.

Character	Variety or line
Earliness	Apan-Russian line, Super precoz, Svalof Mona, Svalof Mari
Adaptation	Apizaco, Celaya, Puebla
Straw Strength	M 86-85, Minn 126, Minn 907, Godiva, 11012-2 (Indian dwarf) Blanco Mariout-Godiva lines, Apizaco-CM 67 derivatives
Disease resistance	Scald - Gaines, Celaya, Atlas 57, Api-CM 67, Benton Helminthosporium (Both H. sativum and H. teres) - Godiva, OC 640, Brachiki, Magn[1] 107 Powdery mildew - Benton, Chevron CI 9185, Emir, Masurka Stem rust - Chevron CI 1111, Cyprus Black A, Arivat-local D8 Leaf rust - Apizaco, Dwg[1]-Api[3], Api - CM 67 Stripe rust - Cyprus Black awns, Chevron CI 1111, Benton
Protein and Lysine	Dickson - Hyproly derivatives Risø Mutant 1508 derivatives Dickson-Hyproly x Cal. Mariout (Hyproly x SV02109-Mari/CM67) CMB73-604-A-17Y-1B-501Y
Naked Kernels	Blanco Mariout-Godiva derivatives Apan-1B 65 derivatives Nepal CI 593
Yield Potential	Apizaco - CM67 - derivatives Porvenir - U. Sask. 1744 - N Porvenir - U. Sask. 1800 - N Minn. 126 - CM 67 - B

TABLE 1.4.B.- Recently named barley varieties. December 1974

Variety Name	Abbrev.	Use	Cross	Year of Release	Country of Release
Apam	Apm	6 SB-M	Sister of Apizaco		
Apizaco	Api	6 SB-M	Pro-Tol I XV-306-1Y-4M-1R	1968	Mexico
Beacon		6 SB-M	Conquest x Dickson	1973	U.S.A.
Berac		2 SB-M	Balder x Erica	1970	Netherlands
Bonanza		6 SB	Vantage x Jet x Vantmore x Parkland[2] x Cq	1970	Canada
Celaya		6 SB-M/F	Pro-Tol I x Cer[2]-Tol I XV-1632-1R-1M-4Y-2M	1972	Mexico
Clipper		2 SB-M	Proctor x Prior A		Australia
CM 67	CM 67	6 SB	(Calif.Mariout[5] x C12376) x (Calif.Mariout[6] xClub Mariout)[2]	1968	California
Julia			Delta x Wisa	1968	Netherlands
Klages		2 SB-M	Betzes x Domen	1972	U.S.A.
Manker		6 SB	Cree /4/ Parkland*2/NDB112/3/Vantage/2/Kindred/Jotun	1974	Minnesota
Masurka			Hylkama 1148 x Heine 4808	1970	Netherlands
Nordic		6 SB-F	Dickson x CI 4738 x Traill x UM 570	1972	U.S.A.
Porvenir	Por	6r SB F	Mor x H35-Val (Er18 : DC-Un) II -2698-9M-2R-1M-3R	1964	Mexico
Promesa	Pro	6 SB	(Er16 x DCI-Un) Ba (Un-Tch929) II -1542-2T-2C-1M	1963	Mexico
Puebla	Pue	6 SB	Cer-Por x TP/Avt-K /Tol I x BZ /Vt XV-2524-6R-1M-1R-0M	1974	Mexico
Steptoe		6 SB F	Washington 3564 x Unitan	1973	U.S.A.
Vanguard		2 SB-M	Betzes x Haisa[2] x Piroline	1971	U.S.A.
WI 3107		2 SB-F	Bonus x CI 3576		Australia
Woodvale		6 SB-F	From Vale (glossy)	1969	U.S.A.
Zephyr		2 SB-M	Heine 2149 x Carlsberg II	1965	Netherlands
Zoapila	Zoap	6 SB-M	Mor-Bu RF9 x Pro/Tol I x Api XV-1836-1M-1Y-4M-2Y	1972	Mexico

LEGEND

WB	•	Winter Barley	2	•	2 row headtype
SB	•	Spring Barley	6	•	6 row headtype
SWB	•	Semi Winter Barley	M	•	Malt
			F	•	Feed

1.5 Triticale

1.5.1 INTRODUCTION

Successful triticale research continues and there now seems little doubt that triticales can become a valuable commercial crop, with potential for making significant contributions to world food supplies. A major task of the future will be to put triticales into production in various areas. In some countries, triticale has outyielded wheat; Table 1.5.A shows the comparative grain yields of triticale and bread wheat varieties in Sonora (winter) and Mexico (summer) nurseries over the past five years. These data clearly show the tremendous improvement in grain yield of triticales, that has been achieved in recent years.

1.5.2 CREATION OF WIDER GENETIC VARIABILITY

1.5.2.1 Developing New Primary Triticales

Techniques for embryo culturing and colchicine treatment were improved in 1974 thus substantially increasing the production of the numbers of new primary amphiploids.

Table 1.5.B shows the new amphiploids, representing 131 different cross-combinations, both at the hexaploid and octaploid level, that had been produced by the end of the 1973 season. All interspecific wheat-rye hybrids cultured from crosses made at CIANO and Navojoa during the 1973-74 season were treated with colchicine and transplanted to the field at El Batan.

1.5.2.2 Winter Triticale

This program has a two-fold purpose: (1) to utilize the germplasm available in winter triticales, in winter ryes, and in winter wheats; increase the genetic variability in the spring triticales, (2) to produce a triticale more suitable for areas with low temperatures during the winter growing season.

The Toluca nursery grew winter triticales during the winter of 1972-73; this location proved suitable when winter types were sown in October-November and spring types in January or February.

Selections from the 1972-73 nursery in Sonora were sent to a number of locations in North America and Europe, including two sets to Oregon State University. In Oregon, winter-kill was severe and only a few CIMMYT strains survived, among those with good frost resistance were selections from Michigan State University, Sweden, and Eastern Europe. Notes on survival were used to make selections for inclusion in the 1973-74 winter nursery.

The 1974 findings suggest that the Toluca nursery offers an excellent location for: making spring x winter crosses; distinguishing true winter forms from intermediate or facultative spring types; and selecting for resistance to several diseases, and against pre-harvest germination. It does not, however, provide a suitable means of screening for winter hardiness. The University of Guelph, Canada became a cooperator during the year thus providing a suitable testing site for selecting for winter hardiness during the 1973-74 season.

1.5.2.3 Cytology

Early in 1973, Dr. Perry Gustafson established that Armadillo carried one pair of D genome wheat chromosomes as a substitution for one pair of the R genome of rye. Numerous wide crosses are made each year at CIMMYT, and there is a high probability that other substitutions exist among the selected strains. This information is valuable in predicting the genetic behaviour of such crosses.

Dr. Arnulf Merker worked on the cytological aspect of the Triticale Program as a post-doctorate in 1974, assisted by Mrs. Margarita Sosa. The Giemsa stain technique was employed to identify rye chromosomes. Numerous triticale strains were examined and the chromosomal make-up established. A series of type strains based on chromosome composition was set up, and these were sown for examination to see if plant type changes might be associated with chromosomal composition. The type strains ranged from triticale strains having the complete set of R chromosomes to strains with only one pair. The rye chromosomes found in the type strains are identified in Figure 1.5.1

The wheat chromosomes that act as a substitute for the missing rye chromosomes have been positively identified in only a few lines. The chromosomes of Armadillo as stained in the Giemsa technique are illustrated in Figure 1.5.1.

Dr. Merker has prepared a paper on his modifications of the Giemsa technique, to be published in Hereditas. Unfortunately, both Dr. Merker and Mrs. Sosa have accepted positions elsewhere; routine chromosome counts are now being made by a technician.

1.5.3 BREEDING FOR INCREASED YIELD, QUALITY AND ADAPTATION POTENTIAL

1.5.3.1 Yield Improvement

Grain yield potential has increased notably following the introduction of the second dwarfing gene from the bread wheats. The first strain of this type (Cinnamon) was entered in yield lists in 1971-72, when it outyielded Armadillo, one of its progenitors. Table 1.5.C shows yield data of some lines derived from backgrounds similar to that of Cinnamon that have increased lodging resistance and increased yields. Over 600 triticale strains were included in 23 advanced yield test at CIANO in 1973-74. In each test, the average yield of the top triticale strain was better than that of Cinnamon by about one metric tone per hectare (Table 1.5.C).

The new strains appear to be more responsive to N fertilization and have better resistance to disease and lodging. In the Mexico City area, testing is conducted in the Toluca Valley, in the Valley of Mexico near Texcoco, and on a farm near Huamantla in Tlaxcala State. Test locations vary in altitude from 2,620 m (7200') at El Batan to 3,130 m (8600') a.s.l. at Toluca. Triticale trials at these elevations indicate that this crop has a yield advantage that seems to be associated with greater resistance to disease, and with a more vigorous growth development at the cooler temperatures. Moreover, at Huamantla (on sandy soil where wheats do poorly) a few triticale lines showed a decided advantage in yield. During 1973, one strain produced 4.5 tons/ha on a field scale at that location; a much better yield than the wheat check varieties.

1.5.3.2 Pathology

Two pathologists from the United Kingdom, J.M. Waller and M.J. Richardson assisted in triticale pathology over a 4-5 week period in late 1973. They isolated and identified a number of plant pathogens attacking triticale in the Toluca and El Batan nurseries. A summary report was issued in 1974.

During 1974, a number of interesting, and possibly important, aspects of disease development in Triticale were observed:

(1) Take-all caused by Gaeumannomyces graminis was observed as a pathogen seriously affecting some triticale strains in Mexico. Severe lodging, shrivelling of grain and yield reduction result from infestation.

(2) Susceptibility of some triticale lines to dwarf bunt, Tilletia controversa was noted by R. Metzger at Oregon State University in plots at Corvallis, Oregon. Several lines were sown in soil that was heavily infested with dwarf bunt; plants of certain lines were attacked. Previously triticale had been essentially free of the smut diseases.

(3) Susceptibility of triticale to leaf spot, caused by Cochliobolus sativus (helminthosporum sp), was observed at the Poza Rica, Mexico Tropical station. Most triticale lines have been found to be susceptible. Similar observations with less severity were reported from Algeria and Turkey.

(4) A severe disease infestation affecting leaves, leaf sheaths, spikes and awns was reported from Normal, Alabama in the spring of 1974. Septoria nodorum was found to be the causal organism. Although this organism was often seen on triticale in several countries, it was not previously considered a serious pathogen on triticale.

(5) Triticale and rye strains in the Winter Nursery at Toluca, 1973-74 developed a heavy bacterial stripe infestation beginning in early April. The spring triticales sown in January in the same nursery was relatively free of the disease; presumably, earlier selection at Navojoa and El Batan was effective in developing more resistant strains.

1.5.3.3 International Testing Programs

The performance of triticale strains in the 2nd and 3rd International Triticale Yield Nursery (ITYN) was reported in April 1974. Figure 1.5.2 shows that there has been

a marked improvement in general adaptation each year. The average yield of the top five triticale strains relative to the best wheat check (over all of the locations of each of the first three tests) reflects this upward trend. Similarly, Table 1.5.D and Fig. 1.5.3 shows that this trend has continued over subsequent ITYN's, and that the top triticale now outyield the wheat checks.

Table 1.5E lists the number of sets of the various triticale nurseries distributed, and areas to which they have been sent.

Information received from the cooperators in screening nurseries is of real value to the CIMMYT Program in planning further improvement.

Programs in Ethiopia, India, and Brazil are investigating the utilization and production practices needed to establish the immediate commercial production of triticale. Scientists in some of the other developing countries are showing keen interest, but seem to be adopting a wait-and-see approach.

1.5.3.4 Quality Research

1.5.3.4.1 Endosperm development and test weight

Seed shrivelling and abnormal endosperm development remain a problem in triticale improvement. The screening of early generation populations by the use of a gravity table was possible at El Batan, but not at CIANO. Visual selection was practiced on F_3 and advanced generations. Test weights in the preliminary and advanced yield trials equalled, but did not exceed, those of the previous season. Table 1.5.F provides data on grain yield and test weights for the 1972-73 crop and the summer crop of 1973.

1.5.3.4.2 Protein and lysine content

Chemical determinations by the Protein Quality Laboratory (CIMMYT) have shown the expected inverse relationship between protein content and yield. Figure 1.5.4 clearly shows the decline in total protein associated with selection for increased yield and better grain development. Despite the decline in percentage of protein, the actual protein production per unit area has steadily increased along with increasing yields. In 1968, total protein production per hectare was 510 kgs/ha, at 17 percent protein. In 1973, production of protein per hectare was 750 kgs, at 12.5 percent protein: an increase of 50 percent in protein and 100 percent in grain production.

Fortunately, there does not seem to be a strong inverse correlation between percent lysine in the protein and yield. High-yielding lines are being identified with high percentage of lysine in the protein. Some of the more interesting strains have high yield potential, plus 12 to 13 percent protein coupled with lysine levels approaching 4 percent in the protein. It is hoped these lines will have high nutritional value. Table 1.5.G shows paired lines with contrasting levels of protein and similar levels of lysine.

Three of the lines shown with different levels of lysine in the protein also are being sent to INCAP (Instituto de Nutrición de Centro America y Panama) in Guatemala; they will be evaluated in bio-assays (using rats and chicks) under the direction of Dr. R. Bressani. Bio-assays using rats also are being arranged with Dr. Shimada at INIP, Palo Alto, Mexico.

1.5.3.5 Adaptation

The new strains of triticale appear to be more competitive with wheat at the higher elevations of Mexico, and on sandy soil, than under the highly productive environment of the Yaqui Valley. Grain yields of the best triticale strains were significantly above the wheat checks at all three locations in the high valleys, but were significantly below the wheat checks at one of the four locations in the Yaqui Valley as shown in the Agronomy report.

Table 1.5.H shows the present comparative yields of triticale and wheat varieties (both bread and durum) in a collection of trials involving the newer triticale strains. Their relative performance compares favourably with that of the wheat checks. It can be seen, however, that the test weight is still inferior to wheat, although improving.

In demonstrations conducted in various locations throughout Mexico, no yield data were obtained, but performance was rated visually. These ratings are shown in Table 1.5.I; Yoreme and Rahum appeared to be consistently most superior in performance.

1.5.4 TRAINING

Three young scientists from Ethiopia, Algeria and Russia were assigned to the Triticale Program for training; all three were highly intelligent, well-motivated and diligent scientists, and it was expected that each would undertake a triticale improvement program on return to their home country. During 1974, one full-time trainee from Iran participated in the program; in addition, scientists from Algeria and South America participated on a part-time basis.

Visiting scientists included Dr. Gregory from England; Ing. Margarita Nebrada, from Chile; and Dr. Gebremarian from Ethiopia.

1.5.5 CIMMYT INPUTS IN TRITICALE PROGRAMS IN DEVELOPING COUNTRIES

Countries with areas potentially suitable for triticales are becoming apparent as research workers test the uniform nurseries and other triticale materials from CIMMYT. In most countries, there has been some hesitancy by research institutions and public agencies to enter into commercial production. Most of this reluctance stems from an uncertainty as to how this grain should be used and, consequently, whether a ready market is likely to be available. There is an increasing body of evidence that triticale can be used for most products in which wheat is currently being used, other than in highly leavened loaves. (However, some quite satisfactory loaves have been made at CIMMYT with some adjustment in the fermentation time and the baking procedure). Given grain yields equal to or better than wheat, however, the possibility of higher nutritional value could make a substantial improvement in diets in several regions with the lines presently available. The following are some of the countries where triticale has demonstrated a potential for production excluding that of wheat.

1.5.5.1 Ethiopia

Agricultural scientists in Ethiopia were among the first to recognize that triticale offered an advantage over wheat and other cereals in grain production. CIMMYT has supplied segregating materials and nursery sets to Ethiopia over the past five years. In 1973 and 1974, materials selected in Ethiopia from early generation CIMMYT materials were tested for yield against introduced CIMMYT triticale selections. The best triticale selections showed advantages over the wheat checks, and one line of triticale is being grown under limited increase for distribution.

1.5.5.2 Kenya

Kenya, like Ethiopia, produces cereals at high elevations, under severe disease infestation. The more destructive diseases are stem rust, stripe rust, Septoria and leaf rust. Kenya appears to have optimum conditions for greatest variation stem rust virulence. New wheat varieties often become susceptible shortly after their release. Triticales, however, have the adult plant resistance of rye for wheat stem rust, thus may offer a method of overcoming this problem. Triticales are now resistant to races of stem and stripe rust; they produce vigorous plants, and appear adapted and capable of giving high grain yields in the Kenya Highlands.

1.5.5.3 India

Programs for triticale improvement are being conducted at four locations in India. Breeding programs at Ludhiana, Pantnagar, New Delhi and in Madhya Pradesh, are being conducted actively, mostly with basic materials derived from CIMMYT. It appears that present triticales will be best adapted in the Northern Hills Region of the country; some of the earlier strains appear superior to wheat. (Interestingly in yield tests carried at Ludhiana and Gorakhpur in the Plains Region of the North Western Punjab, the best triticale outyielded the widely grown Kalyansona wheat variety, by 29 percent, over a two year period).

1.5.5.4 North Africa

Triticale testing in Morocco and Tunisia began with the introduction of uniform triticale yield trials (ITYN) and selected strains from CIMMYT in 1969. The resistance of triticale to *Septoria tritici* provided this cereal with an advantage over wheat in the more humid areas along the coast, although severe leaf blotching was noted in some locations. However, *Septoria tritici* fruiting bodies were not found on the diseased leaves, as was the case with wheat in the same locations, and it was determined that the causal organism was *Cochliobolus sativus* (*Helminthosporium sativum*).

A program for developing triticale strains for Northern Algeria was begun in 1972-73. In 1973-74, demonstrations with fixed strains in the Plateau Region did not appear to be outstanding, but F_3 lines derived from F_2 plants selected within the country did look very promising. This finding indicates that, because of the rather narrow base of triticale germplasm, more specific adaptability to countries might be expected. Similar observations have been made in other country programs.

1.5.5.5 South America

Several areas in South America appear to have potential for triticale production.

In Argentina, strains with good forage potential have been produced, using materials obtained from CIMMYT in 1968 and 1969. Diseases severely limit wheat production in the more humid sectors of the North East. Resistance to these diseases is found among the triticales.

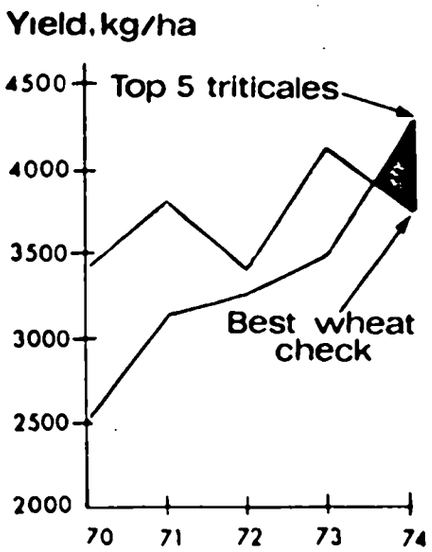
Brazil has very large areas with soils in which aluminum toxicity and Septoria tritici present serious problems for wheat production. Triticales as a class seem to be much more tolerant to this soil condition, and to Septoria leaf blight, than are the wheats. Triticales, therefore, may offer an alternative to wheat as a cereal crop in these areas.

Stripe rust in the high valleys in Colombia, Peru and Ecuador is devastating. Triticales, for the most part, are extremely resistant to stripe rust, thus they have an intrinsic advantage.

In Chile, a collaborative program has been initiated, and the adaptability of triticales there is now being investigated.

1.5.5.6 Mexico

As a part of the INIA-CIMMYT collaboration, wide-scale testing and demonstrations have indicated that triticales may be well adapted in both coastal and highland areas. In late 1974, INIA released a triticale variety, Yoreme, for cultivation, particularly for the highlands; preliminary plans were made for seed production and general distribution.

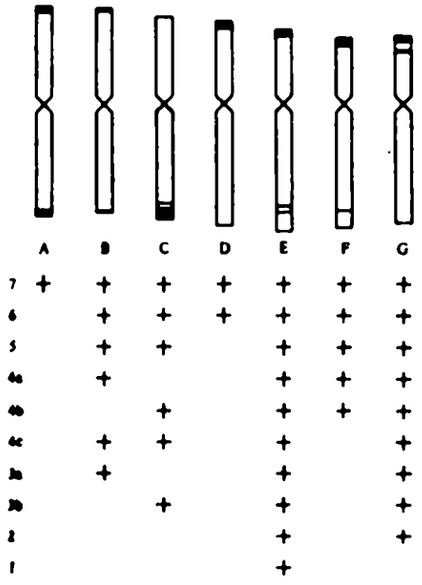


In worldwide trials at dozens of locations each year, triticale yields have climbed rapidly, and in 1974 exceeded yields of the wheat check varieties.

Fig. 1.5.1

CYTOLOGICAL RESEARCH ON THE IDENTIFICATION OF CHROMOSOMES IN TRITICALE AT CIMMYT

A. Merker



Identification of rye chromosomes in the complements of type strains of triticale.

The chromosomes of Armadillo stained with a modified Giemsa stain.

FIG. 1.5.2

RELATIVE YIELDS OF THE TOP FIVE TRITICALE STRAINS COMPARED TO THE TOP WHEAT CHECK AT ALL LOCATIONS IN THE INTERNATIONAL TRITICALE YIELD NURSERY

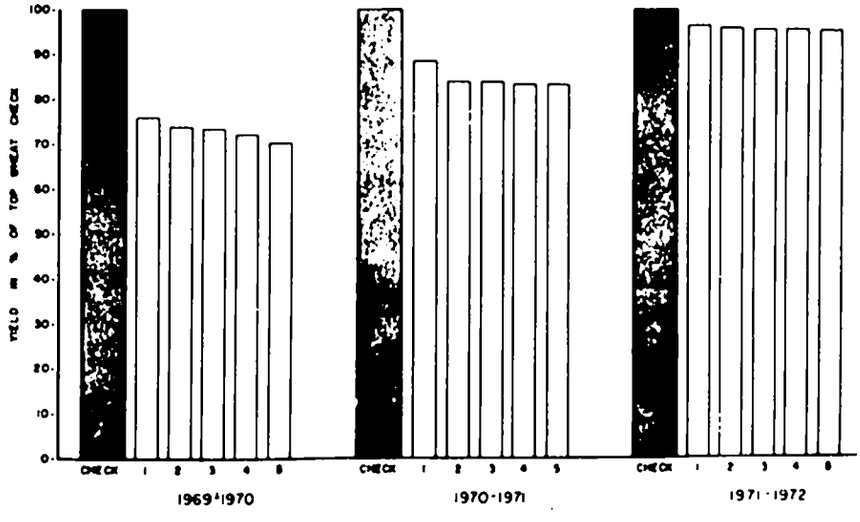


FIG. 1.5.3

THE AVERAGE RELATIVE YIELDS OF TRITICALE AND DURUMS AS A PERCENT OF PITIC BREAD WHEAT CHECK IN THE INTERNATIONAL TRITICALE YIELD NURSERIES 1969-70 TO 1973-74

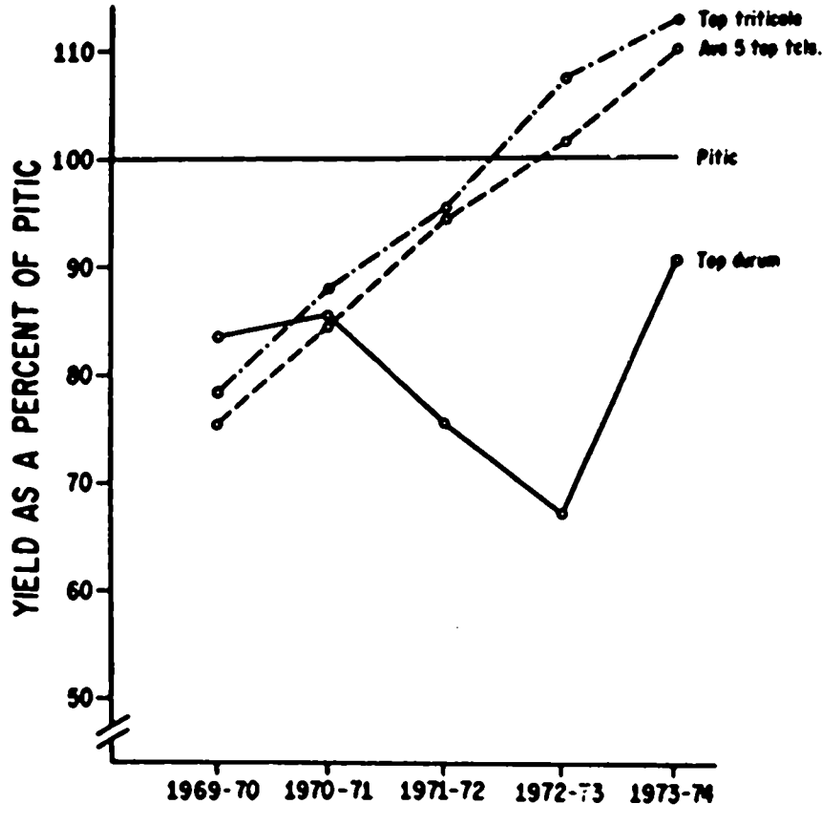


FIG. 1.5.4

GRAIN YIELD VS PERCENT PROTEIN IN TRITICALES AT CIMMYT 1967-1973

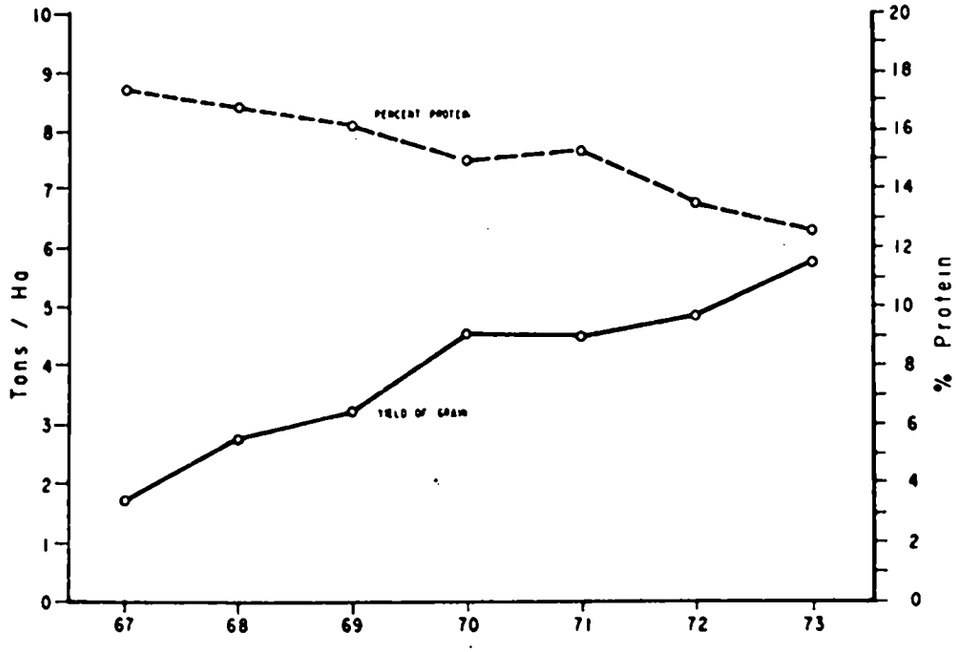


Table 1.5.A YIELDS OF TRITICALES VS WHEAT CHECKS IN ADVANCED YIELD TRIALS AT CIMMYT

Location & year	Triticales Yield in kg/ha Ave	Triticales Yield in kg/ha Top strain	Wheat checks Yield in kg/ha Ave	Wheat checks Yield in kg/ha Top check
		SONORA NURSERIES (Winter)		
CIANO 1967-68	2663	3196	4213	5207
CIANO 1969-70	4492	4990	5417	6202
NAVOJOA 1969-70	5066	6282	5321	6491
NAVOJOA 1970-71	5250	6320	5950	6600
CIANO 1971-72	5237	5388	5432	6457
NAVOJOA 1971-72	5152	5443	4958	5339
CIANO 1972-73	5758	7371	6161	7204
CIANO 1973-74	6456*	7502	6956	7362
		MEXICO AREA NURSERIES (Summer)		
TOLUCA 1968	2691	3190	None included	
EL BATAN & TOLUCA 1969	3229	3972	3554	3645
EL BATAN & TOLUCA 1970	4117	4853	3737	4613
EL BATAN & TOLUCA 1971	3750	4590	3800	4610
TOLUCA 1972	4214	4738	4528	4669
MEXICO 1973**	4253	5198	3611	4566

* Average yield of Tcl checks in all expts.

** Average of entries at 3 locations: Toluca, El Batan and Huamantla

TABLE 1.5.B.- The development of new primary Triticales at CIMMYT 1973-74.

Cycle	Hexaploids: Embryos excised	Hexaploids: Number of crosses Represented	Hexaploids: Number of crosses Doubled	Octoploids: Number of crosses Treated	Octoploids: Number of crosses Doubled
CIANO 1973	1900	176	36(1200)*	-	-
El Batan 1973	2100	205	64(2000)*	159	31
CIANO 1974	2050	206		158(400)**	

* 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 seeds produced.

Table 1.5.C Yields in kg/ha of Triticale strains and wheat checks in advanced yield tests at CIANO 1973-74.

Expt. No.	Cinnamon	Cocorit	Siete Cerros or Cj- 71	Best new Wheat strain	Top Triticale strain	Ave. Top 5 tcls.
I	5921	6632	6538	6659	6876	6744
II	6274	6654	6002	6387	7163	6735
III	6610	7232	6180	6896	7123	7021
IV	6689	7835	6807	8070	7958	7606
V	6877	7716	7015	7074	7291	7165
VI	624	7499	6237	6768	6901	6778
VII	6170	7133	6939	5513	7894	7336
VIII	5839	6659	6182	5597	7017	6776
IX	5903	6763	6877	7336	6975	6851
X	6204	7055	6415	6770	7333	7025
XI	6536	7593	7385	7180	7240	7127
XII	6321	6516	6276	6550	7674	6981
XIII	6360	6857	6508	6864	7829	7244
XIV	6812	7709	6820	5711	7405	7320
XV	6839	7543	7506	7699	8111	7887
XVI	6686	7768	6642	7086	7659	7351
XVII	6378	7514	6610	6783	8176	7611
XVIII	6849	7442	6585	7014	7813	7291
XIX	6713	7724	7262	5864	8062	7748
XX	6550	7420	6462	7499	7558	7391
XXI	6276	7603	6558	6985	7393	7266
XXII	6867	7750	7237	7427	7492	7381
XXIII	6526	7519	7146	7279	7603	7400
TOTAL	14849	168196	154849	156998	172546	165135
AVE.	6456	7312	6732	6826	7502	7179

Summary. Triticale Expts CIANO 73-74
No. of Expts - 23
No. of entries per expt. 30
Total no. of entries - 690

Performance
Average yield of best wheat checks 7362 kg/ha
Average yield of 5 best triticale strains 7179 kg/ha
Average yield of best durum check (cocorit) 7312 kg/ha
Average yield of top triticale strain in each expt. 7502 kg/ha
Average yield of 3 wheat checks 6956 kg/ha

Table 1.5.D PERFORMANCE OF TRITICALE LINES IN INTERNATIONAL YIELD NURSERIES 1969-70 TO 1973-74.

	I ITYN	II ITYN	III ITYN	IV ITYN	V ITYN
No. of locations tested	38	17	26	28	28
% locations Tcl among top 5	11.3	13.8	16.3	25.0	25.9
Ave. No. locations Tcl beat best check	0.0082	0.0404	0.0585	0.0771	0.1129
Top wheat	3389.76	3810.82	3416.15	4093.00	4268.00
Pitic 62	3284.79	3718.31	3416.15	3460.40	7C4219.00
Top durum	2739.21	3176.81	2585.07	2324.10	3807.00
Top Tcl	2578.97	3272.87	3274.66	3715.61	4762.00
Av 5 top Tcl	2479.45	3127.01	3246.61	3517.30	4648.00

Table 1.5.E DISTRIBUTION OF TRITICALE NURSERIES AND SEED SAMPLES BY CONTINENTS

CIMMYT 1974

Continent	No. of nursery sets sent							
	Disease Resistance nursery	Crossing Block	ITYN	ITSN	F_2I	F_2D	Forage	S x W
Africa	2	4	16	18	4	5	6	1
Asia	2	5	11	17	6	6	1	3
Central America	0	0	1	1	1	0	0	0
Europe	1	1	13	14	4	3	2	9
Middle East	0	3	7	6	1	1	3	0
North America	1	5	18	14	6	6	11	11
Oceania	0	0	2	2	0	0	2	0
South America	3	6	9	18	5	8	4	5
Total	9	24	77	92	27	29	30	29

* F_2I = F_2 for irrigated areas

** F_2D = F_2 for drylands

Table 1.5.F Yield and test weight data of Triticale strains at CIANO and Toluca 1973.

GROUP I

Var. No.	Identity	CIANO 72-73 kg/ha	CIANO 72-73 kg/hl	Summer 1973 kg/ha	Summer 1973 kg/hl
312	X2BC2-3Bm-3m-7m-5m-0Y	8352	72.0	4356	57.7
307	X2BC2-3Bm-3m-6m-5m-0Y	8345	71.8	4467	60.8
312	X1648-2m-0M	8046	69.5	3862	57.7
308	X2BC2-3Bm-3m-6m-6m-0Y	8037	72.4	4475	60.9
724	X2BC2-3Bm-2m-6m-3m-0Y	8017	70.5	3378	57.1
519	X1648-2m-1m-0Y	7944	71.1	4017	57.0
321	X2BC2-3Bm-5m-8m-4m-0Y	7805	70.9	3799	56.4
316	X2BC2-3Bm-5m-6m-5m-0Y	7782	70.9	4498	57.1
506	X2148-1m-2m-0Y	7773	70.4	4914	58.8
317	X2BC2-3Bm-5m-6m-6m-0Y	7768	70.4	3860	56.0
504	X2148-1m-1m-0Y	7718	72.0	5288	58.2
406	X2BC2-7Cm-3m-1m-2m-0Y	7620	71.6	4763	58.6
318	X2BC2-3Bm-5m-8m-1m-0Y	7616	70.9	3695	55.5
407	X2BC2-7Sm-2m-7m-1m-0Y	7588	67.5	4651	56.2
309	X2BC2-3Bm-3m-6m-7m-0Y	7532	71.0	4158	59.2
	CJ-71	6802	81.4	3694	69.9
	7 Cerros	6614	81.4	3285	61.8
	Cocorit	6404	80.5	3174	66.0
	Arwis**	5637	69.9	4254	61.2
	Jori	4735	81.2	1767	63.8
	Cinnamon	-	-	4414	61.0

GROUP II

322	X2BC2-4Am-1m-5m-[illegible]	7162	68.2	5944	57.5
414	X2B32-24m-3m-7m-4m-0Y	7282	70.8	5198	59.2
511	X2BC2-4Am-1m-1m-1m-0Y	7[illegible]	67.5	4800	59.1
207	X2B32-24m-7m-2m-0M	7129	70.0	4589	58.1
301	X2BC2-1m-2m-3m-5m-0Y	7208	67.6	4543	56.6

GROUP III

306	X2BC2-3Bm-3m-6m-4m-0Y	7416	71.6	4434	62.8
311	X2BC2-3Bm-3m-6m-8m-0Y	7273	71.1	4361	61.9
412	X2144-12m-4m-2m-1m-0Y	7079	72.8	4307	61.7
414	X2B32-24m-3m-7m-4m-0Y	7282	70.8	5198	59.2
511	X2BC2-4Am-1m-1m-1m-0Y	7083	67.5	4800	59.1
313	X2BC2-3Bm-5m-5m-3m-0Y	7046	71.7	4260	59.1

Table 1.5.G Paired lines of triticale with differing levels of protein and similar levels of lysine 1973-74.

	Y73-74 CB	Protein % (Nx5.7)	Lysine % in protein
No.	154	14.0	4.0
	165	10.5	4.2
	162	13.8	3.6
	168	11.7	3.6
	161	10.2	3.2
	171	13.6	3.3

Table 1.5.H YIELDING ABILITY OF SOME NEW TRITICALE LINES DURING Y1973-74.

Tcl Line	Rank	kg/ha	Kg/hl	wheat check	kg/ha	kg/hl
BACUM	2	6832	71.8	Jupateco	6659	82.9
	8	7494	72.5	Jupateco	7699	83.2
	2	7625	71.4	Cocorit	7442	81.2
	2	7758	72.1	Cocorit	7724	81.3
	1	7603	71.1	Cocorit	7519	81.3
	Average	7462	71.8		7409	82.0
YOREME	4	6671	71.2	Jupateco	6659	82.9
	3	7287	71.5	Cocorit	7716	80.9
	1	7558	73.3	Jupateco	7499	83.6
	5	7242	72.0	Cocorit	7603	81.6
	2	7492	72.4	Cocorit	7790	80.7
	Average	7250	72.1		7453	81.9
RAHUM	3	6738	71.2	Cocorit	6654	81.5
	1	7017	73.5	Cocorit	6659	82.3
	2	7558	73.0	Cocorit	7788	81.6
	1	8062	72.7	Cocorit	7724	81.3
	9	7015	72.6	Jupateco	7499	83.6
	Average	7278	72.6		7265	82.1
RAHUM"S"	2	6788	71.0	Cocorit	6654	81.5
	2	6975	71.9	Jupateco	7336	83.7
	5	7679	72.2	Cocorit	7724	81.3
	3	7390	71.9	Cocorit	7519	81.2
	Average	7208	71.8		7308	81.9
NAVOJOA	3	6703	72.5	Jupateco	6659	82.9
	6	7578	72.0	Jupateco	8072	83.3
	3	7227	73.0	Cocorit	7133	81.3
	9	7138	73.5	Cocorit	7724	81.3
	5	7289	72.2	Cocorit	7790	80.7
	2	7519	73.4	Cocorit	7519	81.2
	Average	7242	72 8		7483	81.8
NAVOJOA"S"	6	6639	71.9	Jupateco	6659	82.9
	4	7089	71.2	Cocorit	7232	80.6
	2	7840	72 4	Cocorit	7514	81.5
	12	7114	72.3	Cocorit	7724	81.3
	5	7259	71.1	Jupateco	7499	83.6
	6	7257	71.8	Cocorit	7790	80.7
	Average	7200	71.8		7403	81.8
ARABIAN	4	7086	69.5	(HK-38MAxRfn^2 908/Fn)Yr	6854	83.8
	4	7714	73.6	Cocorit	7724	81.3
	Average	7400	71.6		7289	82.2
GRAND	AVERAGE	7241	72.1		7373	82.0

Table 1.5.I Visual performance of wheat and triticale strains growing under rainfed conditions in the high altitude states of Mexico.

	Navojoa PM 308	Yoreme PM 312	Bacum PM 414	Rahum PM 504	Cleopatra	Zacatecas	Toluca	Chapingo	Inia 66	Bajio 67	LR 64	Cajeme 71
Tornacuxtla, Hgo.	*	**		**	*	*	-	-				
Pachuca, Hgo.	*	*		*	*	*	-	*				
Palmar de Bravo, Pue.	*	**	*	**	*	-	-	*				
Patzcuaro, Mich.	-	-	-	*	**	**	-	*				
La Batea, Mich.	*	**		**								
Nochixtlan, Oax.	*	**		**	*	*	-	*				-
La Rodura, Chis.		*		*					-	-	-	
Sta. Rita, Chis.									-			
Juncana, Chis.	**	**		**					-	-	-	
El Triunfo, Chis	*	**		**					-	-	-	
Nueva Primavera, Chis.	*	*		**					-			

Note: Before Anthesis

1.6 Agronomy

1.6.1 INTRODUCTION

The agronomy program operated during both the winter and summer cycles of 1973-74-- during the winter cycle, under irrigated conditions at CIANO Cd. Obregon Sonora; and at the Toluca and El Batan stations during the summer, with rainfall.

Development of agronomic practices for triticale was emphasized during the winter cycle, whereas herbicide work was emphasized during the summer season.

Agronomic practices were evaluated for triticale using the newest and highest yielding lines from the breeding program. These experiments included tests of: nitrogen response, depth of seeding, spacing and density, as well as response to herbicide treatments. A number of on-farm demonstrations of promising triticale lines were also conducted. In addition, triticale lines that showed promise as high forage producers were evaluated in forage cutting experiments.

1.6.2 ON-FARM DEMONSTRATIONS

Demonstrations were conducted during both cycles; in the Yaqui Valley, Sonora (winter cycle) and the Toluca Valley Mexico (summer cycle). The participating farmers showed considerable interest and these demonstrations will be continued as part of the agronomy program.

Five demonstrations were sown in the Yaqui Valley and four were harvested. Four demonstrations were conducted in the Toluca Valley, but none were harvested due to frosts on September 7 and 8 that caused severe leaf damage and sterility. The personnel of the Departamento de Agricultura y Ganadería del Estado de México (DAGEM) collaborated in the Toluca Valley demonstrations.

In the Yaqui Valley, the trials were sown and harvested by CIMMYT staff, but other aspects of management such as fertilization, irrigation, were left to the discretion of the individual farmer. Plots measured 1 drill-width by 50 m long, with two replications at each site. The results are shown in Table 1.6.A. One bread wheat, Yecora 70, and one durum wheat Cocorit 71(the most extensively grown commercial bread and durum wheat varieties, respectively) were included as checks. The tests were conducted across a range of environments that differed in yield potential, although all locations were under irrigation in the Yaqui Valley. The yield potential ranged from about 4.0 to 7.0 tons/ha. Except for one location (Maurer), all the new triticale genotypes (PM 312, PM 307, and PM 212) were competitive with the triple dwarf bread wheat Yecora 70. Yecora 70 covered 47 percent of the commercial wheat acreage sown to bread wheat in Northwestern Mexico in the 1973-74 growing season. Over all locations (with the exception of Maurer) the new triticales ranged from 92 percent to 105.4 percent of Yecora 70.

1.6.3 NITROGEN TRIAL

Selected triticale, bread wheat and durum lines were tested for response to varying doses of nitrogen at CIANO, 1973-74. Seven triticales, three bread wheats and two durum lines were tested. The yield results are shown in Table 1.6.B.

Table 1.6.B shows that at 0 kg/ha N the triticales, except for Cinnamon, showed much higher yields than either the bread wheats or the durums. Triticale yields at 0 kg/ha N ranged from 3000 kg/ha for Cinnamon to 4420 kg/ha for DR-44 while bread wheat yields ranged from 2200 kg/ha to 3250 kg/ha. Stork and Cocorit, both durum wheats, yielded 3290 and 3350 kg/ha at 0 kg/ha N. The superiority of triticale at the 0 kg/ha N level may be due to their deeper root system which allows them to exploit leached N deep in the soil. However there is no proof of this hypothesis at present. Root and nitrate distribution in the soil profile will be investigated during the 1974-75 season to clarify these points.

In this trial, most varieties reached a maximum yield at 150 kg/ha N. Only two varieties had significantly better yields at 225 kg/ha N than at 150 kg/ha N ; these were Stork, a durum wheat; and Beagle, a triticale, which yielded 7850 kg/ha and 8680 kg/ha, respectively. Beagle has the highest yield recorded for a triticale at CIANO, to date. Yecora, the most widely used bread wheat in Northwest Mexico during the 1973-74 season, yielded 7940 kg/ha at 225 kg/ha N.

1.6.4 UPTAKE EFFICIENCY OF NITROGEN FERTILIZER

Within the past year, there has been world-wide concern about the efficiency of fertilizer usage, particularly Nitrogen, as a result of current increases in petroleum prices and the concurrent increase in nitrogenous fertilizer prices on the world market. The days of cheap fertilizer may well be at an end; thus greater care must be taken to increase the efficiency of use of this input in crop production, due to its increased cost.

Nitrogen recovery was calculated for the above trial and Table 1.6.C shows the data for the 75 kg N level. Also shown are N uptake (kg/ha) data for the 0 kg/ha N rate and 75 kg/ha N level. Nitrogen recovery was calculated as follows:

$$\text{Percent recovery} = \frac{NP - No}{Nf} \times 100$$

where Np = N uptake (kg/ha) at specified nitrogen application

No = N uptake (kg/ha) at 0 kg/ha N rate.

Nf = Amount of fertilizer N applied

As can be seen from Table 1.6.C there are great differences between genotypes in percent recovery of N. However, this is not so much a genotypic difference as a yield level difference; i.e. as yield increases, percent recovery drops off. For example, DR-44 and PM 212 are both high yielders at 0 kg/ha N but have low recovery rates at 75 kg/ha N. Therefore, this type of test reveals little in terms of genotypic differences in uptake.

The most spectacular feature of Table 1.6.C is the high percentage recovery of N which ranges from 64.4 to 106.3 percent. The usual recovery rates reported in the literature range from 30 to 70 percent. Therefore, these recovery rates are of doubtful validity. The high rates may be due to stimulated root growth as a result of N applicatin; with the roots then exploring N sources deeper in the soil profile. As a result we could be measuring additional native soil N as fertilizer N in this calculation, thus reflecting spurious results. More refined methods are needed to determine N use efficiency in this type of environment. Nitrogen uptake as 0 kg/ha N as shown in Table 1.6.C may help explain the superior yields of some triticales, as compared with bread wheats and durum (especially in the case of DR-44 and PM 212, which absorbed 77.6 and 71.8 kg/ha N respectively but they would appear to be incapable of using additional N effectively).

1.6.5 SPACING AND DENSITY

New triticale lines were tested for response to spacing and density factors, with Yecora 70, a triple-dwarf bread wheat, used as check. The yield results are presented in Table 1.6.D. Results from Yecora are not included: this variety was hit heavily by stripe rust, thus nullifying yield results. The highest yield for Cinnamon was at 40 kg/ha sowing density x 30 cm spacing. This was significantly higher than the yields from all densities at the 45 cm spacing, and all spacings at the 160 kg/ha sowing density. It was also significantly higher than the yield from the 80 kg density x 15 cm spacing. The low yields at the 160 kg/ha density are thought to be due to lodging. In all three varieties, there was a consistent increase in yield as spacing increased from 15 cm to the 45 cm at the 160 kg/ha sowing density. Lodging was intensified for all three varieties as row space narrowed at the 160 kg/ha density. The lowest yields recorded for Cinnamon and PM 312 were at the 160 kg/ha x 15 cm treatment.

PM 212 yielded best with the 80 kg/ha x 30 cm treatment; significantly higher than the yields with 15 and 30 cm spacing at 40 kg/ha. This probably resulted from an inadequate plant population for this variety at the low density. It was also significantly higher than 160 kg/ha x 15 cm treatment; again this result is thought to be due to lodging in the latter treatment.

PM 312 yielded best at the 160 kg/ha x 45 cm treatment; significantly higher than the 160 kg/ha x 15 cm treatment where lodging was again a factor.

In summary, triticale yields were little affected by a wide range of spacing and seeding densities; except (1) where high seed densities and narrow spacings lead to lodging and (2) where low seeding rates were combined with poor emergence -- these factors produced decreased yields.

1.6.6 DEPTH OF SEEDING OF TRITICALES AND WHEATS

Depth of seeding is an important production factor since it affects plant emergence and the establishment of a satisfactory plant stand, a first prerequisite in crop production. Under dryland conditions the seed often has to be placed deep in moisture for germination, thus seeding depth is of special importance.

Research has shown that emergence of deeply sown dwarf wheat is inferior to that of the tall varieties, due to shorter coleoptile length. Very little is known about field emergence of triticales, thus a depth of seeding experiment was established during the winter season of 1973-74. This experiment (Table 1.6.E) used wheat varieties Yaqui 50 and Yecora 70, with heights of 115 cm and 75 cm, respectively; and three triticale lines PM 212, PM 307 and PM 312, with heights of 95, 100 and 95 cms, respectively.

Table 1.6.E shows a remarkable drop-off in emergence of the triticale lines and the dwarf wheat, Yecora, as compared with the older tall variety, Yaqui 50, at depths greater than 6 cms. For example, at the 9 cm depth, Yaqui 50 shows 90.8 percent emergence, whereas Yecora has 75.0 percent. The triticale lines range from 67.4 to 79.0 percent emergence.

This information has important connotations for dryland wheat farming where seeds very often must be placed deeply into moisture to insure germination. These new triticale lines behave much like the dwarf wheats in terms of emergence under field conditions, a factor to consider when planting triticales under different conditions so as to insure good plant stands.

1.6.7 HERBICIDE TRIALS (Y73-74)

Phytotoxicity studies tested two herbicides, Tribunil and Dosanex, to determine their effect on the yield of bread wheat, durums and triticales. Tribunil interests the CIMMYT program because it shows good promise of controlling the weed spectrum encountered in the summer nurseries in Mexico. Dosanex also was tested because of its reported control of a wide range of grass and broad leaf weeds, and because of its success under experimental conditions in the wheat growing areas of North Africa.

1.6.7.1 Dosanex

Table 1.6.E shows the results of the Dosanex experiment; yields for Yecora are not included because of a stripe rust attack which invalidates its yields. There was a consistent decrease in yield as rates were increased and with later applications. The lowest yields recorded were for the 4 kg/ha a.i. application at the late tiller stage, a treatment that yielded significantly less than the weeded control in both varieties. The corresponding dosage at the five leaf stage also depressed the yield of Cocorit significantly, as compared to the weeded control.

Table 1.6.G shows the phytotoxicity readings, which were taken when it was thought the herbicide had achieved its maximum effect. These readings are based on a scale of 0 to 10; (0= no dead plants and 10= total kill). In all treatments, except with the 2 kg/ha a.i. at the five leaf stage of application, phytotoxicity had an adverse effect on yield; phytotoxicity increased with late applications and with increasing doses. Yecora had the highest phytotoxicity readings, followed by those of Cinnamon and Cocorit.

In summary, it can be said that grain yields were affected adversely by the levels of phytotoxicity resulting from applications of Dosanex at above 2 kg/ ha a.i. at the five leaf stage. The method of application may have had an effect on the amount of phytotoxicity produced. Irrigation water was applied immediately after each application, which probably insured good root absorption, plus good leaf absorption; therefore, maximum herbicidal effect.

1.6.7.2 Tribunil

Tribunil also was tested to determine (1) the phytotoxicity produced by of different rates at different dates of application on bread wheat, durum and triticale and (2) the subsequent effect on yields (Table 1.6.H). Again the yields of Yecora are deleted due to a stripe rust attack. The phytotoxicity data are shown in Table 1.6.I.

Yields of Cinnamon and Cocorit were not adversely affected affected by the Tribunil applications (Table 1.6.H) although some phytotoxicity was encountered (Table 1.6.I). However, the plants seemed to be able to recover from the initial phytotoxicity and produced normal yields. Cocorit is the most sensitive to the herbicide followed by Cinnamon and Yecora; all three crops are most sensitive from the 2 1/2 to 3 1/2 leaf stage.

1.6.8 HERBICIDE TRIALS (SUMMER CYCLES)

Broad leaf weed control was emphasized during the summer cycle trials. A wide range of herbicides was tested, at both Toluca and El Batan. Notes were taken on weed control and phytotoxicity at the appropriate times and are reported here, but yield data was not recorded because frosts on Sept. 7 and 8 badly affected the plots. All treatments applied are not reported; only those showing the most promising performance or other unusually interesting features. Herbicides tested included, Tribunil, Dosanex, Bromoxynil, 2,4-D, Diuron, Linuron, Maloran, Sencor, Tok E-25, and Dinitro (DNBP amino salt). The weed species found at the Toluca nursery were: Brssica spp (Wild Mustard) Malve spp (Mallow) Cucumis spp (Wild Cucumber) Commelina spp, Galinsoga spp and one grass species, Poa annua (Annual Bluegrass). Weeds present in the El Batan nursery were Helianthus spp (sunflower) Ipomoea spp (morning glory), Amaranthus spp (Pigweed) and Galinsoga spp.

There is a very heavy natural infestation of weeds in both places and nonweeded plots always give zero yield due to weed competition. To illustrate the intensity of infestation, a competition study was carried out at both locations during the past season, with weeds removed from the crop at various intervals during the growing season. At the Toluca station, weeds yielded 4240 kg/ha dry matter approximately two months after emergence while the weed yield at the El Batan station was 2550 kg/ha dry matter about seven weeks post-emergence. Because of this extremely heavy infestation it is essential that a herbicide be applied to the breeding nurseries early in the season, over a wide germplasm pool, with minimal phytotoxic effect and providing good control of the weed spectrum encountered. The herbicide 2,4-D is effective against most of the weeds encountered in Toluca and El Batan, except for Pao annua in the Toluca station. However late application of 2,4-D may cause ear distortion in some lines due to the wide range of germplasm found in the nurseries. Such ear distortion makes selection very difficult, later on in the season. Dinitro is now being used as a preemerge herbicide. Later germinating weeds are controlled by hand cultivation, which is a major expense.

All of the herbicides mentioned above have been tested in date and rate studies; yield data is not available, but many experiments showed promisingly low phytotoxicity and good weed control. An unreplicated screening trial also was conducted at the Toluca nursery, using 30 barley lines, 50 triticales, 50 durums and 100 bread wheats in a test of six herbicide treatments that have shown promise for use in the CIMMYT nurseries. Two checks (untreated plots) were included for each line. Readings were taken on chlorosis, suppression of growth and proportion of dead plants for each line and treatment. These readings were on a 0 to 10 scale (0 = no dead plants; 10 = total kill of plants). Checks were included every twenty plots; these were: PM 312 (triticale), Yecora 70 (a bread wheat, and Cocorit 71 (a durum wheat). The herbicide treatments were:

Treatment 1: 7 1/2 kg/ha (commercial product) TOK E-25 premerge plus 1 kg/ha a.i. Tribunil, 23 days postemerge (5 leaf stage of wheat)

Treatment 2: 1 kg/ha a.i. Tribunil, 5 days postemerge (1-1 1/2 leaf stage of wheat)

Treatment 3: 0.375 kg/ha a.i. Bromoxynil 15 days postemerge (3 1/2-4 leaf stage of wheat) plus 2 kg/ha a.i. Dosanex 32 days postemerge (6-7 tillers of wheat)

Treatment 4: 2 kg/ha a.i. Tribunil, 19 days postemerge (4 1/2 leaf stage of wheat)

Treatment 5: 4 kg/ha a.i. Dosanex, 21 days postemerge (5 leaf stage of wheat)

Treatment 6: 2 kg/ha a.i. Dosanex plus 0.25 kg/ha a.i. Bromoxynil, (Tank mix) 30 days postemerge (6-7 tillers stage of wheat).

1.6.9 EVALUATION OF SCREENING TRIAL

1.6.9.1 Treatment 1: TOK E-25 and Tribunil

Phytotoxicity readings were not taken on this treatment because the TOK E-25 was applied late and some lines were still emerging. Therefore, any reduction in stand in one line over another was primarily due to a differential in time of emergence. However, there was no control of wild mustard (Brassica spp) by the TOK E-25 application. Tribunil was applied 23 days later and this gave good control of the wild mustard despite the fact that the weed was about 30 cm tall when this latter dose was applied. There was excellent control of annual bluegrass (Poa annua). Perhaps a tank mix of TOK E-25 and Tribunil applied as a preemrge treatment at these rates would give good weed control in these circumstances although the persistence of this mixture is very much in doubt according to data from other experiments.

1.6.9.2 Treatment 2: 1 kg/ha a.i. tribunal , 5 days post emerge (1-1 1/2 leaves of wheat)

This treatment caused growth suppression in most of the barley lines; quite severe in some lines (readings as high as 6.) The average suppression for all barley lines was 2.4. No dead plants were recorded and very little chlorosis noted. There was, however, some suppression of growth in a number of triticale lines, although much less than that in barley. The triticales' highest recorded score was 4 (which occured only once); the average suppression score was 0.70 for the fifty triticale lines. Again no dead plants or chlorosis were recorded.

Suppression was more severe in the durums, more lines were affected and two lines had scores of 4 and 5. The average suppression score was 1.10 for the fifty lines. No dead plants or chlorosis were recorded.

Suppression was very light in the bread wheats: most scores were 1 and 2, with an overall average suppression score of 0.5. No dead plants or chlorosis were recorded.

Weed control was excellent, initially, but wild cucumber (Cucumis spp) and Galinsoga spp begon to come back about mid-August (two months after application). There was very good consistent control of Poa annua.

Treatment 2 can be recommended strongly for use on a wide variety of bread wheats; however, more research is needed on triticale and durum wheats because of growth suppression shown in some lines. It cannot be recommended for barleys; suppression was strong and consistent across all lines in ths crop.

1.6.9.3 Treatment 3: 0.375 kg/ha a.i. Bromoxynil, 15 days postemerge (3 1/2-4 leaf stage of wheat), pluts 2 kg/ha a.i. Dosanex, 32 days postemerge (6-7 tillers of wheat)

The Dosanex was applied later in this treatment to control Malva spp, which Bromoxynil did not kill;Bromoxynil also gave no control of Poa annua; it provided only partial control of wild mustard, which may have been too advanced in vegetative development (30 cm tall) when Bromoxynil was applied. The Dosanex treatment stunted the Malva spp and prevented its further germination. Dosanex did not control Poa annua at this stage but this weed may have been covered by Malva spp, with its leaves thus escaping application of the herbicide. No chlorosis, suppression or dead plants were recorded in any line of any crop as a result of Bromoxynil application.

Because of its low phytotoxic effects, Bromoxynil deserves further study. Earlier application, when weeds are smaller, may lead to better control of Malva spp. and wild mustard. Poa annua remains a problem in the Toluca nursery.

1.6.9.4 Treatment 4: 2 kg/ha a.i. Tribunil, 19 days postmerge (4 1/2 leaf stage of wheat. This treatment caused severe chlorosis and growth suppression in barley, triticale and durums but the effect was less in bread wheats (Table 1.6.K). Two durum lines recorded dead plant scores of 1.

Because of the constant growth suppression and chlorosis, treatment 4 could not be recommended for barleys, triticales or durums, and would be marginal for bread wheats due to suppression in some lines.

The treatment gave excellent weed control that persisted throughout the season.

1.6.9.5 Treatment 5: 4kg/ha a.i. Dosanex, 21 days postemerge, (5 leaf stage of wheat)

This treatment did not cause chlorosis in any of the crops, nor were any dead plants recorded. Suppression was recorded, but was very light: average scores were 0.4, 0.4, 0.2 and 0.1 for barley, triticale, durum and bread wheats, respectively. Dosanex seems to be very attractive as a herbicide for a wide range of germplasm due to its low phytotoxicity. This treatment gave poor control of wild mustard, when applied on 40 mm high weeds. Poa annua control may be due to the fact that this weed was covered by larger weeds and the herbicide did not contact its leaves. Apparently it is very important that Dosanex comes in contact with the leaves of the weeds, a finding that received support in two experiments at Toluca during the summer of 1974. In separate experiment that received 4 kg/ha a.i. of Dosanex on June 15th (19 days postemerge), there was very poor weed control, although satisfactory control had been expected. This application was followed by a very heavy rainstorm, and it is thought that the poor control maybe due to the fact that Dosanex was washed off the leaves, thus reducing leaf absorption. In the screening trial, Dosanex (applied alone after a Bromoxynil) stunted the growth of Malva spp and prevented further emergen· of this weed. However, Dosanex applied in combination with Bromoxynil had little effect on the Malva spp: An effect that may have resulted from the Malva spp being covered by the wild cucumber

and wild mustard, thus not touched by the herbicide. In the treatment with later applications of Dosanex, the wild cucumber had been removed earlier by the Bromoxynil treatment, thus the Malva spp was left. Phytotoxicity had an adverse effect on yield; phytotoxicity increased with late applications and with increasing doses. Yecora had the highest phytotoxicity readings, followed by those of Cinnamon and Cocorit.

1.6.10 FORAGE TRIAL

In this trial, the forage producing ability of some leafy triticale lines was tested against that of oat, barley and wheat lines. Table 1.6.J shows some of the results; each variety was subjected to three cutting treatments: no cut, one cut and two cuts; plots from each of these three cutting treatments were harvested for grain for all varieties, the first cut was taken when the first node was at ground level, and the second cut was made approximately twenty days later. The best triticale line (S.14MV73) yielded 3569 kg/ha of dry matter forage from two cuts, and when subsequently allowed to go to maturity yielded 3078 kg/ha of grain. This line yielded a total of 1075 kg/ha of protein in the two cuts of forage. Another line, S.11, had a good combination of grain and forage with 4587 kg/ha grain and 3148 kg/ha forage, after two cuts. The barley, oat and wheat lines were much lower in protein yield of forage per hectare. The barley recovered well from cutting, yielding 3636 kg/ha of grain after two cuttings. The low grain yields of Pitic 62 at zero cutting was due to a high infestation of stripe rust on this variety.

1.6.11 DATE AND RATE STUDIES

Table 1.6.L shows weed control data for different rates of Dosanex applied at different dates in trials at Toluca; phytotoxicity data for these treatments are shown in Table 1.6.M. These data cover the varieties from the three crops used for testing; PM312 (triticale) Yecora 70 (bread wheat), Cocorit (durum). Treatments numbers are the same for both tables.

Table 1.6.L shows that weed control with a 2 kg/ha application of Dosanex is almost as good as the 4 kg/ha rate. This control coupled with a lower suppression rating (Table 1.6.M) should make it a more acceptable level for use under these conditions. Weed control is lower at the $4\frac{1}{2}$-5 leaf application date; a result thought to be due to the herbicide washing off the leaves, as this application was followed by heavy rainfall. All three crops are less sensitive as they get older (Table 1.6.M). In fact, the 2 kg/ha rate at 7-8 tiller stage seems to be ideal: good weed control combined with zero growth suppression.

Tribunil and Bromoxynil were combined with treatments 1-6 (separate applications of both herbicides). However, these treatments were not needed as Dosanex alone controlled all weeds and persisted throughout the season.

An experiment similar to that discussed above was conducted in El Batan, with similar findings for phytotoxicity. Table 1.6.N shows the results in controlling the different weeds found at El Batan. Again there was excellent weed control; except with treatments 5 and 6, which were followed by rainfall. An application of 2 kg/ha also seems adequate for good control at this location.

Table 1.6.O shows weed control data for different rates and dates of application of Tribunil in Toluca; phytotoxicity data for these treatments are found in Table 1.6.P. The 1 kg/ha of Tribunil rate is almost as good as the 2 kg/ha rate and it is much more acceptable as its phytotoxicity is considerably less. The 1 kg/ha Tribunil rate at the 5 leaf stage gives relatively poor weed control, particularly on Malva spp. Chlorosis, growth suppression and dead plants were given zero ratings for these treatment, thus there must have been some interference with herbicidal activity at this date. This is thought to be an environmental effect, rather than any resistance on the part of the weeds. However, Malva spp showed resistance to the herbicide earlier than the other weeds, and it took an application of 2 kg/ha to achieve satisfactory control (90%) at the 7-8 tiller stage. Applications at $2\frac{1}{2}$-3 leaf stage of wheat gave excellent weed control. However, this control was coupled with high chlorosis and growth suppression ratings in Cocorit (Durum) --such levels of phytotoxicity are unacceptable. Yecora (bread wheat) was extremely resistant over a wide time range, whereas PM312 (triticale) had intermediate resistance. The $2\frac{1}{2}$-3 leaf and 5 leaf applications of Tribunil were combined with 0.25 kg/ha a.i. application of Bromoxynil at jointing. This additional application of Bromoxynil caused no phytotoxicity, but weed control improved to acceptable levels (from 81% to 96% overall control) when Bromoxynil was used in conjunction with 1 kg/ha a.i. Tribunil (5 leaf stage), which had shown poor weed control on its own. Therefore, if early applications of Tribunil should fail, it can be coupled safely with a later application of Bromoxynil for satisfactory weed control.

Other noteworthy treatment included preemergence applications of Tribunil, coupled with a treatment of Bromoxynil applied at jointing. Past experience had indicated that, preemergence application of Tribunil under these conditions did not cause phytotoxic effects, and weed populations were reduced appreciably, although not to an acceptable level. This reduction of weeds, however, allows a favorable environment for crop growth in the initial stages. Thus, a postemergence herbicide with zero phytotoxic effects coupled with this Tribunil preemerge treatment would be desirable; Table 1.6.Q shows the results of such a combination. There was poor control at the 1 kg/ha a.i. rate of Tribunil plus Bromoxynil, but excellent control when Bromoxylin was combined with 2 kg/ha a.i. of Tribunil. Phytotoxic effects were not observed in either treatment. These combinations merit further research, particularly those with earlier applications of Bromoxynil.

Experiments similar to the above were conducted during the 1974 summer cycle at El Batan. The phytotoxicity effects of Tribunil are not as strong in El Batan as in Toluca; but the trends were the same, with Cocorit and PM 312 being more sensitive than Yecora. However, the 1 kg/ha a.i. of Tribunil seems much safer to use at all dates tested at this location. Weed control data for the El Batan location is presented in Table 1.6.R. Hellianthus Ipomoea and Amaranthus spp quickly became very resistant to Tribunil. Thus, in the El Batan environment where these weeds are found, early application of Tribunil are necessary for adequate control. In fact, Ipomoea spp (Morning glory) was quite resistant at all dates and rates. Preemerge applications of Tribunil (1 and 2 kg/ha a.i.), coupled with 0.25 kg/ha a.i. of Bromoxynil applied at jointing, improves Ipomoea spp control; but does not provide a satisfactory level of control.

Table 1.6.S shows weed control data for Bromoxynil at various rates and dates at El Batan. No phytotoxicity was recorded in any of the Bromoxynil treatments for e.i. there (bread wheat or durum). Weed control was excellent with the early applications; Ipomoea and Helianthus spp became somewhat resistant to the 0.25 kg/ha rate at the 6-6 1/2 leaf stage. Amaranthus spp showed resistance to the 0.25 kg/ha rat at all dates, and to the 0.5 kg/ha rate at the later date.

Table 1.6.T shows weed control results for Bromoxynil (0.25 kg/ha a.i.) combined in a tank mix with various other herbicides; phytotoxicity readings for this treatment are shown in Table 1.6.U.

All four treatments produced excellent weed control (Table 1.6.T) except where Amaranthus spp showed some resistance to the Tribunil and Bromoxynil mixture (75% control) Ipomoea spp also showed some resistance to that treatment (82% control). Only bread wheat and durum wheat were tested with these herbicides. Cocorit 71 (durum) showed great sensitivity to the Tribunil treatment; the Diuron plus Bromoxynil treatment produced the most severe symptoms. Such severity precludes its consideration as a feasible treatment this treatment killed some plants in the Cocorit plot.

Again, some of these mixtures showed promise for use over a wide range of germ plasm, thus merit further experimentation regarding timing and dosage.

As mentioned earlier Dinitro (DNBP amonio salt) applied preemerge is the herbicide most commonly used in the CIMMYT nursery. This herbicide was tested in a separate experiment in Toluca, along with TOK E-25 (also applied preemerge). Table 1.6.V shows the emergence data for each of the crops tested. TOK E-25 did not affect the emergence of Yecora 70 and slightly decreased the emergence of Cocorit 71, however, greatly reduced the emergence of the triticale PM 312 (to 73 per cent of the untreated check). Dinitro reduced emergence in all three crops at all three rates. The 10 lt/ha rate reduced emergence rates drastically: to 65 per cent for Yecora and to 48 per cent for both Cocorit 71 and PM 312. Dinitro is applied in the CIMMYT nursery by the following method:

Seeding is usually completed in the Toluca and El Batan nurseries by the end of May, before the onset of the rainy season, thus irrigation is necessary for germination. Dinitro is applied after the irrigation, before emergence.

For the experiment reported here sowing was not done until June 13th, when the rainy season had begun. It is thought that the rain took the Dinitro into the wheat seed zone, thus killing many of the germinating seeds. Therefore, this experiment does not indicate what happens when this herbicide is handled properly, however, it does point out Dinitro's limitations where weather is unpredictable (i.e. where rain is expected before emergence.)

All Dinitro treatments provided 100 per cent weed control; except on Poa annua, which was 90 per cent. This control continued through October 19th (when notes were taken.) Weed control of TOK E-25 was very unsatisfactory, with zero control of wild mustard. The wild mustard competed very vigorously with the wheat because of lack of competition from other weeds.

T.1.6.A Yield of four triticale lines, one bread wheat and one durum wheat under farm conditions (Y73-74)

Location and yield (kg/ha)

Variety	Miranda	% Yecora	Maurer	% Yecora	Karam	% Yecora	ITESM	% Yecora
Cinnamon	3548	86.6	5544	91.6	6366	90.6	5954	90.9
Yecora	4095	100.0	6051	100.0	7023	100.0	6546	100.0
Cocorit	3606	88.1	5173	85.5	7372	105.0	6922	105.7
P.M. 312	4318	105.4	4768	78.8	6993	99.6	6613	101.0
P.M. 307	4225	103.2	5453	90.1	7083	100.9	6529	99.7
P.M. 212	3974	97.0	5059	83.6	7117	101.3	6029	92.0
Average Location Yield (Kg/ha)								
	3959		5341		6992		6432	

T.1.6.B Yield (kg/ha) of selected triticale, bread wheat and durum lines at different levels of nitrogen (E601 Y73-74)

Variety	N LEVEL (kg/ha)			
	0	75	150	225
Yecora 70 (B.W.)	3250	5670	7700	7940
Cinnamon (Tcl)	3000	5460	5940	6970
Cocorit 71 (D)	3290	6280	7960	6670
PM 312 (Tcl)	3690	6250	6870	6740
PM 307 (Tcl)	3480	6290	7170	6250
PM 212 (Tcl)	3910	5410	6090	6630
PM 308 (Tcl)	3880	6100	7490	6920
Stork (D)	3350	6170	6530	7850
Torim (B.W.)	3050	6070	6970	6860
DR-44 (Tcl)	4420	6200	6560	5940
Fiserect 4A (B.W.)	2200	4660	6010	6040
Beagle (Tcl)	3590	5430	7080	8680

L.S.D. (0.50) witin N level = 1220 kg/ha

L.S.D. (0.05) within genotype = 1310 kg/ha.

T.1.6:C Per cent recovery of applied N at 75 kg/ha plus total uptake of N at 0N and 75 kg/ha N. Nitrogen trial (E601 Y73-74).

Variety	N_1	N_2	% recovery at 75 kg/ha N
Yecora 70	58.4	117.1	78.3
Cinnamon	58.8	138.5	106.3
Cocorit 71	59.9	119.5	79.5
PM 312	62.4	128.6	88.3
PM 307	61.3	137.4	101.5
PM 212	71.8	120.6	64.4
PM 308	61.8	137.7	101.2
Stork	55.2	115.8	80.8
Torim	57.4	127.2	93.1
DR-44	77.6	127.8	66.9
Fiserect 4A	48.5	99.0	67.3
Beagle	61.3	122.8	82.0

N_1 = N uptake (kg/ha) at 0N

N_2 = N uptake (kg/ha) at 75 N.

T.1.6.D Effect of Spacing and Density on yields of three triticale lines (E607 Y73-74).

Treatment	Yield (kg/ha) Cinnamon	PM 212	PM 312
40 kg x 15 cm	5880	5430	6360
40 kg x 15 cm	6590	5840	6570
40 kg x 45 cm	5640	6270	6460
80 kg x 15 cm	5720	5980	6870
80 kg x 30 cm	5830	6740	6620
80 kg x 45 cm	5790	6310	6680
160 kg x 15 cm	5040	5560	6130
160 kg x 30 cm	5720	6050	6290
160 kg x 45 cm	5790	6060	7090

L.S.D. 0.05 within genotypes = 790 kg/ha.

T.1.6.E Percentage emergence of two wheat varieties and three triticale lines sown at different depths.

Varieties	Height	Depth sown in cms. 3	6	9	12	15	Mean
Yecul 50	115	107.9	98.6	90.8	53.4	25.9	75.3 a*
Yecora 70	75	99.6	90.8	75.0	17.0	3.6	59.2 b
PM 212	95	86.0	82.9	67.4	27.9	10.5	54.9 b
PM 307	100	110.1	108.1	75.7	36.1	2.4	66.5 ab
PM 312	95	104.1	98.8	79.0	32.1	16.0	66.0 ab
Mean		101.5a	95.8a	77.6b	35.3c	11.7d	

* Means not followed by the same letter are significantly at the 5% probability level.

T.1.6.F Effect of Dosanex applied at different dates and rates on the yield (kg/ha of Cinnamon, Yecora and Cocorit (E602 Y73-74)

Treatment	DAE*	Cinnamon	Cocorit
Weeded control		6100	7220
2 kg/ha a.i. 5 leaf	29	6210	7570
4 kg/ha a.i. 5 leaf	29	5820	5600
2 kg/ha a.i. late tiller	41	5110	6430
4 kg/ha a.i. late tiller	41	4230	3800

* DAE = day after emergence

L.S.D. 0.05 (within genotype) = 1170 kg/ha.

T.1.6.G Phytotoxicity readings on Dosanex trial (E602 Y73-74)

Treatment	Cinnamon	Yecora	Cocorit
Weeded control	0	0	0
2 kg/ha a.i. 5 leaf	0.25	0.42	0.25
4 kg/ha a.i. 5 leaf	0.67	1.00	0.50
2 kg/ha a.i. late tiller	1.00	1.50	0.83
4 kg/ha a.i. late tiller	1.83	1.83	1.67

T.1.6.H Effect of Tribunil applied at different dates and rates on the yield (kg/ha) of Cinnamon, Yecora and Cocorit (E604 Y73-74)

Treatment	DAE*	Cinnamon	Cocorit
Handweeded Control		6540	7130
1 kg/ha a.i. at sowing		6360	7660
2 kg/ha a.i. at sowing		5600	7280
1 kg/ha a.i. at emergence		7010	7650
2 kg/ha a.i. at emergence		6720	7800
1 kg/ha a.i. at 2 1/2 leaf	12	6810	7860
2 kg/ha a.i. at 2 1/2	12	6260	8330
1 kg/ha a.i. at 3 1/2 leaf	20	6120	7070
2 kg/ha a.i. at 3 1/2 leaf	20	6190	7730
1 kg/ha a.i. at 5 leaf	27	6790	7400
2 kg/ha a.i. at 5 leaf	27	6430	7310

* DAE = days after emergence

T.1.6.I Phytotoxicity reading on Tribunil trial (E604 Y73-74)

Treatment	Cinnamon	Yecora	Cocorit
Handweeded Control	0	0	0
1 kg/ha a.i. at sowing	0	0	0
2 kg/ha a.i. at sowing	0	0	0.25
1 kg/ha a.i. at emergence	0	0.08	0.08
2 kg/ha a.i. at emergence	0	0	0.25
1 kg/ha a.i. at 2 1/2 leaf	0.17	0	0.17
2 kg/ha a.i. at 2 1/2 leaf	0.75	0.42	1.33
1 kg/ha a.i. at 3 1/2 leaf	0.08	0.08	0.08
2 kg/ha a.i. at 3 1/2 leaf	0.67	0.17	1.67
1 kg/ha a.i. at 5 leaf	0	0	0
2 kg/ha a.i. at 5 leaf	0	0	0.25

T.1.6.J Forage line performance

Variety	Cut	Grain Kg/Ha	Forage D.M. Kg/Ha	Total Forage yield Kg/Ha	% Protein in Forage	Protein yield in Forage Kg/Ha	Total protein in Forage Kg/Ha
S.14 MV-73 (Tcl)	0	4150					
	1	3101	2409		30.8	742.10	
	2	3478	1160	3569	28.7	333.0	
							1075.0
S.2. MV-73 (Tcl)	0	6224					
	1	4726	2222		31.4	698.0	
	2	3223	1161	3383	28.6	332.0	
							1030.0
S.8. MV-73 (Tcl)	0	3251					
	1	3226	2110		32.4	684.0	
	2	3262	1131	3241	30.1	340.0	
							1024.0
S.11 MV-73 (Tcl)	0	4103					
	1	3412	2051		32.1	658.0	
	2	4587	1097	3148	28.8	317.0	
							975.0
Apan (Barley)	0	4225					
	1	4481	1213		33.7	409.0	
	2	3636	1479	2692	29.0	429.0	
							838.0
Opale (Oats)	0	2550					
	1	2093	1444		31.9	461.0	
	2	785	1461	2905	27.3	399.0	
							860.0
Pitic 62 (Wheat)	0	3824					
	1	3034	1675		29.4	493.0	
	2	2472	961	2636	26.6	256.0	
							749.0

T.1.6.L Weed control (per cent control) by Dosanex applied at different dates and rates (a.i.) Toluca 1974.

Trt.No.	Rate (kg/ha a.i.)	Stage of Wheat	Weed control (per cent)					
			Brassica	Commelina	Cucumis	Poa	Malva	Galinsoga
1.	2	2 1/2 - 3 leaf	97	70	100	100	100	97
2.	4	2 1/2 - 3 leaf	92	83	100	100	100	95
3.	2	4 1/2 - 5 leaf	67	43	100	100	57	100
4.	4	4 1/2 - 5 leaf	57	82	100	100	82	100
5.	2	7 - 8 tillers	77	78	100	100	97	97
6.	4	7 - 8 tillers	100	90	100	100	97	100

T.1.6.K Average growth suppression and chlorosis scores for barley, triticale durum and bread wheat lines getting a herbicide treatment of 2 kg/ha a.i. of Tribunil at 19 days post emerge (4 1/2 leaf stage of wheat)

Crop	Growth Suppression	Chlorosis
Barley	4.6	1.7
Triticale	5.4	2.3
Durum	6.0	3.0
Bread Wheat	1.0	0

T.1.6.M Chlorosis, suppression and dead plant ratings on three crops receiving applications of Dosanex at different dates and rates. (Toluca 1974).

Variety	Treatment No.	Chlorosis	Suppression	Dead Plants.
Yecora 70	1	0	1.3	0
	2	0	1.3	0
	3	0	0	0
	4	0	0.7	0
	5	0	0	0
	6	1.0	1.0	0
Cocorit 71	1	0.3	1.0	0
	2	0.3	0.7	0
	3	0	0	0
	4	0	0.7	0
	5	0	0	0
	6	0	0	0
PM 312	1	0	1.3	0
	2	0	1.7	0
	3	0	1.0	0
	4	0	1.3	0
	5	0	0	0
	6	0	0.3	0

* Treatment numbers correspond to treatment numbers in Table 12.

T.1.6.M Weed control (per cent control) by Dosanex applied at different dates and rates (a.i.) El Batan 1974.

Trt.No.	Rate (kg/ha a.i.)	Stage of Wheat	Weed control (per cent)			
			Hellanthus	Ipomoea	Galinsoga	Amaranthus
1.	2	3 - 3 1/2 leaf	100	100	100	100
2.	4	3 - 3 1/2 leaf	100	100	100	100
3.	2	5 leaf	57	60	50	33
4.	4	5 leaf	80	100	80	53
5.	2	5 - 6 tillers	93	98	90	80
6.	4	5 - 6 tillers	100	100	95	90

T.1.6.P Chlorosis, suppression and dead plant ratings on three crops receiving applications of Tribunil at different dates and rates (Toluca 1974).

Variety	Treatment No.*	Chlorosis	Suppression	Dead Plants
Yecora 70	1	0	0	0
	2	0	0.3	0
	3	0	0	0
	4	0	0	0
	5	0	0	0
	6	0	0	0
Cocorit 71	1	1.3	2.0	0
	2	2.7	4.3	1.0
	3	0	0	0
	4	1.0	1.0	0
	5	1.0	0	0
	6	2.0	2.0	0
PM 312	1	0	1.3	0
	2	0	1.3	0
	3	0	0	0
	4	1.0	1.0	0
	5	1.0	0	0
	6	2.0	2.0	0

* Treatment number corresponds to treatment number in Table. 15

T.1.6.O Weed control (per cent control) by Tribunil applied at different dates and rates (a.i.) Toluca 1974

Trt.No.	Rate (kg/ha a.i.)	Stage of Wheat	Weed control (per cent)					
			Brassica	Malva	Cucumis	Galinsoga	Poa	Commelina
1.	1	2 1/2-3 leaf	100	100	100	100	100	97
2.	2	2 1/2-3 leaf	100	100	100	100	100	98
3.	1	5 leaf	80	57	93	85	80	92
4.	2	5 leaf	100	82	100	98	97	98
5.	1	7-8 tillers	90	72	100	97	93	93
6.	2	7-8 tillers	100	95	100	97	93	100

T.1.6.Q Weed control (per cent) by preemerge applications of Tribunil combined with 0.25 kg/ha a.i. of Bromoxynil at jointing.

Treatment No.	Tribunil Treatment	Weed control (per cent)					
		Brassica	Malva	Cucumis	Galinsoga	Poa	Commelina
1	1 kg/ha	80	73	100	100	85	52
2	5 kg/ha	100	88	98	100	92	83

T.1.6.R Weed control (per cent control) by Tribunil applied at different dates and rates (a.i.) El Batan 1974

Trt.No.	Rate (kg/ha a.i.)	Stage of Wheat	Weed control (per cent)			
			Hellanthus	Ipomoea	Galinsoga	Amaranthus
1.	1	3 - 3 1/2 leaf	92	60	100	100
2.	2	3 - 3 1/2 leaf	100	82	100	100
3.	1	5 leaf	40	0	16	0
4.	2	5 leaf	45	17	67	40
5.	1	5 - 6 tillers	48	17	60	0
6.	2	5 - 6 tillers	33	27	83	27

T. 1.6.S Weed control (per cent control) by Bromoxynil (a.i.) applied at different dates and rates (El Baten 1974).

Trt.No.	Rate (kg/ha a.i.)	Stage of Wheat	Weed control (per cent)			
			Helianthus	Ipomoea	Galinsoga	Amaranthus
1.	0.25	2 leaf	100	100	100	70
2.	0.5	2 leaf	100	100	100	92
3.	0.25	4 - 4 1/2 leaf	100	100	100	90
4.	0.5	4 - 4 1/2 leaf	100	100	100	96
5.	0.25	6 - 6 1/2 leaf	85	83	100	78
6.	0.5	6 - 6 1/2 leaf	100	97	100	78

T.1.6.T Weed control (per cent) by various herbicides in combination (tank mix) with 0.25 kg/ha a.i. Bromoxynil (El Baten 1974)

Trt.No.	Herbicide	Rate*	Stage of Wheat	Weed control (per cent)			
				Helianthus	Ipomoea	Galinsoga	Amaranthus
1.	Tribunil	1.0	4 - 4 1/2 leaf	100	82	100	75
2.	Linuron	0.25	6 - 6 1/2 leaf	97	95	100	87
3.	Dosanex	2.0	4 - 4 1/2 leaf	100	100	100	100
4.	Diuron	0.5	6 - 6 1/2 leaf	100	90	100	93

Rate = kg/ha a.i.

T.1.6.U Chlorosis, growth suppression and dead plant ratings on two crops receiving applications of different herbicides in combination (tank mix) with 0.25 kg/ha a.i. of Bromoxynil (El Baten 1974)

Variety	Treatment No.*	Chlorosis	Suppression	Dead Plants
Yecora 70	1	0	0.7	0
	2	0	1.0	0
	3	0.3	1.3	0
	4	1.0	1.7	0
Cocorit 71	1	1.0	2.7	0
	2	0.7	1.3	0
	3	0.7	2.3	0
	4	2.0	3.7	1.3

* Treatment number corresponds with numbers used in Table 20.

T.1.6.V Per cent emergence ‡ of three crops treated with various rates, pre-emerge, of Dinitro and TOK E-25 (Toluca 1974)

Trt.No.	Herbicide	Rate* (lt/ha)	Per cent emergence ‡		
			Yecora 70	Cocorit 71	PM 312
1	TOK E-25	5	118	94	91
2	TOK E-25	7.5	112	87	81
3	TOK E-25	10	107	92	73
4	Dinitro	5	83	58	84
5	Dinitro	7.5	61	54	63
6	Dinitro	10	65	48	48

* Rate expressed as commercial product

‡ Per cent emergence expressed as per cent of non treated check.

1.7 Physiology

1.7.1 INTRODUCTION

Weather conditions were very favorable in the Yaqui Valley in 1973-74 (Fig.1.7.A) Unhampered by disease, the dwarf variety Yecora 70 (sown between November 15 and December 10) produced 7.95 ton/ha under optimal management and 12 per cent moisture. This was the highest yield of the past three seasons, exceeding the 7.41 ton/ha obtained in 1970-71. Other materials also produced high yields: Stork "S", a durum variety, for example, yielded a record 8.56 tons/ha. High radiation and low night temperatures during February are thought to be the major factors contributing to the high yields.

1.7.2 ASSESSMENT OF YIELD POTENTIAL

Methods of determining yield potential of genotypes with only small quantities of seed available (early generations of a breeding program, for example) were examined in a study using 40 homozygous genotypes. These genotypes were grown as spaced plants (as F_2 are grown) in microplots and large yield plots. The microplots were designed as a compromise to reduce the quantity of seed required, while approximating the competitive environment of normal seeding density and simplifying the harvesting procedure. These plots were 3m long, consisting of four rows, 20 cm apart; with three rows seeded and the fourth row serving as a path between genotypes. At maturity, two meters were harvested from the center of all three rows of each plot. The trial consisted of five replicates of spaced plants (6 plants per replicate), microplots, large plots. Measurement of harvest index was made on all plots, because earlier data had shown a close correlation of harvest index with grain yield in large plots, and it was shown to be a stable character at any density.

Grain yield of the large plots ranged from 5.43 tons/ha for the poorest plots to 8.56 tons/ha for the best. Coefficients of variation were about 10 per cent for grain yield, 5 per cent for harvest index; and intermediate for other yield components. Thus, environmental effects probably had only minimal influence on phenotypic correlation coefficients calculated from the genotype means. (Table 1.7A).

Microplot grain yieldswere significantly associated with large plot yield, but this association explained only 45 per cent of the yield variation noted in the large plots. Obvious changes were apparent in yield ranking of genotypes. For example, erect-leaved lines performed relatively poorly in the microplots. It seems likely that genotypes differed in the advantage taken of the space between plots. The microplot harvest index was closely correlated with large plot yields.

Analysis of spaced planting results showed that the grain yield per plant was not significantly correlated with large plot yield and numerical components of yield measured in the spaced plants were not closely correlated with large plot yield. Yet harvest index per plant was closely correlated with large plot yields, and per shoot correlation was even greater. The stability of harvest index across populations is shown in Table 1.7A.

The study indicates that the harvest index, a relatively simple measurement, might be used as a selection criterion for yield potential; however, results should be checked when used with segregating populations. The microplot results (along with data presented here) cast some doubt on the validity of genotype rankings for yield from small plot trials, where both interplot competition and edge effects are affecting results. It is expected that such competition is largely or entirely for light in an irrigated, high fertility environment. Thus taller types with greater spread would have a competitive advantage.

1.7.3 ENVIRONMENTAL MANIPULATION AND YIELD POTENTIAL

Shading experiments were continued with the high-yielding bread wheat Yecora 70, to investigate the importance of solar radiation for grain yield and, indirectly, to study crop photosynthesis at different development stages. Using single,short shade periods,2 periods of maximum sensitivity were determined;as shown in Fig. 1.7Bthese results agreed with earlier studies. Data are now available from four seasons of experimentation with Yecora 70 at CIANO, and several conclusions can be drawn:

(1) During shading, crop growth (as measured by dry matter accumulation) is reduced by an amount approximately equal to the percentage reduction in radiation.

(2) Shading during the first 50 days after seeding (up to one week or so after terminal spikelet formation on the main shoot apex), has little or no effect on grain yield, although tillering is substantially reduced.

(3) Shading from 55 to 85 days after seeding (approximately 35 to 5 days before 50 per cent spike emergence) has a drastic effect on grain yield that is associated with reduced grains per square meter. Most of the loss is a result of fewer grains per spikelet with little increase in kernel weight to offset the loss. This is the period of maximum accumulation of dry matter in the spike structure.

(4) The period of flowering and early grain growth is relatively insensitive to shading, with grain yield reductions coming from reduced kernel weight; pollination is apparently unaffected by shading.

(5) Kernel weight (hence grain yield) may or may not be sensitive to post-anthesis shading. This depends on whether the number of grains per square meter established in the crop (i.e. sink size) is sufficiently high to create a heavy demand for post-anthesis assimilate (the source). Sink size is governed by radiation in the month before anthesis. Thus, in 1973-74, when grain numbers were high, kernel weight was quite sensitive to post-anthesis shading; however, in 1972-73 (see previous annual report), the reverse was true. These findings indicate that the relative importance of sink size and post-anthesis source in limiting grain yield is more season dependent than genotype dependent.

The above conclusions suggest that further yield improvement in Yecora 70 will require increased crop photosynthesis and/or greater partitioning of assimilate to the growing spike during the one month or so preceding anthesis. Grain yield is likely to become more dependent on post-anthesis photosynthesis only when grain number per square meter is increased. Such conclusions should be restricted to the conditions under which the study was conducted:--low latitude, irrigation, high fertility, and genotype used. Although Yecora 70 is typical of many dwarf, spring wheat varieties, comments on the generality of these conclusions should await completion of shading studies now being conducted.

The final size of any yield organ should be related to the assimilate available during some critical phenological period when the organ is capable of growth. Total assimilate supply to the organ may be increased, not only by the means mentioned above, but also by slowing the rate of development. To test this hypothesis, heating and cooling treatments were applied to small areas of the crop (Yecora 70) for about 4 weeks. Heatings involved an average increase of 5°C in air temperature. Heating treatments reduced yields only when applied 40 days after seeding; however, heating accelerated development at all stages. The greater reductions coincided with the period of rapid spike growth. Cooling, although less effective in reducing air temperature, gave the opposite response. These findings support the results of the shading experiments as well as the hypothesis tests cited above.

Thus, the research challenge is to locate and exploit genes capable of retarding developmental rate during the spike growth period in the month before anthesis. Information is available about genes controlling the development rate in the earlier growth period, from seeding to terminal spikelet formation. However, retarded development in this earlier period leads to more tillering, but generally no increase in grains per square meter or grain yield, which again supports the shading results.

1.7.4 LEAF ANGLE AND YIELD POTENTIAL

Bread and durum wheat selections with erect leaves that were reported as promising last season were tested in yield trials against standard varieties which generally had no-erect leaves. These tests were inconclusive although the durum line Stork "S", which outyielded all others in the test, has semi-erect leaves. These erect-leaved types were not necessarily of the same basic genetic yield potential as the checks, and were, in fact not likely to be. These materials were developed through selection in segregating population and partial backcrossing to provide sets of comparisons with some constancy of genetic background. Yield tests will be continued in 1974-75. In 1972-73, the better relative performance of the lines with erect leaves may have been due to the unusual radiation of that season, and the better lodging resistance of several of the lines used.

Another experiment compared optimal seeding densities for lines with erect leaves vs lines with non-erect leaves. Seeding density ranged from 20 to 240 kgs/ha. In general, there was little yield response to increased density for the erect-leave lines, but the response was positive as shown in Figure 1.7.C. The use of about 100 kg/ha seeding density should be satisfactory in comparing lines of the two types.

In the studies of erect leaves an attempt was made to use the liguleless bread wheat line Eligulate, which confers a leaf angle at the base of the lamina close to vertical. The derived progeny have been of little value to date because of the Eligulate parent has many undesirable traits. As an added complication the liguleless character is a result of the complementary action of two recessive gene pairs.

1.7.5 YIELD UNDER SIMULATED DROUGHT CONDITIONS

In cooperation with Professor L.H. Stolzy of the University of California, Riverside, a cooperative project was continued at CIANO to study drought resistance mechanisms in wheat. Ten distinctive genotypes were studied intensively in large plots to determine effects of three drought regimes, and of well watered conditions. These results and those of a similar study in the previous season have been included in the Ph.D. dissertation of Dr. R.E. Sojka:"Comparative Drought Response of Selected Wheat Varieties (University of California Riverside, September 1974).

Drought reduced yields considerably, but proportionately; so that the highest yielding lines under drought conditions were, in general, those that showed highest yield potential under irrigated conditions. However, there was no evidence from this trial of specific genes for drought tolerance or resistance, although earliness proved advantageous. The only exception to this appears to be Cocorit, which in all experiments shows greater susceptibility to drought. In the Table 1.7.B, Cocorit ranks first, without drought, and is lowest ranking with severe drought. Gabo, a tall, drought resistant Australian wheat variety,and D67-3, a North African durum, were clearly no better under drought stress than Yecora 70 or CIANO, two modern semi-dwarf Mexican varieties. Line T64-2-W, a segregate of a winter x spring cross, failed to show superior performance.

Plant water relations and rooting of Yecora, Gabo and Cocorit were examined closely by Dr. Sojka. Plant water potential was measured with a pressure chamber and showed a stable minimum value from about 10 a.m. to 5 p.m. each day. Leaf diffusive resistance to water vapor, as measured with a diffusion porometer also was approximately stable over this period of the day. As a result, extensive measurements were made to compare the water status of treatments and genotypes. Gabo had the deepest roots, a factor associated with higher water potential (i.e. less stress) and lower leaf permeability; Yecora was intermediate in these traits; and Cocorit had the shallowest roots, lowest water potential and highest leaf permeability. Rooting depth was closely related to per cent yield reduction caused by drought.

The search for drought resistance was expanded to cover 36 genotypes and seven drought regimes at CIANO, including two trials on sandy soil in farmer fields. Plots in this experiment were reduced to 3 m x 2 rows x 30 cm, with an additional unseeded 30 cm separating adjacent plots. Grain yield was harvested from 2 m x 2 rows in the center of each plot. Subsequent examination of the yield data indicated a substantial advantage of edge plots under drought despite the planting of a single border row on the outside of the plot area. There was also evidence of interplot competition. Nevertheless, the results are as shown in Fig. 1.7.D in which the yield of groups of genotypes of similar maturity are compared. The results confirm the above mentioned tendencies for new semi-dwarf and traditional tall wheats. Also the improved durums (including Cocorit) show greater susceptibility to drought. The most significant feature, however, is the superiority of barley under drought. Although this is an intergeneric difference, it suggests a drought resistance mechanism of substantial magnitude. The search for such differences within species will be continued, since it would be of real value to breeders. It is felt, however, that plot size must be increased to allow for discard of edge rows and that more severe drought levels should be included, representative of less favorable dryland situations.

1.7.6 YIELD POTENTIAL IN THE TROPICS

A diverse set of 20 bread wheat and triticale genotypes were sown in the winter cycle at several dates at each of three sites in the tropics. These sites differ in altitude but have similar latitudes (El Batan 2250 m, 20°N Tlaltizapan 940 m, 19°N and Poza Rica 60 m, 20°N). Sowing was done in January and February, at El Batan; and in November, December and January, at the other two sites. This study is a part of a Ph.D. thesis of Mr. D.J. Midmore from the University of Reading, England. Table 1.7.C shows the relevant weather data for 1973-74

The stations represent the following environments in order of ascending altitude: hot, low radiation; hot, high radiation; and cool, high radiation.

Studies had been planned to examine the yield potential of the genotypes, under optimum conditions (irrigation, high fertility, and freedom from diseases and insects). However, at Poza Rica, it was not possible to prevent the heavy attack of *Helminthosporium sativum* on all genotypes; and at Tlaltizapan a soil problem associated with high alkalinity may have reduced yields. Grain yields ranged from 0 to 2 ton/ha at Poza Rica; from 2.5 to 5 ton/ha at Tlaltizapan; and from 3.5 to 8 ton/ha at El Batan. Siete Cerros and Anza were the best genotypes in both appearance and measured yield potential across all sites. Both of these genotypes are intermediate in maturity. Yield across sites, and to some extent across genotypes, was related to grain number per square meter. Across sites, grain number was positively related to radiation received in the 30 days before anthesis: r=0.796**;

and was inversely related to mean temperature from seeding to anthesis: r=minus 0.825**. Because radiation and temperature were inversely related (r=-0.539**) in this year's data it is not possible to determine which of the two had greatest influence on yield.

Developmental patterns were more clearly visible in this study: development was slowest at El Batan, more rapid at Tlaltizapan, and fastest at Poza Rica; in days to floral initiation, to anthesis, and to maturity. The mean daily temperatures were similar at Tlaltizapan and Poza Rica thus the faster development at Poza Rica is probably due to the higher night temperatures.

Across sites leaf numbers and spikelet numbers were directly related to length of the vegetative phases. Similarly, at all sites lateness was associated with larger spikes; but this did not lead to higher grain number per m^2, because lateness was associated with less spikes per m^2 and reduced grain set at the hotter sites.

As compared with other varieties, some later varieties known to have a cold (vernalization) response reached anthesis relatively earlier at El Batan and Tlaltizapan than at Poza Rica; with relative advancement of flowering being greatest at El Batan. This finding suggests that fulfillment of the cold response was directly related to altitude, although not dependent on altitude.

Fig. 1.7. A WEATHER DATA FOR CIANO DURING THE 1973-74 SEASON.

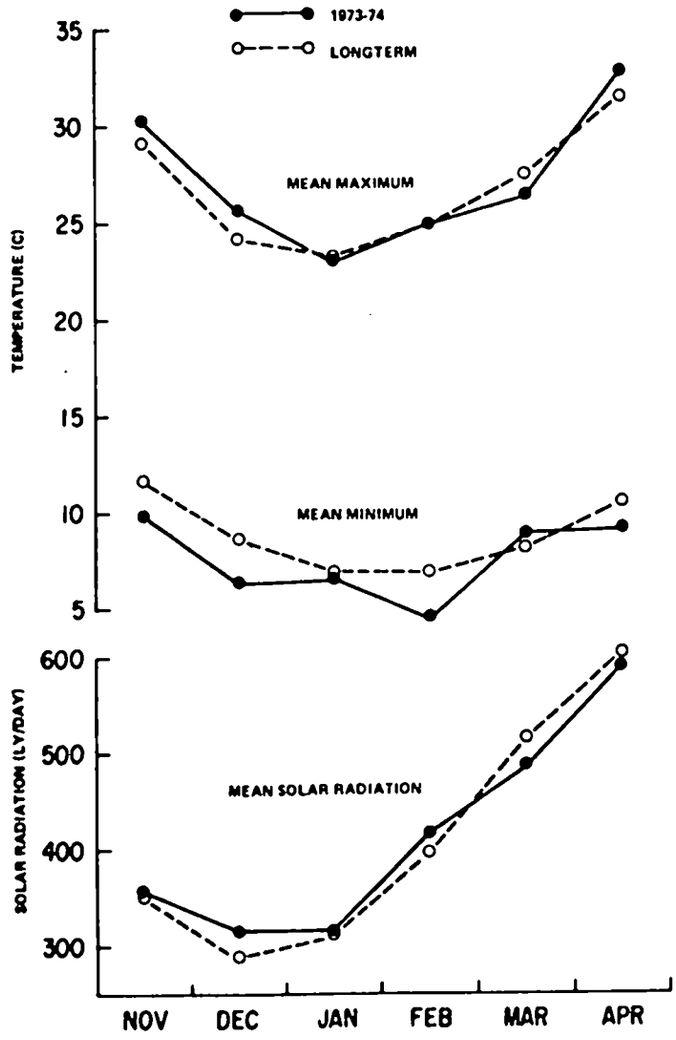


Fig. 1.7.B RESPONSE OF GRAIN YIELD TO SINGLE SHADING PERIODS (14 DAYS x 67 %) AT DIFFERENT DATES AFTER SEEDING. TRIAL E13, CIANO, 73-74.

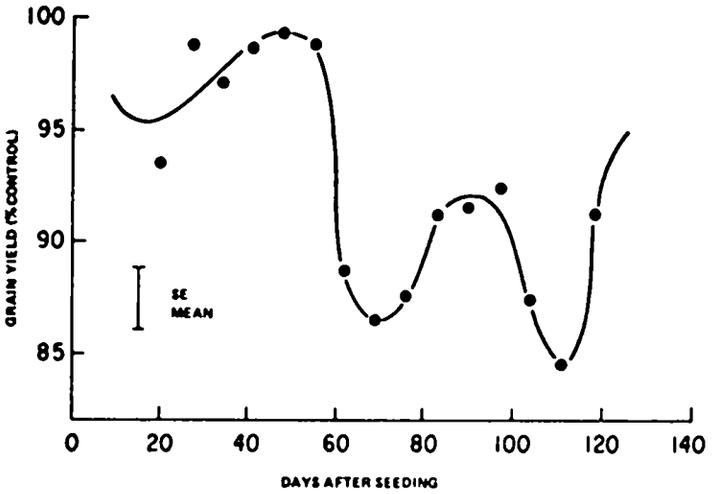


Fig. 1.7. C VARIATION IN GRAIN YIELD WITH SEEDING DENISTY FOR ERECT AND NON-ERECT GENOTYPES. TRIAL E4, CIANO, 73-74.

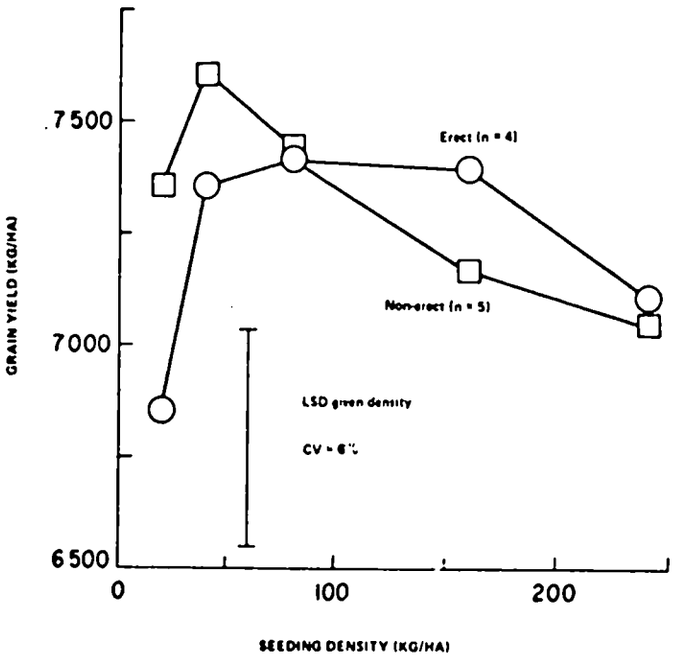
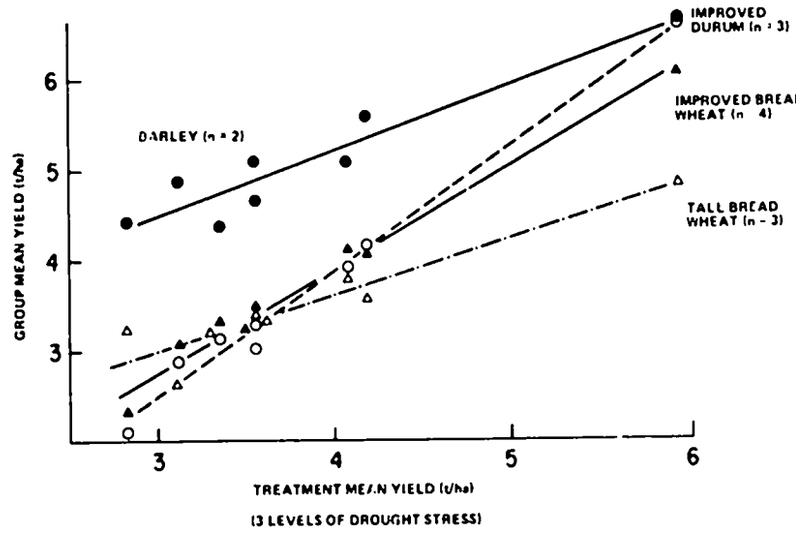
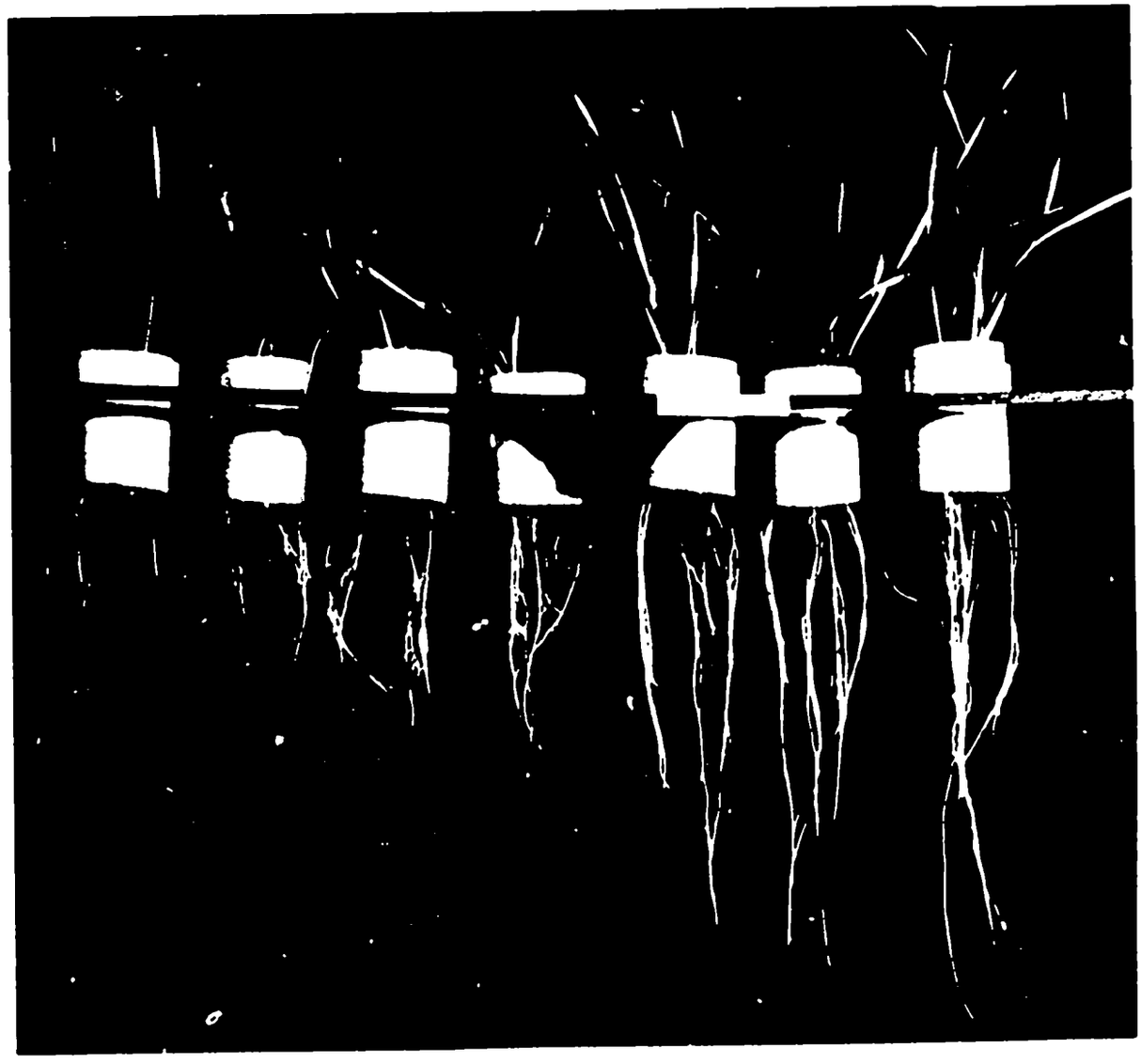


Fig. 1.7.D GRAIN YIELD OF CERTAIN GROUPS OF GENOTYPES VS TREATMENT MEAN YIELD. TRIALS E22 AND E32, CIANO, 73-74.





Tests to identify plants resistant to aluminum toxicity.

TABLE 1.7.A.- Correlation between grain yield in large plots and various parameters measured on spaced plants and microplots. Trials EI, EXI, EXII, EIV, CIANO.

Condition	Parameter	Correlation coefficient large plot+ grain yield	harvest index
Microplot	Grain yield	0.68**	- -
	harvest index	0.73**	0.91**
Spaced plant	grain yield	0.27	- -
	harvest index	0.54**	0.75**
	spikes/plant	-0.11	- -
	spikelets/spike	-0.07	- -
	grains/spikelet	0.28	- -
	kernel weight	0.32*	- -
Single shoot++	harvest index	0.65**	- -

+ * = Significant at 5%, ** = significant at 1% probability.

++ = Single central shoots taken from each spaced plant.

TABLE 1.7.C.- Summary of weather data for wheat cycle 1973-74 at Poza Rica (PR), Tlaltizapan (T) and El Batan (EB). Maize Physiology Met. Station.

Month	Max.temp.°C PR	T	EB	Min.temp.°C PR	T	EB	Solar Rad. ly/day PR	T	EB
Nov.	30	31		20	11		?	454	
Dec.	25	29		14	8		?	407	
Jan.	26	31	22	17	9	1	288	435	434
Feb.	25	32	22	15	10	1	353	508	510
Mar.	30	33	25	18	11	2	425	562	529
Apr.	32	36	25	19	16	5	473	602	554
May		36	25		17	7		587	536
June			23			9			443
July			22			11			460

TABLE 1.7.B.- Response of genotypes to different levels of drought*. Trial EXII, CIANO.

Genotype	Date 50% Spike emergence No drought	Grain yield (t/ha)** No drought	Light drought	Moderate drought	Severe drought	Mean of droughts
Yecora	Mar 2	6.86 100	3.95 58	3.73 54	3.11 45	3.60
Cocorit	Mar 2	7.84 100	3.03 39	3.24 41	1.94 25	2.74
Gabo	Mar 3	4.91 100	4.13 84	3.73 76	2.71 55	3.52
D67-3	Feb 24	6.44 100	4.56 71	3.93 61	2.69 42	3.73
T64-2-W	Mar 4	5.28 100	3.74 71	3.11 59	2.36 45	3.07
Siete Cerros	Mar 4	5.13 100	3.47 68	3.51 68	2.64 51	3.21
CIANO	Feb 23	5.84 100	4.57 78	4.07 70	2.81 48	3.82
Cajeme 71	Mar 11	6.54 100	3.65 56	3.05 47	2.55 39	3.08

Drought x genotype interaction highly significant
Coefficient of variation 10.6%
LSD between genotypes at given drought level 0.56 t/ha

* Light drought = seeded Nov. 24, last irrigation Feb. 4.
Moderate drought = seeded Dec. 6, last irrigation Feb. 4.
Severe drought = seeded Dec. 18, last irrigation Feb. 4.

** Yield on the upper line, yield as a % of yield in the absence of drought on the lower line.

1.8 Basic Germ Plasm Improvement

1.8.1 INTRODUCTION

Basic germ plasm improvement in wheat and triticales focuses on producing genetic material having specific characteristics that later can be incorporated into the respective conventional breeding programs. Since 1972, scientists have also sought inter-generic or wide crosses among oats, barley, rye, and wheat. Table 1.8.A lists some of the important progenitors and their characteristics that have been used in basic germ plasm improvement.

Dwarf factors different from those contributed by Norin 10 have now been incorporated into wheat varieties; and lines are now available in an acceptable agronomic background, with dwarfness derived from the Rhodesian line S948A1, and Tom Thumb. Some lines possessing this dwarfness from the material harvested in the 1973-74 cycle have been delivered to the bread wheat breeding program. However, some work to improve grain type of the dwarfs from S948A1 is continuing in an attempt to produce better parental material.

Wheats with ramified (branched) spikes have been studied in an attempt to raise the grain yield potential. Important advances have been made in: fertility, grain plumpness, resistance to rusts, earliness, degree of tillering, straw strength and degree of branching. During the winter of 1974-75, new highly ramified dwarf lines with good agronomic characteristics will be evaluated for yielding ability. The value of these lines will be measured in terms of productivity.

Improvement of germ plasm also includes crossing and selection to transfer and combine into good agronomic backgrounds certain characters such as: resistance to rusts, resistance to insect damage, improvement in quantity and quality of protein, leaf type, length of peduncle, size of stem, number of spikelets per spike, number of grains per spikelet, and reaction to photoperiod. Most of these characteristics are found widely dispersed in varieties of undesirable agronomic type, and some of these deficiencies must be corrected before they can be used successfully in the conventional breeding program. Populations are now available in F_3 in which the desirable phenotypic characteristic has been combined and maintained; even though in many cases some other characteristics are less productive. (These populations arise from simple crosses, thus few segregants are expected to unite the desirable character being transferred from one progenitor with all the favorable characters of the other. This difficult, exacting, painfully slow research is vital to the support of the bread wheat and durum breeding programs).

1.8.2 CHARACTERS BEING TRANSFERED

The following characteristics are being transferred in creating new parent material:

- Resistance to the rusts and Septoria.
- Resistance to insects - Hessian fly, sawfly and aphids.
- Nutritional Quality - quantity and quality of proteins.
- Grain character - size, texture and color.
- Photoinsensitivity
- Morphologic characters - stem size, stem erectness, straw shortness, long peduncle, erect leaves, branching of the spike, spikelets per spike and grains per spikelet.
- Interchange of germ plasm between wheat and triticales.
- Improvement in fertility and the mechanism of infertility and restoration in triticale.
- Intergeneric crosses among wheat, barley, oats, and rye.

The program, of necessity, works a group of parents with poor agronomic type -- but which have one or two desirable characters of great importance for cereal improvement. The aim is to move these desired characters into an improved background. These parents are listed in Table 1.8.B.

In most of this material we deal primarily with backcrosses, or multiple crosses In the segregating populations, those plants are selected that combine good agronomic type with the desired character (resistance, quality, dwarfness, etc.). When this material has reached an acceptable level of homozygosis, it is given to the appropriate conventional breeding programs concerned for incorporation into those programs.

The lines listed below were delivered to the wheat and triticale programs, from material harvested in 1973-74:

Cross	Pedigree	Origin Y73/74
S-948A1-Sta. Elena[7]	CMH72.380-4Y-2B-0Y	E-1175
S-948A1-Cno "S"[4]	H471.71A-12B-2Y-1B-0B	E-1312
S-948A1-Crim[4]	H474-71A-3B-2Y-3B-0Y	E-1322
Topo "S"-Nar 59	H495.71-4Y-2B-3Y-2B-0Y	E-1411
S-948A1-HuaR[2]	H544.71-7Y-3B-2Y-1B-0Y	E-1425
Hua $(R)_E$-Bui"S"[2] x G71	H546.71-5Y-1B-1Y-1B-0Y	E-1437
Tac.xT.th-Son64/Spro[5]	H550.71-14Y-6B-1Y-2B-0Y	E-1446
Chr-S-948A1xChr[3]	H319-70A-2B-1Y-1B-1Y-2B-0Y	E-1500
H 285.70-Yecora 70	CMH 72-420-2Y-3B-0Y	E-1711
H 285.70-Yecora 70	CMH 72.420-2Y-4B-0Y	E-1712
H 389-70A-Arm "S"	H627.71r2Y-3B-2Y-3B-0Y	PH-101

Observations made in summer 1974 suggested the development of lines with other valuable characteristics, such as dwarfness, rust resistance, resistance to sawfly, erect stem, and long peduncles. This group of lines comes from crosses shown 1.8.B.

The characteristics being studied are recovered with relative ease in the segregating populations; however, dwarfness is often accompanied by factors that cause poor grain formation and poor fertility. Apparently, it is not possible to obtain good grain and fertility together with some types of dwarfness. One example is that of Tom Thumb-Son.64xY50 , in which backcrosses were made 10 times to Y50. In each case the Tom Thumb dwarfness was recovered, but not a single selection had good grain.

In breeding for grain and protein quality, factors other than dwarfness make it difficult to obtain good grain under El Batan conditions, so it is necessary to depend on quality determinations made on seed produced at CIANO in the winter.

Specific germ plasm characteristics for use in the regular breeding programs are gradually being improved; because of their importance, these are being handled carefully, and are being put into backgrounds that can be used by the breeders in the conventional programs.

1.8.3 YIELD EXPERIMENTS ON NEW GERM PLASM

In the winter of 1973-74, 17 lines of the germ plasm section were tested for grain yield: 4 were branched - headed bread wheats, 2 were branched-headed durums, and 11 were dwarf varieties derived from Tom Thumb and S948A1. All lines were tested in a trial that included adequate checks for comparisons with the characteristics of each group. Table 1.8.C shows the material tested and the yields observed.

1.8.3.1 Branched-Headed Varieties

The seed of the branched-headed wheats in this experiment had been tested during

the winter of 1972-73, and in the two cycles they showed similar branching and yield performance. The analysis showed no significant difference between levels of N; nor for interaction of N with varieties in either year. In the 1973-74 tests, a study was made of the relationship of branching and yield to: number of tillers, number of spikes, number of spikelets, number of grains, 1000 grain weight and hectolitre weight. These data are shown in Table 1.8.D.

In tests of the branched-headed bread wheats, results were obtained similar to those in 1972-73. In both previous years, branching was reduced, but did not disappear, when plants were grown with dense populations, and the plants produced as many tillers and spikes as do Cajeme 71 and Super X. When the branching was limited, there appeared to be an increase in the number of spikelets per spike. The lines of the cross M. Reo x No66[2] showed good fertility, but the grain was smaller (these two characters must be modified, since grain size and its development are the principal deficiences of these lines).

In tests of the branched-headed durums, there appeared to be a decrease in the number of tillers and spikes per meter, while the number of spikelets per spike was superior to Cocorit. Similarly, there was as increase in the number of spikelets and grains per meter^2. However, the number of grains per spikelet was lower, which reflects poor fertility. In addition, the grain was small and badly developed, as compared with Cocorit 71.

Table 1.8.D does not show the productive capacity of this material; rather, it shows present deficiencies of the branched wheats. In general, yield of these wheats is mostly limited by: poor fertility, poor grain development and smaller grain size. Elimination of these deficiencies is being sought by continuous intercrossing of the better branched types of bread wheat and durum with the lines and varieties showing the best development for these characters in the bread and durum programs. In the segregating populations, special care is required to ensure vigorous selection to eliminate plants with many unfavorable characteristics. Small advances have now been made, and by the winter of 1974-75 it will be possible to study seven new lines of branched bread wheats and seven of durums. With the data obtained from this material, it is hoped that a better evaluation can be made, and that it will be possible to use these materials in the improvement programs.

1.8.3.2 Dwarfness

Table 1.8.C shows the yields of 11 dwarf wheat lines derived from Tom Thumb and S-948-A1. This material has been developed through backcrossing,using Nadadores 63, Ciano 67 and Santa Elena as backcross parents. Thus, except for their shorter straw, the lines tested were phenotypically similar to the respective parent varieties.

Santa Elena suffered from lodging because of a late irrigation (which was necessary to provide the necessary moisture for Nadadores 63, the latest maturing variety). Lodging was not severe and occurred near the maturity of Santa Elena; thus probably did not affect grain weight appreciably. Lodging did not affect number of tillers and spikes, nor the corresponding value for the number of spikelets and grains. The values of these yield components are superior to Santa Elena in all new dwarf lines. As mentioned, it is possible to directly compare the dwarf lines with the parents Ciano 67 and Nadadores 66, since neither Ciano 67 nor Nadadores suffered from lodging.

Data obtained with this material shows the effect of dwarfness on grain production; clearly, all the new dwarf lines yield more than the corresponding recurrent parents. These findings suggest that the shortening of the straw leads to an economy of nutrients-nutrients which the plant uses in the development of a better production system to produce more tillers, spikes and grain. These wheats show acceptable agronomic and yield characteristics combined with dwarfness which makes them of much greater use in further development. However, some of these lines might conceivably become commercial varieties, immediately.

During the winter of 1973-74 and summer of 1974, new lines with dwarfness from Tom Thumb and S-948-A1 were obtained. Sixty four (64) of the best dwarf lines isolated from this material will be evaluated in yield tests in CIANO in 1974-75. Some of the better lines also will be made available to the bread wheat breeding program, where it is hoped they can be used without the problems encountered in direct use of dwarfness from Tom Thumb and S-948-A1.

1.8.3.3. Triticale

The basic germ plasm improvement effort in triticales has led to a significant

advance in stabilization of characters such as dwarfness and branching of the spike. Also, lines have been selected with heads larger than the conventional triticales (40-45 spikelets per spike under El Batan conditions and up to 50 in Cd. Obregon). At the same time, we have been able to select lines of triticale with 8-10 florets per spikelet. All of the material with the above characters has been delivered to the triticale program, where further crossing is under way. The goal of the germ plasm section is to combine a branched head (with the maximum number of spikelets per spike, a maximum number of seed per spikelet) in a triticale with good agronomic type, good fertility and plump grain. This type, if produced, will provide knowledge of the true potential of yield in triticale.

1.8.3.4 Wheat-Triticale

The aim of our work in crossing wheat by triticales is to interchange germ plasm between these two cereals, and to use the triticale component to transfer useful rye characters to wheat. There are now interesting segregates that show the genetic interchange between the two species. Interchange is possible both at the chromosomal level and at the genetic level, which is very useful where certain genes are to be transferred from rye to wheat.

One of the interesting aspects of these crosses is the expression of branching and awning of the spike in some crosses. The two characters are expressed as recessives in both species, and in crosses between the two. Such results suggest that the genes governing their expression in wheat and triticale are homologues. This is of special interest in the wide-crossing project, as it gives a basis for identifying the hybrids simply and easily. Previously, this has been a serious problem, because CIMMYT has not had a cytogeneticist available to study the problem.

1.8.4 INTERGENERIC CROSSES

CIMMYT, in collaboration with Dr. Lynn Bates of Kansas State University, began a program in 1972-73 to make crosses among wheat, barley, oats and rye. This work involves the combined use of: chemical treatment of female plants prior to flowering to promote crossability, embryo culture, cytological study of possible hybrids, and colchicine for doubling chromosomes.

The chemicals used for treatment are also used in treating humans to prevent rejection of organ transplants, e.g. Eamino Ncaproic acid. The chemicals were applied to the growing female plants in the field before flowering. After crossing, the embryos obtained were cultured artificially. Root tips were used for cytological study. The resultant plants were grown in the greenhouse and at the proper stage of development were treated with colchicine to induce doubling. Plants were grown to maturity.

During the summer of 1974, about 2000 spikes were emasculated and pollinated in crosses of wheat, barley, oats and rye. The results obtained are shown in Table 1.8.E.

Despite the large number of florets pollinated, only 142 grains were produced: thirty-one of these grains produced embryos. Of the embryos, only 14 developed into plants; 10 of these plants died and only four reached the adult stage. The four surviving plants did not appear to be hybrids, but very much resembled the phenotype of the female species (they were fertile, which would be unexpected in intergeneric crosses and could have resulted from self-pollinations).

TABLE 1.8.A.- Main progenitors in the Basic Germplasm development program.

	Variety or cross	Main characteristics
1	Bonza 55	Resistant to the 3 rusts
2	Samaca	Resistant to the 3 rusts
3	Andes 56	Resistant to the 3 rusts
4	Africa-Mayo II-3529-1Y-4M-3Y-1M	Resistant to the 3 rusts
5	Fn x K58-N II-50-17-100Y	Resistant to the 3 rusts
6	Chris	Resistant to the 3 rusts
7	Eagle	Resistant to Puccinia graminis tritici and P. striiformis
8	Era	Resistant to P. graminis tritici
9	Yaqui 50	Resistant to P. graminis tritici
10	Tezanos Pinto Precoz	Resistant to rusts and quality
11	HD-832	Good large amber grain
12	K103-14	Good large amber grain
13	Buitre "S"	Large grain and quality
14	Cheg-Gto x Jar"S"/Kl. Rend-Son64 HM-1023-6P-2B-1T-0P-0Y	Resistant to aphids
15	Nariño 59	Resistant to rusts, aphids, and long peduncle
16	Fury	Long peduncle
17	# 2710	Erect leaf
18	Tzpp/S.N/NP/3/Tob/8156 C-1162-21-1A-1Y-0M	Erect leaf
19	Lechuza CM-2659-A-1Y-1M-1Y-0MF	Erect leaf
20	Kenya Gov.	Protein
21	Frondosa PI-106505.8.1.	Protein
22	Pioneer CI-4324	Protein
23	Mahratta CI-8500	Protein
24	K338-Lemhi[3] CI-13271	Protein
25	Cedar PI-93984	Protein
26	Kenya C.10863 PI-117623	Protein

TABLE 1.8.A.- Continuation.

	Variety or cross	Main characteristic
27	Ment x KC.60.4809-3A PI-202800	Protein
28	Nap Hal	Protein
29	Stw-Agr.elongatum B61-94	Protein
30	L.S.3.1 - Pi62	Protein
31	Salamouni Seafoam	Resistant to Septoria
32	Iasul 20	Resistant to Septoria and aluminum
33	Selkirk	Sensitive to day-length
34	Hisumi	Dwarf
35	S-948-A1	Dwarf
36	Triple dwarf	Dwarf
37	(Tom thum-Son64)-19Y-1C	Dwarf
38	Forlani (E4) H255.67-1Y-1B-1Y-1B-2Y-1B-1Y-0B	Grains per spikelet
39	Morocco	Grains per spikelet
40	Fortuna	Resistant to saw fly
41	Lathrop	Resistant to hessian fly
42	Ribeiro	Resistant to hessian fly
43	PI-94587	Resistant to hessian fly
44	Mutante de Restauracao	Branding head
45	T. turgidum	Branding head
46	S10B3	Stiff stem
47	T. polonicum	Large kernel
48	Camel tooth	Large kernel
49	Tcl.Per.x Tcl.dur.stw. Prol.	Spikelets per spike and branding
50	D6644/Antilope rye//Tc-573(Mex) M73-578 (1)	Large kernel
51	D6644/Antilope rye//Tc-573(Mex) M73-579 (1)	Large kernel

TABLE 1.8.B.- Crosses showing better performing segregates in seasons 1973-74 and summer 1974.

Cross	Cross No.	Characteristic
S-948A1-Cno"S"^{2}x Cno67^{3}	H570.71	Dwarf
S-948A1-Cno"S"^{2}x Cno67^{4}	H499.71A	Dwarf
S-948A1-Cno"S"^{2}x Cno67^{5}	CMH72.381	Dwarf
S-948A1-Cno"S"^{2}x Cno67^{6}	CMH72A.429	Dwarf
S-948A1 x Cno"S"^{4}	H471.71A	Dwarf
S-948A1 x Cno"S"^{5}	CMH72.331	Dwarf
T.th-Son64xCno"S"/Cno67^{5}	CMH72A.351	Dwarf
S-948A1 x Hua R^{2}	H5[illegible].71	Dwarf
S-948A1 x Hua R^{3}	H478.71A	Dwarf
S-948A1 x Sta.Elena^{5}	H567.71	Dwarf
S-948A1 x Sta.Elena^{6}	H498.71A	Dwarf
S-948A1 x Sta. Elena^{7}	CMH72.380	Dwarf
S-948A1 x Sta.Elena^{7}	CMH72A.390	Dwarf
Chris-S-948A1 x Chris^{4}	CMH72A.333	Dwarf
Chris-S-948A1 x Chris^{5}	CMH73.309	Dwarf
Chris-S-948A1 x Chris^{5}	CMH73.489	Dwarf
Chris-S-948A1 x Chris^{6}	CMH73.474	Dwarf
S-948A1 x Crim^{4}	H474.71A	Dwarf
S-948A1 x Crim^{6}	CMH72A.404	Dwarf
S-948A1 x Bonza^{4}	H472.71A	Dwarf
S-948A1-Bonza^{2} x Mengavi^{6}	CMH72A.430	Dwarf
Nad63 x T.th-Son64/Nad63^{3}	H270.70A	Dwarf
Nad63 x T.th-Son64/Nad63^{4}	H553 71	Dwarf
Nad63 x T.th-Son64/Nad63^{5}	CMH73.485	Dwarf
Nar59 x Kalyansona	CMH73.938	Long peduncle
Nar59 x Cno-Gallo	CMH73.939	Long peduncle
Fury x Cno 67	CMH73.950	Long peduncle
Fortuna x Cj71	CMH73.937	Compact stem
Chris-S 948A1 x Chris/Super X^{2}	CMH73.475	Super X resistant

TABLE 1.8.C.- Grain yield in the dwarf branched wheats Experiment I at CIANO, winter 1973-74.

Rank	Variety or cross	Pedigree	Yield Kg/ha.
1	Cocorit 71		6700
2	Cajeme 71		6596
3	S948A1-Sta. Elena^{5}	H567-71-6Y-1B-0Y	6483
4	Super X		6296
5	M.Reo - No.66^{2}	H155.70-2Y-5B-4Y-0B	6158
6	M.Reo - No.66^{2}	H155.70-2Y-7B-2Y-0B	6092
7	Noroeste 66		6033
8	M.Reo - No. 66^{2}	H155.70-2Y-5B-7Y-0B	6013
9	Nad63 x T.th-Son64/Nad63^{3}	H270.70A-3B-1Y-2B-0Y	5797
10	S948A1-Cno"S"^{2}x Cno 67^{4}	H499.71A-3B-0Y	5592
11	S948A1-Cno"S"^{2}x Cno 67^{3}	H569.71-1Y-10B-0Y	5567
12	Rad3"S"(Rad2"S"/Nach-Tc60 x Nach)	H193.70-5Y-4B-1Y-0B	5533
13	Rad3"S"(Rad2"S"/Nach-Tc60 x Nach)	H193.70-4Y-2B-1Y-0B	5521
14	S948A1-Sta. Elena^{5}	H567.71-8Y-3B-0Y	5492
15	S948A1-Cno"S"^{2}x Cno 67^{3}	H569.71-3Y-4B-0Y	5446
16	S948A1-Cno"S"^{2} x Cno 67^{4}	H499.71A-1B-0Y	5396
17	S948A1-Cno"S"^{2} x Cno 67^{3}	H570.71-4Y-1B-0Y	5375
18	Tacuari x T.th-Son64/S.pre.^{5}	H550.71-14Y-6B-0Y	5354
19	Tacuari x T.th-Son64/S.pre.^{5}	H550.71-14Y-7B-0Y	5208
20	Topo"S"-Nar.59	H485.71-4Y-2B-0Y	5129
21	Sta. Elena		5000
22	Ciano F67		4988
23	H844.66-M.ReoxCno^{2}-Chris	H135.70-12Y-103B-1Y-0B	4825
24	Nad. 63		4229
LSD	5% = 581 kg/ha 1% = 772 kg/ha		

TABLE 1.8.D.- General table showing data of the dwarf branched wheats experiment I at CIANO, Winter 1973-1974.

Rank	Variety or cross	Pedigree	Days to flower	Height (cm)	Yield kg/ha.	Stems /m^2	Spikes /m^2	s/S	G/S	G/s	s/M^2	G/M^2	1000 kernel weight (gr.)	Vol. 1000 kernel (c.c.)	Test weight (kg.)	Var. No.
1	Cocorit 71		89	96	6700*	350	332	18.63	44.22	1.62	6186	14685	55.0*	70.0*	81.2	7
2	Crjeme 71		91	82	6596	383	370	17.93	39.71	2.37	6635	14689	48.2	62.5	81.3	24
3	S948A-1-Sta.Elena^5	H567.71-6Y-1B-0Y	87	92	6183	440	428	17.13	40.73	2.22	7333	17434	47.7	60.0	78.6	10
4	Super X		90	101	6296	365	355	17.50	50.29	2.45	6213	17856	39.0	52.5	80.4	19
5	M.Reo-No.66^2	H155.70-2Y-5B-4Y-0B	91	93	6158	353	350	20.33	48.25	1.22	7117	16893	39.2	53.0	79.5	2
6	M.Reo-No.66^2	H155.70-2Y-7B-2Y-0B	90	96	6092	378	372	18.83	46.17	1.63	7006	17174	37.2	50.0	80.9	4
7	Noroeste 66		90	95	6033	315	313	17.46	40.90	2.37	5467	12802	45.7	69.2	81.4	21
8	M.Reo-No.66^2	H155.70-2Y-5B-7Y-0B	90	95	6013	377	373	21.90	48.70	2.55	8169	18165	37.0	50.0	79.6	3
9	Nad 63x[T.th-Son64 /Nad 63^3	H270.70A-3B-1Y-2B-0Y	98	69	5796	507	488	16.46	40.73	2.30	8036	19878*	39.4	52.7	80.5	18
10	S948A1-Cno"S"^{2}x Cno F 67^4	H499.71A-3B-0Y	82	69	5592	485	480	16.90	33.32	2.37	8112	16000	39.0	50.0	82.6	15
11	S948A1-Cno"S"^{2}x Cno F 67^3	H569.71-1Y-10B-0Y	80	67	5567	458	455	17.40	36.84	2.11	7917	16759	37.7	50.0	83.0	11
12	Rad 3"S"(Rad 2"S" /Nach-Tc60xNach)	H193.70-5Y-4B-1Y-0B	95	92	5533	310	283	34.93	56.95*	2.00	9886	16122	42.7	60.0	76.3	6
13	Rad 3"S"(Rad 2"S" /Nach-Tc60xNach)	H193.70-4Y-2B-1Y-0B	93	95	5521	282	265	40.60*	49.74	2.06	10759*	13179	50.5	67.5	79.2	5
14	S948A1-Sta.Elena^5	H567.71-8Y-3B-0Y	94	56	5492	530*	520*	15.66	37.42	2.00	8147	19465	36.0	50.5	75.0	17
15	S948A1-Cno"S"^{2}x Cno F 67^3	H569.71-3Y-4B-0Y	79	68	5446	497	475	17.73	35.55	1.97	8423	16894	40.2	52.5	83.5	12
16	S948A1-Cno"S"^{2}x Cno F 67^4	H499.71A-1B-0Y	80	68	5396	483	475	16.36	32.81	2.26	7774	15580	40.0	51.7	82.8	14
17	S948A1-Cno"S"^{2}x Cno F 67^3	H570.71-4Y-1B-0Y	79	68	5375	465	453	16.70	34.55	2.38	7565	15659	39.7	51.2	82.4	13
18	Tac x[T.th-Son64/ S.pre^5	H550.71-14Y-6B-0Y	71	94	5354	422	403	16.56	38.13	2.47	6676	15368	43.8	58.0	80.4	9
19	TacxT.th-Son64/ S.pre^5	H550.71-14Y-7B-0Y	71	93	5208	437	415	16.66	37.76	2.87*	6917	15673	45.7	60.0	80.2	16
20	Topo-Nar 59	H485.71-4Y-2B-0Y	84	60	5129	417	412	17.50	44.73	1.89	7210	18430	33.5	45.0	80.1	8
21	Sta. Elena		89	124	5000	345	338	16.23	34.70	2.34	5487	11729	51.0	65.0	79.4	23
22	CIANO F 67		76	93	4588	388	387	15.66	29.74	2.07	6063	11507	45.5	57.5	84.0*	20
23	H84[.66-M.Reo x Cno^2-Chris	H135.70-12Y-103B-1Y-0B	91	103	4825	405	395	27.06	43.93	2.13	10691	17354	36.2	50.0	81.8	1
24	Nad 63		99	120	4229	445	428	17.40	36.06	2.21	7447	15437	35.0	49.5	78.0	22
LSD	5%				581	64.20	56.76	3.73	5.18							
	1%				772	85.38	75.48	4.96	6.89							

Abbreviations: s = spikelet S = Spike G = grains * = high yielding

TABLE 1.8.E.- Intergeneric crosses attempted at El Batan, Mexico, during Summer 1974

Cross	Treatment	Heads pollinated	Heads harvested	Grains	Embryos	Seedling	Plants
Dic-Hip x Avena spp	Alla	14	14	-	-	-	-
Dic-Hip x Centeno Snoopy	Alb	7	7	-	-	-	-
Dic-Hip x Centeno Snoopy	Alla	20	19	10	-	-	-
Dic-Hip x Centeno Snoopy	Sin	22	22	-	-	-	-
Dic-Hip x T. monococcum	Alb	1	1	-	-	-	-
Dic-Hip x T. monococcum	Alla	11	10	-	-	-	-
Dic-Hip x T. monococcum	Sin	25	25	-	-	-	-
Dic-Hip x Cocorit 71	Alb	6	5	1	1	1	-
Dic-Hip x Cocorit 71	Alla	20	15	1	-	-	-
Dic-Hip x Cocorit 71	Sin	24	24	1	-	-	-
Dic-Hip x Tob 66	Alb	8	8	-	-	-	-
Dic-Hip x Tob 66	Alla	16	16	5	5	4	1
Dic-Hip x Tob 66	Sin	25	25	-	-	-	-
Dic-Hip x WS 1809	Alb	4	4	-	-	-	-
Dic-Hip x WS 1809	Alla	13	13	-	-	-	-
Dic-Hip x WS 1809	Sin	21	19	-	-	-	-
Dic-Hip x Bza 55	Alb	1	1	-	-	-	-
Dic-Hip x Bza 55	Alla	24	24	2	2	-	-
Dic-Hip x Bza 55	Sin	29	29	2	-	-	-
Apizaco x Avena spp	Alb	2	2	-	-	-	-
Apizaco x Avena spp	Alla	10	9	-	-	-	-
Apizaco x Centeno Snoopy	Alla	27	27	6	-	-	-
Apizaco x Centeno Snoopy	Sin	24	24	-	-	-	-
Apizaco x Centeno 2796	Sin	24	24	-	-	-	-
Apizaco x T. monococcum	Alla	23	23	-	-	-	-
Apizaco x T. monococcum	Sin	20	20	-	-	-	-
Apizaco x Cocorit 71	Alb	9	9	-	-	-	-
Apizaco x Cocorit 71	Alla	18	18	1	1	-	-
Apizaco x Cocorit 71	Sin	26	21	1	-	-	-
Apizaco x Tob 66	Alb	1	1	-	-	-	-
Apizaco x Tob 66	Alla	35	35	-	-	-	-
Apizaco x Tob 66	Sin	30	30	-	-	-	-
Apizaco x Jup 73	Sin	29	29	-	-	-	-
Apizaco x WS 1809	Alb	3	3	-	-	-	-
Apizaco x WS 1809	Alla	20	20	-	-	-	-
Apizaco x WS 1809	Sin	24	23	-	-	-	-
Apizaco x Bza 55	Alb	4	3	-	-	-	-
Apizaco x Bza 55	Alla	22	22	-	-	-	-
Apizaco x Bza 55	Sin	21	21	-	-	-	-
Celaya x Avena spp	Alb	4	4	-	-	-	-
Celaya x Avena spp	Alla	8	8	-	-	-	-
Celaya x Centeno Snoopy	Alb	4	4	-	-	-	-
Celaya x Centeno Snoopy	Alla	36	36	60	-	-	-
Celaya x Centeno Snoopy	Sin	45	45	-	-	-	-
Celaya x T. monococcum	Sin	2	2	-	-	-	-
Celaya x Cocorit 71	Alb	1	1	-	-	-	-
Celaya x Cocorit 71	Alla	33	33	-	-	-	-
Celaya x Cocorit 71	Sin	25	25	10	10	4	-
Celaya x Tob 66	Alb	2	2	-	-	-	-
Celaya x Tob 66	Alla	22	22	-	-	-	-
Celaya x Tob 66	Sin	27	12	1	1	-	-
Celaya x WS 1809	Alb	1	1	-	-	-	-
Celaya x WS 1809	Alla	15	14	-	-	-	-
Celaya x WS 1809	Sin	30	30	-	-	-	-
Celaya x Bza 55	Alb	1	0	-	-	-	-
Celaya x Bza 55	Alla	30	22	-	-	-	-
Celaya x Bza 55	Sin	20	19	-	-	-	-
Cebada M16 x Centeno Snoopy	Sin	10	10	17	-	-	-
Cebada M16 x Cocorit 71	Sin	20	20	-	-	-	-
Cebada M16 x Tob 66	Sin	20	19	-	-	-	-
Cebada M16 x Bza 55	Sin	20	19	1	-	-	-
Avena spp x Apizaco	Ala	8	8	-	-	-	-
Avena spp x Centeno Snoppy	Ala	12	11	-	-	-	-
Avena spp x T. monococcum	Ala	12	11	2	-	-	-

TABLE 1.9.E.- Continuation.

Cross	Treatment	Heads pollinated	Heads harvested	Grains	Embryos	Seedling	Plants
T. monococcum x Apizaco	Ala	23	23	-	-	-	-
T. monococcum x Apizaco	Sin	20	20	-	-	-	-
T. monococcum x Ahoil 3100/70	Sin	10	7	-	-	-	-
T. monococcum x Avena spp	Ala	24	21	-	-	-	-
T. monococcum x Avena spp	Sin	10	10	-	-	-	-
T. monococcum x Avena spp	Ala	24	21	-	-	-	-
T. monococcum x Avena spp	Sin	10	10	-	-	-	-
T. monococcum x Centeno Snoopy	Ala	25	24	1	-	-	-
T. monococcum x Centeno Snoopy	Sin	20	19	8	2	-	-
Cocorit 71 x Dic-Hip	Ala	25	25	1	1	1	-
Cocorit 71 x Apizaco	Ala	35	34	3	2	-	-
Cocorit 71 x Apizaco	Sin	20	10	-	-	-	-
Cocorit 71 x Celaya	Ala	25	25	-	-	-	-
Cocorit 71 x M16	Ala	25	25	-	-	-	-
Cocorit 71 x Ahor 3100/70	Ala	30	30	-	-	-	-
Cocorit 71 x Ahor 3100/70	Sin	20	19	-	-	-	-
Cocorit 71 x Ahor 2194/70	Ala	33	33	-	-	-	-
Cocorit 71 x Cebada CI-2288	Ala	25	25	-	-	-	-
Cocorit 71 x Cebada CI-2288	Sin	20	20	-	-	-	-
Tob66 x Dic-Hip	Ala	23	19	-	-	-	-
Tob66 x Dic-Hip	Sin	25	24	-	-	-	-
Tob66 x Apizaco	Ala	20	20	-	-	-	-
Tob66 x Apizaco	Sin	22	22	1	1	1	1
Tob66 x Celaya	Ala	25	25	-	-	-	-
Tob66 x Cebada M16	Ala	25	25	-	-	-	-
Tob66 x Cebada M16	Sin	27	25	-	-	-	-
Tob66 x Ahor 2104/70	Ala	10	9	-	-	-	-
Tob66 x Ahor 2194/70	Sin	20	19	-	-	-	-
Tob66 x Ahor 3100/70	Ala	27	27	-	-	-	-
Tob66 x Cebada CI-2288	Sin	15	14	-	-	-	-
Tob66 x Avena spp	Ala	10	6	-	-	-	-
Jup 73 x Dic-Hip	Ala	25	25	-	-	-	-
Jup 73 x Dic-Hip	Sin	17	17	1	1	-	-
Jup 73 x Apizaco	Sin	28	28	-	-	-	-
Jup 73 x Celaya	Ala	22	22	3	3	2	1
Jup 73 x Celaya	Sin	16	16	-	-	-	-
Jup 73 x Celaya	Ala	22	22	3	3	2	1
Jup 73 x Celaya	Sin	16	16	-	-	-	-
Jup 73 x Cebada M16	Ala	27	25	1	1	1	1
Jup 73 x Cebada M16	Sin	18	18	-	-	-	-
Jup 73 x Ahor 3100/70	Ala	11	9	-	-	-	-
Jup 73 x Ahor 3100/70	Sin	13	13	-	-	-	-
Jup 73 x Avena spp	Ala	20	18	2	-	-	-

Progenitors used in inter-generic crosses

Dic-Hip	Barley
Apizaco	Barley
Celaya	Barley
M16	Barley
Ahor 2194/70	Barley
Ahor 3100/70	Barley
CI-2288	Barley
Cocorit 71	Wheat
Tob66	Wheat
Jupateco 73	Wheat
WS 1809	Wheat
Bza 55	Wheat
T. monococcum	Wheat
Snoopy	Rye
2796	Rye
Avena spp	Oats

Description of treatments

Stage of development:	A • Initiation of head development
Way of application:	I • Injection
	II • Spreading
Concentration:	a • 1gr/liter
	b • 0.1 gr/liter
Chemical:	EACA • Epsylon Amino-N-Caproic Acid

1.9 Pathology

1.9.1 INTRODUCTION

Rusts and other diseases caused by fungi, bacteria, and viruses, limit yields and produce poor grain quality in wheat crops around the world. Improvement programs continually search for genes for resistan that can be incorporated into commercial varieties.

CIMMYT complements its disease screening program in Mexico with the findings of collaborators in many parts of the world. These findings stem from different international nurseries, as well as tests of materials from their own national programs. Thus, there is a constant interchange of information and germplasms that permits the use of suitable parents to broaden the gene pool for disease resistance in advanced generations.

1.9.2 RUSTS

Under Mexican conditions, three rusts of wheat are screened in the field. Leaf rust epidemics develop naturally in the Northwest and Northeast of Mexico; reactions are recorded on different nurseries planted in the winter in the Yaqui Valley, Sonora; in Los Mochis, Sinaloa; and in Rio Bravo, Tamaulipas. The summer nurseries grown in the Central Plateau (El Batan, Toluca, Patzcuaro) provide valuable information on stripe rust and Septoria leaf blotch. In addition, the stem rust fungus is heavily inoculated in both summer and winter nurseries, allowing the elimination of susceptible plants.

It is assumed that no major change in virulence occurred in the population of Puccinia graminis tritici (the causal agent of stem rust of wheat) in Mexico during 1974. The Mexican varieties under cultivation, as well as the most advanced genotypes in the bread wheat and durum wheat programs, are still highly resistant to the biotypes of the fungus found in commercial wheat crops.

The resistance against leaf rust (caused by Puccinia recondita) is less durable in the Mexican varieties. Race 77 of the fungus was first detected in 1971-1972, and the Bluebird genotypes (Yecora 70, Saric 70 and Cajeme 71) became susceptible. Such changes in virulence makes necessary the development and release of new varieties that can quickly replace susceptible varieties.

Table 1.9.A lists the entries in the 7th. International Bread Wheat Screening Nursery that were found to be highly resistant to leaf rust at 10 locations in the world. Line Kalyan-Bluebird, singly, or in crosses, such as Pavon "S" (= Vcm x Cno "S"-7c/Kal-Bb) or Moncho " " (= Wren-Gto x Kal-Bb), seems to provide a good level of resistance in many countries.

The stripe rust of wheat caused by Puccinia striiformis is found in areas with cool and humid climates. It is particularly important in the Andean Valleys of Ecuador and Peru; in the Central Valleys of Chile, and, occasionally, in the Argentinian pampa. The disease is endemic in the European countries of the North, in the mountains of Kenya, and in certain areas of the Anatolian Plateau in Turkey.

Stripe rust is severe in the summer nurseries grown by CIMMYT near Toluca, State of Mexico, and in other wheat growing regions of the Central Plateau. Table 1.9.B shows the reactions of the genotypes most resistance at eight locations, including data from four sites in Mexico. Three of each of the Pavon "S" (= Vcm x Cno "S" - 7C Kal-Bb) and Emu " " (Tob " " - Napo x No66-Era/Bb-Gallo) lines exhibit a high level of resistance and are used extensively in the breeding program. Some Pavon "S" lines also are resistant to Puccinia recondita, as noted previously.

1.9.3 LEAF BLOTCH (SEPTORIA TRITICI)

In 1971, the International Septoria Nursery (ISEPTON) was started by CIMMYT as a cooperative effort to assemble and distribute resistant germplasm. The materials to be included in ISEPTON were chosen first from the nurseries grown in the vicinity of Patzcuaro, Michoacan State in the Central Plateau of Mexico, where outbreaks of the disease occur naturally every summer.

In addition to CIMMYT's regular nurseries, screening efforts involve the Regional Disease and Insect Screening Nursery (RDISN) from Beirut, Lebanon, the Latin American Disease and Insect Screening Nursery (LADISN), the Septoria nursery from Brazil, and the

Observation Nurseries and Crossing Blocks from other countries.

Table 1.9.C is a summary of the best genotypes recorded in ISEPTON # 4. Most of the resistance originates in Brazil, either in varieties such as IAS 20, Toropi and Nova Prata; or in lines from the Passo Fundo and Cruz Alta Experimental Stations. The Mexican line $Tzpp^2$ - $Andes_E{}^3$ has been resistant for several years. The high ratings for Brazil and Paraguay shown in Table 1.9.C, represent the attack of several foliar pathogens like Septoria tritici, Septoria nodorum, Helminthosporium sp. and Giberella sp. This complex of pathogenic microorganisms occurs simultaneously in such a way that it is virtually impossible to assess damage caused by Septoria tritici, or any other fungus, alone.

Table 3.9.D shows the ratings for leaf blotch among entries of the 7th. International Bread Wheat Screening Nursery, as reported by 6 countries (7 locations).

Table 1.9.E lists the best selection obtained from two disease nurseries, RDISN and LADISN in Patzcuaro, Mexico. After being grown and re-selected for rust resistance in the Yaqui Valley, these materials were incorporated in ISEPTON #6.

1.9.4 POWDERY MILDEW

The causal fungus Erysiphe graminis tritici can attack the wheat plant at all stages of development, and the most severe damages occur when the epidemic develops in the seedling stage. Outbreaks of the disease are observed in some European countries, in the coastal region of the Sea of Marmara in Turkey, in the area of Gorgan in Iran, and in the Southern wheat belt of Brazil. The Mexican variety 7 Cerros and derivatives provide good level of resistance to be used in parental nurseries. Other advanced lines listed in Table 1.9.F offering similar possibilities are: Mengavi-8156; several lines of Kalyan-Bb; $Y50_E$-Kal^3 and Gto - 7C x Bb-Cno.

1.9.5 BARLEY YELLOW DWARF VIRUS (BYDV)

The extent of BYDV epidemics depends on the amount, species, and migrations of the aphid vector. Symptoms of the disease on wheat consist of stunting, general yellowing of the entire plant, chlorosis or "bleaching" of the leaf lamina, poor development of the spike, and negligible grain formation. The severity of the symptoms increases when infection occurs at the early stages of plant development.

Complete destruction of the crops have been observed in Central Chile, Southern Brazil, Paraguay and Argentina, especially in fields where no insecticide has been sprayed for aphid control.

The data shown in Table 1.9.G were recorded at the Experimental Station of Palmerston North, New Zealand.

Comparative studies examine plant growth and development.

T.1.9.A Genotypes from the 7th International Bread Wheat Screening Nursery highly resistant (average coefficient of infection no more than 5.0%) to *Puccinia recondita* in 10 locations*

Entry	Variety or cross and Pedigree	Average Coef. of infect.
285	VcmxCno"S"-7C/Kal-Bb = Pavon "S" CM-8399-0-4M-3Y-1M-0Y	0.2
105	(Tob-B.Man x Bb/Cdl)Sx CM-8972-F-9M-4Y-0M	0.3
238	Peto(R)-Cal/7C x Bb-Cno CM-5746-G-3Y-6M-1Y-3M-0Y	0.3
239	Peto(R)-Cal/7C x Bb-Cno CM-5746-G-3Y-6M-2Y-5M-0Y	0.3
275	We-Gto x Kal-Bb = Moncho "S" CM-8288-A-3M-5Y-4M-0Y	0.3
286	Vcm x Cno"S"-7C/Kal-Bb = Pavon "S" CM-8399-0-4M-3Y-3M-0Y	0.3
230	Bb-Cno/Nad-Chr"S" x Sr CM-5566-B-2Y-2M-1Y-1M-0Y	0.4
47	Vcm x Cno"S"-7C/Kal-Bb = Pavon "S" CM-8399-0-4M-3Y-0M	0.6
162	Cno"S"-Inia x Lfn/Tob x Kl Pet-Ref CM-2281-13M-1Y-3M-1Y-1M-0Y	0.6
188	Cno"S"-7C x Tgn CM-4719-9Y-7M-1Y-3M-0Y	0.6
253	(Potar"S" x Soty-CC/Cno)On x CC-Inia CM-5878-E - 1Y-1M-2Y-2M-0Y	0.6
254	Tp x Cno-Inia"S"/Cno-Inia"S"^{2} CM-5919-B-1Y-1M-1Y-1M-0Y	0.6
274	We-Gto x Kal-Bb = Moncho "S" CM-8288-A-3M-1Y-5M-0Y	0.6
301	CC-We x Yr"S" CM-11530-P-1Y-5M-0Y	0.6
190	Cre x Cno-7C CM-5022-21Y-2M-1Y-3M-0Y	0.7
255	Tp x Cno-Inia"S"/Cno-Inia"S"^{2} CM-5919-B-1Y-1M-1Y-4M-0Y	0.7
58	Cno"S"xNad-Chr"S"/San-Kl.Rendxbb CM-1221-54M-2Y-2M-4Y-0M	0.8
102	Kal-Bb 26992-30M-300Y-300M-5C1Y-5C1M-0Y	0.8
103	Hopps-Ron x Kal = Mork "S" CM-8874-K-1M-1Y-0M	0.8
248	CalxCno-San64(CnoxNad-Chr"S"/San64-Kl.Rend xBb) CM-5774-G-1Y-4M-4Y-1M-0Y	0.8
262	Cno-7C x Yr"S" CM-7213-5M-2Y-1M-0Y	0.8
328	(Cno-Inia"S"^{2}/CnoxNad6) CM-5823-E-1Y-1M-3Y-0M	0.8
310	Cno"S"-Gallo x BbxNA/K4496 CM-11909-A-1Y-9M-0Y	0.9
64	Bb-7Cerros CM-1562-22M-3Y-2M-7Y-0M	1.0
244	CalxCno-San64(CnoxNad-Chr"S"/San64-Kl.Rend x Bb) CM-5774-A-8Y-1M-1Y-2M-0Y	1.0
57	(Fn-NdxK117A/Cofn^2)San64-Kl.Rend/Cno"S"-LR64^4-San CM-2182-5M-1Y-2M-1Y-0M	1.1
91	Gallo-Aust [61.15.7 x Cno-No66 34920-27Y-4M-1Y-2M-3Y-0M	1.1
77	Bb-Tob(Cno-No66/C27)xNp875-E853.5.8 CM-2699-59M-1Y-1M-2Y-0M	1.2
271	(Cno-Inia"S"/Lib64-Inia x Inia-Bb)Bb^4 CM-8228-J-6M-1Y-3M-0Y	1.3
19	Jupateco"S" 30842-58R-1M-4Y-0M	1.4
56	(MX-38MxRfn^2-908/Fn)Yr70 CM-2097-31M-1Y-2M-5Y-0M	1.4
113	(No66-Bb/CnoxNad-Chr"S")7C CM-5375-[illegible]-1Y-1M-1Y-0M	1.4
246	CalxCno-San64(CnoxNad-Chr"S"/San64-Kl.Rendxbb) CM-5774-A-8Y-5M-2Y-3M-0Y	1.4
291	CC x Cnl-Sr CM-10630-45Y-2M-0Y	1.4
299	WS-1877-CJ71 x Cha CM-11517-E-4Y-1M-0Y	1.4
38	Lfn x Cno"S"-No RF4-81	1.5
78	(Fn-NdxK117A/Cofn^2)San64-Kl.Rend/Cno"S"xLR64^2-San64 CM-2182-5M-1Y-2M-3Y-0M	1.5
117	Nad63-LR64AxBb II-30756-35-1M-1T-0M	1.5
229	Bb-Cno"S" x Jor/Cno-7C x CC-Tob CM-5546-A-5Y-3M-2Y-3M-0Y	1.5
258	Yr-Cal CM-6173-7M-1Y-3M-0Y	1.5
270	Cno-San64 x Bb-Inia/Tob x CC-Peto CM-8220-A-8M-1Y-9M-0Y	1.5
104	Cno-7C x Cno-Inia/Sx CM-8943-F-1M-4Y-0M	1.6
324	RR68-WW15/BJ"S"-On^{2}xBon CM-12273-A-2Y-7M-0Y	1.7
59	Inia-Bb(Cno"S" x El Gou-San64/Tzpp-San64 CM-1334-17M-3Y-7M-1Y-0M	1.8
284	Cno"S"-7C x Cno-Inia/Tob CM-8380-F-9M-2Y-2M-0Y	1.8
82	(Fn-NdxK117A/Cofn^2)San64-Kl.Rend/Cno"S"xLR64^2-San64 CM-2182-5M-1Y-3M-1Y-0M	1.9
165	(Inia/San64 x Tzpp-Y54)CzAo Bg-G-1Y-3M-2Y-1M-0Y	2.0
233	Bb-Cno/Cno"S"-No66 x P162 CM-5620-D-3Y-1M-2Y-2M-0Y	2.0
90	Nor-P1/Nor67-Cno x San64 II-35052-28Y-1M-1Y-1M-2Y-0M	2.1
250	Cal x Cno-Inia"S"^{2}/Bb-Tob x Cno^2-Chr CM-5780-I-3Y-3M-7Y-1M-0Y	2.1
101	Bb-Inia = Torim "S" 26591-1T-7M-0Y-218Y-0M	2.2
251	CalxCno-Inia"S"^{2}/Bb-TobxCno^2-Chr CM-5780-I-3Y-3M-7Y-7M-0Y	2.2
293	(On-P162)^2-CalxYr"S" CM-10727-60Y-5M-0Y	2.2
245	CalxCno-San64(CnoxNad-Chr"S"/San64-Kl.Rendxbb) CM-5774-A-8Y-1M-1Y-4M-0Y	2.3
145	CC-Cno"S"^{2}xTob-Cno"S" CM-1323-40M-7Y-2M-1Y-2M-0Y	2.4
158	(Fn-NdxK117A/Cofn^2)(San64-Kl.Rend/Cno"S"xLR64^2-San64) CM-2182-6M-2Y-4M-6Y-1M-0Y	2.4
124	Bb-Inia 26591-1T-7M-0Y-2M-0Y(1-9Y)-0Y	2.7
43	(Inia/San64xTzpp-Y54)CzAo 3.6C.1Y-3M-0Y	2.8
156	(MX-38MA x Rfn^2-908/Fn)Yr CM-2097-31M-1Y-3M-2Y-1M-0Y	2.8
182	Cno-7C x Kal-Bb CM-4407-12Y-1M-6Y-1M-0Y	2.8
45	Kalyan-Bluebird 26702-30M-1Y-1M-500Y-0M	3.0
157	(MX-38MA x Rfn^2-908/Fn)Yr CM-2097-31M-1Y-3M-2Y-2M-0Y	3.4
143	Cno-Inia"S"^{2}/Tob-CfnxBb CM-1248-54M-2Y-1M-4Y-4M-0Y	3.7
315	(Bb x San-Kl.Rend/Cha)Gb(R) CM-11928-A-1Y-2M-0Y	4.2

*) Locations: Egypt (Sakha); Rhodesia (Salisbury); India (Gujarat); Pakistan (Punjab); Mexico (El Batan, Sinaloa, Sonora and Tamaulipas); U.S.A. (Indiana), and Argentina (Pergamino).

T.1.9.B Varieties and lines from the 7th International Bread Wheat Screening Nursery most resistant (average coefficient of infection 5.00% or less) to stripe rust in 8 locations*.

Entry	Variety or Cross and Pedigree	Average Coef. of Infect.
299**	WS 1877-CJ71 x Che CM 11517-E-4Y-1M-0Y	1.3
174**	Fury x Cno"S"-Ho 66 CM 4210-1Y-1M-1Y-1M-0Y	1.4
71**	Jar-Cno x Cfn-Cno/Sr 70 CM 1733-9M-1Y-1M-1Y-0M	1.6
288**	Flr x Cno-Ias/Cfn-Cno"S" x Mar59-On CM 8593-G-2M-1r-1M-0Y	1.9
325**	Tob66-Cno"S"/Cno-7C x CC-Tob CM 6429-17Y-2M-0Y	1.9
114**	Cno-7C x CC-Tob/SD648.5-8156 CM 4756-12Y-1M-3Y-0M	2.1
278**	Tob"S"-Np x No66-Era/Bb-Gallo = Emu"S" CM 8327-C-9M-4Y-4M-0Y	2.2
47**	Vcm x Cno"S"-7C/Kal-Bb = Pavon "S" CM 8399-D-4M-3Y-0M	2.3
282**	Tob"S"-Np x No66-Era/Bb-Gallo = Emu "S" CM 8327-C-9M-4Y-8M-0Y	2.4
281	Tob"S"-Np x No66-Era/Bb-Gallo=Emu"S" CM 8327-C-9M-4Y-6M-0Y	2.6
283	Bb-Cno/Cno"S"-No66 x Pl62 CM 5620-D-3Y-1M-2Y-2M-0Y	3.0
235	Tob-8156 x Pato(R)/Inia-Tzpp CM 5704-D-3Y-1M-2Y-4M-0Y	3.0
158**	(Fn-NdxK117A/Cofn^2) (Son64-Kl.Rend/Cno"S"-LR64^2-Son 64) CM 2182-6M-2Y-4M-6Y-1M-0Y	3.1
53**	Cno"S"-7C x Tgn CM 4982-11Y-3M-1Y-0M	3.3
66	Inia"S"-On x Inia-Bb CM 1607-17M-1Y-1M-1Y-0M	3.4
153	Robin-Chanate CM 1711-10M-8Y-1M-1Y-1M-0Y	3.5
285	Vcm x Cno"S"-7C/Kal-Bb = Pavon "S" CM 8399-D-4M-3Y-1M-0Y	3.5
286	Vcm x Cno"S"-7C/Kal-Bb = Pavon "S" CM 8399-D-4M-3Y-3M-0Y	4.0
92**	Bb-Gallo/Cno-Son 64 x Bb 35129-26Y-2M-1Y-1M-1Y-0M	4.1
48	Tob"S"-Np x No66-Era/Bb-Gallo CM 8327-C-9M-1Y-0M	4.2
283	Np-Cdl x Bb-Cno"S" CM 8371-F-5M-1Y-4M-0Y	4.2
27	PL/Inia-Cno x Cal 34148-5Y-1M-3Y-0M	4.3
115	Cno-Bb x Cdl(7C/Lib64-Inia x Inia-Bb) CM 5872-C-1Y-1M-3Y-0M	4.3
294	Bul-Gallo x We CM 10731-51Y-2M-0Y	4.4
302	Cno-7C x Mar67/Cal-Cno CM 11552-C-3Y-2M-0Y	4.4
244	Cal x Cno-Son64(Cno x Mad-Chr"S"/Son64-Kl.Rend x Bb) CM 5774-A-8Y-1M-1Y-2M-0Y	4.7
234	Tob-8156 x Pato (R)/Inia-Tzpp CM 5704-D-3Y-1M-2Y-3M-0Y	4.8
257	Bb-M Desp 101^2 x Cno-Son 64 SW3-8-1Y-1M-3Y-5M-0Y	4.9
307	CC-Che 70 x Bb-Mar67 CM 11870-C-1Y-3M-0Y	4.9

* Kenya (Njoro); Holland (Wageningen); Mexico (El Batan, Toluca, Celaya); Ecuador (Santa Catalina); and Chile (Chillan, Carillanca)

** Entries with average coefficients of infection of less than 10.0% at all locations.

T.1.9.C Varieties and lines of bread wheat and durum wheat included in ISEPTON # 4 resistant to moderately resistant to Septoria tritici in most of 5 locations. (Scale 0-9).

Entry	Variety or cross and pedigree	England	Algeria	Australia	Ethiopia	South Africa	Brazil	Paraguay	Argentina
4	Iessul = IAS 20	1	5	7	4	1	9	8	2
7	PF 69175	1	7	8	3	1	9	8	2
10	Toropi	2	3	7	2	2	9	5	2
11	Nova Prata	4	5	6	2	2	9	8	5
17	Mexicano 120	2	9	7	2	2	9	9	4
42	Tzpp^2 - An^3$_E$ 11-19025-6M-4Y-101T-101C-0M	3	8	5	5	2	4	8	5
45	Tzpp^2 - An^3$_E$ 11-19025-6M-4Y-4M-101T-101E-0M	4	8	5	5	2	5	6	4
48	C 3228/65	2	5	2	3	2	-	5	6
63	PF 70216	5	7	4	3	1	7	4	6
93	Tehuacán 60 (Durum)	6	3	5	5	1	4	3	4
96	Wells (Durum)	5	-	[illegible]	[illegible]	1	4	4	[illegible]
97	Rolette (Durum)	7	5	6	3	1	4	5	4
98	Capeite (Durum)	5	7	4	3	3	8	7	5

*) Locations: England (Aberystwyth); Algeria (Oued Smar); Australia (Victoria); Ethiopia (Holetta); South Africa (Stellenbosch); Brazil (Cruz Alta R.S.); Paraguay (Capitan Miranda), and Argentina (Balcarce).

T 1.9.D Entries in the 7th International Bread Wheat Screening Nursery resistant to *Septoria tritici* in most of 7 locations (Score 0-9).

Entry	Variety or cross and pedigree	Pergamino (Arg.)	Balcarce (Arg.)	Colombia	Portugal	England**	Poland**	Algeria
6	Potam 70	4	5	0	3	-	1	9
9	WW15=LR-N108 x An^3_E	4	5	0	2	-	2	6
17	Bonanza	4	5	0	3	-	1	9
19	Jupateco "S" 11-30842-59R-1M-4Y-0M	2	2	0	2	-	2	9
27	PL/Inia-Cno x Cal 34148-51Y-1M-3Y-0M	4	4	1	2	-	2	7
31	Tob"S"-Napo x CC-Inia/Cha CM-5541-C-5Y-1M-0Y	4	5	0	3	-	2	9
35	Inia-Bb x RR68/Cno-No CM-2300-24M-3Y-1M-0Y	3	5	1	3	-	1	8
36	(Fn-MdxK117A/Cofn^2) (Son64-Kl.Rend/Cno"S" x LR64^2-Son) CM-2182-5M-1Y-2M-0Y	3	5	2	3	-	2	9
50	Jupateco 73 30842-31R-2M-2Y-0M	5	5	0	2	-	2	9
76	Pato-7C/CC-8156 x Cno"S" CM-2264-7M-1Y-1M-4Y-0M	4	4	1	3	-	2	8
92	Bb-Gallo/Cno-Son64 x Bb 35129-26Y-2M-1Y-1M-1Y-0M	4	5	1	3	-	3	8
166	(Inia/Son64 x Tzpp-Y54)Czho B6-G-1Y-3M-3Y-1M-0Y	4	2	1	3	-	2	9
169	Nor 67-Yecora CM-3941-4Y-4M-4Y-1M-0Y	4	2	1	3	-	1	9
194	Bb-CC/Cno-No66 x P162 CM-5568-5Y-1M-4Y-2M-0Y	3	5	0	3	-	3	9
216	Chris-Pj x Saric CM-5299-A-1Y-3M-2Y-5M-0Y	4	5	0	3	-	1	9
218	Tob"S"-Napo x CC-Inia/Cno-No66 CM-5350-G-3Y-8M-2Y-3M-0Y	4	5	0	3	-	1	9
247	Cal x Cno-Son64(CnoxNad-Chr"S"/Son64-Kl. Rend x Bb) CM-5774-A-8Y-5M-2Y-4M-0Y	3	5	0	5	3	3	7
265	B.Man-7C x Cdl CM-8186-H-1M-4Y-3M-0Y	4	5	1	3	-	2	6
271	(Cno-Inia"S"/Lib64-Inia x Inia-Bb)Bb#4 CM-8228-J-6M-1Y-3M-0Y	4	5	0	4	5	2	8
318	(Son64-Kl.RendxSD648.5-8156/Cno"S"^{2}-Chr) Bb-Cal x Nad CM-12249-F-1Y-1M-0Y	4	3	0	3	-	3	8
319	RR68-WW15/Jl"S"xCno-N-66 CM-12272-Ñ-1Y-1M-0Y	6	4	0	3	2	5	5
328	(Cno-Inia"S"^{2}/Cno x Nad63-Chr"S")Cno-B.Man CM-5823-E-1Y-1M-3Y-0M	4	4	1	4	-	2	5

*) Argentina (Pergamino Station INTA)
Argentina (Balcarce Station INTA)
Colombia (Tibaitatá, ICA)
Portugal (Plant Breeding Station, Elvas)
England (Plant Breeding Institute, Cambridge)
Poland (Pustkow, Wroctaw)
Argelia (Oued Smar)

**) Data reported for *Septoria* spp)

T. 1.9.E. Bread wheat and durum wheat genotypes resistant to *Septoria tritici* selected in Patzcuaro, Michoacan, Mexico in the summer of 1974. (Scale 0-9).

Entry #	Cross	Pedigree.	Septoria rating
	4th. REGIONAL DISEASE AND INSECT SCREENING NURSERY		
55	8156 B-V534	JIT 17-1L	3
58	S 311-Mar 67	JIT 43-1L	4
69	Mang - 8156 R	H 223-64-1Y-6C-1Y-1C-4Y-3C	4
110	CI 12633-CD^2 x Ch 166-Des^{3}xCD	TP 114/207	2
224	Fr-PJ62 x No 66	25446-2M-6R-S5469	5/10%
248	B5-184/1	Tf-Bka^6	2
249	B5-195/1	Tf-Panonija^6	2
250	B5-208/8	Tf-Bez 17	2*
251	JPR 349	Zagreb	2
252	JPR 354		2
253	JPR 369		2
341	Nova Prata		3
384	Pana 247-Arcana B		5/20%
388	Pana 247-Arcana B		3*
459	Lilifen		
511	K 6290/9	AFM-Ram^2 (Kenya	4
516	Tob-8156R	23439-8M-1Y	4
545	PI 293004		4
548	J 9281.67 LR64A	B573-19C-2C-0C	5
558	K 4500-4		5
561		K 4573 L302	4
562	Romany x GB-Gamenya 1A2C	K 6295-4a	4
563	Mexico		4
582	Cardenal "S"	27105-21M-300Y-3M-1Y	4
592	Raujaje 12		3
593	Iassul 20	IAS 20	3
594	Aniversario		1
595	Chris	II 53-525	3
596	Tob-B Man x Bb	25995-5b-3J-101j-4y-1m-0y	2
597	Inia "S"-Mapo x Cal^2	30656-5M-3Y-1M-0Y	4
598	Marukihari		2
599	Sugamuxi	II 12193-7b-1t-2b	4
604	NS 314		4
608	Selam-Seafoam	P106-19	4
609	TP 114/207-208		4
621	Fr/KAD-Cb x Bza	12380-23n-1e-5e-1e-1e-1e	6
686	Selam-Seafoam P 102.12xMup65	I 114-1L-1L-0L	2
694	Mar/Yt54E-Yr4^2 x Dirk	CM781-2L-8L-0L	3
716	Cfn-Cno^2 x 7C	CM1756-3L-1L-0L	6
723	Rfn/Ofn "S"-MAG x Tzpp/S64 - Mr63	D69/490-1L-2L-0L-	4
729	(Rfn^2-908/Fn x II 50.28 x Tc' Inia "S"	D69/28-1L-1L-0L	5
862	F2 Bulk Selam-Seafoam x Inia	7 -9L-0L	3
913	Tob66-Cno"S" x PJ62	CM 7369-6L-0L	5
951	Cno"S" (A)/Tob-Cfn x Bb	CM 5187-2L-0L	3
1047	Mohan Gemais	ACSAD 232/72-73	6
1073	Selam-Seafoam PIC6-19 x Mup	L114-1L-1L-0L	2
1081	Selam-Seafoam PIC6-19 x	L111-0L-7K-1K-0L	4
10	Inia 66		
1091	Parana-Mup		4
1177	CM-2		2
1178	CM-4		4
11AA	HTC-1		3
1223	Fr-ND42xND42-Fr	ND12-11	3
1235	Gaboto-Mag	DV80034-PI 320552	5
1249	Jn^2(ND529-Con x ND122/Jn)Val	ND71-11-115	4
1250	Val"S" 3/2/VRT 238/5/Jn	ND 71-12-108	3
1251	Jn-Th^3 x CI 12632/Rz	ND71-12-109	3
1252	ND373/3/Giza Heçazy Ahmer	ND71-12-111	4
1253	Val x II 54.45 x 2 Val-Sw92	ND71-12-131	2
1254	Cno"S"-Era	ND71-12-148	3
1255	ND 487-Flr	ND71-13-1059	5
1370	Rfu (Fr-KxN/Mar 1CB)	CH-7790-12P-9P-1P-1P	2
1371	Toquifen	CM7817-1P-1P-4P-1P-1P	3
1385	Cabildofen	PI 324517	1
1386	Egypt 3728/2/3 Capelli/Giza	CM 3305-2P-1P-1PA	4
1390	Webster x II 62-16	June 10	3
1391	Id	June 11	3
1392	Id	June 12	4
1394	Id	June 15	2
1395	Id	June 16	3
1396	Id	June 17	4
1398	Id	June 19	2
1399	Id	June 20	3
1401	Id	June 21	3
1402	Id	June 22	3
1403	Id	June 23	3
1404	Id	June 24	2
1405	Id	June 25	2
1406	Id	June 26	2
1407	Id	June 27	2
1408	Id	June 28	2
1409	Id	June 29	2
1413	Id	June 33	3
1414	Id	June 34	3
1425	Tob66-8156(R) x B Man	ICM818-0CM-1A-1A-0A	5
1426	Gto-7C	ICM851-0CM-1A-2A-0A	4
1443	Kl/Pet-Raf x Cno-Ho/Cno^2-Chis	ICM2226-0CM-1A-1A-0A	4
1451	(Cno-Chrx Bb) Ska) Tob"S" - Mpo 63	ICM2402-0CM-1A-2A-0A	4
1592	Blueboy (Winter'	N Carolina	3
1665	Oa x S64-Kl Rend/Cal	31206-2Tu-1MB-08J- J-197	3
1837	Gaviota "S"	D31725-3M-12Y-2M-0Y	4
1855	Cr"S"-Ga"S" x Plc"S'	CM597-26M-1Y-1M-0Y	3
1874	Jo"S"-Cr"S" x Lds/PTL"S"	CM17681-0-2M-0Y	4
1891	BY$_E$-^{2}-^{5} x Gaviota "S"	CM12637-1Y-1M-0Y	5
1939	Gto"S" x 215G3-AA"S"	CM10143-6M-3Y-1M-0Y	5
1947	Gro"S"-Fg"S"	CM10145-52M-4Y-2M-0Y	4
1949	/AA"S"(CF$_E$^{3}-Gz x Tc^3)/BY$_E$^{3}-Tc)_/ 215G3-AA"S"	CM10161-6CM-4Y-2M-0Y	3

T. 1.9.E Cont.

1952	Cit "S"-D 21564	CM2988-5Y-2M-1Y-1M-0Y	4
1968	Wells		4
1970	Gerardo 574		4
1974	Sincape 9		4
2001	D. Dwarf S15-Jori "S"	D33303-3Y-1M-0Y	3
2002	D.Dwarf S15-Crane"S"	D33312-9Y-2M-0Y	3
2003	21563-Brant "S"	31552-7L-0L	4
2006	Durum variety 24		3
2007	Pelicano	B25609-2M-1Y-1M	2
2008	21563-Al"S"	31546-3L-0L	3
2032	Gerardo 598		3
2034	Kyperounda		3
2052	Tr. Polonicum		3
2061	D.Dwarf S15-Cr"S"	D33312-8Y-4M-2Y-0M	4
2083	Gerardo V2469-Plc"S"	CM373-3M-2Y-1M-0Y	4
2093	Giorgio 447		2
2116	61-130 x Lds x Gll/Ganzo"S"	ICM547-0L-4A-0A	3
2166	Mohd-B.Bachir	ACSAD 245/72-73	4
2176	Tal	Kenya	4
2182	DIB		4
2215	IDSN 85	Durum Tunisian Adv. Lines	3
2230	DF 69-1-15A-2A	Id	3
2231	D 68-10-2$_1$-2$_1$	Id	3
2239	D68-8-6A-3A	Id	4
2243	D68-55-9A-3A	Id	3
2245	D68-55-9A-1A	Id	4
2247	D68-4-21A-8A	Id	4
2258	D68-5-3B-4A	Id	4

Entry	Cross	Pedigree		Septoria rating
	2nd LATIN AMERICAN DISEASE AND INSECT SCREENING NURSERY			
15	PI 297027 (R)	Code/70-30	Ethiopia	4
16	K 4500	L1A1A	Ethiopia	2 *
29	G 73921-22		Greece	4 *
30	4500-4		Kenya	3 *
31	Pembina X11-52-3293 x 1153.388		U.S.A.	4
40	Era x Cno"S"-7C	CM5022-21Y-1M-0Y	Mexico	4 *
72	Mar 59^2(1088-Kt x Fr-Fn/Y)		México	4 *
74	K 253-18		Australia	3 *
76	PJ62-Wrt x Cal	26978-2M-300Y-300M	México	4
98	Kl.Rend-Son64^2 x LR64A-Son64/CC-Gto	24971-1M	México	3 *
150	UQ 105		Australia	3 *
157	PV18A-Cno67	27893-1Y-8M-2Y-50CM-0Y	Mexico	7/30%
236	Pichihuila "S"	CM7652-17Y-501M-500Y-CM	México	2
237	Pichihuila "S"	" "	Mexico	2
252	TpxCno-Inia"S"/Cno-Inia"S"^{2}	CM5919-A-6Y-1M-1Y-500M-501Y-0M	México	7/20%
261	Tp (Cno-Ho66)^2	CM5527-A-3Y-500M-500Y-500M-501Y-0M	México	4 *
262	Tp (Cno-Ho66)^2	CM5527-A-3Y-500M-500Y-500M-502Y-0M	México	4
263	Tp (Cno-Ho66)^2	CM5527-A-3Y-500M-500Y-500M-500Y-0M	México	4
377	Fletcher		U.S.A.	5 *
392	Nova Prata		Brazil	5
393	J9253-67		Brazil	4
394	J9137/67-Trintani^2-Rfn		Brazil	4
395	Nobre	B529-22C-1C-0C	Brazil	4
408	Romany	Code/70-12	Ethiopia	3 *
433	21563 AA"S"	D27563-5M-2Y-2M-1Y-0M	México	3
442	Parana 66/270		Argentina	4
448	Roussio80.1419			4
450	Ga"S"(D.Buck x Tma-Tc^2/LR)	D27666-4M-1Y-0M	Mexico	3 *

T. 1.9.P Wheat genotypes resistant to powdery mildew in most of 6 locations. Data from the 7th International Bread Wheat Screening Nursery. (Scale 0-9, except for the USSR given in percent).

Entry	Variety or Cross and Pedigree	Portugal	Poland	Rumania	USSR	Iran	Rhodesia
12	Mengavi-8156(R) M-223-64-1Y-6E-1Y-1C-4Y-3C-100Y	1	2	0	-	1	0
25	$Y50_f$-Kal^3 35188-D-16Y-1M-1Y-0M	3	2	0	10	2	0
32	Son64-Chris x Bb(18M)-8156 CM-5697-J- 2Y-1M-0Y	3	2	-	0	3	0
39	$Y50_f$-Kal^3 35188-5M-(F_1)-31Y-0M-8M-0Y	2	2	-	0	1	0
41	BbxCC-inia 30807-11-2Y-2M-1Y-3M-0Y	3	4	-	5	4	1
42	$Y5C_f$-Kal^3 35188-5M-(F_1)39Y-0M-24M-0Y	2	2	-	0	1	0
44	Kal-Bb 26702-30M-1Y-1M-3Y-0M	3	2	-	5	1	0
45	Kal-Bb 26702-30M-1Y-1M-500Y-0M	3	4	-	10	2	0
50	Jupateco 73 11-30842-31P-2M-2Y-0M	4	2	-	0	4	0
71	Jar-Cno x Cfn-Cno/Sr70 CM-1733-9M-1Y-1M-1Y-0M	4	4	-	5	2	0
79	(Fn-MdxK117A/Cofn^2)Son64-K1.Rend/Cno''S''xLR64^2-Son64 CM-2182-5M-1Y-3M-2Y-0M	4	4	-	0	2	0
82	(Fn-MdxK117A/Cofn^2)Son64-K1.Rend/Cno''S''xLR64^2-Son64 CM-2182-5M-1Y-3M-1Y-0M	4	3	-	0	3	0
90	Nor67-P1/Nor67-Cno x Son64 11-35052-28Y-1M-1Y-1M-2Y-0M	3	3	-	0	3	0
91	Gallo-/ust 11 61-15.7 xCno-No66 34920-27Y-4M-1Y-2M-3Y-0M	4	3	-	0	3	0
106	(Tob-B Man x Bb/Cdl)Sx CM-8972-H-3M-3Y-0M	1	1	-	10	0	0
109	Cno''S''-Cdl x 7C CM-8974-J-5M-1Y-0M	1	1	-	5	0	0
112	(7C/Lib64-Inia x Inia-Bb)Tob-8156 CM-5349-A-9Y-1M-2Y-0M	2	2	-	5	4	0
113	(No66-Bb/CnoxNad-Chris''S'')7C CM-5375-F-1Y-1M-1Y-0M	2	2	0	5	2	0

T. 1.9.P Cont.

7o. ibWSN. Resistant to Powdery mildew (continuation).

Entry	Variety or cross and pedigree	Portugal	Poland	Rumania	USSR	Iran	Rhodesia
115	Cno-BbxCdl(7C/Lib64-IniaxInia-Bb) CM-5872-C-1Y-1M-3Y-0M	1	2	-	5	4	0
135	Cdl x Cno-Son64 CM-1135-41M-4Y-3M-1Y-1M-0Y	1	1	0	-	0	0
136	Cdl x Cno-Son64 CM-1135-41M-4Y-4M-2Y-2M-0Y	1	1	0	0	1	0
153	Robin-Chanate CM-1711-10M-8Y-1M-1Y-1M-0Y	3	3	-	0	1	3
204	Gto-7C x Bb-Cno CM-5278-B-4Y-1M-2Y-6M-0Y	4	2	-	0	2	0
205	Gto-7C x Bb-Cno CM-5278-B-4Y-1M-4Y-1M-0Y	3	2	0	0	1	0
206	Gto-7C x Bb-Cno CM-5278-B-4Y-1M-4Y-4M-0Y	3	2	-	5	1	0
207	Gto-7C x Bb-Cno CM-5278-B-4Y-1M-4Y-6M-0Y	4	2	-	0	1	0
209	Gto-7C x Bb-Cno CM-5278-B-4Y-1M-7Y-6M-0Y	4	2	-	0	0	0
222	Ron-Cha x Bb-Nor67 CM-5484-F-5Y-4M-2Y-3M-0Y	4	2	-	10	4	0
265	B.Man-7C x Cdl CM-8186-H-1M-4Y-3M-0Y	1	1	-	0	0	0
267	Cno-Son64xBb-Inia/Tob-CC x Patc CM-8220	4	4	-	0	4	0
283	Flr x Cno-Ias/Cfn-Cno''S'' x Nar59-On CM-8593-G-2M-1Y-1M-0Y	3	3	0	-	0	0
284	Cno''S''-7C x Cno-Inia/Tob CM-8380-F-9M-2Y-2M-0Y	3	2	0	-	4	0
291	CC x Cal-Sr CM-10630-45Y-2M-0Y	2	2	-	0	4	0
292	Era/CC x Cno-Son64 CM-10656-34Y-3M-0Y	4	4	-	0	2	0
323	RR68-WW15/Bj''S''-On^{2}xBon CM-12273-A-2Y-2M-0Y	2	2	-	0	0	0
324	RR68-WW15/Bj''S''-On^{2}xBon CM-12273-A-2Y-7M-0Y	2	2	-	0	1	0
329	Tth-Son64 x Y50^9 M-495-71A-3B-0Y	4	4	-	0	4	0

Portugal (Plant Breeding Station)
Poland (Pustkow, Wroctaw)
Rumania (ICCPT, Fundulea)
USSR (Abkhazian, ASSR)
Iran (Gorgan Experimental Station)
Rhodesia (Salisbury Research Station, Mashonaland Prov.)

(-) = Data not available

T. 1.9.G Genotypes of the 7th International Bread Wheat Screening Nursery resistant to barley yellow dwarf virus. Palmerston North, New Zealand, 1973-1974. (Scale 0-5)

Entry	Variety or cross and pedigree	Score
243	Bul x LR64^2-Son64/Inia-Bb x Tob-8156(R) CM-5764-A-1Y-2M-3Y-1M-0Y	Tr
8	Yecora 70	1.0
9	WW15=LR-N10B x An^{3}E	1.0
12	Meng-8156(R) M-223-64-1Y-6E-1Y-1C-4Y-3C-100Y	1.0
19	Jupateco 74=12300 x LR64-8156/Nor67 30842-58R-1M-4Y-0M	1.0
20	7 Cerros	1.0
26	Nor67-7Cerros 30367-1M-1Y-2M-1Y-0M	1.0
53	Cno"S"-7C x Tgn CM-4982-11Y-3M-1Y-0M	1.0
65	Bb-Cno x Inia-Soty CM-1502-8M-3Y-3M-2Y-0M	1.0
91	Gallo-Aust II 61-15.7 x Cno-No66 34920-27Y-4M-1Y-2M-3Y-0M	1.0
105	(Tob-B.Man x Bb/Cdl)Sx CM-8972-F-9M-4Y-0M	1.0
108	Bb-Pak F46313 CM-1396-40M-1Y-1M-2Y-0M	1.0
136	Cdl x Cno-Son 64 CM-1135-41M-4Y-4M-2Y-2M-0Y	1.0
152	Cno-Bb x Cdl CM-1702-21M-1Y-1M-1Y-1M-0Y	1.0
165	(Inia/Son64 x Tzpp-Y54)CzAo 86-G-1Y-3M-2Y-1M-0Y	1.0
168	Nor 67 x Tob-8156 CM-3940-8Y-2M-4Y-1M-0Y	1.0
181	CC-Inia x Bb(18M) CM-4320-28Y-2M-3Y-1M-0Y	1.0
182	Cno-7C x Kal-Bb CM-4407-12Y-1M-6Y-1M-0Y	1.0
184	Cno"S"-7C x CgA CM-4481-5Y-1M-1Y-5M-0Y	1.0
188	Cno"S"-7C x Tgn CM-4982-11Y-3M-1Y-4M-0Y	1.0

T. 1.9.G Cont.

Entry	Variety or cross and pedigree	Score
192	Son 64-Kl.Rend x Cno-CC/Tob CM-5359-1Y-3M-2Y-3M-0Y	1.0
201	Inia-7C x Cno-Tob CM-5199-G-1Y-1M-10Y-2M-0Y	1.0
211	Tzpp-Pl x 7C CM-5287-J-1Y-2M-1Y-1M-0Y	1.0
212	Tzpp-Pl x 7C CM-5287-J-1Y-2M-2Y-3M-0Y	1.0
237	Pato (R)-Cal/7C x Bb-Cno CM-5746-G-3Y-4M-1Y-5M-0Y	1.0
239	Pato (R)-Cal/7C x Bb-Cno CM-5746-G-3Y-6M-2Y-5M-0Y	1.0
261	Tob-Cno"S"/Soty-CC x Az67 CM-6430-1M-2Y-1M-0Y	1.0
265	B.Man-7C x Cdl CM-8186-H-1M-4Y-3M-0Y	1.0
272	Cno-Inia"S" x Soty-An64A/Vcm CM-8232-C-3M-4Y-7M-0Y	1.0
273	(CC-Inia/Tob-Cfn x Bb)7C CM-8237-G-1M-3Y-3M-0Y	1.0
279	Tob"S"-Np x No 66-Era/Bb-Gallo CM-8327-C-9M-4Y-4M-0Y	1.0
282	Tob"S"-Np x No66-Era/Bb-Gallo CM-8327-C-9M-4Y-8M-0Y	1.0
307	CC-Cha 70 x Bb-Nor67 CM-11870-C-1Y-3M-0Y	1.0
308	Cno"S"-Gallo x Bb#4A/K 4496 CM-11909-A-1Y-2M-0Y	1.0
311	Cno"S"-Gallo x Bb#4A/K4496 CM-11909-A-1Y-10M-0Y	1.0
316	P162"S" xCC-Inia/Bb x Cno-No66 CM-12244-F-5Y-4M-0Y	1.0
317	P162"S" x CC-Inia/Bb x Cno-No66 CM-12244-F-5Y-5M-0Y	1.0
323	RR68-WW15/BJ"S"-On^2 x Bon CM-12273-A-2Y-2M-0Y	1.0

1.10 International Nurseries

The International Nurseries Program is designed to: (1) disseminate germplasm (2) identify high-yield,and disease and insect resistant,varieties with broad adaptability and (3) serve as a channel for the exchange of germplasm for other National Programs.

The Program now involves 25 different nurseries in 83 countries throughout the world. (See Table 1.10I.) Each nursery focuses on specific features, such as yield stability under a wide range of environmental conditions or disease and insect resistance.

Results of Eight and Ninth International Spring Wheat Yield Nursery (ISWYN) and Results of the Second and Third International Durum Yield Nurseries (IDYN) were published during 1974.

In the summer of 1974, CIMMYT distributed 1210 nurseries (Table 1.10.I) and received 121 shipments of seed (Bread Wheat, Durum Wheat, Triticale and Barley) from 33 countries.

TABLE 1.10.1.- CIMMYT seed nurseries distribution by Geographic area in 1974.

Type of Crop	Nursery Name	Africa	Asia	Central America	Europe	Middle East	North America	Oceania	South America
Bread Wheat	Crossing Block		5	1	1	5	5	-	8
	F_2 Irrigated	12	17	1	7	4	13	-	10
	F_2 Dryland	10	16	1	8	5	10	-	15
	F_2 Spring x Winter	7	13	1	9	9	14	3	10
	IBWSN	33	24	2	17	18	14	4	20
	ISWYN	22	18	1	24	13	22	2	16
	ESYT	7	4	-	1	2	5	-	6
	Multilines	7	8	-	-	3	4	-	4
	ISEPTON	8	1	1	7	3	8	1	5
TOTAL		113	106	8	74	62	95	10	94
Durum Wheat	Crossing Block	5	2	-	1	7	-	-	2
	F_2	8	4	-	11	9	7	-	10
	IDSN	13	5	-	20	18	11	1	14
	IDYN	15	7	-	17	14	12	-	11
	EDYT	6	3	-	6	6	15	-	5
TOTAL		47	21	-	55	54	45	1	42
Triticale	Crossing Block	4	5	-	1	3	5	-	6
	F_2 Irrigated	4	6	1	4	1	6	-	5
	F_2 Dryland	5	6	-	3	1	6	-	8
	F_2 Spring x Winter	1	3	-	9	-	11	-	5
	ITSN	18	17	1	14	6	14	2	18
	ITYN	15	11	1	13	7	17	2	9
	TDRN	2	1	-	1	-	1	-	3
	Forage Lines	6	1	-	2	3	10	2	4
TOTAL		55	50	3	47	21	70	6	58
Barley	Crossing Block	1	2	-	1	3	2	-	3
	F_2	2	3	-	4	6	1	-	4
	IBON	10	6	-	4	11	5	-	5
TOTAL		13	11	-	9	20	8	-	12
					TOTAL 1210 sets				

1.11 Training

1.11.1 IN-SERVICE

Table 1.11.A shows the number of In-Service Trainees enrolling for the full period of 6 to 9 months, over the past five years. CIMMYT does not provide training courses in seed production; the three scientists listed under this heading in 1972 came to CIMMYT under special circumstances. They received some training with the Mexican National Program, and later with Oregon State University.

Table 1.11.B lists the number of trainees, by country, who have received training at CIMMYT since the international training program began in 1960.

In 1974, fewer trainees enrolled for the full courses in the specialized subjects of breeding, pathology and agronomy.

Normally, the cereal-technology course is a shorter period. However, a substantially greater number of young scientists joined this group, working in the fields during the periods of selection to collect materials for their National Programs, or to become acquainted with the CIMMYT methods. Some of this group were classified as Visiting Trainees and Visiting Scientists.

The reduced enrollment in full term activities during 1974 was due largely to difficulty in securing funding for scholarships (the costs of training have risen appreciably under the inflationary pressures). In other cases, Directors of National Programs have found it difficult to be without the services of their scientists for an extended period. Although the shorter term of training may be adequate for some people, CIMMYT staff consider the longer period of much greater value, especially when the scientist has not previously worked in the program. However, a visit coinciding with the selection and harvesting periods can be very valuable in providing an opportunity to gather materials of use in their respective programs.

1.11.2 TRAINING OBJECTIVES

The aims of the CIMMYT training program are the same for full term, or for shorter visits:

1. To stimulate the trainees' interest in applied wheat research. A team approach is fostered in National research and production programs to identify and overcome factors that limit wheat production and net farm incomes.

2. To provide the trainees with technical knowledge needed to conduct research that will form the basis for increased crop production; including an understanding of breeding, pathology, agronomy and cereal technology.

3. To assess and emphasize the interrelationships of the many factors involved in the total agricultural development process. (Supply of inputs, price of product, etc. must also be considered if research results are to be put into practice).

4. To create an "esprit de corps" across disciplines, identifying the trainees as part of a world-wide scientific community dealing with wheat improvement.

1.11.3 INSTRUCTIONAL TECHNIQUES

Training emphasis is on "learning-by-doing," and, whenever possible, trainees are instructed in the wheat fields.

Instruction is informal and may be on an individual or group basis. The young scientists work directly with experienced scientists of the senior CIMMYT staff. Each trainee is exposed to all facets of wheat improvement; however, he is assigned to one of the programs (bread wheat, durum wheat, barley and triticale) for specialized training in breeding, pathology or agronomy. Even those trainees with primary interest in cereal technology instruction are given an opportunity to work in the fields to ensure that they have an appreciation for field work.

This approach is repetitive, however repetition is required to ensure that the trainee firmly understands the technical knowledge and how to use it in the field.

Classroom instruction complements the field periods. Emphasis is placed on group discussions and participating demonstrations or lectures. Formal lectures are presented by CIMMYT staff members and others.

In previous years production or agronomy trainees have been asked to lead some of the discussions and to teach certain of the classes. They were given several days advance notice to prepare for these assignments. In 1974, a new technique was employed: the entire class was assigned reading and asked to be ready to give classroom demonstrations. On a selected day, the name of one of the trainees was drawn at random from a hat and that trainee was then responsible to give the lecture. This technique has stimulated a better preparation and a great deal better class participation. The self confidence of the trainee and his ability to present information to a group have improved greatly, factors of value on his return home. Further, the audience is less likely to tolerate poor instruction; they are prepared to criticize and help the trainee instructor improve his presentation. The trainee instructors also are encouraged to use training aids in their presentation.

1.11.4 TRAINING AIDS

An audiovisual learning center was established during the year, allowing use film strips with cassette narratives. Additional strips have been obtained to provide background knowledge of some of the more basic subjects such as genetics, botany physiology, soils, statistics. Many of the trainees are fully competent in these fields, but others, because of long absence from classroom studies or because of insufficient earlier background, need extra exposure that now can be obtained by self-instruction. When such extra drill is given to all of the trainees in formal classes there is a tendency for those with good understanding to lose interest in the instruction. Cassettes can be readily prepared in several languages.

The first draft of a manual on making recommendations to farmers has been prepared and is being tested with current trainees. Manuals on statistics and wheat production are being translated into Spanish and French. CIMMYT's cooperating programs in Algeria and Turkey also are translating the Wheat Production Manual, with appropriate modifications to suit regional needs. A series of 1100 slides showing various phases of wheat research and production has been completed by the Algerian program, and is available to CIMMYT.

1.11.5 TRAINING THE TRAINERS

National Programs are showing a greatly increased interest in establishing their own training programs in different fields, and particularly in production agronomy. The international centers are not equipped to train the numbers of people required in production agronomy, nor is the training necessarily fully attuned to the needs of each country--this work is, to a considerable degree, location specific. Past experience has shown that simply "training the trainer" is largely unproductive without a pre-planned training program to which the trainee can return and work. Thus, CIMMYT strongly recommends that there should be a national commitment to establish a training program before a country sends a trainee-trainer for instruction.

In 1974, Ecuador selected three men for training who are to be placed in a production-extension training program on their return to Ecuador.

1.11.6 NATIONAL TRAINING PLANS

In the past two years, CIMMYT has encouraged several countries to set up National Training Plans. Such a plan has a number of advantages in identifying, selecting and defining: (1) national wheat production goals and research objectives; (2) priorities for reaching these goals; (3) staffing pattern needs and individual and organizational responsibilities; (4) the personnel required at different degree levels, to man the planned institutional framework; (5) priorities for training personnel; (6) the roles of national training and academic institutions in providing the necessary personnel; (7) the magnitude of need for research and extension people and a specified time frame for training.

1.11.7 TRAINING STAFF

Herbert Floyd, who earlier worked in the wheat programs of Morocco and later with CIMMYT in Algeria, joined the training program in 1974. There are now three training officers on the staff; in addition, all staff members of the wheat program participate in training, with some devoting at least one-quarter of their time working with groups of trainees.

1.11.8 APPLIED RESEARCH PRODUCTION

Each of the In-Service Production Trainees conducts one or more experiments or demonstrations as a part of his training. He is responsible for the design, installation, management, collection and analysis of data and reporting of the results of these trials. A report of these trials is distributed on a limited basis. In 1974, these trials included:

Tillage:

Tillage Practices Trial by Abdelkafi Mostefa Kara Algeria

Seeding:

The Effect of Depth of Seeding on Emergence of Wheat and Triticale by K. Abdul Baten, Bangladesh

Spacing and Densities of Triticales, by Aomar Ait Amer Meziane-Algeria

Effects of Seeding Density with various Phenotypes of Wheat, by Sadok Djarboui - Tunisia

The Effect of Seeding Density in Different Moisture Conditions, by Hossein Amin - Iran

Fertilization:

The Effect of N, P and K on Triticales, by Ahmed R. Kwa - Nigeria

N Fertilization of Triticales by Mohd. Boukhedimi - Algeria

N Fertilizer Trial, by R. Randrianarison - Malagasy.

Response of N under Different Soil Moisture Conditions, by Nasser Banisadr-Iran

Irrigation and Moisture Management:

Irrigation Effect on Wheat Yield, by Sadok Ferjani - Tunisia

Drought Resistance, by Mhd. Ben Amara - Tunisia

Crop Production:

Rate, Date and Phytotoxicity Effects of Metoxuron on Cinnamon, Yecora and Cocorit, by Olatunji Adenola - Nigeria

Tribunil (Methabenthiazuron) Trial, by Hamida Ameur - Algeria

Do Phalaris Seed Stick to Wheat, by Ahmed R. Kwa - Nigeria

Variety Trials:

Off-Station Variety Trials, by Ali Zeghida - Algeria

Other Activities and Demonstrations:

Outcrossing in Wheat by Ali Zeghida -Algeria

Economics of Wheat Production, by Olatunji Adenola - Nigeria

Moisture Calibration Table for Triticales, by Hossein Amin - Iran

Bird Control in Wheat Fields, by Kazi Abdul Baten - Bangladesh

The Trial results were fully discussed and reported by the trainees.

1.11.9 WHEAT FIELD-TEAM NOTES

A newsletter "Wheat Field Notes" was established in July 1974 for former trainees and CIMMYT cooperators and two issues were distributed. The newsletter, with four issues yearly, is intended to: summarize progress in wheat research and production techniques developed by National Programs and CIMMYT; exchange short notes on current wheat crop conditions in the different countries as contributions are received, maintain contact with the wheat team in the cooperating programs and increase the sense of fellowship among these scientists.

Currently, the newsletter is sent to about 500 scientists, a number of whom suggested topics for future issues, and many have suggested colleague's names for the mailing list.

1.11.10 FOLLOWUP STUDIES ON CIMMYT TRAINEES

An examination of the training approaches used by the International Rice Research Institute (IRRI) and CIMMYT was published in 1974 by Burton E. Swanson. The results of this study, and an earlier one made by the CIMMYT training officer in 1971, indicate that former CIMMYT trainees are still employed primarily in wheat research as shown in Tables 1.11.C, 1.11.D, 1.11.E and 1.11.F (from Swanson). Ninety-one percent remain closely associated with wheat as their primary crop interest.

TABLE 1.11.A.- Wheat trainees in specialized courses 1970-74.

Course	1970	1971	1972	1973	1974	Total
Breeding	30	22	18	23	20	113
Production	6	7	10	14	17	54
Cereal Chemistry	4	1	2	4	2	13
Pathology	-	2	5	6	3	16
Seed Production	-	-	3	-	-	3
T o t a l	40	32	38	47	42	199

TABLE 1.11.B.- In-Service wheat trainees completing training, 1960-74.

Country	1960-72	1973	1974	Total
Afghanistan	15	2	1	18
Algeria	12	6	9	27
Argentina	8	9	1	18
Bangladesh	3	3	2	8
Bolivia	2	-	-	2
Brazil	14	-	1	15
Chile	1	2	2	5
Colombia	2	-	-	2
Cyprus	2	-	-	2
Ecuador	5	1	1	7
Egypt	6	2	-	8
Ethiopia	6	1	-	7
Guatemala	2	1	1	4
Hungary	-	-	1	1
India	4	-	-	4
Iran	6	1	4	11
Iraq	7	-	-	7
Jordan	5	-	-	5
Kenya	2	1	-	3
Korea	2	3	-	5
Lebanon	4	-	-	4
Lybia	3	3	1	7
Madagascar	-	-	1	1
Morocco	14	3	-	17
Nepal	2	-	1	3
Nigeria	1	1	2	4
Pakistan	30	-	2	32
Paraguay	1	1	-	2
Peru	3	-	2	5
Philippines	1	-	-	1
Poland	2	-	-	2
Portugal	1	-	-	1
Romania	2	-	-	2
Saudi Arabia	1	-	-	1
Spain	-	-	2	2
Somalia	-	-	1	1
Sudan	4	-	-	4
Syria	5	-	-	5
Tanzania	3	-	-	3
Tunisia	17	-	3	20
Turkey	27	3	3	33
Uruguay	1	1	-	2
U.S.A.	-	-	1	1
U.S.S.R.	-	3	-	3
Yemen	3	-	-	3
Total	229	45	42	316

TABLE 1.11.C.- Production and Research activities completed in 1972 by past CIMMYT wheat trainees still working with wheat. (Swanson)

Activity	No. of trainees N = 105	Percentage	Mean number per trainee N = 105
Laboratory or Greenhouse Experiments	13	12.4%	1.37
On-Station Field Experiments	56	53.3	5.62
Genetic Crosses	56	53.3	227.1
Replicated Applied Research Trials on-station	65	61.9	7.24
on-farms	44	41.9	4.74
On-farm HYV plots	37	35.2	3.71

TABLE 1.11.D.- Use of CIMMYT training on present job.

Level of use	(Swanson 1973) percentage N = 129	(Lindt 1971) percentage N = 38
Full use	46.4%	58.0%
Some use	47.2	39.5
Little use	6.4	2.5

TABLE 1.11.E.- Trainees' response to appropriateness of technical training to home country conditions. (Swanson N = 128)

	Number	Percent
Very appropriate	70	54.7%
Somewhat appropriate	47	36.7
Undecided	3	2.3
Somewhat inappropriate	8	6.3
Very inappropriate	0	-

TABLE 1.11.F.- Trainee satisfaction to overall technical training. (Swanson N = 130)

	Number	Percent
Very satisfied	85	65.4%
Somewhat satisfied	42	32.3
Neutral	1	0.8
Somewhat dissatisfied	2	1.5
Very dissatisfied	0	-

1.12 Wheat Quality

The Micro-Pelshenke test was used to evaluate the gluten strength. A total of 18,200 individual plants selected for seed type from F_3 and F_4 generations during the 1973-74 cycle. With strong selection pressure on seed type in early generations, the tests weight in the advanced generation material has increased markedly over the best three years; thus very few lines are now being discarded because of low test weight in the preliminary yield tests, as was often the case four or five years ago.

In addition, the following advanced bread wheat materials were analyzed:

MATERIAL	No. OF LINES
Crossing Blocks	244
High Yielding material	644
8th IBWSN	399
Advanced lines	695
Observation lines	271
Winter Crossing Block	349
ISWYN (Two dates)	50
4th ESYT	25
Basic germplasm	48

This material was evaluated for milling, protein percent, mixogram, alveogram, sedimentation and baking.

Materials with desirable milling and baking traits were selected for use as parents from the high yielding material included in the International Bread Wheat Screening Nursery (IBWSN).

Table 1.12.A shows the advanced lines from the IBWSN with strong balanced and medium elastic gluten with baking quality potential for pan-type bread and bolillos. Table 1.12.B shows the lines with weak elastic gluten suitable for pastry flours.

The above materials were crossed with progenitors having outstanding yield and agronomic characteristics to increase the proportion of breeding lines with higher protein level and good elastic balanced gluten.

Among the current advanced generation lines with high yield potential a large proportion have tenacious gluten.

The data obtained on quality characteristics of the advanced lines was used in selecting lines to be included in the 1974-1975 yield trials. On the basis of this data, about 11 % of the advanced lines were discarded, because of either low grain test weight or tenacious unbalanced gluten.

The Toluca crossing block of winter wheat varieties was found to be a very important source of lines with weak elastic gluten; some of these lines will be useful as parents to correct the tenacity in the breeding material.

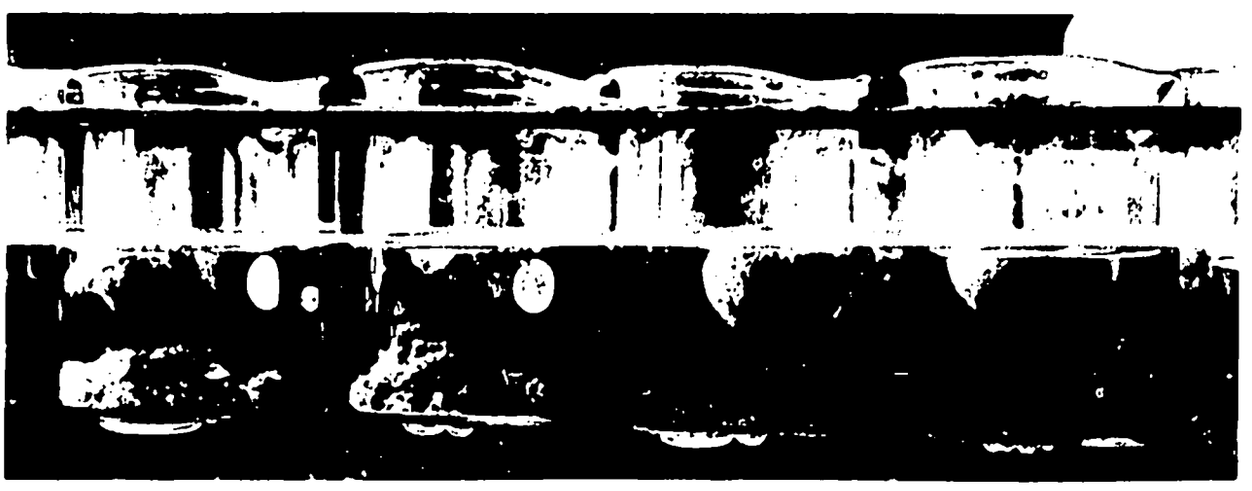


TABLE 1.12.A.- Lines of the 8th. IBWSN with medium and strong elastic gluten and good bread volume used in crosses in the Summer of 1974.

SN No.	Lab. No.	Cross	Pedigree	Protein %	P/G	W	Bread Vol.
36	2899	Pato (R)-Cal/7C x Bb-Cno	CM-5746-F-3Y-1M-0Y	11.8	4.2	308	890
81*	2941	Pj 62-Cal	30403-19M-2Y-1M-0Y	12.5	4.2	501	825
83	2943	Graso "S"	CM-5816-C-1Y-3M-2Y-500M-0Y	10.3	4.4	396	900
84*	2944	Bb-Pato x Inia-Npo	34508-23Y-0M	12.2	3.7	352	875
86	2946	Cal-Lu	CM-1076-19M-3Y-8M-2Y-501M-0Y	11.0	4.2	299	865
89	2949	Cno"S"-Gallo/Kal-Bb x 7C-Nad 63	CM-11771-G-3Y-8M-1Y-0M	11.6	4.1	343	820
175	3031	(Tob-Cno x CC-Sx/Az 67)Flr-Cno x Yr"S"	CM-11793-C-2Y-5M-2Y-0M	11.5	3.4	235	900
182	3037	We x Cno-Inia	CM-7585-1M-1Y-1M-1Y-0M	11.8	4.4	382	810
185*	3040	CC-Inia x Bb(18M)/Cno "S"-7C	CM-8282-G-1M-1Y-1M-1Y-0M	12.2	5.7	394	810
186*	3041	(Cno-7C x CC-Tob/7C) Cno-Chr x Flr-No 66	CM-8607-R-1M-1Y-4M-1Y-0M	12.3	5.8	320	815
190	3045	Cno-7C x CC-Tob/Bb-Cno	CM-4415-4Y-2M-2Y-1M-1Y-0M	11.8	3.5	218	815
193	3048	Cno"S"-Pj 62 x Gallo	II-30793-1M-2R-2M-0R	10.6	2.3	195	810
212	3066	Cal-CC x Son-Nr	CM-5752-J-8Y-1M-1Y-2M-0Y	12.0	2.2	262	840
223	3076	(Tob-Cno x CC-Sx/Az 67)Flr-Cno x Yr"S"	CM-11793-C-2Y-7M-0Y	10.9	2.7	237	825
224	3077	(Tob-Cno x CC-Sx/Az 67)Flr-Cno x Yr"S"	CM-11793-C-2Y-9M-0Y	10.9	2.6	221	825
229*	3082	Cal x Cno"S"-Son 64	CM-1169-18M-1Y-0M-0MCH-0Y	12.6	2.8	282	925
231*	3084	Tob-Cno"S"x Tob-3156 (R)/Cal x Bb-Cno"S"	CM-5816-A-6Y-2M-1Y-3M-0Y	12.5	3.5	456	880
232*	3085	Tob-Cno"S"x Tob-8156 (R)/Cal x Bb-Cno"S"	CM-5816-A-6Y-2M-1Y-2M-0Y	12.2	3.6	435	875
233	3086	Tob-Cno"S"x Tob-8156 (R)/Cal x Bb-Cno"S"	CM-5816-A-6Y-2M-1Y-1M-0Y	11.9	3.8	371	920
241	3093	Cno-7C/Nad 63-Chr"S" x Yr"S"	CM-11797-H-1Y-4M-2Y-8M	12.1	4.2	241	820
243*	3095	NS718 x Meng-8156/Cno "S"-Gallo	CM-11839-B-1Y-1M-1Y-0M	13.0	6.4	333	825
245	3097	Tob"S"-Npo x No66-Era/Bb-Gallo	CM-8327-C-9M-4Y-3M-0Y	11.4	3.6	262	860
247*	3099	(Cno-No66/Son-64 Kl. Rend. x Bb)Cno-Gallo	CM-12330-K-2Y-1M-2Y-0M	12.6	3.2	195	870
267	3118	Cno"S"-Gallo x Kal-Bb* Pichihuila"S"	CM-7652-35M-5M-1M-5Y-0M	11.2	3.7	244	850
277	3128	Cno"S"-Pj62 x Gallo	30793-1M-2R-2M-0R	11.1	2.3	220	830
279	3130	Pi62-Gallo x Vem	CM-8305-D-10M-1Y-5M-3M-0M	11.1	4.2	297	825
311	3160	Son64-Y50Ex Gto/Inia "S"	II-27528-7M-1T-1M	11.1	3.1	235	815
317	3166	(Bb-Cno"S")(Tob-Cno x CC-7C)	II-36859-3S-11M-4T-0M	11.2	3.7	230	850
318	3167	In-Jar x Bb	II-32156-21M-1S-1M-2R-0R	11.0	3.2	274	875
319	3168	Np876-Pj62 x Cno"S"-Inia "S"	II-38040-24Y-2M-1R	10.9	2.4	239	950
321*	3169	Cno "S"/No66-Cno-on	II-32509-5T-3M-0R-0M	12.7	5.2	372	900
324	3172	Jar66-Cno"S" x Cfn-Cno "S"	II-26090-10R-2M-3T	11.5	2.9	305	850
329	3177	Ska-on/Ska x Cno-Chr	31049-13M-1MCH-2MCH-0MCH-0BK	11.8	4.7	354	825
330*	3178	Az66 x Inia"S"-Soty	II-29260-26R-1M-2MCH-0MCH-0BK	12.6	2.4	242	880
331	3179	Cno"S"-Son64 x Cno"S" Inia "S"	II-30506-47M-1MCH-1MCH-0MCH-0BK	11.6	3.4	414	910
333	3181	Tp x Cno-No66/Bb-Cno	CM-5526-A-3Y-1M-1Y-1M-1Y-0M	11.8	2.7	235	830
381	3207	Bj67-Cal x Tob-8156/7C x Bb-Cno	CM-5813-M-2Y-1M-2Y-4M-1Y-0M	11.4	3.3	219	820
	4755	Inia 66		11.8	3.1	248	845

* Lines with higher protein content.

TABLE 1.12.8.- Lines of the 8th. IBWSN with weak elastic Gluten used in crosses in the summer of 1974.

S.N. No.	Lab. No.	Cross	Pedigree	Protein	P/G	W
25	2888	Inia "S" - Soty x Czho.	B-6G-1Y-3M-0Y	9.0	2.4	119
31	2894	Bb-Cno x Inia-Soty	CM-1502-8M-3Y-3M-2Y-0M	10.7	2.3	173
64	2925	Tob "S"-Npo x CC-Inia/ Cha	CM-5541-C-5Y-4M-3Y-3M-0Y	9.5	2.3	122
135	2993	ZbZ x Cal-Cno.	CM-10598-13Y-11M-3Y-0M	11.0	2.7	139
172	3028	Cno-Bb x Cdl (7C/Lib 64-Inia x Inia-Bb)	CM-5872-C-1Y-5M-2Y-2M-0Y	10.6	3.2	162
173	3029	Cal x Bb-Cno/7C	CM-5345-D-4Y-3M-2Y-5M-0Y	10.9	3.4	198
187	3042	Cdl-Tob x Bb(18 M)/ Pak F4 6313	CM-8618-M-4M-1Y-4M-1Y-0M	11.4	2.4	149
188	3043	Ron-Cha x Bb-Nor 67	CM-5484-F-5Y-4M-4Y-4M-1Y-0M	11.7	2.4	135
250	3102	MR22-Yr"S"/Bb-Cal x 7C-Nad.	CM-12534-G-1Y-1M-4Y-0M	11.6	2.7	159
254	3106	Bb-Cno/Cno"S"-8156 (B) x Soty-An 64 A	CM-5590-1T-7M-1Y-0M	10.2	2.1	182
287	3137	Sr-Bon (36896-Cj.54^2 x Yt-54A/CC-8156 x Cno)	CM-8510-H-7M-1Y-6M-2M-0M	9.9	2.5	189
305	3154	Ron-Cha x Bb-Nor 67	CM-5484-F-5Y-4M-1Y-1M-1Y-0M	10.9	1.9	122
306	3155	Ron-Cha x Bb-Nor 67	CM-5484-F-5Y-4M-3Y-3M-1Y-0M	10.9	2.0	146
307	3156	Inia 66-Bb	II-36478-34Y-1M-2T-4M-3S-0M	10.1	2.1	176
357	3204	Tp x Cno-Inia "S"/Cno-Inia "S"^{2}	CM-5919-A-6Y-2M-2Y-1M-1Y-0M	10.4	1.7	168
358	3205	Tp x Cno-Inia "S"/Cno-Inia "S"	CM-5919-A-6Y-2M-3Y-1M-1Y-0M	10.5	1.4	103
384	3229	Perico "S"	II-34886-17Y-4M-4Y-1M-3Y-0M	11.1	3.4	241
385	3230	Cno-Bb x Cdl (7C/Lib. 64-Inia x Inia-Bb)	CM-5872-C-1Y-5M-1Y-0M	10.6	2.9	170

1.13 Regional Activities in Asia and Africa

CIMMYT works closely with the Ford Foundation's Arid Lands Development Program (ALAD) centered in Beirut. ALAD has a fully integrated program, in collaboration with the National Program of Lebanon, which operates from the Lebanese Agricultural Experiment Stations, principally at Tel Amara. All nurseries are grown jointly, and materials are selected for national and regional objectives and/or for both organizations. Dr. Y. Klaimi directs the wheat work in Lebanon, while Drs. Saari and J.P. Srivastava are responsible for coordinating the regional aspects of the program.

Combined program efforts include:nursery planning, varietal testing, selection of segregating materials, disease resistance surveillance, analysis of data, and quality determinations.

The regional wheat and barley program of ALAD-FAO-CIMMYT works cooperatively with 58 countries through the nursery system.

Dr. J.P. Srivastava, formerly Professor of Plant Breeding at Uttar Pradesh Agricultural University in India, joined the ALAD staff in February 1974, assuming the duties of Dr. Kingma who returned to other duties with CIMMYT. In addition to responsibilities with the general program, Dr. Srivastava's work includes the identification of germ plasm and varieties suited to the ALAD region ,as well as the evaluation of new materials. (This germ plasm includes that developed by the Lebanese National Programs, plus that of International Programs such as FAO and CIMMYT).

Dr. E.E. Saari joined the ALAD wheat program under a Ford Foundation-CIMMYT agreement in August of 1973. His principal responsibilities include the identification of varieties or germ plasm with superior disease resistance, through wide scale testing of germ plasm derived from diverse sources. In addition he cooperates with Dr. Prescott and Turkey's National Program in conducting a regional small-grain disease surveillance program--which extends beyond the ALAD region and includes countries from Thailand to Morocco, and throughout the East African community. Mr. J.K. Hraich also assists in the base program work in Lebanon.

Aims of the Regional Program

The central aim of the program is to identify superior germ plasm through wide scale testing of the materials, throughout the region; however, a broader goal is to assist National Programs in strengthening wheat, barley, and triticale research, and to assist governments in achieving their production goals.

The regional program, therefore, works with national programs to:

1. Identify varieties having superior yielding ability, broad adaptation, and good disease resistance, and to distribute small quantities of seed of these varieties to the cooperating countries. (The countries may use this seed as they choose; either as directly introduced varieties for production, or as genetic sources for use as parents for further improvement).

2. Identify varieties that provide yield stability under different ecological conditions.

3. Identify varieties suitable for special environmental conditions.

4. Continue to broaden the disease resistance base of the National Programs.

5. Provide a disease surveillance program that will allow the National Programs to make varietal recommendations based on a wider knowledge of potential threats to production.

6. To act as a center for exchange of materials and information among National Programs.

7. Provide opportunities for further training of National scientists where such assistance is required, and to assist in securing further training opportunities outside the region.

8. Increase CIMMYT's effectiveness in supporting National Programs, with a more directly available outreach and backstopping service.

The regional activities are wide-spread, and complicated by the great diversity of climate and soil within the region. Some of the National Programs have well-trained competent scientists with reasonably complete facilities for research;however, other Programs have a real shortage of trained personnel and very limited resources at their command.

Aside from the limitations in scientific manpower and financing,a wide range of technical problems is encountered. For example, winter-grown cereals are grown in areas where water availability ranges from full irrigation or rainfall exceeding 1000 mms, to less than 300 mms per year. Bread and durum wheats and barley are grown on lands below sea level as well as at heights exceeding 3000 meters. Triticale is still in the experimental stage and has not yet been adapted for commercial production in these countries.

Due to the great variation in latitude and altitude, true winter wheats(which require an extended cold period to assure heading) are needed for the cold winter regions of those countries with elevated plateaus. At low altitudes, with high temperatures and short growing season, short cycle wheats (90 to 100 days maturity) are required. The extremely varied disease spectrum and agronomic problems peculiar to specific areas add further complications. Thus, a program with great diversity must be maintained to meet the needs of the different countries.

Regional Nurseries

The ALAD regional program, in coordination with the Cairo office of FAO, coordinates and assembles regional nurseries, using germ plasm from the National Programs of the area and from International nurseries such as CIMMYT's. These nurseries provide data about varieties that can be used in conjunction with the nationally generated data, for assessment of varieties. This service is particularly useful in countries that lack manpower and facilities, sufficient to mount a full-fledged wheat or barley program. Each year through the regional nurseries, such countries receive the best advanced lines and varieties available from other national and international programs. Table 1.13.A shows the number of nurseries, number of varieties per nursery, and number of countries receiving material in 1973-74 season.

In recent years, superior germplasm has been identified through a systematic series of nurseries and evaluations. The Regional Disease and Insect Screening Nursery first screems varieties and advanced lines for resistance to the important endemic diseases of the region. The advanced lines of National and International Programs are used in this nursery, which is grown by cooperators in various countries of the entire Eastern Hemisphere, at locations known to have serious disease problems. Materials with broad disease resistance and agronomic potential are promoted to the Preliminary Observation Nursery, where results are evaluated critically and only the best lines are forwarded to the Regional Wheat Yield Trial.

Evaluation of this large array of materials provides specific information related to program objectives. For example, germ plasm is identified with potential for drought resistance, and for resistance to certain diseases and/or multiple diseases.Frequently, these lines are unacceptable from an agronomic viewpoint, but can be used to broaden the germ plasm base of the National Programs.

Such lines, are recycled(along with relevant information) in the Regional Crossing Block or as special nurseries. Table 1.13.B lists promising lines identified in the wheat and barley yield nurseries.

Summer Nursery

Scientists of the region have often discussed the need for a summer nursery to advance the generation of materials being developed in the National Programs of North and East Africa and in the Near and Middle East. In 1974, through the courtesy of the Governments of Kenya and Tanzania, successful summer nurseries were grown. In addition to the desirability of this region as a summer nursery site, the area provides excellent conditions for screening for several diseases.

General

The region's surveillance program is attempting to: (1) establish the potential and frequency of disease epidemics, and (2) monitor changes in the cereal rust populations as they are influenced by cultivation of commercial varieties. Regional Disease Trap Nursery and the identification of rust collections are used for this task. It is hoped that this program will permit the mapping of new biotypes of the airborne pathogens, thus charting the movement of spores and races from one area to another. Table 1.13.C shows

the coefficient of infection of some of the principal commercial varieties of the region over the period 1971-73 for sub regional areas.

National Programs' participation with the regional effort has been increasing, as has the submission of material for entry into the various tests. While very encouraging, these increases make it difficult to accommodate all entries; thus it may be necessary to place a quota on entries received from the cooperators. Such a quota suggests stronger selection on material submitted by contributors.

Interest also has been increasing in barley and rainfed wheat cultivation. Provisions have been made to increase the amount of germ plasm to be evaluated in the coming year, and the scope of regional testing has been strengthened in collaboration with Dr. A. Hafiz of FAO in Cairo.

The regional surveillance program has joined together a number of isolated pathology programs, each of which formerly conducted independent, limited surveys. The cooperators in this work feel that this cooperative effort provides better results and that duplication has been minimized.

During the past season, a number of visiting scientists and counterparts have worked with the regional program and the Lebanese National Program. Scientists from Egypt (2), Saudi Arabia (2), Tunisia (1), Syria (3), and Nepal (1) actively participated in the program's base activities in Lebanon in the past year. Six senior staff from the CIMMYT program in Turkey and Mexico visited the program several times during the season. Dr. Klaimi visited Egypt and Turkey on short term ALAD consultancies on behalf of the regional program.

A number of talks, publications and reports also were prepared by the regional staff during the year, and they attended a number of international regional and national meetings.

TABLE 1.13.A.- Summary of germplasm dispatched via The Regional Wheat and Barley Program.

Nursery	No.	No. Varieties per nursery	No. Countries receiving
Preliminary Observation Nursery (PON)			
1. Full sets (breadwheat, durum, barley)	41	428	29
2. Breadwheat + durum	8	328	4
3. Breadwheat + barley	3	300	3
4. Breadwheat	3	200	3
5. Barley	1	100	1
Regional Wheat Yield Trial (RWYT)	33	25	28
Regional Disease & Insect Screening Nursery (RDISN)			
1. Breadwheat and durum	37	2400	19
2. Barley	19	300	14
Regional Disease Trap Nursery (RDTN)			
1. "A" sets	72	56	45
2. "B" sets	76	172	
Regional Crossing Block (RCB)			
1. Full sets (breadwheat, durum and barley)	20	399	15
2. Breadwheat and durum	20	295	15
3. Barley	20	104	17
Segregating Populations (SP)			
1. Breadwheat	15	130	12
2. Barley	15	76	11
Rainfed Wheat Yield Trial (RFWYT)	40	25	25
Regional Barley Yield Trial (RBYT)	25	25	23

TABLE 1.13.B.- Some of the new promising varieties in Regional Yield Trials, 1973-74.

2a. The best combination of yield and disease resistance in the Regional Wheat Yield Trial are:

Variety	Regional Disease Response YR	LR	SR	Country of Origin submitting
Mengavi-8156	MS	MR	MR	Mexico/Egypt
7C-On x Inia-B Man	R	MR,MS	R	Mexico/Lebanon
Arvand	R	MS	R	Iran
Cocorit 71(durum)	R	MR	S	Mexico
UQ 105	R	R	R	Australia
Arz	R	MR	MR	India/Lebanon
36898-G54^{2}xYt54^{2}A(II)	R	MR	MR	Mexico/Sudan
Mexipak (check)	S	S	MR	

2b. The most promising lines in the Rainfed Wheat Yield Trial based on preliminary data are:

Variety	Origin
Pitic 62	Mexico
P106-19	Lebanon
SA42	Pakistan
Cocorit "S"	Mexico
Super X	Mexico

2c. The lines in the Regional Barley Yield Trial that appear to be superior in yield based on preliminary data are:

Variety	Origin
Line 257/14	Egypt
Strain 205	Egypt
Delisa	Netherlands
Beecher	USA/Lebanon

* Average regional disease response: YR = Yellow Rust (Puccinia striiformis); LR = Leaf Rust (P. recondita); SR = Stem Rust (P. graminis).

b. Based on both yield and disease response data a number of the promising bread wheat, durum and barley lines in the Third Preliminary Observation Nursery 1973-74 have been promoted to the Regional Yield Trial for the 1974-75 season.

TABLE 1.13.C.- The average coefficients of infection of the Wheat Rusts on some important dwarf varieties, 1971-73.

Variety	Rust	So. Asia	W. Asia	No. Africa	E. Africa
8156 (Kal.Mexp)	YR	2	8	2	9
	LR	25	26	2	2
	SR	1	9	2	35
Penjamo 62	YR	3	17	1	3
	LR	15	14	1	1
	SR	1	6	1	42
Inia 66	YR	1	10	1	7
	LR	13	3	1	1
	SR	0	1	0	40
Tobari 66	YR	1	5	1	6
	LR	1	1	2	0
	SR	0	1	0	39
Sonalika	YR	1	11	0	3
	LR	5	2	1	0
	SR	1	4	0	44
Chenab 70	YR	1	10	1	5
	LR	51	19	4	1
	SR	1	2	0	53

2.0
Latin America

Wheat Yield Nursery, Marcos Juarez, Cordoba, Argentina. Ing. Rogelio Fogante and Ing. Hector Corrta, foreground.

2.1 Mexico

2.1.1 INIA NATIONAL PROGRAM

Cereal improvement efforts of the National Institute of Agricultural Research (INIA),Department of Cereals, deal primarily with wheat, rice, barley and oats; with research emphasis on genetic, phytopathological, and industrial quality improvement. INIA program directors include: Ing. Genaro Cruz Rivera and Dr. Jose Luis Maya (wheat), Ing. Enrique Riojas (barley) and Dr. Andres Iruegas Evaristo and Ing. Federico Castillo Chacon in charge of the cereal quality aspects. Ing. Rodolfo Moreno Galvez directs the over-all program.

2.1.1.1 Mexico's 1974 Yields

Wheat is one of the more important crops of Mexico, the value of Mexico's 1974 wheat harvest was estimated at $263,280,000 U.S.Cy. In the winter of 1973-74, the area sown to wheat was 609,522 hectares, producing an estimated total of 2,401,621 metric tons, for an average yield of 3.94 tons/ha. In the spring and summer, a rainfed area of 45,578 has. produced an estimated 53,069 tons of wheat, for an average yield of 1.16 tons/ha.

Barley production in the winter amounted to 158,438 tons, for an average yield of 2.96 tons/ha. The rainfed spring and summer sowings of barley on 157,997 has. (with heavy frost damage) produced a total of 81,946 tons for an average of 519 kgs/ha.

2.1.1.2 Perspective: Past and Future

Mexico traditionally has been a wheat importer. However, as the result of an aggressive research program and the widespread utilization of high yielding varieties and improved technology, it first achieved self-sufficiency in this cereal in 1956; remaining self-sufficient to 1970.

The area sown to wheat varies from year to year (Table 2.1.A and Figure 2.1.A), with the maximum of 937,000 has. sown in 1959. Over the past decade, as per hectare yields have risen, there has been a tendency to reduce the area sown to wheat, so as to produce only the amount of wheat needed to meet domestic needs.

However, basic government policy changed in 1970. At that time, with high international prices for cotton and oilseeds and low international prices for wheat, it seemed desirable to adopt a policy that would increase the area sown to both cotton and safflower, even though areas sown to wheat would probably decrease. The rationale for this policy was that cotton, as a labor intensive crop, would increase employment; and since cotton traditionally has been the most important agricultural export commodity, there would be a concurrent increase in foreign exchange earnings. The increase in area sown to safflower during the winter (wheat) season, was seen as a way to greatly reduce the importation of high priced edible oils. It was believed that the reduction in area sown to wheat (which would be reflected in reduced production) could be offset, if necessary,by importing modest quantities of wheat at the low international price then prevailing.

Even though this policy caused lower wheat production, it was effective and economically sound until international wheat prices soared in late 1972 and early 1973. It was then that the large wheat purchases by Russia quickly depleted the world's grain reserves. The sudden rise in world prices of wheat, coupled with soaring prices for imported fertilizer and the collapse of the international cotton market, soon made continuation of this policy economically untenable.

The lag in domestic price adjustments for wheat during the 1973-74 crop season forestalled Mexico's recovery in wheat production. Moreover, with domestic wheat grain prices considerably lower than domestic prices for both maize and sorghum, large quantities of wheat were diverted to poultry, swine and cattle feeds. This practice caused a need for larger imports of wheat than had been anticipated, and substantial drains on foreign exchange (Tables 2.1.A and 2.1.B).

Adjustments in the domestic price for wheat (to bring it more into line with international price) were made in November 1974, before the onset of the 1974-75 wheat planting season. This change, coupled with a sharp decline in the price of cotton, resulted in a substantial increase in the area sown to wheat in the fall of 1974, with a promise of

greater returns for the 1975 wheat harvest.

2.1.1.3 Geographic Shifts in Wheat Production

There has been a major geographic shift in wheat production in Mexico during the past two decades (Table 2.1.C). In national wheat production during the 1950's Central Mexico accounted for 30%, the North 31%, and the Northwest 30%. In the 1960's, the Northwest became the principal producer, accounting for 54% of the national harvest; whereas 28% was produced in Central Mexico, and 17% in the North. By 1970, production in the Northwest had risen to 71%, while the North produced only 16%, and Central Mexico 13%.

Mexican wheat yields have increased by more than 400 percent in the past 30 years due to improved varieties and improved cultural practices. However, the reduced acreages in recent years have, as indicated, led to increased imports as demand continues to rise. By 1980, Mexico could be importing 1.25 million tons of wheat--at prices that are not expected to be much below the range of $192.00 to $232.00 U.S. Cy. per ton.

2.1.2 GENETIC IMPROVEMENT

Mexico's program of genetic improvement operates through experiment stations located in areas of major wheat cultivation; or, in some cases, where weather conditions are favorable for the process of selecting specific characteristics for improved varieties.

The CIANO Station, located near Ciudad Obregon in the State of Sonora, is within Mexico's largest wheat production zone, and is the center of the genetic improvement program. Several sub-stations are attached to CIANO, and they conduct varietal tests in collaboration with the Departments of Soils, Entomology, Pathology, etc. All research is done in the winter (with irrigation) and includes work on bread wheat, durum wheat, triticales, and barley.

The CIANO station conducts exhaustive yield tests on advanced lines; often 40-50 yield trials of 25 varieties are tested each year in bread wheats alone. Conditions are good for leaf and stem rust development, thus strong selection pressure can be applied to the development of rust resistant varieties.

The Sinaloa Station conducts research for its area and that of Southern Baja California. Varietal adaptation of advanced lines is studied, along with the development of optimal cultural practices. Selection for resistance to leaf rust is favored, since this area is the focus of infection for North-West Mexico. Leaf rust develops early in Sinaloa, and natural epidemics are severe.

Several stations are located in Chihuahua, where hybridization and selection work is done in addition to yield testing and agronomic studies. Diseases are relatively unimportant in this area, which is a low rainfall zone, and selection is mainly for better agronomic types suitable for production under these conditions. Selection is made at one station for spring-planted varieties having an intermediate maturity suitable for this zone; whereas other stations test advanced materials for their suitability for spring sowing in higher valleys. The Graduate School at the Agricultural University at Saltillo collaborates in yield testing.

In Tamaulipas, in North-Eastern Mexico, fall-sown segregating populations, varieties, and advanced lines are tested for resistance to leaf rust. Severe epidemics of leaf rust normally occur in this area due to favorable conditions for rust development. Variety trials also are conducted. Very little commercial wheat is grown in the area at present.

In Central Mexico (the Bajio and Central Plateau) research is done under both irrigated and rainfed conditions.

Irrigated crops are grown in both winter and summer at Roque where conditions are suitable for growing two crops per year. In the winter, selection is made for resistance to stripe rust; in the summer, for leaf and stem rust.

The program of research for rainfed conditions is conducted at the Bajio Station under restricted irrigation in the winter; and in the summer at the Refugio Station, with rainfall. Varieties suitable for rainfed agriculture have been developed and were tried in farm fields in Michoacan in 1974.

In the rainfed regions of the high valleys of the Central Plateau, breeding and selection are done at Chapingo. The aim of this program is to complement the genetic improvement of the other centers by growing a second generation each year, thus halving the

time taken for varietal development. Selection can be made for resistance to all three rusts -- stripe, leaf and stem. This program also provides an opportunity to assess varietal adaptation to the rainfed areas of the higher valleys.

An additional testing site is planned for development in 1975 in Southern Mexico near Chiapas.

2.1.3 COOPERATION WITH CIMMYT

CIMMYT and INIA combine their efforts in wheat, barley and triticale improvement work at the Cd. Obregon Station in the winter; and at Toluca near Mexico City in the summer. In this work, there is a full interchange of germ plasm with the different international programs with which CIMMYT is associated.

CIMMYT's wheat program also has laboratory facilities at Chapingo for industrial and nutritional quality studies that provide a means of selecting genetic materials suitable for the farmer, as well as for industry and the consumer.

2.1.4 VARIETAL IMPROVEMENT METHODS

CIMMYT's varietal improvement is basically a hybridization approach, attempting to combine in a single line all of the characters desired for increasing grain yield. Varieties and lines also are introduced from other countries for reselection and use in breeding; and Mexican varieties are reselected where they are found to be heterogeneous for characters such as resistance to disease.

The pedigree method is used throughout the selections from segregating generations. Normally selection begins with F_2; but selection of individual plants are made in F_1, in complex double and triple crosses made between F_1's. The variability of a particular population determines the number of plants selected.

Resistance to disease, general vigor, agronomic type, maturity, height, resistance to drought and shattering, high yield and yield stability are the principal characters used in selection. The meticulous records of the pedigree system provide for close comparisons among the families of a cross, allowing for successive elimination. For example, records of the cross (LR64-Son64 x Np63/Cno67) 28036-111M-1R-2M-1T-0M led to the release of the variety Toluca 73. In this cross, Lerma Rojo 64 was crossed with Sonora 64. A line from this cross was then crossed to the Colombian variety Napo 63 and a resulting line was crossed to Ciano 67. The cross number of the final cross in 28036 and the first selection in F_2 made in Toluca was plant number 111 (in F_3 in Rio Bravo and F_6 in Toluca). The number of selections is greater in F_2 than in succeeding generations. All of the final bulked selections were yield tested at normal seeding rates, whereas early generations were space planted.

2.1.5 YIELD ADVANCES IN WHEAT

When Mexico began its organized wheat research, yields averaged about 700 kg/ha. With varietal improvement and better technology, yields now average more than 3746 kg/ha; thus yield increases per hectare have averaged an advance of more than 100 kgs per year over a 30 year period.

The trend toward better resistance, better productivity and better quality has been maintained over the years. In 1973, CIANO released the varieties Torim F73 and Jupateco F73; the other stations released Mochis F73, Toluca F73, Roque F73, and Delicias S73. In December 1974, 7850 kgs of seed of Cleopatra VS74, Chapingo VF74, Zacatecas VT74, and Narro VF74 were provided to the National Seed Corporation (PRONASE) for preliminary increase. The agronomic characteristics and data on physiochemical properties of these varieties are shown in Table 2.1.D and 2.1.E. These varieties will be available to the farmers in 1975-76.

Four promising lines have been yield tested over the past four cycles: Anahuac F75; Jar F66-Cno"S" x Cfn-Cno "S"; II-26090-10R-2M-3T-0M; No F66-Cno "S" x Jar F66; II-27343-2R-3M-2T-0M; Cno Reciprocal-Jar F66; and II-25288 -35M-3T-8M-1T-0M. These four lines show better resistance to stripe rust than the check varieties Yecora, Tanori and Jupateco. Yield is somewhat superior to the checks, and they are of excellent quality. For example, based on yield-per-hectare-per-day, the check Yecora yields 48 kgs compared with a yield of 51 kgs for Anahuac 75, a gain of 3 kgs/day. In yield of flour, Yecora produces 4,030 kgs/ha and Anahuac 4,515;a grain of 485/ha.It is probable that these four promising lines will be released in 1975.

2.1.6 ADVANCES IN TRITICALE

Information and materials provided by CIMMYT, reinforced by experimental data developed by INIA and the Extension Service, produced a recommendation that one of the better triticale lines be released as a commercial variety; primarily for use as a feed grain crop. The variety is named Yoreme Tcl, and PRONASE placed it under increase for 1975. The findings indicate that Yoreme Tcl is: widely adapted to different soils and climatic conditions; higher in lysine and protein level in the grain; similar in yield to wheat. Flour yield is inferior to wheat, as is industrial quality for bread.

2.1.7 BARLEY ADVANCES

The new barley variety Puebla was named in June, 1974. This variety is 10-15 days earlier to maturity than Apizaco, and yields about 500 kgs/ha more than Apizaco. About 40 percent of the area sown to barley in the high valley is now sown to Apizaco.

In the summer season of 1974, a number of lines from barley yield tests showed promise of becoming varieties. One of these, tested under the number 9360A, showed yields superior to Apizaco and Puebla, but is somewhat lower in malting quality.

2.1.8 CHEMICAL QUALITY

The cereal chemistry laboratory processed 1118 wheat samples for quality in 1974. There was a marked tendency for much of the material to show tenacious gluten. Some lines, however, showed promising agronomic and disease resistance characteristics; and had strong gluten characteristics of a balanced type. Many suitable soft gluten types also were identified. A change in the testing procedure seems necessary, if the tenacious type of gluten is to be eliminated. A new selection regime has been proposed in checking the segregating generations.

Figure 2.1.A. YIELD, PRODUCTION, AREA, AND PRICE OF WHEAT IN MEXICO FROM 1925-28 to 1974

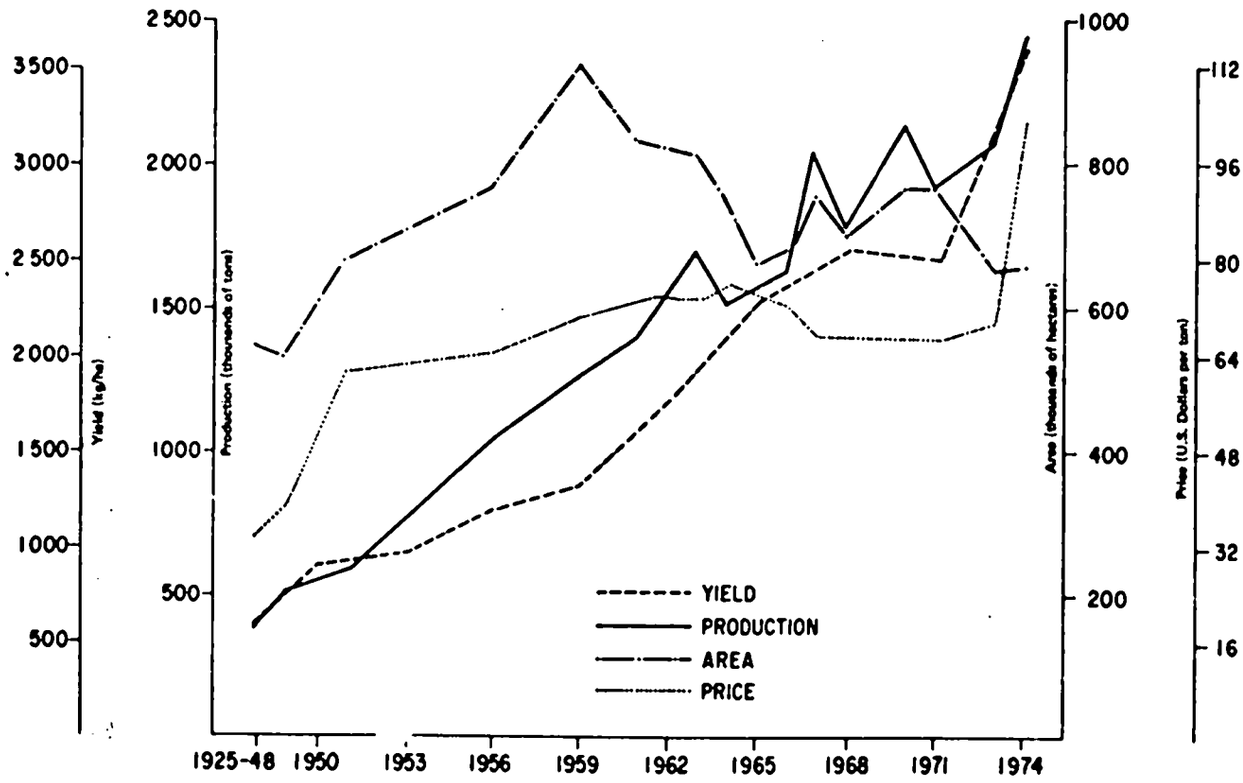


TABLE 2.1.A.- Commercial varieties, area, production, yield and wheat price from 1925 to 1974[1/].

Year	Distributed new varieties	Area (ha)	Production (ton)	Yield (kg/ha)	Price (ton)
1925-48	B. Yaqui, B. Bajío, Ramona, Mentana	550,000	400,000	727	400.00
1948	Yaqui 48, Kentana 48, Mayo 48	534,868	503,244	941	472.00
1951	Yaqui 50, Cruza 5	672,768	589,898	877	750.00
1956	Lerma 52, Kentana 52 Yaqui 53, Chapingo 53, Yaqui 54 Yaktana 54, Kentana 54, Gabo 54 Anahuac 966, Toluca 54	660,000	1,040,000	1350	800.00
1959	Gabo 56, Lerma Rojo, Bucareli Lagunero 58	937,000	1,265,526	1351	880.00
1961	Nainari 60, Tehuacan 60, Santa Elena	837,000	1,401,910	1678	912.00
1963	Pitic 62, Penjamo 62	819,000	1,702,989	2079	920.00
1964	Sonora 63, Nadadores 63	743,000	1,526,613	2056	940.00
1965	Sonora 64, Lerma Rojo 64, Mayo 64	666,000	1,598,853	2401	930.00
1966	Oviachi 65	683,000	1,608,888	2354	913.00
1967	Inia 66, Tobari 66, Noroeste 66, 7 Cerros 66, Jaral 66	751,000	2,061,433	2745	849.00
1968	CIANO 67, Norteño 67, Azteca 67 Bajío 67	705,000	1,780,057	2527	849.00
1970	Juri 69	705,000	2,145,555	2817	850.00
1971	Yecora 70, Cajeme 71, Nuri 70, Potam 70, Saric 70, Ahome, Delicias	763,000	1,915,444	2447	850.00
1973	Cocorit 71, Tanori 71, Vicam 71 Saric 71	647,115	2,098,307	3243	870.00
1974	Torim 73, Jupateco 73, Toluca 73 Mochis 73, Roque 73	655,200	2,454,690	3746	1,300.00

1/ Data on surface, production, yield and price per ton up to 1971 were obtained from "Revista de Estadística", edited by Secretaría de Industria y Comercio, Dirección General de Estadística. Data for 1973 and 1974 were taken from Agrosíntesis magazine, published by Año Dos Mil press, which mentions as source of the information the Secretaría de Agricultura y Ganadería.

TABLE 2.1.B.- Importation of wheat in Mexico during the past five years.

Year*	Quantity (ton)	Price** pesos/ton	Amount in pesos
1971-72	100,000	800.00	80,000,000
1972-73	524,000	1,080.00	565,920,000
1973-74	810,000	1,835.00	1,486,350,000
1974-75	1,040,000	2,400.00	2,496,000,000

* The milling year starts on the 1st. of May and ends on April 30.
** Exchange $ 12.50 pesos to $ 1.00 U.S. Dollar.

TABLE 2.1.C.- Wheat area and production in the different regions in Mexico.

Decade	Region	Area %	Production %
1950	Center	43	38
	North	32	31
	North East	23	30
1960	Center	38	28
	North	28	17
	North East	36	54
1970	Center	13	13
	North	18	16
	North East	57	71*

* The state of Sonora alone produced 52% of the traditional wheat harvest, but in the last two years it had dropped to 47% of national production which means more than 300,000 tons.

TABLE 2.1.D.- Average agronomic characteristics of three cycles: Summer-1973; Winter 1973-74; Spring 1974, in five regions*.

Rainfed varieties	Rust	Days to maturity	Grain yield (kg/ha)	I.R. (kg/day)
Lerma Rojo S64	80S	125	2454	28
Tánori F71	TrR	125	3196	26
Zacatecas VT-74	TrR	125	3546	28
Chapingo VF-74	TrR	130	3656	28
Narro VF-74	5R	120	3373	28
Cleopatra VS-74	TrR	125	3789	30

* Two repetitions per region.

TABLE 2.1.E.- RAINFED WHEAT. Physical and chemical data to grade the industrial quality of flours.

Rainfed varieties	Grain yield kg/ha	Bread volume cc	Flour yield %	Protein %	Flour yield kg/ha	Protein kg/ha
Lerma Rojo S64	3454	600	65	10.0	2245	225
Tánori F71	3196	750	66	10.0	2109	211
Zacatecas VT-74	3546	645	70	12.0	2482	298
Chapingo VF-74	3656	830	63	13.2	2303	304
Narro VF-74	3373	790	65	12.3	2192	270
Cleopatra VS-74	3789	750	64	12.0	2424	291

2.2 Argentina

2.2.1 OVERVIEW

In 1962, the experiment stations of the Instituto Nacional de Tecnologia Agropecuaria (INTA), initiated a new plan for genetic improvement of wheat in cooperation with CIMMYT. The plan was designed to produce varieties withhigh yield, good quality and disease resistance, and suitability for soils with high levels of natural or artificial fertility. Initially, the aim was to diversify germplasm through incorporation of yield characteristics such as size of spike, and number and fertility of spikelets. The new varieties also had to be resistant to lodging, if they were to be suitable for highly fertile soils. This improvement scheme was formed through cooperative work of the experiment stations at Balcarce, Bordenave, Marcos Juárez, Parana, Pergamino, and at Saenz Peña (Chaco).

The materials introduced were subjected to strong selection pressure to produce varieties suitable for production under Argentine conditions.

The first variety developed by the cooperative plan was Precoz Parana INTA (released in 1969) produced from the cross Sonora 64 x Knott. This was followed by Marcos Juarez INTA (released in 1970) originating from the cross Sonora 64 x Klein Rendidor. Varieties released in 1973 were: Diamante INTA from the cross Jaral "S" x Nariño 59; Calden INTA from Cheg 285-Perg. Gab x Jaral "S"; and Leones INTA, a selection from a line of Jaral 66. Thus, the 1962 program was instrumental in producing three new varieties that were released by the Cereal Variety Release Committee in 1973.

Precoz Parana INTA and Marcos Juarez INTA were initially distributed in 1973, and thus have shown very promising yields and adaptability. The field performance of these recent releases has contributed to their acceptance by the farmers to their rapid diffusion.

Previously, the principal commercial varieties were Klein Atlas, Klein Toledo, Buck Manantial, Piamontes INTA and others, all of which(except Piamontes INTA) were produced from crosses made in Argentina. Argentina's wheat production area in 1973 was 4,252,000 hectares. This area produced 6,560,000 tons in 1973-74. Sufficient to supply domestic needs and part of the export needs. The 1973-74 wheat brought a price of $67.00 per ton.

The 1973-74 crop season weather conditions were favorable for wheat cultivation; rain was moderate during the flowering period in the spring. Thus, good readings could be taken on the performance and yield capacity of the experimental material.

The experiment stations participating in the wheat program have developed a large volume of segregating materials and established lines that permits the development of superior varieties.

Currently, research focus is on varieties with early maturity for autumn sowing; specific adaptation to ideal climatic conditions; and resistance to Septoria and Fusarium sp. Information is needed on good management cultivation techniques in the humid and semi-arid regions, if the high yield of the new varieties is to be fully expressed.

In 1974, fertilizer remained in short supply and the price relationship between price of fertilizer and price of grain did not encourage its use.

2.3 Peru

2.3.1 INTRODUCTION

Wheat is an important crop of Peru, covering six percent of the total cultivated area of 2,500,000 hectares, or over 140,000 hectares. Production of wheat is valued over 8 million US$. Wheat is cultivated both on the coast and in the sierra (Mountain valley). Twenty of the 24 political departments grow some wheat. The departments with greatest acreage include the sierra portions of the provinces, Cajamarca and La Libertad in the north, Ancash and Junin in the center and Ayacucho in the south; these five departments represent 75 percent of the area cultivated to wheat. The same departments also are the major producers, with 74 percent of the total Peruvian production.

Wheat is seeded and harvested throughout the year; depending on the region. In the coastal areas, which make up only 2.5 percent of the acreage, seeding is done in April to June. This crop area is grown under average management, and the harvest (from September to mid-November) produces 5.0 percent of total production. In the Sierra, about 15.0 percent of the total planted area is sown (from April to June) under irrigated conditions with average management. Harvest, (from September to mid-December) accounts for about 18.0 percent of the total crop.

About 83.0 percent of the total wheat area is grown under rainfall in the Sierra. Seed is sown from November to February. The crop is grown under a low level of management and harvested in May to August. Approximately, 77 percent of Peru's total production comes from these fields. Figures 2.3.A and 2.3.B show the area and production for the various departments of the country.

During 1973-74, 30,289 hectares were seeded to high yielding varieties, representing about 20 percent of the total estimated area of the more than 140,000 hectares sown to wheat in Peru. Of the area devoted to high yielding varieties, 16,289 hectares (54 percent) was grown by farmers, who received technical assistance credit, and 14,000 hectares (46 percent) were sown from seed the farmers had kept from the previous year.

Table 2.3.A shows the major varieties used in the "direct-action" program for 1973-74, which supplied seed directly.

Of the total of 25,289 hectares of improved varieties, 84.3 percent was seeded in the Sierra primarily using the varieties Ollanta, Cahuide and Huascaran. About 5,000 hectares (16.7 percent) were sown in the coastal area. Helvia Fron and Tinajones were the principal varieties.

2.3.2 PROBLEMS IN WHEAT PRODUCTION

2.3.2.1 Production and Consumption of Wheat

Table 2.3.B shows that Peru's consumption of wheat far exceeds its current ability to produce. Imports have accounted for 75 to 85 percent of consumption in recent years. There has been little variation in yields or in cultivated area, in recent years, while the value of imports has tripled within the last seven years. In 1973, even though imports were reduced, their value increased by 12 percent in relation to the previous year, which reflects the change in international markets.

2.3.2.2 Factors Having an Influence on Wheat Production

As previously mentioned most of the wheat is cultivated in the mountainous regions under rainfed conditions, and rainfall distribution is often erratic. Frosts are a continuous danger that reduce yields. Inputs such as fertilizer are generally unavailable. Yields are also reduced because of unavailability of adequate machinery; credit for purchase of inputs is often not available at the right time and in sufficient amounts for covering production costs; farmers also do not receive a price sufficient to encourage more production. There is also a scarcity of resources for research and extension, with an urgent need for professional extension and research people to promote wheat cultivation.

Many factors affect the research program. For example, research personnel must be paid on a competitive basis; otherwise the best trained people are lost.

Resources also are necessary to ensure a steady flow of new varieties possessing good rust resistance, earliness, and high yields of grain and flour. Similarly, agronomic trials are essential to establish the best levels of fertility,weed control, irrigation, and times of application; herbicide trials also are needed. Each of these activities must have resources if the present recommendations are to be better defined.

An improved seed production program is badly needed; adequate machinery and experimental equipment are required if these activities are to be successful.

A major training program is needed to ensure continuing supply of well-trained, motivated people.

Scientists must interact with scientists of other countries to stay abreast of the more recent developments, both regionally and internationally. Thus, provision must be made to ensure that scientists visit international symposia and visit programs of adjacent countries to interchange knowledge.

Extension activities must be increased to ensure the movement of research results to farm application; coordination and communication also is needed between research scientists and their extension colleagues.

These problems are not common to Peru alone; however they must be overcome if increased activity is to be generated in wheat improvement.

2.3.3 RECENT ACCOMPLISHMENTS

In spite of the problems expressed above, wheat yields in Peru have been stabilized through the introduction and spread of new varieties. Among the factors contributing to improvement are:

2.3.3.1 New Varieties : Since 1960, several new varieties have been developed for production on the coast and in the Sierra. The varieties suitable for the coast include Costa 60, La Molina 60, Helvia Fron, Helvia Li, Helvia Ken, Taymi, San Lorenzo, Tinajones and Tumi. (Taymi was developed by the National University at Lambayeque, and San Lorenzo was developed at the National University, Lima; the others are a result of Ministry research). Varieties suited for the Sierra, include: Sierra 1, Sierra 2, Mantaro, Huascaran, Salcantay, Helvia Ken, Ollanta, Huancabamba, Crespo, Gloriabamba, Huandoy, Cajabamba, Chechani, Cuzqueño, Cahuide, Sinchi and Huanca.

The majority of these varieties have had limited use; however, usage would be improved if more seed could be produced, and an adequate system of maintenance and diffusion were developed.

A number of the newer lines appear very promising; Table 2.3.C lists four of these lines suited for the coastal region, and one line suitable for the Sierra.

2.3.3.2 Agronomic Practices

Agronomic research-based recommendations have been developed for adequate levels fertilizer application, rate and date of seeding, the application and dose rate of herbicides and the control of insects in storage, etc.

Fertilization of wheat. (Ing. Hugo Moreno, Cria I-La Molina): Peru's national average yield of wheat (approximately 900 kg/ha) could be easily tripled or quadrupled to 3,500 kgs/ha, if adequate fertilizers were used. Previously fertilization had provided poor results in wheat, probably because of the use of varieties with low yield potential, tall straw, late maturity, and susceptibility to rusts. Fertilization of such varieties increases their height and subsequent lodging; favours rust attack; and delays maturity--making them more susceptible to frost. However, patient, scientific investigation has produced new varieties that combine high response to fertilization, rust resistance, short straw, high yield, and early maturity. Simultaneously, an improved technological package has been developed to maximize the yields.

Various experiments have shown that the new wheats have a high response to N even up to 160 kgs/ha. Phosphorus has also produced a positive response, in some cases up to 100 kgs/ha. Potash response has been confined to only a few areas, since this element is probably in good supply in the soils of the northern Sierra (Cajamarca-La Libertad). Fertilizer recommendations vary from soil to soil, but the general recommendations are:

Element	Coast	Sierra
	Kgs/ha	Kgs/ha
N	80-100	100-120
P_2O_5	50-80	80-100

Investigations on the Use of Herbicides

Table 2.3.D outlines these investigations and lists the chemicals used

Investigations on the Control of Stored Products Insects

(Ing. Rolf Gloria B. Cria 1, La Molina)

Peru losses 10 percent of its wheat production (13,800 tons) annually to stored products insects. Methods must be found to preserve this harvest, using chemicals that are effective, economical, not phytotoxic, and non-harmful to human and animal health.

The insects that most frequently attack wheat in storage are: Sitophilus oryzae, rice weevil, Sitotroga cerealella cereal moth, Ephestia (Amagasta) Kuchniella, Mediterranean flour moth. In addition, there are others of minor importance (but with potential danger), such as Tribolium confusum and Plodiainterpunctella.

Control of such infestations can be provided by adequate cleaning and desinfection of the storage areas with Baytex or Cidial (1 kg/100 lt water), Malathion, Sevin or Gardona (2 lt or kgs/100 lt water), applying 50 cubic centimeters to cover 1 square meter of surface.

Infestations can be safely controlled with any of these chemicals (except Gardona) at 0.4 to 0 7 gms insecticide per kg of grain, or 20 p.p.m.; leaving the grain wholesome for human or animal consumption. Phostoxin (8-10 pastillas/ton) or Methyl bromide (1 lb to 23 cubic meters of space) can be used as fumigants, under careful direction. Methyl bromide should be used only in grain for consumption, and with the strictest standards of application,because it can cause a very toxic and irreversible action in warm blooded animals, and can also affect grain germination.

Chlorinated hydrocarbons such as DDT, Aldrin, BHC, etc. should not be used for insect control in grain storage areas, since these are persistent chemicals that accumulate in the fat of human and animals.

2.3.3.3 Pathology

Investigations in the greenhouse have shown that the following races of rust are prevalent: Stem rust - 9, 11, 15, 17; Leaf rust - 57, 154

2.3.3.4 Agriculture Production

The Agricultural Plan of Peru for 1974-80 involves the progressive incorporation of better varieties, agricultural credit, and fertilizers over the wheat area. Projections call for an increase in area of 99,000 hectares,with a gradual increase of yield from 1007 kgs/ha in 1973 to 2,300 kgs/ha in 1980. The national production target for wheat by 1980 has been set at 522,210 tons, which suggests a reduction in the level of imports (Table 2.3.E).

The government is considering two alternative production plans, the 1974-80 period. Both have the objective of increasing production and thereby diminishing the degree of imports while contributing to the national supply.

These alternatives A and B are compared in Table 2.3.F and 2.3.G respectively.

2.3.3.5 Credit

The Agricultural Development Bank of Peru has provided loans for agricultural credit as shown in Table 2.3.H

Credits provided by the Agricultural Development Bank prior to 1973 have been insignificant.

2.3.3.6 Commerce

Countries that have traditionally supplied wheat to Peru are the U.S.A., Canada, Australia, Argentina, and occasionally others. Of total imports in 1973, 70 percent were from the U.S.A. and 30 percent were from Canada. Up to 1969, wheat imports were handled by the millers who imported through concerns such as Cargill Bunge, Borne, Continental Grain, and Dreyfus. The milling industry handled all operations including financing and obtaining of credit. The Government gave importation licenses and later exercised control on the finished products(especially the price of flour, pastas and French bread) through a series of control laws.

This situation changed radically when the Empresa Publica de Servicios Agropecuarios (EPSA) took charge of the procurement importation and commercial distribution of imported wheat. After wheat is off-loaded at the ports, it is distributed to the flour millers according to the size of their operation.

The price of wheat sold to the millers by EPSA was $70.00 per ton up to 1973, and was at $120.00 per ton in December 1974. The difference between the higher price of the international market and the price in the national market, represents the subsidy paid by the government. The aim of the subsidy is to maintain the price of flour, macaroni and bread at a level that will allow the great majority of the people to buy this popular and basic foodstuff.

2.3.4 UTILIZATION OF NATIONAL WHEAT

The wheat produced in the Sierra is fully utilized locally; that is, it is processed in small flour mills located in the regions of production (in Ancash Department alone there are 295 of these mills), which handle milling of 80 percent of the production. The flour is characteristically dark in color since the extraction rate is 85 percent. It has an advantage over white flour,being more nutritive food because of its higher protein and vitamins content. The by-products, bran and middlings, are utilized as animal feeds. The remaining 20 percent is consumed directly by the farm family in products native to the region which also serve as items of commerce in the sierra, with some products transported to coastal cities. National wheat usage is shown in Figure 2.3.C.

2.3.5 INDUSTRIALIZATION

Nine large flower mills process almost all the imported wheat. Installed milling capacity is 780,000 tons/year which can be increased to 940,000 tons per year. In milling wheat, flour extraction traditionally was set at 75 percent, but this rate was changed to 82 percent in 1973. This change, in effect, prevents the mills from producing special flour.

2.3.6 STORAGE

The warehouses and silos for storing imported wheat are located at the port of Callao, where the capacity is 23,000 tons, and at the port of Matarani (Arequipa), with 10,800 tons capacity. There are no warehouses in Salaverry and Iquitos, in spite of the fact that these ports serve the flour mills of Trujillo and Iquitos. At the mills, there is silo storage and flat storage, totaling about 120,000 tons. This amounts to a two-months reserve for milling, which is considered sufficient for contingencies.

To make available better seeds in sufficient quantity and at the right time, el Proyecto de Incremento de la Producción Agrícola (PIPA) is building 14 wooden prefabricated silos, especially constructed to be water, mildew, and insect proof. These silos are located in all the major wheat areas.

2.3.7 PRICE TO THE PRODUCER

Unstable prices for agricultural products paid to farmers in the Sierra are often caused by the low quality and irregular production. Yields are subject to great variation, both in quality and quantity, for various reasons, including climate, diseases, and insect attacks, many of which cannot be controlled by man. These variations in production directly affect the price of the wheat offered for sale. In years of high production the price to the producer drops and he suffers a loss; but when harvests are low, the prices rise-- however, the increase usually benefits the middle man. The farmer cannot store his product and must sell it soon after harvest so that he cannot take advantage of rising prices. Because of these disadvantages for the farmer, the government recently set a floor price at an incentive level that seeks to assure the farmer a just return. This floor price has provided confidence and security for the expansion of cultivation. The channels of commerce have been established at a state level,thus eliminating excessive profits of the middle man that were characteristic of commerce in agricultural products in the country until recently.

The government has fixed prices for wheat according to grade, to benefit the poorest sector of the farm population growing this cereal. For Grade I the price set is S7,000/ton (US$160.00 approximately),Grade 2 the price set is S6,500/ton(US$150.00) and Grade 3 S6,000(US$138.00).These prices refer to wheat sold in market centers, unbagged and with a maximum of 14 percent moisture. Grades are determined on the basis of: hectolitre weight, variety, damaged grains, shrunken kernels and extraneous materials.

2.3.5 COSTS OF PRODUCTION

Costs of production, including labour, fertilizer pesticides and power used, have been estimated as a fixed cost by the Agricultural Marketing Board of the Ministry. There are four different costs set according to zone of production and different variations in the inputs. It is considered that 17.6 percent of the seeded area is grown with medium-level technology and the remaining 82.4 percent is grown with lower-level technology. (Medium-level technology yields 2,000 to 3,000 kgs/ha, and lower-level technology yields 800 to 900 kgs/ha). Loans at 7 percent interest are provided to farmers for inputs; according to need as devised by the formula used. The overhead costs of administering the loans is not charged directly to the farmer.

The prices paid to the farmer for wheat in the market place varies according to the zone of production, and is based on costs, average yield, etc. Farmers can request that the authorities grade the wheat produced, and that the millers use and pay the same price for domestic as for imported wheat. This recent channelling of domestic wheat through EPSA has been instrumental in bringing domestic production into the milling market, which formerly was 100 percent of imported wheat.

In the coastal region, wheat offers good economic opportunities as a second crop, and does not compete with high income crops, such as cotton, rice and sugar cane, grown in the other season. In the Sierra, wheat is somewhat less attractive as a crop, considering the amount of family labor involved under the low technology practiced, but it offers a way to take advantage of this labor and to grow a valuable product. In summary, it appears that wheat can currently be grown profitably as a result of government intervention in the market.

Using as a base an application of 80-80-0 and using ammonium sulphate (22%) and superphosphate (20%) the cost of fertilizer use in the coastal region with average technology is US$.07 /kg for superphosphate and US$.085/ kg of ammonium sulphate.

T. 2.3A Seed distribution of high yielding varieties in the 1973-74 campaign in Peru.

Variety	No. of hectares
Ollanta	8,475
Cahuide	2,708
Helvia Fron	1,478
Tinajones	1,467
Huascaran	1,141
Cajabamba	365
Crespo	365
Bella Suprema	323
La Molina 50	101
Nariño	65
Huacabamba	16
Helvia Ken	5
Other varieties	280
Total	16,289

T. 2.3B The domestic demand and production of wheat during the years from 1966 to 1973.

Year	Area 000's has	Yield kg/ha	Production 000's T.	Imports 000's T	Value of imp. mill. Soles	Domestic demand 000's T.
1966	156.7	925	145.0	496	1,006	631.0
1967	159.9	951	152.2	484	1,133	636.2
1968	136.0	836	113.9	426	1,979	718.9
1969	139.1	913	127.0	692	2,214	829.0
1970	136.2	921	125.4	638	[illegible]	763.4
1971	139.5	882	[illegible]	693	[illegible]	805.2
1972*	138.4	1,015	139	853	[illegible]	992.5
1973*	141.0	1,007	142.0	750	3,166	892.0

T. 2.3C Characteristics of some hybrids suitable for production in coastal Peru and for the Sierra.

Hybrid	No of heads per square metre	Smut	Height cms	Rust reaction Pgt	Rust reaction P	Hect. wt. kgs.	Yield kgs/ha
Coastal							
1. Yt54-N10B-21-1c x Y54A x Salcatay II-9908-1CL-24L-1L-3L	361	20S	100	0	0	78.5	4335
2. La Molina 60 x Enano 2 II-9776-1L-L-L-18L	533	20S	100	0	0	82.2	5254
3. Bb"S"-INIA 26591-1T-7M-0Y	392	0	70	0	0	81.0	4843
4. Yecora "S" (Bb93)	396	0	75	0	0	80.6	4708
Sierra							
5. CAI PW 327xFKN (II-50-18) II-4290-1L-1L-2L-2Cz-1Cz			107	TS		76.7	Junin 3,711 Cusco 5,381

T.2.3D Recommendation for chemical control of weeds in wheat. Peru 1973-74 (Ing. Alejandro Corrales Maced Cria I La Molina).

Herbicide compound	Stage of application: Wheat & Barley	Stage of application: Weeds	Dose rate Commercial product per hectare	Type of control	Precautions and estimated cost/ha (product + application)
Amine of 2,4-D at 480 g/lt active	15-25 cms height	From seedling to early flowering	1.5-3.0 litres	Dicotyledons	Use equipment only for weedicides or 'econtaminate the equipment if used for other purposes.
720 g/lt	"	"	1.0-2.0 litres	"	When applying avoid drift to such susceptible plants as tomatoes, chilis, cotton potatoes, etc. Do not use emulsifiers unless in special cases of 0.3% Cost - Soles 650.00
Dimethyl Amine of 2,4-D + MCPA	20-30 cms average height	"	1.5-3.0 litres	"	Similar to the above product. Cost - Soles 780.00
Chlorotoluron	Pregermination or	Pregermination	3.0-4.0 kgs	Dicotyledons and annual monocotyledon (wild oats)	No special precautions
	Post emergence at 15-25 cms	Seedling to early flowering			Damp soils
Trialate	Before seeding	Before seeding	2.5-3.0 litres	Annual monocotyledons specific for (wild oats)	Incorporate and mix immediately into the soil after application Soles 1,950.00 (liquid emulsion) Soles 1,700.00 (granular)
Thyazuron	Pregermination	Pregermination	3.0-4.0 kgs	Dicotyledons	No special precaution but apply in moist soil. Soles 1,450.00
Butachlor	Pregermination	Pregermination	5.0-6.0 litres	"	No special precaution but apply in moist soil. One can use 2,4-D as a complement in post emergence. Soles - 1,300.00
Diuron	"	"	1.0-1.2 kgs	Dicots and annual monocots	No special precautions but apply in moist soils. One can use 2,4-D as a complement in post emergence. Soles 1,100.00
Propanil	20-25 cms	Seedling to early flowering	9.0-10.0	Dicots and annual monocots	Apply as directed Soles 1,450.00

43.5 Soles = $1.00 US cy.

T. 2.3E Projected internal demand for wheat in Peru 1973-80.

Demand	1973 000's tons	Percent-age	1980 000's tons	Percent-age
Internal demand	892	100	1,061.0	100
National production	142	15.9	552.2	52
Imports	750	84.1	508.8	48

T. 2.3F Targets of production in Alternative A

Year	Area 000's has.	Yield kg/ha	Production 000's tons.
1974	147.0	1,259	185.1
1975	169.7	1,452	246.8
1976	184.3	1,593	293.7
1977	196.6	1,746	343.4
1978	208.9	1,935	404.4
1979	221.3	2,105	465.8
1980	240.0	2,300	552.2

T. 2.3G Targets of production Alternative B

Year	Area 000's has.	Yield kg/ha	Production 000's tons
1974	147.0	1,259	185.1
1975	156.0	1,301	203.0
1976	165.0	1,467	242.0
1977	175.0	1,641	287.1
1978	186.0	1,752	325.9
1979	198.0	1,883	372.7
1980	210.0	2,022	424.7

T. 2.3H

Year	Hectares involved	Percent
1970	1,946	1.42
1971	3,862	2.78
1972	4,116	3.00
1973	16,289	11.50

Figure 2.3.A. PERCENTAGE OF WHEAT CULTIVATED, BY DEPARTMENTS

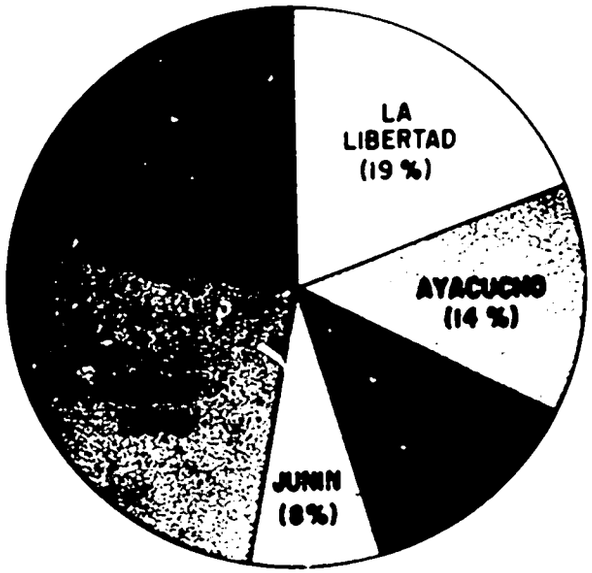


Figure 2.3.B. PRODUCTION OF WHEAT, BY DEPARTMENTS

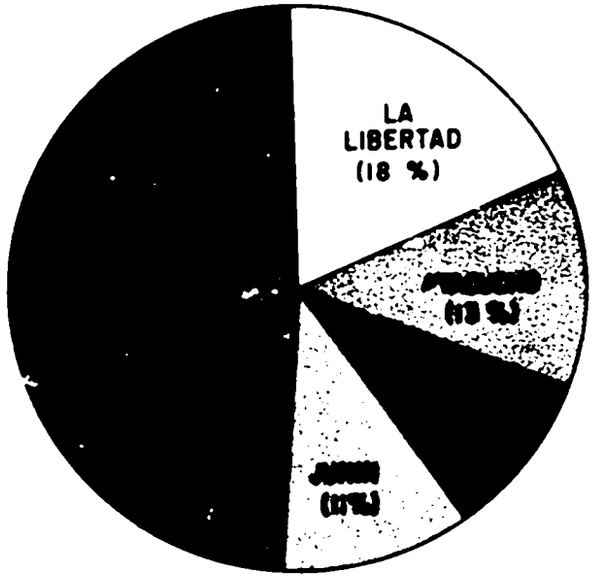
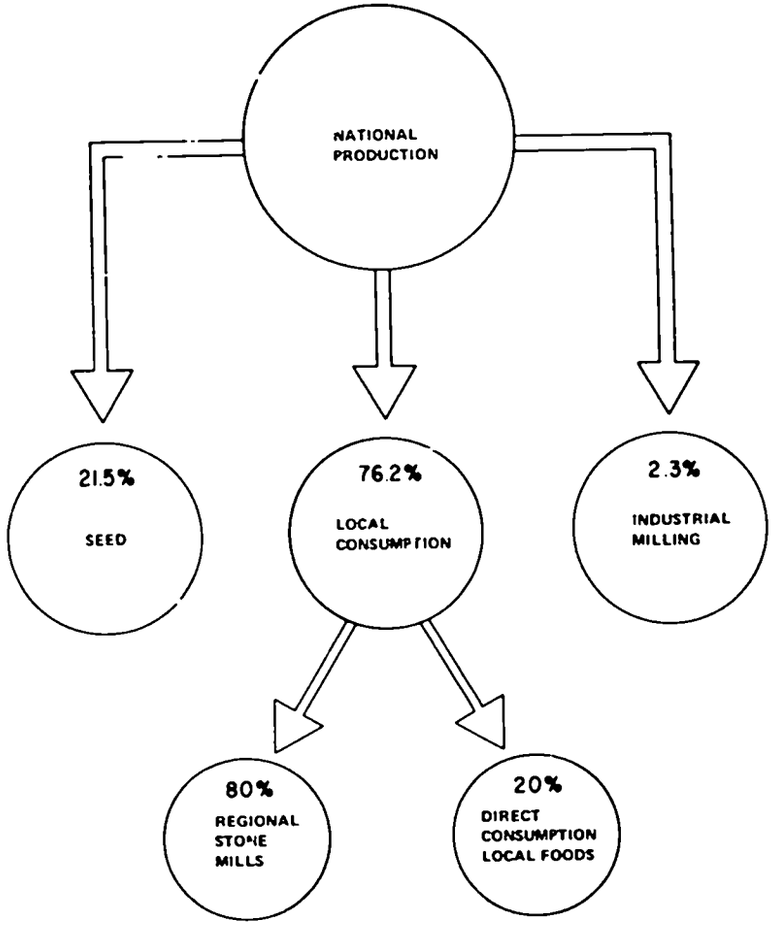


Figure 2.3.C. CURRENT USE OF NATIONAL WHEAT



3.0
Africa and Near East

Abu Ghraib Experiment Station-Baghdad, Iraq: Dr. Omar Ali Ameen inspects triticale plot.

3.1 Algeria

3.1.1 INTRODUCTION

This report summarizes the third year (1974) of the Algerian research program conducted by the Ministry of Agriculture and assisted by CIMMYT, the Ford Foundation, the CCCE of France, FAO, and other organizations. Research emphasis continues to center on breeding and on production practices. New research includes the study of the annual Medicago which is being introduced as a replacement for fallowing practices used in cereal rotation.

Young Algerian scientists continue to receive training locally, and in Mexico, Australia, and Lebanon. Several senior agricultural officials received travel grants to visit Mexico, and to observe Medicago production in Australia.

3.1.2 CLIMATIC CONDITIONS AND FACTORS OF PRODUCTION

Rainfall was below normal during the crop season, in both the Western and Eastern regions, with central areas about normal.

Precipitation was poorly distributed. Throughout the country, the months of September, October and November were extremely dry; substantial rains did not fall until the last two weeks of December. Again, throughout January and the first two weeks of February, there was essentially no rainfall. Heavy precipitation began in mid-February throughout the Western and Central regions, and continued through the first week of May. In the Eastern Region, however, rainfall during these months was well below normal. Constantine and Guelma recorded less than half of the 600 mm. average.

Most of the wheat acreage was seeded into dry soil and emerged late in December and early January, after the rains came. After January, growth was retarded, particularly in the Eastern Region where December rainfall had been low. In the Western and Central Regions, the December precipitation was sufficient to carry the crop through to the February rains, and growth was about normal.

Temperatures at the lower elevations were above normal through January and February, producing rapid growth and heading at the normal date. In the high plateau region, however, cold temperatures retarded development and the crop was comparatively late.

In some regions, late April frosts caused considerably damage, and several severe hailstorms in the Western high plateau region caused complete or partial loss of affected wheat fields. Some damage was experienced from the sirocco winds, but this was confined primarily to the Western region. An overall reduction in yields can be attributed to the drought conditions and late maturity of the grain, both of which caused severe grain shrivelling.

A species of Pentatomidae (stink bug) was prevalent in some areas of the Western Region; farmers who made chemical spray applications obtain 80 - 100 percent control. Bird damage on early fields was common, and some fields were virtually destroyed.

The total area seeded to cereals in 1973-74 was estimated to be 2,750,000 hectares; or 96 percent of the planned production, and about 13 percent above that of the previous year.

The weed problem continues to increase each year, particularly the grass-type species (wild oats, annual ryegrass, brome and Phalaris). It is difficult to assess the losses due to weeds since the effects of drought and other factors were compounded in the losses; conservative estimate, however, would be 20-25 percent. In some fields, the weed infestation was so great that the crops were harvested as hay, and some seed production fields were refused for certification and harvested as grain.

As mentioned, Medicagos were introduced during 1974. Approximately, 2000 hectares were seeded, with variable results. At intermediate and low altitudes, growth was good and seed production excellent, whereas at higher altitudes, the non-adapted Australian varieties did not perform as well. In general, however, results were very encouraging.

3.1.3 DISEASES

Septoria was the only disease of major importance; it was widely prevalent at lower elevations. Development of the disease began in late February, spreading rapidly throughout March.

Its spread was arrested in early April, as rainfall decreased and temperatures rose. Most of the damage was confined to the leaves, and head infection levels were low. Damage was limited to the fields sown earliest, and was the lowest of any year since the introduction of high yielding varieties.

Other foliar diseases were of minor importance; only traces of stem, leaf and stripe rust were found. Helminthosporium and Rhyncosporium were common on barley but damage was slight. Although crown rust was heavy on wild oats, there was little spread to varieties grown commercially.

Ophiobolus and Fusarium foot rots were common. Although neither caused severe damage, Fusarium was most damaging. Both diseases are widely prevalent, which suggests a future hazard, unless crop rotations are introduced to offset its increased development.

3.1.4 PRODUCTION MANAGEMENT

In 1973-74 production management emphasis shifted from studies of dates of seeding and fertilizer management to studies of weed control through crop rotation, clean fallow, and the introduction of Medicago-cereal rotations. The advanced variety trials were continued in support of the breeding program including: 39 varieties of wheat, 7 varieties of barley and three of triticale. These trials were sown on state farms at 18 locations over the different zones. These trials are large plots of more than 100 m^2, which are replicated and sown with regular farm equipment. Of these, 15 trials were successful and yields of the more promising strains are given in Tables 3.1.A, 3.1.B and 3.1.C.

Among the bread wheats tested, Anza showed the greatest promise, with good resistance to Septoria, excellent resistance to leaf and stripe rust, good quality, and high yield. Straw strength is very good (5-10 cms shorter than Siete Cerros) and the plant has good tillering capacity and shattering resistance. Anza was increased in two small plots, and nine quintals of seed were planted for the 1974-75 increase.

Although several selections of bread wheat had excellent yield, some other characteristics were less favorable. Selections Mexico 50 X B_{21} 4-3-5-4-2, T.D.T. 64-2-M-3 and T64 2w-K338 X Etoile de Choisy-Koudiat were eliminated for poor test weight, quality and threshability. BT908 from Morocco had good yield, but grain quality was only fair and it is very susceptible to stem rust.

The variety Era has outstanding resistance to Septoria and good yield, but is late to maturity. Era may be adapted to very early seeding and it should be evaluated for this purpose on the high plateau. Soltane can replace INIA as soon as adequate seed stocks are available.

Of the durum varieties reported in Table 3.1.B Cocorit 71 continues to yield very well. Since it is very early, it is susceptible to late frosts and is not adapted to the high plateau. Although it is susceptible to Septoria, it is more tolerant than Jori 69. Poor quality is Cocorit 71's principal disadvantage and it has a high percentage of yellow berry. Cocorit 71 will probably replace Jori 69 when seed is available, since Jori 69 has not performed well in commercial production because of its lack of disease and frost resistance.

Capeiti and INRAT 69 are recommended varieties that will enter production as soon as seed supplies are adequate. Capeiti yields well in the Oran region and INRAT 69 is adapted to elevations below 500 meters where Septoria is a problem.

Of the new durum selections, Crane "S" B, Anhinga II, and Cisne "S" appear most promising. Cisne "S" has the same parents as Cocorit; but is later, taller and has less yellow berry. It will be better adapted than Cocorit to the lower rainfall areas and the high plateau.

Anhinga II is susceptible to lodging but has high yield, good quality and a desirable maturity and height Crane "S" B is similar to Cocorit, but has better quality.

In 1973-74, barley gave higher yield than wheat in most trials, as shown in Table 3.1.C Zemyr and Maguelone were the outstanding varieties. These varieties have been continued in the 1975 trials, and should now be increased to replace the present standard varieties.

The Triticale varieties Cinnamon and V-306 were inferior to Siete Cerros in yield but these are now old triticale varieties. Newer varieties with better test weight and yield should be introduced and tested. Many of the new selections in the breeding program look better than the two varieties reported here. PM132 is a forage type and had poor grain yield. Its rachis is brittle and there is heavy shattering at maturity.

3.1.5 HERBICIDE TRIALS

Seven herbicide trials were established in the Algiers (Central) Region: 3 trials using herbicides for the control of grassy weeds, and 7 trials using chemicals for the control of broad-leaved weeds.

Weeds are a major limitation to wheat production in Algeria. Heavy populations of both grassy and broad-leaved weeds caused exceptionally heavy losses in the 1973-74 crop. The application of fertilizers to increase crop yields also favor weed development, and the increased competition of the weeds greatly reduces the efficiency of fertilizers used. Control of these weeds is absolutely necessary if yields of cereals are to be increased, and all cultural and chemical means must be used to attack the problem.

The preparation of a good seed bed and presowing tillage for weeds are essential for weed control. The principal difference in yield recorded for experimental plots and adjacent commercial plantings can be accounted for by the better pre-sowing land preparation used experimentally: two additional tillage operations were performed. This additional cultivation helps establish a uniform stand of wheat and destroys germinating weeds, allowing the crop to compete more strongly.

Table 3.1.D shows the effect of early broad-leaved weed competition on wheat yields.

When weeds were controlled chemically at the early tillering stage, yield was increased by an average of about 700 kg/ha. Later control with 2,4-D gave less than 500 kg/ha yield advantage. The early applications increased yields by more than 35 percent over the check. However, timely application of 2,4-D is still an effective control measure for broad-leaved weeds.

The proper time for 2,4-D application (end of tillering to before early boot stage) is very short, usually less than three weeks. Adverse weather (often encountered in this period) precludes the application of the chemical, or further limits the time available for applications. Thus, increasing the length of application treatment, with chemicals such as Quinorexone SP and Oxytril M, allows for a more effective herbicide control of the broad-leaved weeds.

In the three trials established for selective herbicide control of grassy weeds in wheat, all applications were made in the 1-3 leaf stages, under dry soil conditions. There was no rainfall for more than 30 days after application. Since the chemicals tested must be absorbed by the roots, lack of moisture prevented the movement of the chemical into the soil until after the grassy weeds had become resistant, and very little control was observed. At heading time, therefore, there was no difference in control between check and treated plots and harvest data was not taken.

Treatment with Suffix did not provide control of wild oats as well it had in 1973. All applications were made at the rate six liters per hectare, as compared to the rate of 7.5 liters used in 1973. Complete control had been obtained in 1973, whereas in 1974 there was only partial control. In general, wild oats were stunted and retarded in growth, but some survived to produce seed. Because of low density of wild oats in the test areas, no significant yield increases in yield were obtained through chemical application.

3.1.6 MEDICAGO STUDIES

Medicago variety trials were conducted in all of the major wheat regions in 1974. Five Australian varieties were sown in most of the trials: Harbinger and Jemalong appeared to be well adapted over most of the low-to-middle elevation areas of the country; Tornfield was early, and had lower yields than the preceding varieties; Paragosa showed good growth and seed set; Snail developed rapidly, especially in the drier areas, probably as a result of its larger seed. All five varieties showed good seed production. The ability to reseed after wheat will be determined in the 1976 crop cycle.

The plantings of 1974 revealed the high incidence of native Medicago in the soil. In many of the plantings of introduced varieties, there was a high level of indigenous Medicago plants; often these were much more aggressive than the Australian varieties. Simply fertilizing the native stands with phosphate will greatly encourage their growth and seed production.

A major problem in establishing the Medicago wheat rotation, is that of controlling grazing on the Medicago seedings-- for adequate weed control-- while ensuring a good Medicago seed set. Since there are no fenced fields, all pasturing has to be supervised

by shepherds. Lack of water for the sheep near many of the medic pastures offers a further handicap to controlled grazing. Top clipping of weeds in the initial stands also is a necessity, while getting that initial seed set to begin the rotation. This requires suitable mowers be available to farmers All of these problems must be resolved to realize the full benefit of the medic-wheat rotation.

Once the stand is established, however, and adequate seed quantities are put into the soil, some areas may be used for hay production that can be trucked to feeding areas where water is available for the sheep.

Rotation experiments using medics were established in all three regions, including wheat, medics and a hay-forage crop of vetch in rotation with oats, barley or triticales. In 1975, results will be available from the first year of Medicago-wheat experiments.

Tillage management experiments also were established in each region; clean fallow is being compared to the normal pasture fallow. Yield results from trials also will be obtained in 1975, for the first time.

3.1.7 SEED PRODUCTION

In 1973-74, a CIMMYT scientist was in charge of improving seed production of the early generation wheat seed increases. The program was conducted at the El Kroub station and on eight domaines (state farms) in the Constantine region. Seed was produced for the first three generations of increase of 23 different cereal varieties. All operations of seeding, weed control, roguing, and harvesting were supervised. Seed was cleaned by the OAIC under the supervision of the Cereal Project and the El Kroub station.

The program included the training of four technicians in seed production. This aspect of the program might have been more effective, had more Algerian scientists been available for training.

The program demonstrated that good seed can be produced, even under the adverse weather conditions that prevailed. Some local personnel were trained in wheat production practices, also.

The production from third generation increases of bread wheat averaged 1520 kg/ha; durum wheat 1530 kg/ha; and barley 2720 kg/ha. This compares to the regional average last year of about 500 kg/ha in the Constantine region. Again, the increase in production was due to better seed bed preparation, timely seeding, and good weed control. Rainfall in the region was about 320 mms; less than one-half the normal amount.

3.1.8 VARIETAL IMPROVEMENT

The major cereal zone of Northern Algerian occupies a band approximately 100 kms wide, along the Mediterranean Sea. It has six cereal research stations (two in each of the three zones) classified according to their altitude:

Station and Location	Altitude (m)	Rainfall (mms.)
1. Plain or littoral zone		
Algiers (Central)	59	762
Guelma (East)	270	677
2. Hills or sub plateau zone		
Sidi-bel-Abbes (West	486	395
Constantine (East)	600	594
3. High plateau		
Ain el Hadjar (West)	950	430
Sétif (East)	1081	469

The three eastern stations -Guelma, Constantine, Sétif- received less than one-half the average annual precipitation during the 1973-74 crop season. However, the distribution of spring rains was sufficient to provide yields of 1.5-3.0 tons under good management. The lack of late rainfall, and consequent drought stress, favored the earlier maturing varieties-- in both the screening nurseries and yield trials.

In contrast to the eastern region, the central and western regions received average amounts of rainfall; although distribution was irregular, crop development in general was very good. In the Western region there was some shrivelling seed as a result of sirocco damage prior to crop maturation.

The crossing program placed major emphasis on broadening the genetic base in durums during the 1973-74 season. For the lack of better adapted durum lines and varieties, Jori 69 has been grown commercially in the past two years (although susceptible to Septoria and leaf rust). The Mexican variety Cocorit 71 and the Tunisian variety INRAT 69 are being multiplied.

The primary high-yielding commercial varieties of bread wheat are: Siete Cerros, Strampelli and INIA 66. Soltane is being multiplied as a replacement for INIA 66. The major advantages of Soltane are: superior Septoria resistance, better tillering capacity, and a longer vegetative cycle that gives better adaptation and yield stability.

3.1.8.1 Bread Wheats

Although the area immediately around Algiers is not a major cereal area, the high rainfall provides optimum conditions for measuring yield potential and disease resistance. Table 3.1.E shows the results for the superior bread wheat lines, based on 11 first-year trials and four second-year micro-plot trials.

All of the listed lines had higher yield averages and lower Septoria readings in their respective trials than did the two best checks - Soltane and Strampelli. These lines also performed well at the other regional stations in the East and West.

Four lines and varieties were outstanding: INIA-Tob x Np63 CM 746-51-01-OBK, which ranked highest at three stations, and was third-ranked at the fourth station.

Bb"S" x CC-INIA 30521-20M-2Mch-2Mch-0Mch-OBK, which ranked first at all three stations where it was tested.

Anza or Mexicani, which ranked at or near the top in all trials.

Mexicano 1481, was always in the top yielding group. This variety, however, has very soft grain which may eliminate it, on the basis of quality.

These varieties listed in Table 3.1.E are a collection of Septoria resistant genotypes that were selected under conditions of heavy infection, across North Africa. The pedigrees commonly indicate selection from Marrakech (MK), Merchouch (Mch) in Morocco, Beja (Bj), Manouba (MB) in Tunisia; and Baraki (BK) in Algeria. In some instances, the lines came directly from screening nurseries or segregating materials from Mexico-Yaqui (Y), El Batan (M) and Toluca (T).

The advanced lines and varieties listed in Table 3.1.F are some of the best Septoria resistant bread wheats selected from the different nurseries in the 1973-74 crop season.

Many of these varieties also have been reported as resistant in other countries, under heavy Septoria conditions. A total of nine sister lines with Septoria readings of 5-6 were selected from the cross $(Cno\text{-}7C)^2$ x CC-Tob CM 1679-1M-4Y-2M-1Y-500M-0Y-OBK. CIMMYT's strong emphasis on developing genotypes with resistance to Septoria tritici is now showing its effect through the availability of advanced lines with resistance, and good yielding ability.

3.1.8.2 Durum Wheat

Although large numbers of lines of durum have been selected in the Algerian program over the past three years, generation of new genetic diversity in the Algerian crossing program was not emphasized until 1974.

Locally grown varieties are tall and susceptible to the rusts; but they have good grain quality, some Septoria tolerance, and they show general adaptation to the rainfed cereal areas of Algeria. These varieties were widely crossed with the higher yielding, short, strong-strawed types from other countries.

Some of the best durum lines from the first and second year micro-trials are listed in Table 3.1.G.

Although most of the lines are direct selections from CIMMYT Screening Nurseries, the first entry, D70-94, is a Tunisian cross. The second entry is a CIMMYT cross, using a Tunisian F3 with Septoria resistance selected under conditions of heavy infection, at Algiers. Continued on diversifying the genotypes in the durum wheats. With the Regional Disease and Insect Screening Nursery from ALAD-FAO-CIMMYT Beirut, and the exchange of breeding materials among countries, the better sources of resistance for Septoria and the rusts are being assembled; they represent the greatest need for durum improvement in Algeria and North Africa.

3.1.8.3 Barley

The barley area of Algeria is restricted mainly to the dryer regions of the south. Two local varieties, Saida and Tichedrett, are well-adapted and have a yield potential of 4.0 tons under good management. The research needs in barley improvement include: increased resistance to scald, Helminthosporium, powdery mildew and leaf rust.

Zemyr, Esperance x Sv Mari and Selection 168 were three varieties and lines of 2-row barley that yielded well at four stations. The best 6-row barleys were from cross 7028 x 2759, Arivat x Athenais, Bernice, Ager, Astrix and Maguelone. Most of these varieties originate in France. A newly named variety from France, Robur, appears to be resistant to all the Algerian diseases. It has good agronomic and grain type, and was multiplied for inclusion in the 1974-75 season.

3.1.8.4 Triticales

The Algerian triticale program began with a screening nursery and yield trials in 1971-72; it has now expanded to include several screening nurseries, yield trials and three generations of segregating materials distributed widely to all stations.

The screening nurseries and segregating materials are subjected to severe selection for good grain types and many such selections have been advanced to yield trials, and many lines are coming from the cross Maya II x Armadillo "S". Triticale nurseries will be widely grown in 1975.

3.1.9 TRAINING

The training program continued in 1973-74, with a total of nine scientists trained at CIMMYT; three in breeding and Pathology, one in quality, and five in production. Two scientists were trained in Medicago production in Australia, and two were trained in grain legumes in Lebanon. In addition, five grants were provided for consulting missions, attendance at conferences, and visits to study improved techniques in other countries. This activity is considered to be of crucial importance in providing the scientific talent needed to operate Algeria's cereal program in the future.

Thousands of crosses are made each year; emasculation is the first step in this process.

TABLE 3.1.A.- Average yield of Bread Wheat Varieties for the three Cereal Zones, Average of all stations, and percentage of Check Varieties for the 1973-74 Production Research Program in Algeria.

Variety	No. of locations	Yield in Regions Q/ha			Average yield all locations	Percent of check
		Algiers	Oran	Constantine		
Anza	15	36.9	24.2	23.5	27.7	145
Mex 50 x B21 4-3-5-4-2	6	39.0	19.3	- -	31.9	132
BT908	5	40.3	13.4	26.0	29.2	131
TDT64-2-M-3	5	36.8	23.8	21.2	28.0	124
T64-2W-K338 x EdC-Kouidiat	10	37.2	18.9	17.7	25.7	123
Siete Cerros	14	37.0	19.0	19.5	24.3	121
Soltane	15	31.1	21.7	16.6	22.8	119
Zambezi	11	31.4	14.0	20.4	23.2	118
Strampelli	11	34.6	17.0	- -	23.5	116
Era	15	31.5	18.7	17.1	21.7	113
Potam	11	30.9	12.0	19.2	22.1	112
Kl. Rend.-Son64 x Inia-Cno"S"	10	28.3	11.9	21.2	21.2	101
Cajeme 71*	7	28.3	- -	18.9	24.3	100
Mahon Demias*	13	25.5	15.9	16.0	17.4	100
Fl. Aurora*	3	28.7	- -	- -	28.7	100

* Check varieties

TABLE 3.1.B.- Average yield of Durum Varieties for the three Cereal Zones, Average of all stations and percentage of Check Varieties for 1973-74 Program in Algeria.

Variety	No. of locations	Yield in Regions Q/ha			Average yield all locations	Percent of check
		Algiers	Oran	Constantine		
Capeiti	7		24.6	- -	24.6	172
Crane "S" - B	6	32.4	13.5	30.2	28.5	148
Anhinga II	9	36.2	16.1	20.1	24.1	143
Cisne "S"	10	35.8	13.1	18.4	22.0	141
Cocorit 71	15	30.5	21.8	15.1	22.6	139
Crane "S"	6	29.0	14.9	- -	21.9	136
Inrat 69	14	26.3	22.5	19.5	22.9	135
Quilafen	6	26.4	8.5	19.1	23.7	133
Anhinga I	10	31.4	13.3	16.4	20.0	129
Jori 69	14	23.8	18.9	19.4	20.4	120
Oued Zenati*	15	21.4	14.2	14.6	16.2	100

* Check variety

TABLE 3.1.C.- Average Yield of Triticale and Barley Varieties for the three Cereal Zones, average of all stations and percentage of Check Varieties for the 1973-74 season in Algeria.

Variety	No. of locations	Yield in Regions Q/ha			Average yield all locations	Percent of check
		Algiers	Oran	Constantine		
Cinnamon	13	29.3	20.9	28.4	24.7	96*
V-306	13	29.7	21.4	25.0	24.5	95*
PM-132	13	17.9	12.1	20.3	15.1	59*
Zemyr	4	- -	37.8	29.0	33.4	145
Maguelone	4	43.5	15.9	- -	36.6	137
Aurore	6	- -	32.9	22.0	25.[illegible]	123
Ceres	10	32.6	27.3	23.9	26.2	119
Ager	9	35.7	27.4	15.5	24.9	102
Saida**	9	31.9	18.4	20.9	21.9	--
Tichedrett**	8	31.3	17.7	21.7	21.5	--

* Triticales in percentage of Siete Cerros
** Check varieties

TABLE 3.1.D.- Yield of the Strampelli Wheat Variety as affected by Weed Control using commercial spraying equipment at El Asnam in 1973-74.

Herbicide	Stage of wheat growth	Percentage control of broad leaved weeds	Yield Q/ha.	Increase over check Q/ha.
Quinorexone sp.	4 leaf-1st. tiller	99	27.7	7.7
Actril	"	70	27.4	7.4
Troptone	"	60	26.8	6.8
Oxytril M	"	99	26.6	6.6
Buctril M	"	80	25.4	5.4
2, 4-D	End of tillering	95	24.7	4.8
Check	-	0	20.0	-

C.V. = 11.36%
LSD at .05 = 4.93 Q/ha.

TABLE 3.1.E.- Characteristics of the Superior Bread Wheat Lines in First and Second Year Yield Trials at the Central Research Station Algiers in 1973-74.

Genotype & Pedigree	Yield (t/ha)	% of Check	Colour & size of grain	Days to head	Height (cms)	% yellow berry	Septoria tritici reaction
We x Bb-Nor/CJ CM-11483-A-4Y	7.4	115	IR	130	115	10	5
(LR64^2-Son64/Tob-HD832 x Cno"S") Bb4A CM-8245-E-8M-2Y-0BK	7.0	109	IR*	132	115	-	4*
INIA-Tob x Np63 CM-746-51-01-0BK	7.8	118	IR	123	105	30	4.5
Tzpp-Son64 x Np/Cno"S"-INIA"S" 34002-2Mch-4MK-0Mch-0BK	7.7	102	1B(t)	125	95	60	5
HD832-Nor/Cno"S"-Cal x Nad CM-5618-G-7Y-0M-0Mch-0BK	7.8	103	2R	129	110	50	4*
Mex.1481 x Tob-8156/Tob-Cno"S" x 7C CM-5891-A-7Y-0M-0Mch-0BK	7.6	100	2B	125	100	30	5
Bb-Nar x Cno"S"-7C CM-1586-0M-1Mch-0Mch-0BK	7.9	104	IRC	121	110	50	4
CC-INIA"S"/NP876 30845-6Mch-6Mch-0Mch-0BK	7.7	102	2B*	125	105	-	4*
CC-INIA x INIA "S"/NP876 30845-7Mch-7Mch-0Mch-0BK	8.0	106	2B*	128	105	80	5*
Pato(B) x CC-INIA CM-1023-10MB-2BK-0BK	7.3	104	3B	124	95	80	5*
Pato(B) x Tor CM-1022-1MB-2BK-0BK	7.1	101	2B	127	100	60	4*
Bb-Pato x Cno"S"-7C CM-2473-4MB-1BK-0BK	6.5	102	IR*	131	105	10	5
Son 64-Tzpp x Nal/Cno"S" 30906-1Bj-2Bj-11BK-0BK	6.6	104	2R	145	115	60	4*
Bb"S" x CC-INIA 30521-20M-2Mch-4Mch-0Mch-0BK	6.9	106	1R	127	110	20	[illegible]
Pato x Cno"S"^{2}-Tob66 30 30524-8M-1Mch-1Mch-0Mch-0BK	6.7	103	2R	129	100	20	5
CC-INIA/Cno x El Gau-Son64 30565-20M-2Mch-3Mch-0Mch-0BK	6.6	102	2R	128	100	10	6
CC-INIA x Bb"S" 30566-9M-2Mch-5Mch-0Mch-0BK	6.9	106	2R	131	95	10	7
[(U-Sk x San Past.)/Mara x Cno "S"-INIA"S" 31356-2M-1Mch-2Mch-0Mch-0BK	7.0	101	2R	121	95	50	6
Cno"S"/Tzpp-Son64 x Np63 27842-37Y-1M-1Mch-0Mch-0Mch-0BK	7.5	108	1B*	125	105	20	4
Son-Knott^{6}2 x Gallo 30922-12TU-1MB-3BK-0BK	7.1	103	2B	148	115	80	4
Pato(B) x INIA CM-1021-1MB-100BK-0BK	7.6	108	2B+R	129	100	80	5
Cno-INIA (Kl. Rend.-Son64^2 x INIA/Cno) II-35255-5Y-1M-1Y-0M-0BK	6.5	108	1RC	120	90	20	6
Bb(Son64-An-64 x Nad/Jar"S") II-34795-5Y-1M-3Y-0M-0BK	6.6	110	IRC	125	95	20	5
Sparrow"S" CM-2182-5M-1Y-1M-0Y-0BK	6.2	108	2RC	123	100	60	5
[(U-Sk x San Past/Mara) Son64-Pur]/Cno"S"-INIA"S"	6.5	109	2RC	128	100	20	6
Np-Tob"S" x 8156(R) 28071-7M-3Y-1M-0Y-0BK	6.9	105	2B	126	100	-	4
(Son64 x Tzpp-Nal/Np) x (LR64 x Tzpp-An$_F$)/Cno 24313-12R-3M-1T-0BK	6.4	106	2R	123	95	30	7
Anza	7.0	109	2R	134	95	50	3
Soltane (Ave.all trials)	6.4	100	2R	125	105	50	5
Strampelli (Av.all trials)	6.8		2R(t)	140	110	80	3
Siete Cerros	6.2		2B	134	105	-	8

TABLE 3.1.F.- Characteristics of some excellent *Septoria tritici* resistant bread wheat lines and varieties selected under heavy attack of Septoria at Algiers 1973-74.

Variety	Grain classification	Height (cms)	Percent yellow	Percent shriveling	Septoria tritici rating
Yr-Cal CM-8173-7M-1Y-3M-0Y-0BK	2R	105	--	30	5++
RR68-WW15/Jl"S"x Cno-No66 CM-12272-N-1Y-1M-0Y-0BK	2R+	105	20	--	5++
RR68-WW15/Bj"S" - On x Bon CM-12273-A-2Y-7M-0Y-0BK	2R	95	30	--	4++
UQ105+WW15[2]/Pj62-Gb56[4]x Tspp-Nr160	2B+(+R)	90	--	--	5+
(Y48 x K58-N/Fn-KAD x Gb) Coutiches	1B(t)	110	30	--	5+
(Cno-7C)[2] x CC-Tob* CM-1679-1M-4Y-7M-1Y-500M-0Y-0BK	2R	100	10	10	5
Np63-Tob"S" x 8156 (R) 28071-7M-3/-5M-1Y-0M-0BK	2B	80	--	20	5
Fletcher	3R	110	--	40	3+
Vg8881(Fn-Th[3]x H-44-29/Th[2]) N818-3P-6P-1P-0Y-0BK	3R	100	--	30	5
Romany Code/70+12	2RC	115	50	--	3++
Irenerio	2R	80	20	50	3+
Emek 132	2R+2B+	85	--	10	5
# 1959	2R	100	30	20	5
PI 29300	2R	105	--	50	3
Tob-B Man x Bb 25098-5B-3J-101J-4Y-1M-0Y-0BK	1B+	90	--	--	6
Nova Prata	1R long	115	--	20	5

* There were 8 other sisters selected with Septoria readings of 5 and 6.

TABLE 3.1.G.- Characteristics of the Superior Durum Wheat Lines in the First and Second Year Yield Trials at the Central Research Station Algiers in 1973-74.

Genotype and Pedigree	Yield (t/ha)	Percent of check	Grain type	Days to heading	Height (cms)	Percent yellow berry	Septoria tritici reaction
D-70-04+D69.44xD69.41 Cr"S"-F_3 Tur. x AA"S"/Fg"S"	6.4	104	1A+R	142	100	30	4
CM-10200-2BK-0BK	5.9	96	2A	135	95	50	4
JO"S"-Cr"S"xGs"S"-AA"S" CM-0902-5M-2Y-0BK	6.2	113	1A	134	95	10	6
Gav"S"-Pg"S" CM-10142-39M-0Y-0BK	5.7	104	2A	135	100	10	5
By[5]-Tc[5]xGs"S" CM-55-50M-2Y-6M-0Y-0BK	5.8	105	1A	134	100	--	5
Gll"S"xT.dic vernuin-Gll"S" CM-86-1M-2Y-6M-0Y-0BK	5.3	96	1A	126	90	--	8
21563-AA"S" D27625-5M-2Y-2M-2Y-0M-0BK	6.0	101	1A	130	90	20	4
Cocorit 71	5.6	100	2A	122	95		7
INRAT 69	5.6	-	1A	136	120		6
Capeiti	2.9	52	2A	135	120		7
Bidi 7	4.0	71	1A	151	135		5

3.2 Egypt

3.2.1 INTRODUCTION

Egypt's wheat research program and research stations are well staffed, and are assisted by the Ford Foundation, FAO, and CIMMYT. The Government recently has begun to expand the acreage sown to high-yielding varieties; principally, Mexipak and Chenab 70.

In 1974, 573,374 ha. of wheat were sown: 362,565 ha. of traditional varieties and 211,808 has of high yielding semi-dwarf types (HYV). Total production was estimated to be 1.88 million tons of which 1.10 million tons were produced by the traditional varieties and 0.78 million tons by the HYV's. The overall average yield of the crop was estimated 3.27 T/ha: traditional varieties, 3.04 T/ha and the HYV's, 3.66 T/ha.

The HYV's outyielded local varieties in the delta, where about two-thirds of the wheat is grown. In Upper Egypt, however, local varieties yielded better in farmers' fields. Table 3.2.A shows average yields for the three sections of the country, as well as individual variety performance in yield trials.

The semi-dwarf varieties outyielded the locals in yield trials throughout Egypt with the greatest margin in the delta and Middle Egypt. The apparent anomally is due to lower yields reported from farm fields in the upper Egypt. These reports suggest that the higher temperatures of Upper Egypt may have reduced yields of the HYV's as compared to locals; however yield test data do not support this view. The recent introduction of these types to that area and the consequent non-familiarity of the farmers with production practices (especially date of sowing) may have been a factor.

The Egyptian Government procured wheat from the farmers ($100.80 per ton at the official rate of exchange; or $70.00 at the rate quoted internally (real purchasing power). This was well below the international market cost. Because of the expected higher yields of the semi-dwarf varieties, the procurement was placed at 3 ardebs/feddan for those types and 2 ardebs/feddan for local types. The remainder was sold at higher free market prices. This effectively reduced the farmers income from HYV's.

In 1974, Egypt consumed approximately 4.0 million tons of wheat of which about 2.3 million tons was imported.

Fertilizer nitrogen costs the farmer about 29 cents per kilo at the official rate, and 20 cents at local rate. Fertilizer was thus subsidized by the government (loans at three percent interest are readily available, providing the farmer uses recommended rates) P_2O_5 costs 25 cents per kilo at the official rate, and 17.5 cents at local rate. For every hectare of semi-dwarf wheat grown the government allocated and delivers 153 to 173 kgs of N, and 37 kgs of P_2O_5. For the traditional varieties, which may lodge at the higher rates, N is allocated at 111 to 124 kg/ha and no P_2O_5 is recommended or allocated.

The most promising lines currently in advanced yield trials are: ARZ, L1569/6091, L1578/10788, Potam "S", and INIA "S" x Napo 63. For Upper Egypt exclusively Mexicani (=Anza, WW15, Karamu, Moghan 1) apperas well adapted. More lines are required with an ability to perform under high spring temperatures.

From April 13-23 in 1974, daily temperatures were very high --exceeding 40°C throughout much of the Nile Valley. Although this weather was unusual, there is little question that these temperatures accounted for much of the decreased yield observed with the semi-dwarf varieties, especially in Upper Egypt.

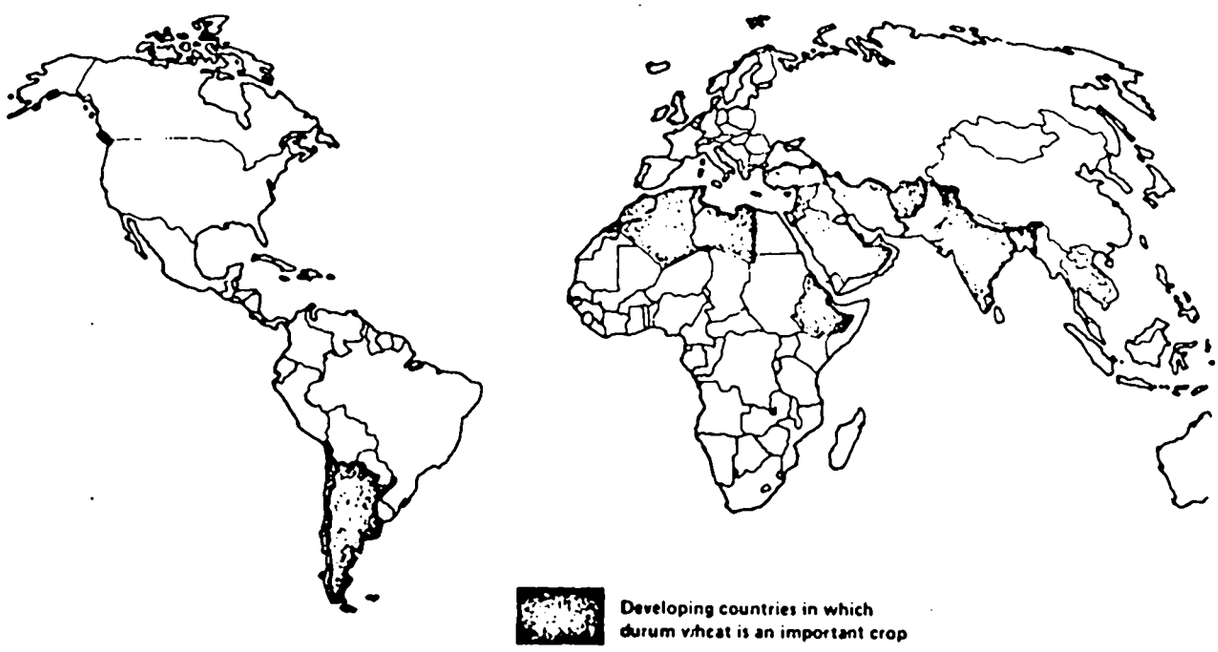
The durums Jori and Cocorit may soon be released to proviede the 80,000 tons of macaroni wheats needed in Egypt. Currently, almost no macaroni wheat is grown, but these varieties appear to be adapted to conditions in Middle Egypt.

Barley is relatively unimportant in Egypt, except in areas that are affected by higher salt concentrations, or that are grown under contract for malting barley to meet brewery needs. Total area of production os 33,600 ha., which produces 96,000 tons for a yield level of 2.86 tons/ha. Giza 119 is the principal traditional variety. Giza 120, a recently released malting type , has been dropped because of its high susceptibility to Helminthosporium gramineum Giza 121, a six-row variety, has now been named and is under seed increase; however, the predominant malting barley continues to be Bonus.

No triticale is grown, except in experimental fields. Its future in Egypt will be largely determined by its bread making quality and yield.

T.. 3.2A Yields of local and semi-dwarf HYV's in the three main wheat growing regions of Egypt 1973-74.

Variety or type	Regions (yields in tons/ha)		
	Delta	Middle Egypt	Upper Egypt
Farm fields			
Local	3.14	3.16	2.88
Semi-dwarf	4.28	3.99	2.48
Yield trials			
Giza 155 (local standard)	4.72	5.36	4.07
Mexipak	5.87	6.30	4.68
Super X	5.72	6.41	4.46
Chenab 70	6.30	6.05	4.39



3.3 Ethiopia

3.3.1 INTRODUCTION

Ethiopian wheat research is conducted by the Ministry of Agriculture in close association with FAO and several international agencies.

In 1973-74, wheat production ranked fifth among the major cereal crops, occupying 1.1 million hectares. Total production was estimated to be 928,000 metric tons, a per hectare yield of 0.74 tons.

Bread wheat accounted for about 20 per cent of the total, and was grown principally in the three highland provinces of Arusi, Bale and Shoa. The remainder was made up of local durums, which is used for unleavened bread and pasta products. High yielding varieties derived from CIMMYT materials and from the Kenya wheat breeding program were grown extensively in the above three provinces.

Weather conditions were generally favorable throughout the 1974 growing season, although the late onset of the main rainy season probably contributed to somewhat lower yields. Sowings were delayed as much as 4-6 weeks in some locations. Among the commercial bread wheat varieties, Laketch (8156 W) occupied the largest acreage; next most popular was the old Mexican variety, Supremo-Kenya, followed by the Kenyan variety, Kenya Kanga.

The average yield for these high yielding varieties was about 2 t/ha.

Wheat breeding within Ethiopia is in its infancy, primarily due to a shortage of trained personnel. A few scientists have been trained at CIMMYT, and a considerable number have studied at universities abroad. Although the number with training is small in relation to need, the group forms an important nucleus for the expansion of breeding efforts in the principal cereals. A modest breeding program is underway and this is being amplified as more scientists return to work at the various centers.

Thus far, the main efforts have focused on making extensive introductions from available sources and evaluating these for production in the country. More recently, germ plasm from local sources has been evaluated and used in the breeding program. Studies involve both bread and durum wheats, plus some research on barley.

Considerable interest also has been generated in the triticales that appear to have advantages over wheats in the highland areas. In part, this is due to greater resistance to *Septoria tritici* (an important disease in the country as well as greater tolerance to low pH of the soil.

Varieties that perform well, show good disease resistance, and have desirable agronomic characteristics, are tested in yield trials for two years before being considered for release. There were 14 early-maturing varieties and eight late-maturing varieties among the bread wheats included in the national yield trials during 1973-74. The data collected on the four best early varieties and three superior late varieties are shown in Table 3.3.A.

The early variety Laketch and the late variety K4527-$L_{45}D_1$ are now grown in commercial production in various regions. The remaining varieties will be considered for release in 1975 or 1976.

A large number of triticale lines have been isolated, which have been tested in preliminary trials. Some of these appear promising, and it is expected that this crop will become important.

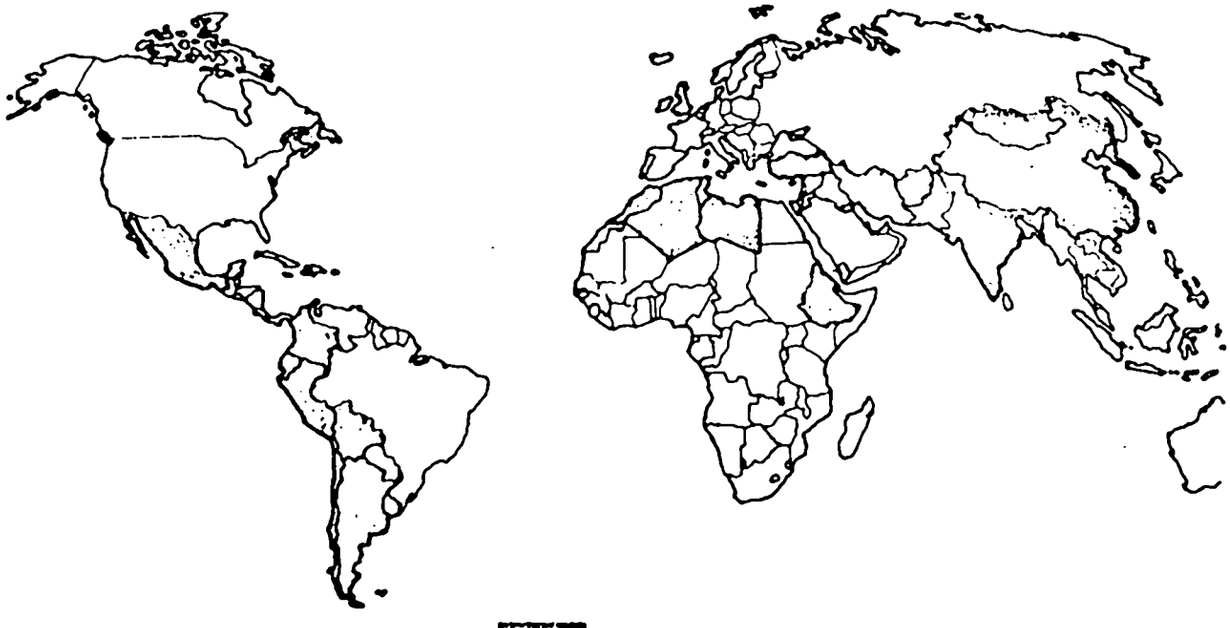
Agronomic research has long been a part of the research stations' activities. Seed rates, sowing dates, fertilizer rates and types, have been established for areas in which the stations are located, and this information is used by the extension organization. Although this research must continue and information developed for many other areas, present knowledge has been instrumental in ensuring success, particularly in areas devoted to the high yielding varieties.

The high costs of seed of high-yielding varieties, and of fertilizer necessary to obtain their high yield potential, slows the rate of adoption by Ethiopian farmers. To alleviate this problem, the Ethiopian Government is: (1) increasing credit facilities for purchasing seed and fertilizers, and (2) providing a subsidy for fertilizer to offset the spiralling costs. Both of these moves have added considerably to the country's productivity. However, there is a need to ensure that subsistence farmers have a supply of fertilizers at a reasonable price in the future. It is thought that lack of such asistance is responsible for failure of the Ethiopian farmers to reach the targeted increase of 4.4 percent of annual production during the first year of the current five year plan (1974-78). Because of the world shortage of fertilizers, and in view of the huge unexploited hydropower potential of Ethiopia, CIMMYT scientists feel that serious consideration should be given to the

establishment of a large nitrate fertilizer plant in Ethiopia. This plant would be capable of supplying the domestic needs of the country and, in addition, could provide exportable surpluses for the very large market in the area surrounding the Indian Ocean.

T. 3.3A Disease and agronomic data and mean grain yield for bread wheat varieties in the national yield trials 1973-74 in Ethiopia (Data 10 locations)

Variety	Days to maturity	Septoria on leaf (0-9)	Septoria on glume (0-9)	Leaf Rust	Stem Rust	Test wt. kgs/ha	Grain yield tons/ha
Laketch (8156W)	101-130	0-8	0-7	0	0	67-78	2.4-5.0
6290-[illegible] (Kenya)	104-130	0-8	0-7	0	0	65-77	2.1-5.1
Romany BX	111-139	0-5	0-5	0	0	64-79	1.8-4.7
$K4500L_6A_4$	104-131	0-7	0-5	0	0	73-82	1.8-4.7
$K4135H_3D_{51}$	103-170	6-8	0	0	0	-	-
K4500-2	110-177	4-8	0	0	0	73-85	2.5-6.2
$K4527L_{45}D_1$	110-182	4-7	1	0	0	69-83	2.4-5.4



Developing countries in which barley is an important crop

3.4 Kenya

3.4.1 INTRODUCTION

The Kenya National Wheat Improvement Program is conducted at Njoro, with assistance from the Wheat Board of Kenya, the Canadian International Development Agency and FAO/Denmark. The extreme drought in low and medium altitudes, and greater than normal stripe rust incidence in the higher altitudes, contributed to lower yields than those obtained in 1972. Average yield in 1973 was 1.27 tons/ha, as compared with 1.43 tons/ha the previous year. Rains came late, and were lower than normal by 200 mm, causing greatest damage to late plantings.

The total wheat production area was 107,389 hectares in 1973, an increase of about 2,500 ha . over that of 1972. However,because of the lower yields, national production was 137,884 tons (12,000 tons lower than 1972).

Table 3.4.A shows the twelve leading wheat varieties grown, along with area covered, total production, average yield, and percent of area and production accounted for by each variety.

Acreage planted in Kenya Mamba continued to increase over than in Kenya Kanga. This variety yields well in spite of heavy attack of stripe rust in the ear. Kenya Bongo and Bounty produced the highest yields, well above the other varieties. Only 53 hectares of durum were grown, since no suitable variety is available.

Two new varieties (Kenya Mbweha (6106-1), a sister line of Kenya Kiboko, and Kenya Kuro (6290-1) a sister of Kenya (Nyati) were expected to be released in 1974. Kenya Mbweha was derived from CI 8154/Frocor*2//Gabo 54/36896. It is medium short, lodging resistant, early to maturity, of good quality, and resistant to stem rust; however because of susceptibility to stripe rust, the variety can be severely damaged at altitudes above 2440 meters. Kenya Kuro was derived from the cross Africa Mayo x Romany. It is medium tall, only moderately resistant to lodging, and of medium maturity. It is resistant to all three rusts in Kenya, can be grown at all altitudes, and is of good quality.

Kenya has severe stem and stripe rust problems. The race structure within these diseases changes rapidly. Thus, in recommending varieties, Kenyan scientists suggest that, for each crop, the farmer grow several different varieites suitable to the altitude at which the wheat is grown.

Studies were conducted on various methods of selecting for yield and disease resistance in segregating generations. Good agreement was obtained between the Shebeski method lines grown with control checks), the clump or hill method, and the linear hill method. The results indicated that the linear hill method was superior and reduced land area used as compared with the conventional visual selection.

In durum wheats D18 (from the parentage LD3932/langdon^2/Langdon/CI8155) was tested with eight other exotic types. This variety appears suitable for semolina quality and rust resistance; it may be released in 1975.

Triticale selections were made from early generation material, selecting for seed plumpness and desirable agronomic characteristics. Two-row barley varieties are being bred to produce malting barleys superior to Proctor and Research. Some work is being done on six-row varieties for animal feeds.

A number of international nurseries were evaluated, and, of 10,852 entries, only 812 showed adequate rust resistance. These are being incorporated in the breeding program.

Wheat stem rust developed slowly in 1973 because of the unusually dry weather and there was little loss from late infections.

Eleven races of stem rust were identified: EA15, 13, 14, 4, 7, 20, 11, 5, 8, 3 and 18; of these the first four were for one prevalent. In the last half of 1973, all of these races were found except #8 and, in addition, races #19 and #21 were identified.

Leaf rust was not serious. Only 6 races are known to exist in Kenya. Race EAL1 is still the most prevalent.

Stripe rust were severe in 1973, and was found in fields at both medium and high altitudes. Heavy infection in the ear phase was found in both wheat and barley, where grain sometimes failed to develop in such varieties as Kenya Nyati and Kenya Mamba. Nineteen races have been identified; with EAY9, EAY5, EAY2, and EAY12 the most prevalent (comprisi ; 60 percent of the total isolates). EAY9 appears to be much more tolerant of warm weather giving,it a competitive advantage.

Barley leaf diseases (particularly scald and net blotch) were common, but were not of economic importance. Take-all (Ophiobolus graminis) was observed in some fields.

Agronomy and fertilizer trials were conducted at various altitudes including trials for: effects of N and P, residual effect of P, effect of liming on yields, effect of time of N topdressing, and seed rate for new varieties.

Phosphorus continued to be the major nutrient requirement. Previous cropping influenced trial responses to N and P. On newly broken pasture land application of P raised wheat yield by 50-70 percent. In succeeding crops, the percentage decreased as N level decreased-- but demands for P remained the same. Response to N increased with succeeding crops (up to 55 and 70 percent on the third and fourth crops after breaking, respectively). Top dressing of N after emergence gave little yield response. Liming of soils at Njoro (ph 5.5) gave no increase in yield. In seed rate trials, Kenya Nyati and Kenya Kiboko gave best yields at 100 kgs/ha while yields of Kenya Mamba were best at 75 kgs/ha.

In tillage experiments, the type of implement used in initial tilling at Njoro had little effect on yield. However, tillage immediately after harvest (rather than just prior to seeding) produced the best results, which were presumed to be a reflection of better weed control and moisture storage: dry years,the effect was magnified. At another location, sweep tillage appeared to be superior to plowing and other methods. In areas where Setaria and Kikuyu grass are a problem, moldboard plowing produced superior results.

Herbicide trials also were conducted at different altitudes. At Njoro, several grasses and broad-leaved plants (including Oxalis) infested the treated area. Among the chemicals tested Preforan at 2.5 kgs/ha produced the best results. Dicuran gave similar results,and a new chemical (Basagran) was effective in controlling nut grass. None of the chemicals was effective in controlling Oxalis. In another region, where Setaria was the predominant weed, Preforan and Igran were found to be most effective. Where broad-leaved weeds such as marigold and double thorn predominated, Dicuran produced the best control. In summary, Preforan at 2.5 kgs ai/ha, Igran at 1.5 kgs ai/ha, and Dicuran at 2.4 kgs ai/ha, showed promising results on herbicides. Preforan caused some early damage on wheat when applied in dry conditions, but there was little effect on final yield.

Scientists in the cereal chemistry section worked closely with the wheat breeding program and evaluated quality aspects of newly released varieties. This section also monitored the effect of altitude and prevailing climatic conditions on gluten characteristics. The laboratory is well equipped to run Pelshenke tests, farinograph, Udey and Kjeldahl protein, and has complete milling and baking equipment. During 1973, 1256 samples were tested including yield test materials and location testing of commercial varieties, as well as Pelshenke and other qualitative tests. Tests of durum wheat were confined to gluten washing to determine non-stickiness, spreadability, and yellow pigment.

As in previous tests, the harvest from the highest elevation station at Molo was found to have the lowest quality.

TABLE 3.4.A.- Principal Varieties of Kenya, their acreage, yield and contribution to production 1973.

Variety	Area (has)	% Area	Production (tons)	Av. Yield (tons/ha)	% Production
Kenya Leopard	18,308	17.0	24,926	1.36	18.1
Kenya Mamba	16,958	15.8	25,261	1.49	18.3
Kenya Kanga	12,037	11.2	13,156	1.09	9.5
Africa Mayo	8,790	8.2	9,581	1.09	6.9
Fanfare	7,512	7.0	9,026	1.20	6.5
Trophy	6,997	6.5	8,126	1.16	5.9
Kenya Hongo	6,991	6.5	10,702	1.53	7.8
Bounty	6,965	6.5	11,825	1.70	8.6
Kenya Swara	5,130	4.8	5,794	1.13	4.2
Kenya Kudu	2,785	2.6	2,676	.96	1.9
Kenya Giange	2,501	2.3	2,430	.97	1.8
Wisconsin Supremo	2,164	2.0	2,404	1.11	1.7
Others	10,251	9.5	11,977	1.17	8.7
Totals	107,389	99.9	137,884	1.23	99.9

3.5 Saudi Arabia

3.5.1 INTRODUCTION

Saudi Arabia's crop improvement program plans greatest emphasis on wheat, with work in barley and triticale, also. Climatic conditions in 1973-74 were generally good for wheat production (the winter was mild) followed by a long cool spring, allowing even late plantings to mature and produce above average yields.

Table 3.5.A shows the total area and production of wheat in Saudi Arabia.

Information is limited on area and production of individual local varieties, except for the totals for all varieties grown. The variety Super X (known locally as Mexipak) was the only introduced variety of any major importance grown during the 1973-74 season for which reliable figures are available on area and production. Local varieties are designated only as bread and durum wheats, and the figures are estimates.

With continued support and emphasis on wheat production, it is expected that 60,000 hectares of wheat will be grown in 1975, with about 10,000 hectares devoted to Super X and other improved varieties. The rapidly expanding area sown to Super X is due to the successful wheat introduction and demonstration program in all principal wheat growing areas.

There are new promising materials in both durum and bread wheats. Adaptive yield trials were conducted at several locations in the country, in addition to the yield trials and observation nurseries furnished by CIMMYT, FAO and ALAD. The more promising varieites selected in previous years were included in the adaptive yield trials. Program scientists now feel that the most rapid advances can be made by selecting varieties developed elsewhere for suitab ility to Saudi Arabian conditions. A special interest is that of better adapted varieties for the marginal rainfall areas of Southwest and Saudi Arabia.

Seed of such promising varieties as Jori 69, Cocorit 71, Tanori 71, Barouk and Mengavi-8156 were increased for further evaluation and testing. Jori 69 will be released for limited sowing in 1975-76. Emphasis being placed on Jori 69 as an improved durum variety because of its large seed, hardiness, and colour of the grain, as well as its nearly identical appearance to the local durums. However it may not have adequate disease resistance for the rainfed regions.

Additional testing is being conducted to select varieties with good yield, adequate disease resistance and good quality.

No support price has been set for wheat in the Saudi Arabia although programs have been devised to keep the price paid to farmers at a profitable level. Grain storage centers, flour mills and marketing programs have kept this in mind when establishing wheat prices. Beginning in 1973-74 a production subsidy of Saudi Rials (U.S. 7 cents) per kilo was paid to all farmers who grow wheat. Payments were made on estimates made at harvest time, rather than on actual measured yield.

Statistics on imports of wheat in 1973-74 are not available. Based on previous years the consumption trends indicate that about 350,000 tons would have to have been imported during the year. This import is expected to increase to 450,000 tons by 1980 even though increased production is allowed for and included in this estimate.

Fertilizer supplies were adequate during 1973-74. A 50 percent subsidy is paid by Government on all approved fertilizers applied in order to encourage fertilizer use and keep prices within the farmer's range. For 1973-74, 20,500 tons of compound fertilizers were imported (none is locally produced). The average subsidized price of compound fertilizer was S.R. 625 per metric ton (US$176). One thousand tons of TSP were imported. Subsidized price for TSP was SR 900 (US$254) per metric ton. Urea which is produced locally and also subsidized averaged about SR 400 (US$112) per metric ton. It is estimated that about 12-15,000 tons of urea were used during the year. Fertilizer supplies are expected to remain adequate although prices will remain expensive.

TABLE 3.5.A.- Area and production of wheat in Saudi Arabia in 1973-74.

Variety	Area (has)	Production (tons)	Average yield (tons/ha)
Super X	600	2,200	3.67
Local Durum	26,600	54,000	2.03
Local Bread	17,800	36,000	2.02
T o t a l	45,000	92,200	2.05

Harvesting of crosses.

3.6 Sudan

Sudan's wheat improvement research is conducted by the Government of Sudan in collaboration with several international agencies. The program operates through research centers at Wad Medani in the Gezira and at Khashm El Girba on the Adbara River, an eastern tributary of the Nile. The wheat crop is entirely irrigated, and is grown in the winter from October to April. Temperature is the most important single factor affecting growth and yield. The prevailing temperatures during 1973-74 are shown in table 3.6.A.

Temperatures were about normal, except for January, when the temperature was somewhat cooler with a minimum temperature of 6.7°C reached near the middle of the month.

In 1974, the wheat area expanded by approximately 80,000 hectares; providing a total acreage of 170,000 hectares for the country. This represents a 45 percent increase in area above that of 1972/73. The total area consists of 107,000 hectares in the Gezira region, 48,000 hectares at Khashm El Girba and 15,000 hectares in the Hudeiba Region of the Northern Province. The increase was the result of government policy to attain self sufficiency by horizontal expansion in the short term, and vertical expansion in the longer term through the use of superior varieties and production practices.

The principal variety grown was Giza 155, which occupied 80 percent of the area. This variety of Egyptian origin is tall and subject to lodging under high fertility conditions. It is also medium-late in maturity (105-110 days) under Sudanese conditions. Its white grain makes it popular with the farmer. Mexicani, a variety selected from the cross Lerma Rojo-Norin 10-BXAndesE^3 and released by the research program in 1971, occupied the remainder of the area. It is of medium-short stature, is resistant to lodging, and as a result responds better to the higher levels of N than does Giza 155. Although Mexicani has slightly poorer baking quality than does Giza 155, it yields about 20 percent more grain on the average and matures 15 days earlier.

There were scattered reports that isolated fields of Mexicani at Khashm El Girba showed late infection by stem rust, stimulating a search for possible alternative varieties. Chenab 70 in tests at Khashm El Girba was equal to Mexicani in yield, but was susceptible to shattering. With the rapid expansion of the wheat area, and resultant shortage of machinery, harvesting is sometimes delayed and shattering losses can be of considerable importance. Thus, experiments are being initiated at Khashm El Girba to assess the progressive loss of yield associated with delayed harvest. Another possible alternative variety is UQ105 from Australia, which is derived from a cross of Australian material with a sister selection of Mexicani known as WW15. In two years of tests, yields of this line were found to be comparable with Mexicani.

Earlier experimental work conducted with older varieties grown at relatively low levels of N indicated that N gave substantial yield increases while P_2O_5 and K_2O gave little response. Currently, the recommended application rate of N is 190 kgs of urea/hectare. Based on this recommendation, the nitrogen fertilizer requirement for the wheat crop alone is between 30,000 and 40,000 tons of urea per season. This amount was obtained under an agreement with the Government of Kuwait at the price of 27 Sudanese pounds/ton. Since this agreement will likely terminate in the current season, it is expected, that 1974/75 prices will be considerably higher due to worldwide shortages of nitrogenous fertilizer.

Total wheat production for 1973/74 was estimated to be 280,000 tons, or about 70 percent of domestic requirements. The balance of the country's needs was imported from the U.S.A., Germany, and other countries. Based on the estimated commercial production and acreage sown, yields were about 1.7 tons/ha., well below yield obtained in experiments. Primary factors responsible for the lower yields were late sowing and irregular irrigation due to lack of water. With the rapid expansion in wheat acreage, farmers with little experience in wheat raising may have obtained lower yields because they did not follow recommendations. Further, the acreage increase has placed a stress on machinery, on availability of personnel to advise the farmers and on seed supply. Water demand in October also was higher due to increased acreage, resulting in late seeding in some areas. These problems should become manageable as the wheat area stabilizes.

During the year 1973-74, wheat was made available to the consumer at about 60 percent of the world price.

T. 3.6A Maximum and Minimum Temperatures for the Months of October to April at the Gezira Research Station, Wad Medani, Sudan for the season 1973-74.

Month	Temperature °C						Average Rel. humidity %
	Maximum			Minimum			
	Mean.	Highest	Lowest	Mean	Highest	Lowest	
Oct.	37.9	40.8	30.5	22.6	25.3	20.2	55
Nov.	35.3	39.0	32.5	16.9	21.9	12.6	36
Dec.	34.6	37.9	30.7	16.4	21.3	12.4	47
Jan.	31.4	37.2	25.4	13.5	18.8	6.7	40
Feb.	35.8	43.3	30.6	16.4	22.8	9.5	35
Mar.	36.7	44.8	30.2	17.2	23.6	11.2	23
Apr.	42.2	45.4	34.8	22.1	28.0	15.2	26

Trainees from around the globe find common cause in their studies of wheat improvement.

3.7 Tunisia

3.7.1 INTRODUCTION

In 1973-74, adequate autumn rains provided good conditions in Tunisia for satisfactory and timely soil preparation; the crop in general was sown at the correct time in all wheat regions. The month of January, however, was one of the driest on record, and yield potential was reduced, particularly at the higher elevations where growth had already been restricted by the cold weather. In other areas, the dry, sunny January triggered early elongation of early varieties, particularly INIA 66. Rainfall was lower than average in late winter and spring, but adequate rain fell at frequent intervals in small increments and the grain was able to fill. Early varieties developed well, but late varieties were severely affected by May droughts. Hail in the horthwest, around Le Kef, destroyed between 1000 and 2000 hectares of wheat.

Because of the dry season, diseases were of little importance in Tunisia during the year. Septoria, leaf and stripe rust and mildew were observed, but did not develop. Even in the nurseries, where artificial inoculations were made, satisfactory screening could not be done. There was little insect damage but the nematode, Heterodera avenae was widespread in the north and caused light damage in some fields.

Weeds, normally a serious constraint on cereal crop production, caused less damage than in preceding years. In part, this was due to improved weed control by both cultural and chemical means. Moreover, the dry season did not favor either weed or crop growth, thus competition was decreased. However, severe damage occurred in fields heavily infested with ryegrass.

Thus the dry season was compensated for by better utilization of N, lower disease incidence, and less weed competition. National production although not a record, was above the average of the past several years; largely due to the spread of new varieties on a broader scale, and improved cultural practices.

3.7.2 AGRONOMY

3.7.2.1 Weed Control Program

The weed control program consisted of demonstrative improved tillage and herbicide practices and experiments designed to develop better recommendations. Applied research and extension made excellent progress in diffusing knowledge of weed control practices to farmers. This is of particular importance in Tunisia where weeds can account for yield reductions of more than 50 percent. About 75% of the weed loss is caused by three grass weeds - Avena sterilis (wild oats), Lolium rigidum (ryegrass) and Phalaris canariensis, P. paradoxa and P. truncate (canary grass). Although broad-leaved weeds account for only about one-quarter of the weed loss, a number of these weeds are damaging. In recent years, the herbicide 24-D had been used on about 100,000 hectares annually; however, 135,000 hectares were treated in 1973-74, a substantial increase. In addition (for the first time commercially) about 4000 hectares were treated with new materials for grassy weed control: 2,500 hectares with Dicuron, 500 hectares with Dozanex and 1,000 hectares with Suffix. This use of new materials was due to the teamwork of four institutions, in collaboration with chemical suppliers, in setting up demonstrations, tours, and seminars.

3.7.2.2 Tillage Practices

Recommended seedbed preparations as well as recommended herbicide treatments were demonstrated on 20 variety demonstration trials. Ten trials were used as regional field demonstrations and about 1,500 growers attended the field days. All demonstrations were visited periodically by local groups. At one location, Goubellat, the grower did not conduct pre-seeding tillage nor did he subsequently apply herbicides. His yields were 201 kg/ha compared with 3,709 kg/ha in the experimental area in the same field. In the experimental demonstrations good seedbed preparation gave good broad-leaf weed control and herbicidal weeds control was not needed. In contrast, however, it is not possible to control grassy weeds by seedbed preparation alone --herbicides are required. In the long term the ultimate solution will be better cultural practices.

Experiments also were conducted to compare hand-weeding and herbicide use, following different seedbed preparation treatments.

3.7.2.3 Applied Research on Herbicide Use

The experimental program with herbicides began in 1970 with three objectives:

(1) To provide flexible methods for broad-leaf weed control, to overcome limitations of 2, 4-D applications.

(2) To develop methods for grassy weed control.

(3) To discover a means of avoiding phytotoxicity caused by 2, 4-D applications.

These objectives have been largely achieved, including demonstrations for farmers. The program gradually expanded as new problems and needs were revealed. Trials were conducted with mobile machinery; a new method was the cutting out of alleys with a non-selective spray instead of hoeing.

A total of 38 trials were conducted at 27 sites, and all but two were harvested. Eight types of trials were grown:

Type1: Evaluation of promising herbicide treatments - 6 trials, 18 treatments.
Type 2: Evaluation of the relative sensitivity of 12 Tunisian cereal varieties to recommend herbicides - 2 trials, 10 herbicide treatments.
Type 3: Demonstration and evaluation of 2,4-D and Suffix application at different stages of wheat development - 2 trials, 4 dates.
Type 4: Demonstration and evaluation of recommended herbicide treatments - 18 trials, 8 treatments.
Type 5: Influence of three levels of soil preparation on three hand-weeded and five herbicide treatments and evaluation of the chemical seedbed approach - 2 trials.
Type 6: Influence of Plant N status on sensitivity of wheat and weeds to four herbicide treatments-2 trials.
Type 7: Search for best dosage combination of Tok and Dicuran and Tok and Dozanex - 2 trials, 4 rates of Tok and two rates Dicuran and Dozanex.
Type 8: Evaluation of three pre-emergence herbicides not previously tested in this program - 4 trials.

Treatments used in these trials are listed in Table 3.7.A and trial results are discussed under headings of the information developed, rather than type of trial.

3.7.2.4 Yield Loss Due to Weeds

Rainfall distribution has a direct influence on grain yield, weed development herbicide effectiveness and loss of yield, as result of weed competition. Moisture conditions at the start of the 1973-74 season were adequate for establishing wheat stands; although succeeding weather was dry, tillering was satisfactory. Weed growth was restricted and competition was reduced, so that yield loss due to weeds was comparatively lighter than in previous years.

To make herbicide recommendations, it is necessary to predict losses of grain yield as a result of weed competition. Losses have varied from year to year, and the influence of the weed infestation on moisture stress has been a key factor as shown in Table 3.7.B. If infestation increased moisture stress, yield loss was high. If there was little stress, loss was low. Thus, in a highly variable rainfall situation, it is difficult to decide whether herbicides are needed; recommendations must be based on meteorological records of previous years to estimate the frequency and degree of moisture stress for different areas of varying rainfall pattern.

Controlling broad leaf weed infestation usually resulted in small yield increases, whereas control of grassy weeds greatly increased yield. It is thought that these results are related to moisture stress: the broad-leaved weeds tend to reach their stage of maximum water extraction before wheat reaches the critical stage of water need. Further, there is a high probability of water shortage at that time. The growth period of grassy weeds parallels wheat; therefore damage is greater.

High loss of yield to broad-leaved species appears associated with shading. Tall crucifers such as Rapistrum rugosum and Synapis arvensis often caused damage. Others may grow taller than wheat, if seedbed preparation has been poor. Species that germinate early, form a rosette and develop long taproots that are difficult to eliminate if seedbed preparation is delayed. A single plant of Celibum marianum (milk thistle) can shade out more than a square meter of wheat seedlings.

Population density of the infestation influences yield loss to weeds as shown in Table 2.7.M. Average gain in yield due to weed control in trials with high infestations was twice that of all trials. Weed poulation densities considered high in 1973-74 were: wild oats, 50 panicles/m^2; ryegrass, 100 spikes/m^2; canary grass, 80 spikes/m^2; and broadleaves, 50 percent of soil covered. (However, in most years treatments will be economic if corresponding figures are 15, 50, 40 and 40 percent of area covered).

Population density also is associated with weed species, some of which occur in dense stands and others as scattered plants. The grassy weeds often occur in dense stands and thus cause high yield losses. Variety of wheat also influences yield loss. Vigorous early growth, abundant tillering, and tallness reduce weed loss. Such varieties as Badri and INRAT 69 (durum and Soltane (bread) are "weed resistant", in this sense, whereas short triple dwarfs such as Amel, Maghrebi and the short Bluebirds can be considered "weed susceptible".

Thus, in predicting yield loss to weeds the important variables are wheat variety, weed species and weed density. The seasonal effect can be estimated from long term weather records. Therefore, there are ample guideliness for application of herbicides.

3.7.2.5 Seedbed Preparation Influences Later Weed Control

Table 3.7.C shows results for experiments conducted at two sites with different tillage preparations (from maximum to minimum) with herbicide and hand weeding treatments superimposed. Differences in weed infestation at the two sites produced very different results. At St. Cyprien, there were more than 1,000 ryegrass plants/m^2 and yield reflected effectiveness of the weed control treatment on ryegrass. There was little effect due to seedbed preparation. The Dozanex treatment gave almost perfect control and resulted in a yield increase of 2180 kg/ha. Among hand weeding treatments, only that of pulling all weeds tended to increase yield.

At Pont du Fahs, weed infestation was light to moderate. With no seedbed preparation, average yield was 1200 kg/ha less than with normal preparation. Yield was not improved with either herbicide application or hand weeding. Lack of rainfall after applying Dozanex and Dozanex + Tok reduced weed control, and both herbicide and hand-pulling treatments probably damaged the wheat crop.

The chemical seedbed approach was evaluated in both trials. Gramoxone (paraquat), available in Tunisia, was sprayed on the soil when ryegrass was in the tiller stage, and before wheat emergence, with the seedbed rough and hard. Yield response was good; yield grains over the check were 1700 kg/ha at St. Cyprien and 400 kg/ha at Pont du Fahs. This method may be useful for ryegrass control in cereal following medicago, when there is not time for adequate cultivation or when seed beds cannot be prepared.

3.7.2.6 Herbicide Phytotoxicity

Herbicide toxicity appears to be higher under Tunisian conditions than in many other countries. Such effects reduce the economic value of its application and could retard adoption. The factors influencing toxicity were studied in all trials and harmful effects were observed in many. In six Type 1 trials, average yield response of the 8 broad leaf treatments was negative, as shown in Table 3.7.D.

In 17 Type 4 trials where recommended treatments were under demonstrations, 30 treatment yields were less than the check as shown in Table 3.7.E. (These treatments included: six with Suffix + 2,4-D; five with Suffix; two with Dicuran; three with Dozanex; one with Dicuran + Tok; and two with Dozanex + Tok). Low yields relative to control often occurred where growth reduction had been observed.

Treatments with yields lower than the control occurred more often among the broadleaf herbicides than with Dicuran and Dozanex, because there was less compensation by weed control benefit. (In these experiments good pre-sowing weed kill was obtained by cultural methods, thus the differences observed would be less than those occurring in many farm fields).

The risk of phytotoxicity can be reduced by lowering dosage and proper timing of application. Modification of recommendations has been made on the basis of program results. Dozanex dosage has been reduced to 4 kg/ha (from 5 kg/ha) and 2,4-D application on bread wheat has been delayed in its timing. Further experimentation may establish a lower recommended dosage for Certrol H, and tests will be conducted to see whether one half the present dose of Dicuran or Dozanex can be used for ryegrass control. A balance must be struck between lower dosage and its associated reduced cost and adequate control.

3.7.2.7 Timing of Application of 2,4-D and Suffix

Time-of-application trials were continued with the important production variety Soltane because it appears to be sensitive to 2,4-D for a longer time than other varieties in Tunisia. Highest yields were obtained from the jointing stage application as shown in Table 3.7.F. However, since early application is desirable to obtain good control of weeds, spraying is recommended as soon as the growing point reaches the soil surface. In 1973-74 application of 2,4-D when the growing point had reached the surface of the soil was satisfactory, but ear distortion resulted if application was made before the growing point emerged.

After this stage, ear distortion resulted only when wheat was in an extremely vigorous growth conditions when sprayed. (Ear distortion is not a proof of yield loss, but is an indication that losses may be expected).

There is no difficulty in using the growing point to make spray applications. Wheat plants can be pulled, and split longitudinally with the thumbnail or a knife. The growing point is easily seen and the soil level is marked on the plant at the juncture of green and white color.

In 1973-74, optimum timing of Suffix application differed from the three preceding years because of the dry conditions. During wet winters, maximum wild oat control and excellent yield responses were obtained with applications made during the jointing stage. In 1973-74, wild oat control was excellent, and maximum yield was obtained from applications at the 4 1/2 leaf stage (mid tillering) as shown in Table 3.7.G. Under dry conditions, as in 1974, wild oats do not continue to emerge, thus application need not be delayed to control late emerging plants. Wild oat competition is damaging at the tillering stage (under dry conditions because tillering of the wheat is reduced by moisture stress. Thus, when using Suffix for wild oats, spraying should be done if the soil is dry at tillering. If the soil is wet, spraying should be delayed.

Suffix phytotoxicity from boot stage application was indicated at Mateur (Table 3.7.G). In preceding years, toxicity was observed when Suffix was applied after the third node was formed above the surface. In 1973-74, no toxicity occurred for applications at the 1 to 2 node stages of jointing.

3.7.2.8 Weed Control Performance of the Herbicide Treatments

Weed control performance is evaluated by estimating reduction of each weed species present. With broad-leaved species, this reduction is measured as the difference in soil surface covered by weeds in treated vs. non-treated plots. The number of spikes or panicles/m^2 is the basis of measurement for grassy weeds and this is expressed as percent control. These average ratings for trial Types 1 and 4 are shown in Tables 3.7.I and 3.7.J. In Table 3.7.K are shown the 3-year averages for weed control in the recommended treatments.

3.7.2.9 Varietal Sensitivity to Herbicides

The important commercial varieties and promising new varieties of Tunisia were evaluated for sensitivity to the recommended herbicides. The chemicals 2,4-D, Suffix, Dicuran, and Dozanex, plus a combination of 2, 4-D + Suffix applied separately, were tested. Each of the single herbicides were applied at the recommended stage of development. Table 3.7.H shows that exceptional growth rate and vigour were associated with high sensitivity (based on yield response). At the 4 1/2 leaf stage, 2,4-D damaged Soltane, Florence Aurore and Ariana. Average yield for these three varieties was 330 kg/ha below the check. Application at early jointing caused no damage.

Suffix was very toxic to barley, and the variety Ceres was more sensitive than was Martin. An application of 2,4-D in addition to Suffix ameliorated the toxicity effect of Suffix. Suffix did not damage wheat; but to avoid phytotoxicity, application should be made by the second node stage of jointing.

Based on observations of symptoms and yield loss it is recommended that Dicuran and Dozanex should not be applied after the 4 1/2 leaf stage. Inia 66 and Tobari 66 tended to be more sensitive to late application than the other varieties, which could be the result of a more advanced stage of growth (although the durum variety Amel, which is also early, was not damaged to this extent).

3.7.2.9.1 Broadleaf Control

2,4-D E.C.	Still the best broad spectrum control except on *Fusaria* sp.
MCPP E.C.	Average effectiveness less than 2,4-D, but excellent control of *Fusaria* sp. Can be used safely when application is necessary before it is safe to use 2,4-D.
Faneron W.P.	Medium effectiveness, weak for some important species.
Certrol H. E.C.	Excellent on important species, but narrower spectrum than 2,4-D.
Actril M. E.C.	Only fair control
Quinerexon E.C.	Excellent, similar to Certrol H. Phytotoxic at the dosage
Tribunil W.P.	Poor in this season due to low dosage, but gives fair control at normal level.

3.7.2.9.2 Grassy weeds

Dicuran W.P.	Effectiveness was reduced at many sites by lack of rain after application. Control was erratic, and not good for wild oats and many broad-leaved species, at several sites. Lolium control was excellent, even at one-half normal concentration. Value of the new liquid formulation was same as the original wettable powder.
Dosanex W.P.	Performance generally good, in spite of low rainfall after application. This chemical gave good control of most important broad leaved weeds, as well as wild oats and ryegrass.
Tok W.P.	Provided no control of any weeds except canary grass. Applied in 100 l of water/hectare, Tok was less effective than when applied in 300-600 liters, probably due to its low solubility.
Suffix E.C.	Controls only wild oats, but was excellent and reliable. The only plants escaping were those that emerged late, and these were stunted. When Suffix was mixed with auxin herbicides for broad-leaf weed control its effect on wild oats was reduced. However, a mixture of MCPP and Suffix was as effective on wild oats as the combination treatment of 2,4-D applied 12 days before or after Suffix.

3.7.2.9.3 Pre-emergence

Chandor E.C.	Fair on wild oats and ryegrass, variable on canary grass, poor on other species.
Tok ultra E.C.	Fair on wild oats, good on canary grass

Yield responses on Chandor and Tok ultra were better than expected, based on weed control observations; probably because weed competition was reduced from the beginning. Further evaluation is necessary.

3.7.2.10 The Canary Grass Threat

The widespread use of chemicals that control wild oats and/or ryegrass, but not canary grass could lead to a serious problem with the Canary grass. Wild oats and ryegrass hold canary grass in check in mixed stands; but when they are removed, canary grass builds up dramatically: a four-fold increase was observed at St. Cyprien, when ryegrass was suppressed; and a three-fold increase at Meteur, when wild oats were suppressed. At St. Cyprien when Tok was added to Dosanex, and 880 kg/ha yield increase was obtained as compared with yields when using Dosanex alone. Similarly, average gains recorded for the treatments of Tok + Dosanex vs. Dosanex alone, were 150 kg/ha in 6 Type 1 trials, and 90 kg/ha in 17 Type 4 trials. The corresponding average gains of Dicuran + Tok over Dicuran were: 110 kg/ha (Type 1 trials) and 70 kg/ha (Type 4 trials).

The Type 7 trial was designed to determine optimum dosage for Dicuran and Dosanex + Tok. Tok at 0, 2, 3, and 4 kg/ha was combined with Dicuran at 1 1/2 and 2 kg/ha and Dosanex at 2 and 3 kg/ha. Since there was very little rain for a month after treatment, no significant differences in yield were measured. Future experimentation with Tok should include studies of the influence of spray volume and of each of the species of Phalaris encountered.

3.7.2.11 Influence of N application and Dicuran and Dosanex results

In 1972-73, severe phytotoxicity symptoms were observed after Dicuran and Dosanex applications, when ammonium nitrate was applied the same day. Type 6 trials were conducted to verify this result, but no phytotoxicity was observed. Yield results are probably not relevant, but observations of ryegrass control substantiate last year's observations. In addition to standard herbicide doses, a one-half dosage level was included to determine if N application could be used to reduce cost. At full dose, there was 100 percent control in all plots; but at one-half dosage N application increased herbicide effectiveness slightly, as shown in Table 12.

At St. Cyprien, ryegrass control decreased where N application was delayed for four weeks after herbicides were applied. At Mateur, ryegrass control decreased when N was not applied. Both observations indicate that plant sensitivity to Dosanex and Dicuran was high under high levels of N. Sensitivity to Dosanex and Dicuran also is frequently high under conditions of low fertility. Although additional factors may be involved, increased sensitivity at both high and low levels of N may be a typical biological response.

Further studies may reveal ways in which herbicide costs may be reduced through lower dosages when N is applied; and it may be possible to reduce the risk of phytotoxicity effects on wheat. Future trials will study effects of applying double dosages and phytotoxicity.

3.7.2.12 Economic Performance of Herbicide Treatments

Although yield losses to weeds tended to be low in 1973-74, large increases in income were achieved in many of the trials as shown in Table 3.7.M. In all trials, controlling of broad-leaved weeds provided low profits, even where infestation was high. There was generally a profit in use of 2,4-D, because of the low cost of the chemical. Suffix was not profitable, on average of all trials, but was profitable on the average in trials where wild oat infestation was high. Suffix (because it is applied later) will usually be profitable if reasonable judgement is used to determine when spray is necessary, as the degree of infestation is known when application is made. The influence of rainfall pattern can be predicted to some degree.

The 1972-73 Tunisia report indicated that "Profit from Suffix may be nil in years with high moisture stress during tillering and early jointing stages, but with ample moisture during the remainder of the season". In 1973-74, moisture stress was high at tillering and --although moisture was deficient for the rest of the season-- wild oat competition was moderate due to low infestations and the adaptation of wheat to limited moisture. Experiments indicated that given these conditions, profit was increased if Suffix was applied early when moisture stress occurred at the tillering stages.

Dosanex, alone and with Tok, was profitable on the average of all trials, and especially in those with high grassy weed infestations. When wild oat infestations were over 50 panicles/m^2, average profit was $80.86 US/ha. Where canary grass infestation was over 80 spikes/m^2 average, Dosanex + Tok profit was $100.80 US/ha. High canary grass infestations were always associated with high or medium infestations of wild oats, or high infestations of ryegrass. Yield increases due to grassy weed control have been much higher and more predictable than those obtained from broad-leave weed control. All evaluation of herbicide profitability is based on trials with recommended cultural practices, including good seedbed preparation and use of the variety Soltane that competes well with weeds.

3.7.2.13 Summary

Weed control practices in Tunisia have improved greatly as a result of the project's weed control program, in combination with the rising expectations of the farmers. As yield increases, profit increases; thus there is more capital to invest in all inputs, as well as greater confidence in these investments.

Cultural practices are the recommended method of weed control for Tunisia. Wheat growers are advised to avoid herbicides when not needed, they are expensive and risky, unless properly applied. However, if weeds have not been controlled by cultural practices, herbicides offer an opportunity to increase the profit from the current crop. Of equal importance, is the reduction of weed seed production for the following year. The farmer must decide, for each field, whether he should use herbicide and which to use. To answer these questions and maximize profit, the farmer must predict losses due to weeds, make effective applications, and minimize phytotoxicity losses. Over the past three years, the project has sought answers to these questions. As information has developed, recommendations have improved and a greater proportion of the project's activities has been devoted to demonstrations and formulation of recommendations.

3.7.3 ROTATION STUDIES

The rotation studies seek to improve cereal production in Tunisia through development of a system of land use superior to the fallow-wheat-system. Although the fallow-wheat system is now widely used in Northern Tunisia, the process depletes organic matter from the soil and restructs total annual production. It is doubtful whether the generally thin soils actually store much moisture for the next crop, although, in certain cases, the current practice assists in preparation of the seedbed.

It has been assumed that the Australian system of annual forage legume-cereal rotation can be adapted to Tunisia, since the annual medicagos appear naturally throughout the country and soils are suitable. The annual medicago works best when it grows spontaneously every other year, with wheat grown in the alternate year. It is intended that the legume will: (1) provide soil N, (2) improve physical properties of the soil, (3) help in controlling weeds by competition, and (4) control diseases by breaking the continuum of host plants. At the same time,it produces a good forage.

If this rotation is to be successful, it should provide yields of cereals at least as high as that using the best available recommendations, and should allow integration of cereal and animal production. Such an innovation would increase income of the farmer substantially.

Activities of 1973-74 completed a 3-year preparatory phase devoted to examination of the feasibility of the rotation system and dissemination of the required technology to Tunisian technicians and farmers.

3.7.3.1 Demonstrations of the Rotation

Of the 16 rotation demonstrations conducted in 1973-74, 8 were in their third year, 6 in the second year, and 2 in the first year. In general, these demonstrations were planned as follows: in the first year, one-half hectare was sown to wheat and one-half to medicago. In the second year, the wheat area was sown to medigago by two methods: the medigago area was divided so that one half regenerated, and the other half was sown to wheat with some of the sites being supplied extra N. In the third year, the 1st and 2nd year medicago area was sown to wheat, and the wheat area of the second year was allowed to regenerate medicago pasture.

It is possible to use the rotation system for weed control along with chemicals and cultural practices. In 1974 two demonstrations were on badly infested ryegrass areas, these are being used to study the competitive effect of the medicago pasture on ryegrass infestation of the following wheat crop. The grazing and fertilizer management necessary to maintain the medic dominance also is being explored. The first demonstration will be assessed in the wheat crop 1974-75.

3.7.3.2 Experiments

In 1971-72, preliminary experiments were established at three locations (St. Cyprien, Smindja and Teboursouk) including: a mini-rotation experiment, a variety trial, a phosphate trial, and an observation block. The mini-rotation experiment is the most important of these. This experiment compares the production of wheat in the wheat-fallow rotation with that in the medic-wheat rotation, and should give indications of the number of cycles of medic required to give comparable wheat crops. Of the 6 treatments --3 fallow-wheat and 3 medicago-wheat-- one of each of the rotations is begun in each of 3 successive years. The most useful data from these experiments is expected from the 4th, 5th and 6th years of the experiment.

The three sites vary in their result: at St. Cyprien the soil has low fertility, whereas Teboursouk has high initial fertility that produced a high infestation of ryegrass. At Smindja, there was a severe cereal cyst nematode problem that caused low yield of wheat; the rotation effect on cyst carryover in the new rotation is being studied.

3.7.3.3 Extension

The Office of Cereals imported five tons of medic seed from South Australia in 1973-74, as in 1972-73. About 1,000 hectares were sown and farmers were advised on sowing and management.

The program's next phase will emphasize production scale plantings on farms. Early plantings were necessary to investigate the stability of the system in Tunisia. The first of these plantings will have reached the stage for spontaneous regeneration in late 1974, when re-establishment can be assessed and reasons for poor reestablishment determined, a necessary step before larger scale commercial production.

3.7.3.3 Results

3.7.3.3.1 Wheat Yields; Annual Forage Legume - Wheat Rotation

Table 3.7.N and 3.7.O record the levels of wheat yields, which reflect N accretion and successful handling of management problems. Yields have increased as the system operation.

3.7.3.3.2 Wheat Yields from Rotation Experiments: medic vs fallow

Table 3.7.P shows the results (in quintals per hectare) of wheat yields following medic and fallow treatments.

3.7.3.3.3 Yields of Forage

Estimates of pasture lands carrying capacity for animals can be gained from a study of yield of dry matter. Such findings should be interpreted with caution; because, in practice, the forage available to the animal depends on the capacity of the pasture to recover after grazing. The additional leaf area of a dense pasture of medicago will support stronger recovery than the sparse pasture of weedy fallow. Spring yields of forage were measured at three sites, and are shown in tons of dry matter per hectare in Table 3.7.Q.

3.7.3.3.4 Seed Yield and Hard Seed Percentage

In 1972-73, yield of pods from 16 sites ranged from 271 to 3203 kg/ha. The total yield of seed, the proportion of hard seed that will not germinate immediately, and rate of breakdown of dormancy, are important characteristics for seed regenerations. Samples of these characteristics were obtained in the summer of 1974.

3.7.3.4 Conclusions

3.7.3.4.1 Suitability of Cultivars

The two varieties introduced commercially are both well adapted. Jemalong (Medicago truncatula) shows wide adaptation to soil type and rainfall, but is best suited to 400-500 mm rainfall zones. It endures moisture stress after germination and tolerates atmospheric aridity after flowering to produce good seed sets. Harbinger (Medicago littoralis) is better adapted to light soils and less rainfall as low as 300 mm. It is early flowering (two weeks before Jemalong) and sets seed strongly. Neither variety will withstand extended cold periods, snow, or inundation with water (as demonstrated in 1973 and 1974). The other varieties used were: Cyprus (M. truncatula) an early variety but not superior to Harbinger; Paragosa (M. rugosa) which performs better in grey brown or black, heavy textured soils, such as those of Beja; and Clare, a variety of Trifolium subterraneum that survived well at all sites, grew well at Teboursouk, and has regenerated in three successsive years, but produces less forage than the medics.

Natural or indigenous cultivars are not being overlooked. Tunisia has a wide range of material, and after collection there is a strong likelihood that superior material will be found for some regions. One such collection is now being assessed. Until further information is available, Memalong and Harbinger can be used for commercial plantings Jemalong in the greater than 400 mm area, and Harbinger in areas of 300-400 mm rainfall. A mixture of the two could be used in the 400 mm range.

3.7.3.4.2 Rhizobia Requirements and Inoculation

Soil must contain adequate Rhizobia, if N fixation is to occur. In 1971-72, all seed sown was inoculated except when intentionally avoided in variety experiments. Inoculation was done before planting, using Rhizobia in peat culture imported from Australia, plus gum arabic and lime. These were mixed with the seed to produce lime-coated seeds for sowing (lime assists Rhizobia survival). In the experiments where varieties were grown with and without inoculation, it was clear the naturally occurring Rhizobia were quite adequate to provide satisfactory nodulation in all varieties except Paragosa (and this variety showed some nodulation that increased with time). Thus inoculation does not seem to be necessary for the more successful cultivars now used.

3.7.3.4.3 Seed Rates

Initial seed rate is important --if all soil conditions are good and there is no weed competition, seeding rates as low as 3-4 kg/ha will produce adequate stands. The rate being recommended is 10 kg/ha, which represents 20 seeds m^2 for Memalong, and 30 seeds m^2 for Harbinger. Higher seeding rates would be more efficient but high seed prices are a determining factor.

As noted, ryegrass is a serious problem in the country and where high infestation occurs a higher seed rate should be used. At St. Cyprien (ryegrass infested) a seeding rate of 15 kg/ha provided good competition, a rate of 20 kg was used at Bou Arada (ryegrass infested), allowing good competition. When planting in a well-worked fallow, or after cereals in areas without serious weed problems, a seeding rate of 10 kg/ha is quite adequate.

3.7.3.4.4 Time of Planting

Early planting favors establishments, but is not a critical factor between mid-October to end of November. Early planting ensures more forage production. Herbage in regenerating stands which establish with the first rains provides yields superior to those of sown crops, even though differences in seed density make comparisons difficult.

At six sites, two plantings were made 25-30 days apart. Invariably, poorer soil preparation and drier soil were encountered at the earlier date in October. Seed set appeared to be about the same, with few observable differences found in the Spring.

3.7.3.4.5 Phosphate Application

In three experiments, 0 and 90 kg/ha of P_2O_5 were applied and no differences were noted in subsequent growth. This finding was probably due to carryover of P_2O_5 from previous applications, since phosphorus has been widely used in Tunisia over many years.

On commercial plantings and demonstrations, natural stands of medic give a strong response to phosphate applied on the soil surface (where it should be placed to establish stands). Phosphate deficiency has been noted when fertilizer is spread and cultivated into the soil below the level at which the small seeds can take advantage of it. Early application of P_2O_5 on regenerating medic is extremely important; allowing it to grow ahead of the grassy weeds that require N for good stimulation. Phosphate at 45 units/ha should be applied before, or during the first autumn rains.

3.7.3.4.5 Time necessary before the Wheat Crop

Cropping in alternate years is desirable with annual species of medics because of the high "hard" seed content and (usually) prolific seed production. However, when fertility improvement has been insufficient after the first year medic, a decision must be made whether to grow a second year of medic, before wheat. In some of the demonstrations an area was left to regenerate for a second year in succession; that invariably became infested with weeds stimulated by the accumulation of N. Although a difficult task, the weeds can be managed by careful and intense grazing; thus it is preferable to sow wheat after one year of medic with supplement of additional N. One demonstration of 6 hectares has been adequately managed with continuous medicago for 3 years, by careful and intense grazing to maintain dominance of the legume. Cropping will be done in 1974-75 to assess fertility build up.

3.7.3.4.6 Seed yields

Seed yields have been high leading,to good regeneration after cropping; however such results depend upon seed maximization in the first year. Observations in the field indicate an 80-95 percent "hard" seed level. Future work will require more precise measurement in the laboratory, with the results related to location and climate; this work was begun in 1974.

3.7.3.4.7 Grazing or Cutting in the First Year

Grazing or cutting is usually necessary in the first year to help increase seed production and reduce weeds. Growth stage and weather conditions determine the date and intensity of grazing or cutting. Normally, in the first year, grazing should be done in late winter or early spring, before flowering begins. This allows better flowering and prevents or reduces production of weed seeds. Grazing should be avoided at flowering time in the establishment year, since this practice caused poor regeneration.

3.7.3.4.8 Preparation for the Wheat Crop

The wheat crop is grown in a seedbed prepared after first autumn trains, a practice that requires heavy summer grazing to base the soil, make it easier to work, and take advantage of the dry forage. In areas where soil erosion is likely, this process may be modified: immediately after the first good rain, seedbed preparation can be started using an offset disk, or a cultivator, working at 5-10 cm (no deeper). As weeds germinate, additional shallow cultivations can be made so that, by the end of November, wheat can be drilled into a well worked seed-bed.

3.7.3.4.9 Yields of Wheat

The yields of wheat obtained in demonstrations and experiments have been recorded and comparable results have been obtained in some commercial fields. It seems probable that two or three cycles of rotation are necessary to establish a micro-climate favorable for producing wheat yields, comparable to those obtained with treatments of fallow + N. A review of the results indicates that there are no constraints to having dominant medic, a weed-free seedbed, and wheat yields equal to fallow + N. In the Mateur demonstration, yields were the same so that there appears to be no N limitations. At Medjez el Bab, on shallow stony soil with some weeds, the progress has been slower. At Enfida, on a dry, low fertility site that had grown good medics, there was still a marked N deficiency. At other sites, where weeds or other problems were present, several cycles will be needed to get satisfactory yields. Thus management emerges as a major problem.

3.7.3.4.10 Spontaneous Regenration after Cropping

Successful regeneration is being obtained indicating that the cultivar is suitable, initial management and seed set have been satisfactory and that the depth of cultiva-

tion in preparing for the seed crop has not been excessive, and that the P2O5 application in the year of regeneration was timely. Yields of forage from regeneration medic (treatments 1 and 9, Table 3.7.P) indicate satisfactory regeneration. This also occurred in earlier establishment generations as shown in Table 3.7.Q.

3.7.4 DATE OF SEEDING OF WHEAT

Five years of experiments have demonstrated the influence of seeding date on wheat yields. Several factors are involved. Septoria attack is one of these, the effect of seeding date on seedbed preparation is another affecting the yields because of differences in stand and weed infestation. Best stands are obtained near the traditional seeding date. In the coastal areas this is the last half of November and this fits the maturity class of traditional varieties. For INIA 66 and other early maturing varieties, highest yields come from December sowing. In the continental inland areas seeding should be done 10-15 days earlier.

In spite of its influence,experiments have been discontinued on dates;since this cannot be manipulated largely due to the need to have rain for crop emergence, and it must be done before continuous rains set in. Thus varieties must be adapted to the traditional date rather than the reverse.

The first step in adapting varieties to seeding date has been the introduction of Septoria tolerance. This removes the danger of Septoria attack when spring weather favorable to attack coincides with the stage of maximum susceptibility of the crop to damage. Thus it is not necessary to seed late to escape Septoria damage. Nursery conditions are similar to commercial fields so that selection is done under the same conditions.

3.7.5 RATE OF SEEDING STUDIES

A wheat seeding rate demonstration with 2 or 3 key varieties was made as part of farm demonstrations. Beside the usual 100 kg/ha rate for bread wheat and 110 kg/ha rate for durums, plots with 50 percent higher rate were grown side by side.

Yield results are tabulated in T. 3.7.R. It is obvious that rate did not affect yield of Soltane or Siete Cerros. INRAT 69 tended to give higher yields at higher seed rate. In most trials tiller production was excellent but during jointing tiller loss was high which may have resulted from low soil moisture. Amel 72 was not influenced by seed rate in two trials although in a third trial it gave 10 g/ha higher yield with higher seed rate. This could have resulted from better weed competition in theis 3-gene dwarf.

3.7.6 FERTILIZER STUDIES

The program for 1973-74 continued the trend of previous years insofar as N application was concerned and the economics of its use. Field response to N is influenced by climate while the economics are a function of prices and year to year response.

As earlier reported, rainfall was 67-93 percent of the 60-year mean and about 50 percent lower than previous year. Distribution was good except in January when it was dry. Moreover late maturing varieties ripened prematurely because of water stress in April and May. N utilization was generally good. Phosphate experimentation was expanded to study interaction with N levels and its effect alone.

Six trials were conducted on time and rate of application of N on durum wheats, 3 on bread wheats, 3 on the interaction of N and P_2O_5, and 14 demonstrations on two rates of phosphate. In each case yield results were analyzed and test weight established.

In all experiments the dominant factor was N application. The results permit the making of the following recommendations:

a) In the high rainfall zone. 500 mm, N should be applied according to the recommendations in T. 3.7.R and 3.7S,with 45 kg/ha being the minimum supplied at seeding. The normal application rate of tillering is 45 kg/ha but should be varied according to moisture reserves. When moisture is limited, quantity to be applied is decreased and if the rainfall has been high it should be increased to offset the possibility of leaching, and denitrification.
b) For medium low rainfall areas, below 500 mm, it is also best to split the application. The total quantity usually should not be less than 45 kg/ha (sowing time and tillering). Again, the farmer should be flexible and modify the applications according to available moisture.

It is important to examine the farmer acceptance of these recommendations in terms of the quantity used in successive years. In T. 3.7.T are shown the number of tons of ammonium nitrate used in the years from 1968-69 to 1973-74. It can be seen that the use of fertilizer has continuously progressed over the period which relfects the increased use of higher yielding, strong-strawed varieties and better management practices.

3.7.7 WHEAT VARIETY IMPROVEMENT

3.7.7.1 Genetics and Plant Breeding

The breeding program continued its development of better quality bread and durum wheats barley and triticales, that are higher yielding, better adapted and disease resistant.

The main breeding nursery was sown at Beja and yield trials were conducted at three additional centers. Rusts and Septoria failed to develop because of the dry season, even when artificially inoculated.

3.7.7.1.1 Bread Wheats

Two new bread wheats were recommended and registered for release. Figure 3.7.A depicts the progress achieved thus far in advancing yield potential. Table 3.7.V shows yield performance of the two new bread wheats, Dougga and Carthage, which are compared with older varieties. Included is a new variety provisionally named Fath, which probably will be released in 1975.

Dougga is derived from the cross Klein Petiso Rafaela x 8156 (R)[2]. It is somewhat earlier than traditional Tunisian varieties. Its yield performance has been excellent, particularly in higher elevations of Northern Tunisia; Septoria tolerance and rust resistance have been good. Carthage is derived from the cross Napo-Tobari "S" x 8156 (R); it has excellent resistance to Septoria and all three rusts. It is of the same maturity at Soltane, but has higher yield potential. Fath, from the cross Cno "S"-Gallo, is a few days earlier than Soltane, and has the same yield and disease resistance, with outstanding grain characteristics and bread making quality. Its grain type is similar to Florence Aurore, but dough quality is better balanced. Table 3.7.W shows the quality of the present commercial wheats and the new varieties.

Due to absence of Septoria in 1974, varieties such as Tanori 71, Torim, Cajeme 71, Yecora 70, UP 301, UP 310, Pak 20, Potam 70, and Jupateco 73 all gave excellent yields in the international trials. However, past experience with Septoria damage precludes their use in Tunisia. Siete Cerros, and varieties later than Siete Cerros, were generally low in yield because of the hot dry conditions at ripening time. Anza and UQ 105 fall in this category. Both did very well in 1972-73; but in this season both performed poorly, although UQ 105 was somewhat superior to ANZA.

There were 420 new lines and varieties under yield test. The most promising crosses are reported in Table 3.7.X. Table 3.7.Y shows the populations yielding the best F_3 lines. Since these lines were selected from F_2 populations which underwent heavy selection for Septoria last year and severe drought in the current year, drought resistant, Septoria tolerant varieties may be expected from this group of lines.

3.7.6.1.2 Durum Wheat

1974, almost 25 percent of the durum acreage was sown to the newer varieties INRAT 69 and Badri. Although their yield potential is slightly below that of the newer bread wheats, the price differential paid for durum makes them more attractive to farmers. Table 3.7.Z compares the performance of the newer durum varieties with some of the most promising lines in advanced stages of testing. Amel and Maghrebi, both selected from CIMMYT materials, continued to perform well and will be in commercial production next season. Amel 72 appeared the most drought tolerant among all the varieties. Selections from D68-8, D68-5 and D68-1, although late in maturing performed as well or better than INRAT 69. Table 3.7.Z.1 shows the quality characteristics of Tunisian durum varieties and advanced lines. The D68's have good semolina color in addition to good yield. All of the advanced lines listed have acceptable levels of disease resistance.

In Table 3.7.Z.2 lists the highest yield lines derived from the first year yield evaluation. Most entries are selections from the International Durum Screening Nursery (IDSN), and these will receive further yield and disease resistance evaluation. The durum program is now being expanded to obtain better disease resistance and quality. More then 400 crosses were made in 1974, and all of these, plus a collection of varieties and breeding lines were grown in the Kenya summer nursery.

Table 3.7.Z.3: the best F_2 populations in terms of plant and grain type. Due to lack of disease selection pressure, their disease resistance could not be judged.

3.7.7.1.3 Barley and Triticales

Tunisia grows nearly 400,000 hectares of barley, with the greatest acreage in the southern part of the country. It is the second most important cereal crop, following wheat. Virtually all the acreage produces Martin (six row) or Ceres (two row). Barley breeding efforts are modest, and are now in the early stages of exploration for better varieties for introduction and for better germplasm. Table 3.7.Z.4 lists the more promising varieties from preliminary yield trials.

The agro-climatic conditions of the barley region are more variable and more extreme than those of the wheat region. As a result different varieties may be needed for South, Center and Northern areas. The principal diseases, in order of importance are Helminthosporium mildew, Rhyncosporium and the rusts.

The best triticale lines from the Fifth International Triticale Yield Nursery (ITYN) are shown in Table 3.7.Z.5. Cajeme 71 was the highest yielding bread wheat check variety in this test but one of the triticales, Maya II-Arm "S", variety 19 was equal to it in grain yield. Many of the other lines yielded only slightly less than Cajeme 71. In the future, it is hoped that triticale work can be expanded to explore the possibilities of using triticale as a feed crop, as a forage crop for marginal lands, and for its potential as a cereal for direct human consumption.

3.7.6.1.4 "On Farm" Varietal Testing

Varietal testing and demonstration at the farm level shifted emphasis in the 1973-74 campaign. The number of varieties was reduced and a larger number of trials was grown in the continental climate of the non-coastal area. This was done to provide better representation in this area since the response of varieties had been quite different in the two regions. In addition to the larger mechanized farms, trials were located on medium-sized having limited equipment, to broaden the base of extension. These trials were placed in areas with low adoption rate for new technology.

Trial techniques were similar to those of preceding years. Two replications of plots 5 x 40 meters were grown for each variety. Project equipment was used for final seed bed preparation, seeding, and weed spraying. The farmers combine was used for harvesting, except when the grain was to be used for seed increase. Nitrogen fertilizer application ranged from 67-90 kgs N/ha depending on rainfall; one-half was applied at seeding, and one-half at tillering. P_2O_5 was applied at rates of 22 or 44 kgs/ha with the seed, depending on whether the farmer had used phosphate earlier.

Twenty trials were seeded and 19 harvested, with one trial lost to hail. One of the harvested trials showed heavy frost damage, but the results provided information on frost resistance. To indicate the influence of climate on variety response, the 6 trials located in the continental climate and the 13 in the coastal area were summarized separately and are reported in Table 3.7.Z.6.

The new variety Dougga 74 was outstanding in the continental region, producing 33 percent more yield than INIA. It appears to have inherited part of this adoptation, from its parent, Siete Cerros. Both Dougga 74 and Carthage 74 appeared to suffer from moisture stress under dry conditions and may show even better performance in a better rainfall year. In 1973-74, and over the 4 year average, Siete Cerros produced 20 percent higher yields than did INIA 66, in the continental climate. This variety is growing in demand; Siete Cerros can be grown in this region without the danger of Septoria tht precludes its use in the coastal area. Soltane did not perform as well as in the past in the continental region; however, Table 3.7.Z.6 shows that an excellent average performance in both climatic zones. Compared with INIA 66, the yield of Ariana 66 has been higher in both climatic zones. Florence Aurore has yielded less than INIA 66 in the coastal area, but is nearly equal in yield in the continental area.

The relative performance of durum wheats as a class has been better in the continental climate than in the coastal climate. Based on the four year average, traditional durum yields have nearly equalled those of INIA 66 under these more severe conditions, and the newer durums have been eight percent higher in yield. However, results in the coastal area show that whereas the newer durum varieties yielded about the same as INIA 66, INRAT 69 yields were only about 67 percent, and Badri 90 about 91 percent, of INIA yields.

The variety evaluation and farm demonstration trials serve the dual purpose of introducing new varieties and demonstrating the package of improved technological practices. Data from the trials provide information on varietal adaptability, and an economic measure of the value of recommended practices in the Tunisian production areas. Thus each trial is a test of the recommendations and a guide to future improvement.

3.7.7.2 Seed Production and Technology

The program seeks to provide timely delivery of good seed of the best varieties. This objective has been supported by cooperation with all segments of the Tunisian seed program. The Ministry of Agriculture plays a central role through its Seed Control Laboratory, by the framing of seed legislation, and by the establishment of a Seed Certification and Control Service. INRAT forms a vital link through its development of new varieties; their recommendation, naming, and registration, and by increase of Breeder's Seed. The CCSPS and the COSEM contract for seed production, process the seed, supply seed to farmers and to the Office of Cereals, and maintain quality standards. The Office of Cereals attempts to anticipate seed needs to balance supply and demand, and to ensure that seed supplied go to the farmer on time and in adequate quantities. The technical Division of the Office of Cereals develops and promotes the new varieties and their agronomy, and stimulates the use of new varieties by the farmer.

3.7.7.2.1 Seed Quality Emphasis

Major emphasis has been placed on seed quality, since the farmer must have good seed if his operation is to be successful. Steps taken by different organizations to ensure that good quality seed is supplied include:

Systematic inspection of seed fields, with reports on each.

Regular sampling and testing of seed lots prior to distribution.

Use of field and lot numbers on bags to accurately relate seed from specific fields to seed lots sold.

Sowing of post-control plots of seed lots to assess genetic purity.

Sampling of seed lots distributed by the Office of Cereals.

Joining of the Government of Tunisia as a member of the International Seed Testing Association (ISTA).

Serious efforts of CCSPS to strengthen its technical staff in cereals and improve quality control.

Redesigning the COSEM seed label to more closely meet requirements of the purposed new seed legislation.

To double check quality, the Technical Division of the Office of Cereals (The Wheat project) randomly sampled seed lots being distributed by the Office of Cereals. They collected 72 wheat samples and 1 barley sample, which were tested by the Seed Control Laboratory and all were found to be adequate. However, 35 of the samples fell below the proposed seed legislation standards,indicating need for further improving seed quality.

Suggestions for improving internal quality control systems have been made in discussions and special reports to the CCSPS and COSEM. The development of sound seed legislation by the Ministry should have a very useful impact on the program. Similarly, the present careful consideration being given to the forming of the Seed Certification and Control Service leads to expectation of improvement in seed quality.

3.7.7.2.2 Use of New Varieties

The seed program has increased its emphasis on new varieties. In 1972-73, only 47 percent of seed production was in the new varieties; in 1974 it was 68 percent. Similarly, for bread wheats the percentage advanced from 37 percent to 45 percent as shown in Figure 3.7.B.

Increased farmers interest accounts for both of these shifts. Based on the report of the Technical Division of the Office of Cereals issued in April 1974, 44 percent of the bread wheat area and 22 percent of the durum area is now planted with the improved varieties. This is a significant gain, but leaves plenty of room for further spread.

3.7.7.2.3 Seed Availability

Multiplication of seed and its processing bagging and delivery to farmers are separate operations. Since most of the select seed is distributed through centers operated by the Office of Cereals, an assessment was made of the distribution program in late 1973. A number of weak points became evident and suggestions were made to the Ministry as to how deficiencies might be overcome, including:

1. There was some difficulty as to timeliness of seed delivery to the centers.
2. The storage for bagged seed was limited at the centers and in the seed cooperatives, especially at COSEM.

3. The incentive for organizations (other than the Office of Cereals) to market seed is limited by the pricing and "exchange seed ratios" as presently operated.

4. The Office of Cereals could play a more innovative role in the total supply of seeds.

5. The Ministry of Agriculture could further improve seed quality and increase seed supplies.

3.7.7.2.4 Personnel Development and Training

Every seed program requires motivated, well-qualified seed technologists; progress has been made in Tunisia toward achieving this objective. However, to accelerate the program --to move beyond the current level of operation and break new ground-- certain needs must be met, including: adding new personnel in a few key positions, assuring that personnel receive training opportunities and providing of adequate incentives and encouragement to maintain motivated personnel in the positions for which they were trained.

Future staff needs within the key organizations have determined: seed activities have been photographed, and potential training materials have been translated into French as part of this training and development function.

3.7.7.2.5 Support to the Algerian Program

Visits were made to the Algerian Program primarily to analyse its operation and give advice on steps which might be taken to strengthen the operation, visits to Constantine and Oran were helpful in achieving this task. Through discussions and reports, a base has been laid for further development. Training programs for Tunisians and Algerians seems to be a fruitful area for the future; and other areas of cooperation could be identified as joint training programs are conducted.

3.7.7.3 EXTENSION

Extension activities continued to be an important phase of project activities. Under Tunisian leadership, the extension program demonstrates the importance of "cereal extension specialists". The regional technicians (most of whom have been trained at CIMMYT) play an essential role in linking research results with their application by the farmers. Two engineers have provided the leadership for extension activities and ten regional technicians have carried field responsibility for the program in their respective regions.

Based upon agronomic research and varietal research and evaluation, recommendations have been formulated for each region, including recommended variety, proper date and rate of seeding, amount and timing of fertilizer application, and the best weed control measures to apply.

The extension staff encouraged adoption of new practices by:

Providing information through mass media (newspaper, TV)

Holding meetings with farmers, before planting and harvest, to provide the plan of action.

Conducting practical demonstrations on the farmers' fields.

Helping to assure that adequate supplies of seed, fertilizer, and weedicides were available and on time.

Assisting in implementing the credit program for small farmers.

A series of 14 farmer meetings were held prior to seeding which stressed methods of fertilization, seedbed preparation, and variety recommendations. More than 1400 farmers attended these meetings. Prior to harvest, over 1500 farmers attended meetings to observe the new varieties grown under improved technology in the demonstrations. Special meetings were held to show weed control practices and results. The regional technicians also took part in the demonstrations.

The 53 practical demonstrations (of 1/4 hectare each) were divided into four sections. The farmer's traditional variety was compared with a recommended higher yielding variety to convince the farmer of the value of using nitrogen and and weed control practices. Table 3.7.2.7 summarizes the demonstration results.

Although the extension program is not directly involved in supplying inputs, it plays a catalytic and liaison role. Regional technicians and project staff assessed input needs, alerted government authorities to those needs, and assisted farmers in locating supplies.

During 1974, a special effort was made to supply small farmers with seed of the high yielding varieties and assure credit for their supply. It is expected that this program will be expanded.

Extension results must ultimately be evaluated in terms of yield increases and overall production. Although the project has had an impact on the total cereal program, greatest success has been achieved in the higher rainfall areas of the north of the country. The new varieties of bread and durum wheat have been diffused widely and it is estimated that these varieties now produce 38 percent of the wheat production of this area.

In the central and southern areas barley is more important when distributed, the new barley varieties now being identified should increase production of the crop.

In 1974, high yielding varieties of both bread and durum wheats were used on about 16 percent of the total wheat area, as contrasted with 10 percent of the area last year. In terms of production, these varieties are contributing more than one-third of the total.

The Tunisian National Program for Wheat Improvement has been assisted by Ford Foundation, CIMMYT, USAID, FAO, bilateral programs with France, West Germany and Belgium and other international agencies.

Fig. 3.7.A. PROGRESS IN YIELD POTENTIAL. YIELD COMPARISONS OF TUNISIAN BREAD WHEAT VARIETIES

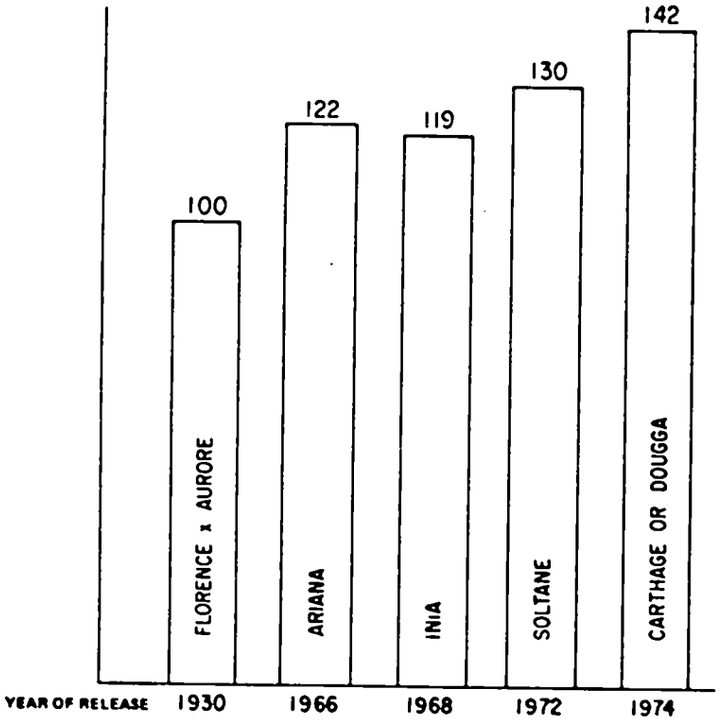


Fig. 3.7.B. SEED WHEAT PRODUCTION IN HECTARES (Tunisia 1972-73 and 1973-74)

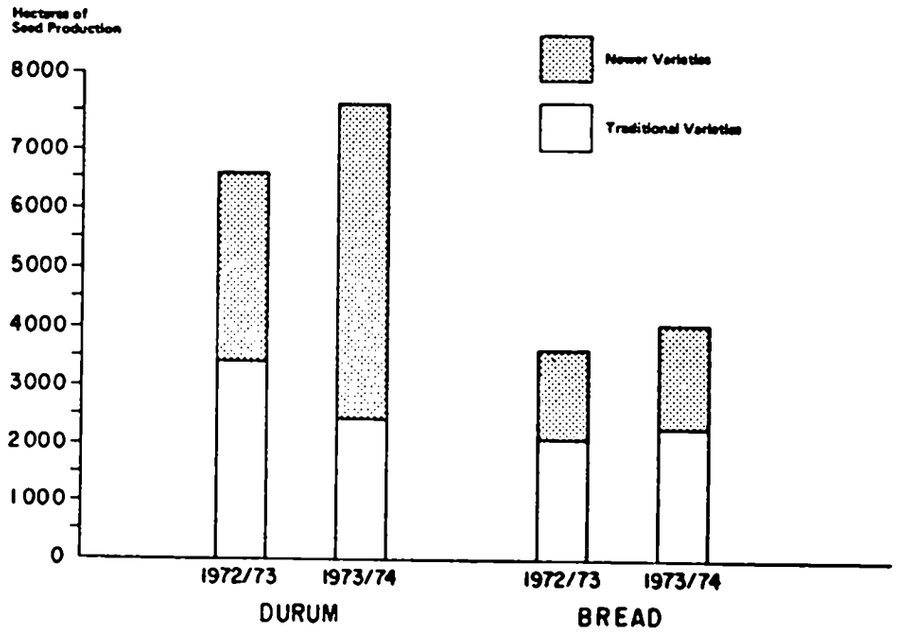


TABLE 3.7.A.- Treatments used in herbicide trials in Tunisia, 1973-74.

Commercial Product	Active ingredient and % by wt. or wt./volume	A.I. Kg/ha.	C.P. kg. or l/ha.	Stage of wheat[a]
2, 4-D	L.V. ester 46	0.60	1.3 l	7 leaf
MCPP	Mecoprop 58.5 (ester)	1.75	3.0 l	4-1/2
Faneron	Bromophenoxeme 50	2.00	4.0 kg.	4-1/2
Certrol II	Ioxynil 12 + mecoprop 36 (ester)	0.42+1.26	3.5 l	4-1/2
Actril M	Ioxynil 15 + mecroprop 37.5(Na salt)	0.45+1.125	3.0 l	4-1/2
MCPP	Mecoprop 58.5 (ester)	1.75	3.0 l	7
Quinerexon	Dicamba 2.75 + mecoprop 42.5 (K salt)	0.10+1.49	3.5 l	4-1/2
Tritunil[b]	Methabenzthiazuron 70	0.875	1.25 kg	4-1/2
Printan 22L	Chlorotoluron 20 + mecoprop 20	2.4+2.4	12.0 l	3
Dicuran "liquid"	Chlorotoluron 50	2.40	4.8 l	3
Dicuran PM	Chlorotoluron 80	2.40	3.0 kg	3
Dosanex	Metoxuron 80	3.20	4.0 kg	3
Dicuran+Tok (Mix)	Chlorotoluron 80 + nitrophene 50	1.6+1.5	2.0kg+3.0kg	3
Dosanex+Tok (Mix)	Metoxuron 80 + nitrophene 50	2.4+1.0	3.0kg+2.0kg	3
Suffix, 2,4-D (Separate applications)	Benzoylprop ethyl 20, L.V. ester 46	1.20, 0.60	6.0 l, 1.30 l	6, 7-1/2
Suffix, MCPP (Separate applications)	Benzoylprop ethyl 20, mecoprop 58.5 (ester)	1.20, 1.75	6.0 l, 3.0 l	6, 7-1/2
Suffix	Benzoylprop ethyl 20	1.20	6.0 l	6
Chandor	Trifluralin 24 + linuron 12	0.96+0.48	4.0 l	pre-em.
Treflan	Trifluralin 44.5	0.89	2.0 l	pre-em.
Tok ultra	Nitrophene 22.7 + linuron 6.4	2.5+0.70	11.0 l	pre-em.
Gramoxone	Paraquat 20.0	0.60	3.0 l	pre-em.

a/ 3 leaf + a few tillers, 4-1/2 leaf + mid-tillering, 6 leaf + end tillering, 7-7-1/2 leaf + start jointing.

b/ One-half recommended dose of Tribunil.

TABLE 3.7.B.- Average yield response in quintals per hectare from 4 herbicide treatments[a] under the climatic conditions of 3 different growing seasons in Tunisia.

Season Rainfall resulting moisture conditions	Type of weed infestation controlled & herbicide used: Broad-leaf 2,4-D	Wild oats Suffix	Most weeds except canary grass Dosanex	Most weeds including canary grass Dosanex+Tok
1971/72 Ideal distribution Adequate for both wheat and weeds	-0.8[b]	0.6	1.3	-
1972/73 Continuous until April 17 Sudden stress followed	1.8	5.8	6.9	-
1973/74 Excellent early, then light Moderate stress after mid-January	1.0	1.5[c]	3.9	5.0

a/ Average includes all relevant trials including those with low weed infestations, number of trials in yield average for 1971/72: 2,4-D 6 trials
Suffix and Dosanex 3 trials
for 1972/73: 12 trials
for 1973/74: 14 to 17 trials.

b/ Yield loss due to phytotoxicity.

c/ Suffix applied too late for maximum yield response under 1973/74 conditions.

TABLE 3.7.C.- Influence of seed-bed preparation on grain yield response to hand weeding treatments and corresponding herbicide treatments, 1973/74, in Tunisia.

Yields in quintals per hectare.

Location & soil trm.	Weed Control Treatments: Broad-leaf: Non treated	Broad-leaf: Hand pulled	Broad-leaf: 2,4-D	Wild oats: Hand pulled	Wild oats: Suffix	All or most weeds: Hand pulled	All or most weeds: 2,4-D	All or most weeds: Suffix	All or most weeds: Dosanex	All or most weeds: Dosanex + Tok	Avg.	C.V. %	L.S.D. 5%	L.S.D. 1%
St.-Cyprien														
Soil minimum	10.3	9.6	11.3	12.7	12.6	17.3	10.5	31.4	-	14.5	13.9		5.1	6.3
Soil medium	9.9	12.3	10.3	10.4	13.5	10.9	9.5	29.9	-	13.3	20.7		6.2	9.1
Soil maximum	14.1	13.3	12.0	13.3	13.3	22.9	13.5	38.3	-	17.6	16.9		6.8	9.8
Average	11.4	11.7	11.2	12.1	13.1	17.0	11.6	33.2	-					
Pont du Fahs														
Soil minimum	27.5	25.9	23.4	23.8	26.0	20.4	24.6	27.5	24.4	24.8	12.3		N.S.	
Soil medium	39.9	41.6	37.1	40.1	37.5	39.1	34.5	34.2	37.7	38.0	5.3		N.S.	
Soil maximim	39.2	38.7	38.2	39.6	34.7	39.6	33.7	41.0	36.7	37.9	4.7		4.0	N.S.
Average	35.5	35.4	32.9	34.5	32.7	33.0	30.9	34.2	32.9					

TABLE 3.7.E.- Yields in quintals per hectare from 17 Type IV herbicide demonstration trials, Tunisia 1973/74.

Location of trials	Weed infestation a/: Wild oats	Rye-grass	Canary grass	Broad-leaves	Treatments: Non treated	2,4-D	Cert. H	Suffix + 2,4-D	Suffix	Dicuran	Dosanex	Dicuran + Tok	Dosanex + Tok	C.V. %	L.S.D. qx/ha. 5%	1%
Tajerouine	1/10	12	1/5	42	10.9	9.3	11.0	10.8	11.2	12.1	11.8	13.0	12.5	8.2	N.S.	
Thala	0	3	0	25	10.7	15.5	14.0	-	-	14.5	17.5	-	-	24.3	N.S.	
Le Kef	30	0	2	25	24.9	25.0	24.0	26.1	25.8	25.7	25.6	-	-	7.2	N.S.	
Siliana	25	0	20	66	50.1	56.6	52.8	55.6	54.4	52.5	55.8	53.6	53.1	4.8	N.S.	
Siliana	10	0	25	25	43.0	43.1	43.1	44.5	44.0	43.5	42.1	44.7	43.9	4.6	N.S.	
Sers b/	5	3	40	73	3.6	3.2	7.6	3.3	3.3	4.6	4.4	4.7	4.4	32.2	N.S.	
St.Cyprien	1	100	5	15	46.7	45.5	46.5	45.0	43.8	45.1	42.0	48.6	43.4	5.7	N.S.	
Béjà	23	0	87	10	33.6	40.1	41.7	40.0	41.3	40.0	40.1	41.0	44.1	2.8	N.S.	
Béjà	10	7	0	20	45.2	46.3	44.5	50.2	48.0	48.4	48.7	50.8	50.0	7.1	N.S.	
Jendouba	20	0	6	40	43.9	45.3	44.0	46.4	44.2	46.4	46.8	46.5	51.4	5.0	N.S.	
Oued Zargua	1	0	1	60	31.7	31.3	32.4	31.6	31.0	32.6	34.1	31.0	33.9	3.6	N.S.	
Mateur	90	1	100	86	8.8	13.2	11.9	16.1	15.2	19.6	24.8	19.3	21.6	13 3	4.8	6.9
Utique	60	90	27	62	13.2	12.0	12.4	15.0	15.8	20.0	19.9	19.1	22.5	13.5	5.0	7.2
Medjez	40	1	26	60	30.3	-	-	34.7	34.8	34.7	34.4	-	-	15.0	N.S.	
Teboursouk	1	1	0	50	25.2	27.9	27.9	30.2	20.7	29.3	30.4	27.9	32.3	9.0	N.S.	
Bou Arada	1	65	7	42	34.1	35.0	34.3	32.8	33.7	35.4	37.5	35.5	37.3	2.6	2.1	3.0
Goubellat	0	15	0	87	29.9	28.5	29.8	28.7	27.0	27.7	28.3	30.3	29.3	6.7	N.S.	
Average c/					28.6	30.0	30.1	30.7	30.8	31.3	32.0	32.0	32.9			
Average yield increase					-	1.4	1.5	2.1	2.2	2.7	3.4	3.4	4.3			

a/ Rating is number of panicles or spikes per square meter for grass weeds, % of soil surface covered for broad-leaf weeds.

b/ Severe frost caused low yields.

c/ Average adjusted for missing values.

TABLE 3.7.D.- Yields in quintals per hectare from 6 Type I herbicide trials, 1973/74, Tunisia.

No.of panicles or spikes per m² or % soil coverage	Mateur	Bou Arada	Bou Salem a/	St. Cyprien	Nouv. Dougga	Le Kef	Average
	Location of trials and severity of weed infestations						
Wild oats No.	130	tr	3	tr	25	55	
Rye grass No.	135	tr	29	400	175	0	
Canary grass No.	195	36	125	150	5	1	
Broad-leaves %	8	22	10	4	35	30	
	Treatments for broad-leaf weed control						
Non-treated	10.6	42.4	20.6	22.1	29.4	22.5	24.6
2,4-D	14.6	42.5	16.3	20.7	31.5	22.1	24.6
MCPP 3 leaf	13.4	42.1	22.2	20.1	29.7	20.7	24.7
Faneron	13.0	42.2	19.2	26.1	28.2	20.8	24.7
Certrol H	15.7	44.6	18.7	19.0	32.4	20.8	25.3
Actril M	14.1	40.3	17.6	24.3	29.8	20.6	24.4
MCPP 7 leaf	10.0	37.8	17.0	17.7	26.4	22.8	21.9
Quinerexon	11.6	39.0	14.5	19.8	29.4	17.3	21.9
Tribunil b/	12.9	41.4	17.1	27.6	29.8	21.9	25.1
	Treatments primarily for grass weed control						
Printan	18.3	42.2	16.0	30.2	35.0	21.0	27.1
Dicuran liquid	19.1	45.8	16.3	27.1	34.8	21.3	27.4
Dicuran WP	21.4	42.5	14.2	34.4	34.8	20.4	27.9
Dosanex	22.6	43.2	19.8	32.0	35.7	25.0	29.7
Dicuran + Tok	18.3	43.6	18.1	40.6	33.0	20.6	29.0
Dosanex + Tok	24.1	45.8	19.5	40.8	33.3	23.8	31.2
Suffix + 2,4-D	14.1	42.1	16.8	17.0	29.3	23.3	23.8
Suffix + MCPP	11.9	44.0	14.9	28.6	28.7	25.0	25.5
Suffix	14.4	44.7	17.1	24.2	31.1	24.0	25.9
C.V.	18.1%	7.0%	23.5%	21.8%	11.1%	12.7%	
L.S.D. 5%	3.8	4.3	N.S.	6.8	4.9	3.9	
L.S.D. 1%	5.0	5.7		8.2	6.6	N.S.	

a/ Trial over-sprayed with 2,4-D which may have increased phytotoxicity.

b/ One-half recommended dosage.

c/ Trial over-sprayed with Suffix, may have caused phytotoxicity in Suffix treatments due to double dosage.

TABLE 3.7.F.- Average yields and yield differences in quintals per hectare of Soltane wheat treated with 600 grams per hectare of 2,4-D at 4 stages of development at sites with few weeds, 3 trials in 1971/72 and 1972/73 and 1 trial in 1973/74 in Tunisia.

Stage of wheat development when treated	Average of years			Avg. dif. from non treated		
	71/72	72/73	73/74	71/72	72/73	73/74
Non-treated	39.2	28.0	40.0	0.0	0.0	0.0
Mid-tillering, 4-1/2 leaves	36.7	26.4	36.8	-2.5	-1.6	-3.2
Finished tillering, 6 leaves	35.4	27.1	40.2	-3.8	-0.9	+0.3
Jointing, 1-1/2 joints	39.1	27.7	40.5	-0.1	-0.3	+0.5
Boot	35.2	23.6	38.6	-4.0	-4.4	-1.3

TABLE 3.7.G.- Average yields and yield differences in quintals per hectare of Soltane wheat treated with 6 liters of Suffix at 4 stages of development at 2 sites with low wild oats infestation, 1973/74 in Tunisia.

Stage of wheat development when treated	Average of trials		Av.dif.from n.treated	
	Mateur	Medjez	Mateur	Medjez
Non-treated	40.0	30.5	0	0
Mid-tillering, 4-1/2 leaves	42.4	32.6	+2.4	+2.1
Finished tillering, 6 leaves	40.3	31.2	+0.3	+0.7
Jointing, 1-1/2 joints	40.0	31.0	0	+0.5
Boot	37.3	-	-2.7	-

TABLE 3.7.H.- Difference between yields obtained on non-treated plots and yields obtained using 4 herbicides applied at the recommended stage of development[a] and at a stage with greater risk of phytotoxicity on 10 cereal varieties at a site with low weed infestation[b], Mateur, in Tunisia in 1973-74. Yields expressed in quintals per hectare.

Variety	Yield non-treated	Yield difference of treated cereal as compared with non-treated									Yield average all treatments
		2,4-D		2,4-D	Suffix		Dicuran		Dosanex		
		4 3/4 leaf	Start of jointing[c]	6-1/2 leaf suffix, 1 node[c]	4-3/4 leaf[c]	2 nodes	2-1/2 leaf[c]	6 leaf to 1 node	2-2/2 leaf[c]	6 leaf to 1 node	
Bread Wheat											
Soltane	42.0	-6.0	-1.3	+2.0	+1.3	+4.0	-0.7	-4.0	+1.3	-2.3	41.7
Ariana 66	31.3[d]	-2.6	+4.7	+6.7	+4.0	+8.0	+5.5	+5.5	+6.7	+7.0	35.8
Tobari	37.3	+0.7	+3.4	+6.7	+6.0	+2.7	+5.0	-3.3	+3.0	-4.0	39.3
INIA 66	34.7	-2.7	0	+4.6	+5.3	-1.4	+0.6	-4.0	+4.0	-4.7	36.7
Fl.xAurore	28.0	-6.0	-0.7	+2.7	+3.3	+0.7	+1.3	-1.3	-0.7	-2.0	27.7
Durum Wheat											
Amel	33.3	+2.7	+1.4	+5.4	+8.0	+1.3	-1.0	-1.3	-0.3	+1.4	35.1
Inrat 69	28.0	-1.3	-1.7	+2.4	+4.0	+2.0	-2.0	-3.3	-1.7	-4.7	27.3
Bedri	33.8	+6.9	+3.9	+3.2	+4.5	+0.2	+3.2	-1.1	+2.2	-1.8	35.9
Mahmoudi	15.0[d]	+3.7	+5.7	+6.3	+2.0	+4.0	+1.7	+5.7	+3.7	+3.7	18.7
Barley											
Ceres	26.7	-3.7	+2.0	-8.0	-0.7	-8.7	-2.0	+2.0	+0.6	-0.7	24.8
Averages											
All cereal varieties	31.0	-0.8	+1.7	+3.2	+3.8	+1.3	+1.2	-0.3	+1.9	-0.8	32.3
5 bread wheats	34.7	-3.3	+1.2	+4.5	+4.0	+2.8	+2.3	-1.4	+2.9	-1.2	36.2
4 durum wheats	27.5	+3.0	+2.3	+4.3	+4.6	+1.9	+0.5	0.0	+1.0	-0.3	29.2-1/-

a/ Average stage of growth listed; varieties differed.

b/ Broad-leaf: 30% soil coverage. Wild oats panicles: 8/sq.m. in variety Amel, 4/sq.m. in other varieties.

c/ Recommended time of application.

d/ Non-treated yield low compared to average of all treatments, therefore tends to mask yield reductions due to phytotoxicity.

TABLE 3.7.I.- Percent weed control in 6 Type I trials, variety Soltane, Tunisia, 1973/74.

Weed Species	No. of trials generating data	Treatments																
		2,4-D	MCPP early	Faneron	Certrol H	Actril M	MCPP late	Quinerexone	Tribunil[a]	Printan	Dicuran liquid	Dicuran W.P.	Dosanex	Dicuran + Tok[b]	Dosanex + Tok[b]	Suffix + 2,4-D[c]	Suffix + MCPP[c]	Suffix
Avena sterilis	5	9	0	5	1	2	0	1	3	56	64	56	78	54	68	96	98	99
Lolium rigidum	5	0	0	4	1	1	0	2	3	99	99	99	98	98	99	0	0	0
Phalaris canariensis	2[d]	0	0	0	0	0	0	0	31	0	0	0	0	0	3	2	3	0
Phalaris paradoxa + P.truncata	6	0	0	1	0	1	0	0	4	5	6	2	0	16	4	3	2	6
Bupleurum lancifolium	1[d]	100	100	100	100	32[v]	100	100	6	100	95	100	100	83	100	100	100	0
Convolvulus arvensis	2[d]	98	24[v]	2	30[v]	3	78	50[v]	0	7	3	0	1	0	0	85	76	0
Fumaria parviflora	1[d]	72	100	100	100	99	100	100	68[v]	99	26	12	65[v]	3	70	49[v]	10	0
Lithospermum arvense	1[d]	33	50	81	98	65	7	35	62	96	90	73	100	55[v]	100	26[v]	0	0
Melilotus sulcata	1[d]	100	100	100	100	35	100	100	0	87	33[v]	43[v]	43[v]	25[v]	50[v]	100	100	0
Papaver rhoeas	1[d]	100	94	75	100	93	93	100	84	84[v]	45[v]	41	93	24[v]	100	100	100	0
Torilis nodosa	2[d]	100	95	78[v]	95	88[v]	98	100	15	100	56	81	57	76	22[v]	100	98	0

a/ Tribunil applied at 1/2 the standard dosage.

b/ Applied as a mixture.

c/ Separate applications, at least 12 days apart.

d/ % control figures are listed in order to indicate performance of treatments which were not used in the 17 herbicide demonstrations. One or 2 trials is not sufficient basis for establishing weed control performance.

v = Variable control within plots or control differs widely among replications of the same trial.

TABLE 3.7.J.- Percent weed control in 17 herbicide demonstrations, variety Soltane, Tunisia, 1973/74.

Weed Species	No. of trials generating data	Treatments							
		2,4-D	Certrol H	2,4-D + Suffix	Suffix	Dicuran	Dosanex	Dicuran + Tok	Dosanex + Tok
Grass weeds									
Avena sterilis[a]	15	8	0	95	99	59	83	55	68
Lolium rigidum[a]	8	0	0	1	0	93	96	84[b]	96
Phalaris canariensis[a]	4	0	0	33	23	0	0	28	34
P.paradoxa + P.truncata[a]	13	0	0	2	2	0	0	9	15
Broad-leaf weeds									
Bunium incrassatum	7	80	71	60	0	1	7	0	8
Bupleurum lancifolium	8	100	100	100	0	49[v]	82[v]	30[v]	76[v]
Calendula arvensis[a]	7	99	88	95	0	99	99	91	93
Chrysanthemum coronarium[a]	2	96	100	95	0	95	100	90	99
Convolvulus arvensis[a]	6	90	21[v]	91	0	0	1	0	0
Fumaria agraria	3	68	100	65	0	27[v]	68[v]	2	57[v]
Fumaria parviflora[a]	5	78	100	65	0	3	62	0	34
Gallium tricorne	3	100	70	100	0	30[v]	99	48[v]	99
Melilotus sulcata	2	100	100	100	0	43[v]	43[v]	25[v]	50[v]
Papaver rhoeas[a]	7	98	100	98	0	50[v]	99	28[v]	98
Rapistrum rugosum[a]	5	100	100	100	0	99	99	81	100
Rhagadialis stellata	3	73[v]	75[v]	73[v]	0	91	96	74	75[v]
Ridolfia segetum[a]	2	100	100	100	0	96	99	100	99
Scandix pectens	5	94	60[v]	90	0	25	9	35	8
Sherrardia arvensis	2	99	70	100	0	3	95	25	88[v]
Scolimus grandiflora	2	98	96	99	0	5	0	0	0
Synapis arvensis	2	100	100	100	0	100	100	75	100
Torilis nodosa[a]	8	99	84	99	0	9	10	10[v]	3
Vaccaria pyramida	2	70	100	82	0	100	100	96	100
Vicia sp.	4	100	99	99	0	73[v]	68[v]	13[v]	15[v]

a/ Species of greatest economic importance.

b/ Handicapped by lack of rainfall following treatments.

v = Variable control within plots.

TABLE 3.7.K.- Weed control ratings of 8 recommended treatments on important weed species of Tunisia based on observations in 1971/72, 1972/73 and 1973/74.

0-34% = 0, 35-64% = P (poor), 65-79% = M (medium), 80-94% = G (good), 95-100% = E (excellent).

Weed Species	2,4-D	Certrol II + 2,4-D	Suffix	Dicuran	Dosanex	Dicuran + Tok	Dosanex + Tok
Avena sterilis (wild oats)	0	0	E	E	P-M	M	P	P-M
Lolium rigidum (annual ryegrass)	0	0	0	0	E	E	E	E
Phalaris sp. (canary grass)	0	0	0	0	0 a/	0 a/	P-M	P-M
Calendula arvensis (calendula)	E	G-E	E	0	E	E	G	G
Chrysanthemum coronarium (chrysanthemum)	E	E	E	0	G-E	E	G-E	E
Convolvulus arvensis (bind weed, morning glory)	G	0	G	0	0	0	0	0
Fumaria sp. (fumitory)	M	E	M	0	0	M	0	M
Papaver rhoeas (poppy)	E	E	E	0	P-G	G	P	G
Rapistrum rugosum and Synapsis arvensis (tall crucifers)	E	E	E	0	E	E	G	E
Ridolfia segetum (wild dill)	E	E	E	0	E	E	E	E
Torilis nodosa (hedge parsley)	E	G	E	0	0	0	0	0

a/ Reducing ryegrass and wild oats competition often results in a striking increase in canary grass.

TABLE 3.7.L.- Influence of timing of ammonium nitrate application on average percent control of ryegrass by 1/2 dosage of Dicuran and Dosanex, 1973/74, in Tunisia.
Values are the average of both herbicides at each location.

Trial location	Time lapse between herbicide application and following nitrogen application: 0 same day	1 week	2 weeks	4 weeks	No NO_3 non-treated
St.-Cyprien	98.4	98.7	99.6	95.7	
Mateur	99.7	98.9	99.2	99.7	95.8
Average	99.1	98.8	99.4	97.4	95.8

TABLE 3.7.M.- Cost of herbicide application, average increase in yield and value per hectare, and net profit per hectare in all Type I and II trials and trials in which high weed infestations of different types were controlled, 1973-74, in Tunisia

	Type of weed infestations controlled: Broad-leaf	Wild oats	Most weeds except canary grass	Most weeds including canary grass
Herbicide application, kg/ha	2,4-D 0.6	Suffix 1.2	Dosanex 3.2	Dosanex 2.4 + Tok 1.0
Cost of application, dinars/ha a/	1.800	15.050	15.550	18.375
	All trials, average of 22			
Yield increase, Qx/ha	1.0	1.5	3.9	5.0
Value of yield increase, dinars/ha b/	5.200	7.800	20.280	26.000
Net profit or loss/ha, dinars/ha	3.400	-7.250	4.730	7.625
	Trials with "high" weed infestations c/ Average of 5 or more trials of each type			
Yield increase, Qx/ha	1.6	4.6	8.9	10.9
Value of yield increase, dinars/ha	8.320	23.920	46.280	56.680
Net profit, dinars/ha	6.520	8.870	30.730	38.305

a/ Cost = 1973-74 price for herbicide + 1.250 dinars for application.

b/ 1973-74 price of bread wheat = 5.200 dinars/qtl.

c/ "High broad-leaf" infestation > 50% coverage of soil surface.
"High wild oats" infestation > 50% panicles/m^2.
"High most weeds except canary grass" > 50 panicles of wild oats or >100 spikes of ryegrass/m^2.
"High most weeds including canary grass" > 80 spikes of canary grass/m^2.

$2.61 US Dollars = 1 Tunisian dinar.

TABLE 3.7.N.- Wheat yields obtained on the rotation of annual forage legume-wheat demonstrations, 1973-74 in Tunisia.

Locality	Variety	Yields in quintals/ha N_0	N_r	Amount of nitrogen in N_r	Preceding crop	
Entcha	Ariana 66	9.24	14.58	53	1st. year medicago	
Port du Fahs	Soltane	16.64	18.24	49	"	"
Goubellat	"	10.57	13.30	49	"	"
El Aroussa	"	19.00	19.00	49	"	"
Gaafour	"	18.76	18.76	49	"	"
Gaafour	"	19.67	23.31	33	2nd. year medicago	
Gaafour	"	18.84	15.36	49	1st. year medicago	
Le Kef	"	12.00	12.00	49	"	"
Siliana	"	-	21.00	53	"	"
Jendouba	"	27.67	27.67	49	"	"
Bou Salem	"	-	27.00	53	Wheat	
Medjez El Bab	"	16.80	20.73	49	1st. year medicago	
Testour	"	13.20	13.50	53	"	"
Mateur	"	43.00	44.00	73	"	"

TABLE 3.7.O.- Wheat yields from the 3rd. year sites of annual forage legume-wheat rotations in quintals/hectare to the nearest quintal in Tunisia 1973/74.

Locality and Farm	Notable features of rotation	Yield 1972/73		Yield 1973/74	
		N_0	N_r	N_0	N_r
Fahs	Moderate rainfall	6	11	17	18
Goubellat	" "	6	8	11	13
El Aroussa	" "	7	9	19	19
Gaafour (Ijtihad)	Low rainfall			19	19
Gaafour (El Bath)	" "	6	7	14	15
Medjez El Bab	Moderate rainfall, shallow, stony soil	5	10	17	21
Mateur	Good rainfall, fertile, free of weeds	31	30	43	44
Le Kef	Higher elevation, excessive wild oats	6	8	12	12

The preceding table gives some of the yields obtained at 3rd. year sites. Significant changes have taken place in the yields recorded at these sites. In general the yields have improved as the problems involved in the use of the techniques have been resolved.

TABLE 3.7.P.- Wheat yic after medic at St.Cyprien and Smindja cc red with those after fallow, Tunisia 4.

Treatment	St.-Cyprien	Smindja	Teboursouk
Wheat after 1 year medic	7.4	10.0	10.0
Wheat after 1 year medic*	10.2-6.5 N_r N_0	8.3-10 N_r N_0	10.5-9 N_r N_0
Wheat after fallow (mean of 2 treatments)	9.4	10.9	9.3

* Plots split and half given the recommended nitrogen treatment as given to wheat on fallow in treatments 5 and 12.

TABLE 3.7.R.- Average yield in quintals per hectare with the normal seeding rate and a rate 50% above the normal seeding rate in 16 variety demonstration trials in northern Tunisia, 1973/74.

Variety	Number of trials in average	Seeding rate a/	
		Normal	150% of normal
Bread Wheats			
Soltane	10	35.8	34.8
Siete Cerros	6	31.0	31.4
Durum Wheats			
Inrat 69	15	26.9	28.0
Amel 72	3	37.4	40.5

a/ Bread wheats normal = 100 kg/ha.
Durum wheats normal = 110 kg/ha.

TABLE 3.7.T.- Nitrogen and phosphate fertilizer recommendations for traditional varieties in Tunisia.

Average rainfall in mm	Soil	Nitrogen - kg/ha			P_2O_5(45%)
		Seeding	Tillering	Total	kg/ha
>500 mm	High fertility a/	33	22	55	45
	Low fertility b/	33	33	66	45
400-500 mm	High fertility	22	22	44	30
	Low fertility	33	22	55	30
>400 mm	High fertility	22	22	44	30

a/ Wheat crop following well worked fallow or pulse crop.
b/ Wheat crop following wheat or forage.

TABLE 3.7.Q.- Dry matter of forage in tons/ha of medicago at three sites in Tunisia 1973/74.

Locality	1st. year medic (mean of treatm. 3 and 8)	Medic regen. after crop (mean of treatment 1 and 9)	From fallow before spring cultivation (mean of treatm. 4,6,10 and 11)
St. Cyprien	4.7	9.7	3.2
Smindja	2.8	6.8	1.9
Teboursouk	2.7	5.2	4.7*

* At Teboursouk the fallow material was composed of about 60% spontaneous medicago. All these trials were sampled at the same time, whereas the trial at Teboursouk may have been less advanced at this time than the others.

TABLE 3.7.S.- Nitrogen and phosphate fertilizer recommendations for high yielding varieties in Tunisia.

Average rainfall in mm	Soil	Nitrogen - kg/ha			P_2O_5(45%)
		Seeding	Tillering	Total	kg/ha
>500 mm	High fertility a/	45	33-45	78-90	45
	Low fertility b/	67	33-45	100-112	45
400-500 mm	High fertility	33-45	22	55-67	30
	Low fertility	45	33	78	30
<400 mm	High fertility	22-33	22	45-55	30
Irrigated	-	67	67	133	67

a/ Wheat crop following well worked fallow or pulse crop.
b/ Wheat crop following wheat or forage.

TABLE 3.7.U.- Quantity of nitrogen fertilizer used on cereals in Tunisia from 1968-69 to 1973-74.

Year	Tons of ammonium nitrate
1968-69	14,330
1969-70	16,835
1970-71	23,640
1971-72	33,000
1972-73	40,000
1973-74	43,000

TABLE 3.7.V.- Yield and Agronomic characteristics of standard Tunisian Bread wheat varieties in comparison to the new varieties - A three year average from 1971-72 to 1973-74.

No.	Name & Pedigree	Height in cm	Days to flower	3 year average yield q/ha	% F x A
1	Florence x Aurore	130	115	32.47	100
2	Ariana	120	124	39.59	122
3	Inia	100	105	38.78	119
4	Soltane	105	113	42.30	130
5	Carthage Np-Tob"s"x8156(R) 28071-7M-3Y-7M-0Y	105	114	45.90	141
6	Dougga Kl. Pct. Rafx8156(R)^2 23997-4Y-100M-300Y	100	121	46.37	143
7	Fath* Cno"s"-Gallo 27829-19Y-2M-5Y-1M-0Y	100	108	41.68	128

* Fath - Average of two years; it is hoped that it will be registered after three years yield evaluation in 1975.

TABLE 3.7.W.- Some of the quality characteristics of the Tunisian bread wheat varieties.

No.	Variety	Test weight kg/hl	1000 kernel weight	Seed Type*	UDY Protein %	P.K. minutes	Alveogram W	P/L	P/G
1	Florence x Aurore	83.5	47.8	1B	14.86	>120	310	1.7	6.8
2	Ariana	84.0	38.0	2R	10.87	80	169	0.7	2.8
3	Inia	85.0	40.3	1R	14.57	>120	195	1.0	3.7
4	Soltane	82.0	38.8	2R	12.95	>120	230	2.7	7.3
5	Carthage	85.0	36.8	2B	12.50	63	291	3.1	8.4
6	Dougga	84.5	38.5	2R	10.91	>120	302	3.5	7.8
7	Fath	84.0	49.7	1B	13.49	82	271	0.98	4.1

* B = amber seed, R = red seed.
1 = big in size, 2 = medium size.

TABLE 3.7.X.- Promising crosses in the early yield testing stages (Tunisia 1973/74).

No.	Cross and Pedigree	Variety No. 1973/74	Yield q/ha	% Soltane a/
1 b/	Pato x CC - Inia CM-1021-7MB-10Bj-0Bj	112	46.90	105
2	On-Tob x Nuri CM-1593-3MB-2Bj-0Bj	139	42.65	100
3	Tob"S"-Np x CC - Inia/Cha. CM-5541-34Y-0M-0Mch-0Bj	222	49.05	106
4	Tob - Cno"S" x 7C CM-1257-2MB-1BK-0Bj	294	44.05	102
5	CC - Inia"S" (Cno x El.Gau-Son64) 30565-52M-1Mch-4Mch-0Mch-0Bj	247	45.20	95
6 c/	[(Fr-Th^{3}xK58/N-Tn^2)(My54-N10B x An$_1$)] 7C 30736-6Bj-2Bj-4Bj-0Bj	164	45.90	-

a/ % based on yield comparison only in trials which included both varieties; therefore does not always correspond with average yield values.

b/ Many sisters in the testing.

c/ Percentage not calculated being a poor trial.

TABLE 3.7.Y.- Promising new crosses in the segregating populations (Tunisia 1973/74).

No.	Pedigree	Cross No.
1	[(Yt.48xK58-N/Fr-KadxGb)Contichis Meng-8156]	CM-14781
2	Cgn x Kal-Bb	CM-15133
3	Cal x Y50$_E$-Kal^3	CM-15618
4	Pj62-CalxY50$_E$-Kal^3	CM-15668
5	Cha #1-Az.67	CM-15739
6	(Bb-Gallo/Cno-Son64xBb)Pato(B)	CM-15818
7	[(ofn/Pi"s"-LBxMfo)Spwt 467/Gb-LxVg9052 Ron]	CM-16163
8	B.Man-OnxCal/Sr70	CM-16209
9	Utique x Potam	CM-16843
10	PV18A-Cno67xCal	CM-21466
11	PV18A-Cno67 x Carthage"s"	CM-21467

TABLE 3.7.2.- Most promising durum lines in advanced stages of yield testing in comparison to the newer durum varieties (Tunisia 1973/74).

No.	Variety	1973/74 Yield Q/ha	1973/74 % INRAT[a/]	1972/73 Yield Q/ha	1972/73 % INRAT[a/]	Average of 2 years Yield Q/ha	Average of 2 years % INRAT[a/]
1	INRAT 69	34.43	100	33.80	109	34.12	100
2	Badri	32.30	94	30.89	91	31.60	93
3	Amel 72	40.15	117	35.11	104	37.63	110
4	Maghrebi 72	38.30	111	36.56	108	37.43	110
5	Gs"s"-AA"s" (BD 2610) 27664-9M-4Y-3M-2Y-0M	39.84	110	38.85	122	39.35	116
6	21564-AA"s" [(Stw^6-Gld BallxStw^6-St464) MexD] 28953-DMx69-200-1A-33A-0A-(BD 2019)	41.14	111	36.83	107	38.99	110
7	AA"s'/LAK$_E$-LD390xCh67 D31762-DMx69-331-2A-1A	40.85	117	46.76	123	43.80	120
8	[(Mah552-LD341/Mah552-BBxMah552)BD 1708] BD1750 D68-1-93A-1A-0A	33.29	95	43.94	111	38.62	104
9	[(Mah552-LD341/Mah552-BBxMah552)BD 1708] BD1750 D68-1-93A-2A-0A	30.19	86	45.67	123	37.93	105
10	BD1419-BD1708/BD1705(53AB.5-Kyp Kamb) D68-8-6A-1A	36.42	104	47.68	132	42.05	118
11	BD1419-BD1708/BD1705(53AB.5-Kyp Kamb) D68-8-6A-3A	37.56	107	51.81	131	44.69	120
12	53AB-5-Kyp KambxBD1705(BD1708-BD1419) D68-5-18A-2A	32.73	102	43.12	109	37.93	106

a/ % based on yield comparison only in trials which included both varieties; therefore does not always correspond with average yield values.

TABLE 3.7.21.- Some of the quality characteristics of the Tunisian durum varieties and advanced lines.

No.	Variety	Test weight	1000 kernel weight	% Yellow berry	Protein % UD	Colour Semolina	Colour Dry dough
1	INRAT 69	85.0	45.6	5	16.57	4.25	2.79
2	Badri	84.0	49.5	5	17.70	1.00	0.54
3	Amel 72	82.0	56.6	12	16.76	2.10	1.75
4	Maghrebi 72	80.5	42.2	3	15.05	2.85	2.43
5	Gs"s"-Cr"s" 27667-9M-4Y-3M-2Y-0M	85.0	52.2	32	14.65	1.60	0.78
6	21564-AA"s" [(Stw^6-Gld Ballx Stw^6-St464)MexD] DMx69-200-1A-33A-0A	79.0	52.6	8	16.72	2.10	1.57
7	AA"s"/LAK$_E$-LD390xCh67. DMx69-331-2A-1A	83.5	49.1	8	15.58	1.75	1.28
8	D68-1-93A-1A-0A	82.0	38.7	2	15.73	4.15	2.52
9	D68-1-93A-2A-0A	83.5	41.2	4	14.28	2.50	1.57
10	D68-8-6A-1A	82.5	43.0	11	14.47	4.00	2.61
11	D68-8-6A-3A	83.0	42.1	15	15.17	3.50	2.79
12	D68-5-18A-2A	81.5	43.0	13	12.89	4.00	3.15
13	Mahmoudi	84.0	41.2	4	-	3.07	1.57
14	Cocorit 71	81.0	40.3	2	-	1.75	0.97
15	Jori C.69	82.0	43.5	0	-	2.79	2.22

TABLE 3.7.22.- Promising durum lines in early yield evaluation (Tunisia 1973/74).

V. No.	Cross	Yield Q/ha	% INRAT 69 [a/]
IV-5	Mgh"s" xJo"s"-Cr"s" CM-9769-1M-0Y	41.26	124
IV-7	AA"s"-Plc"s" 33041-16Y-3M-3Y-0M	41.73	125
IV-11	61.130-LdsxGll"s"/Gs"s" CM-493-1M-1Y-0M	42.44	127
IV-20	Stork"s"# 2	41.77	125
V-2	Cr"s"xT. dic V. Vernum-Gll "s" CM-199-29M-1Y-1M-0Y	44.42	137
V-3	AA"s"(Cp$_L$3-GZxTc^3/By$_E$2-Tc)/31810 CM-10172-37M-0Y	41.11	127
V-14	D.Durum S.15-Cr"s" D33312-7Y-2M-1Y-0M	41.38	128
VI-5	BB-Mah981xKenya338-EC/BD1419 D.67-2-20A-5A-2A	35.75	123
VI-6	Flamingo"s" Mx.0106. 27582-18M-12Y-5M-500Y-0M	35.81	124
VIII-8	[AA"s"(Cp$_L$3-GZxTc^3/By$_E$2-Tc)] Pg"s" CM-10162-76M-0Y	44.35	120

a/ % based on yield comparison only in trials which included both varieties and therefore does not always correspond with average yield values.

TABLE 3.7.23.- Promising durum segregating populations (Tunisia 1973/74).

No.	Cross	Cross Number	No. of Selections
1	Amel-72(BD1419 x BD1708)	D72-1	18
2	Amel-72 (INRAT69 x BD1705)	D72-3	17
3	Brant"s"(INRAT69 x BD1705)	D72-7	20
4	AA"s"(BD1419xBD1705)	D72-21	17
5	DMx69-200-1A-1A(INRAT69xBD1705)	D72-47	19
6	DMx69-200-1A-40A [(53AB.5xKyp Kamb)BD1751]	D72-50	16
7	DMx69-200-1A-40A(INRAT69xBD1705)	D72-51	11
8	[(BD981xKyp) (BD981-BB-BD981)] [(53AB.5xKyp Kamb)BD1751]	D72-70	18
9	INRAT69x(Syn.MahxLD341) [INRAT69-BD1705	D72-100	24
10	INRAT69x(Syn.MahxLD341)/Cr"s"-AA"s"	D72-103	30
11	[(BD981xKyp) (BD981-BB-BD981)] Cr"s"-AA"s"	D72-105	21
12	(AA"s"/LD357E-Tc^{2}xGll "s")Badri	D72-110	22

TABLE 3.7.24.- Promising barley varieties under yield evaluation (Tunisia 1973/74)

N	Variety	Type	Country of origin	Tunis Yield Q/ha	Tunis % Martin a/	Harouta Central Tunisia % Martin a/	Number of days to flower	Height in cm.	P. hordi	Helm. b/
1	Gem	six row	U.S.A.	59.00	120	85	123	115	30MR	8MS
2	Julia	two row	Holland	57.59	117	89	123	100	5-10MR	5MR
3	AlgerxUnion 385-2-2	two row	France	56.67	115	-	134	105	10R	5MS
4	Wi. 2197	two row	Australia	55.83	113	75	111	95	30MS	2MR
5	Giza 120	six row	Egypt	55.72	113	78	119	110	80S	5S
6	Hanif de Grigon	six row	France	52.05	105	111	129	120	-	2MR
7	Wi.2231	two row	Australia	54.05	110	78	119	90	5R	4MR
8	Cl. 13101	six row	-	52.91	107	85	124	120	10R	Tr.R
9	Wi. 2291	two row	Australia	69.00	106	93	119	110	50S	Tr.MR
10	Beladi 16	six row	Egypt	65.10	100	97	120	100	90S	2MR
11	Martin	six row	Tunisia	49.36	100	100	124	110	30MS	6MS
12	Ceres	two row	"	49.80	101	70	122	105	10R	4MR

a/ % based on yield comparison only in trials which included both varieties and therefore does not always correspond with average yield values.

b/ Helm. = Helminthosporium.

TABLE 3.7.26.- Average yield in the coastal climatic zone and in the continental climatic zone a/ in quintals per hectare and percent of Inia 66 in cereal demonstrations on farms in northern Tunisia, 1973/74.

Variety	No. of locations in each zone: Coastal	No. of locations in each zone: Cont.	Average yield: Coastal zone	Average yield: Cont. zone	% of Inia 66 b/: Coastal zone	% of Inia 66 b/: Cont. zone
Bread Wheats						
Inia 66	13	5	31.8	21.5	100.0	100.0
Florence Aurore	13	5	26.3	21.1	82.8	98.1
Ariana 66	13	6	31.6	27.3	99.2	107.6
Tobari	13	3	32.7	31.5	102.8	102.7
Soltane	13	6	34.6	25.3	108.9	99.3
Siete Cerros	2	6	37.3	31.0	98.0	122.0
Carthage 74	7	4	33.1	31.7	99.1	108.9
Douggа 74	7	4	35.2	38.6	107.5	132.9
Durum Wheats						
Inrat 69	13	6	26.0	24.6	81.8	96.8
Badri	13	5	29.7	21.0	93.6	97.5
Amel 72	13	6	31.6	24.9	99.5	98.2
Maghrebi	9	4	29.2	27.0	95.1	92.8
Mahmoudi	4	1	19.8	18.9	67.1	65.8
D 77	4	0	20.9	-	65.0	-
Syndiouk Mahmoudi	1	1	24.4	41.9	70.3	94.3
Chili	1	2	28.9	14.0	72.7	80.1
Barleys						
Martin	3	5	27.9	26.6	79.3	123.6
Ceres	3	5	25.1	30.1	68.4	107.8

a/ Sites in the continental climatic zone: Le Kef, Tajerouine, Ebba Ksour, Sers, Siliana and Thala. The rest were in the coastal climatic zone.

b/ Percent of Inia is based only on trials which contained both Inia 66 and the variety being compared; therefore, it differs from the comparison of average yield in all trials.

TABLE 3.7.25.- Best triticales from the 5th. ITYN in comparison to the best wheat check and the triticale checks. (Tunisia 1973/74).

V. No.	Cross	Number of days to flowering	Yield Q/ha	% Cj	Yield Rank
19	Maya II-Arm"s" X-2832-24N-3M-7N-4M-0Y	124	42.13	100.14	1
9	Maya II-Arm"s" X-2802-38N-3M-6N-4M-0Y	124	41.67	99.05	3
18	Maya II-Arm"s" X-2802-75N-2M-7N-1M-0Y	125	41.53	98.72	4
13	Maya II-Arm"s" X-2802-33N-5M-6N-6M-0Y	125	40.47	96.20	5
4	Inia-Arm"s" X-1645-2N-1M-0Y	126	39.33	93.49	6
10	Cajeme 71 (Bread wheat)	125	42.07	100.00	2
7	Cinnamon	119	35.47	84.31	16
5	Armadillo	124	29.87	71.00	22

TABLE 3.7.27.- Summary of results of practical demonstrations*, Tunisia 1973/74.

Bread Wheat Varieties	Tunis (6 trials) 0-N	Tunis (6 trials) Re-N	Bizerte (2 trials) 0-N	Bizerte (2 trials) Re-N	Nabeul (2 trials) 0-N	Nabeul (2 trials) Re-N	Beja (5 trials) 0-N	Beja (5 trials) Re-N	Siliana (5 trials) 0-N	Siliana (5 trials) Re-N	Jendouba (-) 0-N	Jendouba (-) Re-N	Le Kef (5 trials) 0-N	Le Kef (5 trials) Re-N	Kasserine (2 trials) 0-N	Kasserine (2 trials) Re-N
Inia	13.8	19.3				11.2			18.0	25.3			7.5	10.0		
Soltane	23.7	29.7	12.6	22.8	12.3	16.5	30.9	34.5	17.2	26.3			11.0	14.5		
S. Cerros									14.0	24.6			8.4	12.8	8.1	13.8
Fl.x Aurore	21.2	23.8	14.1	17.0	9.1	14.5	24.3	28.5	17.0	21.4			7.5	10.8		
Average yield of all bread wheat trials	19.5	24.2	13.4	20.0	10.7	24.7	27.6	31.5	16.5	24.4			8.6	12.0	8.1	13.8
Durum wheat varieties	(8 trials)		(3 trials)		(-)		(4 trials)		(5 trials)		(2 trials)		(2 trials)		(10 trials)	
INRAT 69	20.5	22.5	19.0	23.4			21.3	26.8	19.0	25.3	14.0	15.5	7.0	9.0	11.1	17.1
Bedri	20.9	20.2					18.5	32.6	16.7	21.8			9.0	11.0	6.0	12.5
Chili	19.5	19.1					16.6	19.7	11.6	15.2	9.8	11.0				
Mahmoudi	19.8	21.6	16.6	21.4					16.0	19.0			5.0	8.0		
Average yield of all durum wheat trials	20.1	20.8	17.8	22.4			18.8	26.3	15.8	20.3	11.9	13.2	7.0	9.3	8.5	14.8

* 0-N = 0 nitrogen

Re-N = Recommended nitrogen

3.8 Iraq

3.8.1 INTRODUCTION

Iraq lies between 29 and 37° North latitude and 38-48° East Longitude and the climate ranges from arid to semi-arid (southern and middle zones) to high rainfall in the northern hills. Rainfall varies from 50 mm in the southern most desert to over 1,000 mm. in the northern hills and usually occurs during the winter and spring months (November-April). Summers are dry and hot and humidity is generally low while in winter it is high. Temperatures usually range between -8 to 51°C.

Table 3.8.A provides estimates of area, production and yield of wheat and barley for 1973-74.

The table indicates that crop yields are extremly low under rainfed conditions in the North; because most of that region has scant rainfall that is uncertain and erratic in distribution.

Over 80 percent of the irrigated wheat area now produces improved varieties such as Mexipak, Inia 66 and Jori 69, whereas in the low rainfall area, they are grown on about 15-20 percent of the wheat area. Within the entire wheat area of Iraq, about 60 percent is sown to improve high yielding varieties. Improved barley varieties (Baladi, Baladi 265, Arivat, California Mariout, and Numar) occupy about 30 percent of the barley area.

The promising new varieties of wheat such as Abu-Ghraib-1 (Sonora 64 x Klein Rendidor) Abu-Ghraib-2 (Lerma Rojo 64 x Sonora 64)x (Klein Petixo x Rafaela) and Nuri 70 (bread wheats) and Cocorit 71 and V-0229 (durum) are being tested extensively and are under initial multiplication. In addition, many varieties and advanced lines from the National and International Breeding Programs are under observation and selection.

The new barley varieties, Giza 120, CM67 (6-row) and Weibull's Wing, Sarla, Clipper and Magnific-102 (2-row) brewing types appear to be promising and are under initial multiplication.

The production levels indicated in Table 3.8.A are almost sufficient for the country's needs, and no imports are envisaged. There are no support prices at present.

Only about 10 percent of the wheat area is fertilized (mainly under irrigation); due to the high price of fertilizers, prices (per ton) in 1974 were: 21 Iraqui dinars ($70.00 US) for ammonium sulfate, and ID56 ($185.00 U.S.) for T.S.P. Recently, the Government has acted to reduce fertilizer prices by subsidizing 30 percent of cost, and it is hoped that larger areas will be fertilized in 1974-75. The barley crop normally receives no fertilizer, because of lodging susceptibility of the varieties grown. Experiments are in progress to test the effect of fertilizers on the new semi-dwarf lodging resistant varieties: Numar, Arivat and Giza 120.

Since most of the wheat is grown under conditions of scarce rainfall, more material is needed for selection for drought resistance.

The triticale nurseries provided seven promising lines for yield testing against Mexipak and Beladi-265 barley. The three best triticale lines were (Maya II x Arm "S" line 14), (Inia x Arm "S" line 47) and Maya II x Arm "S" line 50), which have been picked for further trials and initial increase.

TABLE 3.8.A.- Area, production and yield of wheat and barley 1973-74 in Iraq.

Crop	Area 000's has	Production .000/T	Av. Yield kgs/ha
Wheat			
North Zone (Rainfed)	1595	1042	653
Middle Zone (Irr.)	522	531	1017
South Zone (Irr.)	132	135	1026
Total	2249	1708	759
Barley			
North Zone (Rainfed)	464	362	780
Middle Zone (Irr.)	323	319	988
South Zone (Irr.)	116	109	942
Total	903	790	875

3.9 Jordan

Agriculture is recognized as the foundation of Jordan's economy, providing direct livelihood for one-third of its 2,000,000 people. The total area of the country is approximately 96,000 square kilometers, but only 10,000 sq. kms. are cultivated and 94 percent of this area is rainfed agriculture.

Wheat has always been the principal field crop, both in acreage and in total gross value. It forms the primary diet of the people and is adapted to growing under relatively dry conditions. Barley is the second most widely grown crop, and is the main crop for animal feeds.

Unfortunately, the yields of wheat and barley are among the lowest in the world; on the average, wheat yields are 650 kg/ha and barley yields 700 kg/ha. The principal reasons for the low yields are sparse and erratic rainfall, coupled with inferior farming practices.

Average annual production of wheat is approximately 150,000 metric tons. Domestic consumption is about 280,000 tons and seed need for the succeeding crop is about 20,000 tons. Thus Jordan has to import about one-half of its consumption. Per capita consumption is estimated to be 140 kg/year.

Wheat requirements are expected to increase, in view of factors such as an annual population growth rate of three per cent, and the shortage and increased prices for rice and other cereals.

Wheat production,because of its dependence on erratic rainfall, varies appreciably from year to year, but barley production remains relatively stable at 60,000 tons/annum. Barley production almost matches consumption, since the crop (used for animal feed supplements) finds less use in years of poor harvests and greater use in better years.

Jordan can be divided into four major divisions on a climatological basis. The climate is usually cold during the winter and virtually all the rain occur in the period from November to early April. Summers are hot and dry. The four climatic regions are:

(1) The western coastal plains: Typically Mediterranean climate, with an average rainfall of 350-600 mms. Average maximum summer temperature is 34°C and average minimum winter temperature is 5°C.

(2) The highland regions: Rainfall ranges from 300-600 mms; average maximum summer temperature is about 30°C and the minimum winter temperature averages about 2°C.

(3) The Jordan valley: Extends from 197 to 394 meters below sea level; rainfall ranges from 50-350 mms. Winters are warm with an average minimum temperature of 10°C, and average maximum summer temperature is 40°C.

(4) The easterly desert region: Annual rainfall is very low, ranging from 100-250 mms;diminishing to zero in the more easterly section; average maximum summer temperature is 39°C, the average minimum winter temperature is 2.5°C.

Wheat and barley production areas fluctuate appreciably, depending on the amount and distribution of rainfall. Wheat and barley occupy about one-half of the total cultivated land, usually under rainfed conditions. Wheat is grown in the 250-400 mms. (10-16 inches) rainfall areas while barley is grown in the dryer areas which receive 200-300 mms. (8-12 inches).

Table 3.9.A shows the acreage of the principal varieties now grown.

The breeding program emphasizes the development of new high yielding varieties with early maturity and resistance to drought and diseases, mainly stem and leaf rust. Breeding research is done at three stations: Deir Alla(which is irrigated and located in the Jordan Valley); Jubieha (in the highland region, rainfed, with average of 450 mms of rainfall) and Shobak (in the marginal highland region, rainfed with average of 300 mms. of rainfall.

Many promising new materials are now under test; each year a large number of crosses are made between local and introduced varieties. Additionally, new advanced lines and other materials are selected from international nurseries. To reduce development time for the new varieties, two generations are grown per year. In the winter, the nurseries are sown at Deir Alla and a summer nursery is grown at Shobak (alt. 1,500 m.a.s.l.). Selection is based principally on high yield potential, early maturity, resistance to drought, medium height (80-90 cms.), resistance to rusts, resistance to lodging, and other criteria such as seed colour, size, and texture.

Jordan has no established pricing policy for wheat or barley. However, the Ministry of Supply initiated a program in 1974 to purchase wheat from the farmers at the relatively high prices of $160-$170 U.S./ton at the farm gate. Since this is approximately equal to world market prices, the farmer is in fact being provided a better than normal price at delivery time.

Chemical fertilizers are not used extensively on wheat in Jordan; small amounts of ammonium sulfate and superphosphate are used, but only on about 2 or 3 per cent of the acreage. Barley is rarely fertilized. The high cost and non-availability of fertilizers at the right time, plus the unpredictability of rainfall, are considered the main deterrents to fertilizer use.

Among the problems that curtail wheat and barley improvement are shortages: of trained personnel, of field and laboratory equipment and of seed production farms for multiplication of foundation and registered seed.

Other needs include the development of staff for seed multiplication, and the inactment of seed laws to ensure the quality of seed offered for sale.

T. 3.9A Areas occupied by the principal commercial varieties of Jordan in 1973-74.

Crop	Total Area (has)	Varieties	Area in has.
Wheat	200,000	Horani Nawawi (durum)	100,000
		Florence Aurore 8	70,000
		Gabo	8,000
		Deri Alla	7,000
		Mexipak	5,000
		Unknown varieties	10,000
Barley	80,000	Arivat	18,000
		Ogalitsu	20,000
		Local varieties	42,000

3.10 Turkey

3.10.1 INTRODUCTION

For the second consecutive year (1974) Turkey's wheat production fell below consumption. Production was estimated at 9.5 million tons, harvested from 8.5 million hectares --an average yield of 1.1 tons/ha. Thus, Turkey must import 1.3 to 1.5 million tons of wheat to meet consumer demand. Wheat production was low primarily due to scarce fall and winter rains on the Central Plateau. However, the spring wheat areas of the Mediterranean and Aegean coastal areas and the Thrace region received adequate rainfall and produced good crops. Unfortunately, these regions produce only 20 percent of Turkey's wheat.

The sub-normal rainfall persisted through the fall of 1974, resulting in poor or delayed fall germination for the 1974-75 crop cycle.

A demonstration program by the Wheat Research and Training Project was initiated in the spring of 1974, in cooperation with the Ankara Province Extension Service. Using inputs and machinery available to the farmers, the program is designed to show that management practices recommended by the Wheat Research and Training Project can produce crop yields that double the national average. The demonstration project involves both research and extension personnel and also serves as a training base for extension personnel and farmers.

3.10.2 BREEDING AND VARIETAL DEVELOPMENT

The four main breeding stations of Turkey are located at: Izmir, Eskeshir, Diyarbakir and Ankara. Primary research responsibilities are coastal spring wheat area (Izmir) the transitional zone (Eskeshir), the durum wheat region of South- eastern Turkey (Diyarbakir), and the winter wheat region of the Central Plateau (Ankara). Additional wheat research centers are at: Adana, Antalya, Adapazari, Istanbul, Samsun, Edirne, and Erzurum; serving mainly as selection and testing centers with little crossing work done. These eleven centers comprise the National Wheat Project, with Cinkora serving as coordination center.

3.10.3 SPRING WHEAT IMPROVEMENT

In the coastal regions, improved high yielding variety (HYV) spring wheats are grown on approximately 60 percent of the acreage. Penjamo 62 continues to be the principal commercial variety representing 90 percent of the HYV area, thus the region is almost a mono-variety culture. The Izmir Center has been concentrating on producing replacement H.Y.V's of spring wheat.

A uniform spring wheat yield trial was begun in 1972-73, and has now been grown at all spring wheat centers during the past two years. This variety trial is designed to identify lines of high yield potential, broad adaptation, and good resistance to the prevalent diseases (stripe rust and Septoria). Table 3.10.A shows the varieties that appear to be most promising, based on two years of testing.

Each of these lines is being multiplied in 1974-75 and submitted for registration in 1975. The proposed names may be changed by the registration committee.

Cigueña and Cigueña "S" have consistently outyielded Penjamo 62 by 10-15 percent. Cigueña and Cigueña "S" are resistant to stem rust, but are moderately susceptible to stripe rust and Septoria; both lines have large white grains, a character prized by the Turkish farmer --thus rapid adoption is anticipated.

Nuri 70 is being considered for release, even though its yield potential is only equal to that of Penjamo 62. Nuri 70 is susceptible to stripe rust and moderately susceptible to leaf rust and Septoria. Again, its white grain is likely to ensure its replacing part of the Penjamo 62 acreage.

Chanate has consistently given a 10 percent yield advantage over Penjamo 62, and appears widely adapted. Its grain is amber and it has reasonably good resistance to the three rusts and Septoria, but has weak straw. Its early maturity may recommend it for use under late sown conditions.

The durum line LD357E-tc^2xAI"S" yields somewhat more than does Penjamo 62, and gives 80-100 percent greater yield than the currently grown local durums. It is moderately resistant to stripe rust, but moderately susceptible to stem rust and Septoria. Because of their yield advantage over local durum varieties, rapid adoption is expected

for both this line and Dicle 1, which is already grown commercially on a limited one in the Diyarbakir area.

In addition to these more advanced lines, several other superior lines have been identified that are under extensive testing. Included in this group are several lines of each of the following crosses - Cno"S"-Gallo (II-27829-, $Y50_E$-Kalyan^3 (II-35188) and Pato-7C (CM1013). The Cno-Gallo lines have shown excellent resistance to the rusts, and good tolerance to Septoria. Grain quality and baking quality in these lines is outstanding and preliminary yield data are encouraging. It is probable that one or more of these lines will be released in the near future. The $Y50_E$-Kalyan^3 lines have displayed excellent yield potential and most of them are resistant or moderately resistant to stem and stripe rusts but all are susceptible to Septoria -like the recurrent parent, Kalyansona (8156W). Most of these lines have the rather small white grain typical of Kalyansona, but their outstanding yield will probably result in release of one or more lines in the future. Lines of the crosses Cno-Gallo and $Y50_E$-Kalyan^3 are particularly promising in the Aegean and Mediterranean regions; an analysis of the yield results of the 1974-75 trials will determine which lines should be multiplied.

The Pato-7C lines are still in preliminary trials, but they show good disease resistance and yield. Other advanced lines from crosses made at Izmir are now entering preliminary trials. Yield potential in these lines should be combined with resistance to stripe and stem rust, and tolerance to Septoria.

In the spring durum program, many new lines are being identified; the principal problem is the inadequate resistance to the rusts and Septoria. Many of the CIMMYT durums are well-adapted environmentally, and have high yield potential, but generally lack adequate resistance for one or more of the prevalent diseases. Current efforts seek to combine desirable characteristics with sources of resistance. Until these lines are evaluated for yield selection will continue on introduced materials. Table 3.10.B lists the more promising durum varieties thus far identified from introductions.

A Turkish spring wheat screening nursery using the best lines from each station has been grown at about 10 locations in the spring wheat region over the past two years. Superior lines from this nursery are entered in the uniform regional yield trial and tested at 15-20 locations for 1-3 years (depending on their potential) after which the successful lines will be considered for release. This nursery probably will be grown in 1974-75 at a larger number of locations and efforts also will be made to increase the number of yield trial sites.

3.10.4 SOUTHERN REGION

This region grows 60-70 percent of the acreage in durum wheat thus breeding activities focus on developing better durum varieties. Cocorit 71 will be released on a small scale under the Turkish names Dicle 1 for the 1974-75 crop season. Dicle 1 has consistently outyielded local durums by 30-35 percent. It also has outyielded Penjamo 62 by 5-10 percent, and the winter bread wheat variety Bezostaja by 20-25 percent. In the coastal area, Dicle 1 yields are equal to or slightly superior to those of Gediz 1, and much superior to the locally grown durums.

Because of its high yield potential, Dicle 1 will be recommended for release in both the Southeastern and coastal regions. It is moderately susceptible to strip rust, stem rust, and Septoria, but due to the low incidence of disease in the dry southeast, this general lack of resistance should create little problem. In the coastal area, however, better resistance is desirable, and the better resistance of Gediz 1 should be popular. Dicle 1 has a tendency to produce yellow berry grain, but since most of the durums of the southeast is used to make bread and bulgur, this is not a serious problem. However, to make sure durum quality does not erode, future durum varieties will be selected with stronger emphasis on pasta quality characteristics.

Several Cocorit sibs appear very promising, and three lines have entered advanced yield trials: Dicle II-27617-18M-6Y-1M-0D; Dicle III 27617-18M-6U-2D-0D; and Dicle IV 27617-9M-5Y-5M-0Y. Dicle III is higher yielding than Dicle I, and Dicle IV has better kernel characteristics and less yellow berry kernels. Other promising lines for the southeastern area are $BY^2{}_E$-Tc x TAC_E-to^4 29595-2M-1Y-1M-0Y; Gediz I and its sister lines; and a few of the Flamingo, Stork and Rabicorno sibs.

3.10.5 WINTER WHEAT PROGRAM

In Thrace (European Turkey), there has been a dramatic shift in varieties over the past four years. Previously, the region grew equal proportions of bread and durum wheats; now, however, Bezostaja occupies 80-85 percent of the total area. Bezostaja is

well adapted and yields at least 25 percent more than the earlier varieties it has replaced. Etoile de Choisy, although equal in yield and released to the farmers, is not expected to be widely grown because of its late maturity and poor kernel characteristics.

The breeding program at Edirne is selecting for varieties superior to Bezostaja. Newer varieties should combine good straw strength, resistance to stem rust, and maturity equal to or earlier than Bezosteja. Other desirable characteristics include resistance to stripe rust and Septoria, with somewhat greater cold resistance than Bezostaja. The most promising materials include some advanced lines from Pakistan, and segregates of winter x spring wheat crosses from Oregon.

The breeding programs for the Anatolian Plateau are located at Eskesehir and Ankara. This region grows approximately five million hectares of wheat annually. The main objective of the programs is to identify high yielding winter wheat varieties with good yield stability and good adaptation to the very variable conditions of the Central Plateau. Such varieties also must have reasonable resistance to stripe rust, stem rust, loose smut and bunt. Varieties must be of winter habit; with adequate winter hardiness, good drought tolerance, proper maturity and broad adaptation. Spring x winter crosses are used extensively in the crossing programs from this region. The objective is to combine the high yielding characteristics of the spring wheats with the desirable characteristics of the winter wheats. Although this concept has been used for only a short time, preliminary results appear promising. Widespread testing of the advanced lines in off-station trials is being used to facilitate the identification of lines with broad adaptation and drought tolerance.

In the 1973-74 season, a total of 24 locations were used throughout the Central Plateau and Transitional Zone. Since these trials also serve as effective demonstration plots, attempts are being made to expand the number of locations. In addition, plans have been made for a series of demonstration plots, using the advanced lines and recommended varieties, hopefully, will speed farmer adoption of the new varieties.

Table 3.10.C shows several lines with good adaptation and yield potential that have been identified over the past two years.

All of these lines have been tested for at least two years, and in 1974-75 will receive final testing and multiplication for possible release. In the 1973-74 trial, (Vil 53-Atl 66/Fn-K58-N) P14-P101 was outstanding. A number of sister selections in this line were bulked in F5 and will enter trials next year. This spring x winter cross has shown excellent yield potential, and it has a good maturity period (early), good grain type and good disease resistance. It is currently under test for adaptation and yield stability.

Varieties in the winter durum program for the high Plateau are hampered by insufficient winter-hardiness. Varieties currently grown are tall, weak-strawed types, with only marginal winter hardiness. Yield potential of these durum varieties is generally inferior to the bread wheat varieties Bolal, Bezostaja, 093-44, and 1593/51. In the last two years, several winter durum lines have been selected with better yield potential. These include two lines of the cross BY^2_E-Td II22252), two lines of the cross 61-130-414/44, six lines of the cross 61-130 Uveyik 162^E (local), and three selections from local populations: 377/2, 1229/1 and 13-Hamari. All of these lines are superior to the present varieties, but the two most promising crosses are 61-130-414/44 and 61-130- Uveyik 162. The BY^2_E-Tc lines have high yield, but are essentially spring types and are only suitable to mild winter conditions. All of these lines also are in final testing stages and are under preliminary multiplication.

To incorporate greater yield potential, many crosses have been made to spring Mexican, Chilean and U.S.A. durums. All of these crosses todate are lacking in winter hardiness and have been only marginally successful. Top crossing or back crossing to the winter parent is underway. Although the resulting segregates are more winter hardy, they also are diluted insofar as yield potential is concerned. Increased emphasis will be given to the winter-spring crosses, when better sources of winter hardiness have been isolated.

The Second International Winter Wheat and Winter Durum Screening Nurseries were distributed to 20 cooperators in 14 countries in 1973-74. This second set contained 76 entries from Rumania, Iran, and Turkey. In 1974-75, the IWWSN and IWDSN will be combined with the International Winter x Spring Wheat Screening Nursery being distributed from the Oregon State University/CIMMYT program in Corvallis Oregon. This new screening nursery will contain materials from: (1) the spring x winter program of OSU, and (2) bread and durum lines from Turkey, Rumania, and Poland. The entire nursery will be distributed to 25 locations around the world, and the OSU group will be sent to an additional 25 locations. The basic purpose of this nursery is to evaluate winter wheats for broad adaptation, disease resistance, and winter hardiness in a wide range of conditions. The nursery is intended also as a vehicle to distribute new and hopefully valuable germplasm to the different cooperators.

The winter barley program begun in 1972-73, will concentrate on the introduction of new germplasm and testing it under Turkish conditions. The objective is to identify high yielding, disease resistant types of barley that can replace the main variety Tokak 157/37 that is currently grown. Attempts also are being made to locate greater winter hardiness sources. Preliminary results indicate that many winter barleys of the US and United Kingdom are reasonably well adapted to Turkey conditions.

The off-station testing of advanced lines will continue and be enlarge. Emphasis will be placed on locating early maturing varieties with large white grain.

3.10.6 PATHOLOGY

As in 1973, the disease incidence in Turkey was low. Common bunt, loose smut, leaf rust, and some root rot damage were noted, with only traces of leaf and stem rust, powdery mildew,and Septoria leaf spot. Losses due to disease were minimi zed by the lower than normal precipitation.

The disease surveillance program continued, including the growing of trap nurseries the mobile disease survey, and race and virulence analysis of rust collected.

The Turkish Trap Nursery is divided into two sets of wheat and barley varieties: (1) set A, including the main commercial varieties grown within the country, and (2) Set B including only known single genes and gene combinations in a similar genetic background.

Race and virulence of rust collections were analyzed at Ankara, Izmir and Eskesehir. Additional collections were submitted to: Dr. R.W. Stubbs in Wageningen, The Netherlands; Dr. M. Boskovic in Yugoslavia and Dr. A.H. Kamel in Egypt; for identification of stripe, leaf and stem rust respectively.

Based on these analyses, stripe rust races 2E16, 6E0, 6E16, 38E144 and 70E16 were encountered in Turkey this year. In addition, the field response indicated virulence on resistance genes Yr6, Yr7, and Yr8, plus a race or races capable of rendering 8156, Bezostaja, Ciano, Calidad and Penjamo 62, ineffective. Only five races of leaf rust were identified: UN17, UN19, UN12, UN13 and UN4. Table 3.10.D shows the distribution of virulence.

Additional stem rust races were identified from the collections, including: Races, 1, 4, 11, 16, 17, 34, 48, 65, 76, 107, 111, 264 and 274. Notably absent was race 189, a highly virulent, but non-aggressive, race previously collected. Virulence was found in the field for Sr5, Sr7, Sr8, Sr9a, Sr9d, Sr10, Sr13, Sr14 and Sr16. Of the 12 single genes tested, only two appeared to be effective against the field races: Sr6 and Sr11. Additional single gene and gene combination lines will be included next year to provide a more refined picture of the stem rust virulence in the country. Artificial epidemics of all three rusts, (particularly stripe rust), were created in the breeding and pathology nurseries at Adana, Adapazari, Ankara, Diyarbakir, Eskisehir and Izmir. The nurseries were inoculated with bulk populations of rust collected from each region of Turkey. Because there was little disease from natural inoculation in 1973-74, the artificial epidemics were particularly important in continuing the selection pressure on the breeding materials.

The Ankara crossing block contains more than 1,000 varieties and lines; these were screened for resistance to common bunt for the third time. Approximately 12 percent of the cultivars showed less than 10 percent infection, indicating the presence of several good sources of resistance. Table 3.10.E lists a number of the cultivars that were immune.

Many specific genes for stripe rust resistance seem to be effective singly, or in combination. Seedling resistance and susceptibility to specific races indicate the presence or absence of specific genes in a particular cultivar. Thus, if cultivars that are seedling susceptible are screened for adult plant resistance against the same races, it should be possible to identify lines with non-specific resistance. Using this approach, tests have been conducted for two years to identify such cultivars. (Table 3.10.F). Currently the segregating populations from crosses of these varieties are being screened.

At Izmir, the main spring wheat breeding station requires combined stripe rust and Septoria leaf spot resistance. However, it is difficult to obtain epidemics of both diseases simultaneously, since both are foliar diseases, and often compete with each other. Thus, whichever disease is first established, the second is prevented from reaching epidemic level, except on plants resistant to one of the diseases. Yet selection is necessary for both. To overcome this difficulty, a separate Septoria screening nursery was begun at Soke south of Izmir, with approximately 4000 entries that have been artificially inoculated and evaluated. Screening for sources of resistance is emphasized, as are studies of the

effect of Septoria on yield and quality.

Additional emphasis is being placed on root rot diseases, particularly Cercosporella. A Cercosporella screening nursery of 911 cultivars was begun: Eskesehir in 1974; hopefully, this nursery will provide additional information for Turkey and the international programs.

The regional disease surveillance program (established in 1971) continued to monitor race/virulence relationships on a regional basis. The Regional Trap Nursery (RTN) was again a cooperative effort of CIMMYT-ALAD-FAO, the Turkish Program, and more than 100 cooperators in 35 countries. The 1973-74 RTN included 45 of the principal commercial barley and wheat varieties of the region. The purpose of the RTN is to forewarn countries of the breakdown of resistance of one of their varieties to a new race or biotype that is attacking this variety in a neighboring country. With such warning, countries may be able to change production from that variety before the new race becomes endemic and causes widespread loss.

Table 3.10.G shows the endemic virulence and resistance trends and relationships, the average coefficient of infection for the rusts among local, improved and dwarf wheat varieties in four geographical areas for the three year period from 1972 to 1974.

The regional disease surveillance program was reorganized in 1974. The objectives remained the same, but methodology changed. During the first years of this program, several specific disease monitoring nurseries were operated in the region. These included: The Yellow Rust Trial (R.W. Stubbs); the European Leaf Rust Nursery (M. Boskovic); The Egyptian Trap Nursery (A.H. Kamel); and The Regional Trap Nursery (J.M. Prescott and E.E. Saari). To avoid duplication of effort, save time, obtain needed nursery space, and provide a stronger network for regional disease surveillance, these four nurseries were combined to form the Regional Disease Trap Nursery (RDTN). Races and virulence of stripe, leaf and stem rust will continue to be identified by Drs. Stubbs, Boskovic and Kamel, respectively.

Coordination dispersal of seed and receipt of data and its compilation are to be performed by Drs. Saari and Prescott. This pooling of scientific effort will aid in determining the distribution and movement of races/biotypes and virulence of these airborne pathogens within the region. Thus, countries faced with potential wheat disease problems can receive advance warning enabling them to take steps to replace certain varieties --or can refrain from commercial introduction of less resistant varieties.

3.10.7 AGRONOMY

The agronomic section has been expanded with the return of Mr. Nadir Izgin, who obtained his M.Sc. from Oklahoma State University. Izgin has assumed the responsibility for tillage and agronomic trials conducted on state farms. These trials are designed to test various production management practices for the Anatolian Plateau. Similar trials were begun in Southeastern Turkey, based at Diyarbakir where durums are widely grown and the environmental conditions are different from those of the Anatolian Plateau.

The Oregon State University/USAID wheat production program on the plateau has completed its last full year of adaptive research trials. Current fallow plots were seeded and will be harvested in 1975, but no new plots were established. Future work of this type will be conducted cooperatively by the extension service and the Wheat Research and Training Center. Additional staff support within the center will be supplied by three U.S. trained Turkish agronomic scientists returning from Oregon State in 1975.

A Regional (Mediterranean) Wheat Workshop was held in Ankara in May, having production management under semiarid conditions as the main theme. Guest speakers from the USA and Australia were invited to present papers on various management topics. The workshop also provided an opportunity for regional scientists to present papers on their in-country research and to exchange viewpoints on management problems.

In the spring of 1974, a field demonstration project was begun in Ankara Province. Eleven farmers' fields were selected in six districts. This project is a cooperative effort of the OSU/AID production management team and the Wheat Research and Training Center. Each demonstration follows the fallow tillage recommendations outlined in the 1973 CIMMYT Report on wheat improvement. It is designed to demonstrate the improved "package of practices" at the village level. Field work was done by the involved farmers, with their own equipment, and with supervision by the scientists of the cooperating groups. Along with the field work, training sessions were conducted with extension personnel (who, in turn can train the farmers, and other interested villagers). The project also includes the use of improved varieties, proper fertilization and the correct rate and time of application of herbicides.

application of herbicides.

Because of the poor moisture conditions through the fall of 1973 and spring of 1974, few comparative differences were found in the tillage and agronomic trials. Yields were mainly determined by rains received from mid-May to June. Under these conditions, agronomic trials (which included N application rates) showed no yield increases with increased N, and at one location yields were less. Rates and dates of seeding trials indicated that a seed rate of 60 kgs/ha was adequate in most cases. Since all plots emerged in the spring, no differences between seeding dates could be expected. All improved tillage treatments produced essentially equal yields, since all emergence was in the spring, early growth was poor, and late rains were responsible for the yields obtained.

Yield data from adaptive research trials conducted by the OSU/AID team have shown a significant yield increase over that of adjacent farmers' crops. For example, the average yield of 27 farmers' fields was 0.85 t/ha, whereas the highest yielding treatment from the nine adaptive research trials was 1.73 t/ha (a yield increase of 104 percent). A series of demonstration trials by Turkish extension personnel, using the best treatments of the adaptive research trials and conducted along with adaptive research trials, yielded 1.55 t/ha (a yield increase of 82 percent). Weed control trials showed a gain of 64 percent yield over the checks in nine trials. Average yields with weed control was 1.65 t/ha; compared with weed checks at 1.0 t/ha.

Additional tillage plots were started in 1974 to (1) determine the effect of depth of spring and summer tillage on moisture retention during the fallow year, and (2) study the timing of spring tillage on amount of moisture retained. In depth of spring and summer tillage plots moisture data obtained before seeding appeared identical; however, emergence differences were noted. The plots deeply tilled in summer showed better emergence than shallow summer tilled plots. Plots deep-tilled in spring also gave better emrgence than did shallow spring tillage. However, greater weed control may have been responsible for this finding. Moisture samples taken at time of spring tillage showed moisture decrease in plots where weeds were allowed to grow and tillage was delayed; but where weeds were chemically controlled, moisture status was similar in these plots --irrespective of tillage time. Emergence data showed the same relationship.

The combined efforts of the Wheat Rsearch and Training Center and the OSU/USAID team have effectively demonstrated that summer fallow management, fertilizer use, weed control, and the use of a high yielding variety, are important factors for efficient wheat production on the Anatolian Plateau. The Government must now give priority to extending this improved management system to the farmers. The package is effective, and if extended, Turkey's Wheat production should exceed demand over the next several years.

Turkey's National Wheat Improvement Program is assisted by the Rockefeller Foundation, USAID, CIMMYT, Oregon State University and FAO.

T. 3.10.A Varieties identified on the basis of 1972-73 and 1973-74 yield trials at spring wheat stations of Turkey as being particularly promising.

Cross	Pedigree	Proposed name
Cigueña	21406-6-2-0Y	Cumhuriyet 50-1
Cigueña "S"	21406-6-2-300Y-0S	Cumhuriyet 50-2
Nuri 70		Nuri 70
Chanate	26265-22Y-300M-301Y-2M-501Y-0S	Sakarya
Cocorit 71*		Dicle 1
$LD357_E$-Tc^2xAL"S"*	27354-1M-1Y-1M-0Y	Gediz 1

* Durum varieties

T. 3.10.B Promising durum wheat lines selected from international materials under test in Turkey 1973-74

Variety	Pedigree	Reaction to		
		Pst*	Prt**	Septoria (1-9)
61-120-LdsxG11"S"/AA"S"	CM498-1S-0S	60S	20MS	7
Jo"S"-Cr"S"	27591-5M-3Y-1M-0Y	0	80S	8
Cr"S"-Gs"S"	CM224-49M-1Y-1M-0Y	20S	60S	8
Pinguino "S"	28984-52Y-2M-500Y-0M	0	20MS	4
Pinguino "S"	28984-62Y-2M-1S-2S-0S	0	20MS	6
USA IVA-Ci"S"	CM9628-2S-0S	10S	15MS	8
Plc"S"-Jo"S"	D31759-4M-2S-0S	10MS	70S	8
21564-AA"S"(DBuckxD^{8}2E-Tc^2/LK)	29451-3Y--3M-4Y-0M	15S	10MR	8
AA"S"	22234-52M-3Y-1M-0Y	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"	27582-2M-13Y-1M-0Y	15MS	5MS	4
***$LD357_E$-Tc^2x AL"S"(Gediz I"S")	D27534-13M-4Y-1M-0Y	5S	90S	5
" "	D27534-3M-1Y-2M-0Y	10S	90S	8
" "	D27534-14M-1Y-8M-0Y	20S	10MR	8
" "	D27534-14M-1Y-4M-1S-0S	10S	60S	8

* Stripe rust
** Stem rust
*** Provisionally named for possible release

T. 3.10.C Promising winter wheat lines identified for suitability to the Central Plateau of Turkey in 1973-74

Line	Pedigree
/[N10B/27-15xRio-Rex]/ Yy 305	P149-7
M374-Sx	M6545-5A-2A-10A-0A
(Vi153-Atl66/FnxK58-N) P14-P101	D68197-5A-2A-0A
/[K58-N/Cnn-TmxMi-Hope) Pn-Cnn]/ Ykt	P558-21-1
8869-220/39	T6206-3-3A-10A-1A-0A
093/44-Stw 597954 x F1	P228-16
093/44-Libero	P605-1-1
Ürciyes	M6405-2-1A-101A-1A-0A
"	M6405-12-6A-1A-2A-0A
093/44(Fn x K58-N/Tmp)	P206-11
Nad63-C0652643	C0702140
Soty-C0652142 x Mara-Sut	C0702095
NB64307	—
Ykt/FnxK58-N	P543-10-1
Sut^5-Ag	68F6674
Nad63-C0652643	C0702291
Nad63-Sut Seln	C0701278
Mex 71043-C0652643xLcr	C0692886
Sut^2 - Ag	Colo. 7365

T. 3.10.D Distribution of virulence of *Puccinia recondita tritici* in Turkey in 1973-74.

Gene line	Percent of collections virulent	Gene line	Percent of collections virulent
Lr 1	0.0	Lr10	93.2
Lr 2A	98.3	Lr17	8.5
Lr 2D	100.0	Lr19	0.0
Lr 3	96.6	Lr23	25.4
Lr 3t	83.0	Kavkaz	13.6
Lr 4	10.2	Besostaya	62.7
Lr 9	3.4	Libellula	49.2

T. 3.10.E Varieties and Lines of Wheat found immune to common bunt in Turkey from 1971-72 to 1973-74.

Yayla 305	Coulee "S"
Kirac 66	Nugaines
V64059-2-24	Pendleton Sel. 69158
V64125-1-10	Riebesel - Burt^2
V64125-1-16	Cleo-Burt^2
VH554377/3	Wa4535-PI178383
(Bowie-QnhxF1/093/44)N604478-4/11	Lutescens 32
Cache	Capitole Vilmorin
Blueboy	Fn-EmaxL50/Vg 7353
Atr^2-7 Cerros	Bez-ID5006
McDermott	HK38MA
Hyslop "S"	Pch-Vg9052=CAR288
CD-P101xGns/P101	Vil 29^2-Vg7353
CD-P101xGns/P101^2	II-50-18-P101xDibo
Burt	Sw92-CI 13645

T. 3.10.G A comparison of the average coefficient of rust infection among local, improved 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	20.16	15.94	18.67	20.41
Improved	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	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	27.79	14.74	18.40	12.03	18.84
Dwarf	16.32	8.17	5.00	2.33	8.35

* Data based on:

1972 - 7 local 12 improved 12 dwarf wheat varieties

1973 - 7 local 31 improved 14 dwarf wheat varieties

1974 - 7 local 21 improved 15 dwarf wheat varieties

TABLE 3.10.F.- Varieties and lines of Bread Wheat with Seedling Susceptibility but adult plant resistance to *Puccinia Striiformis* in Turkey (1972-73-1973-74)

Variety	Pedigree	Variety	Pedigree
Agri	M8402-1-8A-101A-1A-0A	PchaKt54$_E$-Nar59/Lib	T2540-7T-1Y-0T-0A
Agri	M8402-4-21A-3A-1A-1A-0A	Y50$_E$-Kal	35188-E-15Y-0M
Agri	M8402-7-36A-1A-1A-0A	Y50$_E$-Kal	35188-E-20Y-0M
Agri	M8402-2-33A-101A-1A-0A	Y50$_E$-Kal	35188-E-31Y-0M
Kop	M6418-4-11A-101A-1A-0A	Y50$_E$-Kal	35188-E-38Y-0M
3924-Vulgare	Esh37-1-5A-101A-1A-0A	Np63-Tob"S"xSx	28071-7M-1Y-0M
V64059-2-24	- -	Dacia	- -
V64125-1-16	- -	K340xrb-th/NP"S"	Sel. B
VH664437/3	7869	NB67730	- -
Aric 232-69	- -	Jd-JbxCb	Sel. B
Excelsior	- -	Cd^2-Vg6318	Ch8720-5T-1T-1T-0A
Dacia	- -	CD-Vg8058xCd-Sh	Ch8741-3T-1T-2T
Drage	- -	Vg8881-1dF	T1282-0T-0T-1T-3T
T.timo-Italy x Bez	- -	Hyb 46	- -
Arg-R16 x Bez^2	NS-11-63	Sw92-CI13645	Sel. B
Bez-NS118 x Mir600	NS-12-69	61-1458xMex67-5	500A-0A
Zhulice e Bardhe	- -	Ymh-YysKbs-P101	501A-0A
E de Ch-Mex 57	- -	Nor67-Ymh	502A-0A
Cd-Vg8058 x CD-Sh	Ch8741-3T-1T-2T-1D-1D-0A	Hys-7C	503A-0A
Cd-Vg8058 x CD-Sh	Sel A	Nor67/CD-P101xDrc	T1373-500A
Vg 8881-Minn	- -	Hys"S"-Atr	K70015-500A-0A
V64125-10	- -	Hys"S"-Atr	K70015-502A-0A
Canada 8200	- -	Hys"S"-Atr	K70015-506A-0A
Esh6988(=Jar"S")	18889-4M-1T-3Y-4C	Hys-7C	K70016-500A-0A
N10B-P101xP8-5	P138-47	Hys-7C	K70016-501A-0A
(Bowie-QnhxF1/093/44)N604478-4/11 Cheyenne	P248-12	Mrp63-Bez	M69134-32A-501A-0A
	- -	Mph65-Bez	M68135-15A-500A-0A
NB67730	- -	Mph65-Bez	M68135-28A-500A-0A
Nicoma	CI 13874	Hua R	- -
Sun64-SS2	Sel. C	Mph65	- -
Ymh-Tob68	Sel.A	Rul-Gallo	CM1188-38M-1Y-0M
Predgornaia 2	- -	El Gao-Pl82/Sun64xSK$_E$-Ar$_E$	31171-1E-3Y-2M-1Y-0M
BezxIT-PI178383/Wa4765	- -	Bb-Nar59	30384-3T-1M-1Y-0M
Bez-ID5006	- -	CC-Inia x Bb	30566-23M-500Y-500B-0Y
Rulofen	- -	CC-Tob"S"^{2}	36027-13T-2M-6Y-0M
HK38MA	- -	Ca"S"(Arg)	- -
Cno-Jar66	28126-4Y-3M-0Y	Bb-Nar59	30834-3T-2M-1Y-0M
Tob"S"-Nar59/7Cs	32178-14M-4Y-0M	Y50$_E$-Kal^3	35188-E-39Y-0M
Tipp-Kit Jar"S"	18889-6T-0T-4T-1T-0Y	Inia-RL4220x7C	35038-7Y-1M-0Y
Inia-Cal	37220-302M-0Y	Bb(Cno-ChrxOh/Gallo)	25028-30Y-5M-2Y-1M-0Y
B.man-OhxCal	37765-1M-1Y-2M-1Y-0M	LR64^2-Sun64xCC/Sha	34093-10Y-1M-1Y-2M-0Y
Inia-CalxInia-CC	28647-8D-1D-0A	BbxTob-Cno	CM1561-18M-1Y-4M-0Y
Cno"S"-Pj82	35033-30M-2T-0M	Bb-7C	CM1562-1M-1Y-0M
Tipp-Sun64	22407-100M-100Y-100Y-1D-1D-0A	Super X	- -
TobxCC-Pato	- -	Bb 67	23584-18M-10Y-3M-3Y-0M

4.0
Asia and Pacific

Wheat trainee Fouzul Kamal, Bangladesh examines his experiment at CIANO.

4.1 Afghanistan

4.1.1 INTRODUCTION

The Afghan National Wheat Program is conducted by the Ministry of Agriculture and Irrigation with assistance from the United States Agency for International Development, FAO, and other international agencies. CIMMYT continues to supply germplasm materials, and periodic consultant visits by members of its scientific staff.

A drought in Afghanistan during late 1973 and early 1974 lowered yields of wheat, barley and other winter grown crops. Shortage of snowfall in the winter months resulted in water shortage throughout the country during the spring months, which also reduced yields. Reductions were even more severe on the improved varieties than on the indigenous, since improved varieties are mostly grown on the irrigated lands. From mid-March to April, there were no rains in a large part of the rainfed area and about 1.3 million hectares failed completely. The widespread drought continued into the fall season of 1974, preventing many farmers from sowing their 1974-75 crop at the proper date.

4.1.2 VARIETAL DEVELOPMENT

Improved varieties now cover about 60 percent of the irrigated wheat acreage. Bezostaya occupies most of the winter wheat region. This variety (bred in the U.S.S.R. and released in 1960) was tested in Afghanistan for two years before being officially released. It has good lodging resistance, is resistant to prevalent diseases, has good milling and baking properties, and produces high yields. However, it is losing its resistance to stripe rust virulences found in the country, thus is losing its yield potential.

In the warmer areas, Mexipak 65 predominates among the fall-sown spring wheat types. Because of its susceptibility to new virulent forms of stripe and leaf rusts, its usefulness now has declined.

Several selections from CIMMYT,FAO and other nurseries offer better yield possibilities. During 1972-74, Afghan scientists selected Baktar (E_1314) Chenab 70, 17778 and Kavkaz for superior resistance and yield. The first three varieties are spring types suitable for fall sowing in the warmer regions, whereas Kavkaz winter wheat from the U.S.S.R. appears suitable for replacing Bezostaya in the colder regions. It has lodging and disease resistance combined with good quality. Currently, small scale increases of these four varieties are underway at the different experiment stations.

During 1973-74, other promising materials were selected from the introduced nurseries. HB 102-100, Mexipak 15-4 and HD832 are spring type wheats: Vilmorin 27 is a winter wheat; and FB55 and Anhinga are durum varieties. Over the past two years of testing these varieties produced high yields and have continued to be resistant to the rusts, smuts and Septoria. They are currently being retested in replicated trials at all experimental stations. The two durum wheats have acceptable semolina colour, good kernel size, and produce high yields.

4.1.3 BREEDING AND EVALUATION OF VARIETIES

Wheat breeding and yield tests are conducted at nine main stations and three sub-stations representative of wheat areas of the country. Afghanistan, because of its topographic and climatic variations, is agriculturally quite complex, thus varieties are needed with both specific and general adaptability. An aggressive cereal improvement program is required to breed varieties of both winter and spring types, durum wheat, triticale, and barley, for rainfed and irrigated areas.

Crossing blocks were established during the year at both Kabul and Jelalabad. Crosses were made between selected indigenous winter and spring wheats, with exotic materials derived from introduced nurseries. The indigenous wheats seem to possess adaptability, favorable grain size and colour, longer coleoptile, and better emergence; exotic varieties are being used to provide better yielding ability, disease resistance, lodging resistance, and responsiveness to fertilizers. More than 1000 indigenous collections were tested for value, and a few with desirable characters were combined in crosses with selected exotic materials. About 5000 F_2 populations, F_3 and F_4 lines are being grown at different stations collectively.

Adapted varieties should: be sufficiently early to escape late spring and early summer onset of high temperatures, and yet have some frost resistance; be semi-dwarf (one gene) with stiff straw in order to improve the straw-grain ratio: be highly resistant to rusts, mildew and leaf blotch to ensure stability of yield; be resistant to winter killing

and drought and have good tillering ability; have long,highly fertile spikes and small erect leaves.

Crosses have been made to create varieties suitable for dryland areas. Such varieties should have fast growth and establishment, well developed deep root systems, long celeoptiles, a limited number of tillers, early maturity, and small erect leaves and awns.

4.1.4 PATHOLOGY

Because of the widespread dry conditions, disease development in 1974 was restricted, as compared with the much more damaging conditions of 1972-73. Rusts, powdery mildew, Septoria, common bunt and loose smut were encountered in varying degrees from season to season. Two other diseases (one with streak symptoms, and the other producing a mottled leaf appearance) were found and are suspected to be caused by virus. About 3000 lines from various international nurseries were grown for evaluation during the year. In addition, the disease surveillance program begun in 1972-73 was continued.

To date, it has not been possible to create artificial disease epidemics in the nurseries of the breeding programs. Although the methods for creating epidemics are known, and natural epidemics are normally established, it is felt that the program could be much improved with better facilities and additional trained pathologists.

In several parts of the country, the wheat crop was checked periodically for insect damage. The armyworm appears to be the most serious pest; it attacks the crops about the time of head formation and strips off the awns and leaves. No control practices have been used on a major scale.

4.1.5 AGRONOMY

In 1973-74 a number of agronomic experiments investigated optimum date of planting, seed rate, rate of fertilizer and method of fertilizers. In addition, studies were made of the best water management, and time and rate at application of herbicides. All tests were designed to develop a package of practices that, if used, would maximize the farmer's yield. Preliminary results indicate that date of planting is of greater importance than rate of seeding in ensuring good stands in the winter wheats. It is thought that this is due to the fact that optimal temperatures play an important role in obtaining good seed germination and seedling establishment.

Experiments were conducted at six stations using different numbers of irrigations. The aim of these tests was to establish the most effective and economic schedule for irrigation, using critical growth stages as the criteria. Irrigations were made at first node, booting, early heading, and the milk-to-dough stages. Because of the water shortage, it was hoped that some stages might be non-critical and that yield would not be affected if watering were skipped at those stages. Preliminary results indicate that the booting and early heading stages are the most critical. Reducing moisture at these stages, significantly reduced yields. This research will be continued to further refine the recommendations.

4.1.6 FERTILIZER SUPPLY AND SUPPORT PRICES

The use of chemical fertilizers is a relatively new practice in Afghanistan. For ease in introducing the practice and for simplicity in educating the farmers, a single simple recommendation was made by the Ministry of Agriculture and Irrigation. For fall sown wheat, it was recommended that the farmer use one-half bag of DAP and 1 bag of urea per jerib (0.1935 has), which would equal approximately 60 kgs $P_2O_5$and 120 kgs of N per hectare.

The Afghan urea plant that had been under construction for the past years is now in production. It has a rated annual capacity of 105,000 tons. About 24,000 tons had been produced up to the end of the year. The current level of fertilizer use is some 70,000 tons of urea and DAP annually. At his level, wheat production in a normal year is barely adequate to supply demand and prevent a sharp rise in prices. The government is providing a substantial subsidy for fertilizers and currently sells urea at 50 kgs for 440 Afghanis ($7.33 US) (or 146.60 US/ton) and 50 kgs of DAP at 492 Afghanis ($8.20 US) (or $164.00 US/ton). This is well below the world price.

It is felt that Afghanistan can, in a normal year,produce more wheat than is consumed. However, because of the drought in 1973-74, supplies seemed unlikely to meet the demand,and at year end prices of wheat were rising sharply.

4.2 Bangladesh

4.2.1 INTRODUCTION

The Government of Bangladesh operates its own wheat improvement program with assistance and collaboration provided by the Ford Foundation, USAID, and other international agencies. Results of the 1973-74 wheat season were affected by both early and late rains. Early rains in November delayed seeding generally, and emergence suffered due to excessive soil moisture in the seedbed. Early onset of rains in March affected grain development, and wet conditions during harvesting and threshing damaged much of the grain produced.

In Bangladesh, supply of seed is a main constraint. Farmers have shown widespread interest in growing wheat, however the shortage of proper grain storage facilities (coupled with damage at harvest time) has resulted in crops that become unfit for seed, because of low germination. Demand for wheat by consumers has increased rapidly in the urban areas, where families now usually consume two meals of wheat products. (This rapid increase is due to food shortages that were remedied by imported wheat). The market price for wheat also has increased as a result of higher world prices, thus providing greater encouragement for the farmers to grow the crop.

4.2.2 CLIMATE

The average rainfall per month during the wheat season of 1974 was 12.94 inches (31 cms). In the month of November, during the seeding period, rainfall totalled 12.0 inches (30 cms) and at harvest time in April rainfall was 6.3 inches (15.75 cms). During the season, the temperatures reached 90°F (32.2°C) in March and April; whereas the lowest temperatures of 53°F (11.7°C) occurred in January. Relative humidity varied between 47 and 86 percent.

4.2.3 PRODUCTION

The total acreage sown to wheat was 304,000 acres (123,077 ha.), which consisted of 232,000 acres (93,927 ha.) sown to local varieties and 72,000 acres (29,150 has) sown to high yielding varieties. Total production was estimated at 109,000 tons for a yield of 886 kgs/ha, which is still a very low yield base. Import of wheat to supply the domestic needs was estimated to be between 1,600,000 and 1,700,000 tons. No support price was established for wheat in Bangladesh, but market price was Taka 2750 per metric ton (US$366.00). Because of increasing world prices and food shortages within the country the trend over the year was to higher prices.

4.2.4 FERTILIZERS

During the year, approximately 269,000 tons of urea was produced domestically. No phosphatic or potassic fertilizers are produced in the country; 95,000 tons of P_2O_5 and 40,000 tons of K_2O were imported as triple superphosphate and muriate of potash. For the crop year, 354,000 tons of urea were available, including a 1972-73 carryover of 85,000 tons. The total of 146,000 tons of TSP was available and 48,000 tons of muriate of potash including the amount imported plus carryovers from 1972-73 of 51,000 and 8,000 tons, respectively. Estimates of the amounts actually used on all crops were 261,000 tons of urea, 93,000 tons of TSP, and 18,000 tons of muriate of potash leaving net carryovers for the 1974-75 crops of 93,000, 53,000 and 30,000 tons, respectively, for these three major elements.

The price per metric ton of fertilizer during the year was: Take 816.00 (US$109.00) for urea; Take 544.40 (US$72.59) for TSP; and Take 408 30 (US$54 44) for potash. In March, 1974 the fertilizer prices rose to a price of Take 1361 (US$ 181.47); Take 1088.80 (US$145.17); and Take 816.60 (US$108.88) for urea, TSP, and Potash respectively. This represents an increase of 67, 100 and 100 percent for the three elements, but also gives an indication of the level of subsidy on fertilizers which is supplied to the farmers.

4.2.5 RESEARCH

The heavier than usual rainfall during the season adversely affected the first date of the crossing block, the yield trials, and other sowings because of the late seeding. In the Regional Disease and Insect Nursery, emergence was only about 50 percent. Experiments were conducted at the central station of Joydebpur and at the five substation of Jamalpur, Ishurdi, Jessore, Rajshahi and Hathazari. Advanced and preliminary program trials were conducted at all centers except Rajshahi, whereas the international trials were divided between the central station and Ishurdi.

Among the materials tested, three promising lines emerge. At Ishurdi, Cno "S" II-19957-18M-1Y-3M-3Y-0M produced 4.1 tons/ha and this line has been advanced for farm trials for the 1974-75 season. In the preliminary trials, Son 64 x TzPP-Y50/Justin 370-ESP29 produced 5.3 tons/ha and this has been advanced for microplot testing. Tob 66-8156 II-22964-3Y-5M-0Y produced 4.0 tons/ha and has been put in the advanced trial.

Some of the problems facing research and production are:

Research: (1) lack of equipment for land preparation and land levelling, and facilities for irrigation at all research centers; (2) an urgent need for plot and head threshing equipment. Without these facilities threshing is prolonged, resulting in lower yields and damage to the grain before threshing; (3) lack of transportation for scientists to visit the research stations and assess the progress of farmers.

Production: (1) lack of adequate quantities of good seed, of high germinability, which requires facilities for cold storage under low humidity during the monsoon season; (2) need to study the requirements for a support price for wheat. During the year the price of milled rice was 2-2.5 times that of wheat. This encouraged farmers to grow rice, as opposed to wheat, but required 3-4 times the irrigation water needed for the same area of wheat. This is poor economy in water use, when most of it must be pumped in this season (under normal conditions).

4.3 India

4.3.1 INTRODUCTION

Collaborative efforts of the All Indian Coordinated Wheat Improvement Project continued to operate at: Delhi, Indore, Simla, Bhowali, Pusa, Wellington and Lahand (Indian Agricultural Research Institute centers); at at Gurdaspur, Ludhiana, Hissar, Junagadh, Vijapur, Durgapura, Pantnagar, Kanpur, Sabour, Kalyani, Powarkheda, Rudrur, Niphad, Poona, Mahableshwar, and Dharwar (State and university centers). In the fifth, Five Year Plan,a number of additional centers have been proposed for Srinagar, Udaipur, Rewa, Varanasi, Malda, Bhubaneswar, Jorhat, Coimbatore, Bangalore, Almora, Palampur and Imphal. These centers focus on specific areas and are considered necessary to augment wheat research and production efforts.

Some shifts in acreage planted to wheat were noted for the first time in 1973-74. Acreage fell by about 0.8 million ha from the 1972-73 level of 19.9 million ha, so that estimated acreage for the year was 19.1 million ha. Although final estimates of production and yield have not been published, it is judged that production was about 22 million tons, providing a yield level of 1.18 t/ha.

Weather during 1973-74 varied widely over the wheat area. In the entire north of the country, production was reduced by the lack of winter rains and shortages of fertilizer and of diesel and electric power. In the north-west, widespread unseasonal frosts caused damage estimated to range from 5-80 percent in some farmers' fields. In Central and Peninsular India, weather was very favorable for growth, and production was higher than last year.

Sonalika and Kalyansona continued to be the predominant varieties grown under irrigation throughout the country. Other varieties with sizable acreage and having regional importance included: C306, K65; K68; Hyb65; NI 747-19; NI 5439; N59; Bijaga red; Bijaga yellow; JI-7; and UP301. Other varieties grown on a more limited scale included: WG 377 and WG 357 in Punjab; UP 215 in Maharastra and Mysore; Shera (HD 1925) in Madhya Pradesh; K816 in southern Uttar Pradesh; and VL401 and VL404 in the northern hill region of the same state.

4.3.2 VARIETAL IMPROVEMENT

Several new lines were recommended for consideration as potential varieties by the All Indian Annual Meeting. All are being grown under multiplication. These together with parentage, area of recommendation and principal features are shown in Table 4.3.A.

In addition to the varieties listed above, certain other varieties have been released by State Varietal Release Committees, and are under multiplication. Seed production of Sonalika has been much increased in view of its continued high resistance to the three species of rust. Its earliness and large grain are additional factors favoring this variety. Kalyansona in spite of its increased susceptiblility to the rusts, still occupies a large acreage and seed production was continued on a large scale.

In 1973-74, 449 yield trials grown in to evaluate 780 aestivum and durum and 31 triticale strains. Trials, as in the past, were conducted at different fertility levels, under irrigated and rainfed culture, and for normal and late-sown conditions. Three series of new trials were initiated: (1) trials with multilines of Kalyansona, Sonalika, Sharbati Sonora and Lal Bahadur; (2) a special trial with promising lines from CIMMYT, and (3) trials with triticales.

In the multiline trial, 45 strains developed in India were tested at 13 locations. The recurrent parentss -- Kalyansona, Sonalika, Sharbati Sonora and Lal Bahadur plus HD 2009 (Arjun)-- were sued as checks. A number of the lines were superior to Kalyansona and Sharbati both in yield and rust resistance. It is proposed that the superior lines be tested in National Trials, as well as in the multiline trials. They are now under multiplication to obtain 20-25 quintals of individual backcross lines by spring 1975. In the 1974-75 season, it is proposed that multiline mixtures of 7-8 individual lines will be put under test on an all-India basis. It is hoped that India soon will be able to release multilines of their principal commercial varieties.

A group of promising lines from CIMMYT was grown, including Torim 73, Jupateco 73, Cno-Inia x Bb, Tanori 71, Jori "S" x Crane "S" and Anhinga "S", the latter three being durum lines. Of this group, Tanori 71, Jupateco 73 and Cno-Inia x Bb performed well, and will be tested extensively in the 1974-75 All-India Trials.

Two separate Initial Evaluation Trials were conducted with triticales. One trial tested 21 strains, in the plains of India; whereas the second tested 18 strains; in the hills of north India.

In the plains test (on average) all triticale strains were inferior in yield to the wheat check Kalyansona, but some strains were comparable in yield to Sonalika. In the northern stations of Ludhiana and Guidaspur, however, yields from the best triticales were reported to be as much as 29 percent above Kalyansona. Leaf rust was noted on all but two of the triticale strains.

In the North Indian hills, trials were conducted in UP and Himachal Pradesh; and in the southern hills, at Wellington. Yields of such lines at TL22; TL17; TL21; PM112; JNK6T-059; and JNK6T-007 were superior to the check varieties Sonalika and Girija. In some cases, the yield differences were very appreciable. Trials will be continued in 1974-75.

India's coordinated program distributes a National Genetics Stock Nursery each year. In 1974, more than 325 entries were grown at 22 locations. The nursery is designed to include varieties having desirable plant characteristics, and disease resistance for use as genetic stocks for the different breeding centers. Varietal composition changes from year to year as new stocks are identified and old ones become less useful. The nursery provides a strong back up assistance to the breeders.

4.3.3 PATHOLOGY

Due to the dry weather and absence of winter rains, the level of rust infection was low throughout the country. Stripe rust occurred in only limited areas of Punjab and Himachal Pradesh. Leaf rust appeared late and was of no economic significance. Stem rust was not found in farm fields and could only be collected in experimental plots where artificial infections were created. Loose smut, Alternaria, Karnal bunt and other diseases were comparatively low in intensity. On the whole, the year could be classified as an almost disease-free year, except for a limited area of 2000 hectares in Southern Rajasthan where leaf and stem rust appeared in epidemic form. The widespread cultivation of Kalyansona and PV18 with near immunity to loose smut has reduced this disease to minor importance, although at one time it was considered the second most important in India.

The wheat disease surveillance and survey work has continued: 69 trap nurseries of 70 varieties were grown. Varieties included the principal commercial strains and those under pre-release consideration.

In addition, plant pathology screening nurseries of some 2000 varieties were grown at 11 locations. Race analysis work was continued at Simla and Mahableswar and 525 collections were analyzed. Races 21, 34, 117, 12, 77, 104, 162, 162-A, 19, 20, 20A and 3A were the most frequently encountered stem rusts.

All promising lines entered into trial were systematically evaluated for ear-cockle (tundu disease) and for resistance to stored grain pests. Considerable varietal differences were noted.

4.3.4 AGRONOMY

Agronomic trials with the newer strains of wheat were grown at 30 centers to establish optimum fertilizer levels, seed rate, depth of planting, row spacing and time of sowing. Experiments also were conducted to evaluate weedicides for control of wild oats and *Phalaris minor*. The relative performance of dwarf durums and dwarf aestivums was tested under both irrigation and rainfed conditions. Results indicate that the dwarf durums are not superior to the dwarf aestivums at all levels of water supply.

4.3.5 QUALITY

As in the past all strains of wheat and triticales were evaluated for quality characteristics.

4.3.6 SUMMARY COMMENTS

The high prices and shortages of fertilizers, and shortage of diesel and electric power plus lower than normal winter rainfall in the winter 1973-74 account for the second consecutive drop in wheat production in India. Although most farmers continued to use nitrogenous fertilizers, it was often at a lower level. Of greater significance, however, was the drop in use of the higher cost phosphatic fertilizers. The build up in the soil from earlier applications prevented this from being a serious constraint; however, in another year or at most two, a continuation of this situation will reduce production dramatically (and even though N is applied, its efficiency will be greatly reduced without the adequate phosphate).

T. 4.3A Varieties of bread and durum wheats recommendable for consideration as potential varieties in India, 1973-74

Name of Variety			Recommended for	Salient features
Original	Name	Parentage		
HD1982	Janak	E5557xHD845	Irr.in Eastern India	Res. to P. rec.
HD1981	Pratap	"	Rainfed in Western India	"
UP215	UP215	TzppxSon64	Irr.in Peninsular India	Res. to P.g.t.
HD1925	Shera	LR64AxSon64	Late sown conditions Central India	Res. to P.g.t.
MACS9 (durum)	MACS9	T.durumxT. polonicum	Rainfed durum areas Peninsular India	Good yield. Better resistance to P.g.t
HD4502 (durum)	Malavika	Pi"S"-BY^2 X Tc/Z-BxWells	Irr. conditions Peninsular India	High yield and R to P.g.t. and P. rec.
HD2009	Arjun	LR64xNa:60	Irr. conditions Northwest India	High yield R to P. g.t. P.rec and P.s.
Raj911	Raj911	V-0229 of CIMMYT	Irr. conditions Central India	High yield R to P. g.t. and P. rec.
HI385	Mukta	Hy633xNP842	Rainfed conditions Central India	Good yield and gr grain R to P.g.t.
HS1138-6-4	Shailaza	E4870xSonalika	Lower hills of U.P.	High res. to P.g.t. P.rec and P.s.
HS1097-17	Girija	E5165xE4717	Higher hills of North India	

4.4 Pakistan

4.4.1 INTRODUCTION

Final estimates showed that Pakistan's total wheat production fell short of the target of 8.5 million tons in 1973-74; however, yields per acre reached new record highs. Final estimates indicated a total production of 7.5 million tons, compared with 7.3 million tons in the previous year.

Dwarf wheat varieties (grown on 56 percent of the area) were estimated to have contributed 75 percent of the total production, producing nearly twice the yield of the traditional varieties.

Several factors account for Pakistan's failure to achive its target level. For example, heavy frosts occurred on seven consecutive nights during early February when the crop had entered the heading stage. Soon afterward, temperatures rose abruptly and remained high during the grain development stage. These two factors probably accounted for a 10-12 percent reduction, since frost damage was most severe on the early sown crop and high temperatures affected the late sown crop. It had been expected that the total area of wheat would increase to compensate for the 1973 summer floods which soaked the soil and destroyed some of the summer crops. Apparently, however, there was no increase, and any extra land sown to wheat was poorly prepared and heavily infested by weeds.

The problems caused by high temperatures in the wheat growing area occurs frequently.

Part of the problem is due to late harvest of paddy grown as a summer crop, but also because most of the sowing is done on preirrigated land, with heavy irrigation. The water is supplied to each farm in turn by a system of canals, thus the sowing period is extended from the last week of October to early January, as farmers wait for their next turn of canal water.

Preirrigation is used as a method of weed control, since presowing cultivation destroys a crop of weeds germinated by the preirrigation. However, current information suggests that excessive water use (both at sowing and throughout the season) has contributed to rising water tables and loss of N through leaching. Although the practice of dry planting followed by irrigation and planting after irrigation produce similar yields, the weed control effect may in the long run favour preirrigation. However preirrigation should be lighter than is currently applied, and better summer-winter wheat varieties should be developed for planting in the proper season.

4.4.2 MAIN OBJECTIVES AND SIZE OF BREEDING PROGRAMS

The wheat breeding program is conducted in each of the four Provinces. It is practically oriented and emphasizes:

1. Creation of new varieties with improved resistance, increased yields and hard white grain.

2. Production of varities suited to production under barani (rainfed) conditions utilizing spring x winter crosses and other sources of drought resistance.

3. Selection and test of multilines.

4. Production varieties adapted to the different planting seasons of the Punjab and diverse ecological regional situations of the North-Western Frontier Province, Sind, and Baluchistan.

The segregating materials originate from more than 7,000 crosses made in the breeding process. Materials from F1 to advanced lines comprise more than 18,000 entries. Numerous entries are maintained in the genetic stock and the crossing blocks, and more than 5,000 entries in the international trials are tested also --some in replicated yield trials.

4.4.3 FERTILIZATION

Fertilizer use is still quite low, but the estimated consumption improved slightly over the previous year. Table 4.4.A shows the use of N and P_2O_5 in 1972-73 and 1973-74.

The ratio of N to P_2O_5 showed an improvement from 9:1 to 6:1, but is still well below the recommended rate of 2:1. Research has shown that the 2:1 ratio provides the most efficient use of fertilizer under irrigation, and the 1:1 ratio provides best results on many rainfed locations. The figures indicate that use of N has decreased and P_2O_5 has increased but total nutrients per acre are still low at about 32 lbs combined N and P per acre (36.3 kgs/ha).

4.4.4 WHEAT IMPORTS

Pakistan was virtually self-sufficient in wheat production in 1968-69, when wheat imports dropped to 15,000 tons as compared with 1.5 million tons in the previous year. Since then, however, imports have increased, and about 1.2 million tons were imported in 1974.

4.4.5 PRESENT STATUS OF WHEAT PRODUCTION

The adoption of new technology in wheat production was sparked by the introduction of new varieties with improved genetic factors for rust resistance, adaptation and fertilizer respones. Large imports were made initially, but after these introduced varieties had passed through their normal life expectancy, a new generation of materials developed in Pakistan was ready for use. Some of these have been adopted widely; however, the lack of a seed production and seed certification system has prevented many of the products of the Pakistan program from reaching the farmer on a massive scale.

In late 1974 a World Bank Team surveyed Pakistan to determine the feasibility of providing loan money to develop a national seed production corporation. Such a facility is urgently needed, since the earlier releases (including such varieties as Mexipak 65, Chenab 70, Barani 70 and SA42 which are now widely grown) have become susceptible to new leaf rust races. The race known as 158 is increasing in prevalence each year, and such susceptibility poses a great danger to the country's wheat production. Not only are the older varieties now more susceptible, but the newer resistant varieties are not being multiplied fast enough to replace the older varieties on a commercial scale. For example, Pak 70 (a selection of Chenab 70) was intended for wide use in the Sind. From 1970-71 to 1972-73 this variety showed only traces of leaf rust. In 1973-74 the variety became moderately susceptible and its reaction can be expected to be susceptible very soon. Yet this variety is not yet grown extensively.

Table 4.4.B shows the reaction of the principal commercial varieties and newer releases to various diseases in the country. The new varieties Pari 73, Lyallpur 73 and Sandal indicate good resistance to the three rusts.

4.4.6 RELEASED AND PROPOSED VARIETIES

Six new varieties have recently been approved for growing by Pakistani farmers, including:

Pothwar = 114B-35xNad63 - a long duration variety with tolerance to stem rust when sown in October.

Lyallpur 73 = BbxNorteño I1 27100-307M-0Y-100a - resistant to all three rusts and suitable for November planting.

Sandal = (Cno "S" x Son 64-K1 Rend) Mexipak = Bb "S" - high quality, suitable for late November sowing with resistance to stripe and leaf and moderate resistance to stem rust.

Pari 73 = (Cno "S" x Son 64-K1 Rend) Mexipak II23584-303M-0Y-22-1a-1436 = Bb "S" - triple dwarf suitable for late November sowing with resistance to all rusts.

Pak 70 = Sel. of Chenab 70 - High yield, moderate susceptibility to stripe rust and resistant to stem rust.

Tarnab 73 = High yield and quality

Seed of these varieties has been multiplied by the respective Department farms and on the farms of some progressive farmers, but is not generally available as seed.

4.4.7 PROMISING NEW LINES

There are a number of promising lines carried by the Provincial Programs and tested under the National Microplot Trials. In the early stages of testing, a number of varieties

outyielded both Mexipak and Chenab 70. Some of these materials have been submitted to CIMMYT for international testing. The superior lines are:

Cno "S" x HD832 PK3567-1a-1a-0a resistant to rusts. Yield above Chenab.

TN15-Nor67 x Cno67 PK3580-1a-1a-0a - disease resistant,suitable for mid-season sowing.

Son 63-MpkxMpk Pk3296-1t-0t - high yield, disease resistant.

(Son64-Y50$_E$ x Gto/Inia) Bb "S" II30847-1M-0Y - high yield,disease resistant.

Dirk-Tj-558xMy64-Son64 PK1345-5t-3t-6t-0t - high yield, disease resistant.

NAI "S" 1980-Mpk PK 1900-52F-7F-0F - disease resistant.

7C-OnxInia "S" II28424-8Y-1M-1Y-0M - disease resistant.

Kt$_E$-Sk$^6{}_E$ x My54$_E$-An63$^3{}_E$ PK 2268-3F-3F-1F-0F - disease resistant.

6009 (Ly-65-66)-Tarnab 69 PK3706-8K-1F-0F - disease resistant.

6134-C271 PK1041-3F-2K-1F-1F-1F-1F - disease resistant.

4.4.8 PLANT PATHOLOGY

In Sind, rust development was restricted by the dry cool weather of the early season. Leaf rust on Mexipak and Pak 70 averaged about 10 percent, but readings as high as 90 percent were obtained. Stem rust failed to develop.

In Baluchistan, rusts did not develop, but bunt averaged about 10 percent in upland areas; in some fields infections of up to 70 percent were recorded.

In the NWFP, stripe rust appeared late and reached only about 10 percent infection; except in isolated areas where some lines ere severely damaged. Leaf rust was widespread, reaching about 50 percent average on susceptible varieties --Tarnab 73 and Khushal 69 were severely affected. Stem rust developed late, and then only on older varieties. Loose smut was recorded in traces.

In Kashmir, stripe rust developed in only trace amounts; but leaf rust reached an average of 20 percent, and stem rust averaged 30 percent. A few fields were severely damaged. Loose smut was widespread and caused up to 40 percent loss on local varieties.

In Punjab, stripe rust was essentially absent but leaf rust was widespread. All commercial varieties (including Mexipak, Chenab 70, Barani 70 and SA42) were infected at an average level of 20 percent. The new varieties Lyallpur 73, Pari 73 and Sandal remained free of rust, while Pothwar 73 was susceptible. Stem rust appeared late and was found only on the traditional tall varieties. Flag smut incidence rose and averaged 10 percent infection in the northern Punjab; it was especially high on Barani 70. Traces of loose smut and ear cockle were observed in Multar on SA42. Leaf miner (insect)and ear-cockle occurred in traces in Khanpur.

Among the rusts races 11, 15, 15B, 21, 34, 40 and 117 of stem rust were isolated. Common bunt collected from local white of Quetta and Chenab 70 from Rawalpindi were caused by races L-8 and L-9 respectively. Races 2 and 10 of loose smut were isolated.

From a total of 748 advanced lines received from the breeders at five centers, 266 lines were found to be resistant to both leaf and stem rust in seedling tests. Of 1702 varieties and lines screened for common bunt at Quetta, 369 varieties proved resistant, including 25 varieties that have remained resistant for five years at different locations. These form a good base of germplasm for breeding. Some 1954 varieties were screened for Karnal or partial bunt. Of these 205 were resistant, including 41 varieties which have been resistant for four years at various locations. A total of 608 varieties were tested for loose smut, and 311 appeared resistant. Tests for flag smut were made on 1653 varieties and lines, and 284 were found to be resistant.

A National Wheat Disease Screening Nursery (1712 varieties and lines entered by the breeders) were tested at six centers throughout the country to evaluate reaction to different diseases. Of these, 30 lines were resistant to all three rusts, common bunt, partial bunt and flag smut at all six locations. These are shown in Table 4.4.C.

A National Trap Nursery also was grown at the same six locations mentioned above, including twenty-five entries from the commercial lines and promising varieties of the country. Leaf rust developed at four of the centers and other diseases were not recorded.

4.4.9 KAGHAN SUMMER NURSERY

In the summer of 1974, an excellent summer nursery was grown at Kaghan. Rust innoculations were made; however, early varieties escaped due to slow development, whereas late varieties were fully infected. Both stripe and stem rust developed. This nursery provides an opportunity to speed the advance of the breeding generations. The NWFP Wheat Program was responsible for having land ready for timely sowing and for providing facilities for harvesting and threshing.

The Pakistan Wheat Programs, although operating independently within the States, conduct joint testing of materials and it is expected that it soon will be re-organized into a National Coordinated Program under the Agricultural Research Council. Program assistance is provided by USAID, Ford Foundation-CIMMYT, FAO and other international organizations.

TABLE 4.4.A.- Fertilizer use during the wheat season October-February 1973-74 in nutrient tons.

Year	Nitrogenous	Phosphatic	Total	N:P Ratio
1972-73	133,752	14,646	148,398	9:1
1973-74	128,037	21,940	149,977	6:1

TABLE 4.4.B.- Disease Reaction of the most important commercial wheat varieties and latest released varieties in Pakistan.

Name of Variety	Stripe Rust	Leaf Rust	Stem Rust	Common Bunt	Partial Bunt	Loose Smut	Flag Smut
Mexipak	MS	S	S	R	S	MR	S
Pak 70	MR	MS	R	R	S	S	S
Chenab 70	MS	S	R	S	S	S	S
Barani 70	MS	S	R	S	S	MS	S
SA 42	R	MS	R	S	S	S	S
Khushal 69	MS	S	S	S	S	--	S
Tarnab 73	MS	S	R	-	S	--	S
Pothwar 73	S	MS-S	S	R	S	--	S
Pari 73	R	R	R	S	S	S	S
Lyallpur 73	R	R	R	S	S	--	R
Sandal	R	R	MR	S	S	--	S
Blue Silver	R	MR	R	S	(1)	MS	S

TABLE 4.4.C.-

A list of the lines showing resistance to the three rusts, common bunt, partial bunt and flag smut at six locations in Pakistan 1973-74. Data from the National Disease Screening Nursery.

NDSN No.	Parentage or Pedigree	Source
450	Sonalika x (Son64-Y50$_E$xGto/Inia) II-30465-5T-1T-1T	Tandojam
744	Bluxinia II-26591-11-7M-0R	"
752	PJ62	"
768	Chris	"
818	Nor67-7C II-30367-1M-1Y-3M-0Y	"
842	L176/3048	"
808	Nr"S"-Ben CM4023-1Y-0M	"
916	Yr-No66CM4027-1Y-9M-0Y	"
918	Bb-CnoxSuwon-Bb CM5567-A-1Y-4M-0Y	"
922	Sel.of Stellenbosch x Bb CM-34185-1Y-1M-0Y	"
930	Sonalika x Bb"S" 30262-300M	"
953	Tzpp	"
980	Bb"S" (23584-160M-103Y-300Y)x Kl. Rend-Son64^2 /Inia II-23761-4M-5Y-1M-1Y-PK 3294-3t-1t	"
1085	Y54$_E$-TzppxTob-Cno CM5928-10Y-4M-0Y	"
622	NE 701132	Quetta
624	Hillifen	"
629	Centurk	"
194	(Meng-8156(R)/Tob-CfnxBb) Bb CM6531-1B	Bahawalpur
195	(Pato/Son64-PurdxCno-INIA) Yr"S" CM6830-6B	"
676	Bb"S"-Blue Silver PK 6141-1A-3A-(4A)	Lyallpur
708	289599	USDA (ISWRN 73)
719	Justin-Fortuna	"
720	Rye - 168182	ISWRN-73
722	Gator-Rc-1-17	"
724	Kalif - 326408	"
729	Rulofen/4 Frocor/Kenya/2/Newthatch /3/Norin-10/Brevor 2T	"
731	Frocor/3/McM/Kt/2/Y52x2/4 (4777 Front /2/K58/N/3/Nor/Brev)	"
736	Arabian/Sernal/Carch/4/2* Yt54/2/ Nor10-21-1C-3/Sin-A-2/Brevor	"
737	Alifen CH 3268-5P-3P-1P	"
738	Egypt 3728/2/3 Capelli/Giza CB3308-2p-1p-1pA/Capelli/Langdor dwarf (F4/Langdor) A3388-201P-3p-1p	"

5.0 Related Wheat Improvement Information

BULLETINS

Epidemiology of wheat rusts in the western hemisphere. S. Rajaram, A. Campos, 1974 (RB 27).

Hybrid wheats: Their development and food potential. R. Rodríguez, M.A. Quiñones, N.E. Borlaug and I. Narváez, 1967 (RB 3).

A survey on stem rust resistance in the USDA world durum collection and in CIMMYT durum breeding lines. S. Rajaram, B. Devecioglu, N.E. Borlaug, K.W. Finlay, G. Varughese and E. Rodríguez, 1970 (RB 14).

Proceedings of the first wheat workshop, 1971.

Proceedings wheat, triticale and barley seminar, 1973.

India's high yielding varieties programme in wheat 1966-67 to 1971-72. V.S. Vyas, 1975.

Adoption of new bread technology in Turkey. N. Demir, 1976.

Triticale breeding and research at CIMMYT. F.J. Zillinsky, 1973 (RB 24).

BIBLIOGRAPHIES (AVAILABLE TO LIBRARIES ONLY)

Bibliography of wheat, Vol. I, II, III, 1971.

NURSERIES

Near east american spring wheat yield nursery 3rd, 1963-65 (RB 5)

International bread wheat screening nursery 3rd, 1969-70 (RB 22); 4th and 5th, 1970-72 (IB 17).

First and second elite selection yield trial; 1969-70 (IB 4).

International spring wheat yield nursery: 1st, 1964-65 (RB 8); 3rd, 1966-67 (RB 15); 4th, 1967-68 (RB 18); 5th, 1968-69 (RB 19); 6th, 1969-70 (RB 23); 7th, 1970-71 (RB 25); 8th, 1971-72 (IB 14); 9th, 1972-73 (IB 16); 10th, 1973-74 (IB 23).

International durum yield nursery: 1st, 1969-70 (IB 2); 2nd and 3rd, 1970-71 and 1971-72 (IB 15); 4th, 1972-73 (IB 19); 5th, 1973-74 (IB 21).

International triticale yield nursery: 1st, 1969-70 (IB 1); 2nd and 3rd, 1970-71 and 1971-72 (IB 10); 4th, 1972-73 (IB 20); 5th, 1973-74 (IB 24).

International durum screening nursery: 1st to 5th, 1969-74 (IB 18); 6th, 1974-75 (IB 26).

Elite durum yield trials 1st to 4th, 1971-74 (IB 22).

TRANSLATIONS AND REPRINTS

The green revolution peace and humanity. N.E. Borlaug, 1972.

A green revolution yields a golden harvest. N.E. Borlaug, I. Narváez, O. Aresvik and R.G. Anderson, 1969.

Potential for improving production efficiency of cereals. R.G. Anderson, 1975.

Wheat breeding and its impact on world food supply. N.E. Borlaug, 1968.

Genetic improvement of cereal grains. N.E. Borlaug, 1972.

Mankind and civilization at another crossroad. N.E. Borlaug, 1971.

Progress toward novel cereal grains. L.S. Bates, A. Campos V., R. Rodríguez and R.G. Anderson, 1974.

Statement on agricultural chemicals by Dr. N.E. Borlaug, 1972.

International agriculture's progress-everyone's responsibility. N.E. Borlaug, 1973.

Shaping the future. N.E. Borlaug, 1971.

Evaluation of the CIMMYT wheat training program. Burt Swanson, 1975.

OTHER PUBLICATIONS

Durum wheat: New age for an old crop. Steven A. Breth, 1975.

Wheat x rye = triticale. Anthony Wolff, 1976.

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